

資料-6-3 土質調査結果

(1) ボーリング調査

(ボーリングデータのみ抜粋)

DRAFT FINAL REPORT
ON
GEOLOGICAL SURVEY
FOR
THE PREPARATORY SURVEY
ON
THE PROJECT FOR IMPROVEMENT OF WATER SUPPLY
SYSTEM IN BIRATNAGAR
AT
EXISTING DEVKOTA CHOWK PUMP STATION



CLIENT
NEPAL WATER SUPPLY CORPOTON (NWSC)
Kathmandu, Nepal
CONSULTANT
YACHIYO ENGINEERING CO., LTD.
Tokyo, Japan

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JULY, 2020

PLANET TEST

Draft Final Report on Geological Survey for the preparatory Survey on the Project for Improvement of Water Supply System in Biratnagar AT EXITING DEVKOTA CHOWK PUMP STATION SITE

PLANET TEST

3. FIELD INVESTIGATION AND LABORATORY TESTING

3.1 Field Investigation

Our field investigation within the project site started from March 16th 2020 which included a geotechnical reconnaissance of the site and surrounding area, and the drilling, sampling, and logging of three 76mm diameter exploratory test borings of upto 50m depth.

The approximate locations of our test borings are indicated on the Boring Location Map (Figure 1). The borings were advanced using single Rotary Rig with NX size barrel.



Figure 1 : Boring Location Map

3.1.1 Number and Depth of Boreholes

3.1.1.1 General

The number and disposition of the borings was done to reveal any major changes in thickness, depth or properties of the strata to be affected by the expected works and immediate surroundings.

Exploration, in general, was carried out to a depth up to which the increase in pressure due to structural loading is likely to cause perceptible settlement or shear failure. Such a depth, known as the significant depth, depends upon the type of structure, its weight, size, shape and disposition of the loaded areas, and the soil profile and its properties. It is generally safe to assume the significant depth up to a level at which the net increase in vertical pressure becomes less than 10% of the



BORE HOLE LOG

Project : Improvement of Water Supply System in Biratnagar
 Client : Nepal Water Supply Corporation (NWSC)
 Consultant : Yachiyo Engineering Co. Ltd.
 Location : Biratnagar Metropolitan City-12, Devkota Chowk, Morang

Borehole No.-1
 Logged By:-Hem Rana
 Prepared By:-Sushant Giri
 Co-ordinate: 528805.683 E, 2926821.592 N & R.L. from MSL=70.04m
 Start Date: 2020-03-16
 Completion Date:2020-03-17

Scale	Thickness	Symbol	Classification	SOIL DESCRIPTION	Water Table	Depth	SPT/DCP at	No. of Blows			Total SPT/DCP Value	SPT/DCPT	Scale
								15	15	15			
0													
1	1.0			Loose to medium dense light brownish grey clay with sand.	WT=3.0	1.0	SPT-1	4	5	5	10	10	1
2	2.0					2.0	SPT-2	4	6	7	13	13	2
3	3.0					3.0	SPT-3	3	5	6	11	11	3
4	8.0					4.0	UDS					4	
5						5.0	SPT-5	4	5	9	14	5	
6						6.0	SPT-6	4	10	8	18	6	
7						7.0	SPT-7	6	11	10	21	7	
8						8.0	SPT-8	7	6	13	16	8	
9						9.0	SPT-9	10	13	12	25	9	
10						10.0	SPT-10	9	10	13	23	10	
11						11.0	SPT-11	21	31	198	>50	11	
12	7.0			Medium dense to very dense dark grey sand.		12.0	SPT-12	33	50/10	>50	>50	12	
13						13.0	SPT-13	23	50	>50	>50	13	
14						14.0	SPT-14	28	34	50/3	>50	14	
15						15.0	SPT-15	26	50/11	>50	>50	15	



BORE HOLE LOG

Project : Improvement of Water Supply System in Biratnagar
 Client : Nepal Water Supply Corporation (NWSC)
 Consultant : Yachiyo Engineering Co. Ltd.
 Location : Biratnagar Metropolitan City-12, Devkota Chowk, Morang

Borehole No.-2
 Logged By:-Hem Rana
 Prepared By:-Sushant Giri
 Co-ordinate: 528805.063 E, 2926846.622 N & R.L. from MSL=70.21m
 Start Date: 2020-03-18
 Completion Date:2020-03-19

Scale	Thickness	Symbol	Classification	SOIL DESCRIPTION	Water Table	Depth	SPT/DCP at	No. of Blows			Total SPT/DCP Value	SPT/DCPT	Scale
								15	15	15			
0													
1	1.0			Loose light brownish silty sand with clay.	WT=3.0	1.0	SPT-1	3	5	3	8	8	1
2	2.0					2.0	SPT-2	4	4	8	12	12	2
3	3.0					3.0	SPT-3	6	8	6	14	14	3
4						4.0	UDS					4	
5						5.0	SPT-5	9	10	9	19	5	
6						6.0	SPT-6	7	10	15	25	6	
7	7.0			Medium dense light brown clay.		7.0	SPT-7	9	11	11	22	7	
8						8.0	SPT-8	6	7	8	15	8	
9						9.0	SPT-9	7	8	7	15	9	
10						10.0	SPT-10	5	8	11	19	10	
11						11.0	SPT-11	11	10	21	39	11	
12				Dense to very dense drak grey sand.		12.0	SPT-12	25	29	21/9	>50	12	
13	5.0					13.0	SPT-13	21	24	26/13	>50	13	
14						14.0	SPT-14	14	21	24	45	14	
15						15.0	SPT-15	18	20	30	50	15	

DRAFT FINAL REPORT
ON
GEOLOGICAL SURVEY
FOR
THE PREPARATORY SURVEY
ON
THE PROJECT FOR IMPROVEMENT OF WATER SUPPLY
SYSTEM IN BIRATNAGAR
AT
EXISTING TINPAINI PUMP STATION SITE



CLIENT
NEPAL WATER SUPPLY CORPORATION (NWSC)
 Kathmandu, Nepal

CONSULTANT
YACHIYO ENGINEERING CO., LTD.
 Tokyo, Japan



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AUG. 2020

PLANET TEST

Draft Final Report on Geological Survey for the preparatory Survey on the Project for Improvement of Water Supply System in Biratnagar AT EXISTING TINPAINI PUMP STATION SITE

PLANET TEST

3. FIELD INVESTIGATION AND LABORATORY TESTING

3.1 Field Investigation

Our field investigation within the project site started from March 16th 2020 which included a geotechnical reconnaissance of the site and surrounding area, and the drilling, sampling, and logging of three 76mm diameter exploratory test borings of upto 50m depth.

The approximate locations of our test borings are indicated on the Boring Location Map (Figure 1). The borings were advanced using single Rotary Rig with NX size barrel.



Figure 1 : Boring Location Map

3.1.1 Number and Depth of Boreholes

3.1.1.1 General

The number and disposition of the borings was done to reveal any major changes in thickness, depth or properties of the strata to be affected by the expected works and immediate surroundings.

Exploration, in general, was carried out to a depth up to which the increase in pressure due to structural loading is likely to cause perceptible settlement or shear failure. Such a depth, known as the significant depth, depends upon the type of structure, its weight, size, shape and disposition of the loaded areas, and the soil profile and its properties. It is generally safe to assume the significant depth up to a level at which the net increase in vertical pressure becomes less than 10% of the initial overburden pressure. Alternatively, a pressure bulb bounded by an isobar of one-fifth or one-tenth of the surface



BORE HOLE LOG

Project : Improvement of Water Supply System in Biratnagar
Client : Nepal Water Supply Corporation (NWSC)
Consultant : Yachiyo Engineering Co. Ltd.
Location : Biratnagar Metropolitan City-2, Tinpaini, Morang

Borehole No.-1
Total Depth:-15 m
Logged By:-Hem Rana
Prepared By:-Sushant Giri
Co-ordinate: 528669.577 E, 2928669.503 N, R.L from MSL=72.804 m
Start Date: 2020-03-16
Checked By:- Diwakar Khadka
Completion Date: 2020-03-17

Scale	Thickness	Symbol	Classification	SOIL DESCRIPTION	Water Table	Depth	SPT/DCP at	No. of Blows			Total SPT/DCP Value	Scale
								Per 15 cm	15	15		
0												
1	2.0			Loose brownish sandy silt with traces of clay.		1.0	SPT-1	1	3	5	8	
2						2.0	SPT-2	2	4	5	9	
3						3.0	UDS					
4						4.0	SPT-4	3	4	7	11	
5						5.0	SPT-5	4	6	7	13	
6	8.0			Loose medium dense to dense light grey silty clay.		6.0	SPT-6	4	5	7	12	
7						7.0	SPT-7	5	5	9	14	
8						8.0	SPT-8	7	9	10	19	
9						9.0	SPT-9	10	8	13	21	
10						10.0	SPT-10	13	21	29	50	
11						11.0	SPT-11	15	25	20	45	
12						12.0	SPT-12	25	32	18/7	>50	
13	5.0			Very dense light brownish sandy silt.		13.0	SPT-13	23	40	10/4	>50	
14						14.0	SPT-14	34	47	3/1	>50	
15						15.0	SPT-15	30	150/12		>50	



BORE HOLE LOG

Project : Improvement of Water Supply System in Biratnagar
Client : Nepal Water Supply Corporation (NWSC)
Consultant : Yachiyo Engineering Co. Ltd.
Location : Biratnagar Metropolitan City-2, Tinpaini, Morang

Borehole No.-2
Total Depth:-15 m
Logged By:-Hem Rana
Prepared By:-Sushant Giri
Co-ordinate: 528652.711 E, 2928657.956 N, R.L from MSL=73.053 m
Start Date: 2020-03-18
Checked By:- Diwakar Khadka
Completion Date: 2020-03-19

Scale	Thickness	Symbol	Classification	SOIL DESCRIPTION	Water Table	Depth	SPT/DCP at	No. of Blows			Total SPT/DCP Value	Scale
								Per 15 cm	15	15		
0												
1						1.0	SPT-1	4	4	6	10	
2						2.0	SPT-2	2	4	5	9	
3						3.0	UDS					
4						4.0	SPT-4	2	2	3	5	
5	9.0			Loose to medium dense dark grey silty clay.		5.0	SPT-5	3	4	4	8	
6						6.0	SPT-6	4	8	10	18	
7						7.0	SPT-7	5	6	11	17	
8						8.0	SPT-8	4	4	7	11	
9						9.0	SPT-9	5	7	10	17	
10						10.0	SPT-10	10	18	25	43	
11						11.0	SPT-11	12	21	28	49	
12						12.0	SPT-12	37	50/13		>50	
13						13.0	SPT-13	40	50/10		>50	
14	2.0			Very dense grey fine sand.		14.0	SPT-14	30	50		>50	
15						15.0	SPT-15	35	50/10		>50	

FINAL REPORT
ON
GEOLOGICAL SURVEY
FOR
THE PREPARATORY SURVEY
ON
THE PROJECT FOR IMPROVEMENT OF WATER SUPPLY
SYSTEM IN BIRATNAGAR
AT
EXISTING MUNALPATH PUMP STATION



CLIENT
NEPAL WATER SUPPLY CORPORTION (NWSC)
 Kathmandu, Nepal

CONSULTANT
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 Tokyo, Japan



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JUNE, 2020

PLANET TEST

Final Report on Geological Survey for the preparatory Survey on the Project for Improvement of Water Supply System in Biratnagar AT EXISTING MUNALPATH PUMP STATION SITE

PLANET TEST

3. FIELD INVESTIGATION AND LABORATORY TESTING

3.1 Field Investigation

Our field investigation within the project site started from March 5th 2020 which included a geotechnical reconnaissance of the site and surrounding area, and the drilling, sampling, and logging of three 76mm diameter exploratory test borings of upto 50m depth.

The approximate locations of our test borings are indicated on the Boring Location Map (Figure 1). The borings were advanced using single Rotary Rig with NX size barrel.



Figure 1 : Boring Location Map

3.1.1 Number and Depth of Boreholes

3.1.1.1 General

The number and disposition of the borings was done to reveal any major changes in thickness, depth or properties of the strata to be affected by the expected works and immediate surroundings.

Exploration, in general, was carried out to a depth up to which the increase in pressure due to structural loading is likely to cause perceptible settlement or shear failure. Such a depth, known as the significant depth, depends upon the type of structure, its weight, size, shape and disposition of the loaded areas, and the soil profile and its properties. It is generally safe



BORE HOLE LOG

Project : Improvement of Water Supply System in Biratnagar
Client : Nepal Water Supply Corporation (NWSC)
Consultant : Yachiyo Engineering Co. Ltd.
Location : Biratnagar Metropolitan City-8, Munaipath, Morang

Borehole No.-1
Logged By:-Hem Rana
Total Depth:-15 m
Prepared By:-Sushant Giri
Co-ordinate: 527911.813 E, 2928343.907 N, RL from MSL =71.558m
Start Date: 2020-03-15
Completion Date:2020-03-16

Scale	Thickness	Symbol	Classification	SOIL DESCRIPTION	Water Table	Depth	SPT/DCP at	No. of Blows			Total SPT/DCP Value	SPT/DCPT	Scale
								Per 15 cm	15	15			
0													
1	3.0			Medium dense light brownish to grey silty sand.		1.0	SPT-1	2	5	7	12		
2						2.0	SPT-2	2	5	6	11		
3						3.0	SPT-3	3	6	7	13		
4	2.0			Medium dense light brownish to dark grey clayey silt.	WT=4.0	4.0	SPT-4	6	6	9	15		
5						5.0	UDS						
6	2.0			Medium dense dark grey clayey silt.		6.0	SPT-6	7	8	10	18		
7						7.0	UDS						
8						8.0	SPT-8	9	10	20	30		
9						9.0	SPT-9	11	15	25	40		
10						10.0	SPT-10	12	25	25/10	>50		
11	8.0			Dense to very dense dark grey fine sand.		11.0	SPT-11	23	30	208	>50		
12						12.0	SPT-12	25	50		>50		
13						13.0	SPT-13	27	50/12		>50		
14						14.0	SPT-14	30	40	102	>50		
15						15.0	SPT-15	30	50/13		>50		

BORE HOLE LOG

Project : Improvement of Water Supply System in Biratnagar
Client : Nepal Water Supply Corporation (NWSC)
Consultant : Yachiyo Engineering Co. Ltd.
Location : Biratnagar Metropolitan City-8, Munaipath, Morang

Borehole No.-2
Logged By:-Hem Rana
Total Depth:-15 m
Prepared By:-Sushant Giri
Co-ordinate: 527927.375 E, 2928324.447 N, RL from MSL =71.375m
Start Date: 2020-03-16
Completion Date:2020-03-17

Scale	Depth	Thickness	Symbol	Classification	SOIL DESCRIPTION	Water Table	Depth	SPT/DCP at	No. of Blows			Total SPT/DCP Value	SPT/DCPT	Scale
									Per 15 cm	15	15			
0														
1	1.0	1.0			Medium dense light brownish silty sand.		1.0	SPT-1	2	5	8	13		
2		2.0			Medium dense light reddish to silty Sand.		2.0	SPT-2	4	6	5	11		
3	3.0						3.0	SPT-3	4	5	8	13		
4					Medium dense light grey clayey silt.	WT=4.0	4.0	UDS						
5		3.0					5.0	SPT-5	10	14	15	29		
6		6.0					6.0	SPT-6	7	10	15	25		
7							7.0	SPT-7	4	5	7	12		
8							8.0	SPT-8	3	3	6			
9							9.0	SPT-9	10	15	25	40		
10							10.0	SPT-10	23	30	20/10	>50		
11							11.0	SPT-11	25	25	25/7	>50		
12		6.0			Loose dense to very dense light brownish grey sand with traces of silt.		12.0	SPT-12	14	20	25	45		
13							13.0	SPT-13	10	11	12	23		
14							14.0	SPT-14	12	15	20	35		
15		15					15.0	SPT-15	13	14	17	31		

FINAL REPORT
ON
GEOLOGICAL SURVEY
FOR
THE PREPARATORY SURVEY
ON
THE PROJECT FOR IMPROVEMENT OF WATER SUPPLY
SYSTEM IN BIRATNAGAR
FOR NEW CANDIDATE NO.5 PUMP STATION SITE



CLIENT
NEPAL WATER SUPPLY CORPORATION (NWSC)
 Kathmandu, Nepal
CONSULTANT
YACHIYO ENGINEERING CO., LTD.
 Tokyo, Japan

Prepared and Submitted By:



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SEPTEMBER,
 2020

PLANET TEST

3. FIELD INVESTIGATION AND LABORATORY TESTING

3.1 Field Investigation

Our field investigation within the project site started from March 12th 2020 which included a geotechnical reconnaissance of the site and surrounding area, and the drilling, sampling, and logging of three 76mm diameter exploratory test borings of upto 21m depth.

The approximate locations of our test borings are indicated on the Boring Location Map (Figure 1). The borings were advanced using 2 different Rotary Rig with NX size barrel.



Figure 1 : Boring Location Map

3.1.1 Number and Depth of Boreholes

3.1.1.1 General

The number and disposition of the borings was done to reveal any major changes in thickness, depth or properties of the strata to be affected by the expected works and immediate surroundings.

Exploration, in general, was carried out to a depth up to which the increase in pressure due to structural loading is likely to cause perceptible settlement or shear failure. Such a depth, known as the significant depth, depends upon the type of structure, its weight, size, shape and disposition of the loaded areas, and the soil profile and its properties. It is generally safe to assume the significant depth up to a level at which the net increase in vertical pressure becomes less than 10% of the initial overburden pressure. Alternatively, a pressure bulb bounded by an isobar of one-fifth or one-tenth of the surface



BORE HOLE LOG

Project : Improvement of Water Supply System in Biratnagar
Client : Nepal Water Supply Corporation (NWSC)
Consultant : Yachiyo Engineering Co. Ltd.
Location : Biratnagar Metropolitan City-5, Kularba, Morang

Borehole No:-1

Logged By:-Hem Rana
Prepared By:-Sushant Giri
Co-ordinate: 525674.736 E, 2928768.822 N, RL= 70.246 m
Start Date: 2020-03-12
Checked By:- Diwakar Khaadka
Completion Date:2020-03-13

Scale	Depth	Thickness	Symbol	Classification	SOIL DESCRIPTION	Water Table	No. of Blows			SPT/DCPT at	Total SPT/DCPT Value	SPT/DCPT	Scale
							15	15	15				
0													
1	1.0	1.0		m	Light brownish SILT.		SPT-1	2	5	5	10		
2	2.0	2.0		m	Loose to medium dense light brownish silty sand		SPT-2	3	4	3	7		
3	3.0			m			SPT-3	4	8	11	19		
4				m			SPT-4	5	7	9	16		
5		5.0		m	Medium dense brownish to grey silty sand	WT=4.7	SPT-5	6	11	13	24		
6				m			SPT-6	4	6	6	12		
7				m			SPT-7	4	11	14	25		
8	8.0			m			SPT-8	5	10	16	26		
9				m			SPT-9	9	14	14	28		
10		3.0		m	Medium dense to dense greyish fine to coarse sand with trace of pebbles.		SPT-10	12	17	20	37		
11	11.0			m			SPT-11	9	15	16	31		
12				m			SPT-12	23	43	72	>50		
13		4.0		m	Very dense dark greyish fine to coarse sand		SPT-13	25	40	10/3	>50		
14				m			SPT-14	26	35	15/3	>50		
15	15			m			SPT-15	25	45	5/2	>50		



BORE HOLE LOG

Project : Improvement of Water Supply System in Biratnagar
Client : Nepal Water Supply Corporation (NWSC)
Consultant : Yachiyo Engineering Co. Ltd.
Location : Biratnagar Metropolitan City-5, Kularba, Morang

Borehole No:-2

Logged By:-Hem Rana
Prepared By:-Sushant Giri
Co-ordinate: 525670.428 E, 2928745.105 N, RL= 70.225 m
Start Date: 2020-03-13
Checked By:- Diwakar Khaadka
Completion Date:2020-03-14

Scale	Depth	Thickness	Symbol	Classification	SOIL DESCRIPTION	Water Table	No. of Blows			SPT/DCPT at	Total SPT/DCPT Value	SPT/DCPT	Scale
							15	15	15				
0													
1				m			SPT-1	2	3	3	6		
2				m			SPT-2	5	8	10	18		
3				m			SPT-3	4	6	8	14		
4	7.0			m	Medium dense brown sandy SILT.		SPT-4	4	6	6	12		
5				m			SPT-5	4	8	10	18		
6				m			SPT-6	7	9	9	19		
7	7.0			m			SPT-7	2	6	7	13		
8				m			SPT-8	9	13	13	26		
9				m			SPT-9	7	10	14	24		
10				m			SPT-10	8	11	12	23		
11		8.0		m	Medium dense to very dense dark grey fine to coarse sand with traces of pebbles.		SPT-11	10	13	14	27		
12				m			SPT-12	23	24	26/12	>50		
13				m			SPT-13	25	35	15/7	>50		
14				m			SPT-14	27	40	10/3	>50		
15	15			m			SPT-15	23	36	14/5	>50		



BORE HOLE LOG

Project : Improvement of Water Supply System in Biratnagar
Client : Nepal Water Supply Corporation (NWSC)
Consultant : Yachiyo Engineering Co. Ltd.
Location : Biratnagar Metropolitan City-5, Kularba, Morang

Borehole No.:3
Logged By:-Hem Rana
Total Depth:-21 m
Prepared By:-Sushant Giri
Co-ordinate: 525648.008 E, 2928752.459 N, RL= 70.069 m
Start Date: 2020-03-08
Checked By:- Diwakar Khadka
Completion Date:2020-03-13

Scale	Depth	Thickness	Symbol	Classification	SOIL DESCRIPTION	Water Table	SPT/DCP at	No. of Blows			Total SPT/DCP Value	SPT/DCPT	Scale
								Per 15 cm	15	15			
0								15	15	15			
1							SPT-1	3	5	7	12		
2	4.0	4.0			Loose to medium light reddish to brownish silty fine Sand.		SPT-2	4	6	7	13		
3							SPT-3	UDS					
4	4.0	4.0					SPT-4	8	11	9	20		
5							SPT-5	6	9	8	17		
6							SPT-6	7	10	9	19		
7							SPT-7	6	9	11	20		
8							SPT-8	11	9	16	25		
9					Medium dense to dense light brownish silty sand.		SPT-9	8	21	24	45		
10	10.0	6.0					SPT-10	14	20	28	48		
11							SPT-11	20	29	21/12	>50		
12							SPT-12	16	24	26/10	>50		
13					Very dense dark grey sand with traces of silt.		SPT-13	16	31	19/9	>50		
14							SPT-14	24	28	22/8	>50		
15	15.0	11.0					SPT-15	21	33	18/9	>50		



BORE HOLE LOG

Project : Improvement of Water Supply System in Biratnagar
Client : Nepal Water Supply Corporation (NWSC)
Consultant : Yachiyo Engineering Co. Ltd.
Location : Biratnagar Metropolitan City-5, Kularba, Morang

Borehole No.:3
Logged By:-Hem Rana
Total Depth:-21 m
Prepared By:-Sushant Giri
Co-ordinate: 525648.008 E, 2928752.459 N, RL= 70.069 m
Start Date: 2020-03-08
Checked By:- Diwakar Khadka
Completion Date:2020-03-13

Scale	Depth	Thickness	Symbol	Classification	SOIL DESCRIPTION	Water Table	SPT/DCP at	No. of Blows			Total SPT/DCP Value	SPT/DCPT	Scale
								Per 15 cm	15	15			
15	15							15	15	15			
16							SPT-16	34	50		>50		
17							SPT-17	35	50		>50		
18					Very dense dark grey sand with traces of silt.		SPT-18	26	50/12		>50		
19							SPT-19	25	36	14/5	>50		
20							SPT-20	26	28	22	>50		
21	21.0	11.0					SPT-21	20	32	16/2	>50		

FINAL REPORT
ON
GEOLOGICAL SURVEY
FOR
THE PREPARATORY SURVEY
ON
THE PROJECT FOR IMPROVEMENT OF WATER SUPPLY
SYSTEM IN BIRATNAGAR
AT
NEW CANDIDATE KANCHANBARI PUMP STATION



CLIENT
NEPAL WATER SUPPLY CORPORATION (NWSC)
 Kathmandu, Nepal

CONSULTANT
YACHIO ENGINEERING CO., LTD.
 Tokyo, Japan

Prepared and Submitted By:



PLANET TEST (P.) LTD.
 KMC-31, Shantinagar, Kathmandu
 Telephone: 977-1-4107665
 E- mail: planettest2074@gmail.com/info@planettest.com.np

SEP, 2020

PLANET TEST

3. FIELD INVESTIGATION AND LABORATORY TESTING

3.1 Field Investigation

Our field investigation within the project site started from March 5th 2020 which included a geotechnical reconnaissance of the site and surrounding area, and the drilling, sampling, and logging of three 76mm diameter exploratory test borings of upto 50m depth.

The approximate locations of our test borings are indicated on the Boring Location Map (Figure 1). The borings were advanced using 2 different Rotary Rig with NX size barrel.



Figure 1 : Boring Location Map

3.1.1 Number and Depth of Boreholes

3.1.1.1 General

The number and disposition of the borings was done to reveal any major changes in thickness, depth or properties of the strata to be affected by the expected works and immediate surroundings.

Exploration, in general, was carried out to a depth up to which the increase in pressure due to structural loading is likely to cause perceptible settlement or shear failure. Such a depth, known as the significant depth, depends upon the type of structure, its weight, size, shape and disposition of the loaded areas, and the soil profile and its properties. It is generally safe to assume the significant depth up to a level at which the net increase in vertical pressure becomes less than 10% of the



PLANET TEST (P.) LTD
KMC-31, Shantinagar, Kathmandu

BORE HOLE LOG

Project : Improvement of Water Supply System in Biratnagar
Client : Nepal Water Supply Corporation (NWSC)
Consultant : Yachiyo Engineering Co. Ltd.
Location : Biratnagar Metropolitan City-4, Kanchanbari, Morang

Borehole No:-2
Logged By:-Hem Rana
Prepared By:-Sushant Giri
Checked By:- Diwakar Khadka
Total Depth:-15 m
Co-ordinate: E 527820.54, N 2930601.601 & R.L = 73.153 m
Start Date: 2020-03-10
Completion Date:2020-03-11

Scale	Thickness	Symbol	Classification	SOIL DESCRIPTION	Water Table	Depth	SPT/DCP at	No. of Blows Per 15 cm			Total SPT/DCP Value	SPT/DCPT	Scale
								15	15	15			
1	3.0	[Pattern]	m	Medium dense brownish clayey silt.		1.0	SPT-1	3	5	8	13		
2						2.0	SPT-2	4	4	8	12		
3						3.0	UDS						
4	3.0	[Pattern]	m	Medium dense brownish to greyish clayey sand.	WT=4.0	4.0	SPT-4	6	7	8	15		
5						5.0	SPT-5	4	4	8	12		
6						6.0	SPT-6	2	6	14	20		
7						7.0	SPT-7	12	13	7	20		
8						8.0	SPT-8	7	9	11	20		
9						9.0	SPT-9	8	10	15	25		
10	10.0	[Pattern]	m	Dense to very dense light grey fine to coarse sand with few pebbles and cobbles.		10.0	SPT-10	11	19	31/13	>50		
11						11.0	SPT-11	14	25	25/12	>50		
12						12.0	SPT-12	32	40	3-Oct	>50		
13						13.0	SPT-13	28	33	17/7	>50		
14						14.0	SPT-14	30	40	10/7	>50		
15						15.0	SPT-15	19	25	25/3	>50		



PLANET TEST (P.) LTD
KMC-31, Shantinagar, Kathmandu

BORE HOLE LOG

Project : Improvement of Water Supply System in Biratnagar
Client : Nepal Water Supply Corporation (NWSC)
Consultant : Yachiyo Engineering Co. Ltd.
Location : Biratnagar Metropolitan City-4, Kanchanbari, Morang

Borehole No:-1
Logged By:-Hem Rana
Prepared By:-Sushant Giri
Checked By:- Diwakar Khadka
Total Depth:-15 m
Co-ordinate: E 527848.12, N 2930606.112 & R.L = 73.035 m
Start Date: 2020-03-08
Completion Date:2020-03-09

Scale	Thickness	Symbol	Classification	SOIL DESCRIPTION	Water Table	Depth	SPT/DCP at	No. of Blows Per 15 cm			Total SPT/DCP Value	SPT/DCPT	Scale
								15	15	15			
1	3.0	[Pattern]	m	Loose to medium dense brownish silty sand.		1.0	SPT-1	3	5	5	10		
2						2.0	SPT-2	1	3	6	9		
3						3.0	UDS						
4						4.0	SPT-4	4	4	10	14		
5	6.0	[Pattern]	m	Medium dense to dense grey fine to coarse sand with traces of few pebbles.	WT=4.0	5.0	SPT-5	7	26	14	40		
6						6.0	SPT-6	10	14	14	28		
7						7.0	SPT-7	8	16	27	45		
8						8.0	SPT-8	14	13	24	37		
9						9.0	SPT-9	10	13	11	24		
10						10.0	SPT-10	16	32	18/9	>50		
11						11.0	SPT-11	17	16	21	37		
12						12.0	SPT-12	25	29	21/10	>50		
13						13.0	SPT-13	25	35	15/7	>50		
14	3.0	[Pattern]	m	Very dense grey to brownish fine to coarse sand.		14.0	SPT-14	21	31	19/6	>50		
15						15.0	SPT-15	18	25	25/12	>50		



BORE HOLE LOG

Project : Improvement of Water Supply System in Biratnagar
Client : Nepal Water Supply Corporation (NWSC)
Consultant : Yachyo Engineering Co. Ltd.
Location : Biratnagar Metropolitan City-4, Kanchanbari, Morang

Borehole No.:3

Logged By:-Hem Rana Total Depth:-50 m

Prepared By:-Sushant Giri Co-ordinate: E 527825.53, N 2930586.332 & R.L = 73.242 m

Checked By:- Diwakar Khadka Start Date: 2020-03-08

Completion Date:2020-03-13

Scale	Thickness	Symbol	Classification	SOIL DESCRIPTION	Water Table	Depth	SPT/DCP at	No. of Blows			Total SPT/DCP Value	SPT/DCPT	Scale
								Per 15 cm	15	15			
1	3.0			Loose to medium dense brownish silty Sand.		1.0	SPT-1	6	7	6	13		
2						2.0	SPT-2	4	6	4	10		
3						3.0	SPT-3	2	5	6	11		
4	3.0			Medium dense brownish to greyish clayey sand.	WT=4.0	4.0	SPT-4	2	3	5	8		
5						5.0	SPT-5	3	5	4	9		
6						6.0	SPT-6	2	3	5	8		
7						7.0	SPT-7	3	6	9	18		
8	3.0			Medium dense brownish to greyish sand.		8.0	SPT-8	6	8	9	17		
9						9.0	SPT-9	8	10	9	19		
10						10.0	SPT-10	21	38	11/5	>50		
11						11.0	SPT-11	20	25	20	45		
12	8.0			Dense to very dense light grey sand with mica.		12.0	SPT-12	27	50/10		>50		
13						13.0	SPT-13	16	31	19/10	>50		
14						14.0	SPT-14	21	33	17/8	>50		
15						15.0	SPT-15	17	31	19/9	>50		



BORE HOLE LOG

Project : Improvement of Water Supply System in Biratnagar
Client : Nepal Water Supply Corporation (NWSC)
Consultant : Yachyo Engineering Co. Ltd.
Location : Biratnagar Metropolitan City-4, Kanchanbari, Morang

Borehole No.:3

Logged By:-Hem Rana Total Depth:-50 m

Prepared By:-Sushant Giri Co-ordinate: E 527825.53, N 2930586.332 & R.L = 73.242 m

Checked By:- Diwakar Khadka Start Date: 2020-03-08

Completion Date:2020-03-13

Scale	Thickness	Symbol	Classification	SOIL DESCRIPTION	Water Table	Depth	SPT/DCP at	No. of Blows			Total SPT/DCP Value	SPT/DCPT	Scale
								Per 15 cm	15	15			
16				Dense to very dense light grey sand with mica.		16.0	SPT-16	25	37	13/4	>50		
17						17.0	SPT-17	20	33	17/4	>50		
18						18.0	SPT-18	21	40	10/2	>50		
19						19.0	SPT-19	34	50		50		
20						20.0	SPT-20	25	31	19/10	>50		
21	7.0			Very dense light grey coarse sand.		21.0	SPT-21	7	9	12	21		
22						22.0	UDS						
23						23.0	SPT-23	13	16	23	39		
24						24.0	SPT-24	17	14	22	36		
25						25.0	SPT-25	17	28	22/5	>50		
26	3.0			Medium dense to very dense clayey sand.		26.0	SPT-26	18	21	22	43		
27						27.0	SPT-27	14	22	26	48		
28						28.0	SPT-28	18	30	20/10	>50		
29	3.0			Very dense brownish sandy silt.		29.0	SPT-29	16	41	9/5	>50		
30						30.0	SPT-30	16	28	24	>50		



BORE HOLE LOG

Project : Improvement of Water Supply System in Biratnagar
Client : Nepal Water Supply Corporation (NWSC)
Consultant : Yachiyo Engineering Co. Ltd.
Location : Biratnagar Metropolitan City-4, Kanchanbari, Morang

Borehole No.-3
Logged By:-Hem Rana
Prepared By:-Sushant Giri
Checked By:- Diwakar Khadka
Total Depth:-50 m
Co-ordinate: E 527825.53, N 2930586.332 & R.L = 73.242 m
Start Date: 2020-03-08
Completion Date:2020-03-13

Scale	Thickness	Symbol	Classification	SOIL DESCRIPTION	Water Table	Depth	SPT/DCP at	No. of Blows			Total SPT/DCP Value	SPT/DCPT	Scale
								Per 15 cm	15	15			
30													
31						31.0	SPT-31	21	24	25	49		
32				Very dense light to dark grey coarse sand.		32.0	SPT-32	16	25	25/9	>50		
33	5.0					33.0	SPT-33	19	29	50/5	>50		
34						34.0	SPT-34	34	50/5		>50		
35						35.0	SPT-35	32	39	11/3	>50		
36						36.0	SPT-36	41	50/8		>50		
37						37.0	SPT-37	34	38	12/3	>50		
38						38.0	SPT-38	44	50/6		>50		
39	7.0			Very dense light to dark grey coarse sand.		39.0	SPT-39	32	50/12		>50		
40						40.0	SPT-40	43	50/2		>50		
41						41.0	SPT-41	50/9			>50		
42						42.0	SPT-42	50/8			>50		
43						43.0	SPT-43	50/7			>50		
44	8.0			Very dense brownish sandy silt.		44.0	SPT-44	39	50/9		>50		
45						45.0	SPT-45	45	50/5		>50		



BORE HOLE LOG

Project : Improvement of Water Supply System in Biratnagar
Client : Nepal Water Supply Corporation (NWSC)
Consultant : Yachiyo Engineering Co. Ltd.
Location : Biratnagar Metropolitan City-4, Kanchanbari, Morang

Borehole No.-3
Logged By:-Hem Rana
Prepared By:-Sushant Giri
Checked By:- Diwakar Khadka
Total Depth:-50 m
Co-ordinate: E 527825.53, N 2930586.332 & R.L = 73.242 m
Start Date: 2020-03-08
Completion Date:2020-03-13

Scale	Thickness	Symbol	Classification	SOIL DESCRIPTION	Water Table	Depth	SPT/DCP at	No. of Blows			Total SPT/DCP Value	SPT/DCPT	Scale
								Per 15 cm	15	15			
45													
46						46.0	SPT-46	33	50/10		>50		
47						47.0	SPT-47	29	50/9		>50		
48	8.0			Very dense brownish sandy silt.		48.0	SPT-48	40	50/8		>50		
49						49.0	SPT-49	50/14			>50		
50						50.0	SPT-50	50/12			>50		

(2) 地耐力調査

**A REPORT
ON
PLATE LOAD TEST
FOR
GEOLOGICAL SURVEY
FOR
THE PROJECT FOR IMPROVEMENT OF WATER SUPPLY
SYSTEM IN BIRATNAGAR
AT
EXISTING DEVKOTA CHOWK PUMP STATION**



CLIENT
NEPAL WATER SUPPLY CORPORATION (NWSC)
Kathmandu, Nepal

CONSULTANT
YACHIYO ENGINEERING CO., LTD.
Tokyo, Japan



PREPARED AND SUBMITTED BY
PLANET TEST (P.) LTD.
KMC-31, Shantinagar, Kathmandu
Telephone: 977-1- 4107665
E-mail: planettest2074@gmail.com

December, 2020

Report on Plate Load Test for the Geological Survey for the Project for improvement of water Supply System in Biratnagar
At EXISTING DEVKOTA CHOWK PUMP STATION

Table of Contents

1. INTRODUCTION.....	1
2. DESCRIPTION OF SITE.....	1
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6. ANALYSIS AND RESULTS OF PLATE LOAD TEST.....	3
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ANNEXES

<u>Annex No.</u>	<u>Title</u>
1	FIELD TEST DATA AND CALCULATION
2	FIELD TEST PHOTOGRAPHS

Report on Plate Load Test for the Geological Survey for the Project for improvement of water Supply System in Biratnagar
At EXISTING DEVKOTA CHOWK PUMP STATION

1. INTRODUCTION

The suitability of the foundation depends upon the geometrical and the strength property of the soil strata. The Plate Load test in one part of geotechnical investigation to get the ultimate load capacity of ground strata and to determine the load settlement relationships under compression load. The plate load test has been done as per the agreement between YACHIYO ENGINEERING Co. LTD., Tokyo, Japan and PLANET TEST (P.) LTD., Shantinagar, Kathmandu, Nepal to determine the bearing capacity, settlement of soil strata of Existing Devkota chowk Pump Station, Biratnagar, Morang.

2. DESCRIPTION OF SITE

The Existing Devkota Pump Site is located on Biratnagar Metropolitan City-12, Dekota Chowk, Morang. The building site is access through vehicle easily from Koshi Highway. There is presence of existence building surrounding the proposed site. The Site is flat terrain and there is lack of proper drainage facilities however the other physical facilities such as electricity, water etc were easily access at the site.

3. OBJECTIVES

The plate load test is an important test of geotechnical investigation to find out the strength and compression properties of the ground strata. This assignment of conducting plate load test is to get reliable information on:

- a) The bearing capacity of Soil strata at 1.5m depth.
- b) The pressure settlement relation of soil strata.

4. PLATE LOADING APPARATUS

The plate load test is a semi-direct method to estimate the allowable bearing pressure of soil to induce a given amount of settlement. The ASTM D1194-94 has been followed for the equipment setup and the test procedure for plate load test on single column.

The loading apparatus consists of the following apparatus:

1. **Bearing Plate:** Square steel plate bearing plate 2.5 cm thickness and 45 cm X 45 cm in dimension.
2. **Hydraulic Jack:** Hydraulic Jack of Capacity 100 ton (1000 KN).
3. **Settlement recording devices:** Dial gauge capable of measuring settlement of the loaded plate to an accuracy of 0.001 mm.
4. **Reaction Load:** Excavator of loading capacity of 20 tons
5. **Miscellaneous apparatus including:**
 - 5.1 Compression Post
 - 5.2 Reference beam steel stands

Report on Plate Load Test for the Geological Survey for the Project for improvement of water Supply System in Biratnagar
At EXISTING DEVKOTA CHOWK PUMP STATION

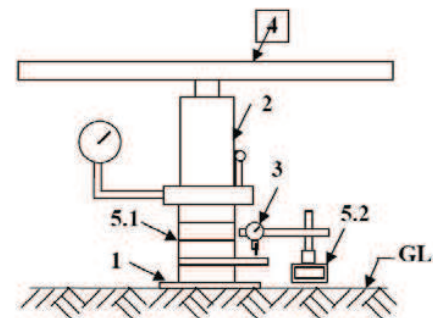


Figure-1: Plate Loading Apparatus arrangement

Plates, square in shape having sizes 0.45m X 0.45m dia and thickness of about 25 mm are has been used for this test. The load on the plate is applied by hydraulic jack. The reaction of the jack load is taken by an excavator of having load more than 1.5 times the design load. The settlement of the plate is measured by a set of two dial gauges of sensitivity 0.01 mm placed at about 180° apart. The dial gauges are fixed to independent supports which do not get disturbed during the test.

5. FIELD WORK PROCEDURE

The fieldwork was scheduled on December 2nd, 2020. At the time of investigation a team of experts and workers with necessary equipment were mobilized to the site to conduct the plate load test.

The Plate load test at the proposed site is conducted at 1.5 m depth from the existing ground level. During the field tests, a 100 tons hydraulic jack was used to press the soil strata below by a 45cm x 45 cm square steel plate of thickness 25 mm. The plate was kept at the center of open excavated rectangular pit of about 1.5 m depth. Ram of Hydraulic jack was rested at the boom of 20.0 tons excavator.

A seating load of 1.5 t was applied with hydraulic jack and released after some time. The load was then gradually increased from 1.5 to 3, 4.5, 6 (tons) respectively. For each increment of loading the settlement of steel plate was recorded with the two different dial gauges till the rate of settlement is less than 0.25mm per hour.

Report on Plate Load Test for the Geological Survey for the Project for improvement of water Supply System in Biratnagar
At EXISTING DEVKOTA CHOWK PUMP STATION

Testing was continued until one of the following stages were reached (i) the settlement became definitely progressive which indicated shear failure, (ii) the applied pressure was exceeded 3 times the allowable pressure, or (iii) the total settlement exceeded 10% the width of the plate. The load was then released. The recorded load and deformation has been attached to the annex.

6. ANALYSIS AND RESULTS OF PLATE LOAD TEST

The result obtained from the test following the applied pressure exceeds 3 times the allowable pressure. The average of the settlements recorded by both dial gauges is taken as the settlements of the plate for each of the load increment. A graph is plotted between applied pressure intensity versus final settlement on linear scales and time-settlement-curve on log-log scales, as shown in Fig. to the Annex.

From the curve shows the nature of semi cohesive soil under pressure where in the ultimate failure point is found out by crossing two tangents at a common point in such a way that tangents could be drawn to the two distinct curvatures. The intersection of the two tangents gives the net ultimate bearing capacity of the plate.

Further, allowable safe bearing capacity is found out by dividing the ultimate load intensity by a factor of safety, usually taken as 2.5.

For Plate Load Test No-1

a. Hence, (i) allowable bearing capacity = ultimate bearing capacity / factor of safety
= 108.00/2.5
= 43.20 KN/m²

b. As the rate of settlement is found minimum with respect to time, which is seen in the time-settlement graph the permissible long-term settlement could be opted for the minimum value (50.00 mm).

c. Estimation of Modulus of Sub-grade Reaction (K-Value)
K= Ultimate Bearing Capacity/ Settlement of Plate
= 108.00/0.050
= 2160.00 KN/m³

d. Seepage water was found around at vicinity of the foundation trench.

For Plate Load Test No-2

a. Hence, (i) allowable bearing capacity = ultimate bearing capacity / factor of safety
= 104.00/2.5
= 41.60 KN/m²

Report on Plate Load Test for the Geological Survey for the Project for improvement of water Supply System in Biratnagar
At EXISTING DEVKOTA CHOWK PUMP STATION

- b. As the rate of settlement is found minimum with respect to time, which is seen in the time-settlement graph the permissible long-term settlement could be opted for the minimum value (50.00 mm).
- c. Estimation of Modulus of Sub-grade Reaction (K-Value)

K= Ultimate Bearing Capacity/ Settlement of Plate
= 104.00/0.050
= 2080.00 KN/m³

- d. Wet soil was found around at vicinity of the foundation trench.

7. CONCLUSION AND RECOMMENDATION

- o All the tests were failed during the field work as permissible settlement was exceed before the designed load was provided.
- o All the test were conducted in wet soil conditions since it was not possible to achieve dry soil conditions on the site even after 5 months of monsoon.
- o It is observed that soil needs to be treated before any foundation construction works is done.
- o The ground water at the site is high and ground water treatment needs to be done before constructing foundation.

8. LIMITATIONS AND UNIFORMITY OF CONDITIONS

- o The recommendations of this report pertain only to the site investigated and are based upon the assumption that the soil conditions do not deviate from those disclosed in the investigation. If any variations or undesirable conditions are encountered during construction, or if the proposed construction will differ from that anticipated herein, Planet Test should be notified so that supplement recommendation can be given.
- o This report is issued with the understanding that it is the responsibility of the client, or of their representative, to ensure that the information and recommendations contained herein are brought to the attention of the design engineer for the project and incorporated into the plan, and the necessary steps are taken to see that the contractor and the sub-contractor carry out such recommendations in the field.
- o The findings of this report are valid as of the present date. However, changes in the conditions of a property can occur with the passage of time, whether they are due to natural process or the works of man on this or adjacent properties.

**ANNEX-1
FIELD TEST DATA
&
CALCULATIONS**

PLANET TEST (P.) LTD.

CONSULTING ENGINEERS
Kathmandu Metropolitan City, Ward No-31, Shantinagar, Kathmandu, Nepal
Tel +977-01-4107665

PLATE LOAD TEST

ASTM D1194-94

Project: Improvement of Water Supply System of Biratnagar
Client: Nepal Water Supply Corporation, Kathmandu
Location: Devkota Chowk Pump Station
Consultant: Yachiyo Engineering Co. Ltd

PLT No.: 1
Eastng: 87° 17' 10.58"
Northng: 26° 27' 21.95"
Date: Dec-2, 2020

Field Settlement Data

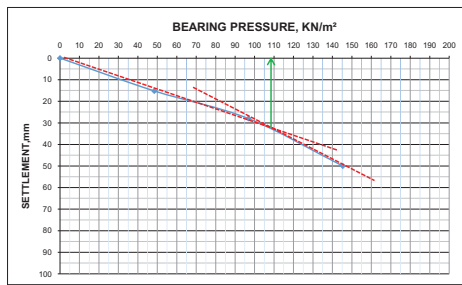
Load in Tonne	Load in KN/m ²	Time	Time Interval	Dial Gauge Reading		Settlement		Average Settlement	Cumulative Settlement	Total Settlement	Remark
				DG-1	DG-2	D1	D2				
1	48.444	7:00	-	0.00	0.00	0.00	0.00	0.00	-	15.23	
		7:01	1	7.89	7.65	7.89	7.65	7.77	7.77		
		7:02	2	9.15	9.09	1.26	1.44	1.35	9.12		
		7:04	4	10.23	10.33	1.08	1.24	1.16	10.28		
		7:08	8	11.65	11.88	1.42	1.55	1.49	11.77		
		7:15	15	12.34	12.65	0.69	0.77	0.73	12.50		
		7:30	30	13.22	13.56	0.88	0.91	0.90	13.39		
		7:45	45	14.18	14.67	0.96	1.11	1.04	14.43		
		7:00	60	15.14	15.32	0.96	0.65	0.81	15.23		
		8:02	-	16.17	16.78	1.03	1.46	1.25	16.48		
2	96.889	8:03	1	18.11	18.23	1.94	1.45	1.70	18.17	28.02	Exceed permissible settlement of 25 mm
		8:04	2	20.23	20.15	2.12	1.92	2.02	20.19		
		8:06	4	22.45	22.24	2.22	2.09	2.16	22.35		
		8:10	8	23.43	23.43	0.98	1.19	1.09	23.43		
		8:17	15	24.13	24.88	0.70	1.45	1.08	24.51		
		8:32	30	25.65	25.67	1.52	0.79	1.16	25.66		
		8:47	45	27.01	27.45	1.36	1.78	1.57	27.23		
		9:02	60	28.00	28.04	0.99	0.59	0.79	28.02		
		9:05	-	43.62	43.52	15.62	15.48	15.55	43.57		
		3	145.333	9:06	1	45.32	45.26	1.70	1.74		
9:07	2			48.63	48.53	3.31	3.27	3.29	48.58		
9:09	4			50.00	50.00	1.37	1.47	1.42	50.00		

PLATE LOAD TEST
ASTM D1194-94

Project: Improvement of Water Supply System of Biratnagar **PLT No.:** 1
Client: Nepal Water Supply Corporation, Kathmandu **Easting:** 87° 17' 10.58"
Location: Devkota Chowk Pump Station **Northing:** 26° 27' 21.95"
Consultant: Yachiyo Engineering Co. Ltd **Date:** Dec-2, 2020

Size of Plates : 0.45 * 0.45 m **L.C. of Dial Gauge:** 0.01
Depth from GL: 1.5 m **Ground Water Table:** 3 m

S.N.	Pressure Gauge Reading in KN/m ²	Load in Tonne	Dial Gauge Reading		Settlement		Average Settlement (mm)	Cumulative Settlement (mm)
			DG-1	DG-2	D1	D2		
0	0	0	0	0	0	0	0	0
1	48.44	1.00	15.14	15.32	15.14	15.32	15.23	15.23
2	96.89	2.00	28.00	28.04	12.86	12.72	12.79	28.02
3	145.33	3.00	50.00	50.00	22.00	21.96	21.98	50.00



From Graph
Ultimate Bearing Capacity: 108.000 KN/m²
Factor of Safety: 2.5
Allowable Bearing Capacity: 43.20 KN/m²
Settlement: 50.00 KN/m²

4.40 T/m²

PLATE LOAD TEST
ASTM D1194-94

Project: Improvement of Water Supply System of Biratnagar **PLT No.:** 2
Client: Nepal Water Supply Corporation, Kathmandu **Easting:** 87° 17' 10.72"
Location: Devkota Chowk Pump Station **Northing:** 26° 27' 22.60"
Consultant: Yachiyo Engineering Co. Ltd **Date:** Dec-2, 2020

Field Settlement Data

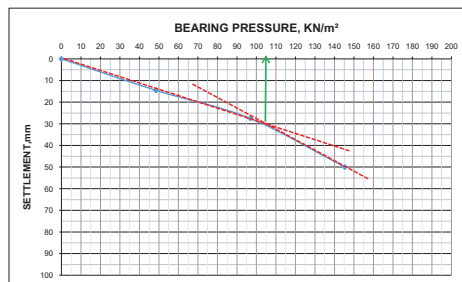
Load in Tonne	Load in KN/m ²	Time	Time Interval	Dial Gauge Reading		Settlement		Average Settlement	Cumulative Settlement	Total Settlement	Remark
				DG-1	DG-2	D1	D2				
1	48.444	11:00	-	0.00	0.00	0.00	0.00	0.00	-	14.55	
		11:01	1	6.45	6.16	6.45	6.16	6.31	6.31		
		11:02	2	7.64	7.67	1.19	1.51	1.35	7.66		
		11:04	4	8.78	8.83	1.14	1.16	1.15	8.81		
		11:08	8	9.14	9.17	0.36	0.34	0.35	9.16		
		11:15	15	10.87	10.92	1.73	1.75	1.74	10.90		
		11:30	30	11.48	11.53	0.61	0.61	0.61	11.51		
		11:45	45	12.40	12.45	0.92	0.92	0.92	12.43		
		12:00	60	14.23	14.87	1.83	2.42	2.13	14.55		
		12:03	-	15.63	15.70	1.40	0.83	1.12	15.67		
2	96.889	12:04	1	16.91	16.98	1.28	1.28	1.28	16.95	27.25	Exceed permissible settlement of 25 mm
		12:05	2	18.68	18.75	1.77	1.77	1.77	18.72		
		12:07	4	19.75	19.82	1.07	1.07	1.07	19.79		
		12:11	8	20.56	20.63	0.81	0.81	0.81	20.60		
		12:18	15	21.87	21.94	1.31	1.31	1.31	21.91		
		12:33	30	22.11	22.18	0.24	0.24	0.24	22.15		
		12:47	45	25.21	25.28	3.10	3.10	3.10	25.25		
		1:03	60	27.00	27.50	1.79	2.22	2.01	27.25		
		1:06	-	40.57	40.68	13.57	13.18	13.38	40.63		
		1:07	1	43.61	43.75	3.04	3.07	3.06	43.68		
3	145.333	1:08	2	45.98	46.12	2.37	2.37	2.37	46.05	50.00	
		1:10	4	48.32	48.42	4.71	4.67	4.69	48.37		
		1:14	8	50.00	50.00	4.02	3.88	3.95	50.00		

PLATE LOAD TEST
ASTM D1194-94

Project: Improvement of Water Supply System of Biratnagar **PLT No.:** 2
Client: Nepal Water Supply Corporation, Kathmandu **Easting:** 87° 17' 10.72"
Location: Devkota Chowk Pump Station **Northing:** 26° 27' 22.60"
Consultant: Yachiyo Engineering Co. Ltd **Date:** Dec-2, 2020

Size of Plates : 0.45 * 0.45 m **L.C. of Dial Gauge:** 0.01
Depth from GL: 1.5 m **Ground Water Table:** 3 m

S.N.	Pressure Gauge Reading in KN/m ²	Load in Tonne	Dial Gauge Reading		Settlement		Average Settlement (mm)	Cumulative Settlement (mm)
			DG-1	DG-2	D1	D2		
0	0	0	0	0	0	0	0	0
1	48.44	1.00	14.23	14.87	14.23	14.87	14.55	14.55
2	96.89	2.00	27.50	27.50	13.27	12.63	12.95	27.50
3	145.33	3.00	50.00	50.00	22.50	22.50	22.50	50.00



From Graph
Ultimate Bearing Capacity: 104.000 KN/m²
Factor of Safety: 2.5
Allowable Bearing Capacity: 41.60 KN/m²
Settlement: 50.00 KN/m²

4.24 T/m²

ANNEX-2
FIELD TEST PHOTOGRAPHS



Photo-1: Preparing Surface for PLT test



Photo-2: Excavating the trial pit at the depth of 1.5m



Photo-3: PLT test apparatus arrangement setup



Photo-4: PLT test apparatus arrangement setup



Photo-5: Recording field test data



Photo-6: Recording field test data



Photo-7: Wet Surface exposed at the trial pit



Photo-8: Excavator at site

**A REPORT
ON
PLATE LOAD TEST
FOR
GEOLOGICAL SURVEY
FOR
THE PROJECT FOR IMPROVEMENT OF WATER SUPPLY
SYSTEM IN BIRATNAGAR
AT
EXISTING TINPAINI PUMP STATION**



CLIENT
NEPAL WATER SUPPLY CORPORATION (NWSC)
Kathmandu, Nepal

CONSULTANT
YACHIYO ENGINEERING CO., LTD.
Tokyo, Japan



PREPARED AND SUBMITTED BY
PLANET TEST (P.) LTD.
KMC-31, Shantinagar, Kathmandu
Telephone: 977-1- 4107665
E-mail: planettest2074@gmail.com

December, 2020

Report on Plate Load Test for the Geological Survey for the Project for improvement of water Supply System in Biratnagar
At EXISTING TINPAINI PUMP STATION

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1. INTRODUCTION.....	1
2. DESCRIPTION OF SITE.....	1
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5. FIELD WORK PROCEDURE.....	2
6. ANALYSIS AND RESULTS OF PLATE LOAD TEST.....	3
7. CONCLUSION AND RECOMMENDATION.....	4
8. LIMITATIONS AND UNIFORMITY OF CONDITIONS.....	4

ANNEXES

<u>Annex No.</u>	<u>Title</u>
1	FIELD TEST DATA AND CALCULATION
2	FIELD TEST PHOTOGRAPHS

Report on Plate Load Test for the Geological Survey for the Project for improvement of water Supply System in Biratnagar
At EXISTING TINPAINI PUMP STATION

1. INTRODUCTION

The suitability of the foundation depends upon the geometrical and the strength property of the soil strata. The Plate Load test in one part of geotechnical investigation to get the ultimate load capacity of ground strata and to determine the load settlement relationships under compression load. The plate load test has been done as per the agreement between YACHIYO ENGINEERING Co. LTD., Tokyo, Japan and PLANET TEST (P.) LTD., Shantinagar, Kathmandu, Nepal to determine the bearing capacity, settlement of soil strata of Tinpaini Pump Station, Biratnagar, Morang.

2. DESCRIPTION OF SITE

The Tinpaini Pump site is located on Biratnagar Metropolitan City-2, Tinpaini, Morang. The Pump Station site is about 0.8 km to the east from the Main Highway. There is presence of Overhead Water Tank & other small building inside the Pump Station. The Site is flat terrain and Physical facilities such as electricity, water etc were easily access at the site.

3. OBJECTIVES

The plate load test is an important test of geotechnical investigation to find out the strength and compression properties of the ground strata. This assignment of conducting plate load test is to get reliable information on:

- a) The bearing capacity of Soil strata at 1.5m depth.
- b) The pressure settlement relation of soil strata.

4. PLATE LOADING APPARATUS

The plate load test is a semi-direct method to estimate the allowable bearing pressure of soil to induce a given amount of settlement. The ASTM D1194-94 has been followed for the equipment setup and the test procedure for plate load test on single column.

The loading apparatus consists of the following apparatus:

1. **Bearing Plate:** Square steel plate bearing plate 2.5 cm thickness and 45 cm X 45 cm in dimension.
2. **Hydraulic Jack:** Hydraulic Jack of Capacity 100 ton (1000 KN).
3. **Settlement recording devices:** Dial gauge capable of measuring settlement of the loaded plate to an accuracy of 0.001 mm.
4. **Reaction Load:** Excavator of loading capacity of 20 tons
5. **Miscellaneous apparatus including:**
 - 5.1 Compression Post
 - 5.2 Reference beam steel stands

Report on Plate Load Test for the Geological Survey for the Project for improvement of water Supply System in Biratnagar
At EXISTING TINPAINI PUMP STATION

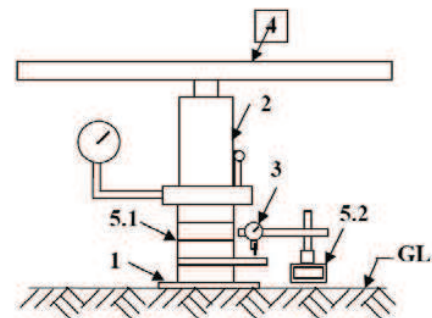


Figure-1: Plate Loading Apparatus arrangement

Plates, square in shape having sizes 0.45m X 0.45m dia and thickness of about 25 mm are has been used for this test. The load on the plate is applied by hydraulic jack. The reaction of the jack load is taken by an excavator of having load more than 1.5 times the design load. The settlement of the plate is measured by a set of two dial gauges of sensitivity 0.01 mm placed at about 180° apart. The dial gauges are fixed to independent supports which do not get disturbed during the test.

5. FIELD WORK PROCEDURE

The fieldwork was scheduled on December 3rd, 2020. At the time of investigation a team of experts and workers with necessary equipment were mobilized to the site to conduct the plate load test.

The Plate load test at the proposed site is conducted at 1.5 m depth from the existing ground level. During the field tests, a 100 tons hydraulic jack was used to press the soil strata below by a 45cm x 45 cm square steel plate of thickness 25 mm. The plate was kept at the center of open excavated rectangular pit of about 1.5 m depth. Ram of Hydraulic jack was rested at the boom of 20.0 tons excavator.

A seating load of 1.5 t was applied with hydraulic jack and released after some time. The load was then gradually increased from 1.5 to 3, 4.5, and 6 (tons) respectively. For each increment of loading the settlement of steel plate was recorded with the two different dial gauges till the rate of settlement is less than 0.25mm per hour.

Report on Plate Load Test for the Geological Survey for the Project for improvement of water Supply System in Biratnagar At EXISTING TINPAINI PUMP STATION

Testing was continued until one of the following stages were reached (i) the settlement became definitely progressive which indicated shear failure, (ii) the applied pressure was exceeded 3 times the allowable pressure, or (iii) the total settlement exceeded 10% the width of the plate. The load was then released. The recorded load and deformation has been attached to the annex.

6. ANALYSIS AND RESULTS OF PLATE LOAD TEST

The result obtained from the test following the applied pressure exceeds 3 times the allowable pressure. The average of the settlements recorded by both dial gauges is taken as the settlements of the plate for each of the load increment. A graph is plotted between applied pressure intensity versus final settlement on linear scales and time-settlement-curve on log-log scales, as shown in Fig. to the Annex.

From the curve shows the nature of semi cohesive soil under pressure where in the ultimate failure point is found out by crossing two tangents at a common point in such a way that tangents could be drawn to the two distinct curvatures. The intersection of the two tangents gives the net ultimate bearing capacity of the plate.

Further, allowable safe bearing capacity is found out by dividing the ultimate load intensity by a factor of safety, usually taken as 2.5.

For Plate Load Test No-1

a. Hence, (i) allowable bearing capacity = ultimate bearing capacity / factor of safety
 = 92.420/2.5
 = 36.97 KN/m²

b. As the rate of settlement is found minimum with respect to time, which is seen in the time-settlement graph the permissible long-term settlement could be opted for the minimum value (50.00 mm).

c. Estimation of Modulus of Sub-grade Reaction (K-Value)
 K= Ultimate Bearing Capacity/ Settlement of Plate
 = 92.420/0.050
 = 1848.4 KN/m³

d. Wet soil was found around at vicinity of the foundation trench.

For Plate Load Test No-2

a. Hence, (i) allowable bearing capacity = ultimate bearing capacity / factor of safety
 = 86.128/2.5
 = 34.451 KN/m²

Report on Plate Load Test for the Geological Survey for the Project for improvement of water Supply System in Biratnagar At EXISTING TINPAINI PUMP STATION

- b. As the rate of settlement is found minimum with respect to time, which is seen in the time-settlement graph the permissible long-term settlement could be opted for the minimum value (50.00 mm).
- c. Estimation of Modulus of Sub-grade Reaction (K-Value)

K= Ultimate Bearing Capacity/ Settlement of Plate
 = 86.128/0.050
 = 1722.56 KN/m³

d. Wet soil was found around at vicinity of the foundation trench.

7. CONCLUSION AND RECOMMENDATION

- o All the tests were failed during the field work as permissible settlement was exceed before the designed load was provided.
- o All the test were conducted in wet soil conditions since it was not possible to achieve dry soil conditions on the site even after 5 months of monsoon.
- o It is observed that soil needs to be treated before any foundation construction works is done.
- o The ground water at the site is high and ground water treatment needs to be done before constructing foundation.

8. LIMITATIONS AND UNIFORMITY OF CONDITIONS

- o The recommendations of this report pertain only to the site investigated and are based upon the assumption that the soil conditions do not deviate from those disclosed in the investigation. If any variations or undesirable conditions are encountered during construction, or if the proposed construction will differ from that anticipated herein, Planet Test should be notified so that supplement recommendation can be given.
- o This report is issued with the understanding that it is the responsibility of the client, or of their representative, to ensure that the information and recommendations contained herein are brought to the attention of the design engineer for the project and incorporated into the plan, and the necessary steps are taken to see that the contractor and the sub-contractor carry out such recommendations in the field.
- o The findings of this report are valid as of the present date. However, changes in the conditions of a property can occur with the passage of time, whether they are due to natural process or the works of man on this or adjacent properties.

PLANET TEST (P.) LTD.

CONSULTING ENGINEERS
 Kathmandu Metropolitan City, Ward No-31, Shantinagar, Kathmandu, Nepal
 Tel +977-01-4107665

PLATE LOAD TEST

ASTM D1194-94

Project: Improvement of Water Supply System of Biratnagar **PLT No.:** 1
Client: Nepal Water Supply Corporation, Kathmandu **Essing:** 87° 17' 5.98"
Location: Tinpaini Pump Station, Tinpaini Chowk **Northing:** 26° 28' 21.89"
Consultant: Yachhiyo Engineering Co. Ltd **Date:** Dec 3, 2020

Field Settlement Data

Load in Tonne	Load in KN/m ²	Time	Time Interval	Dial Gauge Reading		Settlement		Average Settlement	Cumulative Settlement	Total Settlement	Remark
				DG-1	DG-2	D1	D2				
1	48.444	7:30	-	0.00	0.00	0.00	0.00	0.000	-	8.74	
		7:31	1	4.25	4.29	4.25	4.29	4.270	4.27		
		7:32	2	5.68	5.71	1.43	1.42	1.425	5.70		
		7:34	4	6.24	6.3	0.58	0.59	0.575	6.27		
		7:38	8	7.33	7.38	1.09	1.08	1.085	7.36		
		7:45	15	7.97	8	0.64	0.62	0.630	7.99		
		8:00	30	8.42	8.47	0.45	0.47	0.460	8.45		
		8:15	45	8.71	8.76	0.29	0.29	0.290	8.74		
		8:30	60	8.72	8.76	0.01	0.00	0.005	8.74		
		8:33	-	12.21	12.31	3.49	3.55	3.520	12.26		
2	96.889	8:34	1	13.65	13.74	1.44	1.43	1.435	13.70	19.68	
		8:35	2	14.32	14.42	0.67	0.68	0.675	14.37		
		8:37	4	15.41	15.51	1.09	1.09	1.090	15.46		
		8:41	8	16.96	17.04	1.55	1.53	1.540	17.00		
		8:48	15	18.33	18.41	1.37	1.37	1.370	18.37		
		9:03	30	19.25	19.33	0.92	0.92	0.920	19.29		
		9:18	45	19.63	19.71	0.38	0.38	0.380	19.67		
		9:33	60	19.64	19.72	0.01	0.01	0.010	19.68		
		9:38	-	30.26	24.01	10.62	4.29	7.455	27.14		
		9:39	1	34.27	24.42	4.01	0.41	2.210	29.35		
3	145.333	9:40	2	38.42	24.92	4.15	0.50	2.325	31.67	50.00	Exceed permissible settlement of 25 mm
		9:42	4	44.66	27.15	6.24	2.23	4.235	35.91		
		9:46	8	50	50	5.34	22.85	14.095	50.00		

**ANNEX-1
 FIELD TEST DATA
 &
 CALCULATIONS**

PLANET TEST (P.) LTD.
CONSULTING ENGINEERS
Kathmandu Metropolitan City, Ward No-31, Shantinagar, Kathmandu, Nepal
Tel +977-01-4107665

PLATE LOAD TEST
ASTM D1194-94

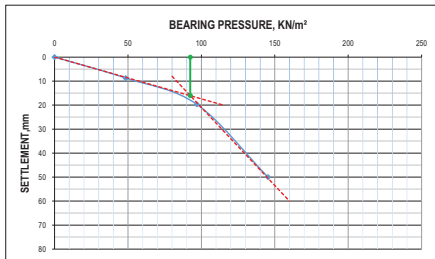
Project: Improvement of Water Supply System of Biratnagar
Client: Nepal Water Supply Corporation, Kathmandu
Location: Tinpainsi Pump Station, Tinpainsi Chowk
Consultant: Yachyo Engineering Co. Ltd.

PLT No.: 1
Easting: 87° 17' 5.98"
Northing: 26° 28' 21.89"
Date: Dec 3, 2020

Size of Plates: 0.45 * 0.45 m
Depth from GL: 1.5 m

L.C. of Dial Gauge: 0.01
Ground Water Table: 3 m

S.N.	Pressure Gauge Reading in KN/m ²	Load in Tonne	Dial Gauge Reading		Settlement		Average Settlement (mm)	Cumulative Settlement (mm)
			DG-1	DG-2	D1	D2		
1	0	0	0	0	0	0	0	0
2	48.444	1	8.72	8.76	8.72	8.76	8.74	8.74
3	96.889	2	19.64	19.72	10.92	10.96	10.94	19.68
4	145.333	3	50	50	30.36	30.28	30.32	50



From Graph
Ultimate Bearing Capacity: 92.420 KN/m²
Factor of Safety: 2.5
Allowable Bearing Capacity: 36.97 KN/m² 3.7684033 T/m²
Settlement: 50.00 mm

PLANET TEST (P.) LTD.
CONSULTING ENGINEERS
Kathmandu Metropolitan City, Ward No-31, Shantinagar, Kathmandu, Nepal
Tel +977-01-4107665

PLATE LOAD TEST
ASTM D1194-94

Project: Improvement of Water Supply System of Biratnagar
Client: Nepal Water Supply Corporation, Kathmandu
Location: Tinpainsi Pump Station, Tinpainsi Chowk
Consultant: Yachyo Engineering Co. Ltd.

PLT No.: 2
Easting: 87° 17' 5.12"
Northing: 26° 28' 22.01"
Date: Dec 3, 2020

Field Settlement Data

Load in Tonne	Load in KN/m ²	Time	Time Interval	Dial Gauge Reading		Settlement		Average Settlement	Cumulative Settlement	Total Settlement	Remark
				DG-1	DG-2	D1	D2				
1	48.444	3:00	-	0.00	0.00	0.00	0.00	0.000	-	6.91	
		3:01	1	1.57	1.62	1.57	1.62	1.595	1.60		
		3:02	2	2.11	2.15	0.54	0.53	0.535	2.13		
		3:04	4	3.02	3.08	0.91	0.93	0.920	3.05		
		3:08	8	4.21	4.25	1.19	1.17	1.180	4.23		
		3:15	15	5.53	5.57	1.32	1.32	1.320	5.55		
		3:30	30	6.63	6.68	1.10	1.11	1.105	6.66		
		3:45	45	6.88	6.92	0.25	0.24	0.245	6.90		
		4:00	60	6.89	6.93	0.01	0.01	0.010	6.91		
		2	96.889	4:03	-	7.96	8	1.07	1.07		
4:04	1			8.24	8.35	0.28	0.35	0.315	8.30		
4:05	2			10.06	10.17	1.82	1.82	1.820	10.12		
4:07	4			11.91	12.04	1.85	1.87	1.860	11.98		
4:11	8			14.25	14.35	2.34	2.31	2.325	14.30		
4:18	15			16.24	16.35	1.99	2.00	1.995	16.30		
4:33	30			18.29	18.4	2.05	2.05	2.050	18.35		
4:47	45			19.98	20.11	1.69	1.71	1.700	20.05		
5:03	60			19.99	20.12	0.01	0.01	0.010	20.06		
3	145.333			5:08	-	38.25	38.37	18.26	18.25	18.255	38.31
		4:04	1	42.25	42.36	4.00	3.99	3.995	42.31		
		4:05	2	48.99	50	6.74	7.64	7.190	49.50		
		4:07	4	50	50	1.01	0.00	0.505	50.00		

PLANET TEST (P.) LTD.
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PLATE LOAD TEST
ASTM D1194-94

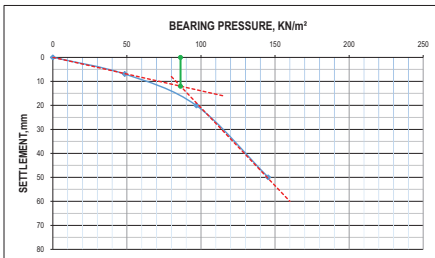
Project: Improvement of Water Supply System of Biratnagar
Client: Nepal Water Supply Corporation, Kathmandu
Location: Tinpainsi Pump Station, Tinpainsi Chowk
Consultant: Yachyo Engineering Co. Ltd.

PLT No.: 2
Easting: 87° 17' 5.12"
Northing: 26° 28' 22.01"
Date: Dec 3, 2020

Size of Plates: 0.45 * 0.45 m
Depth from GL: 1.5 m

L.C. of Dial Gauge: 0.01
Ground Water Table: 3 m

S.N.	Pressure Gauge Reading in KN/m ²	Load in Tonne	Dial Gauge Reading		Settlement		Average Settlement (mm)	Cumulative Settlement (mm)
			DG-1	DG-2	D1	D2		
1	0	0	0	0	0	0	0	0
2	48.444	1	6.89	6.93	6.89	6.93	6.91	6.91
3	96.889	2	19.99	20.12	13.1	13.19	13.145	20.055
4	145.333	3	50	50	30.01	29.88	29.945	50



From Graph
Ultimate Bearing Capacity: 86.128 KN/m²
Factor of Safety: 2.5
Allowable Bearing Capacity: 34.45 KN/m² 3.5118312 T/m²
Settlement: 50.00 mm

ANNEX-2
FIELD TEST PHOTOGRAPHS



Photo-1: Trial Pit Excavation for PLT test



Photo-2: Preparing Plate at the depth of 1.5m



Photo-3: PLT test apparatus arrangement

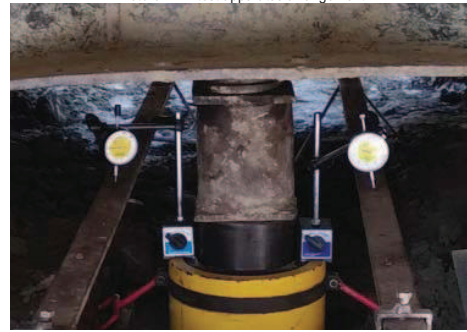


Photo-4: Dial gauge arrangement



Photo-5: Recording field test data



Photo-6: Recording field test data



Photo-7: Providing Hydraulic loading

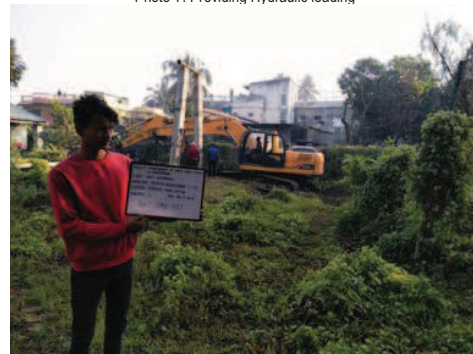


Photo-8: Excavator at site

**A REPORT
ON
PLATE LOAD TEST
FOR
GEOLOGICAL SURVEY
FOR
THE PROJECT FOR IMPROVEMENT OF WATER SUPPLY
SYSTEM IN BIRATNAGAR
AT
EXISTING MUNALPATH PUMP STATION SITE**



CLIENT
NEPAL WATER SUPPLY CORPORATION (NWSC)
Kathmandu, Nepal

CONSULTANT
YACHIYO ENGINEERING CO., LTD.
Tokyo, Japan



PREPARED AND SUBMITTED BY
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Telephone: 977-1- 4107665
E-mail: planettest2074@gmail.com

December, 2020

Report on Plate Load Test for the Geological Survey for the Project for improvement of water Supply System in Biratnagar
At EXISTING MUNALPATH PUMP STATION SITE

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ANNEXES

<u>Annex No.</u>	<u>Title</u>
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At EXISTING MUNALPATH PUMP STATION SITE

1. INTRODUCTION

The suitability of the foundation depends upon the geometrical and the strength property of the soil strata. The Plate Load test in one part of geotechnical investigation to get the ultimate load capacity of ground strata and to determine the load settlement relationships under compression load. The plate load test has been done as per the agreement between YACHIYO ENGINEERING Co. LTD., Tokyo, Japan and PLANET TEST (P.) LTD., Shantinagar, Kathmandu, Nepal to determine the bearing capacity, settlement of soil strata of Existing Munalpath Pump Station Site, Morang.

2. DESCRIPTION OF SITE

The Existing Munalpath Pump site is located on Biratnagar Metropolitan City-8, Munalpath, Morang. The building site is access through vehicle easily from Koshi Highway. There is presence of existence building outside the proposed Munalpath site. The Site is flat terrain and there is lack of proper drainage facilities however the other physical facilities such as electricity, water etc were easily access at the site.

3. OBJECTIVES

The plate load test is an important test of geotechnical investigation to find out the strength and compression properties of the ground strata. This assignment of conducting plate load test is to get reliable information on:

- a) The bearing capacity of Soil strata at 1.5m depth.
- b) The pressure settlement relation of soil strata.

4. PLATE LOADING APPARATUS

The plate load test is a semi-direct method to estimate the allowable bearing pressure of soil to induce a given amount of settlement. The ASTM D1194-94 has been followed for the equipment setup and the test procedure for plate load test on single column.

The loading apparatus consists of the following apparatus:

1. **Bearing Plate:** Square steel plate bearing plate 2.5 cm thickness and 45 cm X 45 cm in dimension.
2. **Hydraulic Jack:** Hydraulic Jack of Capacity 100 ton (1000 KN).
3. **Settlement recording devices:** Dial gauge capable of measuring settlement of the loaded plate to an accuracy of 0.001 mm.
4. **Reaction Load:** Excavator of loading capacity of 20 tonne
5. **Miscellaneous apparatus including:**
 - 5.1 Compression Post
 - 5.2 Reference beam steel stands

Report on Plate Load Test for the Geological Survey for the Project for improvement of water Supply System in Biratnagar
At EXISTING MUNALPATH PUMP STATION SITE

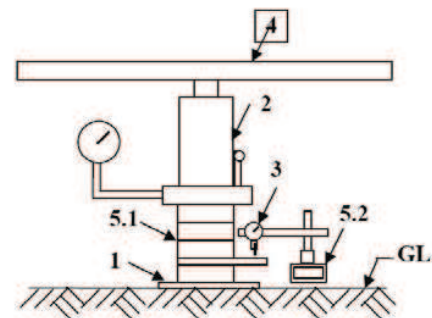


Figure-1: Plate Loading Apparatus arrangement

Plates, square in shape having sizes 0.45m X 0.45m dia and thickness of about 25 mm are has been used for this test. The load on the plate is applied by hydraulic jack. The reaction of the jack load is taken by an excavator of having load more than 1.5 times the design load. The settlement of the plate is measured by a set of two dial gauges of sensitivity 0.01 mm placed at about 180° apart. The dial gauges are fixed to independent supports which do not get disturbed during the test.

5. FIELD WORK PROCEDURE

The fieldwork was scheduled on December 4th, 2020. At the time of investigation a team of experts and workers with necessary equipment were mobilized to the site to conduct the plate load test.

The Plate load test at the proposed site is conducted at 1.5 m depth from the existing ground level. During the field tests, a 100 tons hydraulic jack was used to press the soil strata below by a 45cm x 45 cm square steel plate of thickness 25 mm. The plate was kept at the center of open excavated rectangular pit of about 1.5 m depth. Ram of Hydraulic jack was rested at the boom of 20.0 tons excavator.

A seating load of 1.5 t was applied with hydraulic jack and released after some time. The load was then gradually increased from 1.5 to 3, 4.5, 6 (tons) respectively. For each increment of loading the settlement of steel plate was recorded with the two different dial gauges till the rate of settlement is less than 0.25mm per hour.

Report on Plate Load Test for the Geological Survey for the Project for improvement of water Supply System in Biratnagar
At EXISTING MUNALPATH PUMP STATION SITE

Testing was continued until one of the following stages were reached (i) the settlement became definitely progressive which indicated shear failure, (ii) the applied pressure was exceeded 3 times the allowable pressure, or (iii) the total settlement exceeded 10% the width of the plate. The load was then released. The recorded load and deformation has been attached to the annex.

6. ANALYSIS AND RESULTS OF PLATE LOAD TEST

The result obtained from the test following the applied pressure exceeds 3 times the allowable pressure. The average of the settlements recorded by both dial gauges is taken as the settlements of the plate for each of the load increment. A graph is plotted between applied pressure intensity versus final settlement on linear scales and time-settlement-curve on log-log scales, as shown in Fig. to the Annex.

From the curve shows the nature of semi cohesive soil under pressure where in the ultimate failure point is found out by crossing two tangents at a common point in such a way that tangents could be drawn to the two distinct curvatures. The intersection of the two tangents gives the net ultimate bearing capacity of the plate.

Further, allowable safe bearing capacity is found out by dividing the ultimate load intensity by a factor of safety, usually taken as 2.5.

For Plate Load Test No-1

- a. Hence, (i) allowable bearing capacity = ultimate bearing capacity / factor of safety

$$= 180.00/2.5$$

$$= 72.0 \text{ KN/m}^2$$

- b. As the rate of settlement is found minimum with respect to time, which is seen in the time-settlement graph the permissible long-term settlement could be opted for the minimum value (50.00 mm).

- c. Estimation of Modulus of Sub-grade Reaction (K-Value)

$$K = \text{Ultimate Bearing Capacity/ Settlement of Plate}$$

$$= 180.00/0.050$$

$$= 3600.00 \text{ KN/m}^3$$

- d. Wet soil was found around at vicinity of the foundation trench.

For Plate Load Test No-2

- a. Hence, (i) allowable bearing capacity = ultimate bearing capacity / factor of safety

$$= 111.00/2.5$$

$$= 44.40 \text{ KN/m}^2$$

Report on Plate Load Test for the Geological Survey for the Project for improvement of water Supply System in Biratnagar
At EXISTING MUNALPATH PUMP STATION SITE

- b. As the rate of settlement is found minimum with respect to time, which is seen in the time-settlement graph the permissible long-term settlement could be opted for the minimum value (50.00 mm).
- c. Estimation of Modulus of Sub-grade Reaction (K-Value)

$$K = \text{Ultimate Bearing Capacity/ Settlement of Plate}$$

$$= 111.00/0.050$$

$$= 2220.00 \text{ KN/m}^3$$

- d. Wet soil was found around at vicinity of the foundation trench.

7. CONCLUSION AND RECOMMENDATION

- All the tests were failed during the field work as permissible settlement was exceed before the designed load was provided.
- All the test were conducted in wet soil conditions since it was not possible to achieve dry soil conditions on the site even after 5 months of monsoon.
- It is observed that soil needs to be treated before any foundation construction works is done.
- The ground water at the site is high and ground water treatment needs to be done before constructing foundation.

8. LIMITATIONS AND UNIFORMITY OF CONDITIONS

- The recommendations of this report pertain only to the site investigated and are based upon the assumption that the soil conditions do not deviate from those disclosed in the investigation. If any variations or undesirable conditions are encountered during construction, or if the proposed construction will differ from that anticipated herein, Planet Test should be notified so that supplement recommendation can be given.
- This report is issued with the understanding that it is the responsibility of the client, or of their representative, to ensure that the information and recommendations contained herein are brought to the attention of the design engineer for the project and incorporated into the plan, and the necessary steps are taken to see that the contractor and the sub-contractor carry out such recommendations in the field.
- The findings of this report are valid as of the present date. However, changes in the conditions of a property can occur with the passage of time, whether they are due to natural process or the works of man on this or adjacent properties.

**ANNEX-1
FIELD TEST DATA
&
CALCULATIONS**

PLANET TEST (P.) LTD.

CONSULTING ENGINEERS
Kathmandu Metropolitan City, Ward No-31, Shantinagar, Kathmandu, Nepal
Tel +977-01-4107865

PLATE LOAD TEST

ASTM D1194-94

Project: Improvement of Water Supply System of Biratnagar **PLT No.:** 1
Client: Nepal Water Supply Corporation, Kathmandu **Easting:** 87° 16' 38.53"
Location: Munal Path Pump Station Site, Biratnagar **Northing:** 26° 28' 11.65"
Consultant: Yachiyo Engineering Co. Ltd **Date:** Dec-4, 2020

Field Settlement Data

Load in Tonne	Load in KN/m ²	Time	Time Interval	Dial Gauge Reading		Settlement		Average Settlement	Cumulative Settlement	Total Settlement	Remark
				DG-1	DG-2	D1	D2				
1.5	72.667	7:00	-	0.00	0.00	0.00	0.00	0.00	-	8.57	
		7:01	1	5.74	5.58	5.74	5.58	5.66	5.66		
		7:02	2	6.71	6.39	0.97	0.81	0.89	6.55		
		7:04	4	7.07	6.81	0.36	0.42	0.39	6.94		
		7:08	8	8.32	8.14	1.25	1.33	1.29	8.23		
		7:15	15	8.52	8.45	0.20	0.31	0.25	8.48		
		7:30	30	8.55	8.47	0.03	0.02	0.03	8.51		
		7:45	45	8.58	8.51	0.03	0.04	0.03	8.54		
		8:00	60	8.60	8.53	0.02	0.02	0.02	8.57		
		8:02	-	11.74	12.07	3.14	3.54	3.34	11.91		
3	145.333	8:03	1	12.53	12.84	0.79	0.77	0.78	12.69	19.67	
		8:04	2	13.11	13.47	0.58	0.63	0.61	13.29		
		8:06	4	15.98	16.31	2.87	2.84	2.86	16.15		
		8:08	8	16.42	16.73	0.44	0.42	0.43	16.58		
		8:17	15	17.56	17.85	1.14	1.12	1.13	17.71		
		8:32	30	18.89	19.22	1.33	1.37	1.35	19.06		
		8:47	45	19.48	19.82	0.59	0.60	0.60	19.65		
		9:02	60	19.50	19.83	0.02	0.01	0.01	19.67		
		9:08	-	22.63	22.35	3.13	2.52	2.83	22.49		
		9:09	1	23.82	23.52	1.19	1.17	1.18	23.67		
4.5	218.000	9:10	2	24.63	24.34	0.81	0.82	0.82	24.49	30.34	
		9:12	4	25.41	25.10	0.78	0.76	0.77	25.26		
		9:16	8	26.35	26.07	0.94	0.97	0.96	26.21		
		9:23	15	28.65	28.35	2.30	2.28	2.29	28.50		
		9:38	30	30.11	29.82	1.46	1.47	1.47	29.97		
		9:53	45	30.46	30.17	0.35	0.35	0.35	30.32		
		10:08	60	30.48	30.19	0.02	0.02	0.02	30.34		
		10:14	-	38.65	38.35	8.17	8.16	8.17	38.50		
		10:15	1	43.62	43.32	4.97	4.97	4.97	43.47		
		10:16	2	45.82	45.52	2.20	2.20	2.20	45.67		
6	290.667	10:18	4	48.56	48.26	2.74	2.74	2.74	48.41	50.00	
		10:22	8	50.00	50.00	1.44	1.74	1.59	50.00		

PLANET TEST (P.) LTD.

CONSULTING ENGINEERS
Kathmandu Metropolitan City, Ward No-31, Shantinagar, Kathmandu, Nepal
Tel +977-01-4107665

PLATE LOAD TEST

ASTM D1194-94

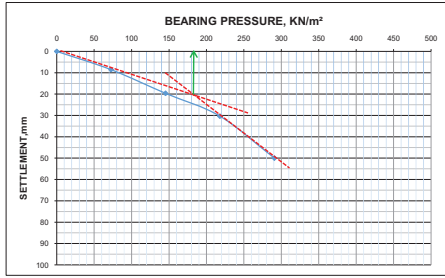
Project: Improvement of Water Supply System of Biratnagar
Client: Nepal Water Supply Corporation, Kathmandu
Location: Munal Path Pump Station Site, Biratnagar
Consultant: Yachiyo Engineering Co. Ltd

PLT No.: 1
Easting: 87° 16' 39.44"
Northing: 26° 28' 11.04"
Date: Dec-4, 2020

Size of Plates : 0.45 * 0.45 m
Depth from GL: 1.5 m

L.C. of Dial Gauge: 0.01
Ground Water Table: 4 m

S.N.	Pressure Gauge Reading in KN/m ²	Load in Tonne	Dial Gauge Reading		Settlement		Average Settlement (mm)	Cumulative Settlement (mm)
			DG-1	DG-2	D1	D2		
0	0	0	0	0	0	0	0	0
1	72.667	1.5	8.60	8.53	8.60	8.53	8.57	8.57
2	145.333	3	19.50	19.83	10.90	11.30	11.10	19.67
3	218.000	4.5	30.48	30.19	10.98	10.36	10.67	30.34
4	290.667	6	50.00	50.00	19.52	19.81	19.67	50.00



From Graph

Ultimate Bearing Capacity : 180.00 KN/m²
Factor of Safety : 2.5
Allowable Bearing Capacity : 72.00 KN/m²
Settlement : 50.00 mm

7.33945 T/m²

PLANET TEST (P.) LTD.

CONSULTING ENGINEERS
Kathmandu Metropolitan City, Ward No-31, Shantinagar, Kathmandu, Nepal
Tel +977-01-4107665

PLATE LOAD TEST

ASTM D1194-94

Project: Improvement of Water Supply System of Biratnagar
Client: Nepal Water Supply Corporation, Kathmandu
Location: Munal Path Pump Station Site, Biratnagar
Consultant: Yachiyo Engineering Co. Ltd

PLT No.: 2
Easting: 87° 16' 39.44"
Northing: 26° 28' 11.04"
Date: Dec-4, 2020

Field Settlement Data

Load in Tonne	Load in KN/m ²	Time	Time Interval	Dial Gauge Reading		Settlement		Average Settlement	Cumulative Settlement	Total Settlement	Remark
				DG-1	DG-2	D1	D2				
1.5	72.667	1:00	-	0.00	0.00	0.00	0.00	0.00	-	8.52	
		1:01	1	5.45	5.98	5.45	5.98	5.72	5.72		
		1:02	2	6.43	6.32	0.98	0.34	0.66	6.38		
		1:04	4	6.95	6.86	0.52	0.54	0.53	6.91		
		1:08	8	8.22	8.04	1.27	1.18	1.23	8.13		
		1:15	15	8.39	8.20	0.17	0.16	0.17	8.30		
		1:30	30	8.54	8.36	0.15	0.16	0.15	8.45		
		1:45	45	8.59	8.42	0.05	0.06	0.06	8.51		
		2:00	60	8.60	8.44	0.01	0.02	0.01	8.52		
		2:03	-	14.28	14.21	5.68	5.77	5.73	14.25		
3	145.333	2:04	1	17.29	17.21	3.01	3.00	3.01	17.25	24.65	
		2:05	2	19.65	19.47	2.36	2.26	2.31	19.56		
		2:07	4	22.35	22.17	2.70	2.70	2.70	22.28		
		2:11	8	23.56	23.38	1.21	1.21	1.21	23.47		
		2:18	15	24.12	24.01	0.56	0.63	0.60	24.07		
		2:33	30	24.63	24.46	0.51	0.45	0.48	24.55		
		2:47	45	24.71	24.55	0.08	0.09	0.09	24.63		
		3:03	60	24.73	24.57	0.02	0.02	0.02	24.65		
		3:08	-	35.26	35.12	10.53	10.55	10.54	35.19		
		3:04	1	38.65	38.52	3.39	3.40	3.40	38.59		
3:05	2	41.73	41.55	3.08	3.03	3.06	41.64				
3:07	4	42.35	42.21	0.62	0.66	0.64	42.28				
3:11	8	44.54	44.37	2.19	2.16	2.18	44.46				
3:18	15	48.29	48.15	3.75	3.78	3.77	48.22				
3:33	30	50.00	50.00	1.71	1.85	1.78	50.00				

PLANET TEST (P.) LTD.

CONSULTING ENGINEERS
Kathmandu Metropolitan City, Ward No-31, Shantinagar, Kathmandu, Nepal
Tel +977-01-4107665

PLATE LOAD TEST

ASTM D1194-94

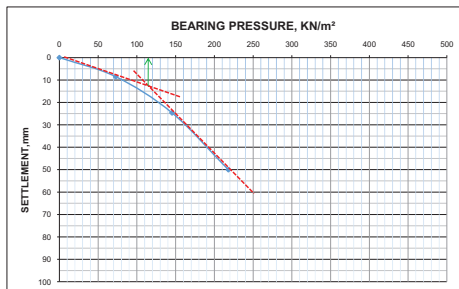
Project: Improvement of Water Supply System of Biratnagar
Client: Nepal Water Supply Corporation, Kathmandu
Location: Munal Path Pump Station Site, Biratnagar
Consultant: Yachiyo Engineering Co. Ltd

PLT No.: 2
Easting: 87° 16' 39.44"
Northing: 26° 28' 11.04"
Date: Dec-4, 2020

Size of Plates : 0.45 * 0.45 m
Depth from GL: 1.5 m

L.C. of Dial Gauge: 0.01
Ground Water Table: 4 m

S.N.	Pressure Gauge Reading in KN/m ²	Load in Tonne	Dial Gauge Reading		Settlement		Average Settlement (mm)	Cumulative Settlement (mm)
			DG-1	DG-2	D1	D2		
0	0	0	0	0	0	0	0	0
1	72.67	1.50	8.60	8.44	8.60	8.44	8.52	8.52
2	145.33	3.00	24.73	24.57	16.13	16.13	16.13	24.65
3	218.00	4.50	50.00	50.00	25.27	25.43	25.35	50.00



From Graph

Ultimate Bearing Capacity : 111.00 KN/m²
Factor of Safety : 2.5
Allowable Bearing Capacity : 44.40 KN/m²
Settlement : 50.00 mm

4.525994 T/m²

ANNEX-2

FIELD TEST PHOTOGRAPHS



Photo-1: Trial Pit Excavation for PLT test



Photo-2: PLT test apparatus arrangement



Photo-3: PLT test apparatus arrangement



Photo-4: Recording field test data



Photo-5: Recording field test data



Photo-6: Providing Hydraulic loading

**A REPORT
ON
PLATE LOAD TEST
FOR
GEOLOGICAL SURVEY
FOR
THE PROJECT FOR IMPROVEMENT OF WATER SUPPLY
SYSTEM IN BIRATNAGAR
AT
NEW CANDIDATE NO.5 PUMP STATION SITE**



CLIENT
NEPAL WATER SUPPLY CORPORATION (NWSC)
Kathmandu, Nepal

CONSULTANT
YACHIYO ENGINEERING CO., LTD.
Tokyo, Japan



PREPARED AND SUBMITTED BY
PLANET TEST (P.) LTD.
KMC-31, Shantinagar, Kathmandu
Telephone: 977-1- 4107665
E-mail: planettest2074@gmail.com

December, 2020

Report on Plate Load Test for the Geological Survey for the Project for improvement of water Supply System in Biratnagar
At NEW CANDIDATE NO.5 PUMP STATION SITE

Table of Contents

1. INTRODUCTION.....	1
2. DESCRIPTION OF SITE.....	1
3. OBJECTIVES.....	1
4. PLATE LOADING APPARATUS.....	1
5. FIELD WORK PROCEDURE.....	2
6. ANALYSIS AND RESULTS OF PLATE LOAD TEST.....	3
7. CONCLUSION AND RECOMMENDATION.....	4
8. LIMITATIONS AND UNIFORMITY OF CONDITIONS.....	4

ANNEXES

<u>Annex No.</u>	<u>Title</u>
1	FIELD TEST DATA AND CALCULATION
2	FIELD TEST PHOTOGRAPHS

Page 1

Report on Plate Load Test for the Geological Survey for the Project for improvement of water Supply System in Biratnagar
At NEW CANDIDATE NO.5 PUMP STATION SITE

1. INTRODUCTION

The suitability of the foundation depends upon the geometrical and the strength property of the soil strata. The Plate Load test in one part of geotechnical investigation to get the ultimate load capacity of ground strata and to determine the load settlement relationships under compression load. The plate load test has been done as per the agreement between YACHIYO ENGINEERING Co. LTD., Tokyo, Japan and PLANET TEST (P.) LTD., Shantinagar, Kathmandu, Nepal to determine the bearing capacity, settlement of soil strata of New Candidate No. 5 Pump Station Site, Biratnagar, Morang.

2. DESCRIPTION OF SITE

The New Candidate No. 5 Pump Station site is located on Biratnagar Metropolitan City-5, Kularba, Morang. The proposed site is access through vehicle easily from Koshi Highway. There is presence of existence Shree Siddhakali School nearby the proposed New Candidate No. 5 Pump Station site. The Kularba Site is flat terrain and there is lack of proper drainage facilities however the other physical facilities such as electricity, water supply etc were not easily access at the site.

3. OBJECTIVES

The plate load test is an important test of geotechnical investigation to find out the strength and compression properties of the ground strata. This assignment of conducting plate load test is to get reliable information on:

- a) The bearing capacity of Soil strata at 1.5m depth.
- b) The pressure settlement relation of soil strata.

4. PLATE LOADING APPARATUS

The plate load test is a semi-direct method to estimate the allowable bearing pressure of soil to induce a given amount of settlement. The ASTM D1194-94 has been followed for the equipment setup and the test procedure for plate load test on single column.

The loading apparatus consists of the following apparatus:

1. **Bearing Plate:** Square steel plate bearing plate 2.5 cm thickness and 45 cm X 45 cm in dimension.
2. **Hydraulic Jack:** Hydraulic Jack of Capacity 100 ton (1000 KN).
3. **Settlement recording devices:** Dial gauge capable of measuring settlement of the loaded plate to an accuracy of 0.001 mm.
4. **Reaction Load:** Excavator of loading capacity of 20 tonne
5. **Miscellaneous apparatus including:**
 - 5.1 Compression Post
 - 5.2 Reference beam steel stands

Report on Plate Load Test for the Geological Survey for the Project for improvement of water Supply System in Biratnagar
At NEW CANDIDATE NO.5 PUMP STATION SITE

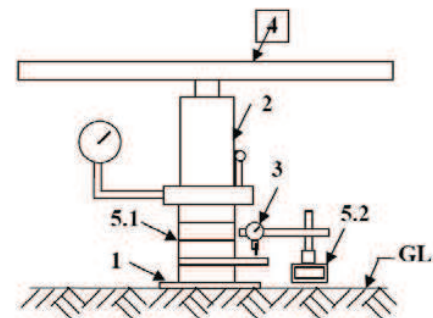


Figure-1: Plate Loading Apparatus arrangement

Plates, square in shape having sizes 0.45m X 0.45m dia and thickness of about 25 mm are has been used for this test. The load on the plate is applied by hydraulic jack. The reaction of the jack load is taken by an excavator of having load more than 1.5 times the design load. The settlement of the plate is measured by a set of two dial gauges of sensitivity 0.01 mm placed at about 180° apart. The dial gauges are fixed to independent supports which do not get disturbed during the test.

5. FIELD WORK PROCEDURE

The fieldwork was scheduled on December 1st, 2020. At the time of investigation a team of experts and workers with necessary equipment were mobilized to the site to conduct the plate load test.

The Plate load test at the proposed site is conducted at 1.5 m depth from the existing ground level. During the field tests, a 100 tons hydraulic jack was used to press the soil strata below by a 45cm x 45 cm square steel plate of thickness 25 mm. The plate was kept at the center of open excavated rectangular pit of about 1.5 m depth. Ram of Hydraulic jack was rested at the boom of 20.0 tons excavator.

A seating load of 1.5 t was applied with hydraulic jack and released after some time. The load was then gradually increased from 1.5 to 3, 4.5, 6 (tons) respectively. For each increment of loading the settlement of steel plate was recorded with the two different dial gauges till the rate of settlement is less than 0.25mm per hour.

Report on Plate Load Test for the Geological Survey for the Project for improvement of water Supply System in Biratnagar
At NEW CANDIDATE NO.5 PUMP STATION SITE

Testing was continued until one of the following stages were reached (i) the settlement became definitely progressive which indicated shear failure, (ii) the applied pressure was exceeded 3 times the allowable pressure, or (iii) the total settlement exceeded 10% the width of the plate. The load was then released. The recorded load and deformation has been attached to the annex.

6. ANALYSIS AND RESULTS OF PLATE LOAD TEST

The result obtained from the test following the applied pressure exceeds 3 times the allowable pressure. The average of the settlements recorded by both dial gauges is taken as the settlements of the plate for each of the load increment. A graph is plotted between applied pressure intensity versus final settlement on linear scales and time-settlement-curve on log-log scales, as shown in Fig. to the Annex.

From the curve shows the nature of semi cohesive soil under pressure where in the ultimate failure point is found out by crossing two tangents at a common point in such a way that tangents could be drawn to the two distinct curvatures. The intersection of the two tangents gives the net ultimate bearing capacity of the plate.

Further, allowable safe bearing capacity is found out by dividing the ultimate load intensity by a factor of safety, usually taken as 2.5.

For Plate Load Test No-1

- a. Hence, (i) allowable bearing capacity = ultimate bearing capacity / factor of safety
= $138.00/2.5$
= 55.20 KN/m^2
- b. As the rate of settlement is found minimum with respect to time, which is seen in the time-settlement graph the permissible long-term settlement could be opted for the minimum value (50.00 mm).
- c. Estimation of Modulus of Sub-grade Reaction (K-Value)
 $K = \text{Ultimate Bearing Capacity} / \text{Settlement of Plate}$
= $138.00/0.050$
= 2760.00 KN/m^3
- d. Wet soil was found around at vicinity of the foundation trench.

For Plate Load Test No-2

- a. Hence, (i) allowable bearing capacity = ultimate bearing capacity / factor of safety
= $210.00/2.5$
= 84.00 KN/m^2

Report on Plate Load Test for the Geological Survey for the Project for improvement of water Supply System in Biratnagar
At NEW CANDIDATE NO.5 PUMP STATION SITE

- b. As the rate of settlement is found minimum with respect to time, which is seen in the time-settlement graph the permissible long-term settlement could be opted for the minimum value (50.00 mm).
- c. Estimation of Modulus of Sub-grade Reaction (K-Value)
 $K = \text{Ultimate Bearing Capacity} / \text{Settlement of Plate}$
= $210.00/0.050$
= 4200.00 KN/m^3
- d. Wet soil was found around at vicinity of the foundation trench.

For Plate Load Test No-3

- a. Hence, (i) allowable bearing capacity = ultimate bearing capacity / factor of safety
= $185.00/2.5$
= 74.00 KN/m^2
- b. As the rate of settlement is found minimum with respect to time, which is seen in the time-settlement graph the permissible long-term settlement could be opted for the minimum value (50.00 mm).
- c. Estimation of Modulus of Sub-grade Reaction (K-Value)
 $K = \text{Ultimate Bearing Capacity} / \text{Settlement of Plate}$
= $185.00/0.050$
= 3700.00 KN/m^3
- d. Wet soil was found around at vicinity of the foundation trench.

7. CONCLUSION AND RECOMMENDATION

- o All the tests were failed during the field work as permissible settlement was exceed before the designed load was provided.
- o All the test were conducted in wet soil conditions since it was not possible to achieve dry soil conditions on the site even after 5 months of monsoon.
- o It is observed that soil needs to be treated before any foundation construction works is done.
- o The ground water at the site is high and ground water treatment needs to be done before constructing foundation.

8. LIMITATIONS AND UNIFORMITY OF CONDITIONS

- o The recommendations of this report pertain only to the site investigated and are based upon the assumption that the

Report on Plate Load Test for the Geological Survey for the Project for improvement of water Supply System in Biratnagar
At NEW CANDIDATE NO.5 PUMP STATION SITE

soil conditions do not deviate from those disclosed in the investigation. If any variations or undesirable conditions are encountered during construction, or if the proposed construction will differ from that anticipated herein, Planet Test should be notified so that supplement recommendation can be given.

- o This report is issued with the understanding that it is the responsibility of the client, or of their representative, to ensure that the information and recommendations contained herein are brought to the attention of the design engineer for the project and incorporated into the plan, and the necessary steps are taken to see that the contractor and the sub-contractor carry out such recommendations in the field.
- o The findings of this report are valid as of the present date. However, changes in the conditions of a property can occur with the passage of time, whether they are due to natural process or the works of man on this or adjacent properties.

**ANNEX-1
FIELD TEST DATA
&
CALCULATIONS**

PLATE LOAD TEST
ASTM D1194-94

Project: Improvement of Water Supply System of Biratnagar
Client: Nepal Water Supply Corporation, Kathmandu
Location: New Candidate No. 5 Pump Station Site, Damabandi
Consultant: Yachiyo Engineering Co. Ltd

PLT No.: 3
Eastng: 87° 15' 17.57"
Northng: 26° 28' 25.00"
Date: Dec-1, 2020

Field Settlement Data

Load in Tonne	Load in KN/m ²	Time	Time Interval	Dial Gauge Reading		Settlement		Average Settlement	Cumulative Settlement	Total Settlement	Remark
				DG-1	DG-2	D1	D2				
1.5	72.667	10:30	-	0.00	0.00	0.00	0.00	0.00	-	7.57	
		10:31	1	4.12	4.06	4.12	4.06	4.09	4.09		
		10:32	2	5.10	5.07	0.98	1.01	0.99	5.08		
		10:34	4	5.47	5.53	0.37	0.46	0.42	5.50		
		10:38	8	6.72	6.82	1.26	1.29	1.27	6.77		
		10:45	15	7.01	7.14	0.29	0.32	0.30	7.07		
		11:00	30	7.45	7.53	0.44	0.40	0.42	7.49		
		11:15	45	7.52	7.61	0.07	0.08	0.07	7.57		
		11:30	60	7.52	7.62	0.00	0.01	0.00	7.57		
		11:32	-	13.62	13.54	6.10	5.92	6.01	13.58		
3	145.333	11:33	1	14.08	14.00	0.46	0.45	0.46	14.04	15.41	
		11:34	2	14.46	14.38	0.38	0.38	0.38	14.42		
		11:36	4	14.69	14.61	0.23	0.23	0.23	14.65		
		11:44	8	15.01	14.93	0.32	0.33	0.33	14.97		
		11:47	15	15.35	15.27	0.34	0.33	0.34	15.31		
		12:02	30	15.41	15.38	0.06	0.11	0.08	15.39		
		12:17	45	15.42	15.38	0.01	0.00	0.01	15.40		
		12:32	60	15.43	15.39	0.00	0.00	0.00	15.41		
		12:35	-	19.80	20.17	4.38	4.78	4.58	19.98		
		12:36	1	20.14	20.56	0.34	0.41	0.38	20.36		
12:37	2	20.71	21.08	0.57	0.50	0.54	20.89				
12:39	4	22.94	23.31	2.23	2.23	2.23	23.12				
12:43	8	24.50	24.83	1.56	1.52	1.54	24.66				
12:50	15	26.45	26.91	1.95	2.08	2.01	26.68				
1:05	30	28.53	28.69	2.08	1.79	1.93	28.61				
1:20	45	28.79	28.90	0.27	0.21	0.24	28.84				
1:50	60	28.80	28.91	0.01	0.01	0.01	28.86				
1:53	-	31.91	31.98	3.11	3.07	3.09	31.95				
1:54	1	35.63	35.72	3.72	3.74	3.73	35.68	50			
1:55	2	36.70	36.76	1.07	1.04	1.05	36.73				
1:57	4	38.29	38.44	1.60	1.68	1.64	38.37				
1:11	8	39.67	40.09	1.58	1.65	1.61	39.98				
2:08	15	42.65	42.94	2.78	2.85	2.81	42.79				
2:23	30	45.22	45.54	2.57	2.60	2.59	45.38				
2:38	45	50.00	50.00	4.79	4.46	4.62	50.00				

PLATE LOAD TEST
ASTM D1194-94

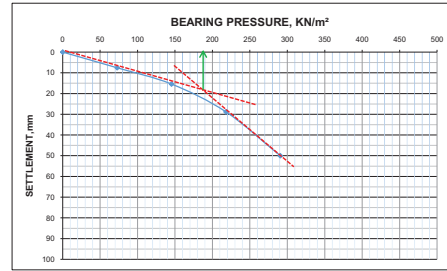
Project: Improvement of Water Supply System of Biratnagar
Client: Nepal Water Supply Corporation, Kathmandu
Location: New Candidate No. 5 Pump Station Site, Damabandi
Consultant: Yachiyo Engineering Co. Ltd

PLT No.: 3
Eastng: 87° 15' 17.57"
Northng: 26° 28' 25.00"
Date: Dec-1, 2020

Size of Plates : 0.45 * 0.45 m
Depth from GL : 1.5 m

L.C. of Dial Gauge: 0.01
Ground Water Table: 4 m

S.N.	Pressure Gauge Reading in KN/m ²	Load in Tonne	Dial Gauge Reading		Settlement		Average Settlement (mm)	Cumulative Settlement (mm)
			DG-1	DG-2	D1	D2		
0	0	0	0	0	0	0	0	0
1	72.67	1.50	7.52	7.62	7.52	7.62	7.57	7.57
2	145.33	3.00	15.43	15.39	7.90	7.77	7.84	15.41
3	218.00	4.50	28.80	28.91	13.38	13.53	13.45	28.86
4	290.67	6.00	50.00	50.00	21.20	21.09	21.15	50.00



From Graph

Ultimate Bearing Capacity : 185.00 KN/m²
Factor of Safety : 2.5
Allowable Bearing Capacity : 74.00 KN/m²
Settlement : 50.00 mm

7.54 T/m²

ANNEX-2

FIELD TEST PHOTOGRAPHS



Photo-1: Trial Pit Excavation for PLT test



Photo-2: Preparing Plate at the depth of 1.5m



Photo-3: PLT test apparatus arrangement



Photo-4: Dial gauge arrangement



Photo-5: Recording field test data



Photo-6: Recording field test data



Photo-7: Providing Hydraulic loading



Photo-8: Excavator at site

**A REPORT
ON
PLATE LOAD TEST
FOR
GEOLOGICAL SURVEY
FOR
THE PROJECT FOR IMPROVEMENT OF WATER SUPPLY
SYSTEM IN BIRATNAGAR
AT
NEW CANDIDATE KANCHANBARI PUMP STATION**



CLIENT
NEPAL WATER SUPPLY CORPORATION (NWSC)
Kathmandu, Nepal

CONSULTANT
YACHIYO ENGINEERING CO., LTD.
Tokyo, Japan



PREPARED AND SUBMITTED BY
PLANET TEST (P.) LTD.
KMC-31, Shantinagar, Kathmandu
Telephone: 977-1- 4107665
E-mail: planettest2074@gmail.com

December, 2020

Report on Plate Load Test for the Geological Survey for the Project for improvement of water Supply System in Biratnagar
At NEW CANDIDATE KANCHANBARI PUMP STATION

Table of Contents

1. INTRODUCTION.....	1
2. DESCRIPTION OF SITE.....	1
3. OBJECTIVES.....	1
4. PLATE LOADING APPARATUS.....	1
5. FIELD WORK PROCEDURE.....	2
6. ANALYSIS AND RESULTS OF PLATE LOAD TEST.....	3
7. CONCLUSION AND RECOMMENDATION.....	4
8. LIMITATIONS AND UNIFORMITY OF CONDITIONS.....	5

ANNEXES

<u>Annex No.</u>	<u>Title</u>
1	FIELD TEST DATA AND CALCULATION
2	FIELD TEST PHOTOGRAPHS

Report on Plate Load Test for the Geological Survey for the Project for improvement of water Supply System in Biratnagar
At NEW CANDIDATE KANCHANBARI PUMP STATION

1. INTRODUCTION

The suitability of the foundation depends upon the geometrical and the strength property of the soil strata. The Plate Load test is one part of geotechnical investigation to get the ultimate load capacity of ground strata and to determine the load settlement relationships under compression load. The plate load test has been done as per the agreement between YACHIYO ENGINEERING Co. LTD., Tokyo, Japan and PLANET TEST (P.) LTD., Shantinagar, Kathmandu, Nepal to determine the bearing capacity, settlement of soil strata of New Candidate Kanchanbari Pump Station, Biratnagar, Morang.

2. DESCRIPTION OF SITE

The New Candidate Kanchanbari Pump site is located on Biratnagar Metropolitan City-4, Kanchanbari, Morang. The building site is access through vehicle easily from Koshi Highway. There is presence of existence building outside the proposed Kanchanbari site. The Kanchanbari Site is flat terrain and there is lack of proper drainage facilities however the other physical facilities such as electricity, water etc were easily access at the site

3. OBJECTIVES

The plate load test is an important test of geotechnical investigation to find out the strength and compression properties of the ground strata. This assignment of conducting plate load test is to get reliable information on:

- a) The bearing capacity of Soil strata at 1.5m depth.
- b) The pressure settlement relation of soil strata.

4. PLATE LOADING APPARATUS

The plate load test is a semi-direct method to estimate the allowable bearing pressure of soil to induce a given amount of settlement. The ASTM D1194-94 has been followed for the equipment setup and the test procedure for plate load test on single column.

The loading apparatus consists of the following apparatus:

1. **Bearing Plate:** Square steel plate bearing plate 2.5 cm thickness and 45 cm X 45 cm in dimension.
2. **Hydraulic Jack:** Hydraulic Jack of Capacity 100 ton (1000 KN).
3. **Settlement recording devices:** Dial gauge capable of measuring settlement of the loaded plate to an accuracy of 0.001 mm.
4. **Reaction Load:** Excavator of loading capacity of 20 tonne
5. **Miscellaneous apparatus including:**
 - 5.1 Compression Post
 - 5.2 Reference beam steel stands

Report on Plate Load Test for the Geological Survey for the Project for improvement of water Supply System in Biratnagar
At NEW CANDIDATE KANCHANBARI PUMP STATION

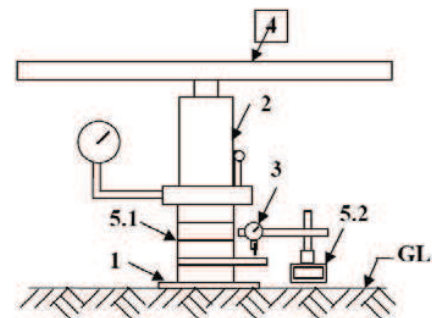


Figure-1: Plate Loading Apparatus arrangement

Plates, square in shape having sizes 0.45m X 0.45m dia and thickness of about 25 mm are has been used for this test. The load on the plate is applied by hydraulic jack. The reaction of the jack load is taken by an excavator of having load more than 1.5 times the design load. The settlement of the plate is measured by a set of two dial gauges of sensitivity 0.01 mm placed at about 180° apart. The dial gauges are fixed to independent supports which do not get disturbed during the test.

5. FIELD WORK PROCEDURE

The fieldwork was scheduled on December 6th, 2020. At the time of investigation a team of experts and workers with necessary equipment were mobilized to the site to conduct the plate load test.

The Plate load test at the proposed site is conducted at 1.5 m depth from the existing ground level. During the field tests, a 100 tons hydraulic jack was used to press the soil strata below by a 45cm x 45 cm square steel plate of thickness 25 mm. The plate was kept at the center of open excavated rectangular pit of about 1.5 m depth. Ram of Hydraulic jack was rested at the boom of 20.0 tons excavator.

A seating load of 1.5 t was applied with hydraulic jack and released after some time. The load was then gradually increased from 1.5 to 3, 4.5, 6 (tons) respectively. For each increment of loading the settlement of steel plate was recorded with the two different dial gauges till the rate of settlement is less than 0.25mm per hour.

Report on Plate Load Test for the Geological Survey for the Project for improvement of water Supply System in Biratnagar
At NEW CANDIDATE KANCHANBARI PUMP STATION

Testing was continued until one of the following stages were reached (i) the settlement became definitely progressive which indicated shear failure, (ii) the applied pressure was exceeded 3 times the allowable pressure, or (iii) the total settlement exceeded 10% the width of the plate. The load was then released. The recorded load and deformation has been attached to the annex.

6. ANALYSIS AND RESULTS OF PLATE LOAD TEST

The result obtained from the test following the applied pressure exceeds 3 times the allowable pressure. The average of the settlements recorded by both dial gauges is taken as the settlements of the plate for each of the load increment. A graph is plotted between applied pressure intensity versus final settlement on linear scales and time-settlement-curve on log-log scales, as shown in Fig. to the Annex.

From the curve shows the nature of semi cohesive soil under pressure where in the ultimate failure point is found out by crossing two tangents at a common point in such a way that tangents could be drawn to the two distinct curvatures. The intersection of the two tangents gives the net ultimate bearing capacity of the plate.

Further, allowable safe bearing capacity is found out by dividing the ultimate load intensity by a factor of safety, usually taken as 2.5.

For Plate Load Test No-1

- a. Hence, (i) allowable bearing capacity = ultimate bearing capacity / factor of safety
= 197.00/2.5
= 78.80 KN/m²
- b. As the rate of settlement is found minimum with respect to time, which is seen in the time-settlement graph the permissible long-term settlement could be opted for the minimum value (50.00 mm).
- c. Estimation of Modulus of Sub-grade Reaction (K-Value)
K= Ultimate Bearing Capacity/ Settlement of Plate
= 197.00/0.050
= 3940.00 KN/m³
- d. Wet soil was found around at vicinity of the foundation trench.

For Plate Load Test No-2

- a. Hence, (i) allowable bearing capacity = ultimate bearing capacity / factor of safety
= 120.00/2.5
= 48.00 KN/m²

Report on Plate Load Test for the Geological Survey for the Project for improvement of water Supply System in Biratnagar
At NEW CANDIDATE KANCHANBARI PUMP STATION

- b. As the rate of settlement is found minimum with respect to time, which is seen in the time-settlement graph the permissible long-term settlement could be opted for the minimum value (50.00 mm).
- c. Estimation of Modulus of Sub-grade Reaction (K-Value)
K= Ultimate Bearing Capacity/ Settlement of Plate
= 120.00/0.050
= 2400.00 KN/m³
- d. Wet soil was found around at vicinity of the foundation trench.

For Plate Load Test No-3

- a. Hence, (i) allowable bearing capacity = ultimate bearing capacity / factor of safety
= 197.00/2.5
= 78.80 KN/m²
- b. As the rate of settlement is found minimum with respect to time, which is seen in the time-settlement graph the permissible long-term settlement could be opted for the minimum value (50.00 mm).
- c. Estimation of Modulus of Sub-grade Reaction (K-Value)
K= Ultimate Bearing Capacity/ Settlement of Plate
= 197.00/0.050
= 3940.00 KN/m³
- d. Wet soil was found around at vicinity of the foundation trench.

7. CONCLUSION AND RECOMMENDATION

- o All the tests were failed during the field work as permissible settlement was exceed before the designed load was provided.
- o All the test were conducted in wet soil conditions since it was not possible to achieve dry soil conditions on the site even after 5 months of monsoon.
- o It is observed that soil needs to be treated before any foundation construction works is done.
- o The ground water at the site is high and ground water treatment needs to be done before constructing foundation.

Report on Plate Load Test for the Geological Survey for the Project for improvement of water Supply System in Biratnagar
At NEW CANDIDATE KANCHANBARI PUMP STATION

8. LIMITATIONS AND UNIFORMITY OF CONDITIONS

- o The recommendations of this report pertain only to the site investigated and are based upon the assumption that the soil conditions do not deviate from those disclosed in the investigation. If any variations or undesirable conditions are encountered during construction, or if the proposed construction will differ from that anticipated herein, Planet Test should be notified so that supplement recommendation can be given.
- o This report is issued with the understanding that it is the responsibility of the client, or of their representative, to ensure that the information and recommendations contained herein are brought to the attention of the design engineer for the project and incorporated into the plan, and the necessary steps are taken to see that the contractor and the sub-contractor carry out such recommendations in the field.
- o The findings of this report are valid as of the present date. However, changes in the conditions of a property can occur with the passage of time, whether they are due to natural process or the works of man on this or adjacent properties.

**ANNEX-1
FIELD TEST DATA
&
CALCULATIONS**

PLANET TEST (P.) LTD.

CONSULTING ENGINEERS
Kathmandu Metropolitan City, Ward No-31, Shantinagar, Kathmandu, Nepal
Tel +977-01-4107665

PLATE LOAD TEST

ASTM D1194-94

Project: Improvement of Water Supply System of Biratnagar
Client: Nepal Water Supply Corporation, Kathmandu
Location: New Candidate Kanchanbari Pump Station Site
Consultant: Yachyo Engineering Co. Ltd

PLT No.: 1
Easting: 87° 16' 36.15"
Northing: 26° 29' 24.99"
Date: Dec-6, 2020

Field Settlement Data

Table with columns: Load in Tonne, Load in KN/m², Time, Time Interval, Dial Gauge Reading (DG-1, DG-2, D1, D2), Settlement, Average Settlement, Cumulative Settlement, Total Settlement, Remark.

PLANET TEST (P.) LTD.

CONSULTING ENGINEERS
Kathmandu Metropolitan City, Ward No-31, Shantinagar, Kathmandu, Nepal
Tel +977-01-4107665

PLATE LOAD TEST

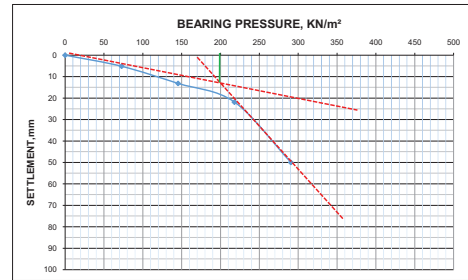
ASTM D1194-94

Project: Improvement of Water Supply System of Biratnagar
Client: Nepal Water Supply Corporation, Kathmandu
Location: Muna Path Pump Station Site, Biratnagar
Consultant: Yachyo Engineering Co. Ltd

PLT No.: 1
Easting: 87° 16' 36.15"
Northing: 26° 29' 24.99"
Date: Dec-6, 2020

Size of Plates : 0.45 * 0.45 m
Depth from GL: 1.5 m
L.C. of Dial Gauge: 0.01
Ground Water Table: 4 m

Summary table with columns: S.N., Pressure Gauge Reading in KN/m², Load in Tonne, Dial Gauge Reading (DG-1, DG-2, D1, D2), Average Settlement (mm), Cumulative Settlement (mm).



From Graph
Ultimate Bearing Capacity: 197.000 KN/m²
Factor of Safety: 2.5
Allowable Bearing Capacity: 78.80 KN/m²
Settlement: 50.00 KN/m²

PLANET TEST (P.) LTD.

CONSULTING ENGINEERS
Kathmandu Metropolitan City, Ward No-31, Shantinagar, Kathmandu, Nepal
Tel +977-01-4107665

PLATE LOAD TEST

ASTM D1194-94

Project: Improvement of Water Supply System of Biratnagar
Client: Nepal Water Supply Corporation, Kathmandu
Location: New Candidate Kanchanbari Pump Station Site
Consultant: Yachyo Engineering Co. Ltd

PLT No.: 2
Easting: 87° 16' 35.43"
Northing: 26° 29' 24.87"
Date: Dec-5, 2020

Field Settlement Data

Table with columns: Load in Tonne, Load in KN/m², Time, Time Interval, Dial Gauge Reading (DG-1, DG-2, D1, D2), Settlement, Average Settlement, Cumulative Settlement, Total Settlement, Remark.

PLANET TEST (P.) LTD.

CONSULTING ENGINEERS
Kathmandu Metropolitan City, Ward No-31, Shantinagar, Kathmandu, Nepal
Tel +977-01-4107665

PLATE LOAD TEST

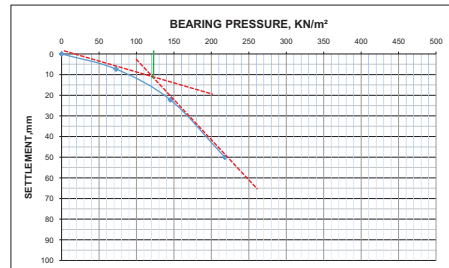
ASTM D1194-94

Project: Improvement of Water Supply System of Biratnagar
Client: Nepal Water Supply Corporation, Kathmandu
Location: New Candidate Kanchanbari Pump Station Site
Consultant: Yachyo Engineering Co. Ltd

PLT No.: 2
Easting: 87° 16' 35.43"
Northing: 26° 29' 24.87"
Date: Dec-5, 2020

Size of Plates : 0.45 * 0.45 m
Depth from GL: 1.5 m
L.C. of Dial Gauge: 0.01
Ground Water Table: 4 m

Summary table with columns: S.N., Pressure Gauge Reading in KN/m², Load in Tonne, Dial Gauge Reading (DG-1, DG-2, D1, D2), Average Settlement (mm), Cumulative Settlement (mm).



From Graph
Ultimate Bearing Capacity: 120.000 KN/m²
Factor of Safety: 2.5
Allowable Bearing Capacity: 48.00 KN/m²
Settlement: 50.00 KN/m²

PLATE LOAD TEST
ASTM D1194-94

Project: Improvement of Water Supply System of Biratnagar
Client: Nepal Water Supply Corporation, Kathmandu
Location: New Candidate Kancharbari Pump Station Site
Consultant: Yachiyo Engineering Co. Ltd

PLT No.: 3
Easting: 87° 16' 35.64"
Northing: 26° 29' 24.36"
Date: Dec-5, 2020

Field Settlement Data

Load in Tonne	Load in KN/m ²	Time	Time Interval	Dial Gauge Reading		Settlement		Average Settlement	Cumulative Settlement	Total Settlement	Remark
				DG-1	DG-2	D1	D2				
1.5	72.667	2:00	-	0.00	0.00	0.00	0.00	0.00	-	7.29	
		2:01	1	11.10	11.34	11.10	11.34	11.22	11.22		
		2:02	2	12.58	11.91	1.48	0.57	1.03	12.25		
		2:04	4	13.90	12.62	1.32	0.71	1.02	13.26		
		2:08	8	14.99	13.65	1.09	1.03	1.06	14.32		
		2:15	15	16.02	14.68	1.03	1.03	1.03	15.35		
		2:30	30	16.60	15.19	0.58	0.51	0.55	15.90		
		2:45	45	17.05	16.01	0.45	0.82	0.64	16.53		
		3:00	60	17.07	16.02	0.02	0.01	0.01	16.55		
		3:02	-	18.50	18.60	1.43	2.58	2.01	18.55		
3	145.333	3:03	1	20.35	20.25	1.85	1.65	1.75	20.30	29.26	Exceed permissible settlement of 25 mm
		3:04	2	22.32	22.82	1.97	2.57	2.27	22.57		
		3:06	4	24.56	24.68	2.24	1.86	2.05	24.62		
		3:10	8	25.15	25.35	0.59	0.67	0.63	25.25		
		3:17	15	26.78	26.98	1.63	1.63	1.63	26.88		
		3:32	30	27.42	27.62	0.64	0.64	0.64	27.52		
		3:47	45	28.45	28.55	1.03	0.93	0.98	28.50		
		4:02	60	29.21	29.31	0.76	0.76	0.76	29.26		
		4:08	-	42.34	42.56	13.13	13.25	13.19	42.45		
		4:09	1	44.78	44.81	2.44	2.25	2.35	44.80		
4.5	218.000	4:10	2	48.53	48.64	3.75	3.83	3.79	48.59	50.00	
		4:12	4	50.00	50.00	1.47	1.36	1.42	50.00		

PLATE LOAD TEST
ASTM D1194-94

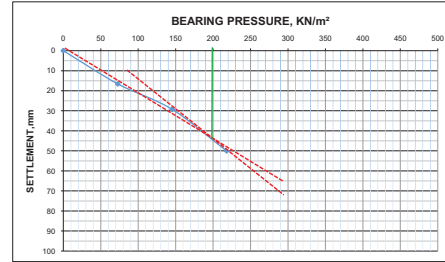
Project: Improvement of Water Supply System of Biratnagar
Client: Nepal Water Supply Corporation, Kathmandu
Location: New Candidate Kancharbari Pump Station Site
Consultant: Yachiyo Engineering Co. Ltd

PLT No.: 3
Easting: 87° 16' 35.64"
Northing: 26° 29' 24.36"
Date: Dec-5, 2020

Size of Plates : 0.45 * 0.45 m
Depth from GL: 1.5 m

L.C. of Dial Gauge: 0.01
Ground Water Table: 4 m

S.N.	Pressure Gauge Reading in KN/m ²	Load in Tonne	Dial Gauge Reading		Settlement		Average Settlement (mm)	Cumulative Settlement (mm)
			DG-1	DG-2	D1	D2		
0	0	0	0	0	0	0	0	0
1	72.667	1.5	17.07	16.02	17.07	16.02	16.55	16.55
2	145.333	3	29.21	29.31	12.14	13.29	12.72	29.26
3	218.000	4.5	50.00	50.00	20.79	20.69	20.74	50.00



From Graph

Ultimate Bearing Capacity: 197.000 KN/m²
Factor of Safety: 2.5
Allowable Bearing Capacity: 78.80 KN/m² 8.03262 T/m²
Settlement: 50.00 KN/m³

ANNEX-2

FIELD TEST PHOTOGRAPHS



Photo-1: Trial Pit Excavation for PLT test



Photo-2: Preparing PLT surface at 1.5m depth



Photo-3: PLT test apparatus arrangement



Photo-4: Dial gauge arrangement



Photo-5: Recording field test data



Photo-6: Recording field test data



Photo-7: Providing Hydraulic loading



Photo-8: Unloading Excavator at site

資料-6-4 垂直電氣探查結果

FINAL REPORT
ON
VERTICAL ELECTRIC RESISTIVITY SURVEY
FOR
THE PREPARATORY SURVEY ON THE PROJECT FOR
IMPROVEMENT OF WATER SUPPLY SYSTEM
IN BIRATNAGAR,
FEDERAL DEMOCRATIC REPUBLIC OF NEPAL
2019



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Vertical electric resistivity survey for the preparatory survey on the project for improvement of water supply system in Biratnagar in the federal democratic republic of Nepal- 2019

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CHAPATER 1: GENERAL INTRODUCTION

1.1 Background

Water is excelsior to life; without it life is not possible. Most of the Civilizations have flourished in the world with the development of reliable water supplies – and then collapsed as the water supplies failed. As viewed from spacecraft, the earth appears to have a blue green cast owing, because of the vast quantities of water covering the earth. Mainly the water from the earth is divided into surface water and groundwater. Groundwater is a very important natural resource. This resource can be extracted from the subsurface aquifer all around the year for purposes like irrigation, industry, drinking water etc. These aquifers get recharged during the monsoon period from infiltration of rain water. This renewed resource (groundwater) can again be used during the next season; and cycle goes on every year. Unlike surface water, it can also be exploited at or nearby the place of use and can be used only when necessity is felt. Short drought does not affect groundwater supply seriously like the surface water. Hence it can be a very good source for regular and reliable supply of water. Due to these advantages, groundwater is being used widely for various purposes.

Groundwater is the water present beneath Earth's surface in pores in soil and in fractures of rock formations. It is stored in and moves slowly through geologic formations of soil, sand and rocks called aquifers. It gets completely saturated in voids at the depth on pores spaces of soil or fractures and forms water table. Ground water recharge or deep drainage is hydrologic process where water moves downward from surface water to groundwater.

An aquifer is a layer of relatively porous substrate that contains and transmits groundwater. When water can flow directly between the surface and saturated zone of an aquifer then the aquifer is unconfined aquifer. The deep parts of unconfined aquifers are generally more saturated since gravity causes the water to flow downwards. The upper levels of this saturated layer of an unconfined aquifer are known as the water table or phreatic surface. Below the water table, where generally all the pore spaces are saturated with water is called the phreatic zone. Substrate with relatively low porosity that permits limited transmission of groundwater is called an aquitard. An aquiclude is a substrate with porosity which is so low it is virtually impermeable to the groundwater. A confined aquifer is that aquifer which is overlain by a relatively impermeable layer of a rock or a substrate such as an aquiclude or aquitard. If a confined aquifer is following a downward grade from its recharge zone then the groundwater can become pressurized as it flows.



This usually creates artesian wells which flow freely without the need of any pump and rise to a higher level than the static water table at the above unconfined aquifer. The properties of aquifers vary with the geology and the structure of the substrate and the topography in which they occur. Usually, the more productive aquifers are found in the sedimentary geologic formations. Relatively, the weathered and the fractured crystalline rocks yield smaller amount of groundwater in most of the environments. Unconsolidated poor cemented alluvial materials that have aggregated as valley-filling sediments in the major river valleys and the geologically subsiding structural basins are included among the most productive sources of groundwater.

Groundwater is not found everywhere. Lithological layers consisting of coarse grains of sediments like sands, gravels form good reservoir or aquifer but layers containing of finer grains of sediments like silts, clay do not form good reservoir or aquifer. Such layers may contain water in them but cannot move from them easily due to lack of permeability. Similarly, there is less chance for groundwater to be trapped in the hard-compact rock terrain, but good chance exists in fractured, jointed rocks. Hence to increase the chance of success of groundwater exploitation (Drilling), a prior study employing suitable scientific method is to be conducted in the area under consideration. Since the demand of groundwater increases with population growth, it is necessary to explore groundwater more intensively adequately and accurately. There are many geophysical methods, which plays a vital role in the exploration of groundwater. One of the best and reliable geophysical methods for the groundwater exploration is Electrical Resistivity method. This method is very useful to understand the hidden subsurface hydrogeological condition

YACHHYO ENGINEERING CO., LTD. has concluded a contract on Consulting Services for the Preparatory Survey for the Project for Improvement of Water Supply System in Biratnagar with JAPAN International Cooperation Agency (JICA). As a part of the project, for the assessment of hydro-geological condition of the area and to locate the probable area before drilling, Geophysical Method (Electrical Resistivity Survey) is desirable and for this purpose of geophysical survey, Vertical Electrical Sounding (VES) has been proposed in five different location at five wards of Biratnagar Metropolitan City. YACHHYO ENGINEERING CO., LTD. has contracted Explorer Geophysical Consultants, Kathmandu Nepal to carryout Vertical Electrical Sounding (VES) survey in the area. Consultant had carried out survey at ten different points located at five different wards around Biratnagar Metropolitan City, Morang District, Nepal.



1.2 Field Visit Program

The field visit program for the Geophysical Survey was conducted by the team comprising of, Geophysicist, Hydro-geologist, Technical Assistants and Local Labors. Field work was carried out on Nov 17, 2019 to Nov 20, 2019. Team returned to head office after completing field works.

1.3 Location and Accessibility

The present study area is located in Biratnagar Metropolitan City, Morang District of Eastern Nepal. The survey site is easily accessible by air and road network from Kathmandu. Each survey location is easily accessible by road network. Geographical location of the study area with their respective wards is as shown in Table 1.1:

Table 1-1 Study Area with Geographical Locations

VES	Geographical Location	Ward No.	Location
VES 1	26°27'5.26"N 87°17'38.68"E 72m (amsl)	8	NWSC -7 (Madhumara, Ashok Chowk)
VES 2	26°27'1.78"N 87°17'44.06"E 72m (amsl)	8	NWSC -7 (Madhumara, Ashok Chowk)
VES 3	26°29'12.36"N 87°17'46.67"E 75m (amsl)	19	NWSC-4 (Khadara Tole)
VES 4	26°29'24.26"N 87°17'55.05"E 75m (amsl)	19	NWSC-4 (Khadara Tole)
VES 5	26°28'32.46"N 87°15'15.12"E 74m (amsl)	5	NWSC- 5 (Dama Bandi Tole)
VES 6	26°28'25.38"N 87°15'16.74"E 74m (amsl)	5	NWSC- 5 (Dama Bandi Tole)
VES 7	26°25'1.61"N 87°15'44.45"E 69m (amsl)	16	NWSC- 3 (Darahiya Tole)
VES 8	26°25'2.58"N 87°15'43.45"E 69m (amsl)	16	NWSC- 3 (Darahiya Tole)
VES 9	26°24'2.58"N 87°16'36.32"E	17	NWSC- 1 (Lenther factory area, Rani)



	65m (amsl)		
VES 10	26°24'3.91"N 87°16'37.99"E	17	NWSC- 1 (Leather factory area, Rani)



Figure 1-1: Map of Nepal Showing Study Area



Figure 1-2: Topography Map of the Study Area showing VES Locations



Figure 1-3: VES Locations on Google Earth Image



Figure 1-4: Location and Orientation of VES - 1 and VES - 2 on Google Earth Image



Figure 1-5: Location and Orientation of VES - 3 and VES - 4 on Google Earth Image



Figure 1-6: Location and Orientation of VES - 5 and VES - 6 on Google Earth Image





Figure 1-7: Location and Orientation of VES -7 and VES -8 on Google Earth Image



Figure 1-8: Location and Orientation of VES -9 and VES -10 on Google Earth Image



1.4 Scope and Objective

The main objective of the present study is to assess the groundwater potential of the study Area. The groundwater resource will be used for fulfilling the demand of water supply in Biratnagar Metropolitan City, Morang. To fulfill the objective, Geophysical Survey (Electrical Resistivity Survey- Vertical Electrical Sounding) was carried out in the area. The main aim of conducting Electrical Resistivity Survey is to find out the subsurface geological features related to water bearing zones (aquifer) for the extraction of reasonable volume of water and to find out drilling location and depth for the exploitation of ground water resource.

To meet the specific objectives, the scopes of work are as follows:

- Make assessment of topographical and morphological features of the area
- Review and Conduct general geological survey of the area
- Carry out Electrical Resistivity Survey (Vertical Electrical Sounding) at five locations for five points. However, ten points at five different locations has been carried out during the study.
- Compute, analyze and interpret field data (VES data) with computer added software.
- Make suggestion and recommendations on hydrogeological condition on the basis of VES interpretation, geological and geomorphological observations.
- Report Preparation.

1.5 Materials and Methodology

The methodology of the study consists of materials collection; literature collection and review, geological observation and geophysical (Electrical Resistivity Survey) survey, data computation, processing and interpretation; and finally report preparation.

The Survey was conducted with GD-10 Series Geo-electrical Resistivity/IP equipment manufactured by ST Geomatic Co., Ltd, China. Other accessories that were used during the study were District Map, GPS (Global Positioning System), Photographic Camera, etc. Literatures and information related to topography, climate, geology, of the area were collected and reviewed.

Resistivity Meter (GD-10 Series Geo-electrical Resistivity/IP equipment manufactured by ST Geomatic Co., Ltd, China) is used for vertical electrical resistivity sounding (VES). Global Positioning System (GPS) is used to take spot location of the observation point (VES- Point) and



other important features like dug wells, tube wells water body etc. Photograph was taken to characterize the topographical and morphological character of the area.

The general geology, hydrogeology of the area is taken from the geological map, hydrogeological map of the area prepared by Department of Mines and Geology. The description of the geology of the area is done from the published and unpublished literatures and verified in the field by observation and field measurement.



CHAPTER 2: GEOLOGY AND HYDROGEOLOGY OF THE STUDY AREA

2.1 Regional Geology of the Area:

Geologically, Nepal occupies the central sector of Himalayan arc. Nearly one third of the 2400 km long Himalayan range lies within Nepal. Nepal Himalaya is divided into five major zones, from north to south as shown in Figure 2-1 zones are

- Tibetan Tethys Himalaya,
- Higher Himalaya,
- Lesser Himalaya,
- Sub-Himalaya (Siwaliks) and
- Indo-Gangetic Plain.

Each zone is characterized by own lithology, tectonics, structures and geological history. The generalized geological map of Nepal is presented in figure 2-1. Geologically the study area lies at Indo-Gangetic Plain of Nepal consisting of Quaternary alluvial deposits.

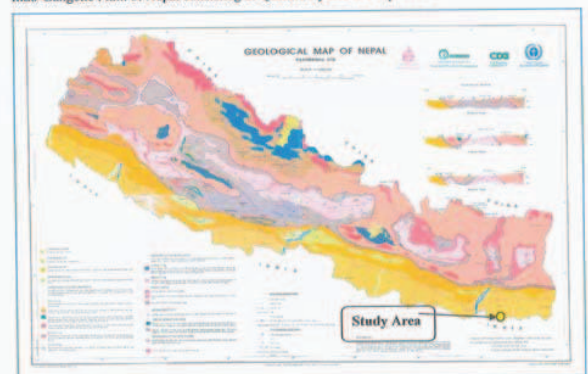


Figure 2-1: Regional Geological Map of Nepal Showing Study Area (DMG)



Indo-Gangetic Plain

The Gangetic Plain is also called as Terai Zone and it is the Nepalese portion of the Gangetic Plain that extends from the Indian Shield in the South to the Sub-Himalayan (Sivalik) Zone to the North. The plain is in less than 200 meters above sea level and usually has thick (nearly 1500 m) alluvial sediments. The alluvial sediments contain mainly boulder, gravel, silt and clay. The width of Terai Zone varies from 10 to 50 km and forms a nearly continuous belt from east to west. Exceptionally at two place, Chitwan and Rapti valleys, the Terai Zone is interrupted by Sivalik for 70 km and 80 km respectively. Terai Zone is a foreland basin and has sediment originated from peaks of Northern part. To the north, this zone is separated by an active thrust system called as the Main Frontal Thrust (MFT) with Sivalik. At some places along MFT, the Sivalik rocks are observed to rest over the recent sediments of the Terai (Dahal 2006).

A large number of borehole logs and geophysical investigation made during the groundwater investigation and petroleum exploration in Terai play a lead role to study the surface and subsurface geology of the Terai. It further helps to classify the Terai into Northern Terai or Bhabhar Zone, Middle Terai and Southern Terai.

Northern Terai (Bhabhar Zone)

The northern Terai is adjoining to the foothills of Sivalik and continues southward to a maximum width of 12 km. This part of Terai is also known as Bhabhar Zone. This zone is mainly composed of boulders, pebbles, cobbles and coarse sand derived from the rocks of Sivalik and Lesser Himalaya. These boulders, pebbles, and cobbles are mostly made up of sandstones and rocks from the immediate northern vicinity. Bhabhar Zone acts as a recharge zone for the groundwater of Terai. Most of the rivers lose their water while passing through this zone. In this Zone, water tables in wells show very sharp fluctuations between the summer and rainy seasons. At some places the wells become completely dry in summer. Due to the very coarse nature of the sediments, low water table and quick percolation of rainwater, this zone is particularly not productive for agriculture and therefore ideal for the development of forest resources.

Middle Terai (Marshy) Zone

This is a narrow zone of about 10-12 km wide and lying between the Northern Terai Zone and the Southern Terai Zone. This zone is characterized by pebbly and brown to grey colored unconsolidated sandy sediments with few clay partings. Clay is mostly dark grey colored and intercalated with brown colored sand layers. The medium to coarse grained sandy layers possesses



good groundwater reservoir. Because of marked change in elevation from Bhabhar Zone, this zone comprises marked development of spring line, natural ponds, marshland and lakes (Dahal 2006). Immediate south of spring lines, there are many artesian layers are found in depth of 25 m to 200 m. The permeability of Middle Terai Zone diminishes towards south and finally non permeable layers are encountered in boundary of the Southern Terai Zone.

Southern Terai Zone

Southern Terai Zone is southernmost part of Terai up to Nepal-India border and also continues into India. This zone consists of main sediments of Gangetic Plain. Basically, sand, silt and clay are the main sediments of this zone. This zone is composed of finer sediments than the Middle Terai Zone. To the extreme south bordering the Indian Plains, the sediments become finer and also show change of facies. The water table is about 3 m below the surface and aquifers are poor. Only in old river channels area north-south extending better aquifers are found. Therefore, except at the northern part and along old river channels, there are particularly no good aquifers in the lower horizons (Dahal, 2006). For this reason, in the southern Terai of Nepal, the development of the groundwater also appears to be difficult by deep tube wells.

2.2 Regional Geology of the Study Area

The study area is located near the Indo-Nepal border of Biratnagar Metropolitan City, Morang District, Province No-01, Nepal, which is represented by Pleistocene to Holocene sediments. The area is 78 meter above sea level (amsl) and usually has thick alluvial sediments. The alluvial sediments contain mainly gravel, coarse to fine sand, silt and clay. Terai plain is a foreland basin and has sediment originated from peaks of Northern part. To the north, this plain is separated by an active thrust system called as the Main Frontal Thrust (MFT) with Sivalik. At some places along MFT, the Sivalik rocks are observed to rest over the recent sediments of the Terai. The Terai plain is sub divided into the three zones respectively, Upper Terai, Middle Terai and Lower Terai. Geologically the study area lies in southern (Lower) Terai Zone of Indo-Gangetic Plain of Nepal. Mainly this zone consist sand, silt and clay. This zone is composed of finer sediments than the Middle Terai Zone. The sediments become finer and also show change of facies towards southern part. There are number of dug wells and shallow tube wells near at the survey area. Groundwater found at the depth of 5-10 m on the shallow subsurface, but these shallow aquifers cannot meet the increasing demand of the water supply. So, Geophysical survey was conducted to understand subsurface geology for extraction of groundwater from deep aquifers.



2.2.1 Quaternary Deposit

The valley floor comprises of the fluvio-lacustrine sediments made up of sand, silt, clay, pebbles, cobbles and boulder size particle brought up by the rivers from the northern part of the hills as well as from the southern parts. The sediment deposits of the valley floor can further be divided into 4 categories based on the type, nature and size of the sediments (Engineering Environmental Geological Map of Biratnagar Area, DMG).

Flood Plain Deposit:

It occurs along the river side on the flood plain itself. It has alluvial loose sediments consisting of fine to coarse sand.

Katahari Deposit:

It is clay dominant deposit and consists of grey, yellowish brown, brownish grey color silty clay, clay (5.3-11 m) at the top which is underlain by grey, brownish grey, fine to coarse grained sand. It is mainly developed in Katahari, Pokharia and Dhanpura areas.

Ramganj Deposit:

It consists of average 4 m thick yellowish brown silty clayey, clay layer at the top which is underlain by fine to coarse grain, brown, grey color sand layer. It is found in Ramganj, Jhatiyahi areas.

Buddhanagar Deposit:

It is considered as sand dominant deposit and consists of brownish grey, yellowish brown silty clay or clay layer (ranges from 0.3 m to 2.9 m) at the top which is followed by fine to coarse grain, dark brown, yellowish brown color sand (>4 m thick). It is mainly found in Darahiya and Buddhanagara areas.

VES 1, VES 2, VES 3, VES 4, VES 5, VES 6, VES 9 and VES 10 lies in the Ramganj Deposit.

VES 7 and VES 8 lies in the Buddhanagar Deposit.

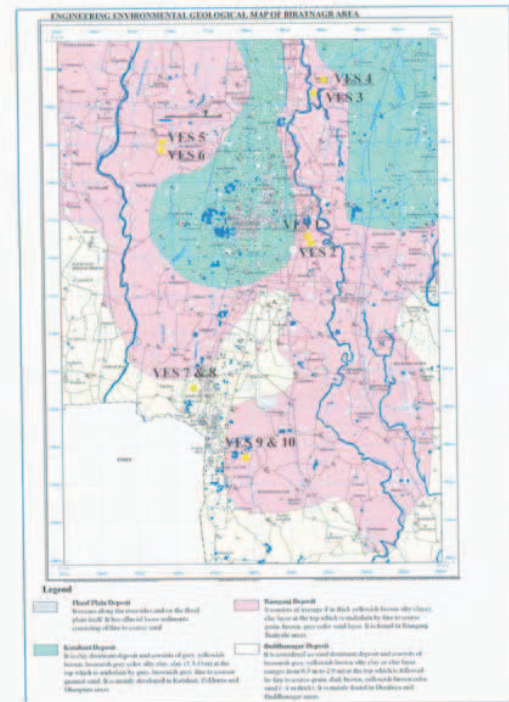


Figure 2-2 General Geological Map of Study Area (Department of Mines and Geology)



2.3 General Climate of the Study Area

Climate of the study area is warm and temperate. Rainfall pattern has wider variations with high rainfall in summer than in winter season. The average temperature is 24.3 °C. Total annual average rainfall is 1898 mm. The driest month is December. With an average of 543 mm, the most precipitation falls in July. The temperature is shown by the red straight line and precipitation by blue bar diagram in the figure below. With an average of 28.9 °C, August is the warmest month. January has the coldest month, with temperatures averaging 16.2 °C.

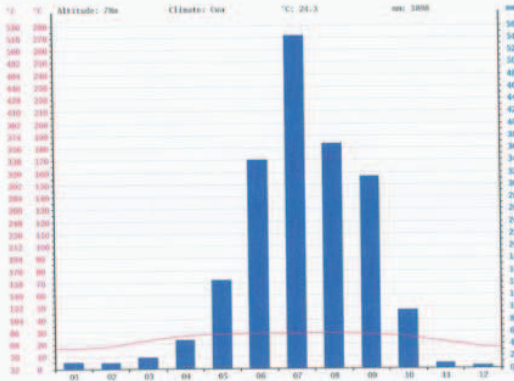


Figure 2-3: Climate Graph/Weather by month near study area

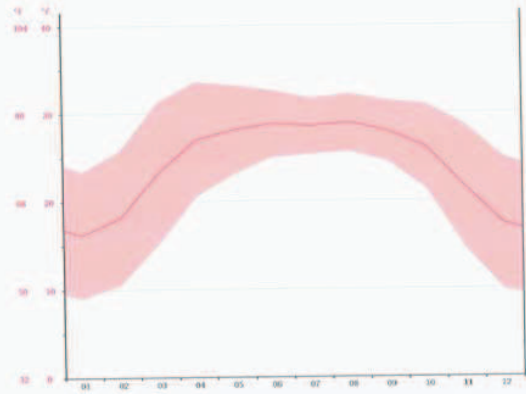


Figure 2-4: Average Temperature in Study Area

	January	February	March	April	May	June	July	August	September	October	November	December
Avg. Temperature (°C)	16.2	17.7	22.3	27	28.9	28.9	28.9	28.9	27.8	25	22.5	17.4
Min. Temperature (°C)	9	11.6	15.1	21.8	23.1	26	28.1	29.1	27.4	23.1	19.4	14.1
Max. Temperature (°C)	23.4	23.9	27.7	32.2	32.2	32.2	32.2	32.2	31.4	29	25.7	20
Avg. Temperature (°F)	61.2	63.9	72.1	81	84	84	84	84	82	77	72.5	63.3
Min. Temperature (°F)	48.2	52.9	59.2	81.2	83.6	79.2	82.6	84.4	81.3	73.8	66.9	57.4
Max. Temperature (°F)	74.1	75.0	81.9	90.0	90.0	90.0	90.0	90.0	88.5	84.2	78.3	68.0
Precipitation / Rainfall (mm)	10	9	18	47	144	300	543	371	233	105	5	4

Figure 2-5: Biratnagar Weather by Month /Weather Averages



CHAPTER 3: GEOPHYSICAL SURVEY

3.1 General

Geophysical methods have wide range of its applicability in locating or tracing an object of interest as suggested by the geophysical response of the object. Detectability of the body depends on the size and distance or depth at which the object occurs. The contrast in physical properties between the body and its surroundings also influences the detectability. There are four main geophysical methods viz. gravity, magnetic, seismic, and electrical (self-potential, electromagnetic, resistivity, induced polarization and well logging) out of which the electrical methods are the most suitable in ground water exploration and management. This is because the electrical properties, especially the resistivity of geological formations, vary significantly between their dry and saturated state which helps in identifying the aquifers.

3.2 Methodology

3.2.1 Electrical Resistivity Principle and Resistivity of Rocks

The resistivity survey is carried out by injecting DC current into the ground through two current electrodes, and measuring the resulting voltage differences at two potential electrodes. For the current value (I) and the observed voltage difference value (V), an apparent resistivity value (ρ_a) is calculated as follows.

$$(\rho_a) = k V/I$$

Where, k is the geometrical factor which depends on the arrangement of the four electrodes.

The calculated value (ρ_a) is not the true resistivity of the sub-surface materials. An "apparent resistivity" value of a homogeneous ground will give the same resistance value for the same electrode arrangement. The relationship between the apparent resistivity and the "true" resistivity is a complex relationship. In fact, an inversion of the measured apparent resistivity values using a computer program is necessary to determine the true sub-surface resistivity.

Electrical resistivity of the rocks or sediments depends on the resistivity of their mineral matrix and the fluid contained in its pore spaces. The electrical resistivity of the soil can be considered as a proxy for the variety of soil physical properties. Electrical resistivity is a function of a number of soil properties, including the nature of the solid constituents (particle size



distribution, mineralogy), arrangement of voids (porosity, pore size distribution, connectivity), the degree of water saturation (water content), electrical resistivity of the fluid (solute concentration) and temperature.

Rocks are composed primarily of quartz, feldspar and mica or other silicate minerals, which are poor conductors. They contain water in the pores, which is usually a better conductor. Thus the resistivity of, say, sandstone, generally depends on geometry of its pore spaces and the resistivity (or salinity) of its contained fluid. As permeability and porosity decrease, resistivity usually increases, when there is no change in formation fluid. The resistivity also depends upon the age of the rock or sediment as, with age, they become compacted and/or weathered. Compacted rocks show very high resistivity compared to unconsolidated sediments like clays, sands, gravels and so on as there will be less fluid in it. The weathered rock shows low resistivity when there is presence of water in it. Dry rocks or sediments have very high resistivity (of the order of 10,000 to 100,000 Ohm-m), whereas water bearing rocks or saturated sediments become much less resistant (10 to 1,000 Ohm-m).

All rocks contain some pores in them. Under any reasonable circumstances, these pores are partly or completely filled with water. This water usually carries some salt in solution so that the water content of rock has a far greater capacity for transmitting current than does the solid matrix of the rock unless highly conducting minerals are present.

In some rocks, such as consolidated sedimentary rocks, porosity is inter granular in nature consisting of the spaces left over after the rock grains were compacted. In other rocks and particularly in igneous rocks, porosity occurs primarily in the form of joints.

In general, hard rocks are poor conductors of electricity, but geological processes like weathering, dissolution, hydrothermal alteration, faulting and shearing can alter rock to increase the porosity and permeability of rock and hence decreases resistivity. By comparison, compaction of sedimentary rock and metamorphism of all types may result in lower porosities and permeability. Resistivity is, therefore, a widely varying parameter, which changes not only from lithology to lithology, but also within a particular formation of same lithology.

Alluvium is a broad term referring to all unconsolidated material formed in recent geological time under conditions other than subaqueous. Classic rock such as sand and gravel are



classified by geologist according to size, sorting and distribution of particles as well as the chemical content of silica, feldspar and calcite. Sand is defined with particle diameters ranges from 0.0625 mm to 2 mm. Gravel is defined with particle diameters ranging from 2mm to an excess of 256 mm. Sand and gravel are defined as continuously graded unconsolidated materials (sediments) formed as a result of the natural disintegration of rocks. These unconsolidated sand and gravel have good infiltration and higher ground water permeability, so they are good source of ground water.

Table 3-1 Wentworth (1922) grain size classification

Millimeters (mm)	Micrometers (µm)	Phi (φ)	Wentworth size class	
4096		-12.0	Boulder	Gravel
256		-8.0	Cobble	
64		-6.0	Pebble	
4		-2.0	Granule	
2.00		-1.0	Very coarse sand	Sand
1.00		0.0	Coarse sand	
1/2	0.50	1.0	Medium sand	
1/4	0.25	2.0	Fine sand	
1/8	0.125	3.0	Very fine sand	
1/16	0.0625	4.0	Coarse silt	Silt
1/32	0.031	5.0	Medium silt	
1/64	0.0156	6.0	Fine silt	
1/128	0.0078	7.0	Very fine silt	
1/256	0.0039	8.0	Clay	
	0.00006	14.0		

The electrical properties and physical behavior of sand and gravel deposits depend significantly on moisture content of the materials. Dry sand and gravel deposit have a high electrical resistivity whereas saturated sand and fine gravel deposit have a much lower resistivity value and can be further influenced by the presence of salinity. The responses of the electric current with response to grain size, (sand, gravel, pebble, boulder, clay, silt fractured weathered



rocks, bedrock, etc. are the basis for the method to identify potential areas for ground water extraction. Coarse sediments (sand, gravel, pebble, boulders layer), fractured /weathered bedrocks mainly limestone, sandstone etc. usually have better potential for groundwater storage compared to fine sediments like clay, silt, sandy clay, clay with gravels, competent bedrock like quartzite, gneiss, biotite, schist etc. Resistivity is a widely varying parameter, which changes not only from lithology to lithology, but also within a particular stratum of same formation.

Table 3-2: Electrical Resistivity versus Lithology (Palaky 1987)

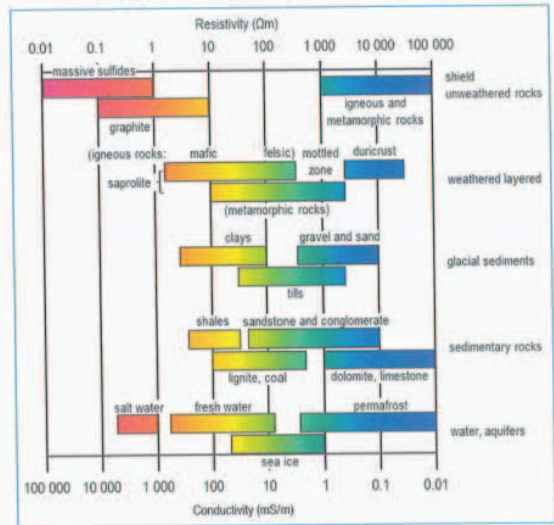


Table 3-3 Electrical Resistivity versus Lithology (W. M. Telford, L. P. Geldart, Robert E. Sheriff, 1990, Applied Geophysics)

Rocks and Soil Materials	Resistivity (Ω m)
Gneiss	$6.8 \times 10^4 - 3 \times 10^6$
Quartzite	$100 - 2 \times 10^6$
Marble	$100 - 2 \times 10^4$
Schist	$20 - 10^4$
Limestone	$70 - 7 \times 10^3$
Slate	$700 - 5 \times 10^3$
Shale	20-2000
Sandstone	$10 - 5 \times 10^3$
Dolomite	$500 - 5 \times 10^3$
Clays	1-100
Alluvium	10-800
Gravels	$10^3 - 8 \times 10^5$
Granite	$7 \times 10^3 - 10^6$
Mudstone	1-5000
Phyllites	50-7000
Ground Water Bearing formations	10-100
Conglomerate	$2 \times 10^3 - 10^4$
Sands	10-800
Graphitic slate	$10^4 - 10^7$
Magnesite	0.1 - 1000

Apparent resistivity values obtained in the field are not equal to the actual resistivity of the geologic units which affect the potential measured at the potential electrodes, unless measurements are being made over homogenous ground (Telford et al, 1990). At shallow exploration depth and at short current electrode spacing, shallow layers through which most of the current flows mostly influence measured apparent resistivity. As electrode spacing increases, a greater proportion of the induced current flows into deeper geologic layers, thus the response measured at the surface is reflective of the resistivity of increasingly deeper geologic units as the electrode spacing are



increased. Hence as the distance between the current electrodes increases, so does the exploration depth or the depth of investigation of the survey.

3.2.2 The relationship between Resistivity and Porosity

Naturally occurring groundwater commonly has high salinity and low resistivity. The resistivity of a rock decreases with increasing water content. In fully saturated rocks, the water content may be equated to the porosity, but in partially saturated rocks, the effect of de-saturation on resistivity must be considered. The texture of a rock also has some effect on the resistivity. One may obtain a theoretical expression for the relationship between resistivity and water content in a rock if a simple pore cemetery is assumed. Calculations of the resistivity of a matrix consisting of uniform spheres have been described many times in the literature. The most satisfactory relationship for the resistivity, ρ_t , of a fully saturated non-cemented rock consisting of equant grains is the following equation (Dakhnov, 1947 and 1948):

$$\rho_t = \frac{1 + 0.25(1 - \phi)^{1/3}}{1 - (1 - \phi)^{2/3}} \rho_w = F \rho_w$$

Where, ρ_w is the resistivity of the water in the pores,

ϕ is the fractional porosity, and

F= is the formation factor, defined as the ratio of rock resistivity to the resistivity of the water contained in the rock.

3.2.3 Equipment used in the field study

The Survey was conducted with GD-10 Series Geo-electrical Resistivity/IP equipment manufactured by ST Geomatic Co., Ltd, China, having following features:

- Multi-function digital DC Electrical Resistivity & Induced Polarization meter
- Copper wire
- Stainless Steel Electrodes

The equipment has the following special technical features:

- a. Capable of conducting DC Electrical Resistivity, Induced Polarization & Spontaneous Potential data acquisition in normal mode



- b. Capable of conducting Electrical Resistivity and Induced Polarization Tomography (Imaging). Any survey length can be covered using roll along technique.
- c. Capable of mass data storage of over 100,000 number of data in equipment memory
- d. Input Impedance over 200 Mega Ohm
- e. Voltage 1100 V DC (2200 V Peak to peak)
- f. Maximum current output 6A
- g. Transmitting Power 6600 Watt (1125 Watt for Imaging)
- h. All data acquisition operations are microcomputer controlled and user friendly menu driven
- i. High anti interference performance and precision, integrated with multistage wave filtration and signal enhancement technology
- j. Automatic cancellation of Self Potential, drift and electrode polarization
- k. Can perform with 18 different electrode configurations. However, virtually any electrode configuration can be used.
- l. Stored field data can be downloaded to the Personal Computer easily using RS 232 port. The data download can also be in RES2DINV/ IPI2Win recognizable format.

3.2.4 Electrical Resistivity Survey

In resistivity measurement, current flow tends to occur close to the surface. Current penetration can be increased by increasing separation of current electrodes. An electrode array is a configuration of electrodes used for measuring either an electric current or voltage. There are number of ways of setting up of current and potential electrodes, in the exploration of groundwater by electrical resistivity methods. The choice of an array and the distance between the electrodes is very important for obtaining the best possible information of the subsurface geology of a given area.

3.2.4.1 Vertical Electrical Sounding (VES) Survey

The method of survey used in the present study is the Vertical Geoelectrical Sounding / Vertical Electrical Sounding using Schlumberger array of electrode configuration. This method is also called Electrical Drilling. This is the standard method used worldwide to assess the groundwater potential in a given area. This is an indirect method and gives general idea about the parameters like thickness and electrical resistivity of subsurface layer, which exists in the sounding point. This method gives the vertical variation in electrical resistivity due to different lithology



present in survey area. Electrical resistivity is correlated to the sediment type (clay, silty clay, silty sand, sand, sand and gravel, fractured rock, bedrock etc.)

In this method, current is injected into the ground by using two current electrodes (A and B) which are made of steel and are driven into the ground. The current is produced with the help of DC battery and equipment with complicated integrated circuitry (resistivity equipment). The travelling current sets its path and amplitude into the ground, which depends upon the nature of underground. The underground lithology (type of earth material) play major role in this regard. The response is recorded in the equipment with the help of two measuring electrodes (M and N), which are also driven into the ground. The procedure is repeated to a number of times by taking the electrodes farther away successively in every step and the response reading is recorded in the equipment. Farther the electrodes from the center point, the response is coming from the deeper part.

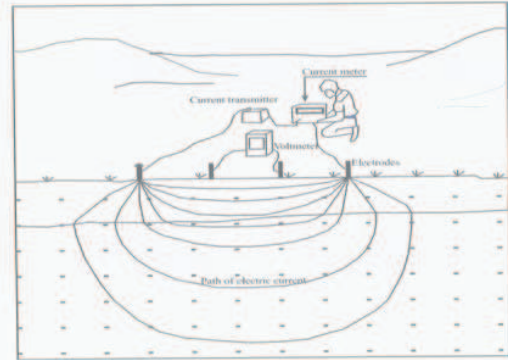


Figure 3-1 Principles of Resistivity Measurements (Robinson and Coruth, 1988)

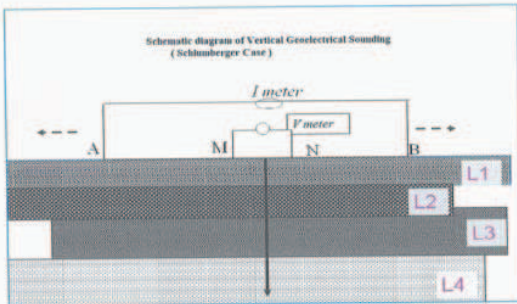


Figure 3-2 Schematic Diagram of Vertical Electrical Sounding

For the current value (I) and the observed voltage difference value (V), an apparent resistivity value (ρ_a) is calculated as follows.

$$(\rho_a) = k V/I$$

Where, k is the geometrical factor which depends on the arrangement of the four electrodes. For Schlumberger Sounding the formula is calculated as,

$$\rho_a^{Schlumberger} = \frac{\pi \cdot (L^2 - l^2) V_{MN}}{2l I_{AB}}$$

Where, $k = \frac{\pi \cdot (L^2 - l^2)}{2l}$, $L = AB/2$, $l = MN/2$

The calculated value (ρ_a) is not the true resistivity of the sub-surface materials. An "apparent resistivity" value of a homogeneous ground will give the same resistance value for the same electrode arrangement. The relationship between the apparent resistivity and the "true" resistivity is a complex relationship.



3.2.5 Data Acquisition

In the present case ten Vertical Geoelectrical Soundings, VES-1 to VES-9 with total length of 800 m, and VES-10 with total length of 600 m using Schlumberger array of electrode configuration were made to cover the survey area. The data acquisition, data filtering and interpretation was carried using standard norms by Geophysicist. The apparent resistivity values ρ_a were plotted against the electrode spacing (AB/2) on a log-log scale to obtain the VES sounding curves using the computer software IPI2WIN software which is developed for the purpose of data processing, analysis and interpretation to check the reliability of the data. The orientation and location of the survey direction is presented in respective Google Earth Image.

The members of the Geophysical survey field crew are Geophysicist, Geologist, Survey assistants, and laborers. The main responsibilities lie on the Geophysicist who was involved in all stages starting from planning to report submission. Present field mission was carried out by an experienced geophysicist who was also involved for all stages of geophysical mission. Geologist was responsible for the study of geology and hydrogeology of the survey area. Experienced assistants were involved during the field work and they were responsible for checking of the field layout.



CHAPTER 4: DATA PROCESSING, ANALYSIS AND INTERPRETATION

Geo-electrical resistivity survey is widely used geophysical method for groundwater exploration, environmental application and other engineering application. The benefit of this method is to perform the survey quite fast and in the cost-effective manner. Detection of water table, variation of resistivity with depths (distinguishing layered earth), contaminants plume detection, detection of bedrocks depth, overburden thickness, types of subsurface geology etc. are the objectives geo-electrical resistivity survey. The interpretation of electrical resistivity data is the process of deriving the values of true resistivity (ρ) and thicknesses (t) of various subsurface strata from the values of recorded resistance R or apparent resistivity (ρ_a) at electrode separations (a). There are a number of interpretation techniques for evaluating (ρ) and (t) of each of the stratum as proposed by many investigators. These can be grouped as analytical, numerical, empirical, graphical, computer (software) based etc. and several amongst each category.

In qualitative interpretation, general conclusive remarks regarding to lithological variation are made in terms of apparent resistivity values. The data acquisition, data filtering and interpretation was carried using standard norms by Geophysicist and Hydro-geologist. For VES the apparent resistivity values ρ_a were plotted against the electrode spacing (AB/2) on a log-log scale to obtain the VES sounding curves using the computer software IPI2WIN software which is developed for the purpose of data processing, analysis and interpretation.

The basic principle behind the relation between resistivity data and lithology/geology are already dealt with in above sections. The general resistivity values of different earth materials are shown in Table 3-2 & Table 3-3. The resistivity of certain layer depends up on rock type, grain size, degree of void spaces and amount of water present, degree of weathering, mineral constituents etc. Based on general geology of study area and different studies carried out in different part of Nepal, the general correlation table has been prepared which is shown in Table 4-1.



Table 4-1 General correlation of Resistivity and Lithology

Resistivity (Ohm-m)	Expected Lithology
< 30	Clay, silty clay
320-50	Saturated silty sand/ silt/ clayey silt
50-80	Unsaturated silty clay/ Saturated fine to coarse sand
70-100	Saturated coarse sand / highly unsaturated silty clay / sand
100-200	Saturated sand and gravel, top dry soil
Above 150	Saturated sand and gravel with pebble cobble, dry sediments / highly unsaturated top soil.



4.1 Analysis and Interpretation of VES data
4.1.1 VES Field Curve and Interpretation Result of VES-1

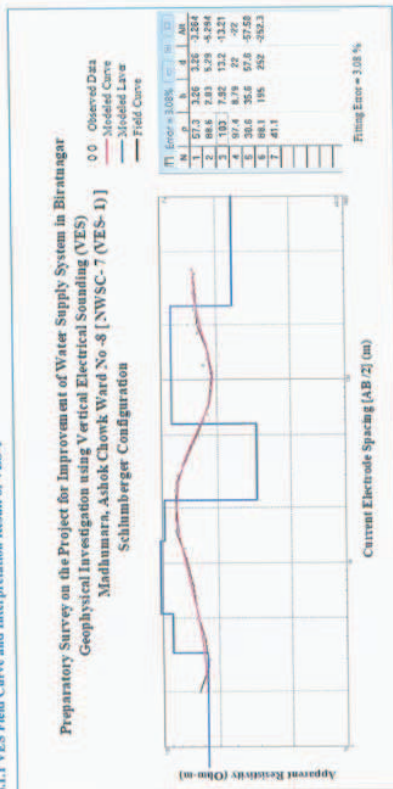


Figure 4-1 Modeled Curve with Field Curve from VES-1



Table 4-2 Expected Lithology from VES-1

Layer No.	VES -1			
	Resistivity [Ohm-m]	Thickness (M)	Depth (M)	Expected Lithology
1	57.3	3.26	3.3	Top Soil with silty clay
2	88.6	2.03	5.3	Silty clay with sand
3	103	7.92	13.2	Coarse sand (Water Table)
4	97.4	8.79	22	Coarse Sand
5	30.6	25.6	57.6	Silt
6	88.1	195	252	Coarse sand
7	41.1			

Interpretation of VES - 1 based on Resistivity data

VES result reveals the presence of multi layered of soil in the survey location. VES result reveals the presence of top soil with silty clay up to around 3.3 m depth, which is indicated by resistivity value of around 57 Ωm. Medium resistivity value of 88 Ωm on second layer indicates the presence of silty clay with sand layer up to 5.3 m depth. The water table is expected at this depth of 5.3 m. Very high resistivity value of 103 Ωm on third layer up to around 13 m depth indicates the presence of coarse sand layer. High resistivity value of 97 Ωm on fourth layer up to 22 m depth indicates the presence of coarse sand layer. Resistivity value 30.6 Ωm on fifth layer up to 57.6 m depth indicates the silt layer. Resistivity value 88 Ωm on sixth layer up to 252 m depth indicates the presence of coarse sand layer.



4.1.2 VES Field Curve and Interpretation Result of VES-2

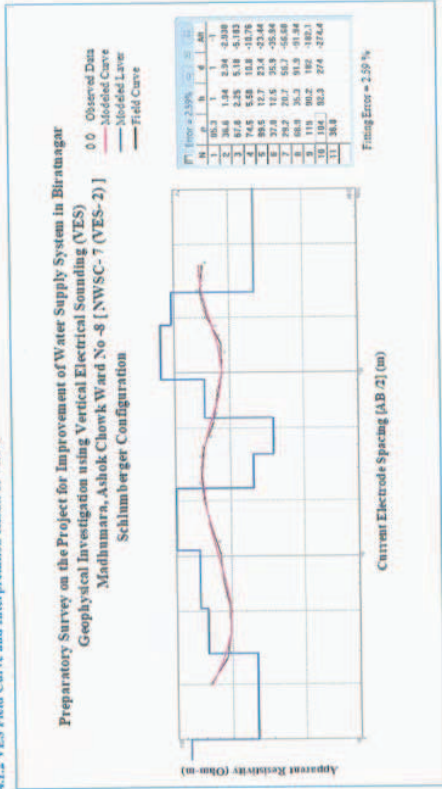


Figure 4.2 Modeled Curve with Field Curve from VES-2



Table 4-3 Expected Lithology from VES-2

Layer No.	VES-2			
	Resistivity [Ohm-m]	Thickness (M)	Depth (M)	Expected Lithology
1	85.3	1	1	Unsaturated top soil with silty clay
2	36.6	1.94	2.9	Clay
3	67.8	2.25	5.2	Silty clay with sand
4	74.5	5.58	10.8	Coarse sand (Water Table)
5	99.5	12.7	23.4	Coarse sand
6	37.8	12.5	35.9	Silt
7	29.2	20.7	56.7	Silt
8	68.9	35.3	91.9	Medium to coarse sand
9	119	90.2	182	Coarse sand
10	104	92.3	274	Coarse sand
11	36.8			

Interpretation of VES 2 based on Resistivity data

VES result reveals the presence of multi layered of soil in the survey location. VES result reveals the presence of unsaturated top soil with silty clay up to 1 m depth, which is indicated by resistivity value of 85.3 Ωm. Resistivity value of 36.6 Ωm on second layer indicates the presence of clay layer up to about 3 m depth. Resistivity value of 67.8 Ωm on third layer up to around 5.2 m depth indicates the presence of silty clay with sand layer. The water table is expected at this depth of 5.2 m. Resistivity value of 74.5 Ωm on fourth layer up to about 11 m depth indicates the presence of coarse sand layer. Resistivity value of 99.5 Ωm on fifth layer up to 23.4 m depth indicates the presence of coarse sand layer. Resistivity value 37.7 Ωm and 29.1 Ωm on sixth and seventh layer up to 36 m depth and 57 m depth respectively indicates the silt layer. Resistivity value 69 Ωm on eighth layer up to 92 m depth indicates the presence of medium to coarse sand layer. High resistivity value of 119 Ωm and 104 Ωm on the ninth and tenth layer up to the depth of 182 m and 274 m respectively indicates the presence of coarse sand layer.



4.1.3 VES Field Curve and Interpretation Result of VES-3

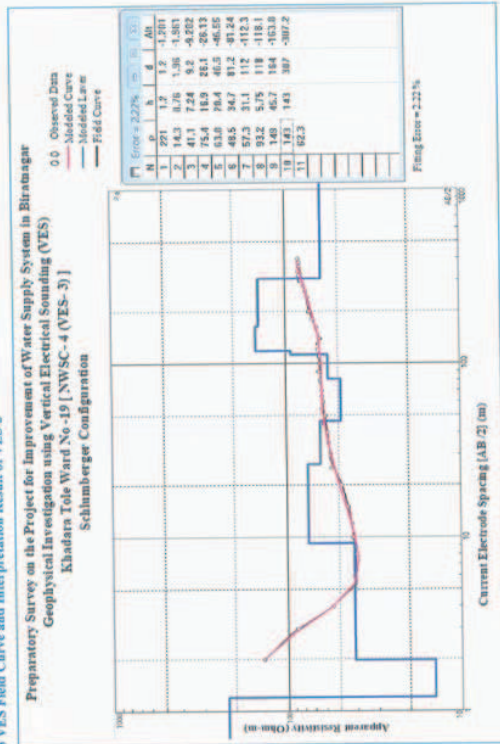


Figure 4.3 Modeled Curve with Field Curve from VES-3



Table 4-4 Expected Lithology from VES-3

Layer No.	VES-3			
	Resistivity [Ohm-m]	Thickness (M)	Depth (M)	Expected Lithology
1	221	1.2	1.2	Top Soil / dry silt clay
2	14.3	0.76	1.9	Brownish clay
3	41.1	7.24	9.2	Silty clay
4	75.4	16.9	26.1	Coarse sand, cobble, pebble (Water Table)
5	63.8	20.4	46.5	Coarse sand
6	48.5	34.7	81.2	Silty sand
7	57.3	31.1	112	Coarse sand
8	93.2	5.75	118	Coarse sand, cobble, pebble, gravel
9	149	45.7	164	Sand gravel layer
10	143	143	307	Sand gravel layer
11	62.3			Coarse sand

Interpretation of VES 3 based on Resistivity data

VES result reveals the presence of multi layered of soil in the survey location. VES result reveals the presence of top soil/dry silty clay up to 1.2 m depth, which is indicated by resistivity value of 221 Ωm. Resistivity value of 14.3 Ωm on second layer indicates the presence of brownish clay layer up to about 2 m depth. Resistivity value of 41.1 Ωm on third layer up to around 9.2 m depth indicates the presence of silty clay layer. The water table is expected at this depth of 9.2 m. Resistivity value of 75.4 Ωm on fourth layer up to about 26 m depth indicates the presence of coarse sand with cobble, pebble layer. Resistivity value of 63.8 Ωm on fifth layer up to 46.5 m depth indicates the presence of coarse sand layer. Resistivity value 48.5 Ωm on sixth layer up to depth of 81 m indicates the silty sand layer. Coarse sand layer is present on seventh layer up to the depth of 112 m which is indicated by resistivity of 57.3 Ωm. Resistivity value 93.2Ωm on eighth layer up to 118 m depth indicates the presence of coarse sand with cobble, pebble and gravel layer. High resistivity value of 149 Ωm and 143 Ωm on the ninth and tenth layer up to the depth of 164 m and 307 m respectively indicates the presence of sand and gravel layer. Coarse sand layer is present from the depth of 307 m up to the investigation depth which is indicated by medium resistivity of 62.3 Ωm



4.1.4 VES Field Curve and Interpretation Result of VES-4

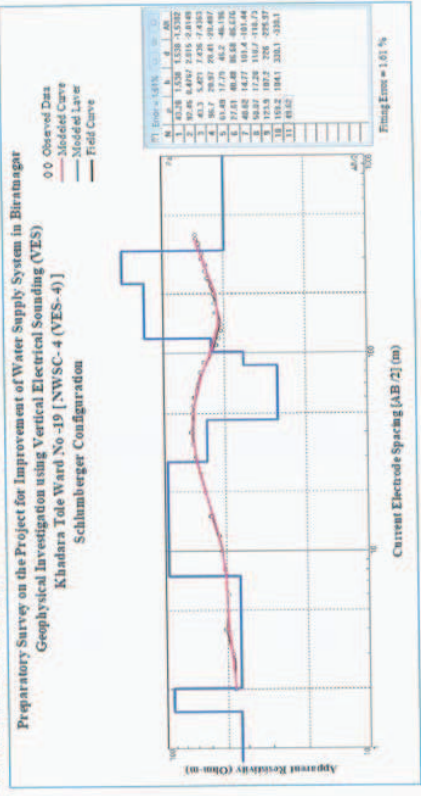


Figure 4-4 Modeled Curve with Field Curve from VES-4

Table 4-5 Expected Lithology from VES-4

Layer No.	Resistivity [Ohm-m]	Thickness (M)	Depth (M)	Expected Lithology
1	43.26	1.538	1.5	Top Soil /silt clay
2	92.45	0.4767	2.0	Coarse sand, cobble, pebble
3	43.3	5.421	7.4	Silty clay(Water Table)
4	96.7	20.97	28.4	Coarse sand, cobble, pebble
5	61.49	17.79	46.2	Coarse sand
6	27.61	40.48	86.6	Silty sand
7	40.62	14.77	101.4	Coarse sand
8	58.07	17.28	118.7	Coarse sand, cobble, pebble
9	123.9	107.2	226.0	Sand gravel layer
10	159.2	104.1	330.1	Sand gravel layer
11	49.62			Coarse sand

Interpretation of VES 4 based on Resistivity data

VES result reveals the presence of multi layered of soil in the survey location. VES result reveals the presence of top soil/dry silty clay up to 1.5 m depth, which is indicated by resistivity value of 43.26 Ohm. Resistivity value of 92.45 Ohm on second layer indicates the presence of coarse sand with cobble, pebble up to about 2 m depth. Resistivity value of 43.3 Ohm on third layer up to around 7.4 m depth indicates the presence of silty clay layer. The water table is expected at this depth of 7.4 m. Resistivity value of 96.7 Ohm on fourth layer up to about 28.4 m depth indicates the presence of coarse sand with cobble and pebble layer. Resistivity value of 61.49 Ohm on fifth layer up to 46.2 m depth indicates the presence of coarse sand layer. Resistivity value 27.61 Ohm on sixth layer up to depth of 86.6 m indicates the silty sand layer. Coarse sand layer is present on seventh layer up to the depth of 101.5 m which is indicated by resistivity of 40.62 Ohm. Resistivity value 58.07 Ohm on eighth layer up to 118.7 m depth indicates the presence of coarse sand with cobble, pebble layer. High resistivity value of 123.9 Ohm and 159.2 Ohm on the ninth and tenth layer up to the depth of 226 m and 330 m respectively indicates the presence of sand and gravel layer. Coarse sand layer is present from the depth of 330 m up to the investigation depth which is indicated by medium resistivity of 49.62 Ohm

4.1.5 VES Field Curve and Interpretation Result of VES-5

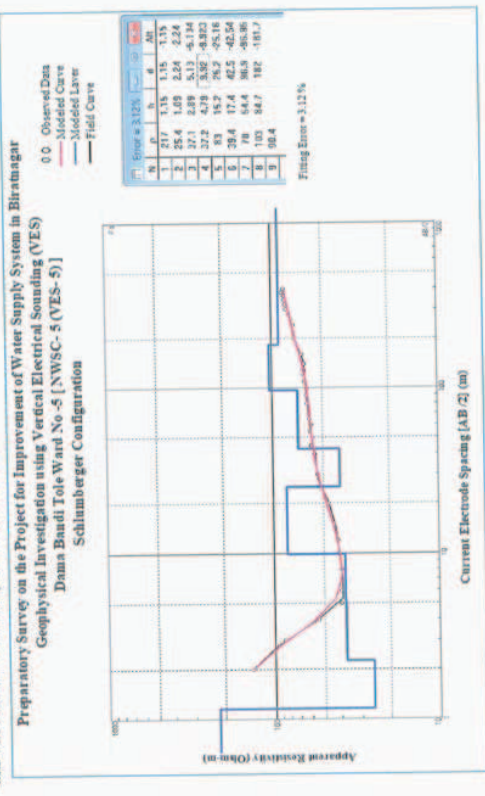


Figure 4-5 Modeled Curve with Field Curve from VES-5

Table 4-6 Expected Lithology from VES-5

Layer No.	Resistivity [Ohm-m]	Thickness (M)	Depth (M)	Expected Lithology
1	217	1.15	1.1	Unsaturated top soil with clayey silt
2	25.4	1.09	2.2	Clay
3	37.1	2.89	5.1	Silty clay
4	37.2	4.79	9.9	Silty clay (Water Table)
5	83	15.2	25.2	Coarse sand, cobble pebble
6	39.4	17.4	42.5	Silt , coarse sand
7	70	54.4	96.9	Coarse sand, cobble pebble
8	103	84.7	182	Coarse sand, gravels
9	90.4			Coarse sand, gravels

Interpretation of VES 5 based on Resistivity data

VES result reveals the presence of multi layered of soil in the survey location. VES result reveals the presence of unsaturated top soil with clayey silt up to 1.1 m depth, which is indicated by high resistivity value of 217 Ohm. Resistivity value of 25.4 Ohm on second layer indicates the presence of silty clay layer up to about 2.2 m depth. Resistivity value of 37.1 Ohm and 37.2 Ohm on third and fourth layer up to around 5 m and 10 m depth respectively indicates the presence of silty clay layer. The water table is expected at this depth of 10 m. Resistivity value of 83 Ohm on fifth layer up to about 25 m depth indicates the presence of coarse sand with cobble, pebble layer. Resistivity value of 39.4 Ohm on sixth layer up to 42.5 m depth indicates the presence of silt, coarse sand layer. Resistivity value 70 Ohm on seventh layer up to depth about 97 m indicates the coarse sand with cobble, pebble layer. Coarse sand with gravel layer is present from the depth of 97 m up to investigation depth on the eighth and ninth layer.

4.1.6 VES Field Curve and Interpretation Result of VES-6

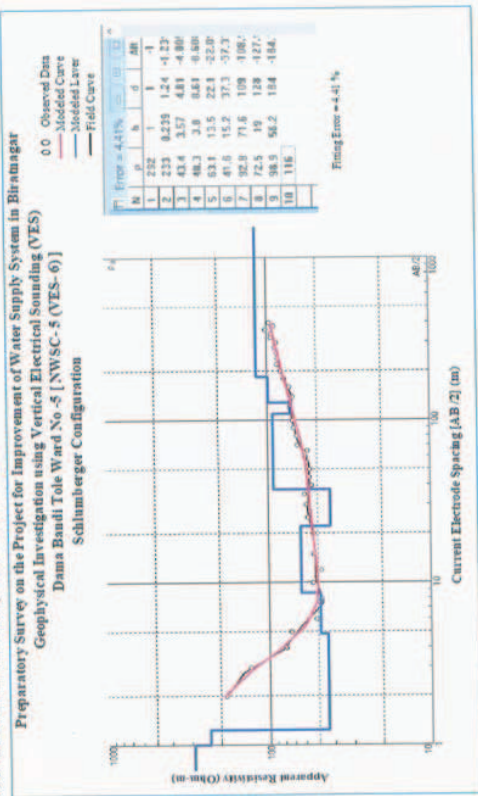


Figure 4-6: Modeled Curve with Field Curve from VES-6



Table 4-7: Expected Lithology from VES-6

Layer No.	VES-6			Expected Lithology
	Resistivity [Ohm-m]	Thickness (M)	Depth (M)	
1	292	1	1	Unsaturated top soil with sand gravels
2	233	0.2	1.2	Unsaturated top soil with sand gravels
3	43.4	3.6	4.8	Silty clay
4	48.3	3.8	8.6	Silty clay (Water Table)
5	63.1	13.5	22.1	Coarse sand, cobble pebble
6	41.6	15.2	37.3	Silt, coarse sand
7	92.8	71.6	108.5	Coarse sand, cobble pebble
8	72.5	19	127.5	Coarse sand, gravels
9	98.2	56.2	183.5	Coarse sand, gravels
10	116			Coarse sand, gravels

Interpretation of VES 6 based on Resistivity data

VES result reveals the presence of multi layered of soil in the survey location. VES result reveals the presence of unsaturated top soil with sand and gravels up to 1 m depth, which is indicated by high resistivity value of 292 Ωm. Resistivity value of 233 Ωm on second layer indicates the presence of unsaturated top soil with sand and gravels up to about 1.2 m depth. Resistivity value of 43.4 Ωm and 48.3 Ωm on third and fourth layer up to around 5 m and 8.6 m depth respectively indicates the presence of silty clay layer. The water table is expected at this depth of 8.6 m. Resistivity value of 63.1Ωm on fifth layer up to about 22 m depth indicates the presence of coarse sand with cobble, pebble layer. Resistivity value of 41.6 Ω m on sixth layer up to 37.3 m depth indicates the presence of silt, coarse sand layer. Resistivity value 92.8 Ωm on seventh layer up to depth of 108.5 m indicates the coarse sand with cobble, pebble layer. Coarse sand with gravel layer is present from the depth of 127.5 m up to investigation depth on the eighth, ninth and tenth layer.



4.1.7 VES Field Curve and Interpretation Result of VES-7

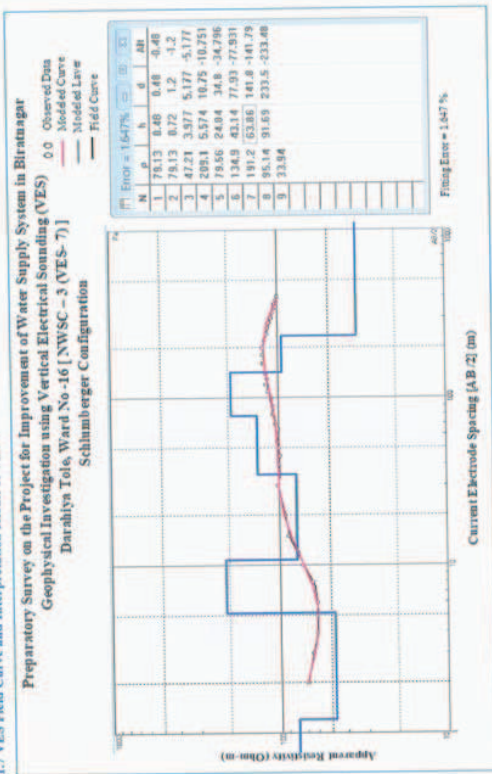


Figure 4-7: Modeled Curve with Field Curve from VES-7



Table 4-8 Expected Lithology from VES-7

Layer No.	VES-7			Expected Lithology
	Resistivity [Ohm-m]	Thickness (M)	Depth (M)	
1	79.13	0.48	0.5	Top Soil with clay silt
2	79.13	0.72	1.2	Silt, sand
3	47.21	3.977	5.2	Silty clay with sand (Water Table)
4	209.1	5.574	10.7	Coarse sand, gravels
5	79.56	24.04	34.8	Coarse sand, cobble, pebble
6	134.9	43.14	77.9	Coarse sand, gravels
7	191.2	63.86	141.8	Coarse sand, gravels
8	95.14	91.69	233.5	Coarse sand, cobble, pebble
9	33.94			Silt, sand

Interpretation of VES 7 based on Resistivity data

VES result reveals the presence of multi layered of soil in the survey location. VES result reveals the presence of top soil with clayey silt up to 0.5 m depth, which is indicated by resistivity value of 79.13 Ωm. Resistivity value of 79.13 Ωm on second layer indicates the presence of silty sand layer up to about 1.2 m depth. Resistivity value of 47.21 Ωm on third layer up to around 5.2 m depth indicates the presence of silty clay with sand layer. The water table is expected at this depth of 5.2 m. High resistivity value of 209.1 Ωm on fourth layer up to about 10.7 m depth indicates the presence of coarse sand with gravels layer. Medium resistivity value of 79.56 Ωm on fifth layer up to 35 m depth indicates the presence of coarse sand with cobble pebble layer. High resistivity value of 134.9 Ωm and 191.2 Ωm on the sixth and seventh layer up to the depth of 78 m and 141.8 m respectively indicates the presence of coarse sand with gravels layer. Resistivity value 95.14 Ωm on eighth layer up to 233.5 m depth indicates the presence of coarse sand with cobble, pebble layer. Silt and sand layer is present from the depth of 233.5 m up to the investigation depth which is indicated by low resistivity of 33.94 Ωm.



4.1.8 VES Field Curve and Interpretation Result of VES-8

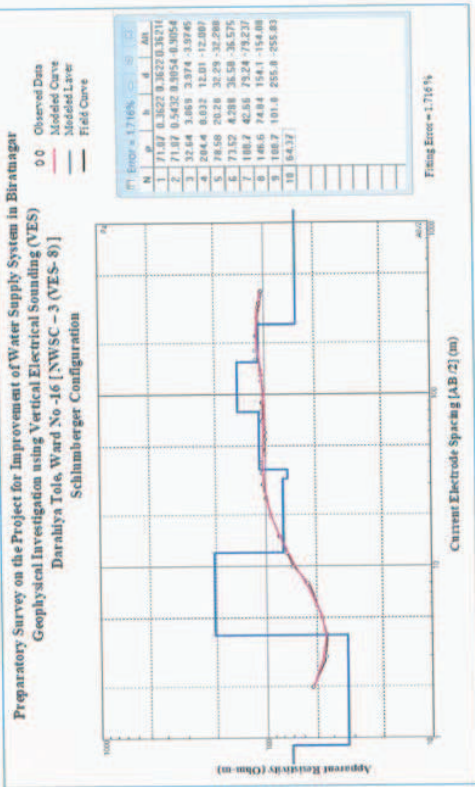


Figure 4-8: Modeled Curve with Field Curve from VES-8

Table 4-9: Expected Lithology from VES-8

Layer No.	VES-8			Expected Lithology
	Resistivity [Ohm-m]	Thickness (M)	Depth (M)	
1	71.07	0.36	0.4	Top Soil with clay silt
2	71.07	0.54	0.9	Silt, sand
3	32.64	3.07	3.9	Silty clay with sand
4	204.4	8.03	12.0	Coarse sand, gravels (Water Table)
5	78.58	20.28	32.3	Coarse sand, cobble, pebble
6	73.52	4.29	36.6	Coarse sand, cobble, pebble
7	108.7	42.66	79.2	Coarse sand, gravels
8	146.6	74.84	153.0	Coarse sand, gravels
9	108.7	101.80	254.9	Coarse sand, gravels
10	64.37			Silt, sand

Interpretation of VES 8 based on Resistivity data

VES result reveals the presence of multi layered of soil in the survey location. VES result interprets the presence of top soil with clayey silt up to 0.4 m depth, which is indicated by resistivity value of 71.07 Ohm. Resistivity value of 71.07 Ohm on second layer indicates the presence of silty sand layer up to about 1 m depth. Resistivity value of 32.64 Ohm on third layer up to around 4 m depth indicates the presence of silty clay with sand layer. The water table is expected at this depth of 4 m. High resistivity value of 204.4 Ohm on fourth layer up to about 12 m depth indicates the presence of coarse sand with gravels layer. Resistivity value of 78.58 Ohm-m and 73.52 Ohm on the fifth and sixth layer up to the depth of 32.3 m and 36.6 m respectively indicates the presence of coarse sand with cobble and pebble layer. High resistivity values of 108.7 Ohm, 146.6 Ohm and 108.7 Ohm on the seventh, eighth and ninth layer up to the depth of 79.2 m, 153 m and 255 m respectively indicates the presence of coarse sand with gravels layer. Silty sand layer is present from the depth of 255 m up to the investigation depth which is indicated by medium resistivity of 64.37 Ohm.

4.1.9 VES Field Curve and Interpretation Result of VES-9

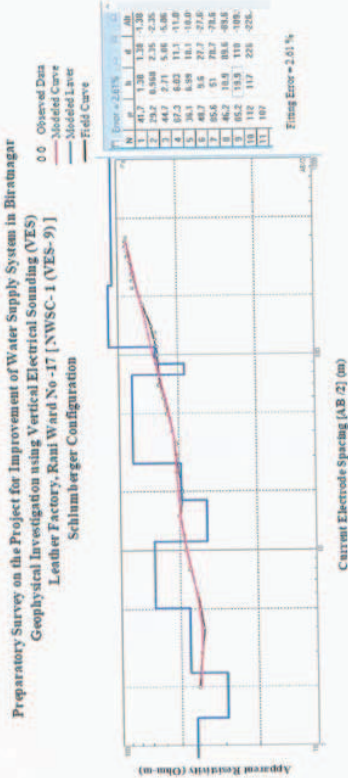


Figure 4-9: Modeled Curve with Field Curve from VES-9

Table 4-10: Expected Lithology from VES-9

Layer No.	VES-9			Expected Lithology
	Resistivity [Ohm-m]	Thickness (M)	Depth (M)	
1	41.7	1.38	1.4	Topsoil with clayey silt
2	29.2	0.97	2.4	Clay
3	44.7	2.71	5.0	Silty clay with sand (Water Table)
4	67.3	6.03	11.1	Coarse sand
5	36.1	6.99	18.1	Silt, Coarse sand
6	48.7	9.6	27.7	Silt, Coarse sand
7	85.6	51	78.7	Coarse sand, gravels
8	46.2	10.9	89.6	Coarse sand
9	65.2	19.9	109.5	Coarse sand, cobble, pebble
10	112	117	226.5	Coarse sand, gravels
11	107			Coarse sand, gravels

Interpretation of VES 9 based on Resistivity data

VES result reveals the presence of multi layered of soil in the survey location. VES result reveals the presence of top soil with clayey silt up to 1.4 m depth, which is indicated by resistivity value of 41.7 Ohm. Resistivity value of 29.2 Ohm on second layer indicates the presence of clay layer up to about 2.4 m depth. Resistivity value of 44.7 Ohm on third layer up to around 5 m depth indicates the presence of silty clay with sand layer. The water table is expected at this depth of 5 m. Resistivity value of 67.3 Ohm on fourth layer up to about 11 m depth indicates the presence of coarse sand layer. Resistivity value of 36.1 Ohm and 48.7 Ohm on fifth and sixth layer up to 18 m and 27 m depth respectively indicates the presence of silt, coarse sand layer. Resistivity value 85.6 Ohm on seventh layer up to depth about 79 m indicates the coarse sand with gravels layer. Coarse sand layer is present on eighth layer up to the depth of 89.6 m which is indicated by resistivity of 46.2 Ohm. Resistivity value 65.2 Ohm on ninth layer up to 109.5 m depth indicates the presence of coarse sand with cobble, pebble layer. High resistivity value of 112 Ohm and 107 Ohm on the tenth and last layer from the 109.5 m depth up to investigation depth indicates the presence of coarse sand with gravels layer.

4.2 Discussion of the Result

Geologically the Study area lies in southern (Lower) Terai Zone of Indo-Gangetic Plain of Nepal. The sounding survey revealed a multi-layered earth in the proposed survey sites. There are layers consisting of topsoil, clay, silty clay, silty sand, medium to fine sand, coarse sand, cobble, pebble and gravels layers at different depths.

The sounding survey revealed a multi-layer earth in the surveyed area consisting of topsoil, clay, silty clay, silty sand, medium to fine sand, coarse sand, cobble, pebble and gravels layers at different depths. Water table is found at 5 to 9 m depth on the study area. Layer of silty clay, sand and coarse sand is encountered at Ward No. 8. Shallow aquifer is encountered at a depth of 10m-23m and a deep seated aquifer is encountered at depth below 56m from the surface. Layer of silty clay, sand, coarse sand, sand and gravel layer is encountered at Ward No. 19. Shallow aquifer is encountered at a depth of 9m-46m and a deep seated aquifer is encountered at depth below 81m from the surface. Layer of silty clay/ clayey silt, sand, coarse sand, sand and gravel layer is encountered at Ward No. 5. Shallow aquifer is encountered at a depth of 10m-25m and a deep seated aquifer is encountered at depth below 42 m from the surface. Layer of silty clay/ clayey silt, coarse sand, sand and gravel layer is encountered at Ward No. 17. Layer below 10m from surface mostly comprise of sand cobble, pebble, gravel layer. Layer of silty clay/ clayey silt, sand, coarse sand, sand and gravel layer is encountered at Ward No. 17. Silty clay/clayey silt is encountered up to 5m, shallow aquifer is encountered at a depth of 5m-11m and a coarse sand and gravel layer is encountered below 27m depth from surface.

Although ten points were surveyed in the area, only 9 points are presented due to some noises in the data obtained at location VES -10.



CHAPTER 5: CONCLUSION AND RECOMMENDATION

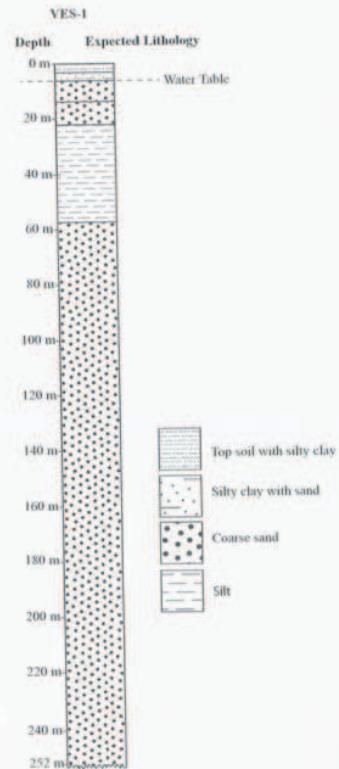
Detail information of the outcome of the interpretation is presented in the previous chapters. It is revealed from above discussion that study area is lies at Lower Terai zone of Gangetic plain. It is revealed from above discussion that there is a potential of deep groundwater in study area due to presence of saturated coarse sand dominant layered. Presence of shallow dug wells and deep tube well near around the survey area also shows the possibility of the groundwater. Groundwater found at the various depth of 5-10 m on the shallow subsurface. Presence of saturated medium to fine sand and coarse sand with cobble, pebble gravel layer at different depth shows the potential of groundwater in the study area. Presence of clay layer at different depth also reduces the effect on shallow subsurface groundwater while extracting the groundwater from deep seated aquifer in the study area.

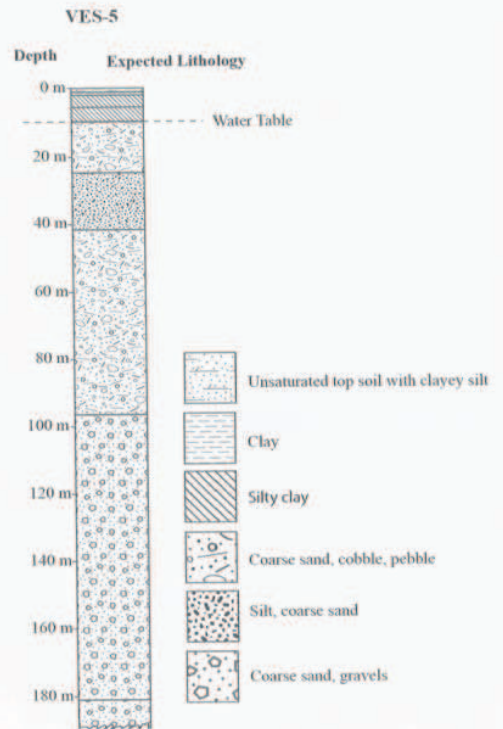
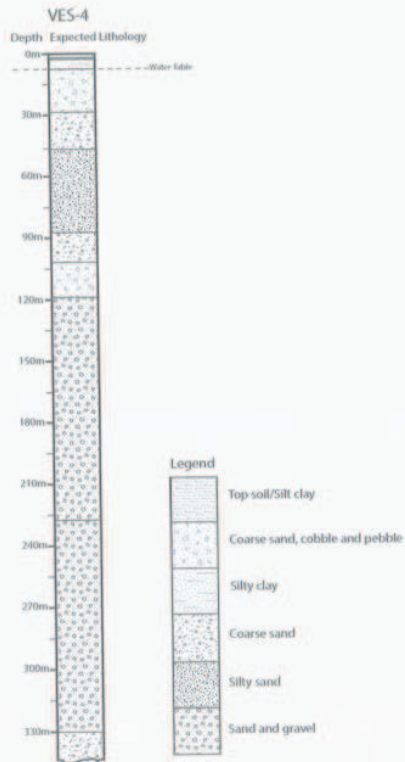
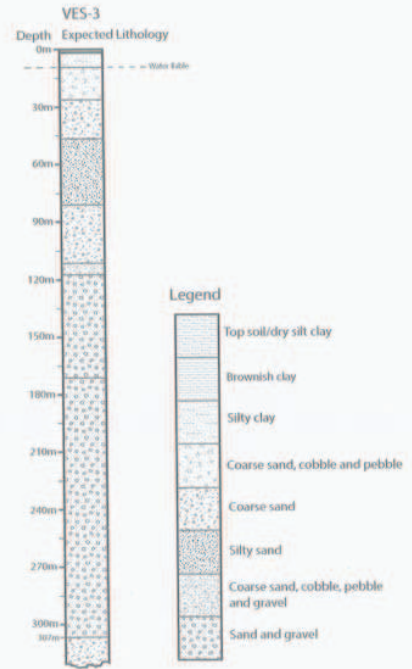
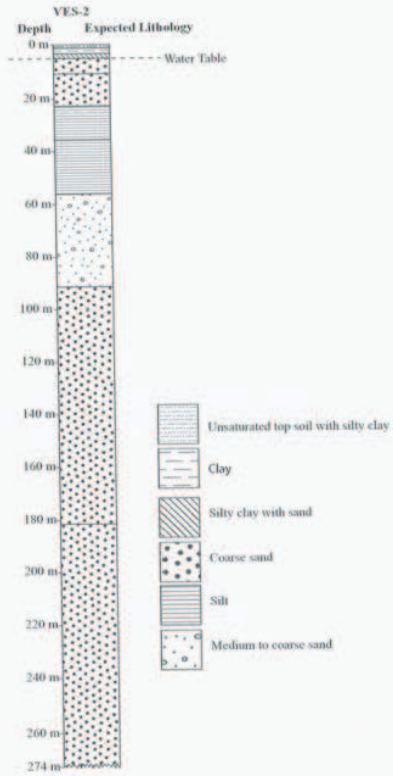
It is recommended to use soft soil drilling machine up to 100 m -150 m depth for extraction of long and sustainable use of groundwater in the area. The deviation on the results interpreted from Vertical electrical sounding data may be due to bad electrode contacts at some locations, canal and stream crossing during the survey.

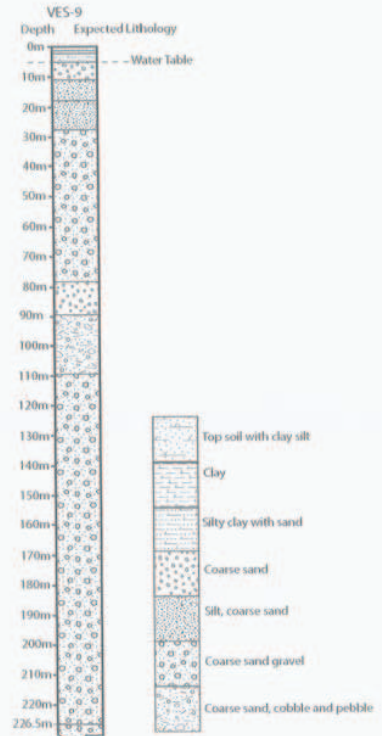
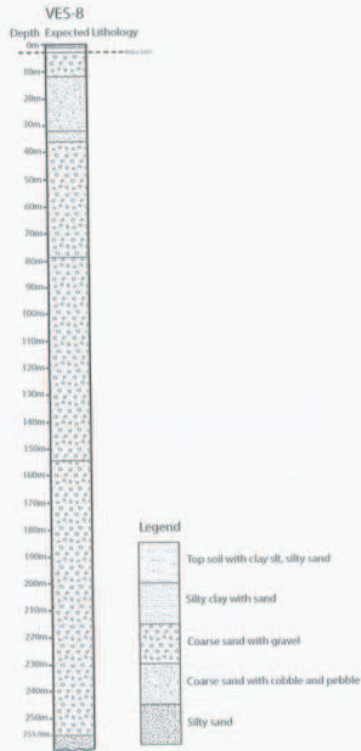
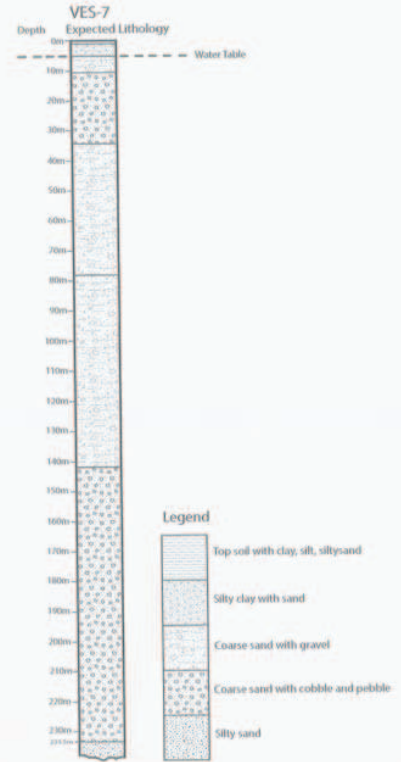
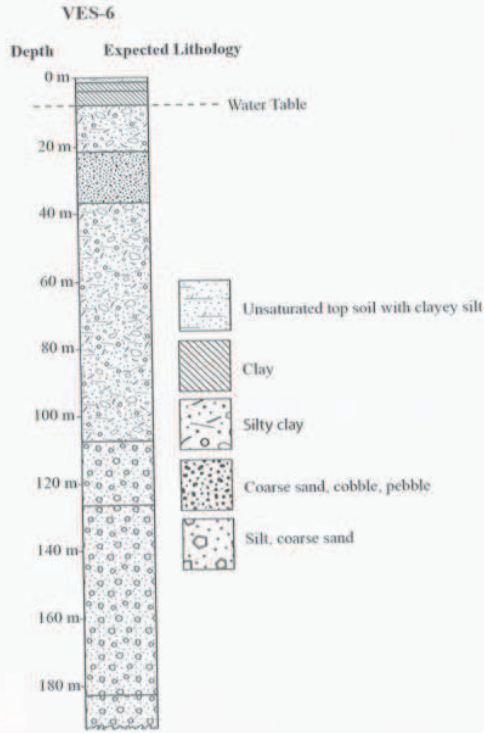


ANNEX-I

EXPECTED LITHOLOGY







ANNEX-II

FIELD PHOTOGRAPHS



Cable Layout and Data acquisition of VES-1 (NWSC -7)



Cable Layout and Data acquisition of VES-2 (NWSC -7)



Cable Layout and Data acquisition of VES-3 (NWSC-4)





Cable Layout and Data acquisition of VES-4 (NWSC-4)



Cable Layout and Data acquisition of VES-5 (NWSC- 5)



Cable Layout and Data acquisition of VES-6 (NWSC- 5)



Cable Layout and Data acquisition of VES-7 (NWSC- 3)





Cable Layout and Data acquisition of VES-9 (NWSC- 1)



Cable Layout and Data acquisition of VES-10 (NWSC- 1)

ANNEX-III

DATA SHEET



VES Data Sheet of VES-1 (NWSC-7)

S.No	AB/2	MN/2	Resistivity(Ro)
1	2	0.5	38.6
2	3	0.5	51.56
3	4	0.5	55.1
4	5	0.5	59.3
5	6	0.5	60.69
6	6	1	62.48
7	8	1	65.59
8	10	1	70.23
9	12	1	71.91
10	15	1	80.46
11	20	1	79.87
12	20	5	80.65
13	25	5	80.72
14	30	5	78.49
15	35	5	73.2
16	40	5	67.91
17	45	5	63.85
18	50	5	60.56
19	55	5	59.44
20	60	5	56.38
21	65	5	53.89
22	70	5	53.59
23	80	5	52.25
24	90	5	51.61
25	100	5	50.88
26	100	15	51.43
27	110	15	50.57
28	120	15	56.85
29	130	15	53.88
30	140	15	53.64
31	160	15	55.28
32	180	15	61.19
33	200	15	60.34
34	220	15	61.7
35	240	15	63.18
36	260	15	61.48
37	280	15	61.94
38	300	15	64.04



39	300	25	66.04
40	320	25	64.65
41	340	25	65.79
42	360	25	66.04
43	380	25	64.97
44	400	25	67.08



VES Data Sheet of VES-2 (NWSC-7)

S.No	AB/2	MN/2	Resistivity(Ro)
1	2	0.5	60.5
2	3	0.5	47.64
3	4	0.5	46.77
4	5	0.5	46.51
5	6	0.5	48.82
6	6	1	49.62
7	8	1	57.98
8	10	1	53.73
9	12	1	53.79
10	15	1	61.26
11	20	1	64.76
12	20	5	68.14
13	25	5	72.21
14	30	5	70.09
15	35	5	70.96
16	40	5	68.22
17	45	5	62.99
18	50	5	61.17
19	55	5	60.53
20	60	5	58.49
21	65	5	58
22	70	5	57.77
23	80	5	57.01
24	90	5	55.63
25	100	5	53.43
26	100	15	54.38
27	110	15	55.25
28	120	15	55.67
29	130	15	52.98
30	140	15	55.69
31	160	15	57.37
32	180	15	59.74
33	200	15	66.68
34	220	15	67.9
35	240	15	69.71
36	260	15	70.01
37	280	15	73.7
38	300	15	70.45



39	300	25	70.73
40	320	25	70.73
41	340	25	72.65
42	360	25	72.41
43	380	25	72.26
44	400	25	72.21



VES Data Sheet of VES-3 (NWSC-4)

S.No	AB/2	MN/2	Resistivity(Ro)
1	2	0.5	107
2	3	0.5	103.9
3	4	0.5	119.65
4	5	0.5	137.18
5	6	0.5	165.19
6	6	1	175.49
7	8	1	207.49
8	10	1	230.55
9	12	1	251.37
10	15	1	290.35
11	20	1	293.81
12	20	5	318.05
13	25	5	327.05
14	30	5	301.94
15	35	5	273.91
16	40	5	241.27
17	45	5	201.13
18	50	5	143.12
19	55	5	123.14
20	60	5	107.77
21	65	5	96.48
22	70	5	77.8
23	80	5	73.07
24	90	5	66.03
25	100	5	62.9
26	100	15	66.45
27	110	15	61.84
28	120	15	60.54
29	130	15	54.37
30	140	15	51.67
31	160	15	52.05
32	180	15	53.03
33	200	15	52.41
34	220	15	58.75
35	240	15	62.25
36	260	15	66.92
37	280	15	62.65
38	300	15	67.36



39	300	25	70.05
40	320	25	70.41
41	340	25	69.6
42	360	25	67.86
43	380	25	72.31
44	400	25	70.65



VES Data Sheet of VES-4 (NWSC-4)

S.No	AB/2	MN/2	Resistivity(Ro)
1	2	0.5	44.4
2	3	0.5	43
3	4	0.5	48.72
4	5	0.5	47.88
5	6	0.5	47.31
6	6	1	51.78
7	8	1	53.4
8	10	1	55.42
9	12	1	52.92
10	15	1	62.28
11	20	1	66.02
12	20	5	62.62
13	25	5	66.32
14	30	5	69.67
15	35	5	73.9
16	40	5	73.15
17	45	5	71.53
18	50	5	72.01
19	55	5	70.71
20	60	5	70.18
21	65	5	67.88
22	70	5	67.1
23	80	5	65.67
24	90	5	62.61
25	100	5	58.41
26	100	15	59.14
27	110	15	
28	120	15	45.7
29	130	15	52.46
30	140	15	52.07
31	160	15	56.33
32	180	15	56.39
33	200	15	56.88
34	220	15	55.91
35	240	15	62.19
36	260	15	61.95
37	280	15	62.12
38	300	15	64.89



39	300	25	64.2
40	320	25	63.6
41	340	25	65.97
42	360	25	66.18
43	380	25	68.08
44	400	25	68.41



VES Data Sheet of VES-5 (NWSC- 5)

S.No	AB/2	MN/2	Resistivity(Ro)
1	2	0.5	118
2	3	0.5	74.95
3	4	0.5	46.67
4	5	0.5	33.75
5	6	0.5	33.73
6	6	1	36.83
7	8	1	36.57
8	10	1	38.12
9	12	1	38.46
10	15	1	40.44
11	20	1	43.68
12	20	5	48.51
13	25	5	55.67
14	30	5	56.18
15	35	5	57.31
16	40	5	58.42
17	45	5	60.84
18	50	5	59.88
19	55	5	62.29
20	60	5	61.21
21	65	5	62.36
22	70	5	62.6
23	80	5	64.15
24	90	5	64.88
25	100	5	64.2
26	100	15	61.29
27	110	15	63.6
28	120	15	64.62
29	130	15	64.47
30	140	15	63.49
31	160	15	65.75
32	180	15	69.8
33	200	15	72.69
34	220	15	73.12
35	240	15	73.94
36	260	15	75.71
37	280	15	77.62
38	300	15	81.14



39	300	25	81.22
40	320	25	82.45
41	340	25	82.96
42	360	25	82.94
43	380	25	85.82
44	400	25	83.99



VES Data Sheet of VES-6 (NWSC- 5)

S.No	AB/2	MN/2	Resistivity(Ro)
1	2	0.5	184.6
2	3	0.5	131.27
3	4	0.5	78.59
4	5	0.5	72.81
5	6	0.5	51.17
6	6	1	52.53
7	8	1	48.69
8	10	1	54.58
9	12	1	48.83
10	15	1	54.2
11	20	1	54.34
12	20	5	50.65
13	25	5	78.78
14	30	5	55.42
15	35	5	56.65
16	40	5	51.44
17	45	5	53.19
18	50	5	52.55
19	55	5	54.86
20	60	5	56.26
21	65	5	54.35
22	70	5	62.39
23	80	5	63.27
24	90	5	65.85
25	100	5	66.74
26	100	15	69.76
27	110	15	70
28	120	15	71.69
29	130	15	72.39
30	140	15	70.13
31	160	15	82.82
32	180	15	72.78
33	200	15	82.39
34	220	15	86.23
35	240	15	85.91
36	260	15	86.61
37	280	15	88.95
38	300	15	87.55



39	300	25	87.16
40	320	25	93.66
41	340	25	93.72
42	360	25	100.7
43	380	25	90.25
44	400	25	96.26



VES Data Sheet of VES-7 (NWSC- 3)

S.No	AB/2	MN/2	Resistivity(Ro)
1	2	0.5	73.7
2	3	0.5	67.86
3	4	0.5	64.14
4	5	0.5	64.13
5	6	0.5	64.33
6	6	1	62.48
7	8	1	66.08
8	10	1	75.4
9	12	1	80.79
10	15	1	94.39
11	20	1	95.85
12	20	5	94.74
13	25	5	100.71
14	30	5	104
15	35	5	101.23
16	40	5	101.86
17	45	5	100.56
18	50	5	102.19
19	55	5	104.93
20	60	5	103.96
21	65	5	87.53
22	70	5	106.42
23	80	5	110.57
24	90	5	110.59
25	100	5	112.52
26	100	15	106.59
27	110	15	118.74
28	120	15	114.22
29	130	15	112.44
30	140	15	114.26
31	160	15	118.62
32	180	15	119.07
33	200	15	119.11
34	220	15	116.37
35	240	15	112.8
36	260	15	110.56
37	280	15	108.58
38	300	15	105.86



39	300	25	109.18
40	320	25	107.49
41	340	25	105.42
42	360	25	103.6
43	380	25	102.04
44	400	25	100.04



VES Data Sheet of VES-8 (NWSC- 3)

S.No	AB/2	MN/2	Resistivity(Ro)
1	2	0.5	52.3
2	3	0.5	40.43
3	4	0.5	42.73
4	5	0.5	47.2
5	6	0.5	49.08
6	6	1	55.12
7	8	1	55.63
8	10	1	68.03
9	12	1	73.94
10	15	1	82.08
11	20	1	92.56
12	20	5	92.52
13	25	5	94.4
14	30	5	90.88
15	35	5	102.8
16	40	5	103.91
17	45	5	100.31
18	50	5	99.61
19	55	5	99.24
20	60	5	102.32
21	65	5	99.82
22	70	5	107.07
23	80	5	105.64
24	90	5	105.22
25	100	5	104.76
26	100	15	105.79
27	110	15	105.66
28	120	15	105.03
29	130	15	104.23
30	140	15	104.88
31	160	15	112.07
32	180	15	113.13
33	200	15	110.38
34	220	15	111.15
35	240	15	104.75
36	260	15	104.58
37	280	15	106.03
38	300	15	109.45



39	300	25	107.53
40	320	25	113.25
41	340	25	108.07
42	360	25	115.43
43	380	25	111.21
44	400	25	124.53
45	400	50	137.41



VES Data Sheet of VES-9 (NWSC-1)

S.No	AB/2	MN/2	Resistivity(Ro)
1	2	0.5	24.9
2	3	0.5	30.85
3	4	0.5	29.58
4	5	0.5	31.34
5	6	0.5	32.21
6	6	1	38
7	8	1	44.58
8	10	1	42.38
9	12	1	44.1
10	15	1	46.54
11	20	1	44.65
12	20	5	42.7
13	25	5	45.93
14	30	5	44.88
15	35	5	45.58
16	40	5	48.05
17	45	5	49.03
18	50	5	50.73
19	55	5	51.39
20	60	5	52.96
21	65	5	53.89
22	70	5	55.57
23	80	5	55.56
24	90	5	55.99
25	100	5	56.74
26	100	15	59.58
27	110	15	59.77
28	120	15	59.16
29	130	15	59.12
30	140	15	61.72
31	160	15	67.74
32	180	15	70.37
33	200	15	73.12
34	220	15	78.65
35	240	15	79.36
36	260	15	88.32
37	280	15	79.16
38	300	15	80.79



39	300	25	86.03
40	320	25	88.71
41	340	25	88.91
42	360	25	64.43
43	380	25	90.79
44	400	25	90.32



資料-6-5 試掘調査結果

Report on Construction of Deep Tubewell

**Biratnagar Metropolitan City – 9
Morang, Province No. 1, Nepal**

**Submitted To:
Yachiyo Engineering Company Ltd.**

**Submitted By:
Purbanchal Groundwater Tubewell Udhog, Biratnagar-3**

2020

Salient Features of Deep Tubewell

Tubewell No.	: 01
Location	: Biratnagar-9, Devkota chwok
Name of Client	: Yachio Engineering Company Ltd.
Fiscal Year	: 2020
Contract No.	:
Agreement Date	: February 9, 2020
Drilling Starting Date	: February 9, 2020
Drilling Method	: Direct Rotary Drilling
Well Size	: 12/8"
Drilled Depth	: 150 m
Logging Date	: 12 March 2020
Total Lowered Depth	: 150 m including 0.50 m AGL
Total Screen Length	: 18m
Total Housing Length	: 48 m
Completed Date	:
Static Water Level	:
Pumping Discharge	: 22 LPS (During well development by pump)
Dynamic Water Level	: 36m BGL

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Introduction

Groundwater is one of the main sources of water for drinking, irrigation and sanitary water purpose since long time. For the construction of deep tubewell drinking water supply purpose in Biratnagar Metropolitan City 9, Devkotachhwok an agreement between Purbanchal Groundwater Tubewell Udhog, Biratnagar and Yachiyo Engineering Company Ltd. on 9 February 2020. The main job according to the contract consists of construction of 1 nos. of 150 m depth 12/8" diameter deep tubewell.

The tubewell drilling site is located at Biratnagar 9, Devkotachhwok of Morang District (GPS location 26.457077, 87.286255). The drilling site is easily accessible by black top road from Biratnagar Section of Dharan-Biratnagar Highway. The drilling site is a part of Middle Terai Plane.

Geologically the site lies in the Middle Terai of Nepal Himalaya. This part of Terai is characterized by fluvial deposits consisting of clay, sand and some fine gravels. Hydrogeologically, this part of terai belt is characterized by unconfined to semi confined aquifer. The purposed area is feasible for both shallow and deep tubewell.

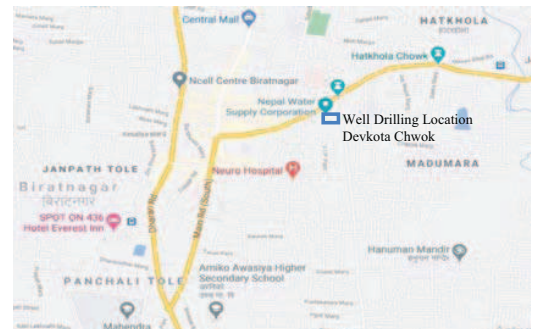


Figure 1: Deep Tubewell Drilling Location Devkota chwok, Biratnagar (map not in scale).

Well drilling, lowering of well assembly, Gravel packing and sealing of borehole with impermeable materials was completed successfully. Well development was interrupted due to Covid-19 pandemic. After the interruption, the well was cleaned with all its might, but the well could not be completely cleaned due to the effect of the interruption. Therefore, the pumping test under the initial contract was not conducted by the competition with JICA Study Team.

2

2. Tubewell Construction

2.1 Site Mobilization

After the contract agreement, the contractor was mobilized the equipments and machinery after contract award and then drilling work was started by Direct Rotary Drilling Machine. The necessary machinery and equipments used are:

- Drilling Rig Machine
- Generator
- Truck
- Tractor
- Logger machine
- Compressor
- Submersible pump

2.2 Drilling and sampling

After Site Mobilization, the drilling work on the selected site has been done with Drilling Rig. During the drilling operation, the drilling fluid carried out the cut particles to the surface through the borehole by bailing. Representative samples of different layers were collected. The collected samples of different horizons were washed, dried and placed in sampling plastic bags labeled with the depth. The litholog of the constructed tubewell at Biratnagar-9, Devkotachwok is shown in Annex A. The driller has also prepared litholog on the basis of cuttings, nature of progress and nature of drilling fluid losses. The contractor has carried out the whole drilling work under direction and close supervision of the client.

2.3 Geophysical Borehole Logging

After the completion of the drilling work, electrical resistivity logging was carried out on 12 February 2020. A resistivity log from apparent resistivity values of different formation against depth was prepared. The main water bearing aquifers and their boundaries were separated or marked based on electric logging and lithological log data, Annex D. The electrical resistivity data and prepared resistivity log is shown in Annex B.

3

2.4 Well Design and Well Assembly

On the basis of the Electrical Resistivity Log, Drillers log and comments of the involved driller while drilling like drilling fluid losses, penetration rate etc, the water bearing zones and their thickness were identified. On the basis of the data, the tubewell was designed, well assembly is prepared and submitted to the client for approval and suggestion. The Well Design and Well Assembly is shown in Annex C. According to the geological and electrical logging data, the stainless steel (SS) 8 inch was installed 65-71m, 116-122m and 139-145m overall well assembly has presented below table 1.

Table 1. Well assembly.

SN	Depth (m)		Length (m)	Description	Remarks
	From	To			
1	150.00	145.00	5.00	Well Plug / Casing	8" ø
2	145.00	139.00	6.00	SS Screen	
3	139.00	122.00	17.00	Casing	
4	122.00	116.00	6.00	SS Screen	
5	116.00	71.00	45.00	Casing	
6	71.00	65.00	6.00	SS Screen	
7	65.00	48.00	17.00	Casing (BP)	
8	48.00	0.00	48.00	Housing	12" ø

On the basis of lithology and electrical logging the potential aquifer is about 55-85m, 112-130m, 114-129m and 137-150m as per attached well assembly chart (casing Program). This aquifers are tapped with 200 mm diameter stainless steel screen with expected open area of 25%.

Considering the entrance velocity in the gravel pack and screen as 0.03 m/sec, average open area of the stain less screen as 25% and the clogging coefficient of 60%, the theoretical discharge of the well is about 25 Lps.

4

2.3 Lowering and Gravel Packing

Prior to lowering of well assembly, the borehole was reconditioned to clear the hole. Recondition of a borehole is necessary to clear the bulging on the borehole, remove cuttings as well as excess drilling mud. The recondition of the bore hole is done by lowering the drilling bit and by removing the drilling fluid and cuttings by bailing. According to the well design different lengths of casing, stainless screen pipe and well plug arranged for the particular tubewell design. The arranged pipes assembled and lowered in to the drilled hole by welding and strapping.

In the tubewell, gravel packing is necessary to fill open space between the well screen and drilled wall. The gravel pack create continuous and porous zone around the well screen. The sizes of the gravels were selected on the basis of the grain size of the aquifer being trapped. Non-calcareous round to sub-rounded gravels of dia 4-8mm has packed in the annular space between the drill hole and well assembly. Overall gravel packing depth and lowering tubewell assembly has presented on Annex F.

2.4 Bore Hole Sealing

Bore hole sealing has been carried out as per technical specification and site engineer's instruction. Up to the 1m below ground bore hole has sealed with concrete and up to 6m with silt and 6-38m filled with bentonite clay.

5

Well Development

Development of tube well has been carried out immediately after installation of the pipe assembly and gravel packing. The well development has broad objectives:

- To repair damage done to the formation (aquifer) by the drilling operation so that the natural hydraulic properties are restored
- To alter the basic physical characteristics of the aquifer near the borehole so that the water will flow more freely to the well.

The methods used for the well development process are as described herein.

3.1 Mechanical Surging

The development of tube well was carried out by back washing and inner washing. Rig Machine with mud-pump was used to remove the drilling fluids and dirt from the tubewell. This process was done to remove fine materials and to stabilize the proper gravel packing around the screen.

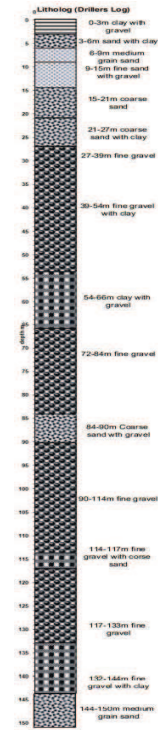
3.2 Air Compressor

After the development of well by the mechanical method, well was again developed by Air Compressor to remove fine particles contained in the well. The well development by air compressor was run for 38.4 hours with turbidity results 20 NTU.

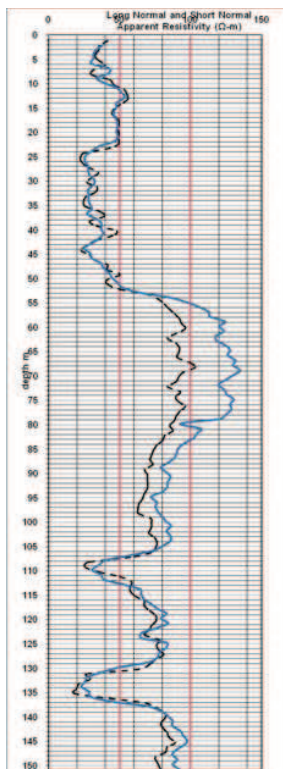
3.3 Well Development by Pump

After completion of well development by air compressor, the well development was conducted by submersible pump for 94 hrs. Date and time of work conducted has presented below in annex table E. During the well development the turbidity of water shows more than 20 NTU.

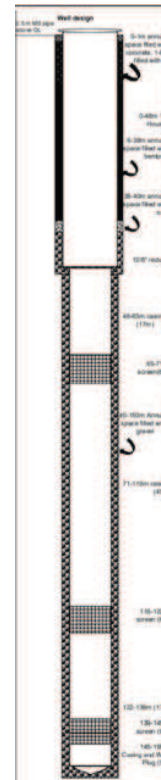
Annex



Annex A: Litholog drillers log.



Annex B: Long Normal and Short Normal Apparent Resistivity value.



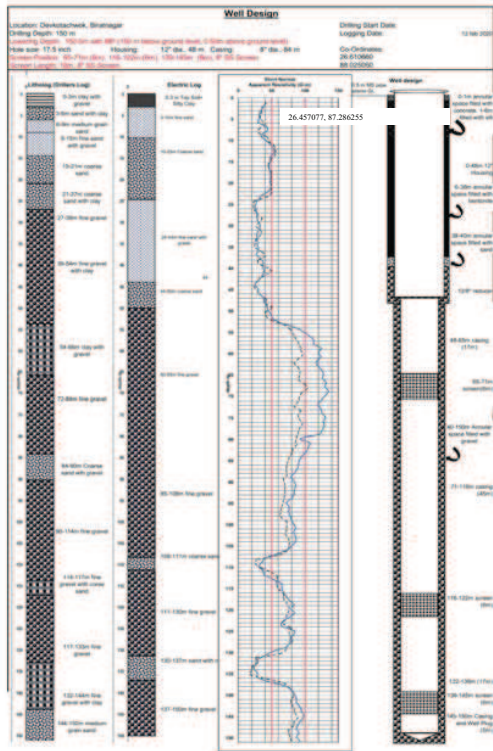
Annex C : Well Assembly.

Meter reading Depth (m)	Sort Normal (Sn)	Long Normal (Ln)	Meter reading Depth (m)	Sort Normal (Sn)	Long Normal (Ln)	Meter reading Depth (m)	Sort Normal (Sn)	Long Normal (Ln)
0.00	16.06000	1.47000	51.00	8.24000	2.58000	102.00	14.08000	4.27000
1.00	8.29000	1.96000	52.00	9.97000	3.16000	103.00	14.90000	4.27000
2.00	7.16000	1.71000	53.00	13.58000	4.17000	104.00	15.17000	4.03000
3.00	7.01000	1.57000	54.00	15.34000	4.83000	105.00	15.05000	3.67000
4.00	6.48000	1.57000	55.00	16.24000	5.25000	106.00	14.35000	2.81000
5.00	6.95000	1.50000	56.00	16.90000	5.82000	107.00	11.50000	2.00000
6.00	7.94000	2.12000	57.00	17.71000	5.64000	108.00	5.51000	1.77000
7.00	6.30000	2.12000	58.00	18.36000	6.18000	109.00	5.55000	1.53000
8.00	5.99000	1.69000	59.00	18.61000	5.97000	110.00	5.02000	1.83000
9.00	8.57000	1.98000	60.00	19.19000	6.14000	111.00	7.05000	1.98000
10.00	9.13000	2.37000	61.00	17.93000	5.85000	112.00	9.93000	2.60000
11.00	10.59000	2.57000	62.00	16.64000	5.90000	113.00	11.63000	3.22000
12.00	11.04000	2.67000	63.00	17.81000	6.21000	114.00	11.41000	3.24000
13.00	11.10000	2.39000	64.00	18.34000	6.35000	115.00	11.46000	3.35000
14.00	10.03000	2.38000	65.00	18.22000	6.27000	116.00	12.13000	3.58000
15.00	9.12000	2.27000	66.00	18.02000	6.54000	117.00	13.40000	3.82000
16.00	8.90000	2.32000	67.00	19.78000	6.46000	118.00	14.20000	4.13000
17.00	9.70000	2.41000	68.00	20.61000	6.71000	119.00	15.05000	3.94000
18.00	9.89000	2.41000	69.00	18.86000	6.48000	120.00	15.07000	4.18000
19.00	9.64000	2.38000	70.00	18.25000	6.19000	121.00	14.46000	3.74000
20.00	9.84000	2.43000	71.00	17.81000	5.95000	122.00	14.10000	3.27000
21.00	9.73000	2.29000	72.00	16.63000	6.15000	123.00	13.42000	3.25000
22.00	9.85000	1.79000	73.00	18.46000	6.24000	124.00	15.59000	4.15000
23.00	8.67000	1.52000	74.00	17.84000	6.48000	125.00	15.14000	4.11000
24.00	4.93000	1.53000	75.00	18.14000	6.35000	126.00	15.41000	3.89000
25.00	4.46000	1.28000	76.00	19.13000	6.40000	127.00	16.12000	3.81000
26.00	4.76000	1.37000	77.00	18.41000	6.24000	128.00	14.98000	3.52000
27.00	5.58000	1.39000	78.00	17.91000	5.99000	129.00	14.19000	2.48000
28.00	6.99000	1.44000	79.00	17.57000	4.61000	130.00	12.73000	1.92000
29.00	6.19000	1.61000	80.00	16.99000	5.33000	131.00	5.29000	1.38000
30.00	5.40000	1.58000	81.00	17.40000	5.19000	132.00	5.88000	1.28000
31.00	6.75000	1.38000	82.00	18.29000	5.08000	133.00	4.34000	1.16000
32.00	6.58000	1.41000	83.00	15.99000	4.77000	134.00	3.92000	1.43000
33.00	5.30000	1.40000	84.00	15.20000	4.55000	135.00	3.52000	1.44000
34.00	4.60000	1.84000	85.00	13.81000	4.27000	141.00	15.72000	4.33000
35.00	5.13000	1.51000	86.00	14.46000	4.41000	137.00	13.55000	3.46000
36.00	7.13000	1.35000	87.00	14.21000	4.20000	138.00	15.16000	3.97000
37.00	7.89000	1.70000	88.00	14.59000	3.93000	139.00	16.28000	4.17000
38.00	5.80000	1.86000	89.00	13.45000	4.15000	140.00	16.33000	4.34000
39.00	6.64000	1.84000	90.00	13.81000	4.27000	141.00	15.72000	4.33000
40.00	9.53000	1.92000	91.00	13.83000	4.16000	142.00	15.97000	4.61000
41.00	9.00000	1.76000	92.00	13.90000	4.15000	143.00	16.63000	4.71000
42.00	6.60000	1.51000	93.00	13.82000	3.97000	144.00	16.87000	4.86000
43.00	5.37000	1.24000	94.00	13.43000	3.59000	145.00	17.75000	4.73000
44.00	4.60000	1.46000	95.00	13.16000	3.79000	146.00	16.62000	4.45000
45.00	5.75000	1.51000	96.00	12.71000	3.75000	147.00	16.38000	4.34000
46.00	6.45000	1.84000	97.00	12.55000	3.83000	148.00	15.01000	4.50000
47.00	8.25000	1.92000	98.00	12.59000	3.96000	149.00	15.20000	4.35000
48.00	8.20000	2.12000	99.00	14.34000	4.11000	150.00	15.54000	4.59000
49.00	10.02000	2.21000	100.00	14.41000	4.28000	151.00	15.59000	4.67000
50.00	8.23000	2.42000	101.00	14.38000	4.12000			

Annex D: Electrical Resistivity Logging Data.

Date	Pump start time	Pump stop time	Pump run time	Remarks
23 July 2020	11:00AM	3:00PM	4 hrs	
24 July 2020	10:00AM	3:00 PM	5 hrs	
27 July 2020	10:00AM	4:00PM	6 hrs	
28 July 2020	11:00AM	4:00PM	5hrs	
29 July 2020	10:00AM	5:00PM	7 hrs	
30 July 2020	11:00AM	5:00PM	6 hrs	
30 July 2020	6:00PM	10:00PM	4 hrs	
31 July 2020	10:00AM	5:00PM	7 hrs	
3 August 2020	11:00AM	4:00PM	5 hrs	
3 August 2020	6:00PM	10:00PM	4 hrs	
4 August 2020	10:00AM	5:00PM	7 hrs	
4 August 2020	6:00PM	10:00PM	4 hrs	
5 August 2020	11:00AM	4:00PM	5 hrs	
5 August 2020	6:00PM	10:00PM	4 hrs	
6 August 2020	10:00AM	5:00PM	7 hrs	
6 August 2020	6:00PM	10:00PM	4 hrs	
7 August 2020	10:00AM	4:00PM	6 hrs	
7 August 2020	6:00PM	10:00PM	4 hrs	
Total			94 hrs	

Annex E: Time and date of well development by submersible pump.



Annex F : Well assembly with drillers log and resistivity log.



Photo No.1 : Tubewell Drill by Direct Rotary method.



Photo No.2 : Borehole Geophysical logging, 12 March 2020.



Photo No.3: Inspection of casing welding, 14 March 2020.



Photo No.4: Installation of Casing and screen, 14 March 2020



Photo No 5: Bore hole top sealing with 1m concrete.

Photo No 6: Well Development by Compressor, 7 October 2202



Photo No 7: Well Development by submersible pump, 3 August 2020.

Photo No 8: Water level Measurement during well development, 3 August 2020.



Photo No. 9: Joining of MS pipe by welding.

Photo No.10: Borehole top concreting.



Photo No.: 11 Completion of Bore hole top concreting.

Photo No.12 Column Pipe lowering for well development.



Photo No.: 13 Compressor pipe lowering for well development by compressor.

Photo No.: 14 Water checking during well development.

Field Photograph

資料-6-6 井戸掘削調査結果

**FINAL REPORT
ON
TEST PIT SURVEY
FOR
THE PREPARATORY SURVEY
ON
THE PROJECT FOR IMPROVEMENT OF WATER SUPPLY
SYSTEM
IN
BIRATNAGAR, MORANG**

**CLIENT
NEPAL WATER SUPPLY CORPORATION
BIRATNAGAR**

**PREPARED FOR
YACHIYO ENGINEERING CO., LTD.
TOKYO, JAPAN**

Prepared and Submitted By:

December, 2020



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CONSULTING ENGINEERS
Kathmandu Metropolitan City, Ward No-51, Shantinagar, Kathmandu, Nepal
Tel-977-01-4107665

Ref No:

Date: December 29th, 2020

To,

Yachiyo Engineering Co., Ltd.

Tokyo, Japan

Subject:-Submission of Revised Trial Pit Survey Report.

Dear Sir/Madam,

It is our pleasure to submit you this Revised Report on Trial Pit Survey for the Preparatory Survey on the Project for Improvement of Water Supply System in Biratnagar, Morang. This investigation was carried out according to yours request.

This report includes the results of field investigation result to confirm the condition of underground utilities along the planned pipelines.

For any further information or clarifications, please don't hesitate to contact us.

We would like to thank you for your condience, hoping to cooperate with you in the near future.



Yours Sincerely
Diwakar Khadka

Managing Director/Geotechnical Engineer

Geotechnical investigation work, core drilling and construction materials testing; Pavement design; Foundation settlement and slope stability analysis; Design of roads, bridges, highways, buildings, hydropower's and towers.

Final Report on Test Pit Survey for Preparatory Survey on the Project for the Improvement of Water Supply System AT BIRATNAGAR METROPOLITAN CITY, MORANG, NEPAL

PLANET TEST

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Final Report on Test Pit Survey for Preparatory Survey on the Project for the Improvement of Water Supply System AT BIRATNAGAR METROPOLITAN CITY, MORANG, NEPAL

PLANET TEST

1. SITE AND PROJECT DESCRIPTION

The project site lies within Biratnagar Metropolitan City of Morang District in Province-1. Biratnagar City is the headquarter of Province-1 and it is major City of Eastern Nepal. Biratnagar lies in the Terai region of Nepal. Since, Biratnagar is politically historical city of Nepal hence the population density has been increased in the recent past. The increase in Population has increased the demand of pure water supply in the City. So, Government of Nepal and Government of Japan have agreed to upgrade the Water Supply System. Hence, JICA has funded Nepal Water Supply Corporation for the upgrading of Water Supply System in Biratnagar. Yachiyo Engineering Co., Ltd. Tokyo, Japan has been engaged for the Study for the upgrading of Water Supply System in Biratnagar. Yachiyo Engineering Co. Ltd will work with close collaboration with Nepal Water Supply Corporation, Biratnagar for the design of the upgrading of water supply system within Biratnagar Metropolitan City. Hence, Yachiyo Engineering Co. Ltd has hired Planet Test Pvt. Ltd, Shantinagar, Kathmandu for the job of Test Pit Survey.

Planet Test Pvt. Ltd had performed the job of excavation of Trial Pit with the approval of the concerned authorities such as office of Biratnagar Metropolitan City and Nepal Water Supply Corporation, Biratnagar Branch office. The test pit excavation work was started from March 5th 2020 to March 8th 2020. Planet Test has completed excavation of 9 test pits out of 10 test pits.

2. ABOUT THIS STUDY

2.1 Purpose of the Study

The purpose of test pit is to determine the route of water pipeline by confirming the condition of underground utilities along the planned pipelines for the design of Pipeline System within project area.

2.2 Scope of Investigation

The Scope for this study comprises the followings:

1. Total 10 test pit location shall be excavated.
2. The dimension of the test pit excavation shall be 1.0m W x 1.0m L x 1.5 m (depth) for earth covering for pipes of 1.2m approximately and 1.5m W x 1.5m L x 2 m (depth) for earth covering for pipes of 2m approximately. However, actual dimension of test pit shall be determined at the site for achievement of the purpose of the survey.
3. The excavation shall be done by man power to avoid making damage to the existing utilities.
4. The restoration of the excavated Tests Pits to the original shall be done.
5. The pipeline size, type, depth from the existing ground level, conditions shall be checked.

2.3 Location Map: Test Pit all over Biratnagar



Location Map: Test Pit all over Biratnagar

2.4 Location map of surveyed test pit



Location Map-1: TP-1(Devkota Chowk, Coordinate 26°27'29.84\"/>



Location Map-2: TP-2(Aqua Park, Coordinate 26°26'53.04\"/>



Location Map-3: TP-3 (Anukaran Chowk, Coordinate 26°28'57.39\"/>



Location Map-4: TP-4(Kesaliya Road, Coordinate 26°27'20.18\"/>



Location Map-5: TP-5(Tinpaini Road, Coordinate 26°28'12.89\"/>



Location Map-6: TP-6 (Saleshwori Marg, Coordinate 26°27'28.33\"/>



Location Map-7: TP-7(Bhattimode Kesaliya Marg, Coordinate 26°27'21.69"N, 87°16'26.55"E)



Location Map-8: TP-8(Police Station, Coordinate 26°27'31.55"N, 87°17'34.68"E)



Location Map-9: TP-9 (Mahendra Chowk, Coordinate 26°27'15.26"N, 87°16'39.98"E)



Location Map-10: TP-10 (Pichara, Coordinate 26°27'12.75"N, 87°16'2.92"E)

3. EXPLORATORY METHOD

We explored subsurface conditions at the project site on since March 5th 2020. Our exploration and evaluation program comprised the following elements:

1. Surface reconnaissance of the site;
2. Nine test pits were excavated since March 6th 2020 to March 8th 2020.
3. The final test pit was excavated in December 23, 2020.
4. Appropriated size of test pit as mentioned on ToR was excavated manually to different depth as per site conditions.
5. Soil profile of the test pit was noted.
6. The size, type, conditions, depth of existing pipe from ground level was noted.

3.1 Test Pit Procedure

Our exploratory test pits (TP-1 through TP-10) were excavated manually using shovel and pickaxe. A Geotechnical Engineer from our firm observed the test pit excavations and logged the subsurface conditions.

The enclosed test pit logs indicate the vertical sequence of soils and materials encountered in each test pit, based on our field classifications. Where a soil contact was observed to be gradational or undulating, our logs indicate the average contact depth. The soils were classified visually in general accordance with the system described in each borelog sheet.

4. TEST PIT AND LOG DESCRIPTION

4.1 Test Pit-1

The first Test Pit TP-1 was opened at the location of Devkota Chowk as shown in Figure-1. The Section of TP-1 is as shown in Figure-2. The depth of test pit is about 1.1m. Close view of the soil strata is shown in the figure below. The test pit was logged and a different stratum in more detail is described in test pit log.

The first observation made from the test pit is the top layer of sub-grade fill material on the road side. The top soil layer thickness varies from 0 mm to 300 mm. Just under the top soil the medium dense light brownish sandy clay lies up to the excavated depth of 1.1m. The water table was not present at the time of investigation. The pipe below the test pit encountered was of DI pipe type of 12" size.

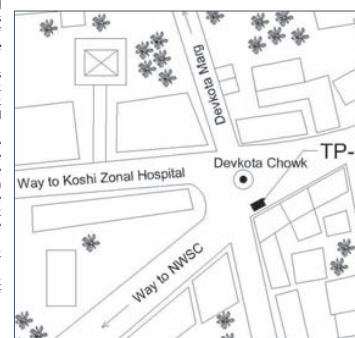


Figure-1: Tentative Site Plan of TP-1 (Devkota Chowk)

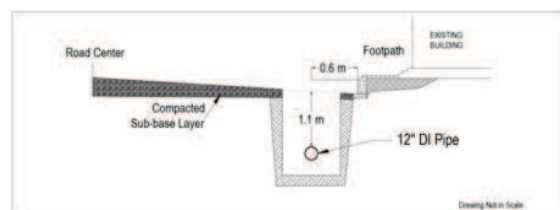


Figure-2: Section of TP-1 (Devkota Chowk)



Fig. Helper Measuring Test Pit Dimension



Fig. Helper Measuring Depth of Water Supply Pipe from Surface



Fig. Site Condition of Trial Pit location before Excavation



Fig. Test Pit Location After Backfill

TRIAL PIT LOG

Project : Improvement of Water Supply System in Biratnagar
Client : Nepal Water Supply Corporation (NWSC)
Consultant : Yachtyo Engineering Co. Ltd.
Location : Biratnagar Metropolitan City-4, Kanchanbari, Morang

PIT No:-1
Location:- Devkota Chowk
Co-ordinate: 26°27'29.84"N, 87°17'13.31"E
Total Depth:-1.1m
Start Date: 2020-03-08
Completion Date:2020-03-08

Scale	Depth	Thickness	Symbol	SOIL DESCRIPTION	Water Table	Backfill	Scale
	m	m			m	m	
	0			Dense to very dense gravel mixed soil.			0
	0.3			Medium dense light brownish sandy clay	Water Table Not Encountered	Completely backfilled.	0.3
	0.6		0.6				
	0.9						0.9

Dimension:

General Remarks:
 Trial pit terminated due to pipeline exposed.

4.2 Test Pit-2

The first Test Pit TP-2 was opened at the location of South of Aqua Park as shown in Figure-6. The Section of TP-2 is as shown in Figure-7. The depth of test pit is about 1.2m. Close view of the soil strata is shown in the figure below. The test pit was logged and a different stratum in more detail is described in test pit log. The test pit was already exposed as location was excavation by NSWC for Pipe seepage maintenance. The survey for pipe was conducted with close co-ordination with NSWC, Biratnagar. The backfilling and pavement was restored by NSWC, Biratnagar.

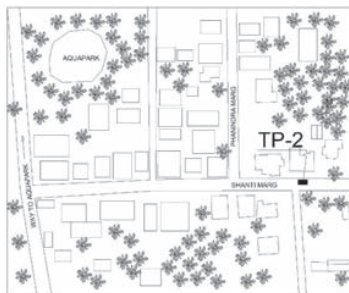


Figure-1: Tentative Site Plan of TP-2 (South of Aqua Park)

The first observation made from the test pit is the top layer of sub-grade fill material on the road side. The top soil layer thickness varies from 0 mm to 300 mm. Just under the top soil the medium dense light brownish sandy clay with refill material lies up to the excavated depth of 1.2m. The water table was not present at the time of investigation. The pipe below the test pit encountered was of GI pipe type of 6" size.

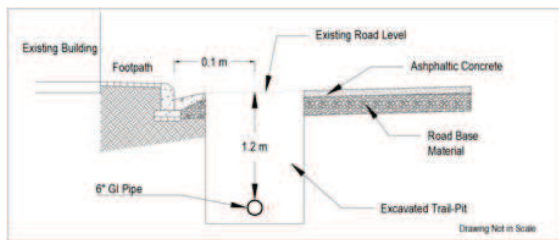


Figure-2: Section of TP-2 (South of Aqua Park)



Fig. Helper Measuring Test Pit Dimension



Fig. Helper Measuring Depth of Water Supply Pipe from Surface



Fig. Site Condition of Trial Pit location before Excavation



Fig. Test Pit Location After Backfill

TRIAL PIT LOG								
Project : Improvement of Water Supply System in Biratnagar Client : Nepal Water Supply Corporation (NWSC) Consultant : Yachiyo Engineering Co. Ltd. Location : Biratnagar Metropolitan City-4, Kanchanbari, Morang								
PIT No:-2			Location:- South of Aqua Park			Total Depth:-1.2m		
Co-ordinate: 26°26'53.04"N, 87°17'1.13"E			Start Date: 2020-03-07			Completion Date:2020-03-07		
Scale	Depth	Thickness	Symbol	SOIL DESCRIPTION	Water Table	Backfill	Scale	
0	0	0		Dense to very dense gravel mixed soil.	Water Table Not Encountered	Completely backfilled.	0	
0.3							0.3	
0.6							0.6	
0.9				Medium dense light brownish sandy clay with III materials.			0.9	
1.2							1.2	
Dimension:				General Remarks:				
				Trial pit terminated due to pipeline exposed.				

4.3 Test Pit-3

The first Test Pit TP-3 was opened at the location south of Thulo mill chowk near Anukaran Chowk as shown in Figure-1. The Section of TP-1 is as shown in Figure-2. The depth of test pit is about 0.45m. Close view of the soil strata is shown in the figure below. The test pit was logged and a different stratum in more detail is described in test pit log.
The first observation made from the test pit is the surface was paved with Tiles. We found gravel mixed soil upto 0.3m. A medium dense dark grey sandy clay stratum was found then after. We encountered the pipe at the depth of 0.4m. The water table was not present at the time of investigation.
The pipe below the test pit encountered was of GI pipe type of 6" size.



Figure-1: Tentative Site Plan of TP-3 (Near Anukaran Chowk)

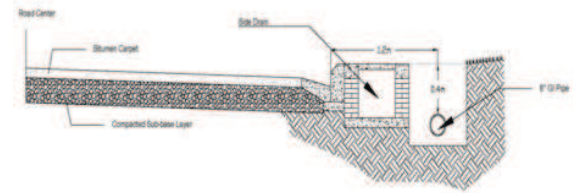


Figure-2: Section of TP-3 (Anukaran Chowk)



Fig. Measuring Pipe Depth From Surface



Fig. Measuring Trial Pit Dimension



Fig. Trial Pit location Before Excavation



Fig. Trial Pit location After Excavation

TRIAL PIT LOG								
Project : Improvement of Water Supply System in Biratnagar Client : Nepal Water Supply Corporation (NWSC) Consultant : Yachiyo Engineering Co. Ltd. Location : Biratnagar Metropolitan City-4, Kanchanbari, Morang								
PIT No:-3			Location:- Nearby Anukaran Chowk			Total Depth:-0.45m		
Co-ordinate: 26°28'57.39"N, 87°17'2.39"E			Start Date: 2020-03-07			Completion Date:2020-03-07		
Scale	Depth	Thickness	Symbol	SOIL DESCRIPTION	Water Table	Backfill	Scale	
0	0	0		Paved Tiles followed by gravel mixed soil.	Water Table Not Encountered	Completely backfilled.	0	
0.2							0.2	
0.4				Medium dense dark grey sandy clay			0.4	
Dimension:				General Remarks:				
				Trial pit terminated due to pipeline exposed.				

4.4 Test Pit-4

The first Test Pit TP-4 was opened at the location at a road south of bhattmode L.N General store as shown in Figure-1. The Section of TP-4 is as shown in Figure-2.

The pipe was initially exposed as it was damaged during construction. The depth of test pit is about 1.2m. Close view of the soil strata is shown in the figure below. The test pit was logged and a different stratum in more detail is described in test pit log.

The first observation made from the test pit is the top layer of Dense sub-grade fill material on the road side. The top soil layer thickness varies from 0 mm to 200 mm. Just under the top soil the medium dense dark brown sandy clay with silt lies up to the excavated depth of 1.1m from curbstone. The water table was not present at the time of investigation.

The consultation with the local people and NWSC was made before excavating the trial pit. The pipe below the test pit encountered was of GI pipe type of 3" size. However, with the consultation with NWSC it has been observed that the pipeline through south of L.N General store originally was 4" DI pipe. However, at the location of trial pit-4, during earlier leakage through the pipeline the repair work was done and due to lack of 4" DI pipe smaller size of 3" GI was connected to stop the leakage. And same leakage pipe line was encountered during excavation.

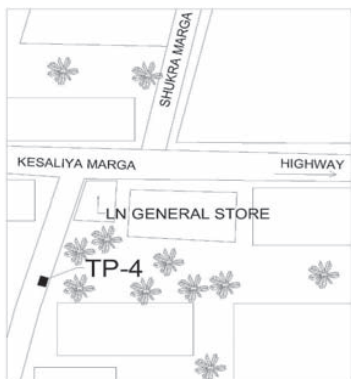


Figure-1: Tentative Site Plan of TP-4 (South of L.N General Store)

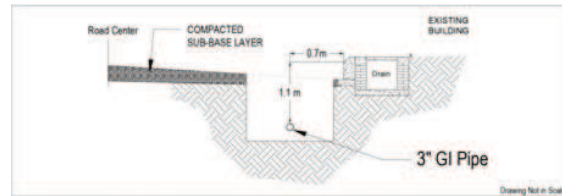


Figure-2: Section of TP-4 (South of L.N General Store)



Fig. Damaged Pipe Found Being Repaired at Trial Pit Location



Fig. Helper Measuring the External Diameter of Water Supply Pipe



Fig. Site Condition of Trial Pit Location



Fig. Pipe Being Repaired afterwards by NWSC

TRIAL PIT LOG

Project : Improvement of Water Supply System in Biratnagar		Client : Nepal Water Supply Corporation (NWSC)		Consultant : Yachiyo Engineering Co. Ltd.		Location : Biratnagar Metropolitan City-4, Kanchanbari, Morang	
PIT No:-4		Location:- South of Kesaliya Road		Total Depth:-1.2m		Start Date: 2020-03-06	
Co-ordinate:26°27'20.18"N, 87°16'32.14"E		Completion Date:2020-03-06					
Scale	Depth	Thickness	Symbol	SOIL DESCRIPTION	Water Table	Backfill	Scale
0	0.3	0.3	[Symbol]	Dense to very dense gravel mixed soil with Sub-base material.	Water Table Not Encountered	Backfilled done by NWSC after maintaining leakage of water.	0.3
0.6	0.9	0.3	[Symbol]	Medium dense dark brown sandy clay.			0.6
1.2							1.2
Dimension:				General Remarks:			
				Trial pit terminated due to pipeline exposed.			

4.5 Test Pit-5

The first Test Pit TP-5 was opened at the location at Tinpaini Chowk in front of Prabhu Bank as shown in Figure-1. The Section of TP-5 is as shown in Figure-2. The depth of test pit is about 1.5m. Close view of the soil strata is shown in the figure below. The test pit was logged and a different stratum in more detail is described in test pit log. The first observation made from the test pit is the top layer of Dense sub-grade fill material on the road side. The top soil layer thickness varies from 0 mm to 300 mm. Just under the top soil the medium dense light to dark brown sandy clay with silt lies up to the excavated depth of 1.23m from surface. The water table was not present at the time of investigation. The pipe below the test pit encountered was of DI pipe type of 8" size.



Figure-1: Tentative Site Plan of TP-5 (Tinpaini Chowk)

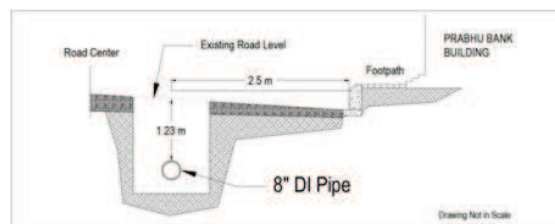


Figure-2: Section of TP-5 (Tinpaini Chowk)



Fig. Site Condition Before Excavation of Test Pit



Fig. Helper Measuring External Dia. of Pipe



Fig. Helper Measuring Pipe Depth From Surface



Fig. Test Pit After Excavation



Fig. Helper Compacting During Backfill



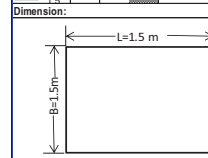
Fig. Test Pit After Backfill

TRIAL PIT LOG

Project : Improvement of Water Supply System in Biratnagar
Client : Nepal Water Supply Corporation (NWSC)
Consultant : Yachyo Engineering Co. Ltd.
Location : Biratnagar Metropolitan City-4, Kanchanbari, Morang

PIT No:-5
Location:-Timpaini Chowk
Co-ordinate:26°28'12.89"N, 87°17'3.59"E
Total Depth:-1.5 m
Start Date: 2020-03-06
Completion Date:2020-03-06

Scale	Depth	Thickness	Symbol	SOIL DESCRIPTION	Water Table	Backfill	Scale
0	0.5			Dense to very dense gravel mixed soil with Sub-base material.	Water Table Not Encountered	Completely backfilled.	0
1	1.5			Medium dense light to dark brown sandy clay.			1



General Remarks:
Trial pit terminated due to pipeline exposed.

4.6 Test Pit-6

The first Test Pit TP-6 was opened at the location at Sallish Mandir Road as shown in Figure-1. The Section of TP-6 is as shown in Figure-2. The depth of test pit is about 0.4m. Close view of the soil strata is shown in the figure below. The test pit was logged and a different stratum in more detail is described in test pit log. The first observation made from the test pit is the top layer of refill soil with debris. The top soil layer thickness varies from 0 mm to 100 mm. Just under the top soil the medium dense dark grey sandy clay with silt lies up to the excavated depth of 0.4m from surface. The water table was not present at the time of investigation. The pipe below the test pit encountered was of GI pipe type of 4" size.

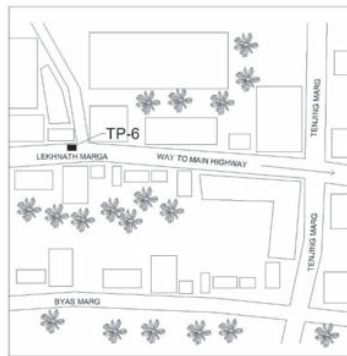


Figure-1: Tentative Site Plan of TP-6 (Sallish Mandir Road)

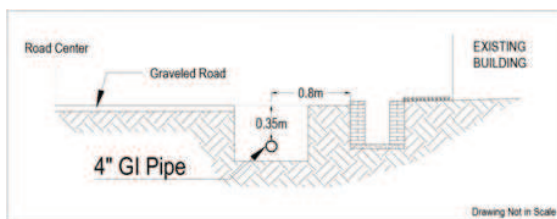


Figure-2: Section of TP-6 (Sallish Mandir Road)



Fig. Site Condition Before Excavation of Test Pit



Fig. Helper Measuring External Dia. Of Pipe



Fig. Helper Measuring Test Pit Length



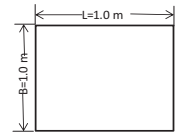
Fig. Helper Measuring Test Pit Breadth



Fig. Test Pit After Excavation



Fig. Test Pit After Backfill

TRIAL PIT LOG							
Project : Improvement of Water Supply System in Biratnagar Client : Nepal Water Supply Corporation (NWSC) Consultant : Yachiyo Engineering Co. Ltd. Location : Biratnagar Metropolitan City-4, Kanchanbari, Morang							
PIT No:-6				Total Depth:-0.40m			
Location:- Saileshwori Marg				Start Date: 2020-03-08			
Co-ordinate:26°27'28.33"N, 87°16'27.59"E				Completion Date:2020-03-08			
Scale	Depth	Thickness	Symbol	SOIL DESCRIPTION	Water Table	Backfill	Scale
0	0			Top refill soil mixed with debris.	Water Table Not Encountered	Completely backfilled.	0
0.2	0.2			Medium dense dark grey sandy clay			0.2
0.4	0.4						0.4
Dimension: 				General Remarks: Trial pit terminated due to pipeline exposed.			

4.7 Test Pit-7

The first Test Pit TP-7 was opened at the location west of Nepal Communist Party, Morang Office near Bhattimode as shown in Figure-1. The Section of TP-7 is as shown in Figure-2. The depth of test pit is about 0.75m. Close view of the soil strata is shown in the figure below. The test pit was logged and a different stratum in more detail is described in test pit log. The first observation made from the test pit is the top layer of refill soil with debris. The top soil layer thickness varies from 0 mm to 100 mm. Just under the top soil the medium dense dark grey sandy clay with silt lies up to the excavated depth of 0.75m from surface. The depth of GI pipe of size 3" was encountered at a depth of 0.70m from ground level and 5cm of clearance below pipe level was maintained for measuring the size of pipe. The water table was not present at the time of investigation. The pipe below the test pit encountered was of GI pipe type of 3" size.



Figure-1: Tentative Site Plan of TP-7 (West of Nepal Communist Party office, Bhattimode)

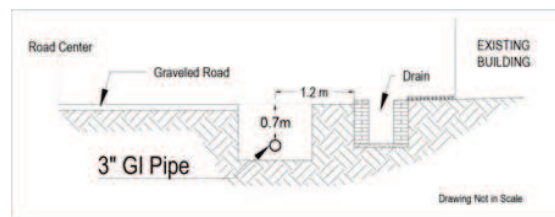


Figure-2: Section of TP-7 (West of Nepal Communist Party office, Bhattimode)



Fig. Site Condition Before Excavation of Test Pit



Fig. Helper Measuring External Dia. Of Pipe



Fig. Helper Measuring Pipe Depth From Surface



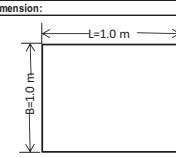
Fig. Helper Measuring Test Pit Dimension



Fig. Test Pit After Excavation



Fig. Test Pit After Backfill

TRIAL PIT LOG							
Project : Improvement of Water Supply System in Biratnagar Client : Nepal Water Supply Corporation (NWSC) Consultant : Yachiyo Engineering Co. Ltd. Location : Biratnagar Metropolitan City-4, Kanchanbari, Morang							
PIT No:-7				Total Depth:-0.45m			
Location:- Bhattimode-Kesaliya Marg				Start Date: 2020-03-08			
Co-ordinate:26°27'21.69"N, 87°16'26.55"E				Completion Date:2020-03-08			
Scale	Depth	Thickness	Symbol	SOIL DESCRIPTION	Water Table	Backfill	Scale
0	0			Top refill soil mixed with debris.	Water Table Not Encountered	Completely backfilled.	0
0.2	0.2			Medium dense dark grey sandy clay			0.2
0.4	0.4						0.4
Dimension: 				General Remarks: Trial pit terminated due to pipeline exposed.			

4.8 Test Pit-8

The first Test Pit TP-8 was opened at the location south of Police station Near Geeta mandir as shown in Figure-1. The Section of TP-8 is as shown in Figure-2.
The depth of test pit is about 0.35m. Close view of the soil strata is shown in the figure below. The test pit was logged and a different stratum in more detail is described in test pit log.
The first observation made from the test pit is the top layer of refill soil with debris. The top soil layer thickness varies from 0 mm to 100 mm. Just under the top soil the medium dense dark grey sandy clay with silt lies up to the excavated depth of 0.45m from surface. The water table was not present at the time of investigation.
The pipe below the test pit encountered was of GI pipe type of 3" size.



Figure-1: Tentative Site Plan of TP-8 (South of Police station Near Geeta mandir)

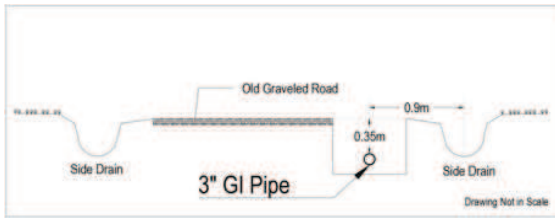


Figure-2: Section of TP-8 (South of Police station Near Geeta mandir)



Fig. Site Condition Before Excavation of Test Pit



Fig. Helper Measuring External Dia. Of Pipe



Fig. Helper Measuring Pipe Depth From Surface



Fig. Engineer Measuring Test Pit Dimension



Fig. Test Pit Being Backfilled



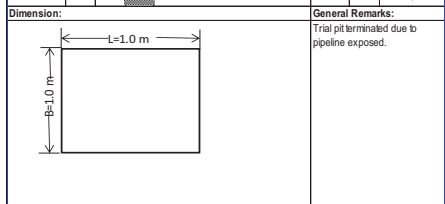
Fig. Test Pit After Backfill

TRIAL PIT LOG

Project : Improvement of Water Supply System in Biratnagar
Client : Nepal Water Supply Corporation (NWSC)
Consultant : Yachiyo Engineering Co. Ltd.
Location : Biratnagar Metropolitan City-4, Kanchanbari, Morang

PIT No:-8
Location:-Hatkhola Play ground
Co-ordinate:26°27'31.55"N, 87°17'34.68"E
Total Depth:-0.35m
Start Date: 2020-03-07
Completion Date:2020-03-07

Scale	Depth	Thickness	Symbol	SOIL DESCRIPTION	Water Table	Backfill	Scale
0	0		[Blue grid symbol]	Top greenfield.	0	0	0
0.15	0.15		[Dark grey symbol]	Medium dense to dense light brown silty clay mixed with gravels.	Water Table Not Encountered	Completely backfilled.	0.15
0.3	0.3						0.3



4.9 Test Pit-9

The first Test Pit TP-9 was opened at the location at Eastside of Mahendra Chowk Road as shown in Figure-1. The Section of TP-9 is as shown in Figure-2.
The Test was already exposed as location was excavated by NWSC for pipe maintenance.
The depth of test pit is about 1.75m. Close view of the soil strata is shown in the figure below. The test pit was logged and a different stratum in more detail is described in test pit log.
The first observation made from the test pit is the top layer of Dense to very dense gravel mixed soil with Sub-base material. The top soil layer thickness varies from 0 mm to 600 mm. Just under the top soil, Medium dense light to dark brown sandy clay mixed with refilled gravel lies up to the excavated depth of 1.75m from surface. The water table was not present at the time of investigation.
The pipe below the test pit encountered was of DI pipe type of 8" size.



Figure-1: Tentative Site Plan of TP-9 (Eastside of Mahendra Chowk Road)

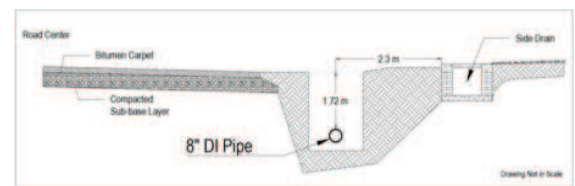


Figure-2: Section of TP-9 (Eastside of Mahendra Chowk Road)



Fig. Site Condition Before Excavation of Test Pit



Fig. Helper Measuring External Dia. Of Pipe



Fig. Helper Measuring Pipe Depth From Surface



Fig. Condition of DI Pipe after Excavation

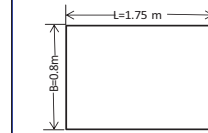
TRIAL PIT LOG

Project : Improvement of Water Supply System in Biratnagar
Client : Nepal Water Supply Corporation (NWSC)
Consultant : Yachyo Engineering Co. Ltd.
Location : Biratnagar Metropolitan City-4, Kanchanbari, Morang

PIT No:-9
Location:-Mahendra chowk. Total Depth:-1.75 m
Co-ordinate: 26°27'15.26"N, 87°16'39.98"E Start Date:2020-03-06
Completion Date:2020-03-06

Scale	Depth	Thickness	Symbol	SOIL DESCRIPTION	Water Table	Backfill	Scale
	m	m			m	m	
0							0
0.25				Dense to very dense gravel mixed soil with Sub-base material.			0.25
0.5							0.5
0.75							0.75
1				Medium dense light to dark brown sandy clay mixed with refilled gravel.	Water Table Not Encountered		1
1.25							1.25
1.5							1.5
1.75							1.75

Dimension: L=1.75 m, B=0.8m
General Remarks: Trial pit terminated due to pipeline exposed.



4.10 Test Pit-10

The first Test Pit TP-10 was opened at the location of Pichara, Biratnagar as shown in Figure-1. The Section of TP-10 is as shown in Figure-2. The depth of test pit is about 0.3m. Close view of the soil strata is shown in the figure below. The test pit was logged and a different stratum in more detail is described in test pit log.

The first observation made from the test pit is the top layer of sub-grade fill material on the road side. The top soil layer thickness varies from 0 mm to 100 mm. Just under the top soil the medium dense dark grey sandy clay lies up to the excavated depth of 0.3m. The water table was not present at the time of investigation. The pipe below the test pit encountered was of Old GI pipe type of 3" size.

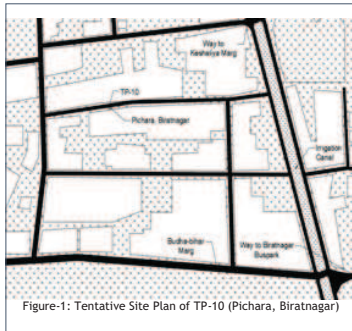


Figure-1: Tentative Site Plan of TP-10 (Pichara, Biratnagar)

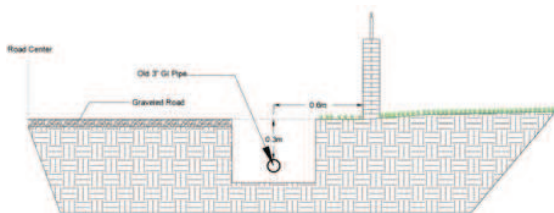


Figure-2: Section of TP-10 (Pichara, Biratnagar)



Fig. Helper Measuring Test Pit Dimension



Fig. Helper Measuring Depth of Water Supply Pipe from Surface



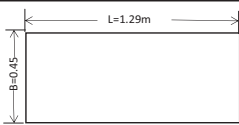
Fig. Helper Excavating Test Pit



Fig. Test Pit Location After Backfill

TRIAL PIT LOG

Project : Improvement of Water Supply system in Biratnagar
 Client : Nepal Water Supply Corporation (NWSC)
 Client : Yachiyo Engineering Co. Ltd
 Location : Biratnagar Metropolitan City-12, Pichara, Morang

PIT No:-10				Total Depth :- 0.3m		
Co-ordinate :- 26°27'12.75" N, 87°16'2.92" E				Date :- 2020-12-23		
Scale	Depth	Thickness	Symbol	SOIL DESCRIPTION	Water Table	Scale
	m	m			m	
0				Made graveled ground	Water Table Not Encountered	0
0.1						0.1
0.2				Medium dense dark grey sandy clay		0.2
0.3						0.3
Dimension:				General Remarks:		
				Trial pit terminated after reaching 0.3 m depth		

資料-6-7 社会条件查結果

The Project for Improvement of Water Supply System
In Biratnagar
Federal Democratic Republic Of Nepal

Prepared for



YACHIYO ENGINEERING CO., LTD.

Prepared by

HAMI YUWA

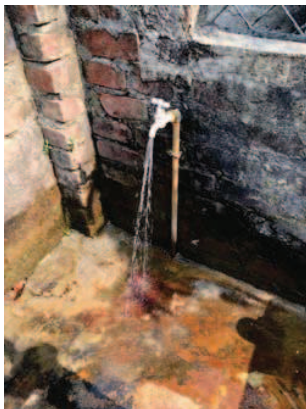


December 11, 2019

Map of Biratnagar



Final Report



The Project for Improvement of Water Supply System in Biratnagar

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List of Abbreviations:

- NWSC - Nepal Water Supply Corporation
- NWCB – Nepal Water Supply Corporation Biratnagar
- WSC – Water Supply Corporation
- WSCB - Water Supply Corporation Biratnagar
- WASH – Water ,Sanitation And Hygiene
- HDI – Human Development Index
- WECS – Water and Energy Commission Secretariat
- DWSS – Drinking Water Supply and Sanitation.
- MDG – Millennium Development Goals.
- ADB – Asian Development Bank
- WHO – World Health Organization.
- NRTH – Nepal Research and Training Hub
- NDHS- Nepal Demographic and Health Survey

INTRODUCTION

Nepal is a landlocked country in south Asia, situated on the lap of Himalayas, covered with snow capped mountains, green forests, rivers and shares territorial borders with India in the south ,west and east as well as China in the north with an estimated population of 28.4 million and an area of 147,181 sq.km. It is 48th largest country by population and 93rd largest country by area. Nepal has 0.574 HDI value and ranks 149th in the world out of 189. By the election of 2015, Nepal has been divided into seven provinces with 77 districts, 753 rural municipalities, 276 municipalities, 11 sub-metropolitan cities and 6 metropolitan cities.

Geographically, Nepal is divided into Terai region, Hilly region and Mountain region. Nepal has rivers, streams which are major source of freshwater; some Majors Rivers are Koshi, Karnali, Narayani and Maha-kali.

The pipe water supply system was introduced only in 1930's in Nepal. Before 1994, 46% of people had access to drinking facility and only 6% had access to sanitation (1990). But by 2011, the number increased to 85% for drinking facility and sanitation to 62%. Now nearly 97% of people have access to sanitation and 87.4% have access to drinking water supply (DWSS, 2018). The Government of Nepal has re-structured into Central Government, State Government and Local-level Government. The Governance structure is inclusive and it is now easier to overcome financial and technological barriers. The Federal Government has decentralized power and resources so more planning, budgeting and governance system will support effective and efficient water policy at central and local-levels. Earlier due to centralized policy design process it was difficult to address and work at local-levels but now the interaction between the central and local government can help to highlight both the opportunities and problems of water resource management.

Drinking water and management comes under the authority of Local Government, according to the recent political and jurisdictional development of Nepal. Also Central, State and Local Government has rights for water resource management. Issues of collaboration and lack of coordination in policy implementation are major problems of Federal Government in Nepal. Lack of clarity in role within water resource management ministry, department and office lead to ineffective translation of work. The water resource management and its utilization comes under the Ministry of Energy , Ministry of Irrigation and Ministry of Water and Sanitation, the involvement

of three Ministries makes it difficult to utilize the potential of water to its full extent. Although Water and Energy Commission Secretariat (WECS) was formed to look overall water management and its utilization but due to lack of power, authority and budget it is unable to function properly on its own. There is need of an institution to fulfill the gap between all ministries and departments to utilize the water resources at its full potential.

As due to poor management system Nepal as itself was relying on international donors. The financial cost of poor health treatment and opportunities which are caused by lack of availability of basic services result for the estimated cost around 34 billion dollars in south Asia. Being the member of UN, Nepal has adopted MDGs goal (2000-2015) Furthermore, Nepal has adopted Sustainable Development Goal 6 which calls for clean water supply and sanitation. The goal has 8 targets to be achieved by 2030 and all the investment related to water supply and sanitation is guided by it.

Access to safe drinking water supply and sanitation services is fundamental to improving public health and meeting national poverty reduction objectives. Many people both in rural and urban areas, are affected by waterborne and water related diseases due to the use of unsafe water and poor hygiene practices and inadequate sanitation facilities. Particularly in rural areas women spent several hours a day to fetch water from different other sources due to which economic growth and women empowerment is getting affected.

Nepal has made improvements to reach a basic level of sanitation and water supply. Demand led project, local people and community participation social inclusion are some of the positive steps that Nepal administration has made to take a step further towards its goal.

Various National Level Policies have been implemented and some are currently running:

Water Resource Strategy (2002)

Urban Water Supply and Sanitation Policy (2009)

Nepal Water Supply, Sanitation and Hygiene (2016-2030)

Rural Water Supply and Sanitation Improvement Policy (2014).

Water Resource Strategy (2002):

This strategy focuses on providing basic level of water supply and encouraging economic growth along with women empowerment and inclusiveness in development works .The main aim was to find effective, scientific and sustainable consensus to provide action oriented programs. Only 68% water supply system's supply water all over the year. Out of total population 85% use water supply service, 45% use piped water and 40% use tube-well and well water, 10% are away from utilizing basic water supply facility.

Urban Water Supply and Sanitation Policy (2009):

In urban areas nearly 87% of people are entertaining water supply service. This has the strategy to provide umbrella policy to achieve constant, quality, basic water supply to urban areas. It has the aim to extend service, standard and quality to the houses entertaining the water supply service. Sustainable water supply and improvement in quality of drinking water in upcoming years was the vision of this policy.

Nepal Water Supply, Sanitation and Hygiene sector Development (2016-2030):

This strategy was developed to cover the WASH objectives; it was for the first time Nepal has developed single long-term strategy which decentralized its program to federal, provincial and local level of Government. Access and utilization, functionality and sustainability, ecosystem and water production, monitoring and evaluation, quality and service improvement are some of the major priorities of this policy.

Present Situation of Water in Nepal:

Nepal has made great improvements to meet the WASH objectives, increased focused on sanitation promotion, action oriented programs, community participation , social inclusion in sharing benefits of project are some of the positive steps taken by the government .

The major challenges in the water supply services are lack of unclear roles and responsibilities, lack of efficiency and lack of transparency in setting goals and targets which ultimately results in inadequate or poor budget allocation, lack of proper consensus, duplication of resources, lack of poor evaluation and monitoring. The major focus of water supply and sanitation programs is to place priority on increasing water supply sanitation coverage even at basic level over the next five

years. According to DWSS in Nepal even though an estimated 80% of the total population has access to drinking water, it is not safe. Only 25% of water supply system are well functioning and 68% can supply water to water-taps throughout year. Studies have shown that the surface water available in the country is estimated to be about 225 billion cusec meter per annum. The reality is due to different in terms of supply of water. Though the population of Kathmandu valley is 5 million but the infrastructure for water supply distribution couldn't meet the population of the valley.

Similarly, in Dhangadi the quality of water is poor and its reliability too. The services made available to consumers is very low and are only limited within the town area. The households don't get regular supply and are compelled to use hand pumps, which are often contaminated and have high risks of iron in water.

Similarly, in Butwal there is chronic water shortage and inefficient as well insufficient service delivery with water demand higher than its capacity. Lack of technical knowledge, political commitment and financial investment are also some problems in the area. About 57% of drinking water from private taps is microbial contaminated. However, the groundwater samples were found microbial safe.

Similarly, in Birgunj the sanitary condition of tap water was found poor with poor drainage and algal growth, tube wells lack managed drainage. Private taps were found with 60% fecal contamination and 20% tube wells with fecal contamination. While, overall risks of diseases was high in the case of 30% of the sample.

Biratnagar is a metropolitan city in Nepal which is located near India's border and is the capital city of the Province No.1. Biratnagar is known as the industrial corridor Jute Mills,also holds the historical famous Kali Mandir that holds high religious importance in Hinduism in the country. Named after King Birat, the city serves as the entrance point to multiple destinations of Eastern Nepal such as Baraha Chhetra, Dharan,Bhedetar,dhankuta, Dhampalthan Ilam and many more. It also holds the record for the second most densely populated after Kathmandu and the fourth most popular city of Nepal, with a population of 242,548 per the 2011 census. Biratnagar has politically been the most active city of Nepal. It lies 399 km east of Nepal's capital, Kathmandu, and 6 km north of the Jogbani border of the Indian state of Bihar.

Nepal Water Supply Corporation –Biratnagar (NWSCB) supplies 10303 households underground water after filtration. The system comprises of old pipe-lines running more than 40 years. Along with NWSCB various water supply stems are distributed over the town who supply water to the households. The quality of water is too poor. Most of the people of every ward are suffering from the problem of pure drinking water. Almost every household who have pipeline connection use other source of water like from water vendor, bottle water for household chores especially drinking. Most of the house has water facilities whether they used hand pump or pipeline water. The satisfaction level of people using the pipeline is very low whereas the houses using hand pump are almost satisfied with the water quality though some households are using iron water from tube-wells because of no alternatives for them. Recently few years ago in 2014 Biratnagar had faced severe problem of Jaundice, leading some death report due to consumption of poor drinking water, whereas it became the National level issue in the country. Local governance announces it as the state of emergency. Than after, people come out to be more conscious for the drinking water which leads consumption of water from various vendors.

The research done by ADB in 2010 shows that tap water was used for direct drinking, cooking, washing and bathing at household level. Most of the visited tube wells lacked well managed drains and haphazard dumping of solid wastes around the tap. About 75% of community tap waters had high health risks. Only 16.6% of tube wells were found safe for drinking. The major threat of water in the region was from microbial contamination, iron and manganese.

In 2012, Jalsrot Vikas Sanstha conducted a research to address the situation of water in Biratnagar. According to them 78% people indicated satisfaction regarding reliability, 92% said water supply adequately met their needs, 80% were happy and felt certain about the quality of water-safe. Iron content were found in water samples but were under the WHO guidelines. No problem at source or supply point but at pipeline due to corrosion was addressed. Hidden cost, lack of coordination between NWSC (Biratnagar) and Biratnagar Municipality, lack of cooperation between Water Corporation and clients were reported as major problems.

Methods:

Sample Design:

The primary focus was to provide estimation of water supply user's satisfaction level, reliability, quality and transparency of service provider from four different Water Supply Corporations running in Biratnagar Metropolitan City. In addition the survey was designed to point out the problems tackled by users and to know the view and opinion of consumers for water service provider to implement further programs in sustainable way.

Sample Frame:

NWSCB and WSCB water supply service area is divided into 19 wards and further divided into peripheral, semi-peripheral and core area. The data on service user's households were obtained from the office of NWSCB and WSCB. The name list of users served as actual frame for study.

Sample Selection:

Samples were selected randomly through the selection process. In first stage complete household mapping was carried out in all the 19 wards. As the numbers of user's households were different in each ward, in second stage, 160 respondent households were randomly selected to ensure the actual representation from each ward. In ward 18 zero served household were studied because it has no water supply pipelines.

Questionnaires:

Two sets of questionnaires were administered namely served household and Non –Served household to 160 randomly selected respondents. The household questionnaire was adopted from the collaboration of NWSCB and JICA. The household respondents and their feedback on reliability, adequacy and quality of services, satisfaction with the service responsiveness of service providers, hidden cost involved and willingness to pay. A separate questionnaire was designed to collect information on the details of NWSCB management including social, technical and accountability. The survey protocol was reviewed and approved by the Nepal Research and Training Hub (NRTHT) .

Field work and Data Processing:

15 days long field work was carried out by a specially trained assistant. Questionnaire was administered through face to face interviews to 160 sampled households and written in a paper based questionnaire. Collected sample data were entered into the software application and the output were obtained. The obtained output offered a distinct advantage in that it maximizes the likelihood of the data being error free and accurate.

Methodology:

In this study data of 19 wards of Biratnagar Metropolitan city were surveyed mainly on the basis of two structured questionnaire through random selection. According to the need of this study the current situation of drinking water supply was studied and what further steps should be taken to make the water supply managed and safe. The study was conducted in served household and non-served household by dividing them in these two categories in the 19 wards according to the following table:

Ward.No	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	Total
Served Households for Survey	7	5	9	8	8	11	5	8	4	7	8	10	4	6	7	4	4	0	3	118
Non-Served Households for Survey	2	2	3	3	3	3	1	2	1	2	2	3	1	2	2	1	2	6	1	42
Total	9	7	12	11	11	14	6	10	5	9	10	13	5	8	9	5	6	6	4	160

According to the table given above, the current situation of drinking water supply in all the 19 wards of Biratnagar was collected. The surveyors were provided a day training given by the expertise to fulfill the questionnaire. After finishing the paper questionnaire data was analyzed through the computer software.

In this study, the data are briefly described through various topics in different tables. In this survey the questionnaire were divided into two categories according to the served household and non-served household. Therefore the tables are arranged on the basis of served and non-served household.

Data analysis on the basis of composition of family:

The data obtained from the survey of all the 19 wards of Biratnagar Metropolitan city. The situation of people residing in the house and the children below 12 years of age was studied and the data obtained from the survey of served household and non-served household were arranged on the basis of composition which is shown below in the table:

Table 1: Composition of family

Ward	Male	Female	Under 12 Children	Served House hold	Non-Served Household
1	19	21	4	7	2
2	21	20	12	5	2
3	19	20	9	9	3
4	19	27	7	8	3
5	16	15	6	8	3
6	27	30	10	11	3
7	12	13	5	5	1
8	18	16	19	8	2
9	11	11	5	4	1
10	14	13	1	7	2
11	18	21	10	8	2
12	30	26	4	10	3
13	9	12	2	4	1
14	22	16	6	6	2
15	31	28	8	7	2
16	16	12	4	4	1
17	13	15	7	4	2
18	13	12	9	0	6
19	8	7	6	3	1
Total Average:	17.68	17.63	7.05	6.21	2.21

Source: Social Condition Survey 2076

The table above clearly shows the situation of male, female and children below 12 year of age in the sampled household. On the basis of gender, the number of males and females is almost similar but in ward number 4 the number of male is comparatively lower than females by 8. Also from this study the number of children under 12 years is only 1 in ward 10.

Means of livelihood of sample household:

In this study, among the sampled household, income of every individual household has been asked in order to keep the data of business and occupation of the family. Survey questions are part of the demographic questions which are used by researchers to evaluate the financial status of the respondent. Earning is the basic part of every human being, which creates statistics about income, assistance, earnings, and poverty status. As it directly creates impacts of their basic needs like education, health status, and behaviors and so on. Earning is taken as the key source in any research. So, in the above study of served and non served household it shows the social condition and lifestyle of Biratnagar.

Table 2: Means of livelihood

SN	Private Company Employee	Public Employee	Waged Worker	Self-Employed	Farmer/Fisher	Employee	Others
1	3	4	0	2	0	0	0
2	3	0	0	3	1	0	0
3	4	4	0	3	0	0	1
4	2	2	1	5	0	1	0
5	4	1	0	3	0	0	3
6	5	3	0	4	0	0	2
7	3	1	0	2	0	0	0
8	3	0	0	4	1	0	2
9	0	0	0	1	1	0	3
10	2	1	0	2	0	0	4
11	2	0	0	7	1	0	0
12	3	3	0	7	0	0	0

13	0	0	0	2	1	0	2
14	2	2	0	2	0	0	2
15	3	0	1	4	0	0	1
16	2	0	0	2	0	1	0
17	3	0	0	3	0	0	0
18	2	0	0	1	1	1	1
19	1	0	1	0	1	0	1
Total Average	2.47	1.11	0.16	3.00	0.37	0.16	1.16

Source: Social Condition Survey 2076

The above mentioned table clarifies the status of major occupation of every ward of Biratnagar metropolitan city. The survey done for livelihood in every sampled household has the majority of self employed followed by company employee and public employee respectively.

Income and Expenditure in sampled houses:

Similarly, if we observe the monthly income and expenditure of sampled household, the least income is seen in ward 19 and the highest in ward 13. The current ward 19 of Biratnagar Metropolitan city was previously in Baijyanathpur Village Development Committee so still the people are involved in agriculture and waged worker for their livelihood which was found from the field survey. In the urbanized wards having high opportunities and possibilities of economic earning had high income and expenditure in both served household and non-served household. The data of monthly income and expenditure of all the 19 wards is shown in the table below:

Table 3: Income and Expenditure

Ward	Served household income	Served household expenditure	Non-served household income	Non-served household expenditure
1	57,142.86	38,571.43	25,000.00	16,000.00
2	48,000.00	23,000.00	65,000.00	44,000.00
3	44,444.44	30,000.00	40,000.00	28,333.33

4	38,750.00	30,625.00	26,666.67	20,000.00
5	80,000.00	37,500.00	33,333.33	25,000.00
6	41,818.18	29,727.27	46,000.00	30,333.33
7	37,000.00	29,000.00	60,000.00	50,000.00
8	42,500.00	33,875.00	25,000.00	14,500.00
9	61,250.00	37,500.00	50,000.00	30,000.00
10	66,428.57	47,142.86	30,000.00	20,000.00
11	38,125.00	26,625.00	25,000.00	16,500.00
12	49,000.00	31,300.00	23,333.33	17,000.00
13	51,250.00	40,000.00	100,000.00	30,000.00
14	67,500.00	46,666.67	35,000.00	20,000.00
15	50,000.00	30,714.29	91,750.00	30,500.00
16	50,000.00	28,750.00	80,000.00	70,000.00
17	40,000.00	26,250.00	65,000.00	50,000.00
18	0.00	0.00	23,333.33	14,666.67
19	27,333.33	22,333.33	15,000.00	12,000.00
Total Average:	46,870.65	31,030.57	45,232.46	28,359.65

Source: Social Condition Survey 2076

If we observe the data of income and expenditure from the above table, the highest income is 80,000 in ward 5 and the expenditure is 37,500 per month in served household and the lowest household income and expenditure is seen in ward 19 with the amount being 27,333.33 and 22,333.33 per month respectively.

Payment of electricity bill in sampled household:

In this part, the data of the amount of electricity bill paid by sampled household was collected. In this survey, the comparison of electricity bill between served and non-served household is shown in the table. The totals of 160 households were surveyed from both served and non-served household which is shown in the table Table 4: Payment for electricity bill, in next page:

Table 4: Payment for electricity bill

Ward	Served payment	Non-served payment
1	2,071.43	500.00
2	2,464.00	2,100.00
3	1,533.33	1,233.33
4	1,787.50	866.67
5	2,737.50	800.00
6	2,118.27	1,500.00
7	960.00	1,500.00
8	1,562.50	2,500.00
9	2,500.00	1,500.00
10	2,071.43	950.00
11	4,238.38	1,850.00
12	1,710.00	466.67
13	3,750.00	1,000.00
14	1,800.00	1,250.00
15	2,600.00	1,650.00
16	1,850.00	1,300.00
17	2,000.00	3,500.00
18	0.00	438.33
19	866.67	200.00
Total Average:	2,032.68	1,321.32

Source: Social Condition Survey 2076

From the above table we can conclude that, the amount of payment for electricity bill is higher in served household than in non-served household. On the basis of ward, due to no supply of water connection in ward 18 there is 0 bill amount in served household. Similarly, the amount of payment for electricity bill is lowest in ward 19 and highest in ward 11 and 13. In case of, non-served household the highest amount paid for electricity bill was seen in ward 18.

Kinds of assets in sampled household:

The survey done in Biratnagar metropolitan of every ward collected data about the kinds of household assets like television, radio, refrigerator and other assets which clarifies the condition of those households. In one of the national level survey it was found that the assets of television users were found to be 52% and radio users were found to be 29% in a similar way, in the village area the assets are not only used as household purpose but also to show about the modernization. In this survey of every ward of Biratnagar different assets were found being used which is shown in the table below:

Table 5: Kinds of Assets

Ward	Television	Radio/Cassette player	Refrigerator	Air-conditioner	Electric lighting	Electric cooker	Motor bike	Automobile	Washing machine	Computer/laptop	Others
1	8	1	7	1	51	3	4	0	0	7	0
2	7	0	6	1	38	1	14	1	2	2	0
3	12	5	12	0	80	8	6	0	0	6	0
4	11	3	10	1	70	4	5	0	1	5	0
5	11	3	9	2	46	6	8	0	1	8	0
6	14	0	14	3	77	6	12	1	1	8	0
7	5	1	6	0	26	2	5	0	0	4	0
8	9	1	9	0	68	5	7	2	0	6	1
9	5	0	5	1	47	1	4	1	1	3	0
10	9	4	9	1	62	6	5	0	3	6	0
11	10	1	10	0	71	2	6	0	0	5	0
12	13	3	10	1	123	1	9	3	2	9	0
13	5	0	5	3	26	4	1	1	2	4	0
14	8	0	7	2	52	4	8	2	2	6	0
15	9	1	9	2	47	6	10	1	5	7	0
16	5	1	5	0	37	3	2	1	0	2	0
17	6	0	6	4	37	4	6	2	5	3	0
18	4	1	0	0	34	1	3	0	0	0	0
19	3	0	3	0	19	1	1	0	0	1	0
Total Average:	8.11	1.32	7.47	1.16	53.21	3.58	6.11	0.79	1.32	4.84	0.05

Source: Social Condition Survey 2076

From the above table we conclude that different kinds of household assets which are run by electricity are being used in every ward. The data clarifies that in every ward of Biratnagar metropolitan city the assets run by electricity were electric lightning which is very common.

Water source for domestic use:

In the Terai region of Nepal, along with water supply corporations people are also dependent on tube-well, well and other Water Purification Center for domestic use. In this survey, it was found that hand pump and public pipeline were used extensively in all the 19 wards of Biratnagar Metropolitan City. In this field study, the water source used for domestic purpose by the respondents was studied and the data collected is presented in the table below:

Table 6: Water Source for Domestic Use Served Household:

Ward	Public pipe	Water vendor	Bottle water	Rain water collection	Hand pump	Stream/river/pond
1	7	0	1	0	0	0
2	5	0	1	0	2	0
3	9	0	1	0	0	0
4	8	0	0	0	0	0
5	8	0	5	0	1	0
6	11	0	1	0	5	0
7	5	0	1	0	2	0
8	8	0	4	0	1	0
9	4	0	0	0	2	0
10	7	1	0	0	1	0
11	8	0	3	0	4	0
12	10	0	0	0	7	0
13	4	0	1	0	3	0
14	6	0	1	0	3	0
15	7	0	0	0	1	0
16	4	0	0	0	1	0

17	4	0	1	0	2	0
18	0	0	0	0	0	0
19	3	0	0	0	0	0
Total Average:	6.21	0.05	1.05	0.00	1.84	0.00

Source: Social Condition Survey 2076

If we observe the average value of 160 households, 1 household was found using water vendor for domestic purpose. Also the respondents were found using public pipe and hand pump for domestic use.

Water Source for Domestic Use (For Non-Served Household):

The water source used for domestic purpose in non-served household sample was collected from 42 household which are presented in the table below:

Table 7: Water Source for Domestic Use Non Served Household:

Ward	Water vendor	Bottle water	Rain water collection	Hand Pump Well	Stream/river/pond
1	0	0	0	2	0
2	0	0	0	2	0
3	0	0	0	3	0
4	0	0	0	3	0
5	0	0	0	3	0
6	0	0	0	3	0
7	0	0	0	1	0
8	0	0	0	2	0
9	0	0	0	1	0
10	0	0	0	2	0
11	0	0	0	2	0
12	0	0	0	3	0
13	0	0	0	1	0
14	0	0	0	2	0

15	0	0	0	2	0
16	0	0	0	1	0
17	0	1	0	2	0
18	0	0	0	6	0
19	0	0	0	1	0
Total Average	0.00	0.05	0.00	2.21	0.00

Source: Social Condition Survey 2076

According to the above table, the non-served households separated for the study in this survey were found using hand pump. In this data, a household was found using bottled water in ward 17.

Amount for Payment of sampled household:

In this survey, the sampled households inside the Biratnagar Metropolitan City were surveyed in which they were served by different water corporation and the situation of payment for water service was studied. How and how much payment was paid by the consumers of Water Corporation monthly was also studied. Total of 160 households from both served and non-served households of all the 19 wards were studied and the data were categorized on the basis of range of payment done monthly is shown below:

Table 8: Amounts for payment of Served Household

Ward	110-250	251-391	392-532	533-673	674 and above	Total
1	3	3	0	0	1	308.5714
2	4	0	0	0	1	806.0000
3	2	6	0	0	1	456.6667
4	2	4	2	0	0	306.2500
5	7	1	0	0	0	145.0000
6	3	3	2	0	3	400.9091
7	2	2	1	0	0	262.0000
8	1	2	3	0	1	826.2500
9	3	1	0	0	0	170.0000

10	6	1	0	0	0	155.7143
11	6	0	0	0	2	357.5000
12	9	1	0	0	0	161.0000
13	2	0	0	0	2	527.5000
14	2	1	2	0	1	370.0000
15	1	0	4	0	2	601.4286
16	2	0	1	0	1	375.0000
17	0	1	1	1	1	525.0000
18	0	0	0	0	0	0
19	1	0	0	1	1	650.0000
Total Average:	2.95	1.37	0.84	0.11	0.89	389.73

Source: Social Condition Survey 2076

From the above table, the minimum payment for water ranges from 110-250 which consist of 56 households. Similarly there are 26 households paying in the range between 251-391 and 19 households paying above 673 per month.

Payment for water in non-served household:

Non-served household are not being connected to any water corporation running in Biratnagar Metropolitan City, they were questioned about the payment they made for bottled water but all the respondents were using hand pump for domestic use. They were happy to connect water pipeline in coming future if provided with quality supply and were willing to pay rupees 204.13 per month.

Quantity of water usage per month:

The consumers of four Water Corporation running inside the Biratnagar metropolitan city and the amount of water consumed from these water corporations were studied on the basis of consumed amount and the form in which water is being consumed. In this survey, after observing the condition of the water supplied from the four different water corporations, the amount of water consumed during the dry season and wet season was studied. Mainly in this survey the quantity of water consumed monthly by served household and non-served household is shown in the table below:

Table 9: Quantity of water usage per month

Ward	Served household (dry season)	Served household (wet season)	Non-served household (dry season)	Non-served household (wet season)
1	19.14	17.29	0.00	0.00
2	34.00	30.00	35.00	35.00
3	15.78	13.89	24.33	23.33
4	19.38	17.50	25.00	22.67
5	25.13	20.75	38.33	36.67
6	37.18	35.82	50.00	41.67
7	18.00	18.00	39.00	36.00
8	36.75	34.25	12.50	10.50
9	17.50	15.25	15.00	12.00
10	19.29	17.14	23.50	22.50
11	31.25	27.50	7.00	6.50
12	34.30	29.60	31.00	23.33
13	33.75	29.25	50.00	50.00
14	34.50	30.00	30.00	25.00
15	26.57	22.14	29.00	22.50
16	23.75	20.00	40.00	30.00
17	34.25	27.75	30.00	22.50
18	0.00	0.00	31.67	24.17
19	25.33	23.33	0.00	0.00
Total Average:	25.57	22.60	26.91	23.39

Source: Social Condition Survey 2076

According to the data obtained from the survey, the four water corporations namely Mangadh, Devkota chowk , Pichara and Bakhri Water Corporations supply with in their area and the quantity of water consumed in served household during the dry season was 25.57 cubic meter per month and 22.60 cubic meter per month during the wet season. Similarly, in non-served household 26.91

cubic meters per month was being consumed during the dry season and 23.39 cubic meters per month during the wet season.

Quantity of Water Storage Tank:

In the sampled household the quantity of water storage capacity was studied so that it could help for the easy implementation of new programs related to drinking water supply. In this survey the data were collected being concerned with the capacity of water storage. Also the frequency of cleaning storage tanks were considered to be important and the data of cleaning was also included in the survey. In this topic, the data of surveyed household related to water storage capacity and frequency of cleaning is shown in the table below:

Table 10: Water storage tank

Ward	Quantity of water storage (cubic meter/tank)	Frequency of water storage (times/month)	Frequency of cleaning(times/month)
1	0.56	12.89	0.00
2	0.64	27.29	0.14
3	0.75	20.58	0.00
4	0.73	17.82	0.00
5	0.41	18.64	0.00
6	0.96	25.07	0.00
7	0.42	6.00	0.17
8	0.92	16.00	1.00
9	0.40	16.00	6.00
10	0.64	20.11	0.00
11	1.50	24.00	0.00
12	0.85	27.31	0.00
13	0.60	27.00	0.20
14	0.44	16.88	0.25

15	1.00	18.33	0.11
16	0.70	12.40	0.40
17	1.00	30.00	1.50
18	0.00	0.00	0.00
19	0.88	17.50	0.00
Total Average:	0.70	18.62	0.51

Source: Social Condition Survey 2076

In the above table, the data of 160 households from all the 19 wards of Biratnagar Metropolitan City was listed and in average 0.70 cubic meters per tank water storage capacity was found. But in ward 18 due to lack of public water supply pipe and dependency in hand pump the storage capacity was found to be 0. Also the water storage tank cleaning frequency was seen 0.51 times per month in average. In the case of cleaning tanks some wards are seen to have 0 frequencies.

Problems of current situation of water supply:

In this table, NWSC and the other consumers supply had questioned and kept basic information about the present condition of quality and satisfaction level of the consumer.

Questions related to client's satisfaction included information on reliability, adequacy and quality including support services and provider's responsiveness. Also it includes the satisfaction level on accountability and transparency. In addition, questions related to various problems tackled by consumers during amount payment and other problems were questioned.

In this part, mainly the consumers have put in front of the various challenges, level of quality and satisfaction during the survey. Here the consumers have pointed out the problems faced by them while consuming the water supply services. In the table below problems addressed by a small sample size from all the 19 wards has been presented.

Table 11.1: Problems of current situation of water supply Served House (NWUSC)

Ward	Short hour of water supply	Quantity of water supply	Pressure of water supply	Quality of water supply	Services at pay office	Amount paid	Others	None
1	4	0	0	6	0	0	0	0
2	4	1	4	5	0	0	0	0
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5	5	1	3	8	0	0	0	0
6	5	0	0	9	0	0	0	0
7	2	0	1	5	0	1	0	0
8	2	2	0	4	1	1	0	1
9	2	0	3	4	0	0	0	0
10	7	0	6	6	2	0	0	0
11	7	0	6	7	3	1	0	0
12	1	0	2	4	1	0	0	0
13	2	0	2	4	1	0	0	0
14	4	0	0	5	0	0	0	0
15	1	0	0	4	1	0	0	1
16	2	0	1	0	0	0	0	1

17	1	0	0	4	1	0	0	0
18	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0
Total Average :	2.58	0.21	1.47	3.95	0.53	0.16	0.00	0.16

Source: Social Condition Survey 2076

In this study, the water users of NWSC pointed quality of water supply as key problem and also the short hour of water supply was an important problem among the users. The users also gave response regarding other problems in which pressure of water supply was frequently observed and the amount paid monthly was also noted as the problems among the users.

Table 11.2: Problems of current situation of water supply Served House (WUSC)

Ward	Short hour of water supply	Quantity of water supply	Pressure of water supply	Quality of water supply	Services at pay office	Amount paid	Others	None
1	1	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	3	0	1	3	0	0	0	5
4	1	0	0	0	0	0	0	7
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0

8	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0
12	1	0	1	4	0	0	0	0
13	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0
19	0	0	0	1	0	1	0	1
Total Average:	0.32	0.00	0.11	0.42	0.00	0.05	0.00	0.68

In this study, the water users of WUSC pointed quality of water supply as key problem and also the short hour of water supply was an important problem among the users. The users also gave response regarding other problems in which pressure of water supply was frequently observed and the amount paid monthly was also noted as the problems among the users.

NOTE:- In comparison with the users of NWSC and WUSC, the users of WUSC were found to have less problems.

Problems of current situation of water supply Non Served House:

The non-served household has no connection with water supply from any water supply corporation; the non-served household had been using hand pump water for their daily use so they have explained about the problems related to tube-well water .which is shown in the table below:

Table 12: Problems of current situation of water supply Non Served House:

Ward	Short hour of water supply	Quantity of water supply	Pressure of water supply	Quality of water supply	Services at pay office	Amount paid	Others	None
1	0	0	0	1	0	0	0	1
2	0	0	0	1	0	0	0	1
3	0	0	0	1	0	0	0	2
4	0	0	0	0	0	0	0	3
5	0	0	0	1	0	0	0	2
6	0	1	0	1	0	0	0	1
7	0	0	0	1	0	0	0	0
8	0	0	0	1	0	0	0	1
9	0	0	0	0	0	0	0	1
10	0	0	0	1	0	0	0	1
11	0	0	0	0	0	0	0	2
12	0	0	0	3	0	0	0	0
13	0	0	0	0	0	0	0	1
14	0	0	0	0	0	0	0	2
15	0	0	0	1	0	0	0	1
16	0	0	0	0	0	0	0	1
17	0	0	0	1	0	0	0	1
18	0	0	0	0	0	0	0	6

19	0	0	0	0	0	0	0	1
Total								
Average:	0.00	0.05	0.00	0.68	0.00	0.00	0.00	1.37

Source: Social Condition Survey 2076

In the above table, the problems of non-served households which are using tube-well water for daily activities had been centralized in which low quantity of water was put in front by 1 respondent and 27 respondents had no problem with the water.

Water cost for public water supply and Consumers View:

In this part, the view of consumers from NWSC and WSC towards the cost of public water supply has been discussed. Consumers compare the cost of water supply with the quality and the amount of water they use during the time of need. During the fieldwork almost every sample household compare the cost with the quality and quantity of water they used. According to the data obtained during social condition survey, the water cost for public water supply is shown in the table below:

Table 13: water cost for public water supply

Ward	Very expensive	Expensive	Fair	Cheap	Very cheap
1	0	2	7	0	0
2	0	0	7	0	0
3	0	3	9	0	0
4	0	2	9	0	0
5	0	3	8	0	0
6	0	3	11	0	0
7	0	2	4	0	0
8	0	3	7	0	0
9	0	2	3	0	0
10	0	3	6	0	0
11	0	5	5	0	0

12	0	5	8	0	0
13	0	2	3	0	0
14	0	2	6	0	0
15	0	2	7	0	0
16	0	1	4	0	0
17	0	0	6	0	0
18	0	4	2	0	0
19	0	2	2	0	0
Total	0.00	2.42	6.00	0.00	0.00
Average:					

Source: Social Condition Survey 2076

According to the above table, the water service supplied whether from the government sector or from the consumers committee the cost of water supply was found to be expensive from the data of the sampled household. The households considering the water cost cheap are not found whereas most of them have the opinion of water costs to be fair.

Satisfaction level with current public water supply service:

The consumers of four different water corporation running with in the Biratnagar Metropolitan City addresses their views towards the level of satisfaction for the water supply services in this section. For the evaluation of water quality and satisfaction level, people had analyzed on the basis of physical appearance of water but water being such an important aspect of life can only be just to be drinkable or not only after laboratory test without scientific test, evaluation of quality of water on the basis of turbidity, presence of small solids particles and sand particles cannot be done. In this study, the data was collected keeping the quality of current water supply and various areas in central point. This section mainly deals with the quality of water being supplied. The respondents were questioned about the level of satisfaction from the water they are using for domestic purpose. The table below describes the situation.

Table 14.1: Satisfaction level with current public water supply service Served House (NWSC)

Ward	Very satisfied	Satisfied	Fairly satisfied	Not satisfied	Not satisfied at all
1	0	1	1	4	0
2	0	0	0	4	1
3	0	0	0	0	0
4	0	0	0	0	0
5	0	0	0	8	0
6	0	0	2	9	0
7	0	0	0	3	2
8	0	1	1	1	5
9	0	0	0	2	2
10	0	0	0	6	1
11	0	0	0	2	6
12	0	0	0	1	4
13	0	0	0	4	0
14	0	0	0	6	0
15	0	5	0	2	0
16	0	3	0	1	0

17	0	0	0	3	1
18	0	0	0	0	0
19	0	0	0	0	0
Total	0.00	0.53	0.21	2.95	1.16
Average:					

Source: Social Condition Survey 2076

According to the above table, the survey done in the 19 wards of Biratnagar Metropolitan City indicates the low level of satisfaction in almost all the wards, among them wards 15 and 16 have users with good satisfaction level which was supplied by "Rani" sub-division of NWSCB.

Table 14.2: Satisfaction level with current public water supply service Served House (WUSC)

Ward	Very satisfied	Satisfied	Fairly satisfied	Not satisfied	Not satisfied at all
1	0	1	0	0	0
2	0	0	0	0	0
3	1	5	1	2	0
4	0	8	0	0	0
5	0	0	0	0	0
6	0	0	0	0	0
7	0	0	0	0	0
8	0	0	0	0	0

9	0	0	0	0	0
10	0	0	0	0	0
11	0	0	0	0	0
12	0	1	2	1	1
13	0	0	0	0	0
14	0	0	0	0	0
15	0	0	0	0	0
16	0	0	0	0	0
17	0	0	0	0	0
18	0	0	0	0	0
19	0	3	0	0	0
Total Average:	0.05	0.95	0.16	0.16	0.05

On the basis of information analyzed from the above table the users of various WUSC were satisfied while very few household were not satisfied with the current water supply.

NOTE:- As comparing the tabulated average data between the users of NWSC and WUSC of Biratnagar, the users of WUSC were more satisfied.

Satisfaction level with current public water supply service (For Non- served household):

The non-served households are using tube-wells and well water according to their economic condition was found in this field study. The respondents were questioned about the satisfaction level of water being used currently. The data is shown in the table below:

Table 15: Satisfaction level with current public water supply service of Non Served House:-

Ward	Very satisfied	Satisfied	Fairly satisfied	Not satisfied	Not satisfied at all
1	1	0	0	1	0
2	0	1	0	1	0
3	0	2	1	0	0
4	0	3	0	0	0
5	0	2	0	1	0
6	0	1	0	2	0
7	0	1	0	0	0
8	0	1	0	0	1
9	0	1	0	0	0
10	0	1	0	1	0
11	0	2	0	0	0
12	0	0	0	3	0
13	0	1	0	0	0
14	0	0	2	0	0
15	0	0	0	1	1
16	0	0	0	1	0
17	0	0	1	1	0
18	0	4	1	1	0
19	0	0	0	1	0
Total Average:	0.05	1.05	0.26	0.74	0.11

Source: Social Condition Survey 2076

In the above table, the household categorized into non-served according to the aim of this study had 47.61% respondents with good satisfaction level and 4.76% with poor satisfaction level.

Vision and knowledge towards waterborne disease:

When we observe health, the major cause was found to be unhealthy water supply from different studies in almost every part of Nepal. Diarrhea, Cholera, Typhoid fever, Hepatitis are some of the major water borne diseases. In the past there are various examples of epidemic and loss of life caused due to unhealthy water. Even Biratnagar had faced human loss in 2013-2014 AD because of unhealthy water supply. In this study the sampled households were questioned about the water borne diseases faced by them. In this section, mainly water borne diseases like Diarrhea, Cholera, Typhoid fever, Hepatitis and other diseases faced by the respondents are discussed below in the table:

Table 16: Water borne diseases

Ward	Diarrhea	Cholera	Typhoid fever	Hepatitis A	Others	None
1	0	0	1	0	2	16
2	0	0	0	0	2	19
3	0	0	0	0	0	19
4	0	0	0	0	0	19
5	1	0	0	0	2	13
6	0	0	0	0	0	27
7	0	0	0	0	2	10
8	2	0	0	0	1	15
9	0	0	0	0	0	11
10	0	0	0	0	2	12
11	0	0	0	0	2	16
12	5	0	0	0	0	25
13	0	0	0	0	0	9
14	4	0	0	0	2	16
15	4	0	0	0	0	27
16	0	0	0	0	0	16
17	0	0	0	0	0	13

18	0	0	0	0	0	13
19	0	0	0	0	1	7
Total Average:	0.84	0.00	0.05	0.00	0.84	15.95

Source: Social Condition Survey 2076

In the context of Biratnagar, currently the cases of people being suffered from diarrhea, cholera, typhoid fever like diseases are seen in little ratio whereas 16 cases of jaundice was seen as other frequently occurring disease in the sampled household. We can conclude diarrhea, jaundice and typhoid as major water borne diseases in Biratnagar.

Payment for service if water supply services are improved:

95% of households are in reach of pure drinking water supply in Nepal (NDHS-2016). NWSC and various WSC have provided quality drinking water facility and have contributed to create healthy citizens. Due to the lack of maintenance for old water supply services various conditions have occurred that create the water pollution. In this similar context various water supply corporations running in Biratnagar Metropolitan City have bad physical condition whereas some have worst conditions which have negatively affected human health. In this section respondents were questioned about the payment they can make when the conditions of water service, quality improvement and increment in supply hours are made. In this study when the water supply conditions are improved the payment that sampled household can make are described in the table below:

Table 17: Payment for service if water supply services are improved

Ward	Served(payment)	Non-served(payment)
1	235.71	250.00
2	250.00	155.00
3	255.56	153.33
4	131.25	150.00
5	325.00	170.00

6	162.73	200.00
7	282.00	150.00
8	301.25	175.00
9	240.00	200.00
10	207.14	200.00
11	243.75	175.00
12	200.00	166.67
13	177.50	110.00
14	253.33	110.00
15	189.29	155.00
16	102.50	110.00
17	477.50	1,100.00
18	0.00	130.00
19	420.00	0.00
Total Average:	234.45	203.16

Source: Social Condition Survey 2076

From the above table, two categories of sample were surveyed according to serve household and non-served household in which a maximum number of people were ready to pay a minimum cost for water supply. The served households currently paying 110 rupees as minimum cost are willing to pay 234.45 rupees for pure and quality water supply whereas the non-served households are willing to pay 203.16 rupees on average.

Complaint and Suggestion:

In the light of above data description and our in-depth interview and interactions with the respondents based on structured questionnaires along with our informal discussion based on semi structured questionnaire, we are going to highlight some of the important complaints and suggestion raised from this study. This section is mainly about complaints and suggestions we have come across from interview, interaction, data-description and discussion during our field survey of 160 households of all 19 wards of Biratnagar Metropolitan City area. The respondents are the users of four different Water Supply Corporation running in Biratnagar.

We have noted that, most of the consumers have complained about the quality of water in almost every ward, whereas we considered ward 3, 4 and 19 as exception. In ward 3 and 4 the complaints was about high deposit cost that customer has to pay for the connectivity of water supply pipelines to their house. It seems quite evident from *Table 2: Means of livelihood* that, most of the population of this survey are engaged in private sector companies where in general they earn comparatively less amount for their subsistence, so high 'Deposit Cost' for the water pipeline connectivity creates extra economic burden for them, which shows the level of difficulties they face to have the access to tap waters. Our study suggests that, compulsory deposit cost for the connection of water supply pipe line for new costumers should be decreased so that it will reduce the economic burden for economically weak section of the population. In order to provide the access to safe drinking water to the poor and marginalized population, water supply connection for the economically weaker section of the population, subsidized or minimal amount of 'deposit cost' will be highly appreciated.

Based on our conversation and integrations for the data collections we have also come across the complaints by the respondents about the short supply hours of tap water. As per our study, the water supply runs mostly in the morning and it got cut off after 9 am, which in general is the peak hour for household chores in context of Biratnagar. While respondents with storage tanks were satisfied with this supply hour as they have to capacity to store sufficient amount of water they need in their water tank. So it is very apparent that most of the households are forced to use unhealthy water supply in order to meet their household activities, including drinking. Based on our discussions interview in ward 16 and 17, the situation of untimely water supply raised untrustworthiness of costumers and they get extremely discouraged to be reliable on water supply authority.

The city authority and water supply cooperation should discourage its population to use unhealthy water by enhancing the quality of water as well as 24*7 availability of water in the tap. This is one of the suggestions we very frequently received from the respondents during the survey and we received in almost all the wards we choose to interview our respondents.

As it has been experienced in past, the water supply pipelines get damaged and disturbed due to road construction and repair which hindered water supply serviced to consumers. Similarly, current undergoing heavy construction of roads, sewerages, drainages, etc for physical

development of Biratnagar Metropolitan City has damaged the water supply pipelines. We have received the complaints from the consumers against water supply authority for delayed response to repair and resume the water supply service disturbed because of construction. This situation has been considered as the major challenge to the access of water for the consumers.

As our study suggests, the costumers from Rani Water Supply region are facing problems in term of the bill payment of water supply. They mentioned that the authority has allocated only two days for the costumers to pay the bill for water consumption and they had to travel all the to NWSC Heatquater is situated at Devkota Chowk which is considerably far from their Rani region. We believe, the water supply authority must encourage its costumers to pay bill, and in order to make the bill payment easy and comfortable. We suggest, the authority should provide some trouble-free and transparent bill payment system, maybe by creating 'special window payment system' at different ward office of Biratnagar Metropolitan.

The household from Raghupati Jute Mill area have no access to NWSC water supply. They says the chunk of land here is owned by the mill and the administration of mill seems reluctant and are not paying attention towards providing water supply of the households resides here. The slums area of Biratnagar is also not connected to the water supply as the land is owned by the Government. Thus, lack of availability and accessibility to the water supply, the helpless residents of unauthorized slum are compelled and forced to use water from hand pump which highly contain iron. From our study, we recommend the local body, in order to accumulate population residing in slums for safe drinking water, the idea of installing 'public tap' by creating the cluster of households in slums area will be very effective, as they says 'everyone in the world has the right to have access to safe and pure drinking water'.

The respondents along with the description of various problems faced by them had also provided some suggestions to Water Supply Corporation and Government for further implementation of sustainable program in the coming future. Major wards near the border area had no water supply and households had to use unhealthy water so the installation of water supply pipes in such area was the major suggestion. Similarly proper coordination between concerned department and ministry for sustainable development work is also a need.

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For the pictorial view of the data collection, interview sessions, and discussion process, please refer to the next pages.....





資料-6-8 モニタリングフォーム案

モニタリングフォーム（建設時）

－モニタリングは、環境レビューによって JICA によるモニタリングが必要と判断された項目について、プロジェクト実施主体者が測定値等を JICA に定期的に提出することで行うが、提出にあたっては、以下モニタリングフォームを必要に応じ参照する。

－モニタリング項目、頻度、方法を定めるにあたっては、プロジェクトのフェーズあるいはライフサイクル（建設フェーズと操業フェーズなど）に留意する。

1. 許認可

モニタリング項目	報告期間中の状況
給水省からの指摘事項への対応	

2. 汚染対策

－水質（排水測定値）

項目（単位）	測定値 （平均値）	測定値 （最大値）	現地基準	参考：日本の 排水基準	備考 （測定場所、 頻度、方法等）
TSS (mg/L)			600	200	河川への流入 前地点にて週 1 回

3. 社会環境

－既存の道路への影響

モニタリング項目	報告期間中の状況
建設機械の稼働状況及び交通渋滞の状況	
建設時の騒音状況（昼間 63dB 以下）	

－労働環境

モニタリング項目	報告期間中の状況
労働事故 安全器具（安全ベルト、ヘルメット等）の着用 安全会議	

モニタリングフォーム（供用時）

－モニタリングは、環境レビューによって JICA によるモニタリングが必要と判断された項目について、プロジェクト実施主体者が測定値等を JICA に定期的に提出することで行うが、提出にあたっては、以下モニタリングフォームを必要に応じ参照する。

－モニタリング項目、頻度、方法等を定めるにあたっては、プロジェクトのフェーズあるいはライフサイクル（建設フェーズと操業フェーズなど）に留意する

1. 汚染対策

－水質（排水測定値）

項目（単位）	測定値 （平均値）	測定値 （最大 値）	現地基準	参考：日本の 排水基準	備考 （測定場所、頻度、 方法等）
TSS (mg/L)			600	200	河川への流入前 地点にて週 1 回

－地下水位

測定項目	測定値	備考
地下水位		月 1 回 本プロジェクト対象地 域内の井戸

2. 社会環境

－労働環境

モニタリング項目	報告期間中の状況
労働事故 安全器具（安全ベルト、ヘルメット等）の着用 安全会議	

資料-6-9 環境チェックリスト

環境チェックリスト：1.4. 上水道 (1)

分類	環境項目	主なチェック事項	Yes: Y No: N	具体的な環境社会配慮 (Yes/Noの理由、根拠、緩和策等)
1 許認可・説明	(1) EIAおよび環境許認可	環境アセスメント報告書 (EIAレポート) 等は作成済みか。 EIAレポート等は当該国政府により承認されているか。 EIAレポート等の承認は付帯条件がある場合は、その条件は満たされるか。 上記以外に、必要な場合には現地の所管官庁からの環境に関する許認可は取得済みか。	(a) N (b) N (c) N (d) N	(a) (b) (c) (d) IEEの規模要件に該当し、現地再委託でIEEレポートドラフト作成を実施する。
	(2) 現地ステークホルダーへの説明	プロジェクトの内容および影響について、情報公開を含めて現地ステークホルダーに適切な説明を行い、理解を得ているか。 住民等からのコメントを、プロジェクト内容に反映させたか。	(a) Y (b) Y	(a) (b) ワードの議長及び周辺住民を対象にステークホルダー協議を実施し、協議を重ねている。
	(3) 代替案の検討	プロジェクト計画の複数の代替案は (検討の際、環境・社会に係る項目も含めて) 検討されているか。	(a) Y	(a) 1.PSを新規建設せず、既存PSの改修も行わない場合、2.PS及び浄水施設を建設する場合、3.PSを建設するが、浄水施設を建設しない場合について検討している。
2 汚染対策	(1) 大気質	消毒用塩素の貯蔵設備、注入設備からの塩素による大気汚染はあるか。 作業環境における塩素は当該国の労働安全基準等と整合するか。	(a) (b) N	(a) (b) 塩素の貯蔵設備、注入設備からの漏洩がないため、塩素による大気汚染は生じない。 また、大気質に係る塩素の環境基準はない。
	(2) 水質	施設稼働に伴って発生する排水のSS、BOD、COD、pH等の項目は当該国の排水基準等と整合するか。	(a) Y	(a) ネパール国の排水基準 (公共用水域への排出) に適合させて排水する。
	(3) 廃棄物	施設稼働に伴って発生する汚泥等の廃棄物は当該国の規定に従って適切に処理・処分されるか。	(a) Y	(a) BMC所有の廃棄物処分場で適切に処分する。
	(4) 騒音・振動	ポンプ施設等からの騒音・振動は当該国の基準等と整合するか。	(a) Y	(a) 騒音は、環境基準のMixed Residential Areaの値 (昼間63dB、夜間55dB) に適合させる。 振動に係る基準は存在しない。
	(5) 地盤沈下	大量の地下水汲み上げを行う場合、地盤沈下が生じる恐れがあるか。	(a) N	(a) ポンプ容量が地下水の適正揚水量を超えないように制御する。 また、PS又はその周辺に地下水水位観測孔を設ける。 (a) 本プロジェクトの予定地は、国立公園や世界遺産に該当しない。
3 自然環境	(1) 保護区	サイトは当該国の法律・国際条約等に定められた保護区内に立地するか。プロジェクトが保護区に影響を与えるか。 サイトは原生林、熱帯の自然林、生態学的に重要な生息地 (珊瑚礁、マングローブ湿地、干潟等) を含むか。 サイトは当該国の法律・国際条約等で保護が必要とされる貴重種の生息地を含むか。	(a) (b) (c) (d) N	(a) (b) (c) (d) 本プロジェクトの予定地には、生態学的に重要な生息地や林地はない。
	(2) 生態系	生態系への重大な影響が懸念される場合、生態系への影響を減らす対策はなされるか。 プロジェクトによる取水 (地表水、地下水) が、河川等の水域環境に影響を及ぼすか。水生生物等への影響を減らす対策はなされるか。	(a) N	(a) 既存のハンドポンプにより汲み上げられる地下水よりも深い帯水層からポンプで取水するため、既存の水利用に影響はない。
	(3) 水象	プロジェクトによる取水 (地下水、地表水) が地表水、地下水の流れに悪影響を及ぼすか。	(a) N	

環境チェックリスト：14. 上水道 (2)

分類	環境項目	主なチェック事項	Yes: Y No: N	具体的な環境社会配慮 (Yes/Noの理由、根拠、緩和策等)
4 社 会 環 境	(1) 住民移転	(a) プロジェクトの実施に伴い非自発的住民移転は生じるか。生じる場合は、移転による影響を最小限とする努力がなされるか。 (b) 移転する住民に対し、移転前に補償・生活再建対策に関する適切な説明が行われるか。 (c) 住民移転のための調査がなされ、再取得価格による補償、移転後の生活基盤の回復を含む移転計画が立てられるか。 (d) 補償金の支払いが移転前に行われるか。 (e) 補償方針は文書で策定されているか。 (f) 移転住民のうち特に女性、子供、老人、貧困層、少数民族・先住民族等の社会的弱者に適切な配慮がなされた計画か。 (g) 移転住民について移転前の合意は得られるか。十分な実施 (h) 住民移転を適切に実施するための体制は整えられるか。十分な実施能力と予算措置が講じられるか。 (i) 移転による影響のモニタリングが計画されるか。 (j) 劣化如他の住民が考慮されるか。	(a) (b) (c) (d) (e) (f) (g) (h) (i) (j) N	(a) (b) (c) (d) (e) (f) (g) (h) (i) (j) 本プロジェクトでの新規PS建設予定地はBMC所有であり、非自発的住民移転は発生しない。
	(2) 生活・生計	(a) プロジェクトにより住民の生活に対し悪影響が生じるか。必要な場合は影響を緩和する配慮が行われるか。 (b) プロジェクトによる取水（地表水、地下水）が、既存の水利用、水域利用に影響を及ぼすか。	(a) N (b) N	(a) 給水サービスの改善により、安全な飲料水が確保される。 (b) 既存のハンドポンプにより汲み上げられる地下水よりも深い帯水層からポンプで取水するため、既存の水利用に影響はない。
	(3) 文化遺産	(a) プロジェクトにより、考古学的、歴史的、文化的、宗教的に貴重な遺産、史跡等を損なう恐れはあるか。また、当該国の国内法上定められた措置が考慮されるか。	(a) N	(a) 本プロジェクトの予定地には、遺跡、史跡等は存在しない。
	(4) 景観	(a) 特に配慮すべき景観が存在する場合、それに対し悪影響を及ぼすか。影響がある場合には必要な対策は取られるか。	(a) N	(a) 新規の高架水槽建設が生じるが、建設予定地は景観上重要な地域ではない。
	(5) 少数民族、先住民族	(a) 当該国の少数民族、先住民族の文化、生活様式への影響を軽減する配慮がなされているか。 (b) 少数民族、先住民族の土地及び資源に関する諸権利は尊重されるか。	(a) (b) Y	(a) (b) 少数民族を含め、平等な給水サービスを実施する。
	(6) 労働環境	(a) プロジェクトにおいて遵守すべき当該国の労働環境に関する法律が守られるか。 (b) 労働災害防止に係る安全設備の設置、有害物質の管理等、プロジェクト関係者へのハード面での安全配慮が措置されているか。 (c) 安全衛生計画の策定や作業員等に対する安全教育（交通安全や公衆衛生を含む）の実施等、プロジェクト関係者へのソフト面での対応が計画・実施されるか。 (d) プロジェクトに関係する警備員が、プロジェクト関係者・地域住民の安全を侵害することのないよう適切な措置が講じられるか。	(a) (b) (c) (d) Y	(a) (b) (c) (d) ネットワーク（Labour Act 2074）に基づき、安全具、ヘルメット、ベルトの着用を徹底し、作業員の安全・衛生を確保する。

環境チェックリスト：14. 上水道 (3)

分類	環境項目	主なチェック事項	Yes: Y No: N	具体的な環境社会配慮 (Yes/Noの理由、根拠、緩和策等)
5	(1) 工事中の影響	(a) 工事中の汚染（騒音、振動、濁水、粉じん、排ガス、廃棄物等）に対して緩和策が用意されるか。 (b) 工事により自然環境（生態系）に悪影響を及ぼすか。また、影響に対する緩和策が用意されるか。 (c) 工事により社会環境に悪影響を及ぼすか。また、影響に対する緩和策が用意されるか。 (d) 工事による道路渋滞は発生するか、また影響に対する緩和策が用意されるか。	(a) Y (b) N (c) N (d) Y	(a) 低騒音型の車両導入、側溝・柵による適切な濁水の排水、散水による粉じんの飛散防止を行う。 (b) (c) 工事による自然環境・社会環境への影響は想定されない。 (d) 工事車両を適切に時間管理し、特定の時間帯に集中しないよう配慮する。
その他	(2) モニタリング	(a) 上記の環境項目のうち、影響が考えられる項目に対して、事業者のモニタリング計画・実施されるか。 (b) 当該計画の項目、方法、頻度等はどこのように定められているか。 (c) 事業者のモニタリング体制（組織、人員、機材、予算等とそれらの継続性）は確立されるか。 (d) 事業者から所管官庁等への報告の方法、頻度等は規定されているか。	(a) Y (b) Y (c) Y (d) Y	(a) 水質汚濁、既存の社会インフラへの影響、事故、地下水位のモニタリングを行う。 (b) 工事中：モニタリングシートに基づき、水質汚濁を週1回、車両運行状況、及び労働環境を必要に応じて測定・記録する。 (c) 供用時：モニタリングシートに基づき、水質汚濁を週1回、地下水位を月1回測定・記録する。 (d) 工事業者が工事中のモニタリングを行い、NWSCが供用時のモニタリングを行う。これらの予算は、建設費、維持管理費にそれぞれ含まれる。 (e) 環境許認可証に基づき、NWSCが測定・報告を行う。
6	他の環境チェックリストの参照	(a) 必要な場合は、ダム、河川に係るチェックリストの該当チェック事項も追加して評価すること。	(a) N	(a) 上記以外の環境・社会への影響は想定されない。
留意点	環境チェックリスト使用上の注意	(a) 必要な場合には、越境または地球規模の環境問題への影響も確認する（廃棄物の越境処理、酸性雨、オゾン層破壊、地球温暖化の問題に係る要素が考えられる場合等）。	(a) N	(a) 地球環境への影響は想定されない。

注1) 表中『当該国の基準』については、国際的に認められた基準と比較して著しい乖離がある場合には、必要に応じて対応策を検討する。
 当該国において現在規制が確立されていない項目については、当該国以外（日本における経験も含めて）の適切な基準との比較により検討を行う。
 注2) 環境チェックリストはあくまでも標準的な環境チェック項目を示したものであり、事業および地域の特性によっては、項目の削除または追加を行う必要がある。

資料-6-10 IEE 調查結果



नेपाल खानेपानी संस्थान
Nepal Water Supply Corporation

IMPROVEMENT OF WATER SUPPLY SYSTEM IN BIRATNAGAR



INITIAL ENVIRONMENTAL EXAMINATION REPORT

1

IMPROVEMENT OF WATER SUPPLY SYSTEM IN BIRATNAGAR

INITIAL ENVIRONMENTAL EXAMINATION

Submitted by
METCON Consultants
Kathmandu, Nepal

Submitted to:
Ministry of Water Supply
Government of Nepal
Singha Durbar, Kathmandu
Nepal

[AUGUST 2021]

Nepal Water Supply Corporation

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Abbreviations

ADB	Asian Development Bank
BMC	Biratnagar Metropolitan City
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
EMP	Environment Management Plan
EPA	Environment Protection Act
EPR	Environment Protection Rules
ESMP	Environmental and Social Management Plan
GIS and RS	Geographic Information Systems and Remote Sensing
GoN	Government of Nepal
HDPE	High Density Poly Ethylene
IEE	Initial Environmental Examination
IUCN	International Union for Conservation of Nature
JICA	Japan International Cooperation Agency
LCD	locally-fitted, compact, and distributed
LGs	Local Governments
MLD	million litres per day
NDWQS	National Drinking Water Quality Standards
NEA	Nepal Electricity Authority
NGO	non-governmental organization
NWSC	NEPAL WATER SUPPLY CORPORATION
O & M	Operation and Maintenance
OHTs	Overhead tanks
PS	Pump Station
SDGs	Sustainable Development Goals
SPS	Safeguard Policy Statement
WHO	World Health Organization
WUSC	Water User and Sanitation Committee

Weights and Measures

°C	degree Celsius
dB(A)	decibel acoustic
Ha	hectare
km	Kilometer
kV	kilovolt
kWh	kilo watt hour
lpcd	Liter per capita per day

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4

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Executive Summary

Background of the Project

Biratnagar Metropolitan City is one of the fast growing cities of Nepal. With the fast growth, the water demand of Biratnagar is growing rapidly as well. Thus, need to improve the current water supply system of the city have been realized. Water demand study carried out in the year 2018 by Japan International Cooperation Agency (JICA) concluded that with 2% annual rate of population growth, the current water demand was estimated to be 120 *lpcd*. Furthermore, the current water demand has also been reported to be 26,100m³/day, whereas 9,100 m³/day is being supplied. Thus there is an urgency to improve the existing water supply system in the city.

Distribution system of the Biratnagar City is one of the oldest in the country which has not been improved till date. Contamination of the water through leakages in the distribution lines is a serious possibility, exposing users to water borne diseases. In 2014, jaundice outbreak in Biratnagar was speculated to have caused due to this reason. The Himalaya Times reported that 12 deaths and more than 2000 people were taken ill in Biratnagar during that time¹. This also indicates urgency for the improvement of distribution lines.

Thus, NWSC in support of JICA has initiated this project for improvement of drinking water supply system of Biratnagar.

Introduction of the Project

The proposed project will supply drinking water to 14 wards (1,2,3,4,5,6,7,8,9,10,11,12,13, and 14) of the Biratnagar Metropolitan City.

The followings are components of the project:

- Rehabilitation of 3 existing pump stations (PS) located at Tinpaini, Devkota and Munal Path
- Construction of a new pump station/ PS No.5 at ward 5, and
- Laying of approximately 170 km of distribution pipe lines in all 14 wards of BMC

After the completion of the project, a total of about 15,652 m³/day will be distributed. This project will add 6,552 m³/day of water to the existing system, thus a total of 93,720 population of BMC will be served.

IEE study

An Initial Environmental Examination (IEE) is required to be carried out in accordance with the requirement of Environmental Protection Act 2019 and Environmental Protection Regulations 2020, which have stipulate that an IEE study has to be carried out for the water supply schemes designed to distribute water to the population between 50,000 to 200, 0000 and/or if new sources are to be constructed for the same. The main objective of the IEE study is to undertake assessment of the impacts associated with the project construction and

¹ THT (2017) Biratnagar at high risk of jaundice epidemic, The Himalayan Times, Kathmandu <https://thehimalayantimes.com/nepal/biratnagar-high-risk-jaundice-epidemic>

implementation, and design measures to minimize adverse impacts while enhancing social and environmental benefits.

Environmental Condition and Impacts

Physical Environment

Biratnagar Metropolitan City (BMC) serves as the administrative capital of Province no.1 located about 399 km (248 mi) east from the Kathmandu. It lies close to the Koshi River, which is about 30km in the west, while two small rivers bordering the town Singiyahi that flows from the east and Kesaliya from the west. Most of the land is covered by agricultural land and Settlements. These rivers (Kesaliya and Singiyahi) are flooded during summer monsoon during dry winter period, the water in these rivers is very low. The water quality in these two rivers are of very poor quality. Similarly, the air quality status of the project area is also poor due to fugitive dust from the vehicular movements particularly over unpaved roads and construction activities. The main source of noise quality deterioration is due to the honking of the vehicles, unmanaged traffic and construction works. Likewise, the solid waste management in BMC lacks proper care. The management comprises of waste collection from households and institutional sources but the waste is also dumped on the banks of Keshaliya River, about 300 meters north of Keshaliya Bridge. Moreover, due to the limited space for dumping, waste in the landfill is often burnt to reduce the volume and make room for dumping of more waste.

Biratnagar Metropolitan city has managed to supply water by the Nepal Water Supply Corporation (NWSC) and three Water User and Sanitation Committees (WUSCs) namely Jamunagachhi WUSC, Pichhara Biratnagar WUSC and Mangad WUSC. The current sources of water has been listed below along with the location of the sources:

- Devkota Chowk PS, (Ward 9, BMC)
- Munal Path PS, (Ward 2, BMC)
- Tinpaini PS, (Ward 2, BMC)
- Rani Area PS, (Ward 13, BMC)
- Pichhara, (Ward 11, BMC)
- BFM (Ward 6, BMC)
- Kanchanbari (Ward 4, BMC)

Physical Impacts

Excavation works and diggings are essential during construction period, primarily to lay down pipelines, which might cause erosion and cave-ins thereby causing soil erosion, silt runoff and unsettling of street surfaces. Furthermore, unorganized disposal of the excavated earth can disturb the street surface and decrease the aesthetic and economic values of the area.

Air pollution during construction period, mainly in the form of dust is expected. The air pollution is considered as one of the significant impacts in magnitude because it will affect the resident population as well as the dwellers, as the construction works will be carried in the heavily populated and market areas.

The excavation works are expected to disturb the drainage pattern, disturb local drains, and also create puddles, which will result in water logging. Since the project area is located in the Terai region, water logging can become breeding ground for mosquitos increasing risk of fatal diseases like dengue.

Noise is almost inevitable during the construction phase. Construction works will be carried out in the heavily populated area, thus, its impact is expected to be higher to the local population. Furthermore, its significance will be even higher in areas where noise-sensitive institutions such as health care and educational facilities are situated. Though the market area already have higher noise level, mainly contributed by traffic, the construction works and use of heavy vehicles will add noise. The noise will be more disturbing for local population if the construction works are carried out during the nights.

Biratnagar has two rivers, namely Singiyahi and Kesaliya, which are already polluted. Both of these river get polluted one rivers enter Biratnagar residential and market areas. However, construction activities could further pollute them by: (i) poorly managed construction sediments, and waste materials; and (ii) poor sanitation practices of construction workers.

Construction works might damage local infrastructure, such as local road, drains, sewers pipelines, and compound walls of local houses. Water pipelines are usually laid underground about 3 feet deep, so existing roads and streets will have to be dug to lay those water pipes. Thus about 170 km of trenches in roads and streets and foot-paths will have to be dug along the proposed alignments to lay those pipes. The width of the trenches that will have to be dug will be about 2 feet to accommodate the pipes and give needed spaces for the concerned workers to work on them. The width and depth of the trenches may vary as per the sizes of the pipes and situation of the roads/streets.

The construction will generate spoil from the excavations. Solid waste will also be generated from the workers. These need to be collected and disposed safely; otherwise, these will create sanitary issue. This is particularly sensitive as the construction will be carried out in the populated areas.

Biological Environment

The project area belongs to Sub-tropical climatic zone characterized by hot and humid summers, intense monsoon rain, and dry winters. Biratnagar Metropolitan city, our core working area, doesn't consist of any prescribed patches of forest. Out of the total area of Morang district, only 24% of area in the north-east region is covered with forest area (445.5 sq. km.) (DFRS, 2018). However, the proposed construction site consists of different tree species like Mango (*Mangifera indica*), Sissoo (*Dalbergia sissoo*), Masala (*Eucalyptus camaldulensis*), Ashok (*Saraca indica*), etc. Similarly, shrubs like Aasuro (*Adhatoda vasica*), Simali (*Vitex negundo*) and grasses like Bermuda grass (*Cynodon dactylon*), Common Fingal grass (*Digitaria eriantha*) are available.

Similarly, birds of Near Threatened status Sarus (*Ciconia episcopus*) along with common having Least Concerned status like Koili (*Eudynamis scolopacea*), Nyauri (*Megalaima asiatica*), Bhangera (*Passer domesticus*), etc are also observed in the site.

Also, reptiles like Dhaman (*Ptyas mucosus*), Hariyo Sarpa (*Trimeresurus albolabris*), Chhepara (*Calotes versicolor*), amphibians like Asian Common Toad (*Duttaphrynus melanostictus*), Skittering Frog (*Euphlyctis cyanophlyctis*) and mammals like Nyauri (*Herpestes auro-punctatus*), and Musa (*Rattus rattus*), etc are available on the site.

The site also consists some invasive species like Lahare banmara (*Mikania micrantha*), Seto Banmara (*Eupatorium odoratum*) and Lajjawati (*Mimosa pudica*).

Biological Impacts

- Open space of Tinpaini PS being used for parking may get affected during the transportation and piling of construction materials.
- Since, the construction work takes place in very small area of land, environmental impacts on the vegetation and natural ecosystem seem to be less significant. However, grass species and regeneration will get affected during the construction work in the site but can be re-established later.
- The construction site is not directly associated with the forests that are supposed to be prime habitat of different fauna. However, the movement of wildlife may get affected due to construction work.
- Most of the bird species were found to be native to the project site. In addition, the site is also the destination for migratory birds. Therefore, the activities carried out during the construction period for example, movement of workers, vehicles, etc. may affect the movement and occurrence of birds on the site.
- The aesthetic beauty of the site during the construction period will be unappealing.
- The constructed site later may get affected by the invasion of existing invasive species like Mikania, Water Hyacinth, etc.

Socio-economic and Cultural Environments

The current population of BMC is 2,14,663², which is about 19.77% of the total population of the entire Morang district. The population was 1,66,674 [male 53% (87,664) and female 47% (79,010)] in 2001 and was 2,01,125 [male 51% (108,827) and female 49% (105,836)] in 2011. The increased population between 2001 and 2011 seemed at 34,451. The increased population refers the annual growth (straight line) at 2.07% growth rate. The other report of the same area claims total population as 2,71,354³. The methods of calculating might be different purposively. With reference to the Report of RUDP, the annual Straight-Line population growth rate stands at 6%. However, the base population is 236,895 for the year 2015 and the

² As posted on its official website

³ Regional Urban Environmental Improvement Project (RUDP)

annual population growth at 3.37% for IEE⁴. IFRUDP's growth rate (3.37%) is considered then the population of BMC would be 289,017 for the year 2021. With the population density of 2,788 per (m)². The ward no 6 is largest ward (17,748) and ward no 19 is smallest one (5,640) in terms of population and household too. Similarly, ward no 4 is largest one in terms of physical area. The overall ratio of male to female population is 1.03 with 50.70% (108,827) of males and 49.30% (105,836) of females. The sex ratio of male to female population was 1.11 in census year 2001.

The population is categorized into 3 major groups⁵ i.e. young dependent population (age: <15) constitutes 34%, most economically active population (age: 15 to 59) constitutes more than 61% and elder dependent population (age: >59) constitutes about 5% based on the census of 2001. The dominant ethnic population is Hill Brahmin constituting more than 20% followed by the other terai caste/ethnicity. The presence of dalit vulnerable population (Damai, Kami, Sarki etc.) is less than 1%⁶. Majority of the people use Nepali language followed by the Maithali. The BMC is religiously harmonized municipality wherein exists Hindu, Islam, Jainism, Kirat, and Christianity.

⁷The total literacy rate is 50.5%, (male 59.5% & female 39.6%)⁸.

⁸There are 3 hospitals including other with several private clinics and pathology labs, more than five nursing homes, 50 private clinics & 10 pathology laboratories, one veterinary hospital offering eminent verities of treatment facilities like X-ray, laboratory, operation theatre, OPD and ECG to both human being and animal as well⁹.

⁹About 71% of the total population is economically active, of which about 46.2% are engaged in agriculture followed by 32.4% in service and rest in trade and labor⁸.

The IEE survey enumerated a total of 1,192 population in a total of 216 sample household in the proposed new PS area i.e. ward no 5 of BMC. The proportion of the male and female is 51.01% and 48.99% respectively. Majority of population is enumerated under the age group 21 - <=30 (25.59%) followed by age group 0 - <=10 (23.07%), age group 11 - <=20 (19.30%) and so on. For this purpose, the population of less than 10 years and more than 60 years are

⁴ Additional Drainage, Sewerage, and Roads Improvement Works for Biratnagar Sub-metropolitan City.

⁵ IEE report on Additional Drainage, Sewerage, and Roads Improvement Works prepared by the Regional Urban Environmental Improvement Project (RUDP) for Biratnagar Sub-metropolitan City

⁶ PPTA

⁷ IEE report on Additional Drainage, Sewerage, and Roads Improvement Works for Biratnagar Sub-metropolitan City Biratnagar

⁸ As per census 2001

considered to be the economically dependent to the economically active population. Excluding the referred figure, about 72% population are economically active.

The primary survey identified more than 25 ethnic group within the project area (new PS site) as the mixed community of both hill and terai inhabitants. The majority represents by Mandal (17.13%), followed by Yadav (9.26%), Khawas (8.80%), Satar (6.02%) and so on. Further, almost 68% (male 34.14% and female 33.39%) of the total people are either can read only (4.87%) or are able to read and write (62.67%). The population under the age 6 was also found to be going school (private) under pre-primary level. Very interestingly, the education level of both men and women are almost the same.

The previous tendency of people merely engaging in the agriculture are now radically changing as most of the people are found diverted into other occupation mainly in salary/wage (52.31%), followed by having their own enterprises (22.22%), and abroad job (15.74%) as agriculture remained less lucrative to acclimatize as the major occupation and source of income. This might be the reason of being metropolitan city as well. However, the given enumerated case of holding the job in abroad is assumed to be very nominal. As anticipated, the reason behind this might be fear of taxation. At the same time, activities like rearing livestock is also given less priority to express as the major occupation.

The income of people is almost equal to the national income. In overall, the per capita income of the people is about 128 thousand. The expenditure of the people is almost equal to the income of the people. In accordance to the annual income, the households are categorized into 3 groups i.e., the households having income more than 2 lakh are categorized under High Income Group (HIG), having income between 200K & 75K under Middle Income Group (MIG), and having income less than 75K under the Low Income Group (LIG). The majority of households are computed under MIG (71%), followed by the HIG (15%) and LIG (14%).

Only about 12% of the household (HHs) have their own land in the proposed new PS site. At the same time, nearly 80% of the HHs' either don't have their own product (30%) or insufficient (49%) to meet their year round demand of foods. Only 6% of HHs' are reported having surplus food. On the other hand, 100% of the HHs' have their own house. However, the houses are categorically different one to another, Kachhi with thatched roof house (62%), Semi-Pakki roofed by either tin or tile (14%) and modern type of house structure with cemented column/wall with concrete casting roof (24%). Very alarmingly, about 2.3% HHs' reports that they do not have own toilet at their house premises and use open land for defecation. This is a very crucial and distressing situation which needs prompt action against it. Almost 100% people in the project area uses ground water using conventional hand pump with no any deficiency all-round year of water fetched from the hand pump.

Electricity facility is connected in almost all houses supplied from the national grid provided by NEA and almost all have at least one set of functioning mobile set. A municipal school

under GoN namely Siddhakali Aadarbhut Vidyalaya established in 2046 BS is situated in the Damabandi, Kulharba. The urbanizing pace is taking in place.

The proposed project site is being built up in the municipal owned land. So there won't be any land acquiring issues. Even a single parcel of land of the private site is needed.

Perception towards the Project

Peoples' perception towards the project is very affirmative and believed that this would help to institute favorable impacts in their day to day life's deeds. Most of the people perceived that the project would stand as the landmark to change their lives giving adequate and quality water. By the completion of the project, their source of drinking water would change as they have been consuming iron containing ground water. Secondly, if the source of water is changed then their health status would also be changed in a positive manner. At the same time, the people would have a gracious opportunity too for the opening of employment opportunities. The project is highly worthy in terms of entire manner of social life.

Socio-Economic Impacts

There won't be any private property conceived to be occupied for the project purpose. Hence, no any physical housing or other assets or resources which are belonging to the private owner will be lost or damaged. The selected land and area are completely free from encumbrances. Neither land-use would change nor would any agricultural land come under the depletion by the intervention of the project. The project won't damage even the standing crops and the existing cropping pattern would remain the same.

Excavation of the roads for laying down the distribution water supply pipeline would temporarily cause inconvenience to local businessman, vendors, local resident and pedestrians to use those roads & walkway during the construction period. At the same time, temporarily, few informal vendors are also observed running the roadside fast-food and other business along the pipe laying alignment, which might have some critical affects during the construction period. Correspondingly, even big permanent shops of different types might not get sufficient customers and would be unable to manage their daily income and expenditure due to disturbed roads access during the construction period.

Vulnerably, the local people would not be prone to face any critical situation for their living and livelihood. Even the indigenous people/community would not have any adverse impact due to installation of the new pump station but they do have positive impact as they would have opportunity of the project connecting with the piped line water. Similarly, this would not prone to affect the heritage, customs and traditions of the area. However, the inflow of outside employees would elevate few risks on social, economic and communicable aspects. The threat of social security also cannot be ignored in the presence of outsiders.

Except for some of the adverse impact anticipated during the construction period, the project won't give much negative impact at the operation phase. It would have a better opening for the people with having hygienic water supply which might motivate their cleanliness and better health.

Mitigation Measures

Physical environment

During the construction, precautionary measures will be taken to prevent and/or minimize erosion. Proper backfilling trenches will be done. The exposed soil has to be stabilized by covering the trenches by permanently or temporarily with road blacktopping or cement or vegetated to prevent further soil erosion.

Prevention/minimize air pollution:

The following measures will be carried out to prevent and/or minimize air pollution:

- confining earthworks according to excavation segmentation plan that should be part of site-specific environmental management plan (SEMP);
- watering of dry exposed surfaces and stockpiles of aggregates at least twice daily, or as necessary;
- if re-surfacing of disturbed roads cannot be done immediately, spreading of crushed gravel over backfilled surfaces;
- during demolition, watering of exterior surfaces, unpaved ground in the immediate vicinity and demolition debris;
- place signage at active work sites in populated areas;
- requiring trucks delivering aggregates and cement to have tarpaulin cover;
- limiting speed of construction vehicles on access roads and work sites to a maximum of 30 km/h;
- prohibit burning firewood in work and labor camps (promote liquified petroleum gas for cooking purposes and electric heater for heating purposes);
- use of vehicles complying with Nepal Vehicle Mass Emission Standards (NVMES), 2069 enforcement, and green sticker standards; and
- prohibit open burning of solid waste.

Minimization of noise level: The following measures will be carried out to minimize the noise coming from the construction works.

- using equipment that emits the least noise, well-maintained and with efficient mufflers; restricting noisy activities to day time;

- avoiding use of noisy equipment or doing noisy works at night time;
- limit engine idling to a maximum of one minute;
- spread out the schedule of material, spoil and waste transport; and
- minimizing drop heights when loading and unloading coarse aggregates.

Prevention/minimization of pollution of the water bodies is maintained by;

- excess spoils will be disposed designated spoil disposal sites
- locating temporary storage areas on flat grounds at safe distance from main surface drainage routes;
- shielding temporary storage areas with sandbags; and
- providing adequate water supply and sanitation facilities at work sites.

Minimize damage to local infrastructures: Installing of the pipeline will damage roads/footpaths. The roads in BMC are blacktopped with foot-paths on both sides of the roads/streets. Care will be taken to lay the water pipes in the side foot-paths as far as possible

to avoid any disturbance to traffic along the roads/streets. The dug roads/streets will be immediately backfilled once the pipe laying work is complete in each of them. However the complete reinstatement work may take some time (usually not more than a year) as the concerned contractor may wait for the newly backfilled soil/earth in the trenches to get compacted and also wait until constructions of air valve chambers/sluice valve chamber are not fully done. In case of blacktopped or cemented roads/streets the complete reinstatement work may take some more time/even 2-3 years depending on the completion time given to the concerned contractor/s.

The water pipelines may criss-cross the sewer pipes/drains. Usually the sewer lines are laid deeper than 3 feet as per need to gain enough slope/grade, so in such cases there may not be any damage except in the cases of manholes where due precautionary measures will have to be done to avoid any damage. However the road drains and other open drains constructed to dispose the rain/storm water may get damaged in some cases while digging trenches for water pipes. These will have to be repaired instantly once the water pipes are laid.

Biological environment

- Construction materials will be transported at the time of its use only.
- The construction area will be surrounded by fence to prevent the movement of wildlife and green curtain barrier will be managed to prevent the birds' movement on the working site. Such barrier will also help on reducing the impact on aesthetic value of the site.
- The invasion of alien species can be controlled by cutting them before their flowering stage and using them as livelihood option, for example, making compost manure.
- Tree felling will be avoided in the project site. If they have to be harvested, it will be done under the directives of Divisional Forest Office (DFO). It will also be ensured that 25 native tree species are planted to compensate felling of one single tree.

Socio-economic environment

- For overall, a nodal officer is suggested to nominate from the municipality to be solely engaged for addressing the grievances which are likely to emerge from the locals throughout the project construction period. Furthermore, it is also recommended that the BMC authority in association with the water supply office at Biratnagar should notify all the impacting people, business houses etc. about the construction of the project before the construction starts. To control over the loss asset like business and constraint on the walkways due to the excavation of road for laying the pipeline, the contractor should manage to use favorable options such as planking etc. At the same, the contractor should excavate in such a way that should minimize damage.
- It is suggested to establish a small health desk board & open up employment opportunity to skilled & unskilled labor for the local people.

Alternative Analysis

- With no new project designs proposed and no new operation procedures, the stress on the existing water supply would be inadequate and of poor quality which could further escalate the adverse effects on the health of the residents which could get worse due to

constant increase in population. This will lead to increase in adverse effects on health of the city population.

- Similarly, with an alternative source of water supply to the metropolitan city which is from the nearby Singiyahi and Kesaliya river as an alternative to the project. The water is of very poor quality and not very reliable during the dry season. With the need of robust intake structures, there needs to be a lookout on these rivers for flooding during the rainy season along with the necessity of pumping stations, new water pump lines, power transmission lines and standby power generators for this particular alternative. Furthermore, both rivers have very limited water flow in the dry season, hence water supply on these will drastically reduce the flow in the downstream which will have considerable adverse effects on the fish culture and on other river water related human activities in the downstream.
- Alternative Source of Project which can be from the Koshi River to the project area has been conducted. In terms of the project design, technology and site; abundant water will be available to the beneficiaries as it is a big river. However, the location being very far that is around 30 km from Biratnagar city will emphasize the need of pump stations to be constructed at different points/locations to pump the river water. Also, the project will need robust intake structure to be constructed (to survive the frequent flood conditions) and a full-fledged treatment plant to treat water pumped all the way from the source (water mostly laden with silt and dirt most of the time). The need of long water pumping transmission and distribution lines, surface and overhead reservoirs will be crucial which will further increase the time schedule of the project as there are more physical structures to be constructed. The project will need the acquisition of productive land for the construction of pump stations at different locations and some land for the treatment plants, surface reservoirs and over-head tanks. With such conditions such as the need of robust structures long transmission pipeline and multi stage pumping, treatment plants, the project will be relatively an expensive one.

Consultation, Disclosure and Grievance Redress Mechanism

The stakeholders were involved during the IEE throughout the discussions on site. Stakeholders have expressed their views which were incorporated in the IEE project. The consultation process will continue during project implementation to ensure that the stakeholders are engaged in the project and will have the opportunity to participate in the development and implementation of the project.

Environmental Monitoring Plan

The project management office, regional project management office and the consultant will be responsible for the environmental monitoring. With the support from the regional project management office, the consultant will submit monthly reports to the Project Management Office. These very monthly reports will be submitted on semi-annual basis for further development.

Conclusion

Under GON's Environmental Protection Act 2020 and Regulation 2021, the proposed project has been classified under Schedule 2, i.e. the projects requiring IEE study. Thus, this IEE study was carried out to meet, following the approval of its Terms and Reference (ToR) document. Primary finding of this is that the proposed project is not an environmentally critical undertaking. IEE indicates that the proposed project, and its components, is not located within or adjacent to environmentally sensitive areas. The extent of adverse impacts is expected to be local, confined within the projects main areas of influence, waste disposal sites, and the routes to and from these sites. With mitigation measures in place and ensuring that the bulk of earthworks are completed before the onset of the rainy season, the potential adverse impacts during construction would be site specific.

Similarly, the proposed project will bring about benefits of access to a reliable supply of safe and potable water; promote good hygiene and sanitation practices and reduced health and safety risks as positive impacts; and enhance community health, improved quality of life and safe communities as outcomes. Based on the above findings, we have concluded that the proposed project no further require special study or detailed EIA.

कार्यकारी सारांश

प्रस्तावको भूमिका

विराटनगर महानगरपालिका नेपालकै सबैभन्दा गतिशिल शहरहरूमा पर्दछ । यस शहरको जनसंख्या वृद्धिमा आएको तिब्रताले गर्दा पानीको मागमा पनि तिब्र वृद्धि भई रहेको छ । सन् २०१८ मा जपान अन्तर्राष्ट्रिय सहयोग संस्था (JICA) ले गरेको एक अध्ययनले विराटनगरमा प्रतिदिन प्रतिव्यक्ति १२० लिटर पानीको माग रहेको जनाएको थियो । हाल विराटनगरको पानीको माग कूल दैनिक २६,१०० घन मि. भएतापनि, खानेपानी संस्थानले केवल ९,१०० घन मि. पानी मात्र उपलब्ध गराउन सकेको छ । यसको साथै, विराटनगरको खानेपानी बितरण प्रणाली पनि साह्रै पुरानो भइसकेको, जसको कारणले धेरै ठाँउहरूमा चुहवाटको समस्या रहेको छ । यी चुहवाटहरूबाट खानेपानी प्रदूषण भई उपभोक्ताहरूलाई रोग लाग्ने संभावना पनि प्रवल रहेको छ । २०१४ मा विराटनगरमा फैलिएको पीलिया (Jaundice) रोगको कारक प्रदूषित खानेपानी हुनसक्ने अनुमान गरिएको थियो । त्यसबेला १२ जनाको मृत्यु र करिब २००० जनालाई संक्रमण भएको तथ्याङ्क "द हिमालयन टाइम्स"को रिपोर्टमा उल्लेख गरिएको थियो । यसले विराटनगरको समग्र खानेपानी बितरण प्रणालीको स्तर उन्नति गर्नु पर्ने टडकारो आवश्यकता रहेको जनाउछ । यसकारणले नेपाल खानेपानी संस्थानले JICA को सहयोगमा यस "विराटनगर खानेपानी सुधार आयोजनाको" पहल गरेको छ ।

प्रस्तावको परिचय

प्रस्ताव गरिएको आयोजनाले विराटनगर महानगरपालिकाको १४ वटा वार्डहरूमा खानेपानी आपूर्ति गर्नेछ ।

- यस आयोजनाको मुख्य संरचनाहरू यस प्रकार छन् ।
- हाल संचालित तिनपानी, देवकोटा तथा मुनालमा रहेका ३वटा पम्प स्टेशनहरूको स्तरोन्नति
- वडा नं ५, शिबकाली आधारभूत स्कूल नजिकै नयाँ पम्प स्टेशनको निर्माण
- कुल करिब १७० कि मी बितरण पाइप लाइन विराटनगर महानगरपालिकाको १४ वटा वार्डहरूमा बिछ्याईने

यस आयोजनाले थप ६,५५२ घन मी पानी प्रति दिन हालको बितरण प्रणालीमा प्रदान गरि कुल १५,६५२ घन मी पानी विराटनगरमा बितरण गर्नेछ, जसले गर्दा कुल १३,७२० जनालाई यस आयोजनाले खानेपानी पूर्वाप्ति गर्नेछ ।

प्रारम्भिक वातावरणिय मूल्याङ्कन अध्ययन

वातावरण संरक्षण नियमावली २०७७ को अनुसूची २ (नियम ३ सम्म सम्बन्धित) अनुसार, खानेपानी स्किम जसको क्षमता ५० हजार देखि २ लाख सम्म जनसंख्यालाई पानी बितरण गर्ने तथा वा जसले नयाँ पानीको श्रोतको उपयोग गर्छ, त्यस्तो आयोजनाको प्रारम्भिक वातावरणिय मूल्याङ्कन अध्ययन गर्न अनिवार्य हुन्छ । जसलाई सम्बोधन गर्न, यस प्रारम्भिक वातावरणिय मूल्याङ्कन अध्ययन गरिएको हो । यस अध्ययनको मुख्य उद्देश्य आयोजनाको निर्माण तथा संचालन गर्दा हुनसक्ने वातावरणिय तथा

सामाजिक प्रभावको विश्लेषण गरी प्रतिकूल प्रभावहरूको न्यूनिकरण गर्दै आयोजनाको सकारात्मक प्रभावलाई बृद्धि गर्ने रहेको छ ।

वातावरणिय परिस्थिति तथा प्रभावहरू

भौतिक वातावरण पृष्ठभूमि

विराटनगर महानगरपालिका (BMC) काठमाडौँबाट करिब ३९९ किलोमिटर (२४८ माइल) पूर्व प्रदेश नम्बर १ को प्रशासनिक राजधानीको रूपमा अवस्थित छ । विराटनगरलाई दुई साना नदीले घेरिएको छ: पूर्वबाट बग्ने सिङ्गियाही र पश्चिमबाट बग्ने केशलिया भने पश्चिममा कोशी नदी ३० किलोमिटर टाढा रहेको छ । वर्षायाममा बाढी आउने केशलिया र सिङ्गियाही नदीहरू, हिउँदमा सुख्खा रहन्छ । यी दुई नदीको पानीको गुणस्तर निकै कम रहेको पाइन्छ । यस योजनाको अधिकांश जमिन कृषियोग्य रहेको र धेरैमा घर-बस्तिले भरिएको पाइन्छ । त्यसैगरी आयोजना क्षेत्रको वायु गुणस्तर कच्ची सडक र निर्माण कार्यमा सवारीसाधनको आवागमनबाट निस्कने धुलोका कारणहरूले कमजोर छ । यसबाहेक आवाजको गुणस्तर कमहुनुको मुख्य कारण सवारीसाधनको हर्न, अव्यवस्थित यातायात र निर्माण कार्य हो । त्यस्तै विराटनगर महानगरपालिकाको फोहोरमैला व्यवस्थापनमा पनि उचित ध्यान लगाउनु पर्नेछ । व्यवस्थापनमा घरायसी तथा संस्थागत स्रोतबाट फोहोर सङ्कलन हुने गरेको भएपनि केशलिया नदीको किनारमा फोहर फाल्ने गरेको छ । यसबाहेक, डम्पिङको लागि सीमित ठाउँको कारण, ल्यान्डफिलमा फोहोरको मात्रा कम गर्न र थप फोहर फाल्ने ठाउँ बनाउनको लागि प्राय जलाइन्छ ।

विराटनगर महानगरपालिकालाई नेपाल खानेपानी संस्था (NWSC) र जमुनागञ्जी WUSC, पिछेरा विराटनगर WUSC र Mangad WUSC गरी तीनवटा खानेपानी उपभोक्ता तथा सरसफाई समितिले खानेपानी उपलब्ध गरिरहेको छ । पानीको वर्तमान स्रोतहरूको स्थान सहित तल सूचीबद्ध गरिएको छ:

- १ देवकोटा चोक PS, (वडा ९, बी.म.पा.)
- २ मुनाल पथ PS, (वडा २, बी.म.पा.)
- ३ तिनपानी PS, (वडा २, बी.म.पा.)
- ४ रानी क्षेत्र PS, (वडा १३, बी.म.पा.)
- ५ पिछेरा, (वडा ११, बी.म.पा.)
- ६ BFM (वडा ६, बी.म.पा.)
- ७ कञ्चनबारी (वडा ४, बी.म.पा.)

निर्माणको दौरान पाइप बिछ्याउनको लागि जमिनको खुदाइ तथा उत्खनन जस्ता कार्यहरू अनिवार्य हुन्छ । यी कार्यहरू मुख्यतया: शहरी क्षेत्र भित्र हुने हुँदा, यसको प्रभाव धेरै जनसंख्यालाई पर्ने अनुमान गरिएको छ । खुदाईको कारणले बाटोघाटो अवरुद्ध हुनको साथै उत्खननबाट उत्पन्न हुने माटो, सडकको छेउमा धुपारिँदा, स्थानियहरूको आवतजावतमा व्यवधान आउनुको साथै त्यस स्थानको सुन्दरतामा पनि ह्रास आउनेछ ।

निर्माण अवधिको दौरान निस्कने धुलोको कारणले गर्दा वायु प्रदूषण हुने अपेक्षा गरिएको छ, जसले स्थानिय वासिन्दाको साथै आवतजावत गरिरहने जनता र आयोजनाको कामदारहरूलाई समेत प्रभाव पार्न सक्नेछ ।

उत्खनन तथा खुदाइका कार्यहरू मुख्यतया: शहरी क्षेत्रमा गरिने हुँदा, माटो पानीसँगै बगेर शहरको पानी निकासहरूमा जम्मा हुने, जसले गर्दा निकासहरू धुनिएर पानी जम्मा हुनसक्छ । तराई क्षेत्रमा यहाँको भूबनोटका कारण पानी जम्मा हुने (water logging) समस्या बढि हुने गर्दछ । यस्ता स्थानहरू लामखुटेको प्रजनन स्थल बन्नले डेंगु जस्ता रोगको विस्तार हुन मद्दत पुग्दछ । निर्माणका कार्यहरूले ध्वनि प्रदूषण हुनसक्ने प्रवल संभावना रहन्छ । निर्माण कार्यहरू शहरी क्षेत्रमा हुने हुँदा, यसको प्रभाव अझै बढि मात्रमा हुनसक्छ । त्यस माथि अस्पताल, स्कूल आदिमा यसले धेरै प्रभाव पार्नेछ । दिनमा गरिने निर्माणले भन्दा रात्रिमा गरिने निर्माणले झन बढि प्रभाव पार्नेछ । विराटनगर भएर दुई खोलाहरू बग्दछन् - सिङ्गियाही र केशलिया । यी दुबै खोलाहरू हालको अवस्थामा प्रदूषित छन्, मुख्यतया, यी खोलाहरू विराटनगरको शहरी क्षेत्रमा प्रवेश गरेपछि झन प्रदूषित भएको देखिन्छ । निर्माणको चरणमा, पानीसँगै बगेर गएको माटो र आयोजनाका कामदारहरूको खराब सरसफाईको अभावसले यी खोलाहरू अरु बढि प्रदूषित हुनसक्छन । निर्माण कार्यले, मुख्यतया, पाइप लाईन बिछ्याउदा, करिब ३ फिट गहिरो र २ फिट फराकिलो खाडल खुल्नुपर्ने हुन्छ, जसले गर्दा सडकहरू, पानी निकासका ढलहरू, घरहरूको पाखाँल वा मिताहरूमा क्षति पुग्न सक्छ । निर्माण स्थलहरूबाट उत्पादन हुने माटो र कामदारहरूबाट उत्पादन हुने फोहोरको व्यवस्था राम्रोसंग नगरिएमा यसबाट स्वच्छता र जनस्वास्थ्यमा नकारात्मक प्रभाव पर्न सक्छ । शहरको घना वर्तमान संचालन हुने निर्माण कार्य भएकोले यो प्रभाव झन संवेदनशिल हुनसक्छ ।

जैविक वातावरण

यस परियोजना स्थल नेपालको तालो र आद्र गर्मी, भाँगे मनसुन बर्षा र सुख्खा जाडो जस्ता विशेषता भएको उप-उष्णकटिबन्धीय जलवायु क्षेत्रमा रहेको विराटनगर महानगरपालिकामा पर्दछ । यस परियोजना स्थलमा हुने क्षेत्रले निर्धारित मापदण्डको वन भने समेटेको छैन । वास्तवमा मोरङ जिल्लाकै कुल भू-भागको २४ प्रतिशत उत्तर पूर्वी भाग मात्रै वन क्षेत्रले ओगटेको पाइन्छ (DFRS, 2018) । तर हालको परियोजना स्थलमा रूख प्रजातिहरू जस्तै ओष (Mangifera indica), सिसे (Dalbergia sissoo), मसला (Eucalyptus camaldulensis), त्रेशोक (Saraca indica) आदि, फाँटो तथा वृट्टयानहरू जस्तै असुरो (Adhatoda vasica), सिमली (Vitex negundo) र घाँस प्रजातिहरू जस्तै (Cynodon dactylon, Digitaria eriantha) रहेको भन्ने पाइयो ।

त्यस्तै आइयूसीएन को सूचीमा संवेदनशिल अवस्थामा पर्ने सारस (Ciconia episcopus) देखी सामान्य अवस्थामा रहेका कोइली (Eudynamis scolopaceus), न्याउली (Megalaia asiatica), मँगोरा (Passer domesticus) आदि प्रजातिका चरा, धामन (Ptyas mucosus), हरियो सर्प (Trimeresurus albolabris) र छेपारो (Calotes versicular) जस्ता धम्रने जीव, म्यागुता (Duttaphrynus melanostictus, Euphyllis cyanophlyctis) र न्याउरी (Herpestes auropancatus) र मुसा (Rattus rattus) जस्ता स्तनधारी जीवहरू रहेको पाइयो । त्यसैगरी केही मिचचाहा प्रजातिका फारहरू जस्तै लहरे वनमारा (Mikania micrantha), सेतो वनमारा (Eupatorium odoratum) तथा लज्जावती भार (Mimosa pudica) पनि कार्यस्थलमा रहेको पाइयो ।

हामीले काम गर्ने कार्यक्षेत्रमा हाल सञ्चालनमा रहिरहेको खानेपानी पम्पिङ्ग स्टेशनका साथै अन्य उपकरण तथा संरचनाहरू रहेका छन् । सोही क्षेत्रको पनि केही खुल्ला भागमा केही स्वरुह र वृट्टयानहरू स्थापित भइसकेको देखिन्छ । यस कारण निर्माण कार्य चलिइरहेको यी वनस्पतिहरूलाई अत्यावश्यक परेको खण्डमा काट्ने, फाँड्ने जस्ता क्रियाकलापहरू हुन सक्नेछ ।

तिनपैनी पम्पिङ्ग स्टेशन वन्यजन्तुको मुख्य बासस्थान नभएको भएतापनि त्यस ठाँउ वरपर रहेका वनस्पतिको कारण विभिन्न वन्यजन्तु तथा चराचुरूङ्गीको आवतजावत हुनेगरेको पाइयो । यदि निर्माण कार्य चलिइरहेको उनीहरूको आवतजावत भएमा निर्माण सामान ढुवानी तथा भण्डारणका कारण उनीहरूको आवतजावतमा असर पर्न सक्छ ।

यस आयोजनाले वनस्पति र प्राकृतिक परिस्थितिकीय प्रणालीमा खासै असर नपर्ने देखिन्छ । यद्यपि यसका केही निर्माणकार्यले थोरै मात्रमा घासको प्रजाति र तिनको नरुत्यादनमा असर पर्ने देखिन्छ जुन पछि पुनः स्थापित हुन सक्छ ।

आयोजना क्षेत्र जङ्गली जनावरहरूको बासस्थानसँग जोडिएको छैन वा टाढा रहेको छ । तथापि वन्यजन्तुको आवत जावतमा भने निर्माण कार्यले असर गर्ने सक्ने देखिन्छ ।

आयोजना क्षेत्रमा पाइएका धेरैजसो चराचुरूङ्गीहरूको प्रजाति रैथाने रहेको पाइयो । साथै उक्त क्षेत्र वसाई सन चराचुरूङ्गीको गन्तव्यको रूपमा पनि रहेको हुँदा निर्माण कार्यका बेलाका हुने विभिन्न गतिविधिहरू जस्तै कामदार तथा गाडीहरूको आवतजावतले यस्ता चराचुरूङ्गीको घटना दर्ताका साथै उनीहरूको आवतजावत मा समेत असर गर्ने देखिन्छ । निर्माण कार्य सम्पन्न भएको स्थल पछि गएर वनमारा, जलकृमि, जस्ता मिचाना प्रजातिले बाकिन सक्छ ।

सामाजिक आर्थिक र सांस्कृतिक वातावरण

बिनापा को वेव साइटले दिएको जानकारी अनुसार हालको जनसंख्या २,१४,६६३ छ, जुन सम्पूर्ण मोरंग जिल्लाको कुल जनसंख्याको झन्डै पाँच भागको एक भाग (१९.७७%) हो । जनगणना २००१ मा १,६६,६७४ (पुरुष ५३% (८७.६६%) र महिला ४७% (७९.०१%) थियो, भने २०११को जनगणना अनुसार यहाँको जनसंख्या २,०१,१२५ पुरुष ५१% (१०८.८२%) र महिला ४९% (१०५.८३%) थियो। साल २००१ र २०११ जनगणना बीचमा करीब ३४.४५१ बृद्धि भएको देखिन्छ । RUDP ले २०१५ मा तयार गरेको IEE को आफ्नो प्रतिवेदनमा जनसंख्या वृद्धिदर ३.३७% लाई मानेको छ र यही वृद्धिदरलाई यस प्रतिवेदनमा पनि मानिएको छ जस अनुसार सन् २०२१ को बिनापा को जनसंख्या २,८९,०१७ हुनेछ। जनघनत्व २.७८८ प्रति वर्ग की.मी. छ । जनसंख्याको हिसावले वार्ड नं ६ सबैभन्दा ठूलो वार्ड (१७,४४८) हो भने वार्ड नं १९ सबैभन्दा सानो १,५६,४०० वार्ड हो, त्यस्तै वडा नम्बर ४ भौतिक क्षेत्रको हिसावले सबैभन्दा ठूलो हो। पुरुष र महिला जनसंख्याको समग्र अनुपात १.०३ छ (पुरुष ५०.७०%) र महिला (४९.३०%) रहेको छ।

बिनापा.मा उमेर: <२५ का आश्रित जनसंख्या ३४%, उमेर: १५ देखि ५९ वर्षका आर्थिक रूपले सक्रिय जनसंख्या ६१%, र उमेर: >५९ का बृद्ध बुद्धा आश्रित जनसंख्या ५% रहेका छन्। जनसंख्याको हिसावले दलित (दमाई, कामी, सार्की आदि) को उपस्थिति १% भन्दा कम छ । बहुसंख्यक भाषीहरू मैथिली भाषा

र नेपाली भाषा दुवै बोल्दछन्, र बंगाली लगायत थारु भाषा को उपस्थिति पनि उल्लेख्य छ । धार्मिकरूपले अति सहिष्णु नगरपालिकामा हिन्दू, इस्लाम, जैन, किरात, र ईसाई सामाजिक सामन्त्यमा रहेका छन् ।

कुल साक्षरता दर ५०.५५% (पुरुष ५९.५% र महिला ३९.५%) छ। यहाँ ३ निजी अस्पतालहरू सहित धेरै निजी क्लिनिकहरू र प्याथोलोजी प्रयोगशालाहरू, पाँच भन्दा बढि नर्सिंहोम, ५० निजी क्लिनिक र १० प्याथोलोजी प्रयोगशालाहरू, एक पशु चिकित्सालय छन् जसबाट एक्सरे, अपरेसन थिएटर, ओपीडी जस्ता उपचार सुविधाहरू उपलब्ध छन्।

आर्थिक रूपमा सक्रिय जनसंख्या मध्ये करीब ४६.२% कृषिमा संलग्न छन्, ३२.४% सेवा र बाँकी व्यापार र श्रममा छन्।

परियोजना क्षेत्रको आधारभूत स्थिति (PS नम्बर ५)

प्रस्तुत सर्वेक्षणले प्रस्तावित नयाँ पम्प स्टेशन (वार्ड नं ५) मा कूल संकलित २१६ नमुना घरधुरीमा कूल १,१९२ जनसंख्या गणना गरेको छ। पुरुष र महिलाको अनुपात क्रमशः ५१.०१% र ४८.९९ % छ। बहुसंख्यक जनसंख्या २५.५९% उमेर समूह २१ देखि ३० वर्षका छन् भने उमेर समूह ० देखि १० वर्ष भित्रका २३.०७% रहेकाछन् र उमेर समूह ११ देखि २० वर्ष भित्रका १९.३०% रहेकाछन्। लगभग ७२% जनसंख्या आर्थिक रूपमा सक्रिय छन्।

प्रस्तुत प्रारम्भिक सर्वेक्षणले परियोजना क्षेत्र (नयाँ PS साइट) भित्र २५ भन्दा बढी पहाडी र तराईका जातीय बासिन्दाहरूको मिश्रित समुदायको रूपमा पहिचान गरेको छ। बहुमत मण्डल (१७.९३%), पछी यादव (९.२६%), खवास (८.०%), सतार (६.०२%), त्यस पछि अन्य रहेका छन्। कुल जनसंख्याको लगभग ६८% (पुरुष ३४.९४% र महिला ३३.३९%) मध्ये ४८.७% जनसंख्या पढ्न मात्र जान्दछन् ६.२७% जनसंख्या पढ्न र लेख्न दुवै जान्दछन्। समूहमा ६ वर्ष मुनि का जनसंख्या पनि पूर्व प्राथमिक तह अन्तर्गत विद्यालय (निजी) जाँदै गरेको पाइयो। रोचक कुरा दुबै पुरुष र महिलामा शैक्षिकताको स्तर लगभग उस्तै छ।

केवल कृषिमा संलग्न रहने पहिलेको प्रवृत्तिमा अब आमूल परिवर्तन आएको देखिन्छ। आजकाल धेरैजसो मानिसहरू मुख्य रूपमा तलबन्ज्याला (५२.३९%) मा संलग्न छन् भने आफ्नै उद्यम (२२.२२%) मा संलग्न हुनेको संख्या पनि कम छैन यस बाहेक बैदेशिक रोजगार (१५.४४%) मा पनि संलग्न छन्। आजका दिनमा कृषिले दिने प्रतिफलको न्यूनताको कारणले कृषिपेशा प्रतिको आकर्षक कम हुँदै गएको देखिन्छ। सम्भवतः यस्तो अवस्था यो महानगर भएको कारणले पनि हुनसक्छ।

आयव्ययको हिसावले यहाँको जनताको आय लगभग राष्ट्रियस्तरको आय जतिकै छ। औसतमा, यँहा प्रतिव्यक्ति प्रतिवर्ष आय लगभग १२८ हजार छ। साथै खर्चपनि लगभग उतिकै छ। वार्षिक आयको अनुसार यहाँका परिवारहरूलाई ३ समूहमा वर्गीकृत गर्न सकिन्छ । वार्षिक २ लाख भन्दा बढी आय भएका परिवारहरूलाई उच्च आय समूह (HIG), ७५ हजार देखि २ लाख सम्मका आय भएका परिवारलाई मध्यम आय समूह (MIG) र वार्षिक ७५ हजार भन्दा कम आय भएकालाई न्यून आय समूह (LIG) वर्गीकरण गरि विस्तारपूर्वक गर्दा समग्र जनसंख्याको ७१% MIG मा १५% HIG मा र बाँकी १४% LIG मा देखिन्छ।

प्रस्तावित नयाँ PS साइट क्षेत्रमा घरधुरी मध्ये लगभग ७८% घरधुरीको आफ्नै निजि जग्गा छैन भन्ने बुझिन्छ भने बाँकी १२% मात्रै आफ्नै निजि जमिन छ। आफ्नै खेत र बारीमा निजि उत्पादन भएको

खाद्यान्नले वर्षभरी नै पुग्छ कि पुरैदिन भन्ने सवालमा झन्डै ८०% HHs को आफ्नै उत्पादनले वर्षभरी खान पुरैदिन, केवल ६% घरधुरीको मात्रै वर्षभरी खान पुग्ने र अतिरिक्त ववतपनि हुन्छ भन्ने बुझिन्छ। बाँकी ३ देखि ६ महिनासम्म (८%), ६ देखि ९ महिनासम्म (५%), र ९ देखि १२ महिनासम्म (२%) छ। निजि आवासको सवालमा भन्नु पर्दा यस क्षेत्रमा सर्वेक्षण गरिएका मध्ये सबै परिवारको आफ्नै निजि आवास छ तर आफ्नो हेरिसयत अनुसार घरको निर्माण संरचना भने फरकफरक छन्। ६२% घरपरिवारको खर / फुसले छाएको कच्ची घर छ, १४% को टिन अथवा टाण्टलले छाएको अर्धपक्की घर छ भने बाँकी २४% को सिमेन्ट कै गारो वा पिलर सहितको ढलान गरिएको पक्की घर छ।

सर्वेक्षणले देखाएको सबैभन्दा आश्चर्य लाग्ने सूचना भने शौचालय सम्बन्धी विवरण हो। महानगरपालिका क्षेत्र भित्रको अंश भएपनि यहाँ करीब २.३% घरपरिवारको आफ्नो घर परिसर भित्र आफ्नै निजि शौचालय छैन र शौचको लागि नजिकैको खुल्ला जमिन (प्रायः खेत/बारी) प्रयोग गर्दछन। यदि यो घरधुरीले दिएको विवरणमा कैफियत छैन भने यो अत्यन्त संवेदनशील विषय हो। यसको विशिष्ट अध्ययन गर्राई हाल्तु पर्ने अवस्था देखिन्छ र मानवीय स्वास्थ्यको दृष्टिकोणबाट अति महत्वपूर्ण यो विषयलाई तत्काल सम्बोधन गरी शौचालय निर्माणको लागि पहल गर्नुपर्ने अत्यावश्यक देखिन्छ। खानेपानीको सवालमा यस क्षेत्रमा सबैजसो घरपरिवारको निजि हान्दपम्प छन्, सबैले भूमिगत जल प्रयोग गर्दछन र उपलब्धता पर्याप्त छ। तर धेरैजसोले कपडा पहिरो हुने गरेको गुनासो गर्दछन। त्यसैगरी यहाँ राष्ट्रिय विद्युत प्रसारणलाइनबाट प्रशारित विद्युत सबैजसो घरले प्रयोग गर्दछन र हेरक घरमा एउटा र एउटा घरमा अलग अलग मोबाइल फोन छ। साथै शिक्षाको लागि यसै कुल्हरबा (दमावदी) टोलमा बि.स. २०४६ सालमा स्थापित नगरपालिका अन्तर्गत सिद्धकाली आधारभूत विद्यालय संचालित छ। शहरीकरणको गति बढिरहेको छ।

स्थानीय वासिन्दा, वडा कार्यालय र बिनापा ले उपलब्ध गराएको आधिकारिक जानकारी अनुसार प्रस्तावित आयोजना स्थल नगरपालिकाको स्वामित्वमा रहेको जग्गा हो त्यसैले कुनै जग्गा अधिग्रहण गर्नुपर्ने सवालहरू हुनेछैनन्।

परियोजना प्रतिको स्थानीयको धारणा

परियोजना प्रति स्थानीय वासिन्दाको धारणा उत्साहपूर्ण र सकारात्मक पाइएको छ। स्थानीयहरू, आयोजनाले स्वच्छ खानेपानीको उपलब्धता गराई स्थानीय वासिन्दाको दैनिक जीवन सहज बनाउने छ भन्ने विश्वास अभिव्यक्त गर्दछन। भूमिगत जलको सोझै प्रयोगले निम्त्याएको कपडा पहिरो हुने समस्यालाई यस आयोजनाले समाप्त पार्ने छ भन्ने प्रति पनि स्थानीयहरू आशाति छन। धेरैजसो मानिसहरूलाई यो आयोजनाले पर्याप्त र गुणस्तरीय पानी उपलब्ध गराएर उनीहरूको जीवन परिवर्तन गर्नको लागि यो एक ऐतिहासिक स्थल (PS-५) बनेछ। परियोजना सम्पन्न भएपछि, उनीहरूको पिउने पानीको स्रोत परिवर्तन हुनेछ, अहिले भूमिगत जलमा भएको फलामिय तत्व प्रत्यक्ष खाइरहेका छन् सो पुर्णरुपमा बन्द हुनेछ, जसले उनीहरूको स्वास्थ्य स्थिति पनि सकारात्मक तरीकाले परिवर्तन हुनेछ। साथसाथै, आयोजना निर्माण अवधिमा स्थानीयले रोजगारीको अवसर पनि प्राप्त गर्नेछ। तसर्थ, समग्ररूपमा, यो परियोजना मानवीय सामाजिक जीवन परिवर्तनको सकारात्मक संवाहक बनेर छ र समग्र दृष्टिकोणबाट उपयुक्त, अत्यावश्यक र योग्य छ।

परियोजनाले पार्ने प्रभावहरू

यस परियोजनाले परियोजनाको उद्देश्य पूर्ति गर्नको लागि कसैको कुनै निजी सम्पत्ति प्राप्त गर्न छैन। साथै कुनैपनि आवास, भौतिक संरचना वा अन्य निजी व्यक्तिगत सम्बन्धित सम्पत्ति लगायतका स्रोतहरू नाश वा क्षति हुने छैन। नयाँ पम्पस्टेशन (PS-५) स्थापना तथा संचालन गर्न छनौट गरिएको भूमि/क्षेत्र बाधाहरूबाट पूर्णतया मुक्त छ।

यस परियोजनाले न वर्तमान भू-उपयोगमा परिवर्तन गर्ने छ न कुनै कृषि योग्य भूमिमा हस्तक्षेप गर्नेछ न त उत्पादनमा नै नकारात्मक प्रभाव पार्नेछ। यहाँसम्म कि यो परियोजनाले वर्तमान अवस्थामा लगाईएको बालीलाई पनि नाश गर्नेछैन। विद्यमान बालीदाँवा परिवर्तन हुँदैन, उस्तै रहनेछ।

तर, पुरानो पाईपलाई विस्थापित गर्न वा पूर्ण रूपले नयाँ पाईप बिछ्याउन बिनापा, वडा नं १ देखि १४ सम्मको करीब १६५ की.मी. सडकक्षेत्र खन्नु पर्ने वाध्यता छ। यसकारण स्थानीय बासिन्दा, सडक सगैका टूला-साना व्यापारी, सडक क्षेत्रमा बसेर पसल संचालन गर्ने विविध खाले अनौपचारिक व्यवसायीहरू लगायत पैदल यात्रीहरूलाई निर्माण अवधिभर सामान्य तर प्रत्यक्ष असर हुने देखिन्छ। यस अवधिमा टूला-साना स्थायी पसलहरूमा पर्याप्त ग्राहकहरू नहुन सक्छन जसले दैनिक आय र व्ययको व्यवस्थापन गर्न असहज हुनेछ। साथै अनौपचारिक व्यवसाय या त सो अवधिमा बन्द गर्नुपर्ने हुन्छ या अन्यत्र स्थानतन्त्र गरी संचालन गर्नुपर्ने हुन्छ। त्यसैगरी पैदल यात्रीहरूले पनि निर्माण अवधिभर असुविधा महसुस गर्नु पर्ने हुन्छ।

आदिवासी जनजाति/समुदायलाई पम्प स्टेशन स्थापनाको कारण कुनै प्रतिकूल असर पर्ने देखिदैन। त्यसैगरी यस क्षेत्रको सामाजिक सांस्कृतिक सम्पदा, परम्परालाई नकारात्मक असर पार्ने पनि देखिदैन। तर ठेकेदारबाट परिचालित बाह्य कर्मचारीहरू एवं मजदूर हरूको आगमनले सामाजिक, आर्थिक र सामाजिक सञ्चारका पक्षहरूमा केही जोखिम बढाउन सक्नेछ। साथै सामाजिक सुरक्षामा पर्ने सक्ने देखल लाई पनि नकार्न सकिदैन।

निर्माणको दौरान, वायु प्रदूषण, नेत्र जलन र अन्य श्वाशप्रकाश सम्बन्धी समस्याहरू पर्न सक्छन, विशेषगरी वालवालिका र ज्येष्ठ नागरिकहरूमा यो समस्या अझ झन जाटिल हुन सक्छ। त्यसैगरी ध्वनि प्रदूषणले स्थानीय जनता/बासिन्दाहरूलाई असहज अवस्था हुन सक्नेछ। विशेषगरी रातको समयमा सामान्य ध्वनिपनि कर्कसहने हुनाले निर्माणक्षेत्र नजिकका मानिसहरूको निद्रा प्रभावित हुनसक्छ। निर्माण अवधिको केही प्रतिकूल प्रभाव बाहेक परियोजना सञ्चालन चरणमा धेरै नकारात्मक असरहरू हुने छैनन् भन्ने आंकलन गर्न सकिन्छ। यो स्वच्छ पानीको आपूर्तिसंग सम्बन्धित परियोजना भएको कारण स्थानीयहरूलाई आफ्नो घर वरपरको सरसफाईलाई ध्यानदिन प्रेरित पनि गर्नसक्छ। स्थानीयहरूको लागि यो एउटा सुनौलो अवसर साबित हुन सक्छ।

न्यूनिकरणका उपायहरू

भौतिक वातावरण

- माटोको क्षयलाई रोक्न वा कम गर्न निर्माण चरणमा सक्दो सावधानी अपनाउन जरुरी छ, जसमा खाडला पाईप बिछ्याउदा लाग्ने खाडलहरू माटोले पुगि, सकेसम्म स्थायी वा अस्थाई सडकको कालोपत्रेले वा सिमेन्ट वा घास विरुवाले छोपु पर्छ ।
- वायु प्रदूषण रोकथामको लागि निर्माण चरणमा उत्खनन भई धुपिएको माटो जसबाट वायुमा धुलोको मात्रा बढ्न सक्छ, त्यसरी जम्मा हुने माटोलाई सकेसम्म छोपेर राख्ने, वा पानी छर्केर

- राख्ने गर्नु पर्छ । साथै खनिएका सडकहरू कालोपत्रे गर्ने, नत्र अस्थायी रूपमा रोडाहरूले छोपु पर्छ ।
- ध्वनि प्रदूषणलाई कम गर्न सकेसम्म कम आवाज गर्ने उपकरणहरूको प्रयोग गर्नु पर्दछ, साथै शहरि क्षेत्रमा घना वस्ति नजिक निर्माण कार्य दिनमा मात्र संचालन गर्नु पर्दछ । यस लगायत, अस्पताल, स्कूल जस्ता संवेदनशिल क्षेत्र नजिक निर्माण गर्दा विशेष ध्यान पुर्याइ, समन्वय गरि मात्र कार्यहरू सम्पादन गर्नु पर्दछ ।
 - आयोजनाबाट हुनसक्ने खोलानालाहरूको प्रदूषण रोक्न वा कम गर्न उलखनबाट निस्केको माटोलाई समयमै तोकिएका स्थानमा बिसर्जन गर्नु पर्छ । यसको साथै निर्माण सामग्रीहरूको भण्डारण गरिने स्थान खोलानालाबाट टाढा राख्नुपर्छ ।
 - निर्माण गर्दा सडकमा खाडल बनाउनु पर्ने बाधता रहन्छ, जसलाई सकेसम्म कम गर्न सडक छेउको फुटपाथमा पाईप लाईनलाई बिछ्याउन प्राथमिकता दिनु पर्छ, जसले सडकको क्षति कम हुनुको साथै आवतजावतमा पनि कम असर पर्नेछ । खनिएको सडकको पुनर्निर्माणको व्यवस्था पनि यसै आयोजना भित्रै पारिने छ, जसले गर्दा सडकको छिटै पुनर्निर्माण गर्न सकिनेछ ।
 - पाईप लाईन बिछ्याउदाको खाडलले स्थानियहरूको ढल लाईन, घरको पर्खाल आदीमा पनि असर पर्न सक्दछ । आयोजनाले यस्ता असरलाई सकेसम्म कम गर्ने प्रयास गर्नेछ, तर कुनै अवस्थामा असर पर्न गएमा, आयोजनाले तुरन्तै त्यस्ता क्षतिको पुनर्निर्माण गर्न प्रवधान पनि राख्नेछ ।

जैविक वातावरण

- निर्माण कार्यका लागि सामग्रीहरू प्रयोगको बेलामा मात्र स्थलमा पुर्याइनेछ ।
- निर्माण स्थलमा वन्यजन्तुको आवतजावत रोक्न छेकबार र चराचुरुङ्गीको आवतजावत रोक्न अल्टो हुने गरी हरियो जाली लगाईने छ ।
- मिचवाहा प्रजातिहरूलाई फेलिन नदिन यसलाई फूल फूल अगावै काट्ने र यसरी काटिएको भागलाई जैविक मल बनाई जीविकोपार्जनको विकल्पको रूपमा पनि प्रयोग गर्न सकिन्छ ।
- परियोजना क्षेत्रमा रूख कटानको कार्यलाई प्राथमिकता दिईने छैन । रूख काट्नुपर्ने अवस्था आएमा डिभिजन वन कार्यालयको निर्देशनमा काटिने छ र प्रत्येक रूख काटे बापत प्रति रूख २५ वटा रूकान्तिमा पनि० का दरले रैथाने प्रजातिका विरुवाहरू रोप्न लगाईनेछ ।
- आयोजनाका कामदार, प्रावधिक, व्यवस्थापक आदीको साथै स्थानिय वसिन्दाहरूलाई आयोजना क्षेत्रमा पाईने वनस्पति तथा जिव जनावरहरूको बारेमा जानकारी दिई संरक्षणमा सहयोग पुर्याउने चेतनामूलक कार्यक्रमहरू संचालन गर्नु पर्नेछ । साथै आयोजनासंग सम्बन्धितहरूलाई बाध्यात्मक अवस्था बनाउन, उनीहरूको नियुक्ति, कार्य सम्झौता, आदीमा जैविक विविधताको संरक्षण प्रतिको प्रतिबद्धता समावेश गरिनु पर्छ ।

सामाजिक - आर्थिक वातावरण

- समग्रमा, बिनापाको तर्फबाट एकजना सम्पर्क अधिकारी मनोनयन गर्न सुझाव गरिन्छ जसले परियोजनाको निर्माण अवधि भर स्थानीयहरूबाट उब्जिन सक्ने गुनासाहरूलाई सम्बोधन गर्न

- सकोस।यसबाहेक, बिनापा र खानेपानी कार्यालयको संयुक्त आयोजनामा परियोजना शुरूहुने (विषेसगरी खन्न थाल्नु भन्दा अगाडि) विषयमा माइकिंग-सार्वजनिक सूचना जारी गरी स्थानीयलाई सो अवधिभरी संयमित भई सहयोग गर्ने र आफ्नो व्यवस्था मिलाउने समय सिमा तोकौं दिनु पर्नेछ ।
- आवासको पहुँचमा अवरोध, हानि, वा त्यस्तै अन्य सम्पत्ति जस्तै व्यापार/व्यवसाय वा बाटो हिन्देलाई हुनसक्ने अवरोध न्यून गर्न व्यवस्थित-अनुकूल विकल्पकासाथ खन्ने काम गर्न ठेकेदारलाई निर्देशित गर्नु पर्नेछ ।
 - ध्वनि, वायु तथा धूलो आदि जस्ता प्रदूषणबाट स्थानीयहरूलाई बचाउन, रातको समयमा उच्चध्वनि युक्त उपकरणहरूको उपयोग सकेसम्म नगर्न सिफारिश गरिएको छ। धूलोजन्य प्रदूषण नियन्त्रण गर्न निर्माण अवधिभर खनिएको ठाउँहरूमा पानी छर्कन सिफारिश गरिएको छ । साथै तत्काल प्राथमिक स्वास्थ्य सेवा उपलब्धताको लागि एक स्वास्थ्य डेस्कबोर्ड स्थापित गर्न अभिप्रेरित गरिएको छ भने निर्माण कार्यको लागि स्थानीय श्रमको उपयोग गर्न सुझाव दिईएको छ ।

वैकल्पिक विरलेषण

- कुनै नयाँ परियोजना डिजाइन प्रस्तावित छैन र कुनै नयाँ संचालन प्रक्रिया पनि छैन। विद्यमान पानी आपूर्तिमा रहेको चाप अपर्याप्त र कम गुणस्तरको हुनाले स्थानीयको स्वास्थ्यमा प्रतिकूल असरलाई बढवा दिने छ। जुन बढ्दो जनसंख्या बृद्धिले अझै नाजुक हुन सक्ने देखिन्छ। महानगरलाई पानी आपूर्तिको वैकल्पिक स्रोतको रूपमा नजिकैको सिङगियाही र केसलीया नदी परियोजना एक विकल्पको रूपमा छ। नदीको पानी धेरै कम गुणस्तरिय छ र पानी चाहिने सुब्बा नौरममा यो धेरै मर्यादा छैन। वर्षाको समयमा आउन सक्ने बाढीलाई मध्यनजर गर्दै, यस स्रोतको लागि बलियो इन्टेक संरचनाको आवश्यकता पर्छ, जस्तै त्यहाँ पम्प स्टेशनहरूको निर्माण, नयाँ पानी पम्प लाइनहरू, विजुली प्रसारण लाइनहरू र स्ट्यान्डवाइ विजुली जर्नेटरको उपलब्धता हुन सके यो एक विशेष विकल्प हुने देखिन्छ ।
- दुबै नदीहरूमा सुख्खा मौसममा पानीको बहाव धेरै न्यून हुन्छ। तसर्थ यि नदीहरूको डाउन स्ट्रिममा तट पानीको आपूर्ति तथा बहावमा भारी गिरावट हुन्छ। जसले गर्दा माछा मारी जीविकोपार्जन गर्न संस्कृति तथा अन्य नदिजन्य मानवीय क्रियाकलापमा उल्लेखनिय रूपमा नराम्रो असर गरेको हुनेछ ।
- परियोजनाको वैकल्पिक स्रोत कौशी नदी देखि परियोजना क्षेत्र सम्म हुन सक्छ। परियोजना डिजाइन, प्रविधि र परियोजना स्थलका सन्धर्भमा यो एक ठूलो नदी भएकोले लाभार्थीहरूलाई प्रशस्त मात्रामा पानी उपलब्ध हुने छ। तर यो नदि विगतनगर शहरबाट ३० किलोमिटर टाढा भएकोले नदीको पानी पम्प गर्न विभिन्न विन्दु स्थानहरूमा पम्प स्टेशनहरूको निर्माणको आवश्यकता पर्नेछ । साथै, परियोजनालाई बलियो इन्टेक संरचना निर्माण गर्न को लागी (जसमध्ये बाढीको विध्वित बचन) र एक पूर्ण क्षमतायुक्त पानी प्रशोधन प्लाण्ट आवश्यक पर्ने छ। जसले सम्पूर्णपले स्रोतबाट पम्प गरिएको पानी फोहर तथा गादयुक्त लाई प्रशोधन गरोस। यसको लागि पानी पम्प गर्ने लामो ट्रांसमिशन र वितरण लाईन, सतह तथा ओभरहेड जलाशय महत्वपूर्ण आवश्यकता हुने छन्। जुन निर्माण गर्न धेरै भौतिक संरचनाहरूको आवश्यकता पर्ने र यसले परियोजना निर्माणको समय तालिका अझ बढाउने छ।माथि उल्लेखित अवस्थालाई पूर्ति गर्न बलियो संरचना लामो

प्रसारण पाइपलाइन तथा बहु चरण गरिने पम्पिंग र प्रशोधन प्लान्ट्स आवश्यक हुने, जसले परियोजनाको लागत अनपेक्षाकृत बढाउने देखिन्छ।

परामर्श, प्रकटीकरण र गुनासो निवारण संयन्त्र

परियोजना स्थलमा गरिएको प्रारम्भिक वातावरणिय परिक्षण छलफलमा सरोकारवालाहरूलाई संलग्न गरिएको थियो। र सरोकारवालाहरूले व्यक्त गरेका विचारहरूलाई प्रारम्भिक वातावरणिय परिक्षण परियोजनामा समावेश गरिएको थियो। परियोजनाको कार्यान्वयन अवधिभर सबै सरोकारवालाहरूलाई नियमित परामर्श प्रक्रियामा समावेश गरिने छ जसले उनीहरूलाई परियोजनासँग जोडी राख्ने तथा परियोजना को निर्माण र कार्यान्वयन गर्न अवसर प्रदान गर्ने छ।

पर्यावरण अनुगमन योजना

वातावरणिय अनुगमनकालागि परियोजना व्यवस्थापन कार्यालय, क्षेत्रीय परियाजना व्यवस्थापन कार्यालय र परामर्शदाता जिम्मेवार हुने छन्। क्षेत्रीय परियाजना व्यवस्थापन कार्यालयको सहयोगमा, परामर्शदाताले मासिक रिपोर्ट परियोजना व्यवस्थापन कार्यालयलाई बुझाउनु पर्ने छ। र यी मासिक रिपोर्टहरू, अर्धवार्षिक रूपमा परियोजनाको आगामी विकाशकालागि बुझाईने छ।

निष्कर्ष

यस आयोजनाको प्रारम्भिक वातावरणीय परिक्षण नेपाल सरकारको वातावरण संरक्षण नियमावली २०७३ अनुसार गरिएको छ। यस आयोजनाले निर्माणको चरणमा वातावरणमा न्यून असर गर्ने देखिन्छो छ, जसको निवारण वा न्यूनिकरण गर्ने उपायहरू यस अध्ययनले सिफारिस गरेको छ। समग्रमा यस परियोजनाको वातावरणिय परियोजना बढि सकारात्मक असर बढि रहेको छ।

1 NAME AND ADDRESS OF THE PERSON/INSTITUTION PREPARING THE REPORT

Proponent of the proposed project is Nepal Water Supply Corporations (NWSC). The office address of NWSC is:

Nepal Water Supply Corporation
Tripureshwor Marga
Kathmandu, Nepal
P.O. Box: 5349

NWSC has entrusted Yachiyo, Japan to undertake the detail design of the project, and thereafter, Yachiyo has assigned METCON as the sub-contractor for undertaking the IEE study of the proposed project for and on behalf of NWSC. The detailed address of Yachiyo, Japan and METCON is presented below:

Yachiyo Engineering CO., LTD
Consulting Engineers and Architects
Tokyo, Japan.
Email: kt-fujii@yachiyo-eng.co.jp

METCON Consultants
House No. 22, Bakrarekha Galli, Chundeivi, Kathmandu, Nepal
Phone: (977)-4412-902
Email: info@mgplconsult.org
Web: www.mgplconsult.org

2 INTRODUCTION

2.1 Objective of the study

The IEE report of this project is being prepared in the English language in reference to the Article 7, (sub-article 8) of EPR2020, which has the provision of preparing the IEE and related documents in English language for the project with foreign investment. This project is funded by JICA.

Similarly, the primary objective of the proposed project is to improve existing water supply system of Biratnagar Metropolitan City (BMC), which is the third largest economic city of Nepal. Currently Nepal Water Supply Corporation (NWSC) and three Water User and Sanitation Committees (WUSC) are implementing the drinking water supply system in the city. However, only between 25% – 30% of the current population is receiving the water supply. The huge population is still devoid from their services.

The project will cover the following wards of BMC - 1,2,3,4,5,6,7,8,9,10,11,12,13 & 14.

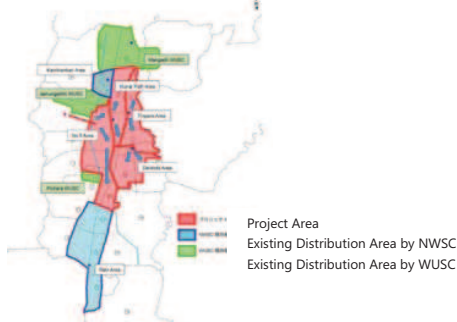


Figure 1: Project Area

Table 1: Estimated Coverage of Piped Water Supply

WUSC	Service Population 2019	Population 2019	Coverage
NWSC	56,900	305,968	30%
Jamungathhi WUSC	3,472		
Pichara Biratnagar WUSC	4,325		
Mangadh WUSC	26,505		

Source: JICA Study Team

2.2 Landuse impact of the project

The proposed project is not expected to make any significant changes in the existing land use, primarily because it proposes to improve existing water supply system of BMC. It intends to improve existing pump station, water treatment, and supply systems. The only new addition is the water pumping station at Pump no 5 which is near the Bishal Chowk in Jyoteshwor, Biratnagar which needs to be established as a new pumping station including water treatment facility and storage facilities. Currently, the land is used for grazing, though its ownership belongs to a school- Siddhakali Aadhharbooth Bidhyalaya. The school has already agreed to provide this land to the project.

2.3 Environmental Impact, Impact on human lives and Population pressure

The first and primary positive impact of this project is that it will significantly improve the sanitary and health condition of BMC. Currently, NWSC has not been able to adequately meet the water demand of BMC. The water supply has been limited to residents of the core BMC, while majority of residents are compelled to rely on hand pumps or private boring to meet their water supply needs. Moreover, quality of the water supplied by NWSC as well as the ground water extracted by hand pumps/boring has been doubted for contamination. The 2014 outbreak of jaundice had been attributed to the poor quality of water (Poudyal, et al., 2017). Thus the proposed project is expected to improve the water supply in terms of quantity and quality.

The construction activities, itself, have been considered primary source of environmental impact as well as impact on local human lives. The construction works will be carried out in the core urban area, as a result of which the project is expected have significant impacts, such as:

- The local ambient air quality as well as noise level are expected to deteriorate due to the dust generated from the construction activities, traffic congestion and jam due to the road blockages as roads will be excavated for distribution line laying, as well as the exhausts coming from the heavy machineries deployed for the construction works.
- The primary source of water for the proposed project is ground water. 4 pumping stations distributed around BMC are proposed to be improved, thus, the quantity of water pumped out will significantly increase. Though ground water recharge in the Biratnagar region is strong fed by the Sapta Koshi River system as well as Siwalik range, changes in the ground water status might be a possibility. If the ground water table goes down, it can decrease effectiveness of hand pumps and borings used by locals, or drying of local well and ponds, particularly during the dry season.

2.4 Impact on local infrastructure

The construction activities, particularly spoil storage that are generated from road excavations might disturb the drainage systems causing water loggings. This situation might worsen during the monsoon period and impact the local infrastructures. Furthermore, spoil can also clog the sewage and drain as these will drain into the streets and clog along the roadside affecting the inhabitants.

The excavation in the urban area will damage existing municipal and private infrastructures, such as - sewage lines, drainage lines, water supply lines, electric distribution lines, telephone lines, multimedia supply lines etc.

3 PROJECT BACKGROUND

The proposed project intends to improve existing water supply system of the Biratnagar Metropolitan City to meet increasing demand of safe drinking water. The project intends to improve existing water distribution system, improve existing pumping station, and construct a new pumping station. Thus, this project falls into the category of projects that require undertaking of Initial Environmental Examination (IEE) in accordance with the Environmental Protection Regulation 2020 (EPR2020), which stipulates that the water supply project that intends to supply water to a population of 50,000 to 2 lakh or if a new source is to be constructed for the same requires undertaking of IEE study.

3.1 Type of Project

3.1.1 Existing Water Supply System

The history of piped water system in Biratnagar is about 50 years old. Before that residents of Biratnagar have been using water from the shallow tube wells/bore holes called hand pumps or dug wells constructed at different points by the municipality or by individuals themselves in their backyards.

The primary source of water for Biratnagar has always been the ground water. Though the Koshi River flows about 30 km west from the city in the west, its water has not been considered for drinking water of Biratnagar. Furthermore, two small rivers - Singiyahi (flows from the east of the city) and Kesaliya (flows from the west of the city), however, these river has limited water, particularly in the dry seasons, and are heavily contaminated. So people have been opting for the ground water for their domestic use as it is very easily accessible.

The ground water is easily available at a depth of 5-8 feet though the quality is not reliable and is mostly contaminated. The average depths of hand pumps/shallow tubewells used by common people are in the range of 15-50 feet. Deeper the tube-well better is the quality. Water of most of the hand pumps in the city contains excessive iron and is contaminated to great extent. A large section of the population are still using such hand pumps as all areas are not fully covered by the existing piped water system or piped water supply does not fulfill/meet all the water demand. Presently Nepal Water Supply Corporation (NWSC) and three Water User and Sanitation Committees (WUSCs) namely Jamunagachhi WUSC, Pichhara Biratnagar WUSC and Mangadh WUSC are looking after the water supply in Biratnagar. The main urban areas are covered by NWSC and outer peri-urban areas are looked after by the local constituted WUSCs.

The existing NWSC run piped water supply system is being served by water pumped from deep tube wells (more than 100 metres deep) located at different parts of the city, stored in the several overhead/elevated concrete tanks and through pipelines laid underground along the streets. The elevated tanks mostly are located within the tube well/ pump station compounds. Water reaches to the residents through private connections. The supply system was augmented at different times with addition of deep tube wells, elevated tanks and extensions of pipelines in various newly developed areas as time passed on. The system was operated by the municipality itself earlier and later it was handed over to Nepal Water Supply Corporation (NWSC) about 40 years ago. Water is being served through ½" private connections for general households while some businesses and industries have bigger size connections. Because of rapid growth of population and extension of widely scattered dwellings, the present water supply has become inadequate.

The most significant issues that NWSC has to address immediately are (a) provide sufficient water, and (b) improve quality of the supplied water, (c) increase service hours. With the current circumstances, available financial resources needs to be invested for water treatment and storage. Thereafter, improvement of service coverage, shall be prioritized later. Basic design conditions are mentioned in the table below:

Table 2: Basic Design Condition

Indicator	Present	Plan for 2027
Piped water coverage	30% for the Target Survey Area	50%
Service Population	56,900	69,322 in East 24,398 in West
Consumption	100 -120 LCD	125LCD
Water quality	Contaminated with coliform, iron, manganese	Within Nepal drinking water quality standards
Distribution service hours	Approx. 13 hours	24 hours

Source: JICA Study Team

In order to achieve the goals the following items will be implemented:

- The construction of a new pumping station / renewal of well pumping stations / water purification facilities,
- the renewal of aging water distribution pipes / water pipes.

3.1.2 Water Sources

The details of the existing water sources around the BMC have been illustrated in the table below:

Table 3: Details of existing water sources

SN	Description	Tube well unit	Depth of the well M	Size of the well Inch	Column Pipe size mm Dia	Pump installed end level m	Pump capacity HP	Pump Discharge Lpm	Pump head m	Date of construction Year	Present status	Remarks
I	Devkota Chowk PS	1	200	14x8	125	21	35	1800	50-60	1984	Running	Pump Station-PS
		2	150	12x8	100	21	35	1800	50-60	2012	Running	
		3	150	12x8	100	21	21	1100	50-60	2016	Running	
II	Tinpaini PS	1	150	12x8	150	21	25	1300	50-60	2014	Running	
		2	150	12x8	200	21	25	~1300	50-60	2019	Running	
III	Munali path PS	1	200	12x8	100	21	20	1000	50-60	1998	Running	
		2	150	12x8	150	21	20	1000	50-60	2015	Running	
		3	200	12x8	100	21	20	1000	50-60	1998	Running	
IV	Rani PS	1	150	12x8	100	21	15	700	50-60	2016	Running	
		2	150	12x8	100	21	20	1000	50-60	2013	Running	
V	BFM PS	1	150	12x8	150	21	20	1000	50-60	2014	Running	
		2	150	12x8	125	21	20	1000	50-60	2013	Running	
VII	Pichara PS	1	150	12x8	100	21	20	1000	50-60	2013	Running	
		2	150	12x8	100	21	20	1000	50-60	2013	Running	

3.1.3 Storage and Treatment
The available storage and treatment plants and the existing water reservoirs have been mentioned in the table below.

Table 4: Details of existing water reservoirs

SN	Reservoir/Location	Type	Unit	Material	Capacity	Treatment Plant and capacity	Remarks
1	Devkota Chowk PS	Elevated Surface/Ground	1	RCC	450 m ³	--Chlorine (Bleaching Powder) mixing unit	
2	Munali Path PS	Elevated Surface/Ground	1	RCC	450 m ³	--Chlorine (Bleaching Powder) mixing unit	
		Surface/Ground	--	--	--	--Iron and Manganese removal device or pressure filter(Not effective)	
3	Tinpaini PS	Elevated Surface/Ground	1	RCC	450 m ³	--Chlorine (Bleaching Powder) mixing unit	
		Surface/Ground	--	--	--	--	
4	Rani Area PS	Elevated Surface/Ground	1	RCC	450 m ³	--Chlorine (Bleaching Powder) mixing unit	
		Surface/Ground	--	--	--	--Iron and Manganese removal devices	
5	Pichhara	Elevated Surface/Ground	--	--	--	--	Water directly pumped into the distribution system
		Surface/Ground	--	--	--	--	Water directly pumped into the distribution system
6	BFM	Elevated Surface/Ground	--	--	--	--	Water directly pumped into the distribution system
		Surface/Ground	--	--	--	--	Water directly pumped into the distribution system
7	Kanchanbari	Elevated Surface / Ground	--	--	--	--	Water directly pumped into the distribution system
		Surface / Ground	--	--	--	--	Water directly pumped into the distribution system

3.1.4 Pipelines (Transmission & Distribution)

The distribution pipelines in the Biratnagar city was laid about 50 years back when the system was first built. The distribution system was extended at different times to meet the growth of the city and on demand of the local people. New pipelines were laid as new tube wells were constructed in new areas and extensions were subsequently made by laying further new distribution lines as per the demands of new settlements in different later years. Most of those pipelines have been of Ductile Iron (DI) and Galvanized Iron (GI) pipes. Only limited records of the old pipelines exist in Biratnagar NWSC Branch office. However an approximate length has been estimated with the help of old working plumbers. Total length of pipelines (service and distribution mains) is estimated to be about 100 km of different sizes ranging 12"-1.5" in diameter.

3.1.5 Public, Government and Private Taps

The details of the available public, governmental and private pipeline have been illustrated in the table below:

Table 5: Details of Existing Water Connections

SN	Size	Public	Government	Private	Total	Remarks
1	½" Dia.	25	132	11,612	11769	- Except for the public taps, all connections are metered.
2	¾" Dia.	None	12	16	28	
3	1" Dia.	None	18	24	42	- Average 60-65 new connections per month
4	1.25" Dia	None	None	None	None	- Average revenue per tap per month- NRs.250=300/-
5	1.5" Dia.	None	None	None	None	
Grand Total					11839	As of 21 March,2021

Source: NWSC, Biratnagar Branch

Note: Water is supplied either through the gravity flow from OHTs or water from the deep tube well is directly pumped into the distribution mains.

3.1.6 Water Quantity and Quality

Out of the total population of Biratnagar city, only around 30-33% of the population is supplied with water. The beneficiary population of the water supply system was estimated to be about 72,000 in year 2016). By 2019 the number of people served is expected to have gone to more than 90,000.

Table 6: Estimated Coverage of Existing Piped Water Supply

WUSC	Service Population 2019	Population 2019	Coverage
NWSC	56,900	91,202	30%
Jamungathi WUSC	3,472		
Pichara Biratnagar WUSC	4,325		
Mangadh WUSC	26,505		

Source: JICA Study Team

Total Daily Water Demand ----- 26,100m³/day (26.1 MLD)
 Total Daily Water production capacity-----9100 m³/day (9.1 MLD)
 Total Daily Water supply -----5300 m³/day (5.3 MLD)
 Non-revenue water (NRW) -----3800m³/day (3.8 MLD) makes about 42% and it gives water per capita per day--73 lpd as water coefficient.

The water supply is intermittent and the supply is made three times a day, with the total supply period/time of 10-11 hours. The supply hours are 5:00 AM -9:00 AM; 12:00 Noon -2:00 PM and 4:00 PM – 9:00 PM.

Generally, deep tube has satisfactory water quality unlike hand pumps as these extract water from shallow aquifer. The hand pump water found to have excessive iron content, and sometimes also contaminated with coliforms. In case of Biratnagar city piped supply, the water being ground water from deep wells, is good at all the sources except for some iron and manganese. However, its quality can deteriorate considerably due to poorly maintained, old and leaking distribution system pipelines. To address such contamination, extensive chlorine treatment by dosing bleaching powder is carried out. There are no other treatments except for one iron removal device at Rani PS and one pressure filter at Munali path PS, however, these were found to be ineffective and/or inadequate. There was a Jaundice outbreak in Biratnagar in 2014 during the period of April to July. There were 120 cases of infection and 12 deaths. People had suspected the city water supply as one of the prime causes. So NWSC has become quite serious about disinfecting water with chlorine before sending it for distribution.

[Source: JICA Report (REPORT ON SITUATIONAL ANALYSIS OF WATER SUPPLY IN BIRATNAGAR/ Nepal Water Supply Corporation, Biratnagar-August, 2019)]

The current water quality in the existing pump has been mentioned in the table below. Similarly, a treatment plant for the Iron and Manganese removal has been proposed and illustrated in the figure below.

Table 7: Iron and Manganese Concentration in Existing Pump Stations

Item	Unit	NDWQS	Tinpaini PS			Munali Path PS			Devkota PS			Neighbouring Facility of New No 5 HP- 3 (Ward 5)
			Well 1	Well 2	Well 3	Well 1	Well 2	Well 3	Well 1	Well 2	Well 3	
Iron	mg/l	0.3	0.3	0.17	1.53	0.52	0.81	0.36	0.49	0.29	0.37	
Manganese	mg/l	0.2	0.44	0.49	0.65	0.61	0.24	0.16	0.42	0.24	0.07	

Source: JICA Study Team

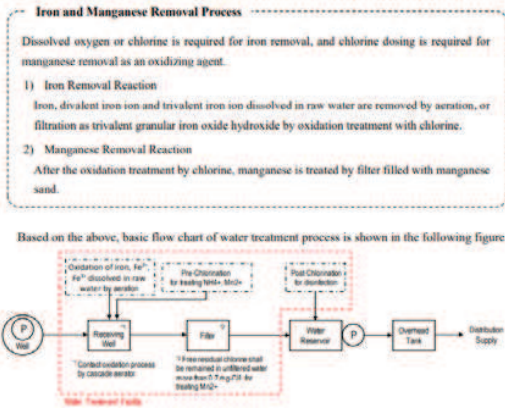


Figure 2: Proposed Water Treatment Process for Iron and Manganese Removal Process

3.1.7 Proposed New Water Supply Project

The proposed new project is supposed to focus areas mainly covered by Ward 1,2,3,4,5,6,7,8,9,10,11,12,13, and 14 of Biratnagar Metropolitan City. Major components of the proposed new project in brief:

- Construction of 1 new pump station /PS No.5,
- Rehabilitation of 3 existing Pump Stations (PS) located at Tinpainsi, Devkota and Munal Path respectively,
- Laying approximately 170 KM length of transmission and distribution pipe lines of sizes ranging from 3'' to 12'' Dia.

Table 8: New Project components in detail

SN	Project components/ Locations	New Tube well construction		Treatment Plant for removal of iron and manganese		New Reservoir/Water Tank construction (Clear water tank)		Pump house construction	Administration office	Drainage construction	Remarks
		Unit	Capacity	Unit	Capacity	Unit	Capacity				
a	Construction of 1 new pump station/PS 5	3	4,889 m ³ /day (Max.)	1	3600 ltr/min.	1	450 cu-m	1	1	1	-To serve west Biratnagar
b	Rehabilitation of 3 existing Pump stations(PS)	Note: Clear water reservoir will have an 8 hours capacity.									
	Tinpainsi PS	3	1200 ltr./min. 4,584m ³ /day (Max.)	1	3600 ltr/min.	1	1200 cu-m	1	1	1	To serve east Biratnagar
	Devkota Chowk	3	1200 ltr./min. 4,903m ³ /day (Max.)	1	3600 ltr/min.	1	1200 cu-m	1	1	1	
	Munal Path	3	1200 ltr./min. 4,406m ³ /day (Max.)	1	3600 ltr/min.	1	1200 cu-m	1	1	1	
c	Pipeline construction in the project area	Length		Size		Materials		Remarks			
		Approximately 170 KM		3'' to 12'' Diameter		DI and HDPE		DI-----Ductile Iron, HDPE-----High Density Poly Ethylene			

Table 9: Proposed Distribution pipe plan

Diameter	Renewal+ new(m)						Sub-total	Existing (m)	Total (m)
	12"	10"	8"	6"	4"	3"			
Material	DIP	DIP	HDPE	HDPE	HDPE	HDPE	DIP/GI		
Devkota PS	323	2,164	318	2,373	15,008	14,225	34,411	8,633	43,044
Tinpainsi PS	-	61	323	3,865	11,036	8,125	23,410	13,951	37,361
Munal Path PS	497	1,893	-	728	8,538	7,164	18,820	13,504	32,324
New No.5 PS	3,344	465	2,841	3,350	18,539	12,193	40,732	16,073	56,805
Total	4,164	4,583	3,482	10,316	53,121	41,707	117,373	52,161	169,534

3.1.8 Water Quality after the completion of the new proposed project

As the ground water in Biratnagar area contains excess iron and manganese, the water is proposed to be treated for iron and manganese removal in the new project. So treatment plants are proposed at all the four pump stations where works are to be done under the new project. Oxidation treatment is required for the removal of Iron and Manganese. Iron is oxidized by air, and Manganese is oxidized by chlorine. The resulting water quality for distribution after treatment will be as per Nepal Drinking Water Quality Standard.

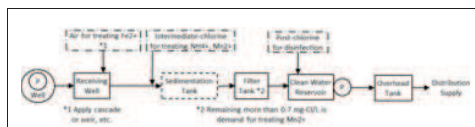


Figure 3: Block Flow

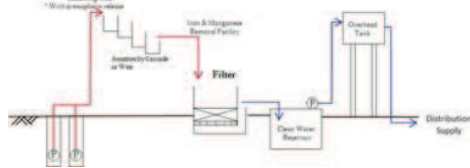


Figure 4: Water Treatment Process

3.1.9 Construction facilities

The available and new pumping station has been illustrated below with the pump station (PS) facility plan.

Table 10: PS facility plan

Area	Distribution Area	Water Supply Quantity (Daily maximum) m ³ / day	Well	Water Treatment Facility	Clean Water Reservoir (Semi-basement)	Elevated tank
East	Devkota PS	4,903	1,200L/min × 3 wells (Renewal)	3,600L/min (New)	1,200m ³ (New)	450m ³ (use the existing tank)
	Tinpainsi PS	4,584	1,200L/min × 3 wells (Renewal)	3,600L/min (New)	1,200m ³ (New)	450m ³ (use the existing tank)
	Munal Path PS	4,406	1,200L/min × 3 wells (Renewal)	3,600L/min (New)	1,200m ³ (New)	450m ³ (use the existing tank)
	Sub-total	-13,893			8-hour capacity	
West	New No.5 PS	4,889	1,200L/min × 3 wells (New)	3,600L/min (New)	450m ³ (New)	1,200m ³ (New)
	Sub-total	-4,889			8-hour capacity	
	Total	-18,782				

3.1.10 Wells and Water Treatment (Removal of Iron, Manganese) Facilities

Based on the existing wells, water intake quantity of wells is set to be 3600 l/min (1,200 Liter / min * 3) for 3 wells in each PS. The figure below shows the Borehole Structure of Deep Well.

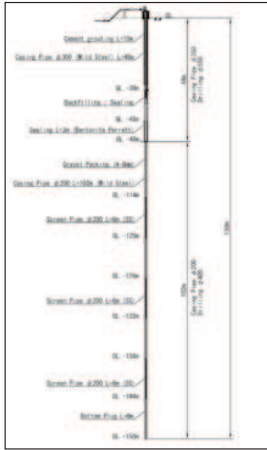


Figure 5: Borehole Structure of Deep Well

According to the water quality test, concentrations of Iron and Manganese were found to be remarkable for water treatment. Thus, such contamination will be focused for the removal of such to satisfy the Nepal Drinking Water Quality Standards. The Figure below illustrates the water treatment system and processes. Oxidation treatment is required for the removal of Iron and Manganese. Iron is oxidized by air, and Manganese is oxidized by chlorine.

Figures below show the drawings of the Water Treatment Facility.

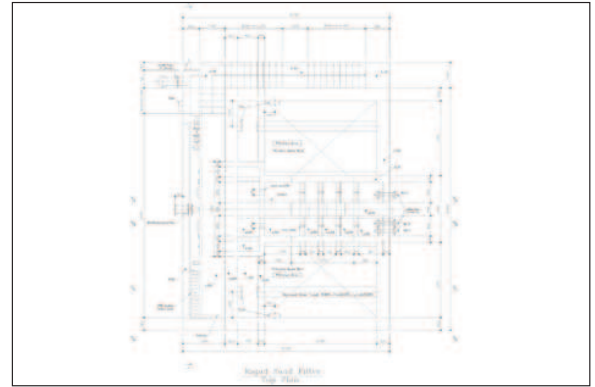


Figure 6: Top Plan of Water Treatment Facility

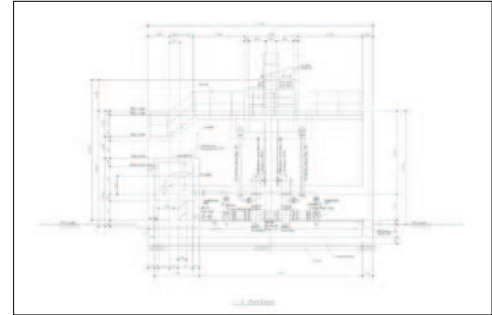


Figure 7: Section of Water Treatment Facility

3.1.11 Clean Water Reservoirs and Overhead Tanks

The storage capacity will be secured by both types of reservoirs in total. The 3 existing PSs have little space for additional overhead tanks (OHTs). Therefore, storage capacity will be

secured by large size of clean water reservoirs which will be in semi-basement type. The capacity of a clean water reservoir is 1,200 cubic meters for each pumping station. Similarly, for the new pumping station, both overhead tanks and treated water reservoirs will be constructed. The capacity of the overhead tanks is 1,200 cubic meters and the capacity of the clean water reservoir is 450 cubic meters. The main aim is to secure an 8-hour capacity of daily maximum water volume. The figure below illustrates the drawings of clean water reservoirs in the existing pumping stations.

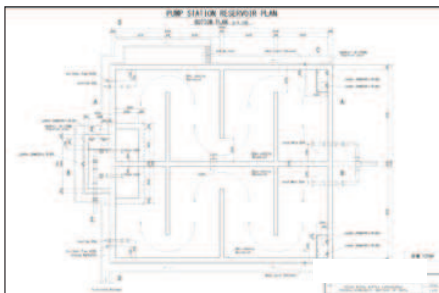


Figure 8: Plan of Clean Water Reservoir in existing PSs (1,200 m³)

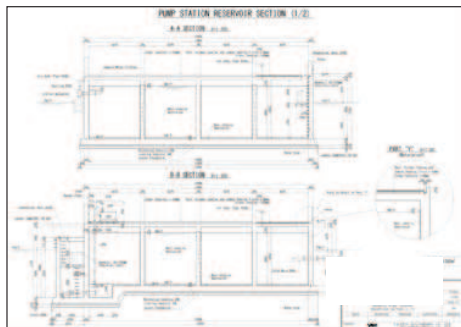


Figure 9: Section of Clean Water Reservoir in existing PSs (1,200 m³)

Figure below shows the drawings of the Clean Water Reservoir for new PS.

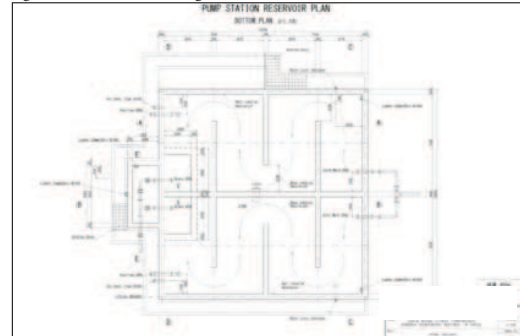


Figure 10: Plan of Clean Water Reservoir in new PS (450 m³)

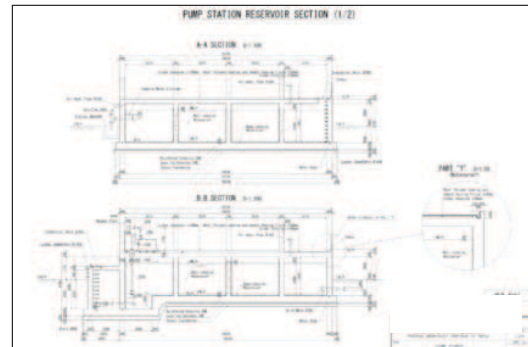


Figure 11: Section of Clean Water Reservoir in new PS (450 m³)

Similarly, the figure below shows the detailed layout of the overhead tank in the new pumping station.

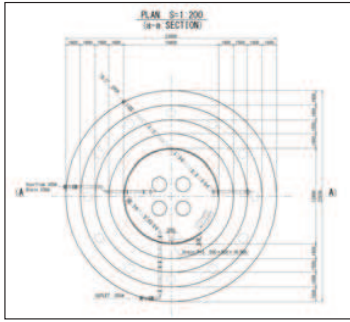


Figure 12: Plan of Overhead Tank in new PS.

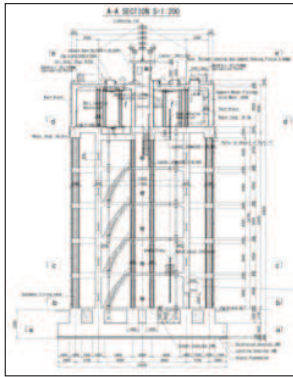


Figure 13: Section of Overhead Tank in new PS

3.1.12 Administration Building

An administration building for the new pumping station should be built for the operation and maintenance of the project. The administration building consists of an office room, storage units and toilets, etc. A plan of administration building is shown in Figure below. Similarly,

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septic tank for the toilets is required besides the administration building. And for the exiting pumping stations , existing administration building including septic tank will be utilized (not included) in the Project.

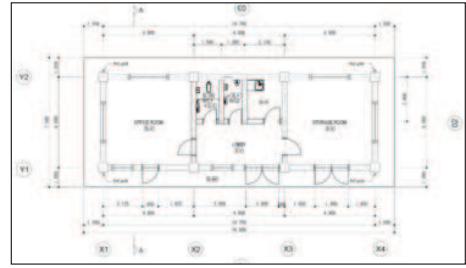


Figure 14: Plan of Administration Building

3.1.13 Operation Room

An operation room for the new installed facility (3 PSs to be rehabilitated and 1 PS to be newly constructed) such as chemical facility, treated water pumps to the overhead tanks, electrical facility, etc. will be built on the ground water tank to minimize required space of pumping stations and to avoid flood disaster. The detailed plan of the operation room is shown in the Figure below.

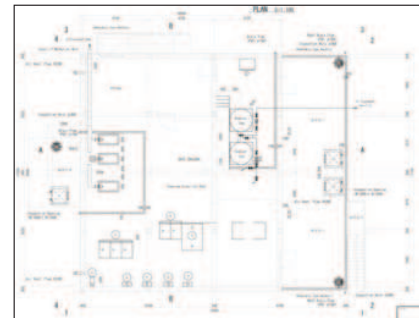


Figure 15: Plan of Operation Room

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3.1.14 Distribution Networks

The existing pipes need to be replaced since there are a lot of old aged pipes which results in a lot of leakage in volume and number of locations. However, the priority of the existing pipes to be replaced has been based on the area covered by ADB road project and then by the area necessary for double pipelines on both sides of road. Similarly, other important pipelines which may also have leakages are also to be mended. The details of the distribution pipe plan are shown in the Table and in the Figure below.

Table 11: Distribution Pipe Plan

Diameter	Renewal + New(m)						Sub-total	Existing (m)	Total (m)
	12"	10"	8"	6"	4"	3"			
Material	DIP	DIP	HDPE	HDPE	HDPE	HDPE		DIP/GI	
Devkota PS	323	2,164	318	2,373	15,008	14,225	34,411	8,633	43,044
Tinpaini PS	-	61	323	3,865	11,036	8,125	23,410	13,951	37,361
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New No.5 PS	3,344	465	2,841	3,350	18,539	12,193	40,732	16,073	56,805
Total	4,164	4,583	3,482	10,316	53,121	41,707	117,373	52,161	169,534

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Figure 16: Plan for Route of Pipelines to be laid (Main pipe)

3.2 Construction Management of the study

3.2.1 Temporary yard

A temporary yard is needed for the construction purpose. Biratnagar Metropolitan City (BMC) has agreed to provide the yard during construction with an area of 3,500 square meters approximate.

3.2.2 Quarry sites

The Project will purchase the crushed stones and sands from suppliers. Therefore, the Project does not quarry directly.

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3.2.3 Excavation and Disposal site

Disposal site for surplus soil has also been allocated by the BMC which will excavate soils with an estimated area of approx. 30,000m². The necessary land area is 10,000m² and with an assumption of the height of the soil pile up to 3m. The estimated location for the disposal site for surplus soil is shown in the figure below.



Figure 17: Candidate of disposal site for surplus soil

3.2.4 Temporary office

A temporary office will be installed with an area of approx. 200 square meters the location of which will be determined later by the Contractor.

3.2.5 Material storage

Storage unit for the construction is adjusted not to exceed the capacity of the temporary yard where the materials will be covered by sheets, not to get wet.

3.3 Project Management for Construction

3.3.1 Material required for the project

Major construction materials required during and for the construction of the Project have been mentioned in the table below.

Table 12: Major materials required for the Project

Construction works			
Items required			
Item number	Civil Engineering facilities	Distribution pipelines	Machineries etc.
1	Crushed stones/aggregates	DI pipes	Pumps for deep wells
2	Cement	HDPE pipes	Sand to remove Manganese
3	Sand	Valve	Chlorine tank
4	Rebar/Steel Reinforcement		

3.3.2 Human Resources

Necessary human resources required for the project has been mentioned in the table below. Accidents which include even the traffic accidents are anticipated during the construction stage and the operating stage as well. To prevent the accidents, personal protective equipment such as gloves and helmets as well as safety training for construction works will be managed. Similarly, also during the operation phases accidents by operation of machineries are probable, hence safety training for such are also encouraged.

Table 13: Human Resources Required for the Project

Construction works			
SN	Civil Engineering facilities	Distribution pipelines	Machineries
1	Foreman	Plumbers	Electricians
2	Skilled labour/Drillers		Mechanists
3	Common labour		
4	Rebar worker		

3.3.3 Construction and Operation Stages

The major activities carried out during the construction and the operation phase has been illustrated below:

Construction phase:

- i. Procurement of pipes and fittings and other necessary construction materials like cement, stone aggregates, sand, steel bars etc. as per need at appropriate times
- ii. Digging trenches(2' wide-3' deep -about 170 km long) at different places for laying pipes and other project works
- iii. Laying, jointing of pipes and backfilling with necessary compaction
- iv. Reinstatement of roads damaged by pipe laying work or any project activities
- v. Construction of new deep tube wells and rehabilitations of existing old tube wells
- vi. Construction of surface reservoirs, treatment plants, administrative buildings, boundary wall, Over-head tank etc. at different sites as planned/designed in the project.

Operation Phase:

- i. Pumping water from the deep tube wells
- ii. Treatment of the water pumped and storage of the treated water in the reservoirs
- iii. Distribution of the treated water to the city population as per the set time table.
- iv. Other administrative activities like responding to the grievances of the consumers, giving new connections, monitoring the quality of water produced after treatment, collection of revenues, operation and maintenance of the pumps, other mechanical equipments, regular monitoring of tap water quality at different points in the city etc.

3.4 Land Requirement for Project Components

The rehabilitation of pumping stations will be utilizing the existing lands. For the instalment of the new pumping station, the land to be used is to be rented by the Government. The BMC will implement the procedures of land use, based on the Land Acquisition, Resettlement and Rehabilitation Policy 2015 AD in Nepal.

3.4.1 O & M Equipment and Tools

Equipment is required for the measurement of the water quality. NWSC will measure water quality in the administration office. Equipment list for the measurement of water quality parameters are mentioned below. Similarly, mini excavators will be required for the construction of service pipes and other construction facilities.

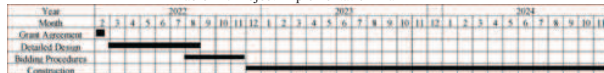
Some equipment's to measure the water quality has been listed below:

- pH meter
- Turbidity meter
- Residual chlorine meter
- Iron / Manganese meter
- E coli meter

3.4.2 Project Implementation Plan

The project will begin its work after the completion of the grant agreement which is followed by the detailed design study for 6 months. The project facilities are expected to be completed by the end of 2024. A general project implementation plan has been shown in the table below.

Table 14: Project Implementation Plan



Source: General Project Outlines/ Yachiyo Engineering Co., Ltd. (YEC)-Japan

The salient feature of the project has been listed in the table below:

Table 15: Salient Features of the Project

SN	Items	Description
1	Name of Project	Improvement of Water Supply in Biratnagar
2	Type	
3	Study Level	Initial Environmental Examination
4	Location Area	
	Province	Province no 1
	District	Biratnagar
	Municipality	Biratnagar Metropolitan City
	Wards	Partial Areas of Ward Nos. 1,2,3,4,5,6,7,8,9,10,11,12,13,14
5	Available Facilities	
	Road	Dharan road and Municipality road
	Water Supply System	Available
	Electricity	Available
	Communication	Available

	Health Services	Available
	Banking Facilities	Available
6	Population status of the beneficiary of the subproject	
	Present Population (2019): Survey Year	56,900 (served population)
	Design Year Population (2027)	93,720 (served population)
7	Water Demand (LCD)	
	Design Year (2027)	125 LCD
8	Proposed Water Source Characteristics	
	Source Name	Ground water
	Source Location	Devkota, Tinpaini, Munal Path, and New No. 5 (Ramganj)
	Safe Yield (lpm)	1,700 Litter / min
9	Structures	
	OHTs	RC, 1,200 m ³ (New No.5), H=approx.. 30 m
	Pumps	1,200 Litter / min, centrifugal pump
	Deep Tube wells	Dia. 350mm, Depth: 150m
	Electricity line	approx. 100 m * 4 PS (service electrical wire)
	Transformer	11kV to 400V, and 400V to 200V, in each PS
	Generator	-
	Valve Chambers	-
	Office Building	1 story, 7m * 12m, constructed in new No. 5 PS, RC frame brick wall
	Guard house	-
	Generator House	-
	Household Connection	Constructed by NWSC's another project
	Fire Hydrants	
	Distribution Network (kilometre)	Approx. 170 kilometres
10	Total Cost of the Project (NRs.)	
	Water Supply Component (NRs.)	approx. 2 billion 3 thousand million
	Sanitation Component (NRs.)	0

3.5 Data Requirement and Collection Methods

3.5.1 Physical Environment

Database pertaining to environmental conditions (listed below) of the project area for the Initial Environmental Examination was specific and quantitative, thus both primary and secondary data/information has been used. These data were reviewed and assembled to evaluate the baseline environmental conditions of the project.

- Geology and soil;
- Land Use;
- Climate and meteorology;
- Hydrology;
- Air quality;
- Water quality;
- Solid waste management;
- Noise Level

3.5.2 Biological Environment

Walkover survey, group discussion and interviews were conducted to collect baseline information on biological environment of the project area. Since the proposed project site does not have forest land, forest sampling was not conducted. The walkover survey in and around the project area was done to observe vegetation available and habitat of different species. The wildlife and birds in the area were identified from direct observation, evidences encountered, and interviews with local people. Secondary information were collected from the review of literature.

3.5.3 Socio-Economic Environment

Field Survey: The consultant team including team leader, water supply engineer, forestry expert and socio-economist accompanying research assistants and enumerators visited the site with the purpose of collecting data/information through formal and informal sources and observation the site both participatory and non-participatory approach. The field visit has given an ample opportunity in order to get oriented with the current scenario of municipality and conceptualize the project condition as well. The consultation with the beneficiaries and municipal authorities has guided a clear outlook about the project and an idea for shaping the IEE through a prominent social screening. Enumerators were mobilized to collect the data from the households in new PS site.

Delineation of Field Survey Area: For socio-economic survey purposes, the consultant team has first delineated the authentic surveying area from where the specific number of household samples, key informants and so on could be exactly selected and obtained the reliable primary data/information. The intended objective of the project i.e. rehabilitation, new installation, replacing the old pipes and the targeted area are primarily considered while delineating the survey area. The project is not going to facilitate its services to the entire wards/areas of the BMC.

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Rehabilitation: The ward chairperson of wards 1 (Tinpaini PS and Munal Path PS) and ward 9 (Devkota Chawk PS) were selected as key informants interview and few other persons for project related general information. The social screening was done in the support of ward chairperson of those wards.

New installation: Similarly, the ward chairperson of ward 5 (Kulharuwa) was covered for social screening with few others key informants for local information like activities around the area, land value etc. At the same time household samples from the 500 meters of periphery were collected as formal household survey.

Replacement of old pipes: Likewise, chairpersons of 2 wards for social screening and the shopkeeper and other concerned people were covered for consultation either sides of rode of 165 KM and in major intersections.

Sampling Frame: For the collection of socio-economic information, the major focus was given to the new PS installing site as the new site is likely to have some crucial issues during and after the construction. Obtaining the household level information through the household survey was the major crux besides public consultation and social screening to come across the actual situation of the area. In other words, the individual house could give a genuine picture which would help to verify that information collected through the public consultation. However, the information in order to be oriented with the current situation and the peoples' perception on proposed project itself, mainly the KII and walkover survey is covered i.e. in wards 1-14 of the BMC.

Formal Household Survey: The population of ward 5 for the current period (2021) was estimated to be approximately 15,000 residing in total 3,500 households⁹, and 1/3 household and population respectively 1,050 and 4,500 residing within the area of 500 meter periphery from the centre of the PS site. Hence the team had considered 1,050/4,500 to be the most affecting households/population and a base of chunk for sampling.

Total 216 household samples were captured at 95% confidence level and 5.95% margin of error through the systematic random sampling methods prominently from the ward no 5 of BMC. This area is proposed for the new PS installation site. The captured samples stand at 26% which is quite relevant. The international standard of sampling is 10% of the total is assumed to be relevant to mirror the actual situation of the entire chunk. The following formula was employed to obtain the prominent numbers of samples for the formal household survey;

$$n = \frac{NZ^2 \cdot p \cdot (1-p)}{Nd^2 + Z^2 \cdot p \cdot (1-p)}$$

Where,

n = sample size

N = total number of households (i.e. 1050)

Z = confidence level at 95%

p = estimated population proportion (50%)

d = margin of error (5.95%)

Key Informants Interview /Group Discussion: Formally and informally several persons were also consulted keeping the PS site at centre of mind like 3 rehabilitating PS sites i.e. Tinpaini

⁹ The CBS Census-2011 had enumerated 3,374 households and 14,880 populations in ward no. 5 of BMC.

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PS, Munal Path PS and Devkota PS along with pipe replacing area and construction material storage yard & spoil dumping site. At the same time, the "Social Screening" sheet was also used to measure the degree of impact as well as assessing the information in order to address resettlement plan as per ESMP guideline. Two extensive group discussions were organized in new PS site.

Observation: Both participatory and non-participatory observation approach was also applied to be oriented the situation as well as to authenticate the information formally received on the ground.

Survey Tools: Semi structured household questionnaire, checklist for key informant interview, involuntary resettlement impact screening sheet, and IPS & vulnerable group's impact screening sheet were used to collect and validate the socio-economic situation. The survey tools are depicted in Annex C.

Secondary Information: The municipal profile uploaded in <https://biratnagar.mun.gov.np/>, Semi-Annual Social Safeguard Monitoring Report, published on January, 2020 by Regional Urban Development Project (RUDP), Project Implementation Unit, Biratnagar, Nepal, Population Monograph V01, published on 2014 by CBS, IEE report of Additional Drainage, Sewerage, and Roads Improvement Works published on February, 2017 by Regional Urban Environmental Improvement Project (RUDP) etc. were comprehensively reviewed and cited in the report wherever were appropriate.

Data Processing, Analysis and Reporting

- **Data Entry:** All completed household questionnaires after the completion of data collection were entered by the experienced and well familiarized data entry operator into the SPSS under close supervision of the socio-economic expert. A support from a statistician was also accompanied for creating an appropriate database format. A half day orientation was organized to data entry operators to objectively understand the format and codes used in the database prior to start the data entry process.
- **Data Cleaning:** After completion of the data entry, a through data cleaning process was followed. The data cleaning was done by the consultant himself accompanied by the data entry operators and statistician. All errors were extensively removed in this process. Irrelevant data/figures are omitted.
- **Data Processing:** The Consultant had developed dummy tables according to the indicators. Such dummy tables were formatted in such a way that almost all indicators that were used in the baseline survey could be properly evaluated. Following the dummy tables, all the information was processed. The household data/ information retrieved from the SPSS were further statistically analysed in EXCEL software. Numeric values and the percentage of the respective values were demonstrated wherever was necessary while interpreting the data/ information.

3.5.4 Reporting on Socio-economic part

The Consultant has prepared the given socioeconomic report with the support of data/information collected through primary source and at the same time also tried to cite most relevant information collected through the secondary source.

3.5.5 Involuntary Resettlement Impact Screening & Categorization

During the course of field survey in order to collect the most genuine data/information to extensively support the ongoing IEE process, the 'Involuntary Resettlement Impact Screening & Categorization' was also screened to find out whether, the project needs to address those aspect or not. If needs then what sort of resettlement plan is obligatory? A comprehensive checklist in accordance to the ESMP guideline was used for this purpose. The used checklist is presented in Annex C Survey tools.

3.5.6 IPS & Vulnerable Groups Impact Screening & Categorization

During the course of field visit, the screening of vulnerable group's impact and categorization of the project was also addressed in accordance with the standard template since the indigenous peoples are diligently bonded to the natural resources like land, forests, water, wildlife, and so on. Thus, special considerations apply if the project emphatically affects such bond. Therefore, the special consideration for indigenous peoples was prearranged. In the backdrop of this, while preparing the social action plan, the consideration that kept in mind that the project properly focuses to pay particular attention to: i) the customary rights of the Indigenous Peoples, both individual and collective, pertaining to lands or territories that they traditionally owned, or customarily used or occupied, and where access to natural resources is vital to the sustainability of their cultures and livelihoods; ii) the need to protect such lands and resources against illegal intrusion or encroachment; iii) the cultural and spiritual values that the Indigenous Peoples attribute to such lands and resources; and iv) Indigenous Peoples' natural resources management practices and the long-term sustainability of such practices.

According to the United Nations the term "Cultural Property" includes sites having archeological (prehistoric), paleontological, historical, religious, and unique natural values. Cultural property, therefore, encompasses both remains left by previous human inhabitants (for example, middens, shrines, and battlegrounds) and unique natural environmental features such as canyons and waterfalls. The Cultural Property Policy of World Bank seeks to avoid harm to significant, non-replicable cultural property, and detailed how background information on all aspects with regard to the management of cultural property.

Important aspects of the policy are:

- To assist in preservation and to seek to avoid elimination of cultural properties.
- Avoid damage to non-replicable cultural property.
- Protection and enhancement of cultural properties
- Relocation of sites and structures that can be preserved studied and restored on alternate sites.
- Scientific study, selective salvage, and preservation. Include the training and strengthening of institutions entrusted with safeguarding a nation's cultural patrimony.

4 POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

All the relevant policies, acts and regulations along with guidelines have been reviewed during the preparation of the project document.

4.1 THE CONSTITUTION OF NEPAL (2072)

The Constitution of Nepal 2015 was promulgated by the Constitutional Assembly in September 2015, when the Federal Democratic Republic in Nepal was established. This constitution has 35 parts, 308 articles and 9 schedules. It defines that every citizen has the right to live in a healthy and clean environment (Clause 1 of Article 30). If there are any damages caused due to environmental pollution or degradation, then the victim shall have the right to be compensated according to law. (Clause 2 of Article 30). The constitution further mentions on giving priority to the protection of environment whilst maintaining a balance between the development works and the environment. Furthermore, the Constitution of the Government of Nepal has passed series of environmental laws, policies and regulations and standards which are elaborated below.

4.2 ENVIRONMENTAL PROTECTION RULE 2077 (2020)

The EPR 2020 stipulates the need of an IEE for water supply that is to be disseminated to a population of 50,000 to 2 lakh or if a new source is to be constructed for the same.

4.3 NATIONAL POLICY ON RURAL DRINKING WATER SUPPLY AND SANITATION, 2004

The policy provides guidance on the provision of safe, accessible and adequate water and sanitation facilities in rural areas including the use of stakeholders groups and using community led participatory approaches. The policy provides for an emphasis on the regular monitoring and evaluation of micro-organisms, chemicals and physical elements for maintaining the quality of water.

4.4 NATIONAL URBAN POLICY (2007) POLICY

The policy highlights the need and importance of balance in the management of sanitation and environment services in urban areas. It emphasises on the development and preparation of planning and managing integrated local development activities addressing the need of nation's urban water supply and sanitation challenge. It further emphasises on the importance of environment conservation while carrying out urban development works and natural resource; thus, supporting the environmental protection in development projects.

4.5 NATIONAL URBAN WATER SUPPLY AND SANITATION SECTOR POLICY, 2009

The policy is formulated to ensure accessible, adequate and safe water supply and sanitation to all urban populations to ensure an improved quality life. It has been further mainstreamed to ensure and enhance the institutional and operational capacity at local level with the active participation of the women and vulnerable groups in decision making processes at all practical levels in water supply and sanitation services. The policy aims to ensure that the roles and

responsibilities of central and local government bodies, external development partners, private sector including NGOs and user groups are clearly defined in scheme implementation and regulation and performance management in accordance with national decentralization policy.

4.6 THE FIFTEENTH PLAN (FISCAL YEAR 2076/77-2080/81)

The Fifteen Plan has envisioned to shape Nepal with quality and modern infrastructure ensuring environmental cleanliness with the proper provisions of basic water supply & sanitation services, faecal sludge management and waste water management. It reiterates the need of considering the climate risks and disaster risks in water supply and sanitation interventions.

4.7 GOVERNMENT OF NEPAL ENVIRONMENTAL LEGAL FRAMEWORK

Environment Protection Act (EPA), 2054 B.S. (1997 A.D), requires a proponent to undertake Brief Environmental Study, or IEE or EIA of the proposed subproject and have the report approved by the concerned sector agency or ministry of environment, respectively, prior to implementation. Schedule 2 mentioned about the projects that require IEE and EIA.

Other environmental acts, rules, plans, policies, guidelines that are relevant to the sub-project are presented below:

Table 16: Other Relevant Environmental Act, Rules, Plan, Policies & Guidelines of Nepal

Act/ Rule Policy/ Law/Guideline	Year	Relevant Provisions	Remarks
Environment Protection Act	2076 BS 2019 AD	The act emphasizes on new aspects like provisions of Brief Environmental Study, IEE and EIA under the jurisdiction of local authority, provincial government, and central government. Need of Strategic Environmental Assessment for policies/plans/programs, and considerations of climate change for projects are among the newly enforced aspects of this act.	
Environment Protection Rules	2077 BS 2020 AD	Environment Protection Rules (EPR), 2020 has defined thresholds for environmental assessment under 3 categories; Brief Environmental Study, IEE and EIA. It has defined the roles of the provincial government and the local government as well in the process of environmental assessment of development projects.	
Water Resources Act	2049 B.S. (1992 A.D.)	A comprehensive law on the development, use and conservation of water resources in Nepal, it aims to minimize damage to water bodies by requiring IEE/ EIA & preparation of an IEE/ EIA report before granting license to use water resources for any purpose. Proponents shall make sure that the beneficial use of water resources does not cause damage to other water users/users (Article 4). Article 16 requires proponents to apply for any necessary land acquisition accordingly. Article 18 requires the compliance to quality standards in making use of water resources. Article 19 prohibits the pollution of water resources. Under the Act are two regulations for drinking water purposes namely; Water Resources Regulation, 1993, setting out the implementation procedures for the Act; and the Drinking Water Regulation, 1998, which specifies compliance with the drinking water quality standards and control of water pollution (or sanitation) as it affects drinking water.	The EMP provides measures to comply with the environmental quality standards and national drinking water quality standards

Forest Act	2076 B.S.	It stipulates that the GoN can develop a land use plan of a forest in order to maintain the balance of environment and development. It also has the provision that the government can develop a specific forest conservation plan for a particular section of a national forest. It also states that the forest area can be used with approval for national priority projects.	Based on preliminary assessment and site visits, no forest trees covered by the Forest Act will be cut. As per IEE study, tree cutting is not required. EMP stipulates no illegal quarrying of natural aggregate materials.
Land Acquisition, Resettlement and Rehabilitation Policy	2015 A.D.	The policy is based on the principles that the assessment of land requirements needs to be carried out based on the alternatives having minimum impacts of land loss. It indicates the need to conduct social impacts assessment to identify impacts on affected people, community and vulnerable group. In case of Land acquisition and ownership transfer, land can be acquired also through voluntary donation which will be accepted only if the land provider has agreed without any pressure, and in presence of local authorities to donate land for the purpose.	EMP provides measures to mitigate impacts.
National Environmental Policy and Action Plan	2049 B.S. (1993 A.D.)	The most relevant objectives to the project is sustainable management of water resources; mitigate adverse environmental impacts of development projects and to integrate environment and development with adequate legislation and economic incentives	Provides basis for Local Government to monitor the environmental performance of the subprojects. EMP provides the
Local Government Operations Act	2017	The Local Government Operation Act, 2017 empowers the local authority for the conservation of local natural resources and implementation of environmental conservation activities along with prime responsibility of conducting development projects which includes water supply, sanitation and awareness activities.	

responsibilities of LGs in EMP implementation.			
Child Prohibition and Regulation Act	2056 B.S. (2001 A.D.)	The section 3 of the act prohibits a child from engaging in work, sub clause 1 of the clause 3 states "Nobody shall engage in work a child who has not completed fourteen years of age as a labor and sub clause 2 states "Nobody shall engage a child in a risk full occupation or work set forth in the Schedule". The section 4 states "Child not to be engaged in work against his will by temptation or fear or pressure or by any other means".	
Implementation Directives for the National Drinking Water Quality Standards	2062 B.S. (2005 A.D.)	It sets out the water sampling, testing, analysis and monitoring and surveillance procedures to certify that the quality of supplied drinking water conforms to the National drinking Water Quality Standards.	Monitoring of the quality of supplied water is prescribed in the EMP following the NDWQS Directives.
Updated 15-Yr Development Plan for Small Towns Water Supply & Sanitation Sector	2067 B.S. (2009 A.D.)	The Plan defines the population threshold of "small towns" to be in the range of 5,000 to 40,000. Reference to Schedules 1 and 2 of the EPR, as amended in 2007, places water supply projects in small towns under Schedule 1 or within the threshold of water supply projects requiring only an IEE. The Plan emphasizes monitoring and evaluation as an important component of a project to determine the overall impact of a project.	EMP prescribes environmental effects and performance monitoring.
Solid Waste Management Act	2068 B.S. (2011 A.D.)	Article 4 provides that the management of hazardous, medical, chemical or industrial waste rests upon the generators of such wastes. Management should be as prescribed in the Act. Article 5 provides that individuals and entities have the duty to reduce the amount of solid waste generated while carrying out work or business.	EMP prescribes eco-friendly management of solid and hazardous wastes.

4.8 RELEVANT ENVIRONMENTAL QUALITY STANDARDS

Some of the relevant Environmental Quality Standards have been mentioned in the table below. However, for surface and ground water quality monitoring, the National Drinking Water Quality Standard shall be applied since these resources are used for drinking.

Table 17: Environment Quality Standards

Particular	National Standard	International Standard
Ambient air quality	National Ambient Air Quality Standards, for Nepal, 2003	WHO Air Quality Guidelines, Global Update, 2005
Emission standard for diesel generator discharge to ambient Air	Emission standard for diesel generator	EPR-15, 1997
Noise	National Noise Standard Guidelines, 2012	WHO Guideline Values on Noise Level
Drinking water quality	National Drinking Water Quality Standards, 2006	WHO Guidelines for Drinking-water Quality, Fourth Edition, 2011

5 PROJECT DESCRIPTION

5.1 PROJECT BACKGROUND

5.1.1 Project area

The project area include Biratnagar Municipality City of Province 1 wards number 1,2,3,4,5,6,7,8,9,10,11,12,13 and 14.

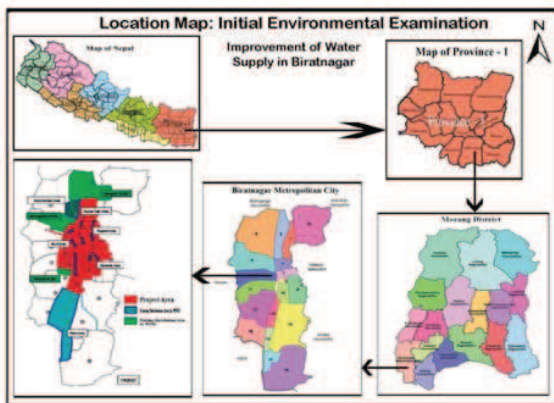


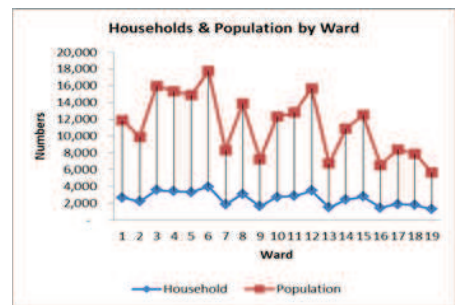
Figure 18: Project Location Map

5.1.2 Demographic Features of the Project Area

The population of BMC was reported to be 1,66,674 by 2001 census, which grew to 2,01,125 in 2011 census. The population of men comprised of 53% (i.e. 87,664) and women population was 47% (i.e. 79,010) in 2001 census, whereas, the sex proportion changed in 2011 census with percentage of men decreased to 51% (108,827), whereas women population grew to 49% (105,836). The increased population between 2001 and 2011 seemed at 34,451, which refers the annual growth rate (straight line) at 2.07%.

According to BMC's official website, the total population is 2,14,663 (male 1,08,827 and female 1,05,863) and households 47,798 for the year (2020). Moreover, the Regional Urban Environmental Improvement Project (RUDP) officials had reported the total population of census 2011 is 2,71,354 increased total 1,04,680 population. If the given figure is considered then the annual straight-line population growth rate stands at 6%. However, they had viewed that they had considered the base population is 236,895 for the year 2015 and the annual population growth is 3.37% while preparing the report for Initial Environmental Examination

(IEE) on Additional Drainage, Sewerage, and Roads Improvement Works for Biratnagar Sub-metropolitan City. If the growth rate (3.37%) of RUDP is considered then the population for year 2021 would be 289,017.



The IEE survey enumerated the population of 1,192 in 216 sampled households within the delineated project area. The ratio of the male to female is 51.01% and 48.99%.

Table 18: Household/ population of the project area

S.N	Name of Settlement	# of Household	# of Population
1	Damabandi	49	258
2	Damabandi, Karkhana tole	17	104
3	Damabandi, Kulharba	56	310
4	Damabandi, Prithivi chowk	4	27
5	Damabandi, Pulchowk	14	78
6	Damabandi, Shankarbari	63	349
7	Shankarbari, Keshaliya	13	66
Total		216	1,192

Source: Household Survey, April, 2021

5.1.3 Historical and Archaeological sites

No definable historical and archaeological sites are evident within the project area. Though it is not closer to the project area but in entire BMC area Temples, mosques, and churches are existed. Kali mandir, Hanuman Mandir, Radhakrishna mandir etc. of Hindus and Bilal Masjid, Kari Sahab Mosque, Jama Masjid etc. of Muslim are famous cultural sites.

5.1.4 Access to the project area

There are different ways to reach the project area from the capital (by bus, by car or by air). By air the flight time between Biratnagar (BIR) and Kathmandu (KTM) is around 40 min and covers a distance of around 232 km. When you drive by car or by bus, we will need to travel

approximately 379 km via the BP Highway and East West highway which will take an approximately 9 hours.

5.1.5 Study Team

The IEE study carried out with the involvement of the multidisciplinary team of environmental experts. Following experts were engaged for the IEE study of proposed project.

Table 19: Study Team

S.No	Name	Position / Responsibility
1	Ajay Bhakta Mathema	Team Leader / Environment Expert
2	Gyanesh Bajracharya	Water Supply Engineer
3	Jiwan Paudel	Forestry Expert
4	Kiran Raj Mishra	Socio- Economic Expert
5	Shubhuti Kiran Ghimire	Environment Engineer

5.1.6 Field Study

The major part of the field work was started with a reconnaissance field work in March 2021 and continued through September. Specific data were obtained by going to the field, district headquarters whenever the need was there.

Table 20: Major Field periods of the different themes covered by the IEE

Field Study Date (2021)	Themes Studied
March 21 st , 2021	Reconnaissance field visit
April (20 th – 22 nd)	Project Site Monitoring
September (3 rd – 5 th)	Public Hearing and Consultations

5.2 Existing Physical Environment

5.2.1 Topography

Biratnagar Metropolitan City (BMC) serves as the administrative capital of Province no.1. It is located about 399 km (248 mi) east from the Kathmandu. BMC covers an area of 58.48 sq. km and is located at 26°28' N and 86°19' E.

The municipality is mainly located in the Tarai region, thus, it has gentle terrain, which is gradually sloping from north to south. The range of elevation observed in the municipality is between 62masl in the southern parts and 76m in the northern parts. BMC lies close to the Koshi River, which is about 30km in the west, while two small rivers bordering the town Singiyahi that flows from the east and Kesaliya from the west.

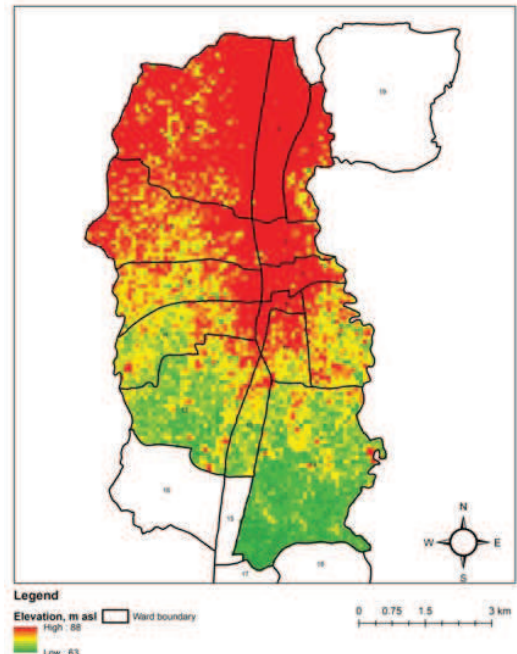


Figure 19: Terrain of the project ward (source: SRTM)

5.2.2 Land use

The Biratnagar Metropolitan covers an area of 58.48 km² where most of the land is covered by agricultural land and settlements. The project area especially the area allotted for pump number 5 lies in the flat topography categorized by plain lands for cultivation. The current area allotted for the spoil disposal site is a barren land.

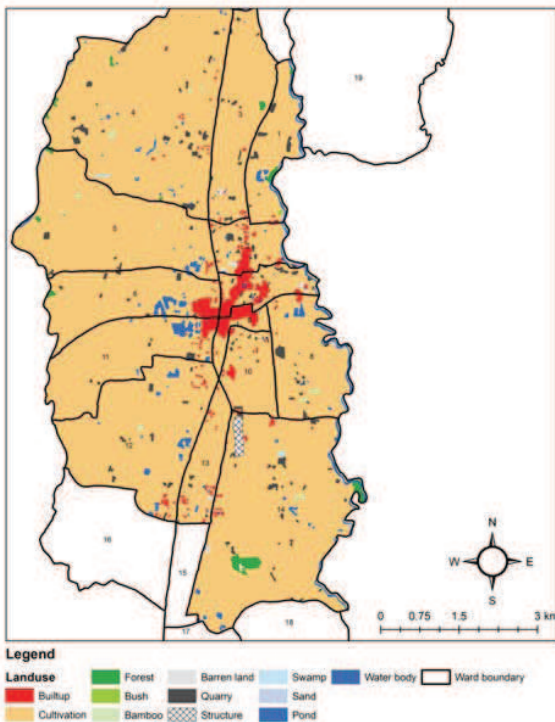


Figure 20: Land use of the project wards (Source: Survey Department, Google Earth 2020)

5.2.3 Climate

The climate of the project area is sub-tropical. The mean annual temperature ranging from about 25°C to 30°C and the maximum and minimum temperature is 42°C and 0°C respectively.

The annual precipitation ranges from about 1595 – 2279 mm. More than 80% of the total annual rainfall occurs in four summer months – June to Sept.

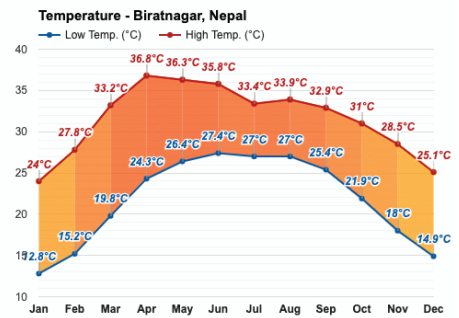


Figure 21: Average monthly temperature (source: DHM)

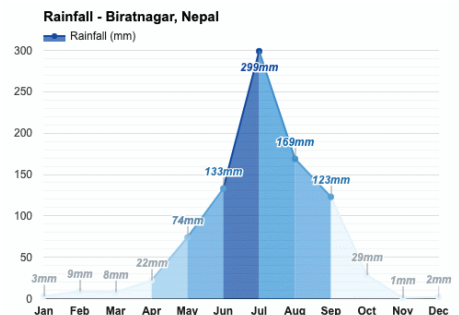


Figure 22: Average monthly rainfall of the project area

5.2.4 Hydrology

The subproject area is drained by Singiyahi and Kesaliya River. These rivers are flooded during summer monsoon and river bank cutting, particularly at the meander bend during flooding, is common. During dry winter period, the water in these rivers is very low. There is absolute lack

Table 21: Physical and Chemical water quality parameters of Singiyahi River

Parameters	Units	WHO GV	NDWQS	Upstream	Mid-Point	Downstream	Desired Water Quality	APHA, Standard Methods and equipment used
pH	-	8.1-8.5*	6.5-8.5*	7.8	7.8	7.8	6.5 -8.5	pH Meter
Turbidity	NTU	-	5	5.8	17.2	11.1	5 (10)	Electronic Turbidity Meter
Electric Conductivity	µS/cm	-	1500	332.0	207.0	231.0	1500	Conductivity Meter
Temperature	°C	-	-	26.7	26.5	26.5	25 -30	Mercury Thermometer
TDS	mg/l	-	1000	165.0	102.0	116.0	-	Gravimetric Method
DO	mg/l	-	-	4.0	4.1	4.1	-	Winkler Method
Total Hardness	mg/l	500	500	492.1	502.6	508.1	-	EDTA Method
Alkalinity	mg/l	500	-	4.2	4.2	4.4	-	Titration Method
Phenolphthalein Alkalinity	mg/l	-	-	0	0	0	-	Titration Method
Ammonia	mg/l	1.5	1.5	0.1	0.1	0.1	1.5	Phonate Method
Nitrate	mg/l	50	50	2.9	2.8	2.8	-	Phenol Disulphonic Method
Phosphate	mg/l	NA	NA	0.4	0.5	0.5	2.0	Spectrophotometric Method

APHA: American Public Health Association, Standard Methods for the Examination of Water and Waste Water, WHO GV: World Health Organization Guidelines Value, 2006 Update, NDWQS: National Drinking Water Quality Standard, 2002 (Nepal)* These values show lower and upper limits.

of information on the behaviour of surface and ground water. Groundwater depth is between 9-15 m with 1.-2m fluctuation during dry and wet seasons.

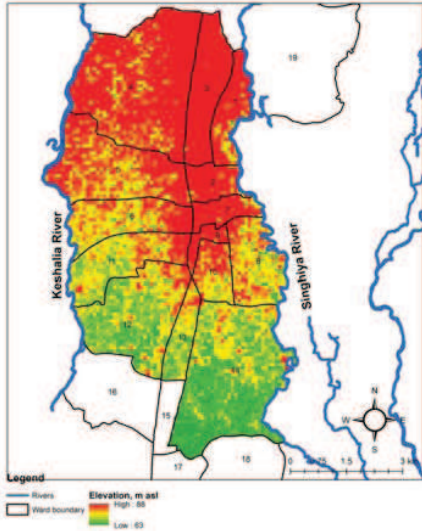


Figure 23: River network of the project area

5.2.5 Water Supply and Sanitation

The water supply in Biratnagar Metropolitan city is managed by the Nepal Water Supply Corporation (NWSC) and three Water User and Sanitation Committees (WUSCs) namely Jamnagachhi WUSC, Pichhara Biratnagar WUSC and Mangad WUSC. The main urban areas are covered by NWSC and outer peri-urban areas are looked after by the local constituted WUSCs. The existing NWSC run piped water supply system is being served by water pumped from deep tube wells (more than 100 metres deep) located at different parts of the town, stored in the several overhead/elevated concrete tanks and through pipelines laid underground along the streets. The elevated tanks mostly are located within the tube well/ pump station compounds. The water reaches to general people through private connections. The water is being served through ½” private connections for general households while some businesses and industries have bigger size connections. Because of rapid growth of population and extension of widely scattered dwellings, the present water supply has become inadequate.

5.2.6 Water Quality

The quality of water in the deep tube wells is good but with majority of hand pumps in the city, the water quality is not that good both chemically and biologically. The reason behind this low quality water is due to the shallow water which contains excessive iron and is usually found to be contaminated. In case of Biratnagar city piped supply, the water being ground water from deep wells, is good at all the sources except for some iron and manganese. However the quality goes down considerably when it reaches consumers through the distribution system due to faulty leaking pipelines as they are mostly very old and are poorly maintained. To address to this type of contamination the water is being chlorinated/ treated by dozing bleaching powder water solution at the sources. There are no other treatments except one iron removal device at Rani PS and one pressure filter at Munalpath PS which are not that effective or are inadequate. NWSC is quite serious about disinfecting water with chlorine before sending it for distribution. (JICA Report (REPORT ON SITUATIONAL ANALYSIS OF WATER SUPPLY IN BIRATNAGAR/ Nepal Water Supply Corporation, Biratnagar-August, 2019)] During the field inspection, water samples from the rivers bordering the metropolitan city were collected and its water quality analysed for various physical and chemical parameters illustrated below:

Table 22: Physical and Chemical water quality parameters of Keshalya River

Parameters	Units	WHO GV	NDWQS	Upstream	Mid-Point	Downstream	Desired Water Quality	APHA, Standard Methods and equipment used
pH	-	8.1-8.5*	6.5-8.5*	8.1	7.9	7.6	6.5 -8.5	pH Meter
Turbidity	NTU	-	5	41.7	17.9	12.8	5 (10)	Electronic Turbidity Meter
Electric Conductivity	µS/cm	-	1500	333.0	345.0	284.0	1500	Conductivity Meter
Temperature	°C	-	-	26.7	26.9	26.3	25 -30	Mercury Thermometer
TDS	mg/l	-	1000	167.0	174.0	147.0	-	Gravimetric Method
DO	mg/l	-	-	4.2	4.0	4.1	-	Winkler Method
Total Hardness	mg/l	500	500	442.4	440.1	444.1	-	EDTA Method
Alkalinity	mg/l	500	-	2.5	2.6	2.4	-	Titration Method
Phenolphthalein Alkalinity	mg/l	-	-	0	0	0	-	Titration Method
Ammonia	mg/l	1.5	1.5	0.0	0.0	0.0	1.5	Phonate Method
Nitrate	mg/l	50	50	2.4	2.5	2.4	-	Phenol Disulphonic Method
Phosphate	mg/l	NA	NA	0.3	0.4	0.4	2.0	Spectrophotometric Method

APHA: American Public Health Association, Standard Methods for the Examination of Water and Waste Water, WHO GV: World Health Organization Guidelines Value, 2006 Update, NDWQS: National Drinking Water Quality Standard, 2002 (Nepal)* these values show lower and upper limits.

The test reports show that all parameters of water quality of the sample collected are within the permitted value of NDWQS.

5.2.7 Ground Water

Biratnagar is located in the Tarai plains, where the existing sources of water supply are primarily ground water. Piped water system was initiated about 50 years ago. People get their water from shallow tube wells/bore holes called hand pumps or dug wells constructed at different points by the municipality or by individuals themselves in their backyards. The city's source of water supply is fully ground water as people opt for ground water for their domestic use as it is very easily accessible. The average depths of hand pumps/shallow tubewells used by common people are in the range of 15-50 feet. Quite a big section of population still use and are dependent on such hand pump water as all areas are not fully covered by the existing piped water system or piped water supply does not fulfil/meet all the water demand.

5.2.8 Groundwater Quality

Groundwater depth in the project area lies between 9-15 m with 1-2m fluctuation during dry and wet seasons. Its ease of availability at a depth of 5-8 feet has made it a reliable source of water even though its quality is not reliable and is mostly contaminated. Water of most of these hand pumps in the city contains excessive iron and is contaminated to great extent. However, with deeper tube-well, the quality of ground water becomes better.

5.2.9 Air Quality

During the field survey, field observations show the main cause of air pollution in the project area are the air pollution caused by fugitive dust from the vehicular movements particularly over unpaved roads and construction activities. Air emissions are also observed from open burning especially in the agricultural lands, vehicular exhaust from old vehicles and emission from industrial emissions. The magnitude of air quality in the project area is observed to be minimal and lies within the range of the maximum concentration in ambient air

Table 23: National ambient air quality standard for Nepal, 2003

Parameters	Units	Averaging Time	Concentration in Ambient Air, Maximum	Concentration in Ambient Air in project Area	Test Method
TSP (Total Suspended Particulates)	µg/m ³	Annual	-	-	High Volume Sampling
		24 hours *	230	154.05	
PM10	µg/m ³	Annual	-	-	Low Volume Sampling
		24 hours *	120	98	
Sulphur Dioxide	µg/m ³	Annual	50	-	Diffusive sampling based on weekly average
		24 hours **	70	-	To be determined before 2005A.D
Nitrogen Dioxide	µg/m ³	Annual	40	-	Diffusive sampling based on weekly average

		24 hours **	80	64	To be determined before 2005A.D
Carbon Monoxide	µg/m ³	8 hours **	10000	-	To be determined before 2005A.D
		15 min	100000	-	Indicative samplers ****
Lead	µg/m ³	Annual	0.5	-	Atomic Absorption Spectrometry, analysis of PM 10 samples****
		24 hours	-	-	
Benzene	µg/m ³	Annual	20*****	-	Diffusive sampling based on weekly average
		24 hours	-	-	

* Note: 24 hourly values shall be met 95% of the time in a year, 18 days per calendar year the standards may be exceeded but not on two consecutive days.

**Note: 24 hourly standards for NO2 an SO2 and 8 hours standard for CO are not to be controlled before MoPE has recommended appropriate test methodologies. This will be done before 2005.

***Note: Controlled by spot sampling at roadside locations: Minimum one sampler per week taken over 15 minutes during peak traffic hours, i.e. in the period 8am-10am or 3pm-6pm on a work day. This test method will be re-evaluated by 2005.

****Note: If representativeness can be proven, yearly averages can be calculated from PM10 samples from selected weekdays from each month of the year.

*****Note: To be re-evaluated by 2005.

Source: Batabaranyamapdanda tatha sambhandit suchana haru ko sangalo, Ministry of Environment, 2067

5.2.10 Noise Quality

The project area lies in the main area of the city where the main source of noise quality deterioration is due to the honking of the vehicles, unmanaged traffic and construction works. The increasing number of automobiles and unmanaged traffic contributes to noise pollution.

Table 24: Noise quality standard

Noise Level Guidelines		
Receptor	Daytime Laeq(dBA)	Night Time Laeq (dBA)
Residential, Institutional and Educational	55	45
Industrial, Commercial	70	70

Source: IFC EHS Guideline, 2007.

Sound level meters were used to measure the noise quality over a time period of 24 hours in our project areas (4 pumping stations). The graph below shows the variation in noise during the daytime and during the night time as well. The graph presents the sound level to be highest during the morning and evening traffic office hours (6:00 am to 10:00 am and 5:00pm to 7:00

pm) which crosses the threshold of the IFC EHS Guideline 2007 in pump number 5, and Tinpaini Pumping Station.

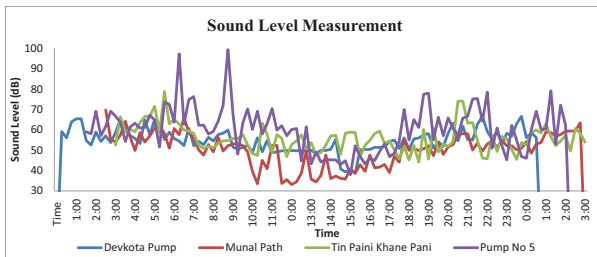


Figure 24: Noise level of the project area

5.3.11 Solid Waste Management

The project area is an important industrial area of the country where the majority of the population is daily commuters who travel to the city from adjacent towns for work and education. The current situation of solid waste management in Biratnagar Metropolitan city comprises of waste collection from households and institutional sources. However, the quantity and estimation of waste collected varied largely with other cities due to the floating population in BMC and higher commercial activities occurring in the city.

The solid waste collection method deployed in the project area is open dumping the waste. Waste is dumped on the banks of Keshaliya river, about 300 meters north of Keshaliya Bridge on the Keshaliya Marga situated in Ward No 6 of BMC. Moreover, due to the limited space for dumping, the waste in the landfill is often burnt to reduce the volume and make room for dumping of more waste.

The metropolitan city employees a public private partnership (PPP) model whereby the responsibility for collection and management of waste is handed to a private company, Waste Management Group Nepal Pvt. Ltd. and J.V. as per the contract with BMC. The company uses a total of 51 vehicles for the collection and transportation of waste.

Similarly, during the survey the waste management service for the industries operating in and about the city of Biratnagar had been enquired. The industries are required to manage their own hazardous waste within their own premises. However, according to the local officials, in practical most of the industries neutralize their waste within their own treatment plants and dispose it to the river nearby.

5.3 Existing Biological Environment

5.3.1 Distribution of Vegetation in the project area

The project area is located in the urban area where the presence of vegetation is sparse. However, the urban vegetation found has been recorded. Some exotic tree species like

Gulmohar (*Delonix regia*), Ashok (*Saraca indica*), Ipil ipil (*Leucaena leucocephala*), Masala (*Eucalyptus camaldulensis*), Teak (*Tectona grandis*). Furthermore, fruit trees like Coconut (*Cocos nucifera*), Mango (*Mangifera indica*), Amala (*Phyllanthus emblica*), Amba (*Psidium guajava*), etc. were also recorded. In addition to it, some fodder species like Kutmero (*Litsea monopetalala*) were also recorded from the project sites. This vegetation has been presented in the table below.

Table 25: Tree species recorded in the project area

SN	Local Name	English Name	Scientific Name	Family	CITTES-Appendix Status
A. Tinpaini Pumping Site					
1	Neem	Neem	<i>Azadirachta indica</i>	Meliaceae	-
2	Gulmohar	Gold Mohur	<i>Delonix regia</i>	Leguminosae	-
3	Aap	Mango	<i>Mangifera indica</i>	Anacardiaceae	-
4	Maulsari	Indian fruit Tree	<i>Mimmsops elengi</i>	Sapotaceae	-
B. Munal Path Pumping Site					
1	Kadam	Burflower tree	<i>Anthocephalus chinensis</i>	Rubiaceae	-
2	Neem	Neem Tree	<i>Azadirachta indica</i>	Meliaceae	-
3	Simal	Silk cotton	<i>Bombax ceiba</i>	Bombacaceae	-
4	Sissoo	Indian rosewood	<i>Dalbergia sissoo</i>	Leguminosae	II
5	Masala	Red gum	<i>Eucalyptus camaldulensis</i>	Myrtaceae	-
6	Mango	Mango	<i>Mangifera indica</i>	Anacardiaceae	-
7	Amba	Guava	<i>Psidium guajava</i>	Myrtaceae	-
8	Jamun	Java Plum	<i>Syzigium cumini</i>	Myrtaceae	-
C. Devkota Pumping Site					
1	Seto siris	White Siris Tree	<i>Albizia procera</i>	Mimosaceae	-
2	Chativan	Devil Tree	<i>Alstonia scholaris</i>	Apocynaceae	-
3	Kadam	Burflower tree	<i>Anthocephalus chinensis</i>	Rubiaceae	-
4	Coconut	Nariwal	<i>Cocos nucifera</i>	Anacaceae	-
5	Sissoo	Indian rosewood	<i>Dalbergia sissoo</i>	Leguminosae	-
6	Masala	Red gum	<i>Eucalyptus camaldulensis</i>	Myrtaceae	-
7	Dumri	Dumri	<i>Ficus racemosa</i>	Moraceae	-
8	Mango	Mango	<i>Mangifera indica</i>	Anacardiaceae	-
9	Ashok	Ashoka	<i>Saraca indica</i>	Leguminosae	-
D. Proposed Soil Dumping Site					
1	Kadam	Burflower tree	<i>Anthocephalus chinensis</i>	Rubiaceae	-
2	Bans	Bamboo	<i>Bambusa nutans</i>	Graminaceae	-
3	Ipil Ipil	Ipil-Ipil	<i>Leucaena leucocephala</i>	Mimosaceae	-
4	Kutmero	Litsea	<i>Litsea monopetalala</i>	Lauraceae	-
5	Mango	Mango	<i>Mangifera indica</i>	Anacardiaceae	-
6	Amala	Amala	<i>Phyllanthus emblica</i>	Euphorbiaceae	-
7	Ashok	Ashoka	<i>Saraca indica</i>	Leguminosae	-
8	Jamun	Java Plum	<i>Syzigium cumini</i>	Myrtaceae	-
9	Sagawan	Teak	<i>Tectona grandis</i>	Verbenaceae	-
E. Yard					
1	Seto siris	White Siris Tree	<i>Albizia procera</i>	Mimosaceae	-
2	Rajbriksha	Indian Laburnum	<i>Cassia fistula</i>	Caesalpinaceae	-
3	Masala	Red gum	<i>Eucalyptus camaldulensis</i>	Myrtaceae	-

4	Rubber	Rubber Plant	<i>Ficus elastic</i>	Moraceae	-
5	Mango	Mango	<i>Mangifera indica</i>	Anacardiaceae	-
6	Khote salla	Chir pine	<i>Pinus roxburghii</i>	Pinaceae	-
7	Ashok	Ashoka Tree	<i>Saraca indica</i>	Leguminosae	-
8	Jamun	Java Plum	<i>Syzygium cumini</i>	Myrtaceae	-

The volume of the standing trees were calculated using the constant values like Pi Value (3.1415), Form-factor (0.5). The diameter and height values were measured and collected from the site. The diameter was measured using diameter tape and height was measured using sunto clinometer. The detail inventory data from the site are provided below.

Table 26: Volume of standing trees in the project area

S.N.	Species	Diameter (in cm)	Height (in m)	Volume (in cubic m)	Remarks
A. Tinpatni Pumping Site					
1.	Gulmohar	38.20	5.2	0.2979	
2.	Mango	26.74	6.5	0.1825	
3.	Maulsari	35.01	7.1	0.3418	
4.	Neem	27.69	8.1	0.2439	
B. Munal Path Pumping Site					
1.	Kadam	48.70	14.1	1.3133	
2.	Simal	130.51	23.4	15.6511	
3.	Sissoo	29.28	8.5	0.2863	
4.	Kadam	53.79	14.1	1.6023	
5.	Masala	66.21	23.6	4.0626	
6.	Masala	54.75	18.4	2.1659	
7.	Sissoo	18.78	10.3	0.1427	
8.	Masala	50.93	23.2	2.3631	
9.	Sissoo	39.47	11.5	0.7036	
10.	Sissoo	32.79	12.1	0.5108	
11.	Sissoo	26.10	12.3	0.3291	
12.	Jamun	44.56	9.8	0.7643	
13.	Mango	35.97	6.0	0.3048	
14.	Kadam	19.74	8.5	0.1300	
15.	Kadam	80.85	10.3	2.6440	
C. Devkota Pumping Site					
1.	Kadam	39.79	8.7	0.5409	
2.	Seto Siris	20.69	10.5	0.1765	
3.	Seto Siris	30.56	10.5	0.3850	
4.	Mango	44.25	10.1	0.7764	
5.	Mango	29.92	9.2	0.3234	
6.	Mango	41.70	8.0	0.5463	
7.	Ashok	12.10	3.8	0.0218	
8.	Ashok	13.69	4.1	0.0302	
9.	Ashok	12.73	4.2	0.0267	
10.	Ashok	14.32	4.1	0.0330	

11.	Sissoo	24.19	8.5	0.1953	
12.	Mango	34.38	11.5	0.5337	
13.	Mango	31.19	8.3	0.3172	
14.	Dumri	52.52	12.2	1.3216	
15.	Mango	21.65	5.1	0.0938	
16.	Dumri	49.02	14.2	1.3400	
17.	Sissoo	18.14	12.1	0.1564	
18.	Masala	49.97	19.5	1.9125	
19.	Masala	40.11	18.1	1.1434	
20.	Ashok	16.55	4.6	0.0495	
21.	Seto Siris	56.02	13.4	1.6515	
22.	Chativan	14.01	3.2	0.0246	

In the overall project site, majority of mango trees are available followed by Sissoo, Masala, Kadam and Ashok respectively. However, in case of volume, Simal trees have high volume (15.6511 m³) followed by Masala (11.6475 m³), Kadam (6.2305 m³), Mango (3.0781 m³), Dumri (2.6616 m³), Sissoo (2.3242 m³), Seto Siris (2.213 m³) and so on. Majority of Kadam, Masala and Sissoo were found in the Munal Path pumping site. Similarly, in case of Devkota pumping site, majority of tree species like mango, Ashok, seto siris, etc. are available.

There is no any prescribed forest area in the Biratnagar metropolitan city. Also, other adjacent local levels (municipalities or rural municipalities) have no forest patches nearby. The nearest access to forest resource is the north-east region of Morang district occupying 3409 ha of forest in Belbari Municipality and 1916 ha in Sundarharaiha Municipality (DFRS, 2018). However, different shrubs species like Aasuro (*Adhotoda vasica*), Argeli (*Girardinia diversifolia*), Simali (*Vitex negundo*), etc. were also found in the project area. The details of the shrub species are provided below:

Table 27: Shrub species reported in the project area

SN	Local Name	Scientific Name	Family	IUCN Status
1	Aasuro	<i>Adhotoda vasica</i>	Acanthaceae	Least Concern species
2	Argeli	<i>Girardinia diversifolia</i>	Urticaceae	Least Concern species
3	Simali	<i>Vitex negundo</i>	Lamiaceae	Least Concern species

The project site is also rich in variety of grass species. Grasses like Bermuda grass (*Cynodon dactylon*), Common Finger grass (*Digitaria eriantha*), Weeping grass (*Eragrostis curvula*), Sabai Grass (*Eulaliopsis binata*), etc. were reported on the sites.

Table 28: Grass species found in the project area

SN	Local Name	English Name	Scientific Name	Family
1	Dubo	Bermudagrass	<i>Cynodon dactylon</i>	Gramineae
2		Common Finger grass	<i>Digitaria eriantha</i>	Gramineae
3		Weeping grass	<i>Eragrostis curvula</i>	Gramineae
4	Babiyo	Sabai Grass	<i>Eulaliopsis binata</i>	Gramineae
5	Siru	Kunai Grass	<i>Imperata cylindrica</i>	Gramineae
6	Kans	Wild sugarcane	<i>Saccharum spontaneum</i>	Gramineae
7	Amliso	Broom Grass	<i>Thysanolaena latifolia</i>	Gramineae

Epiphytes like (*Drynaria quercifolia*), (*Lepisorus thunbergianus*), (*Nephrolepis cordifolia*), (*Pyrrhosia lanceolata*), etc. and Ferns like (*Diplazium esculentum*), (*Adiantum caudatum*), were observed during the field visit on the project site. Similarly, Endemic and alien species like Lahare banmara (*Mikania micrantha*), Seto Banmara (*Eupatorium odoratum*), Besaram (*Ipomea carnea*), Jalajambhu (*Alternanthera philoxeroides*) and Lajawati (*Mimosa pudica*) were also reported in the site.

Table 29: Endemic and alien species found in the project area

SN	Local Name	English Name	Scientific Name	Family	Protection status
1	Gandhe	Goatweed	<i>Ageratum conyzoides</i>	Asteraceae	NA
2	Jalajambhu	Alligator weed	<i>Alternanthera philoxeroides</i>	Amaranthaceae	NA
3	Kalo Banmara	Crofton weed	<i>Eupatorium adenophorum</i>	Asteraceae	NA
4		Devil weed	<i>Eupatorium odoratum</i>	Asteraceae	NA
5	Besaram	Morning Glory	<i>Ipomea carnea</i>	Convolvulaceae	NA
6	Gandhe kanda	Spanish flag	<i>Lantana camara</i>	Verbenaceae	NA
7		Cut grass	<i>Leersia hexandra</i>	Poaceae	NA
8	Lahare banmara	Bitter vine	<i>Mikania micrantha</i>	Asteraceae	NA
9	Lajawati	Touch-me-not	<i>Mimosa pudica</i>	Fabaceae	NA

5.3.2 Faunal Diversity and Distribution

As the project area is urban area, not much of the wildlife was found. Some wildlife that could adapted to the urban environment were reported and are presented below.

According to local residents, the movements of wild animals in the proposed site is very low due to the lack of forest patches and densely populated settlements. However, due to the vegetation of cultivated land and trees on the private land, few and very common wild animals and birds are sometimes observed on the area. Though the reported wild animals and birds from the project area are commonly found in Terai regions of Nepal, the working area is not a specific habitat for any wildlife.

Around 14 bird species were reported in the project sites of which 13 species were of Least Concerned status, for example, Koili (*Eudynamis scolopaceus*), Nyauli (*Megalaima asiatica*), Bhangera (*Passer domesticus*), Dage rupi (*Acridotheres tristis*), Jureli (*Pycnonotus cafer*), etc and one was Near Threatened status i.e. Saras (*Ciconia episcopus*). On the basis of bird's behavior, they can be resident and visitors and they can be common, fairly common and uncommon on the basis of population status. The details of birds reported in the site are given below:

Table 30: Bird Species in the Project Area

SN	Local Name	English Name	Scientific Name	Family	IUCN Status	Remarks
1	Bhith Rupi	Bank Myna	<i>Acridotheres ginginianus</i>	Sturnidae	LC	R, FC
2	Dangre Rupi	Common Myna	<i>Acridotheres tristis</i>	Sturnidae	LC	R, FC
3	Bakkulla	Cattle Egret	<i>Bubulcus ibis</i>	Ardeidae	LC	R, FC

4	Saras	Woolly-necked Stork	<i>Ciconia episcopus</i>	Ciconiidae	NT	SV, UC
5	Parewa	Common Pigeon	<i>Columba livia</i>	Columbidae	LC	R, FC
6	Kag	House Crow	<i>Corvus splendens</i>	Corvidae	LC	R, FC
7	Kafal Pakyo	Indian Cuckoo	<i>Cuculus micropterus</i>	Cuculidae	LC	SV, C
8	Koili	Asian Koel	<i>Eudynamis scolopaceus</i>	Cuculidae	LC	R, FC
9	Nyauli	Blue-throated Barbet	<i>Megalaima asiatica</i>	Megalaimidae	LC	R, C
10	Phistey Chara	Common Tailorbird	<i>Orthotomus sutorius</i>	Cisticolidae	LC	R, FC
11	Bhangera	House Sparrow	<i>Passer domesticus</i>	Passeridae	LC	R, FC
12	Suga	Slaty-headed Parakeet	<i>Psittacula himalayana</i>	Psittacidae	LC	R, UC
13	Jureli	Redvented Bulbul	<i>Pycnonotus cafer</i>	Pycnonotidae	LC	R, FC
14	Dhukur	Red-collared Dove	<i>Sreptopelia tranquebarica</i>	Columbidae	LC	R, C

Note: LC = Least Concern; NT = Near-threatened
R= Residential, SV= Summer Visitor, C= Common, FC= Fairly Common, UC= Uncommon

The project area contains a variety of reptiles, for example, lizards, snakes, etc. Among them Snakes like Karet (*Bungarus lividus*), Dhaman (*Pyas mucosus*), Hariyo Sarpa (*Trimeresurus albolabris*), and Lizards like Chheparo (*Calotes versicolor*), were reported in the site having Least Concerned status in IUCN Red List. The reptiles reported from the site are given below:

Table 31: Reptiles reported from the project area

SN	Local Name	English Name	Scientific Name	Family	Conservation Status(UCN)	CITIES APPENDIX
1	Harhare Surpa	Striped Keeback	<i>Amphisma stotatum</i>	Colubridae	LC	-
2	Krait	Lesser Black Krait	<i>Bungarus lividus</i>	Elapidae	LC	-
3	Krait	Greater Black Krait	<i>Bungarus niger</i>	Elapidae	LC	-
4	Goman	Spectacled Cobra	<i>Naja kaouthia</i>	Elapidae	LC	II
5	Andho Surpa	Chinese Mountain Pit Viper	<i>Ovophis mannicola</i>	Viperidae	LC	-
6	Dhamaan	Oriental Rat Snake	<i>Python mucosus</i>	Colubridae	LC	II
7	Haryo Surpa	Green pit viper	<i>Trimeresurus abalabrhis</i>	Viperidae	LC	-
8	Chhepari	Oriental Garden Lizard	<i>Calotes versicolor</i>	Agamidae	LC	-
9	Mausuli	Brooke's House Gecko	<i>Hemidactylus brooki</i>	Gekkonidae	LC	-

Note: LC = Least Concern

As amphibians, various types of frog species like Asian Common Toad (*Duttaphrynus melanostictus*), Himalayan Toad (*Duttaphrynus Himalayanus*) and Skittering Frog (*Euphlyctis cyanophlyctis*) were observed during the field survey of which details is given below:

Table 32: Amphibians reported from the project area

SN	Local Name	English Name	Scientific Name	Family	Status
1	Bhyaguto	Asian Common toad	<i>Duttaphrynus melanostictus</i>	Bufoiidae	LC
2	Bhyaguto	Himalayan toad	<i>Duttaphrynus Himalayanus</i>	Bufoiidae	LC
3	Bhyaguto	Skittering frog	<i>Euphlyctis cyanophlyctis</i>	Dicroglossidae	LC

Note: LC = Least Concern

Mammals reported in the project area are Nyauri (*Herpestes auro-punctatus*), and Musa (*Rattus rattus*). The detail status of such species is mentioned below:

Table 33: Mammals reported from the project area

SN	Local Name	English Name	Scientific Name	Family	Status
1	Nyauri	Small Indian Mongoose	<i>Herpestes auro-punctatus</i>	Herpestidae	LC
2	Musa	House Rat	<i>Rattus rattus</i>	Muridae	LC

Note: LC = Least Concern

5.4 Existing Socio-Economic Environment

5.4.1 Demographic Features

The population of BMC was reported to be 1,66,674 by 2001 census, which grew to 2,01,125 in 2011 census. The population of men comprised of 53% (i.e. 87,664) and women population was 47% (i.e. 79,010) in 2001 census, whereas, the sex proportion changed in 2011 census with percentage of men decreased to 51% (108,827), whereas women population grew to 49% (105,836). The increased population between 2001 and 2011 seemed at 34,451, which refers the annual growth rate (straight line) at 2.07%.

According to BMC's official website, the total population is 2,14,663 (male 1,08,827 and female 1,05,863) and households 47,798 for the year (2020). Moreover, the Regional Urban Environmental Improvement Project (RUDP) officials had reported the total population of census 2011 is 2,71,354 increased total 1,04,680 population. If the given figure is considered then the annual straight-line population growth rate stands at 6%. However, they had viewed that they had considered the base population is 236,895 for the year 2015 and the annual population growth is 3.37% while preparing the report for Initial Environmental Examination (IEE) on Additional Drainage, Sewerage, and Roads Improvement Works for Biratnagar Sub-metropolitan City. If the growth rate (3.37%) of RUDP is considered then the population for year 2021 would be 289,017.

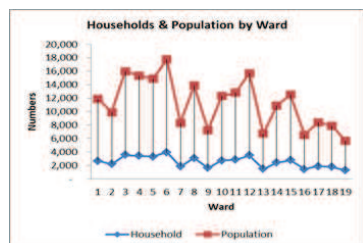


Figure 25: Household and Population by Ward

The IEE survey enumerated the population of 1,192 in 216 sampled households within the delineated project area. The ratio of the male to female is 51.01% and 48.99%.

Table 34: Household/ population of the project area

SN	Name of Settlement	# of Household	# of Population
1	Damabandi	49	258
2	Damabandi, Karkhana tole	17	104
3	Damabandi, Kulharba	56	310
4	Damabandi, Prithivi chowk	4	27
5	Damabandi, Pulchowk	14	78
6	Damabandi, Shankarbari	63	349
7	Shankarbari, Keshaliya	13	66
Total		216	1,192

Source: Household Survey, April, 2021

5.4.2 Household and Population

The actual ward wise household and population can only be confirmed after 2021 CBS census is complete. However, the BMC official website reported that the total population and household of entire BMC and only population distribution of each ward. Currently the BMC is having 19 wards and earlier there were 22 wards while executing its services as the sub metropolitan city. Nevertheless, the team had tried to retrieve the sex wise population by ward for the current year adopting the reference of sex wise population of census 2001.

The ward no 6 is largest ward (17,748) and ward no 19 is smallest ward (5,640) in terms of population and respectively household too. Similarly, the ward no 4 is largest one in terms of physical area. The overall ratio of male to female population in BMC is 1.03 with 50.70% (108,827) of males and 49.30% (105,836) of females. The sex ratio of male to female population was 1.11 in census year 2001.

Table 35: Population of BMC by Sex (2020 AD)

Ward	Household	Population			Area in Sq. Km.	Average Household Size	Sex Ratio	Population Density
		Total	Male	Female				
1	2,656	11,928	6,047	5,881				
2	2,208	9,914	5,026	4,888				
3	3,563	16,002	8,112	7,890				
4	3,417	15,346	7,780	7,566				
5	3,313	14,880	7,544	7,336				
6	3,952	17,748	8,998	8,750				
7	1,857	8,342	4,229	4,113				
8	3,091	13,880	7,037	6,843				
9	1,613	7,245	3,673	3,572				
10	2,738	12,295	6,233	6,062				
11	2,848	12,792	6,485	6,307				
12	3,495	15,697	7,958	7,739				
13	1,492	6,701	3,397	3,304				
14	2,429	10,910	5,531	5,379				
15	2,787	12,515	6,345	6,170				
16	1,456	6,537	3,314	3,223				
17	1,869	8,393	4,255	4,138				
18	1,759	7,898	4,004	3,894				
19	1,255	5,640	2,859	2,781				
Total	47,798	214,663	108,827	105,836	76.99	4.49	1,028	2,788.19

Sources¹⁰

Similarly the project area has a large portion of son/daughter by relation. Please refer to Table below. Almost 85% of the households reported as joint family and rests are either extended (very few) or nuclear.

Table 36: Population by relation HH by sex in the project area

SN	Relation to HH	Sex of Member		Total
		Male	Female	
1	Head	17.37	0.76	18.12
2	Husband/wife	0.42	17.53	17.95
3	Son/Daughter	22.15	11.33	33.47
4	Grand children	7.47	4.78	12.25
5	Son/Daughter in law	0.00	10.23	10.23
6	Daughter/Son in law	0.08	0.00	0.08
7	Parent	1.59	1.93	3.52
8	Father/Mother in law	0.00	0.08	0.08
9	Brother/Sister in law	0.08	0.76	0.84
10	Household Widow	1.85	1.59	3.44
Total		51.01	48.99	100.00

Source: Household Survey, April, 2021

¹⁰ The population by ward was sourced from <https://biratnagar.gov.np/en/ward-profile> and the number of households and the population by sex was adjusted from the accumulated figure of Biratnagar Metropolitan city as demonstrated in <https://biratnagar.gov.np/en/ward-profile>

5.4.3 Population by Age Group

The population in BMC is categorized into 3 major age groups i.e. (a) younger dependent population, (b) economically active population and (c) elder dependent population.

The recent age wise population data is not available, thus, 2001 census data has been considered as the references and presented in the percentage value so as to understand the conspicuous scenario of the age composition in BMC.

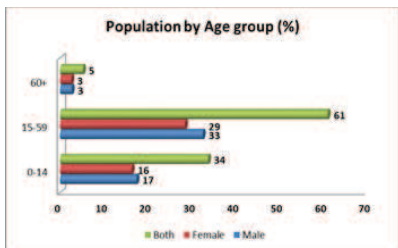


Figure 26: Population by Age Group

The age group between the age of 15 and 59 has been considered as the economically active age group. In BMC, this age group constitutes more than 61 percent, whereas younger dependent age group has 34 percent and elder dependent are 5 percent.

The sampled population of the project area is grouped into different age groups in order to understand population size by the age group. This grouping is also useful to understand the proportional ratio of economically active and dependence population within the project area. The majority of enumerated population were under the age group 21-<=30 (25.59%) followed by age group 0-<=10 (23.07%), age group 11-<=20 (19.30%) and so on. Normally, the population of less than 10 years and more than 60 years are considered to be the economically dependent to the economically active population. With this reference, the project area has about 28% dependent population. Please refer to the table below.

Table 37: Population by age and sex

Sl. No.	Age Group	Sex of Member		Total
		Male	Female	
1	0-<=10	13.76	9.31	23.07
2	11-<=20	7.38	11.91	19.30
3	21-<=30	13.67	11.91	25.59
4	31-<=40	3.78	4.70	8.47
5	41-<=50	7.05	5.62	12.67
6	51-<=60	3.19	2.77	5.96
7	61-<=70	1.51	2.01	3.52

8	71+	0.67	0.76	1.43
Total		51.01	48.99	100.00

Source: Household Survey, April, 2021

5.4.4 Population by Ethnic Group

The IEE report of Additional Drainage, Sewerage, and Roads Improvement Works prepared by the Regional Urban Environmental Improvement Project (RUDP) for Biratnagar Sub-metropolitan City, has depicted that the dominant ethnic population of Biratnagar is Hill Brahmin constituting more than 20 % followed by the other Terai caste/ethnicity except to Tharu (Indigenous/Janajati), Rajbansi (Indigenous/Janajati), Dhanuk, Muslim, Baniya, Yadav, Kewat, Malaha (Indigenous), Marwari, Teli, Halwai, Kayastha, Dushad/Paswan (Dalit Vulnerable Pop), other Terai Dalit. The least population is of Kami, Damai, Sarki (Dalit Vulnerable Population) which is less than 1 %. The following table (Table 35) is intended just for the reference to be oriented on the caste/ethnic composition with their respective representation within the BMC. So the total population herein referred will vary with the other table given for the population.

Table 38: Population by ethnicity/caste

Caste/Ethnicity	Population	%	Rank by Population
Hill Caste/Ethnicity			
Hill Brahmin	37,493	20.80%	1
Chhetri	18,068	10.00%	3
Newar (Indigenous/Janajati)	9,594	5.30%	5
Rai	2,821	1.60%	18
Kami, Damai, Sarki (Dalit Vulnerable Pop) Total	1,708	0.90%	21
Other Caste/Ethnicity (Total)	5,847	3.20%	9
Total Hill Caste/Ethnicity	75,531	41.90%	
Terai Caste/Ethnicity			
Tharu (Indigenous/Janajati)	4,994	2.80%	14
Rajbansi (Indigenous/Janajati)	5,028	2.80%	13
Dhanuk	6,587	3.70%	8
Muslim	16,490	9.20%	4
Baniya	2,503	1.40%	20
Yadav	7,320	4.10%	6
Kewat	7,078	3.90%	7
Malaha (Indigenous)	4,460	2.50%	15
Marwari	5,737	3.20%	10
Teli	5,493	3.00%	11
Halwai	3,330	1.80%	17
Kayastha	3,618	2.00%	16
Dushad/Paswan (Dalit Vulnerable Population)	2,635	1.50%	19
Other Terai Dalit	5,288	2.90%	12

Other Terai Caste/Ethnicity	24,046	13.30%	2
Total Terai Caste/Ethnicity	104,607	58.10%	
Total Population	180,138	100.00%	

Source¹¹:

The survey had identified more than 27 ethnic groups within the project area (new PS site), which is a mixture of both Hill and Terai communities. To be oriented with the exact name of ethnicity, the entire ethnic people are not grouped into the standard format as CBS does. The majority represents by Mandal (17.13%), followed by Yadav (9.26%), Khawas (8.80%), Satar (6.02%) and so on. Please refer to the table below.

Table 39: Ethnicities of the project area population

SN	Ethnicity	Name of Settlement							Total
		Damabandi	Damabandi, Karkhana tole	Damabandi, Kulharba	Damabandi, Prithivi chowk	Damabandi, Pulchowk	Damabandi, Shankarbari	Shankarbari, Keshaliya	
1	Badahi	1.39	-	0.46	0.46	-	2.31	-	4.63
2	Gaderi	-	-	-	0.46	-	-	-	0.46
3	Hajam	-	-	-	-	-	0.46	-	0.46
4	Hill Brahmin	1.39	-	-	0.46	-	1.39	-	3.24
5	Hill Chhetri	1.39	-	2.31	-	-	1.39	-	5.09
6	Hill Dalit	0.46	-	0.46	-	-	0.93	0.46	2.31
7	Hill Janajati	-	-	0.46	-	1.85	0.46	-	2.78
8	Jhangad	2.31	-	0.46	-	-	0.93	4.63	8.33
9	Kamat	-	0.46	-	-	-	-	-	0.46
10	Kewat	-	-	-	-	-	1.85	-	1.85
11	Khawas	0.46	5.56	0.46	0.46	-	1.85	-	8.80
12	Mahato	-	-	-	-	0.93	0.46	-	1.39
13	Mandal	2.31	-	6.94	-	-	7.41	0.46	17.13
14	Mehata	1.39	-	-	-	-	-	-	2.77
15	Mushahar	-	-	0.93	-	-	-	-	0.93
16	Muslim	0.93	-	1.85	-	0.46	0.93	-	4.17
17	Pandit	0.46	-	-	-	-	-	-	0.46
18	Poddar	-	-	-	-	-	0.93	-	0.93
19	Rai	0.46	-	-	-	-	-	-	0.46
20	Rajbansi	0.46	0.93	0.46	-	-	-	-	1.85
21	Ray	0.46	-	-	-	1.85	2.78	-	5.09
22	Satar	5.56	-	-	-	-	-	0.46	6.02
23	Teli	0.93	-	0.46	-	0.46	0.46	-	2.31
24	Terai Dalit	0.46	-	2.78	-	-	-	-	3.24

¹¹ IEE report on Additional Drainage, Sewerage, and Roads Improvement Works prepared by the Regional Urban Environmental Improvement Project (RUDP) for Biratnagar Sub-metropolitan City

25	Tharu	0.46	0.93	-	-	-	1.39	-	2.78
26	Turaha	-	-	2.78	-	-	-	-	2.78
27	Yadav	1.39	-	5.09	-	0.93	1.85	-	9.26
Total		22.69	7.87	25.93	1.85	6.48	29.17	6.02	100.00

Source: Household Survey, April, 2021

5.4.5 Population by Linguistic

The majority of the people use Nepali language for their day to day communication followed by the Maithali language. At the same time local indigenous languages like Birat Rajbansi also known as Khottha/Khoratha is also the communicating language spoken by the respective communities. Further, Hindi and Marwari are also the language for some population.

The Hill and Terai communities are living harmoniously in the project area. Nepali is understood as well as used for communication by the locals. However, almost 85% of respondents have Maithili as their mother tongue followed by Nepali 11.1%. Some Bangali and Tharu speaking populations were also reported from the project area. Please refer to the table below.

Table 40: Language spoken by locals in the project area

SN	Name of Settlement	Language				Total
		Bangali	Maithili	Nepali	Tharu	
1	Damabandi	0.5	19.9	2.3	0	22.7
2	Damabandi, Karkhana tole	0.9	6.5	0	0.5	7.9
3	Damabandi, Kulharba	0.5	22.7	2.8	0	25.9
4	Damabandi, Prithivi chowk	0	1.4	0.5	0	1.9
5	Damabandi, Pulchowk	0	4.6	1.9	0	6.5
6	Damabandi, Shankarbari	0	24.5	3.2	1.4	29.2
7	Shankarbari, Keshaliya	0	5.6	0.5	0	6
Total		1.9	85.2	11.1	1.9	100

Source: Household Survey, April, 2021

5.4.6 Literacy and Education

The exact data on education and literacy status of the BMC is not available, as it will be available only after completion of the census 2021. However the source¹² taken from PPTA mentioned that the total literacy rate is 50.5%, which comprises of 59.5% of men and 39.6% of women. The census 2001, reported that the literacy rate was more than 75%, which comprised of 44.2% of men and 31.5% of women.

Table 41: Literacy rate of BMC (2001)

Sl. No.	Status	Male	Female	Total
1	Can't Read & Write	8.5%	15.5%	24.0%
2	Can Read Only	2.6%	2.6%	5.3%
3	Read & Write	41.6%	28.8%	70.4%
4	Not Stated	0.1%	0.2%	0.3%
Total		52.8%	47.2%	100.0%

¹² IEE report on Additional Drainage, Sewerage, and Roads Improvement Works prepared by the Regional Urban Environmental Improvement Project (RUDP) for Biratnagar Sub-metropolitan City

Source: Census 2001, CBS

The primary survey for the IEE study revealed that almost 68% (34.14% men and 33.39% women) of the total people are either can read only (4.87%) or are able to read and write (62.67%). The survey on education part was carried out to population above the age of 6. However, the populations under the age 6 were also found to be going school (private) under pre-primary level. Those populations also can read and write but omitted for calculating the education level and literacy rate. Interestingly, the education level of both men and women; were found to be almost equal in the project area. Please refer to the table below.

Table 42: Literacy status of locals (by sex) [%]

SN	Education Level	Sex of Member		Total
		Male	Female	
1	Can't Read & Write	7.05	9.06	16.11
2	Can Read Only	2.35	2.52	4.87
3	Read & Write	31.80	30.87	62.67
4	Not Applicable	9.82	6.54	16.36
Total		51.01	48.99	100.00

Source: Household Survey, April, 2021

5.4.7 Population by Religion

The BMC has population belonging to different religious groups, though remarkably large population belongs to the Hinduism. The other religions are Islam, Jainism, Kirat, and Christianity. Biratnagar is known for its high-spirited festival celebration. During Dashain, the largest festival in the country, a large number of devotees visit the Kali Mandir, a temple dedicated to Goddess Kali that lies in the heart of the town.¹³

The people of almost all religious beliefs except Christian were reported from the project area. The majority of the population belongs to the Hindu religion, which is almost 95% of the total population followed by the Muslim 4.2% and Buddhist less than 1%. Please refer to the table below.

Table 43: Population by religion in the project area

SN	Name of Settlement	Religion			Total
		Buddhist	Hindu	Muslim	
1	Damabandi	0.0	21.8	0.9	22.7
2	Damabandi, Karkhana tole	0.0	7.9	0.0	7.9
3	Damabandi, Kulharba	0.0	24.1	1.9	25.9
4	Damabandi, Prithivi chowk	0.0	1.9	0.0	1.9
5	Damabandi, Pulchowk	0.5	5.6	0.5	6.5
6	Damabandi, Shankarbari	0.0	28.2	0.9	29.2
7	Shankarbari, Keshaliya	0.0	6.0	0.0	6.0
Total		0.5	95.4	4.2	100.0

Source: Household Survey, April, 2021

5.4.8 Population Density

With given population as 214,663 and total area of the BMC as 76.99, the density could be estimated as 2,788 people per sq. meter.

¹³ <https://en.wikipedia.org/wiki/Biratnagar#Religion>

5.4.9 Education and Literacy

The IEE report¹⁴ mentioned that the total literacy rate of BMC is 50.5%, 59.5% of which are men and 39.6% are women female. However, the census 2001 reported that the literacy rate was more than 75% which comprised of 44.2% men and 31.5% women.

Table 44: Literacy rate (2001AD)

SN	Status	Male	Female	Total
1	Can't Read & Write	8.5%	15.5%	24.0%
2	Can Read Only	2.6%	2.6%	5.3%
3	Read & Write	41.6%	28.8%	70.4%
4	Not Stated	0.1%	0.2%	0.3%
Total		52.8%	47.2%	100.0%

Source: Census 2001, CBS (Unit: as shown)

A municipal school under GoN namely Siddhakali Aadharbhut Vidyalaya established in 2046 BS is situated in the Damabandi, Kulharba in order to facilitate the children of the area. However this is primary level school and need to go away from the area for higher education. The survey reported that about 49% of the household send their children to government school whereas 37% sending to private boarding school which is situated outside of the project area. About 15% has reported that their children either go to private boarding school or government school.

Table 45: Education facilities in the project area [%]

SN.	Name of Settlement	Education Facility			Total
		Government School	Private Boarding	Both Government & Private School	
1	Damabandi	8.3	12.0	2.3	22.7
2	Damabandi, Karkhana tole	4.6	1.4	1.9	7.9
3	Damabandi, Kulharba	15.3	5.6	5.1	25.9
4	Damabandi, Prithivi chowk	0.9	0.9	0.0	1.9
5	Damabandi, Pulchowk	0.9	4.6	0.9	6.5
6	Damabandi, Shankarbari	15.7	9.3	4.2	29.2
7	Shankarbari, Keshaliya	2.8	3.2	0.0	6.0
Total		48.6	37.0	14.4	100.0

Source: Household Survey, April, 2021

5.4.10 Health and Sanitation

The Initial Environmental Examination (IEE) on Additional Drainage, Sewerage, and Roads Improvement Works for Biratnagar Sub-metropolitan City Biratnagar had enumerated three hospitals, namely (a) Koshi Zonal Hospital, (b) Maternity Hospital and (c) Golcha Eye Hospital. The Koshi Zonal Hospital had facilities like X-ray, laboratory, Operation Theater, OPD and ECG.

¹⁴ IEE report on Additional Drainage, Sewerage, and Roads Improvement Works prepared by the Regional Urban Environmental Improvement Project (RUDP) for Biratnagar Sub-metropolitan City

Beside these hospitals; Biratnagar also have several private clinics and pathology labs. There were more than five nursing homes, 50 private clinics and 10 pathology laboratories within the municipality. One veterinary hospital was also located within the municipality. The common diseases reported were stomach ache/problem (25% cases), cough/asthma (19%), typhoid/pneumonia (19%), diarrhea (6%), malaria (6%), head ache (6%), eye infection (6%) and throat/nose infection (6%). The main cause for gastroenteritis and diarrhoea could be due to poor water quality, lack of proper surface drainage systems and solid waste management.¹⁵

About the health seeking behavior, more than 75% of the people of the project area reported that they consult for their health problem either to government district hospital (38%) or both private and government district hospital (40%). Less than 20% of the people go to private hospital. Please refer to the table below:

Table 46: Population using the local health facility type [%]

SN	Name of Settlement	Health Facility					Total
		Government Health Post/Health Centre	Government District Hospital	Government Other Institution	Private Hospital	Both District & Private Hospital	
1	Damabandi	0	3	0	10	9	23
2	Damabandi, Karkhana tole	0	3	0	0	4	8
3	Damabandi, Kulharba	0	15	0	5	6	26
4	Damabandi, Prithivi chowk	0	1	0	0	0	2
5	Damabandi, Pulchowk	0	1	0	0	5	6
6	Damabandi, Shankarbari	2	10	0	2	15	29
7	Shankarbari, Keshaliya	0	5	0	1	0	6
Total		2	38	1	19	40	100

Source: Household Survey, April, 2021

About 2.3% of the population have reported to disown toilets at their houses thus practice open defecation and urination. This is an alarming situation, which needs to be promptly addressed. The seldom occurring of water born disease is may be the causes of open defecation by those who do not have own toilet at their house premises.

Table 47: Type of toilets in the project area houses [%]

SN	Name of Settlement	Type of toilet	Total
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¹⁵ Initial Environmental Examination (IEE) on Additional Drainage, Sewerage, and Roads Improvement Works for Biratnagar Sub-metropolitan City.

		Toilet with flush (connected to sewer)	Toilet with flush (connected to safety tank)	Toilet without flush	Public latrine	No toilet	
1	Damabandi	0.0	1.9	19.4	0.0	1.4	22.7
2	Damabandi, Karkhana tole	0.0	0.5	7.4	0.0	0.0	7.9
3	Damabandi, Kulharba	0.0	0.9	24.1	0.0	0.9	25.9
4	Damabandi, Prithivi chowk	0.0	0.0	1.9	0.0	0.0	1.9
5	Damabandi, Pulchowk	0.5	1.9	4.2	0.0	0.0	6.5
6	Damabandi, Shankarbari	0.0	0.5	28.2	0.5	0.0	29.2
7	Shankarbari, Keshaliya	0.0	0.0	6.0	0.0	0.0	6.0
Total		0.5	5.6	91.2	0.5	2.3	100.0

Source: Household Survey, April, 2021

5.4.11 Gender Issues

Both men and women had equal education levels in the project area, which indicates that the growing gender equality in the newer generation. Critical gender issues are less evident in the project area.

5.4.12 Economic Activities

As per 2001 census, about 71% of the total population is economically active. About 46.2% of the economically active population is engaged in agriculture followed by 32.4% in service and rest in trade and labor.¹⁶

5.4.13 Major Occupation

The trend of people engaging in the agriculture in Nepal has been changing. People are now diverting into other occupations as agriculture is becoming less attractive, particularly in the urban areas. The agriculture and its associated sub activities like rearing livestock is being a less priority to express as the major occupation for the people as only 8.33% (agriculture 7.87% and livestock (0.46%) of the total surveyed household expressed that agriculture was their major occupation. Majority of the people were engaged in Salary/Wage (52.31%), followed by the having Own Enterprises (22.22%), External job (15.74%) and so on.

Table 48: Major occupation of the HH in the project area [%]

SN	Main Occupation of HHH	Name of Settlement							Total
		Damabandi	Damabandi, Karkhana tole	Damabandi, Kulharba	Damabandi, Prithivi chowk	Damabandi, Pulchowk	Damabandi, Shankarbari	Shankarbari, Keshaliya	
1	Agriculture	2.78	-	2.31	-	0.93	0.93	0.93	7.87
2	Livestock	-	-	-	-	-	0.46	-	0.46
3	Salary/Wage	7.41	6.02	17.59	0.46	2.31	17.59	0.93	52.31
4	Own Enterprises	9.72	0.46	1.39	-	1.85	4.63	4.17	22.22

¹⁶ RUDP

5	External job	2.78	1.39	4.17	1.39	1.39	4.63	-	15.74
6	Household Work	-	-	-	-	-	0.93	-	0.93
7	Remittances	-	-	0.46	-	-	-	-	0.46
Total		22.69	7.87	25.93	1.85	6.48	29.17	6.02	100.00

Source: Household Survey, April, 2021

5.4.14 Income and Expenditure

The data on income/expenditure of the households within the project area were collected simply by asking them on the real time basis. Normally, people do not keep any records of income in a systematic way so as to be able to express whenever is asked about the budgeting. Hence the amount presented in the report needs further verification with different parameters in order to express accurately. The given income amount is just to be oriented the income status. However, the survey data shows that the income of the people is almost equal to the national income. In overall the per capita income of the people in the project area is about 128 thousand. Please refer to the table below.

Table 49: Income level [NRs]

S N	Name of Settlement	# of Household	# of Population	Sum of Income ('000)	Income/HH ('000)	Income/Capita ('000)
1	Damabandi	49	258	36,842	751.89	142.80
2	Damabandi, Karkhana tole	17	104	11,068	651.07	106.43
3	Damabandi, Kulharba	56	310	36,326	648.69	117.18
4	Damabandi, Prithivi chowk	4	27	2,580	645.00	95.56
5	Damabandi, Pulchowk	14	78	12,926	923.27	165.72
6	Damabandi, Shankarbari	63	349	45,292	718.92	129.78
7	Shankarbari, Keshaliya	13	66	8,213	631.77	124.44
Total		216	1192	153,248	709.48	128.56

Source: Household Survey, April, 2021

The project area households were grouped based on their income levels as (a) High Income Group (HIG), (b) Middle Income Group (MIG) and (c) Low Income Group (LIG). The households having income more than 2 lakh are categorized under HIG, having income between 2 lakh and 75 thousand under MIG and having income less than 75 thousand under LIG. With this categorization, the majority of the households fall under the MIG with 71%, followed by the HIG 15% and LIG 14.

Table 50: Income groups [%]

SN	Name of Settlement	Income Group			Total
		LIG	MIG	HIG	
1	Damabandi	3	14	6	23

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2	Damabandi, Karkhana tole	2	6	0	8
3	Damabandi, Kulharba	3	21	2	26
4	Damabandi, Prithivi chowk	0	1	0	2
5	Damabandi, Pulchowk	0	5	1	6
6	Damabandi, Shankarbari	4	20	5	29
7	Shankarbari, Keshaliya	1	5	0	6
Total		14	71	15	100

Source: Household Survey, April, 2021

The income and expenditure of the people in the project area were also found to be equal.

Table 51: Expenditure level [NRs]

S N	Name of Settlement	# of Household	Numbers of Population	Sum of Expenses	Expense s/HH	Expenses /Capita
1	Damabandi	49	258	39,366	803.39	152.58
2	Damabandi, Karkhana tole	17	104	14,926	877.98	143.52
3	Damabandi, Kulharba	56	310	41,173	735.24	132.82
4	Damabandi, Prithivi chowk	4	27	2,520	630.00	93.33
5	Damabandi, Pulchowk	14	78	15,336	1,095.43	196.62
6	Damabandi, Shankarbari	63	349	50,285	798.17	144.08
7	Shankarbari, Keshaliya	13	66	11,700	900.00	177.27
Total		216	1192	175,306	811.60	147.07

Source: Household Survey, April, 2021

While calculating the income and expenditure of the people in the project area, almost 14% was found to be in deficit.

Table 52: Per-capita income and expenditure [NRs]

S.No	Income	128.56
1	Expenditure	147.07
2	Saving +/- Deficit -	(18.50) -14%

5.4.15 Land and Agriculture

The survey had reported that about 12% of the households owned the land. The data of peoples' engagement as the main occupation as agriculture also validates the data of holding own land. About 8% of the total households had reported engaged in agriculture as main occupation.

Table 53: Ownership of the cultivated land in the project area [%]

SN	Name of Settlement	Total
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Nepal Water Supply Corporation

	Having own cultivating land	Damabandi	Damabandi, Karkhana tole	Damabandi, Kulharba	Damabandi, Prithivi chowk	Damabandi, Pulchowk	Damabandi, Shankarbari	Shankarbari, Keshaliya	Total
1	Yes	5.09	-	3.24	-	2.78	0.93	12.04	
2	No	17.59	7.87	22.69	1.85	6.48	26.39	5.09	87.96
Total		22.69	7.87	25.93	1.85	6.48	29.17	6.02	100.00

Source: Household Survey, April, 2021

About 80% of the households have either no own product (30%) or sufficient food from their own product (49%). Only 6% is having surplus food.

Table 54: Food sufficiency [%]

SN	Name of Settlement	Food Sufficiency months						Total
		Less than 3 months	3 to < 6 months	6 to < 9 months	9 to < 12 months	12 or surplus	No Own Product	
1	Damabandi	8	0	1	0	4	9	23
2	Damabandi, Karkhana tole	5	2	0	0	0	0	8
3	Damabandi, Kulharba	6	3	1	0	1	14	26
4	Damabandi, Prithivi chowk	1	0	0	0	0	0	2
5	Damabandi, Pulchowk	5	0	0	0	0	1	6
6	Damabandi, Shankarbari	24	2	3	0	0	0	29
7	Shankarbari, Keshaliya	0	0	0	0	0	5	6
Total		49	8	5	2	6	30	100

Source: Household Survey, April, 2021

5.4.16 Housing & Ownership

100% of the households have reported that they have their own house in the project area though there are variations in terms of housing structure. Of the total households more than 60% households having *Kachhi* with thatched roof house structure whereas about 14% are having *Semi-Pakki* structure roofed either by tin or tile. Further, 24% of the total households have reported that they have modern type of house structure with i.e. cemented column/wall with concrete casting roof.

Table 55: House structure type [%]

SN	Name of Settlement	Type of House			Total
		Concrete roof/Pakki/Cemented	Semi-Pakki (tin/tile/slate roof)	Kachhi-Thatched roof	
1	Damabandi	8	3	12	23

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2	Damabandi, Karkhana tole	1	2	5	8
3	Damabandi, Kulharba	2	5	19	26
4	Damabandi, Prithivi chowk	1	0	1	2
5	Damabandi, Pulchowk	4	2	0	6
6	Damabandi, Shankarbari	7	3	19	29
7	Shankarbari, Keshaliya	0	0	6	6
Total		24	14	62	100

Source: Household Survey, April, 2021

5.4.17 Irrigation and Cropping Pattern

The rain fed is the main irrigation system in the project area. The dominant crop in the project area is paddy followed by the wheat.

5.4.18 Electricity & Communication

Almost all houses have electricity facility connected with the national grid provided by NEA. Similarly, due to advance change in mobile technology, almost all have at least one set of functioning mobile set.

5.4.19 Urbanization

The urbanization is taking rapid pace in the project area. The private older housing structures are being concretized rapidly. The older type (normally pit latrine) toilets are being replaced by the modern means of technology using pan or flush system. As far as the public amenities like road, drain sewer line etc. are concerned, except the supply of piped water most of the things are being introduced/builtup. The land value in all most all wards is being hiked. The land price is almost beyond the touch of the normal people in the core area (mainly ward 1-14).

5.4.20 Water Supply & Sufficiency

Almost cent percent of the people in the project area uses ground water using conventional hand pump.

Table 56: Sources of drinking waters in the project area [%]

SN	Name of Settlement	Main source of drinking water		Total
		Hand pipe/Tube-well	Open well	
1	Damabandi	22.7	0.0	22.7
2	Damabandi, Karkhana tole	7.9	0.0	7.9
3	Damabandi, Kulharba	25.5	0.5	25.9
4	Damabandi, Prithivi chowk	1.9	0.0	1.9
5	Damabandi, Pulchowk	6.5	0.0	6.5
6	Damabandi, Shankarbari	29.2	0.0	29.2
7	Shankarbari, Keshaliya	6.0	0.0	6.0
Total		99.5	0.5	100.0

Source: Household Survey, April, 2021

Nepal Water Supply Corporation

Almost cent percent of the surveyed household (ward no 5 i.e. proposed new PS) have reported that they have been using the water from the hand pump i.e. ground water and not facing any deficiency in supply. No systematic piped water supply is available within this area. However, the scenario of the other parts of the BMC is different and clearly elaborated in other text of the same document. In relation to the new PS site, it can be clearly declared that they have a mix supply of systematic piped water supply and urgently need it. They are wondering to shift from hand pump ground water to the systematic piped water as swift a possible due to quality of ground water.

Table 57: Water sufficiency in the project area [%]

SN	Name of Settlement	Water Sufficiency		Total
		Yes	No	
1	Damabandi	22.7	0.0	22.7
2	Damabandi, Karkhana tole	7.9	0.0	7.9
3	Damabandi, Kulharba	25.5	0.5	25.9
4	Damabandi, Prithivi chowk	1.9	0.0	1.9
5	Damabandi, Pulchowk	6.5	0.0	6.5
6	Damabandi, Shankarbari	28.7	0.5	29.2
7	Shankarbari, Keshaliya	6.0	0.0	6.0
	Total	99.1	0.9	100.0

Source: Household Survey, April, 2021

5.4.21 Cultural Phenomenon

Almost every kind of festivals of different religions are celebrated in BMC. A remarkable portion of the population practice Hinduism, thus Hindu festivals are celebrated in the project area such as Dashain, Dipawali, Jitiya Pavain are the famous festival of the people in the area. A large number of devotees visit the Kali Mandir, a temple dedicated to Goddess Kali that lies in the heart of the town. At the same time the existence of other religions like Islam, Jainism, Kirat, and Christianity are also well respected. Biratnagar is known for its high-spirited festival celebration.

5.4.22 Historical and Archaeological site

No definable historical and archaeological sites are evident within the project area. Though it is not closer to the project area but in entire BMC area Temples, mosques, and churches are existed. Kali mandir, Hanuman Mandir, Radhakrishna mandir etc. of Hindus and Bilal Masjid, Kari Sahab Mosque, Jama Masjid etc. of Muslim are famous cultural sites.

5.4.23 Perception of the People towards the Proposed Project

During the field survey, the peoples' perception towards the ongoing project was also collected. It was carried out to make locals aware and/or understand how the project would affect them. Their perceptions are presented below:

- Most of the people had viewed that the project would stand as the landmark to change their day to day life. Soon after the completion of the project, their source of drinking water would change as they had been using iron containing ground water these days.
- Secondly, if the source of water is changed then their health status would also be changed in a positive manner. At the same time, the people would have a gracious opportunity too to work in the project during and after construction. The project is highly worthy in terms of entire manner of social life.

6 IMPACT ASSESSMENT

Based on baseline environmental studies, the initial environmental examination of direct, indirect and cumulative nature of the proposal actions on the following aspects of the environment shall be identified and predicted for construction and operation phases of the proposal. Adverse and beneficial Impacts/Issues that are not identified or anticipated at this stage, if later discovered during IEE study, shall be duly incorporated in the report.

6.1 Socio Economic and Cultural Impact

Impact during Construction phase

Loss of housing, other assets, resources use: As the new pump station is being constructed under the municipal owned land, the replacement of the pipes are being done within the ROW approximately spanning 165 KM crossing to different road intersections, the debris yard during the construction period is planned to be selected at the public land, therefore, there won't be any private property is conceived to be occupied for the project purpose during the project construction period. Hence, no any physical housing or other assets or resources which belong to the private owner will be lost or damage. The selected land and area are completely free from encumbrances.

Land Use, Agricultural lands, Cropping Pattern: Neither land use would be changed within the project area nor would any agricultural land come under the depletion by the intervention of the proposed project. Even the project won't damage the standing crops. The existing cropping pattern would remain the same.

Loss of access to facilities, services, or natural resources: The installation of the new pump stations and rehabilitation of 3 existing pump houses would not generate to any loss of access to facilities, services or may natural resources. However, the excavation of the roads for laying down the distribution water supply pipeline would temporarily cause inconvenience to local businessman, vendors, local resident and pedestrians to use those roads & walkway during the construction period. At the same time, temporarily, few informal vendors are also observed running the roadside fast-food and other business along the pipe laying alignment, which might have some critical affects during the construction period. Correspondingly, even big permanent shops of different types might not get sufficient customers and would unable to manage their daily income and expenditure due to disturbed roads access during the construction period.

Living and Livelihood: Vulnerably the local people would not prone to face any critical situation for their living and livelihood as the project would not affect in any way the economic and social activity of the local people. Nevertheless, the equipment, vehicles and mass of labors used for the construction activities at the period of the construction, some noise, dusts and air pollution would evident which might cause disturbance among the locals people, permanent businessmen and community at large.

Indigenous community, Dalit and Janajati: Few indigenous people/community, hill & Terai dalit and muslim are reported residing within the surveyed area i.e. the area proposed for the new pump station. Most of the people won't have their own land within the vicinity of the project area. They would not have adverse impact due to installation of the new pump station but they would have the positive impact as they would have opportunity of the project connecting with the piped line water. They even would not lose any housing, strip of land, crops, trees and other fixed assets owned or controlled by them.

Heritage, customs and traditions: Except few religious temples along the roadside, no as such cultural heritage sites are confirmed. The project will not affect at any cost such roadside temples. Further, the project will not alter or undermine the people's local knowledge, customary behaviors or institutions. They are open to maintain distinctive customs and traditions and economic activities in their locality. No cultural integrity will be disturbed.

Influx of Outsider: Inflow of contractor's construction employees camping nearby the local community would elevate few risks on social, economic and communicable aspects. The threat of social security also cannot be ignored in the presence of the outsiders. Disturbance on the local socio-cultural environment due to the compelled interaction between locals (such as shops etc.) and outsiders is likely to affect the local social harmony. This might cause some disputes too. Sometimes the bartering between locals and outsiders during the shopping would also turn into the big disputes in the area.

Land Occupation: The new pumping site is proposed in the public land under Municipality's control. Currently, this land is being used of local residents for stockpiling their agriculture inputs as well as to hold their livestock temporarily. The occupation of this land for the pump station would prevent their free usage which might cause few temporary grievances.

Health Condition: During the construction period, the air pollution might cause irritation and respiratory discomfort to the local residents. Particularly, children and senior citizen, and residents with chronic respiratory syndromes might suffer from such cause severe than youngsters. Similarly the sound/noise pollution would rudely disturb to the local peoples/residents. The sounds at the night time even become much screamer than that of day which cruelly affects the sleep of people in the nearby areas. This might irritate them and also might have some different health problems. Water borne disease might affect the population in case the drinking water is contaminated by sewage lines and clogged drains. Possible drain clogging and water logging with increased sewage/waste water production and inadequate sewerage system will lead to foul smell and good mosquito breeding spots which may prove to be big nuisance for the city people. In addition to that too many mosquito breeding spots have numerous health consequences. Nearby flowing Singhihari river and Kesaliya River will have more flow of contaminated water because of additional waste water getting in from the city areas making them smelly which the local people will not appreciate.

Resettlement: No resettlement plan is required to this project.

Impact during the Operation Phase

Except some of the adverse impact anticipated during the construction period, the project won't give much negative impact at the operation phase. It would have a better opening for the people with having the hygienic water supply which might motivate them cleanliness of their surroundings too. This might open for employment generation, increase in income, skills enhancement, development of market/commercial center, appreciation of land value, women empowerment, enhancement to market activities etc.

Mitigation Measures

In overall, a nodal officer is suggested to nominate from the municipality to be solely engaged for addressing the grievances which likely to emerge from the locals throughout the project construction period. The locals might be defined as the local residents, shopkeepers, temporary

vendors and so on. The officer would be responsible for collecting the possible grievances and forward it to the concerned authority for prompt response so that the proposed project would constructed smoothly without any major hassles. Further, it is also recommended that the BMC authority in association with the water supply office at Biratnagar should notify all the impacting people, business houses etc. about the construction of the project before the construction starts.

In order to control over the loss of housing, other asset like business and constraint on the walkways due to the excavation of road for laying the pipeline, the contractor should manage to use favorable options such as planking etc. At the same, the contractor should excavate in such a way that cause minimum damage. Similarly, if possible, recommend a prominent location for roadside temporary business for those who lose their daily income.

In order to safeguarding the people through screaming noise, air and dust pollution, not suggested to use high sounding equipment at night, sprinkle the water to control over the dust pollution. Establishment of small health desk board is suggested. Open up the skilled and unskilled labour employment opportunity if possible for the locals.

6.2 Biological Impacts

Impact during Construction Phase

Loss of open space: The baseline information reveals that there is no any sort of ecologically important species. Therefore there will be no harm in the ecology of the area. Open space in Tinpainsi PS however was very small and used for parking usually, may be affected while transporting and piling the construction materials during construction phase.

Loss of vegetation and regeneration: Firstly, the felling of trees will be avoided while doing the construction work of pumping stations as per design. If it is unavoidable, the felling of selected trees, as marked and approved by divisional forest office, will be done (Maximum 50 trees from all site). There will be loss of grass species and regeneration in construction phase, which may be re-established during operation phase or in long run. Since, the project components require a very small area of land for implementation, environmental impacts on the vegetation and natural ecosystem don't seem to be significant. Thus, the project will have less or no impacts on floral diversity.

Impacts on fauna: As the working site is not directly connected with forest patches nearby and the permanent habitat of any mega-fauna was also not recorded, thus no major impacts are expected. Major structures will be built on relatively clear land which was not inhabited by any wildlife. However, some native animals' movement on the area, usually on the night, will be affected. And their movement on construction site, during working period will be affected.

Impacts on birds: From field visit, major bird species included in Least Concerned status in IUCN Red List were found to be common. Though most of them were native to the pumping site, their nest was not seen on the vicinity. However, PS of Munal Path was found to be the habitat of birds, for example, nests in the Bombax ceiba, which may be affected if tree had to be harvested during the construction phase. Similarly, reporting of Near Threatened bird species (*Ciconia episcopus*), a migratory bird, was also done during field visit, and there will be no direct impact in its habitat, however its movement may be affected while construction

work happen in the site. Also, the movement of workers and vehicles for transporting construction materials may affect the appearance of birds on the site.

Impacts on aesthetic value: The aesthetic value of the site during construction will not be appealing to eyes due to ongoing construction works, pile of construction materials, pile of construction waste, etc. in the site.

During Operation Phase:

Invasion of alien plant species: The cleared site during construction later may get covered by the invasive species like Mikania, Jalajambhu, Besaram, etc.

Mitigation Measures

Loss of open space: Raw materials required will be bought and brought at the time of its utility.

Loss of vegetation and regeneration: In condition to felling trees, individuals those who will be marked and approved by divisional forest office for removal, only be felled (Maximum of 50 from all site). As compensation to those felled trees, plantation of tree saplings at the ratio of 1:25 (minimum) must be done, i.e. for every tree cut down, 25 replacements must be planted to the proposed area. The site for re-plantation should be approved and mentioned prior. While replacements be made, introduction of exotic species should be discouraged and native species should be given priority.

Impacts on fauna: The movement of the fauna in the working site can be controlled by the fencing. As the movement of fauna to the site may be due to the leakage-water from the pumping station which may be alternatively supplied by constructing small water pond in nearby vicinity, outside the active working area.

Impacts on birds: Generally, there is practice of providing barriers of green curtain materials so that the movement of the birds will be checked entering into the construction site. The height of the barrier must be according to the height of flight made by the birds in the site.

Impacts on aesthetic value: (i) Raw materials required will be bought and brought at the time of its utility (ii) Construction site will be enclosed with barriers (green curtain material).

Invasion of alien plant species: One of the prominent mitigation measures for the invasion of alien species is cutting before its flowering stage. The cuttings after, can be dried and can be added to make a compost manure.

6.3 Physical Impacts

Impacts during the Construction phase

Land stability and erosion: Excavation works and diggings are essential during the construction period primarily to lay down pipelines, which might cause erosion and cave-ins thereby causing soil erosion, silt runoff and unsettling of street surfaces. Furthermore, unorganized disposal of the excavated earth can disturb the street surface and decrease the aesthetic and economic values of the area. These activities can cause disturbance and discomfort for road users and locals. Since the construction work will be carried out in the flat terrain, thus landslides are not expected. However, some erosion can be expected as the ground will be excavated in the

project area, thus, which can get eroded by water and wind. The impact is thus direct in nature, local in extent, high in magnitude and short term in duration.

Air pollution: Air pollution during construction period, mainly in the form of dust is expected. Dust will be generated from (i) earthworks such as clearing, grubbing, excavations, and drilling; (ii) demolition works; (iii) stockpiling of natural aggregates, excavated materials and spoils; (iv) transport, loading and unloading of natural aggregates; (v) movement of construction-associated vehicles; and (vi) on-site rock crushing and concrete mixing; (vii) burning of firewood for cooking and heating in work and labor camps. The air pollution is considered as one of the significant impacts in magnitude because it will affect the resident population as well as the dwellers, as the construction works will be carried in the heavily populated and market areas. The impact is thus indirect in nature, local to regional in extent, medium in magnitude and short term in duration. The excavation works are expected to disturb the drainage pattern, disturb local drains, and also create puddles, which will result in water logging. Since the project area is located in the Terai region, the water logging can become breeding ground for mosquitos increasing risk of fatal diseases like dengue. The excavation works are expected to disturb the drainage pattern, disturb local drains, and also create puddles, which will result in water logging. Since the project area is located in the Terai region, the water logging can become breeding ground for mosquitos increasing risk of fatal diseases like dengue.

Noise: Noise is almost inevitable during the construction phase. It will be mainly coming from earthworks, concrete mixing, demolition works, movement and operation of construction vehicles and equipment, and loading and unloading of coarse aggregates. Construction works will be carried out in the heavily populated area, thus, its impact is expected to be higher to the local population. Furthermore, its significance will be even higher in areas where noise-sensitive institutions such as health care and educational facilities are situated. Though the market area already have higher noise level, mainly contributed by traffic, the construction works and use of heavy vehicles will add noise. The noise will be more disturbing for local population if the construction works are carried out during the nights. Noise levels should not exceed the national standards for noise or WHO noise level guidelines, whichever is more stringent, or result in increase in background noise level of 3 decibels at the nearest receptor location off-site. The comparative illustration of national standards versus WHO guidelines is in Table 11 of Section III. The impact is thus direct in nature, local in extent, medium in magnitude and short term in duration.

Pollution of the nearby water bodies: BMC has two rivers, namely Singiyahi and Kesaliya. These rivers are currently already in the polluted state, mainly once these rivers enter the BMC residential and market area. However, construction activities could further pollute them by: (i) poorly managed construction sediments, and waste materials; and (ii) poor sanitation practices of construction workers. The impact is thus direct in nature, local to local in extent, medium in magnitude and short term in duration.

Damage of local infrastructures: Construction works might damage local infrastructure, such as local road, drains, sewers pipelines, and compound walls of local houses. The project has provision of installing 117.5 km of pipelines of different sizes ranging between 12" dia. to 3' dia. The water pipelines are usually laid underground about 3 feet deep, so existing roads and streets will have to be dug to lay those water pipes. Thus about 170. km of trenches in roads and streets and foot-paths will have to be dug along the proposed alignments to lay those pipes.

The width of the trenches that will have to be dug will be about 2 feet to accommodate the pipes and give needed spaces for the concerned workers to work on them. The width and depth of the trenches may vary a little bit as per the sizes of the pipes and situation of the roads/streets.

Sewer lines and road drains have been constructed in many parts of Biratnagar city, most of which are laid underground along and in the roads/streets. Hence there are lot of possibilities that constructions of water pipelines and other related necessary structures like air valve chambers, sluice valve chambers may come across those existing many sewer lines and road drains, and they may get damaged to some degrees.

While digging trenches for the pipelines or pits for appurtenances like air valve chambers or sluice valve chambers in the footpaths or in narrow roads/streets, the nearby/adjointing boundary walls of private and public properties may get damaged by caving- in of their foundations in spite of all the possible precautionary measures.

NTC and NEA both are trying to replace pole held overhead transmission cables and wires based service delivery system by service through transmission cables and wires held in underground plastic conduits. These conduits are also usually buried underground about 3 feet deep and there are chambers with manholes at different places for regular maintenance purposes. Hence there are possibilities that digging trenches for water pipes along the roads/streets may damage those underground conduits holding cables or wires and the appurtenance chambers built for maintenance inspite of all the efforts to avoid that type of incidents. In case such damages happen they should be repaired immediately.

Table 58: Impact of the project components on the land

Project Component	Land use Category	Type of Acquisition	Area (in ha)	Area (in %)
Pipeline	Build up area	Temporary	15.3	93.0
Munal Path PS	No change			
Tinpaini PS				
Devkota PS				
Pump Station No 5 / Pump Station Area	Grassland / Barrenland	Permanent	0.15	1.0
Spoil Disposal Site 1	Grassland / Barrenland	Temporary	0.6	4.0
Spoil Disposal Site 2	Grassland / Barrenland	Temporary	0.4	2.0
Total			16.45	100%

Generation of spoil and solid waste: The construction will generate spoil from the excavations. The solid waste will also be generated from the workers. These need to be collected and disposed safely; otherwise, these will create sanitary issue. This is particularly sensitive as the construction will be carried out in the populated areas.

Impact during Operation Phase

Ground water depletion: The ground water recharge in the Biratnagar region is strong fed by Sapta Koshi River system as well as Siwalki range, the possibility of ground water depletion needs to be explored as a possible impact during operation of the system.

Water quality of Singhiyahi and Kesaliya: More waste water/sewage will be generated/produced as more water will be consumed by the city population, thus in absence of adequate proper sewerage system and treatment system, high possibility of water logging due to clogged drains leading to foul smells and good mosquito breeding spots. The quantity of sewage will increase with the increased water supply. The sewage will finally be disposed in to Singhiyahi and Kesaliya rivers, degrading their water quality.

Mitigation Measures

Most cost effective and pragmatic mitigation and enhancement measures for all perceived adverse impacts of the identified environmental issues for construction and operation phases shall be identified to minimize the adverse environmental impacts and maximize the beneficial ones.

Prevention/minimization of erosion: During the construction, precautionary measures will be taken to prevent and/or minimize erosion. Proper backfilling trenches will be done. Temporary access, diversions, and signboards for pedestrians will be provided. The exposed soil will be stabilized and revegetated to prevent further soil erosion.

Management of wastewater: During the construction period, environment friendly discharge of wastewater from construction sites and workers' camp and the collection of drain water from the in settlement tank will be collected before releasing them to the surface water bodies.

Minimization of noise level: The following measures will be carried out to minimize the noise coming from the construction works

- using equipment that emits the least noise, well-maintained and with efficient mufflers;
- restricting noisy activities to day time;
- avoiding use of noisy equipment or doing noisy works at night time;
- limit engine idling to a maximum of one minute;
- spread out the schedule of material, spoil and waste transport; and
- minimizing drop heights when loading and unloading coarse aggregates.

The standard for the noise level will be followed, according to which noise levels should not exceed the national standards for noise or WHO noise level guidelines, whichever is more stringent, or result in increase in background noise level of 3 decibels at the nearest receptor location off-site. The comparative illustration of national standards versus WHO guidelines is presented below

Table 59: Noise standards

Receptor	National Standard Guidelines, 2012 [dB] ¹⁷	WHO Guidelines Value for Noise Level Measured Out	Standard values to be followed

¹⁷ Environmental Protection Act 2020 (as implementing rules on noise standard guidelines)

	Doors [One house LA _q in dBA] ¹⁸		by the project [dB] ¹⁹	
	Day	Night	07:00 - 22:00	22:00 - 7:00
Industrial area	75	70	70	70
Commercial area	65	55		65
Rural residential area	45	40	55	45
Urban residential area	55	50	55	45
Mixed residential area	63	55	55	45
Quiet area	50	40		50
Water pump	65	65		65
Diesel generator	90	90		90

Prevention/minimization of pollution of the water bodies is maintained by;

- excess spoils will be disposed is designated spoil disposal sites
- locating temporary storage areas on flat grounds at safe distance from main surface drainage routes;
- shielding temporary storage areas with sandbags; and
- providing adequate water supply and sanitation facilities at work sites.

For management and final disposal of solid wastes following mitigation, measures that will be applied are:

- collection of recyclable solid wastes and supply to scrap vendors
- ensure all the camp wastes and construction wastes are placed in the designated waste collection pits away from receiving water.
- establishment of separate bounded areas for the collection and storage of all the toxic material wastes, including batteries, oil filters, mobile, burnt oils, etc. at the construction site
- collection of biodegradable wastes in separate vessels and transfer to municipal waste disposal system.
- application of various waste disposal systems for diverse wastes produced on site as per consultations with environmentalists.

Minimize damage to local infrastructures: Installing of the pipeline will damage roads/footpaths. The roads in BMC are blacktopped with the foot-paths on the both sides of the roads/streets. Care will be taken to lay the water pipes in the side foot-paths as far as possible to avoid any disturbance to traffic along the roads/streets. The dug roads/streets will be immediately backfilled once the pipe laying work is complete in each of them. However the complete reinstatement work may take some time (usually not more than a year) as the concerned contractor may wait for the newly backfilled soil/earth in the trenches to get

¹⁸ Guidelines for Community Noise, WHO, 1999.

¹⁹ If less stringent levels or measures are appropriate in view of specific project circumstances, the project office will provide full and detailed justification for any proposed alternatives.

compacted and also wait until constructions of air valve chambers/sluice valve chamber are not fully done. In case of blacktopped or cemented roads/streets the complete reinstatement work may take some more time/even 2-3 years depending on the completion time given to the concerned contractor/s.

The water pipelines may criss-cross the sewer pipes/drains. Usually the sewer lines are laid deeper than 3 feet as per need to gain enough slope/grade, so in such cases there may not be any damage except in the cases of manholes where due precautionary measures will have to be done to avoid any damage or minimum damage. However the road drains and other open drains constructed to dispose the rain/storm water may get damaged in some cases while digging trenches for water pipes. These will have to be repaired instantly once the water pipes are laid.

If the boundary walls of other private structures are damaged during the construction, these need to be reinstated as soon as possible by the project without causing any loss to the owners. In case there are losses to the owners, they should be compensated fully at the earliest.

Table 60: Summary of Socio-Economic Impacts

SN	Description of Impact	Magnitude	Extent	Duration	Significance
Construction phase					
1	Loss of housing, other assets, resources use	Minor	10 Site Specific	10 Short Term	5 25
2	Land Use, Agricultural lands, Cropping Pattern	Minor	10 Site Specific	10 Short Term	5 25
3	Loss of access to facilities, services, or natural resources	Minor	10 Local	20 Short Term	5 35
4	Living and Livelihood	Minor	10 Local	20 Short Term	5 35
5	Indigenous community, Dahi and Janajati	Minor	10 Local	20 Short Term	5 35
6	Heritage, customs and traditions	Minor	10 Local	20 Short Term	5 35
7	Influx of Outsider	Moderate	20 Local	20 Short Term	5 45
8	Land Occupation	Minor	10 Site Specific	10 Short Term	5 25
9	Health Condition	Minor	10 Local	20 Short Term	5 35
10	Resettlement	Minor	10 Site Specific	10 Short Term	5 25
Operation phase					
1	Beneficial Impact	Moderate	20 Local	20 Medium Term	10 50

Table 61: Summary of Biological Impacts

SN	Description of Impact	Magnitude	Extent	Duration	Significance
Construction phase					
1	Loss of open space	Minor	10 Site Specific	10 Short Term	5 25
2	Loss of vegetation and regeneration	Moderate	20 Site Specific	10 Short Term	5 35
3	Impacts on fauna	Minor	10 Site Specific	10 Short Term	5 25
4	Impacts on birds	Minor	10 Local	20 Short Term	5 35
5	Impacts on aesthetic value	Minor	10 Site Specific	10 Short Term	5 25
Operation phase					
1	Invasion of alien plant species	Minor	10 Local	20 Short Term	5 35

Table 62: Summary of Physical Impacts

SN	Description of Impact	Magnitude	Extent	Duration	Significance
Construction phase					
1	Land instability and erosion	Minor	10 Site Specific	10 Short Term	5 25
2	Air pollution	High	60 Local	20 Short Term	5 85
3	Water logging	High	60 Local	20 Short Term	5 85
4	Change in land use	Minor	10 Site Specific	10 Long term	20 40
5	Noise pollution	High	60 Local	20 Short Term	5 85
6	Water pollution	Medium	20 Local	20 Short Term	5 45
7	Damage to existing infrastructures	High	60 Local	20 Short Term	5 85
8	Spoil and solid waste generation	High	60 Local	20 Short Term	5 85
Operation phase					
1	Ground water depletion	Minor	10 Local	20 Medium Term	10 40
2	Poor sewage unable to manage increased water consumption and disposal	Minor	10 Local	20 Medium Term	10 40
3	Water degradation on Singhliya and Keshalya River due to increased disposal of water	Minor	10 Local	20 Medium Term	10 40

7 ANALYSIS OF ALTERNATIVES

7.1 No Project

With no new project designs proposed and no new operation procedures, the stress on the existing water supply would be inadequate and of poor quality. This could further escalate the adverse effects on the health of the residents which could get worse due to constant increase in population. Furthermore, shortfall of safe drinking water will continue and will rather go on increasing as time will pass with continuous growth in population. This will lead to increase in adverse effects on health of the city population.

7.2 Project Location

An alternative source of water supply to the metropolitan city, that is from nearby Singiyahi and Kesaliya river is an alternative to the project. However, not much water is available in the sources. The water is of very poor quality and not very reliable during the dry season. With the need of robust intake structures, there needs to be an outlook on these rivers for flooding during the rainy season. Similarly, there is also the necessity of pumping stations, new water pump lines, power transmission lines and standby power generators for this particular alternative. For the treatment of water, an effective water treatment plant needs to be in operation with numerous pump stations and overhead reservoirs along with necessary water transmission lines and distribution lines.

Studying for the alternative for procedure of operation, the water from the two rivers will be pumped for needful treatment to treatment plants located nearby surface reservoirs as the treated water will be pumped to the overhead reservoirs for distribution. If these changes are to be adapted to the project, additional time will be needed for the project as there are more physical structures to be constructed and more raw materials like aggregates and sand will be needed for the construction of related physical structures which needs to be brought from far away quarries and sand mines/rivers.

The project might make more safe water available to the city population which will have good effect on the health condition of the local people. However, there will be the need to acquire land for the purpose of construction of treatment plants and surface reservoirs. This alternative might not have a direct impact on the critical wildlife habitat and protected species, but the reduced flow in both of the rivers will have adverse effects on the fish life in the downstream of the river.

Both of the rivers have very limited water flow in the dry season, hence water supply on these will drastically reduce the flow in the downstream which will have considerable adverse effects on the fish culture and on other river water related human activities in the downstream. In the rainy season, there is severe flooding in the rivers thus needing very robust intake structures.

7.3 Alternative Source of Project

Studying for the alternative source of water supply from Koshi River to the project area has been conducted. In terms of the project design, technology and site; abundant water will be available to the beneficiaries as it is a big river. However, the location being very far that is around 30 km from Biratnagar city will emphasize the need of pump stations to be constructed at different points/locations to pump the river water. Similarly, the project will need robust intake structure to be constructed (to survive the frequent flood conditions) and a full-fledged

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treatment plant to treat water pumped all the way from the source (water mostly laden with silt and dirt most of the time). The need of long water pumping transmission and distribution lines, surface and overhead reservoirs will be crucial which will further increase the time schedule of the project as there are more physical structures to be constructed. Similarly, more raw materials like aggregates and sand will be needed for construction of the related physical structures which will be brought from far away quarries and sand mines/rivers. Similarly, the project will also need the acquisition of productive land for the construction of pump stations at different locations and some land for the treatment plants, surface reservoirs and over-head tanks. Though there is abundant water in Koshi river, it is very far from the project area and water will have to be pumped with booster pumps at several places. The water is mostly laden with silt and mud and thus an effective treatment system/plant will have to be provided. With long transmission pipeline and multi stage pumping, the project will be relatively an expensive one.

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Nepal Water Supply Corporation

8 ENVIRONMENT MONITORING PLAN

8.1 Institutional Arrangement

8.1.1 Project Management Office

Department of Water Supply (DSS) will be the executive agency, which will establish a Project Management Office (PMO) for the project. PMO will be responsible for overall planning, management, implementation, monitoring and reporting of the project.

The project officer (Environment) will be engaged in PMO to ensure implementation of environmental safeguards. He/she will be responsible for:

- Review and confirm existing IEEs and EMPs are updated based on detailed designs;
- Ensure that EMPs are included in bidding documents and civil works contracts;
- Provide insights on environmental management aspects of the project to ensure EMPs are implemented;
- Establish a system to monitor environmental safeguards of the project including monitoring the indicators set out in the monitoring plan of the EMP;
- Facilitate and confirm overall compliance with all Government rules and regulations regarding site and environmental clearances as well as any other environmental requirements as relevant;
- Supervise and provide guidance necessary to properly carry out the environmental monitoring and assessments;
- Review, monitor and evaluate effectiveness with which the EMPs are implemented, and recommend necessary corrective actions to be taken;
- Consolidate monthly environmental monitoring report;
- Ensure timely disclosure of final IEEs/EMPs in project locations and in a form accessible to the public;
- Assist with ongoing meaningful consultation and assist in setting up of GRM in respect of environment concerns
- Address any grievances brought about through the Grievance Redress Mechanism (GRM) in a timely manner as per the IEEs;
- Undertake regular review of safeguards-related loan covenants, and the compliance during program implementation; and
- organize periodic capacity building and training programs on safeguards for project stakeholders.

8.1.2 Project Management and Quality Assurance Consultant.

The Project Management and Quality Assurance Consultants (PMQAC) will provide support to the PMO in the following areas. The detailed TORs are in the PAM:

- Ensure that the quality of the designs and construction of all water supply and sanitation components implemented under the project are to the required standards; and
- Assist the PMO with the overall planning, implementation and monitoring of the project during all stages of implementation including adherence to all environmental and social safeguards' requirements.

8.1.3 Civil Works Contracts and Contractors

The contractor will be required to designate an Environment, Health and Safety (EHS) supervisor to ensure implementation of EMP during civil works. Contractors are to carry out all environmental mitigation and monitoring measures outlined in their contract. The

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contractor will be required to submit to PMO, for review and approval, a site-specific environmental management plan (SEMP) including (i) proposed sites/locations for construction work camps, storage areas, hauling roads, lay down areas, disposal areas for solid and hazardous wastes; (ii) specific mitigation measures following the approved EMP; (iii) monitoring program as per SEMP; and (iv) budget for SEMP implementation. No works can commence prior to approval of SEMP. The contractor will be required to undertake day to day monitoring and report to the PMO.

A copy of the EMP or approved SEMP will be kept on site during the construction period at all times. Non-compliance with, or any deviation from, the conditions set out in the EMP or SEMP constitutes a failure in compliance and will require corrective actions.

The PMO will ensure that bidding and contract documents include specific provisions requiring contractors to comply with: (i) all applicable labor laws and core labor standards on (a) prohibition of child labor as defined in national legislation for construction and maintenance activities; (b) equal pay for equal work of equal value regardless of gender, ethnicity, or caste; and (c) elimination of forced labor; and with (ii) the requirement to disseminate information on sexually transmitted diseases, including HIV/AIDS, to employees and local communities surrounding the project sites.

8.2 Mitigation Measures

Most cost effective and pragmatic mitigation and enhancement measures for all perceived adverse impacts of the identified environmental issues for construction and operation phases shall be identified to minimize the adverse environmental impacts and maximize the beneficial ones. A mitigation and enhancement matrix shall be prepared for construction and operation phases showing environmental issues, impacts, mitigation commitments to address the impact, agency responsible for implementation, implementation schedule and mitigation costs in tabular matrix. Furthermore, the following shall be also considered:

- Enhancement measures shall be proposed for heightening benefits accrued from the project: required fund shall be allotted to realize the intended enhancement. Any activities/measures proposed for the enhancement of living-living standard / quality of life/functioning or performance of local institutions shall be separately discussed under Corporate Social Responsibility (CSR);
 - The Proponent shall also review the responsibilities of the local, district and central level institutions and those affected by the project construction and propose steps to ensure necessary coordination during the project implementation;
 - Awareness and training programs described in the report shall include sufficient detail to cover the target group, frequency and program conductor. Allocated cost for such program shall justify the proposed activities;
 - The cost for mitigation and enhancement measures shall be provided separately according to construction and operation stages for physical environment, biological environment and socioeconomic and cultural environment;
 - Those mitigation measures that can be or are part of contractual obligation for project construction shall be clearly identified. Mechanisms of ensuring implementation of those mitigation measures as compliance of contractors shall be proposed;
 - Organization chart for implementation of mitigation measures, with a clear provision of mitigation and monitoring unit, shall be proposed;
- Management of muck and spoil disposal sites shall be proposed considering on matters like spoil/muck volume and its weight, topography, slope stability of proposed sites, depth of overburden, rock mass properties, and likelihood of generating new slides. Disposal site shall be planned with drainage facilities.

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8.3 Management Measure

An EMP includes mitigation measures to reduce all negative impacts to the acceptable levels. The EMP will guide the environmentally-sound construction of the project and ensure efficient lines of communication between PMO, consultants and contractors. The EMP will

- a. ensure that the activities are undertaken in a responsible non-detrimental manner;
- b. provide a pro-active, feasible and practical working tool to enable the measurement and monitoring of environmental performance on site;
- c. guide and control the implementation of findings and recommendations of the environmental assessment conducted for the subproject;
- d. detail specific actions deemed necessary to assist in mitigating the environmental impact of the subproject; and
- e. ensure that safety recommendations are complied with.

The contractor will be required to (i) carry out all of the mitigation and monitoring measures set forth in the approved EMP; and (ii) implement any corrective or preventative actions set out in safeguards monitoring reports that the employer will prepare from time to time to monitor implementation of this IEE, EMP and site-specific EMP (SEMP). The contractor shall allocate budget for compliance with these IEE, EMP and SEMP measures, requirements and actions. The contractor will be required to submit, for review and approval, a SEMP including (i) proposed sites/locations for construction work camps, storage areas, hauling roads, lay down areas, disposal areas for solid and hazardous wastes; (ii) specific mitigation measures following the approved EMP; and (iii) monitoring program as per EMP. No works can commence prior to approval of SEMP.

8.3.1 Prevention/minimization of erosion

During the construction, precautionary measures will be taken to prevent and/or minimize erosion. Proper backfilling trenches will be done. Temporary access, diversions, and signboards for pedestrians will be provided. The exposed soil will be stabilized and revegetated to prevent further soil erosion.

8.3.2 Prevention/minimize air pollution

The following measures will be carried out to prevent and/or minimize air pollution:

- a. confining earthworks according to excavation segmentation plan that should be part of site-specific environmental management plan (SEMP);
- b. monitoring of the air quality in and around the project areas
- c. watering of dry exposed surfaces and stockpiles of aggregates at least twice daily, or as necessary;
- d. if re-surfacing of disturbed roads cannot be done immediately, spreading of crushed gravel over backfilled surfaces;
- e. during demolition, watering of exterior surfaces, unpaved ground in the immediate vicinity and demolition debris;
- f. place signage at active work sites in populated areas;
- g. requiring trucks delivering aggregates and cement to have tarpaulin cover;
- h. limiting speed of construction vehicles on access roads and work sites to a maximum of 30 km/h;
- i. prohibit burning firewood in work and labor camps (promote liquified petroleum gas for cooking purposes and electric heater for heating purposes);
- j. use of vehicles complying with Nepal Vehicle Mass Emission Standards (NVMES), 2069 enforcement, and green sticker standards; and
- k. prohibit open burning of solid waste.

The following air quality standards shall be maintained in the project area:

Table 63: Ambient air quality standards

Parameter	Averaging period ²⁰	Nepal's ambient air quality standard, 2003 ²¹ [µg/m ³]	WHO air quality guidelines		Standard value to be followed by the project
			Global Update 2005	Second Edition 2000	
TSP	Annual	-	-	-	-
	24 hour	230	-	-	230
PM ₁₀	Annual	-	20	-	20
	24 hour	120	50	-	50
PM _{2.5}	Annual	-	10	-	10
	24 hour	-	25	-	25
SO ₂	Annual	50	-	-	50
	24 hour	70	20	-	20
NO ₂	Annual	40	40	-	40
	24 hour	80	-	-	80
CO	8 hour	10,000	-	10,000	10,000
	15 min	100,000	-	100,000	100,000
Pb	Annual	0.5	-	0.5	0.5
	Annual	20	-	-	20

8.3.3 Minimization of noise level

The following measures will be carried out to minimize the noise coming from the construction works

- a. using equipment that emits the least noise, well-maintained and with efficient mufflers;
- b. restricting noisy activities to day time;
- c. avoiding use of noisy equipment or doing noisy works at night time;
- d. limit engine idling to a maximum of one minute;
- e. spread out the schedule of material, spoil and waste transport; and
- f. minimizing drop heights when loading and unloading coarse aggregates.
- g. frequent noise quality monitoring in and around the project areas

The standard for the noise level will be followed, according to which noise levels should not exceed the national standards for noise or WHO noise level guidelines, whichever is more stringent, or result in increase in background noise level of 3 decibels at the nearest receptor location off-site. The comparative illustration of national standards versus WHO guidelines is presented below:

²⁰ Due to short term duration of the civil works, the shortest period will be more practical to use.

Table 64: Noise standards

Receptor	National Noise Standard Guidelines, 2012 [dB] ²²		WHO Guidelines Value for Noise Level Measured Out Doors [One house LA _q in dBA] ²³		Standard values to be followed by the project [dB] ²⁴	
	Day	Night	07:00 - 22:00	22:00 - 7:00	Day	Night
	Industrial area	75	70	70	70	70
Commercial area	65	55			65	55
Rural residential area	45	40	55	45	45	40
Urban residential area	55	50	55	45	55	45
Mixed residential area	63	55	55	45	55	45
Quiet area	50	40			50	40
Water pump	65	65			65	65
Diesel generator	90	90			90	90

8.3.4 Prevention/minimization of pollution of the water bodies

- a. excess spoils will be disposed in designated spoil disposal sites
- b. locating temporary storage areas on flat grounds at safe distance from main surface drainage routes;
- c. shielding temporary storage areas with sandbags; and
- d. providing adequate water supply and sanitation facilities at work sites.
- e. monitoring of the water quality of two rivers

For management and final disposal of solid wastes following mitigation, measures that will be applied are:

- a. collection of recyclable solid wastes and supply to scrap vendors
- b. ensure all the camp wastes and construction wastes are placed in the designated waste collection pits away from receiving water.
- c. establishment of separate bounded areas for the collection and storage of all the toxic material wastes, including batteries, oil filters, mobile, burnt oils, etc. at the construction site
- d. collection of biodegradable wastes in separate vessels and transfer to municipal waste disposal system.
- e. application of various waste disposal systems for diverse wastes produced on site as per consultations with environmentalists.

8.3.5 Minimize damage to local infrastructures

Installing of the pipeline will damage roads/footpaths. The roads in BMC are blacktopped with the foot-paths on the both sides of the roads/streets. Care will be taken to lay the water pipes in the side foot-paths as far as possible to avoid any disturbance to traffic along the roads/streets. The dug roads/streets will be immediately backfilled once the pipe laying work

²² Environmental Protection Act 2020 (as implementing rules on noise standard guidelines)

²³ Guidelines for Community Noise, WHO, 1999.

²⁴ If less stringent levels or measures are appropriate in view of specific project circumstances, the project office will provide full and detailed justification for any proposed alternatives.

is complete in each of them. However the complete reinstatement work may take some time (usually not more than a year) as the concerned contractor may wait for the newly backfilled soil/earth in the trenches to get compacted and also wait until constructions of air valve chambers/slucice valve chamber are not fully done. In case of blacktopped or cemented roads/streets the complete reinstatement work may take some more time/even 2-3 years depending on the completion time given to the concerned contractor/s.

The water pipelines may criss-cross the sewer pipes/drains. Usually the sewer lines are laid deeper than 3 feet as per need to gain enough slope/grade, so in such cases there may not be any damage except in the cases of manholes where due precautionary measures will have to be done to avoid any damage or minimum damage. However the road drains and other open drains constructed to dispose the rain/storm water may get damaged in some cases while digging trenches for water pipes. These will have to be repaired instantly once the water pipes are laid. If the boundary walls of other private structures are damaged during the construction, these need to be reinstated as soon as possible by the project without causing any loss to the owners. In case there are losses to the owners, they should be compensated fully at the earliest.

8.3.6 Pressure on the Ground Water Resources

It is important to keep updated records of the water extracted from the pumping stations, including the status of water discharge in nearby wells and hand pumps. Though the Terai region has large overall aquifer, local ground water table might get affected by the pumping stations. This has to be continuously monitored on one hand, on the other if the drying of the water is recorded, the project will compensate by providing the water to the users of those well and pumps.

8.3.7 Water quality of Singhiyahi and Kesaliya

The BMC has to consider expansion of sewage coverage in the city so that it can trap the increased waste water. It is important for Biratnagar, as water logging is common issue in Terai region, which provide breeding ground for water borne diseases. In order to prevent these, sewage system has to be improved. Furthermore, the waste water treatment facility of BMC has to be upgraded as well to accommodate the additional waste water. And lastly, regular water quality monitoring of the Keshaliya and Singhaniya rivers shall be conducted to keep track of their pollution level.

Subject Area	Activities increasing positive impact	What to do	Where to do	How to do	When to do	Who will do	Estimated HR, Budget and Time	Monitoring and Evaluation
Improved Drinking water supply	Provision of water treatment plant to meet satisfactory water quality	Housed deslag unit with ventilation for chlorine and training operators for handling chlorine.	BMC	Construction of water treatment plant	During Operation phase	Environmental Officer, Contractor	This cost is included in the project cost.	Incorporated in the final design and communicated to the contractors
Improvement of Socioeconomic status	Staffing will be required during construction which can result in an increase in local revenue.	Engagement of the local workforce	BMC	Recruitment of local people in the project	Before construction phase begins	Construction Contractor	This cost is included in the project construction cost	Specific provisions to comply with: -all applicable labor laws and core labor standards on the prohibition of child labor as defined in national; -equal pay for equal work of equal value regardless of gender, ethnicity, or caste; and -elimination of forced labor; and -provision of safe working conditions and information on sexually transmitted diseases, including HIV/AIDS, to employees and local communities surrounding the project sites.
Enhancement of Market Activities	Use of construction materials from the local market increasing the revenue of the project area	Secure the required materials for the project	BMC	Prioritize procurement from local market	Before construction phase	Construction Contractor	This cost is included in the project construction cost	Specific provisions to comply with the legislation for construction and maintenance activities;
Development of market commercial center	The project will increase the opportunity for income generation	Promote the products and emphasize on the utilization of the local market.	BMC	Prioritize local market for procurements	Construction phase	Contractor	This cost is included in the project construction cost	Open up the skilled and unskilled labor employment opportunity if possible for the locals.

Table 65: Environment Management Plan

Subject Area	Activities increasing positive impact	What to do	Where to do	How to do	When to do	Who will do	Estimated HR, Budget and Time	Monitoring and Evaluation
Disruption of socio-economic existing utilities	Identify and include local operators of these utilities in the detailed design documents to prevent unnecessary disruption of services.	Identify and include local operators of these utilities in the detailed design documents	BMC	List of affected utilities, and operators, Bid document to include a requirement for contingency plan for service interruptions	During construction phase	Environmental Officer	NA	The number of complaints to be monitored.
Waste generation	Generation of solid waste, wastewater from waste may cause pollution.	Follow the principle of "Reduce, Reuse, Recycle, and Recover" with measures	BMC	Placement of collection bins in the project sites, Placement of the signage, Collection and disposal of waste in the municipal Solid Waste Landfill site, Awareness and training of the workforce on solid waste management.	During construction phase	Environmental Officer, Contractor	30,00,000	Follow the principle of "Reduce, Reuse, Recycle, and Recover" with measures such as the prohibition of uncontrolled littering and discharge of waste. Solid waste management in a pit or disposed in municipal collection system

Noise Quality deterioration	Temporary increase in noise level and vibrations by excavation equipment, and the use of heavy machinery and people. Construction works being carried out in heavily populated area might impact the local population living with sensitive methods such as health care and educational facilities are situated.	vehicle's speed to be limited to 30kph. The project will follow ROW alignment along with the preparation of the project with community consultation and local administration.	BMC	Measures such as minimize drop heights, no horns until the use of road, use of vehicles and machinery with low noise emissions while maintain low noise levels.	During construction	Contractor	30,00,000	Number of complaints from sensitive receptors need to be monitored. Works near the sensitive places are to be initiated only after the approval of the institutions.
Disturbance to the Biodiversity	Activities in WUSC acquired area. There are no protected areas that will be impacted in or around project sites.	Felled trees will be replaced by compensatory plantation at minimum 1:10 down. 10 saplings must be planted.	BMC	Compensatory plantation	Construction phase	Contractor / Environmental Officer/ PMO/ Divisional Forest Office Biratnagar	10,00,000	PTU and PMO to report in writing the number of trees cut and planted if any (during detailed design stage). Complaints need to be monitored from sensitive receptors on disturbance of vegetation, etc.

Hindrance for pedestrians and other forms of transport	Road closure is not anticipated. Hauling of construction equipment and operation of equipment onsite can cause traffic problems.	BMC	Placement of signage for road diversion, Traffic management using traffic police and workers	Construction phase	Construction Contractor	15,00,000	Care will be taken to lay the water pipes in the side foot-paths as far as possible to avoid any disturbance to traffic along the roads/streets. The dug roads/streets will be immediately backfilled once the pipe laying work is complete in each of them.
Community health and safety	Impeding air circulation due to construction works causing irritation and respiratory discomfort to the local residents particularly children and senior citizen.	BMC	Supply masks to the workers, Awareness and training for workers on preventing health hazards	Before the work begins	Contractor	500,000	Following the code of conduct for workers includes restricting workers in designated areas, no open defecation, no littering, no firewood collection, no fire except designated places, no trespassing, and no residence at construction sites.
Damage due to debris, spoils, excess excavation materials	All excavated roads shall be reinstated to original condition. All affected structures are to be rehabilitated and the construction camp needs to clear of spoils.	BMC	Refer to air pollution abatement measures mentioned above	Construction phase	Contractor		PMO report in writing that the worksite is restored to original conditions and all construction related structures not relevant to OKM are removed

Drinking water supply system	To avoid the delivery of unsafe water preparation and maintenance plan should be done. Proper handling and storage of chlorine with well labeled persons to handle disinfection, safe storage of chemicals. Ensure capacity of WUSC to implement quick response to hazardous chemical spill. Water safety plan and monitor the water quality.	BMC/ Pumping station - water treatment plants	Regular water quality tests to ensure the quality meets NDWSS	Operation phase	Environmental Officer/ DWSS Biratnagar		This cost will be included in the running cost of the project.
Mishandling of chlorine	Ensure proper storage and handling practices for chemicals along with assurance of a registered and skilled person in handling of chlorine.	Pumping station - Water treatment plants	Water quality test	Operation phase	DWSS - Biratnagar/ Environmental Office		This cost will be included in the running cost of the project.

#Note: Cost incorporated are in Nepalese rupee (NPR)

9 PUBLIC HEARING

The EPR 2020 stipulates undertaking of public hearing as one of the mandatory requirements of the IEE process. A community level consultation public hearing was organized for the proposed pumping station to fulfil the EPR 2020 requirement. The public hearing also served to bring together the proponent and affected stakeholders in a forum to express their opinions and offer suggestions on a proposed undertaking in order to assist the decision-making process. Thus, the public hearings for the proposed pumping station was organized to:

- Inform local communities in the project area about the findings and outcomes of the IEE study of the rehabilitation of the pumping stations and the installing the new pumping station.
- consult the potential project affected families and other stakeholders on the issues dealt by the IEE study; and
- provide an official forum for the affected families and other stakeholders to express their concerns, opinions and suggestions on the issues dealt by the IEE report, and/or on any other outstanding issues.

Total 26 stakeholders participated in public hearing.

Table 66: Schedule of public hearings is presented below

SN	Level	Location	Date	Total number of participants	Project impact
1	Community level.	Shiddhakali Aadharbhoot Bidhyalaya, Kulaharuwa, Ward No 5	Bhadra 20, 2078	26	New Pumping station to be built

9.1 PUBLIC DISCLOSURE

The following documents were disclosed for the public hearing.

- Project brochure
- IEE executive summary in Nepali
- The main purpose of the above disclosure materials was to adequately inform the stakeholders of the IEE findings. These documents covered the essence of the IEE report in simple language.

9.2 PUBLIC HEARING PROCEDURES

Preparation for the Public Hearing

The announcement was made on the disclosure of the summary of the draft IEE Report in Nepali as well as the dates of public hearings and national workshops in the national daily "Gorkhapatra" on 13th Bhadra, 2078 (August 29th, 2021).

The IEE summary in Nepali with a cover letter was delivered to the project affected municipalities and affected ward offices, community organisations, women groups, local NGOs. The cover letter made a request to the stakeholders for providing their comments and suggestions as well as to participate in the public hearings. The names of the stakeholders at district and municipality/wards are shown in Annex.

Notification of the Public Hearing

The affected families and concerned stakeholders were notified about the undertaking of public hearing program through:

- invitation letters to the concerned stakeholders,
- pasting of public notice in the project affected municipalities and wards, and
- announcements in public media.

Invitation for the public hearing: The concerned stakeholders were formally invited for the public hearing with the invitation letter. The invitation letter along with the Summary IEE report were hand delivered to the invitees.

Pasting of the public hearing notice: The notice of the public hearing were also pasted in the project affected area. The notice was pasted at the public places like – ward office, schools, health posts and sub-health posts, offices of forest users groups, etc. The letter confirming pasting of the notice by these offices are attached in the Annex.

Announcement in Public Media: The public hearing notice was published in the national daily and local daily which were used to inform local population of the project area about the details of the public hearing. The brochures were distributed on the day of the public hearings.

Shiddhakali Aadharbhoot Bidhyalaya Public Hearing

The Shiddhakali Aadharbhoot Bidhyalaya Public Hearing was attended by 26 participants from project influenced ward; Ward No 5 of Biratnagar metropolitan city. The attendance of participants has been presented in Annex. The participants included farmers, teachers, students, NGOs, CBOs, businessmen, servicemen, forest user groups, government organizations, indigenous community, women, youths and representatives from district and VDC level political parties.

Type: Public Consultation and Information Meetings

Subject of Consultation: Presentation of the proposed project and soliciting opinions of stakeholders.

Date: 20th Bhadra, 2078, (5th September, 2021)

Location: Shiddhakali Aadharbhoot Bidhyalaya, Kulaharuwa, Ward No 5, Biratnagar

Time Duration: 10: 00 AM to 12:00 noon

Total Participants: 26 (Male-14 & Female-12)

Purpose of Consultation and Issues/themes covered:

The main purpose of this public consultation was to provide information about the proposed project to the project affected people and the institutions located within the project area, create friendly environment so that the participants discuss about the positive and negative impacts due project implementation among the participants and with the IEE Team, and to collect the major environmental impacts, issues and recommended mitigation measures as foreseen by the project people.

Targeted Stakeholders: Local communities, Project Affected People, NGO, Co-operatives, and other institutions located in the project area

Institutions/firms and individuals involved in communicating: IEE consultant team, Nepal Khanepaani Sanshan Biratnagar Branch officer.

Preparation of Consultation:

Prior Information Dissemination: One week prior to the actual consultation meetings, three representations of the consultants visited the project affected area to invite officials of municipality, wards, CBOs, local NGOs, schools, local government officials, and other institutions located in the project area and requested them to participate in the public consultation meeting.

Mode of Consultation: Verbal Communication

Documentation and Records of Consultation: Minutes, written and signed opinions and suggestions, attendance sheets signed by stakeholders, photographs, video.

Attendees/Participants

Altogether, 26 stakeholders participated in the public hearing workshop which was organized at the affected areas. Specifically, the workshop was conducted at community level organized at the project affected area in Shiddhakali Aadharbhoot Bidhyalaya Ward no 5. There were 14 male participants and 12 female participants in the workshops. The expert team members shared the IEE report in order to get their comments and their concerns on it.

Table 67: Participants in public hearing workshops

Consultation venue	Female	Male	Total
Shiddhakali Aadharbhoth Bidhyalaya Ward no 5.	12	14	26

9.3 Major issues discussed on the IEE Report

The main social concerns/issues raised by during the public hearing at Biratnagar Metropolitan City Hall and the locals in the public hearing program at Kulhanwa of BMC were;

- The IEE report has carried out detailed investigation on the possible impacts of the project to the Biratnagar environmental, social and economic condition, which we believe will minimize the possible impacts.
- The report has mentioned that the improvement project will add additional 6,555 m³/day water making the available water for supply to 15000 m³/day. However, the report also says the current demand for drinking water is 26000 m³/day and in future this demand will grow with the growth in population. Thus, it is necessary for the NSWC to start planning for next phase of projects immediately.
- The report has also mentioned necessity for improvement of water quality, we appreciate that the project has included water treatment plant and water quality testing laboratory as a part of the improvement project.
- The IEE report and its executive summary shall be made available to the Municipality once the report is approved by concerned authority.
- People of ward no 5 has fought hard to get the land for pump station 5 for this project. We hope that this project makes good use of our effort to complete the project so that people of Biratnagar can get clean drinking water.
- Shiddhakali Adharbhoth School is located right next to the proposed pump site 5, thus, during the project construction period, the school operation might be affected due to noise. Thus, the project and school have to coordinate to synchronize work schedule as well as the project shall prioritize use of less noisy equipment to minimize noise disturbance.
- Since Shiddhakali Adharbhoth School is the immediate neighbor of the project, we hope that the project and school can work together to improve the condition of the school. The Corporate Social Responsibility (CSR) of NWSC might be directed towards school improvement.

10 CONCLUSION

Under GON's Environmental Protection Act 2020 and Regulation 2021, the proposed project has been classified under its schedule 2, i.e. the projects requiring IEE study. Thus, this IEE study was carried out to meet, following the approval of its Terms and Reference (ToR) document.

The primary finding of this is that the proposed project is not an environmentally critical undertaking. IEE indicates that: the proposed project, and its components, is not located within or adjacent to environmentally sensitive areas.

The extent of adverse impacts is expected to be local, confined within the projects' main areas of influence, waste disposal sites, and the routes to and from these sites. With mitigation measures in place and ensuring that the bulk of earthworks are completed before the onset of the rainy season, the potential adverse impacts during construction would be site-specific.

The few adverse impacts of moderate magnitude during construction will be temporary and short-term (i.e., most likely to occur only during peak construction activities). These will not be sufficient to threaten or weaken the surrounding resources. Mitigation measures, integral to socially and environmentally responsible construction practices, are commonly used at construction sites and are well known to Contractors. Hence, mitigation measures would not be difficult to implement.

The proposed project will bring about: (i) the benefits of access to a reliable supply of safe and potable water; (ii) promotion of good hygiene and sanitation practices and reduced health and safety risks as positive impacts; and (iii) enhanced community health, improved quality of life and safe communities as outcomes.

Based on the above findings, we have concluded that the proposed the project no further require special study or detailed EIA.

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ANNEXES

ANNEX A: FIELD SURVEY



D. Information on Affected Persons

Any estimate of the likely number of households that will be affected by the project?

[] No. [] Yes. If yes, approximately how many?

No. of HHs losing <10% of their productive assets (land/ cowshed/shops/economic units)

No. of HHs losing 10% or more of their productive assets?

Are any of them poor, female-headed households, or vulnerable to poverty risks? [] No. [] Yes.
If Yes, please briefly describe their situation with estimated numbers of HHs?

Are any vulnerable households including Dalits and Janjatis affected? [] No. [] Yes.
If yes, please briefly describe their situation with estimated numbers of HHs?

What are the needs and priorities for social and economic betterment of vulnerable people including Dalits and Janjatis who are affected by this project?

E. Decision on Categorization
After reviewing the answers above, it is determined that the project is:

- Categorized as an A project, a full Resettlement Plan is required []
- Categorized as a B project, a short Resettlement Plan is required []
- Categorized as a C project, no Resettlement Plan is required []

Prepared by: _____ Reviewed by: _____
Date: _____ Date: _____

Approved by: _____ Endorsed by: _____
Date: _____ Date: _____

ANNEX F: IPS & VULNERABLE GROUPS IMPACT SCREENING & CATEGORIZATION FORM SOCIAL MONITORING

A. Project Data:
Municipality: Biratnagar Metropolitan City
Project Title: Improvement of Water Supply in Biratnagar
Name of Pump Station/Spoiling Site/Storage Yard:
Location: Ward No.....
Name of Consulted Person:
Date of Social Screening (dd/mm/yy).....

B. Identification of Impact on IPs/ Vulnerable Group in the project Area

Impact on Indigenous Peoples (IPs)/ Ethnic Minority(EM)/ Vulnerable Group	Not known	Yes	No	Remarks or identified problems, if any
1. Are there Dalits, Janjatis, or ethnic minorities present in project locations?				
2. Do they maintain distinctive customs and traditions and economic activities in their locality?				
3. Will the project in any way affect their economic and social activity and make them more vulnerable?				
4. Will the project affect their socioeconomic and cultural integrity?				
5. Will the project disrupt their community life?				
6. Will the project positively affect their health, education, livelihood or social security status?				
7. Will the project negatively affect their health, education, livelihood or social security status?				
8. Will the project alter or undermine their local knowledge, customary behaviors or institutions?				
9. Are IP and VC households likely to lose customary rights over, access to land?				
10. Are IPs and VCs likely to lose shelter/business and be displaced?				
11. In case no disruption of indigenous community life as a whole, will there be loss of housing, strip of land, crops, trees and other fixed assets owned or controlled by individual indigenous households?				

C. Specific Impacts on IPs and VCs	Public utilities affected	No of IP/VC Squatters affected	No of other IP/VC structures affected	No of IP/VC shops affected	No of IP/VC houses affected	Forest land required in Sq mts	Govt land required in Sq. mts.	No of IP HHs losing house over 10% of their residence	No VC families losing land	No of IP families losing land

D. Additional Information Required

- Total and affected areas of land, by type of land assets;
- Total and affected areas of structures, by type of structure (main or secondary);
- Legal status of affected land and structure assets, and duration of tenure and ownership;
- Quantity and types of affected crops and trees;
- Quantity of other losses, e.g. business or other income, jobs or other productive assets, estimated daily net income from informal shops;
- Quantity/area of affected common property, community or public assets, by type;
- Summary data on PAP households including ethnicity, name of the head of household, sex, household size, primary and secondary source of income, if headed by women, or consists of marginalized ethnic groups, Dalits, Muslims/religious minorities, elderly, disabled, indigenous people, below poverty line), landless or households losing 50% of total landholdings (particularly those totally dependent on agriculture for livelihood).
- Identify whether affected land or source of income is primary source of income; and
- Knowledge of the project and preferences for compensation and as required, relocation sites and rehabilitation measures.

E. Anticipated project impacts on indigenous peoples

Project activity and output	Anticipated positive effect	Anticipated negative effect
1.	1.	
2.		
3.		
4.		
5.		

F. Decision on Categorization

After reviewing the above, it is determined that the project is:

- Categorized as an A project, an Indigenous Peoples Development Plan (IPDP) is required []
- Categorized as a B project, a specific action favorable to indigenous peoples is required and addressed through a specific provision in related plans such as a Resettlement Plan, or a general Social Action Plan []
- Categorized as a 'C' project, no IPDP or specific action required []

Prepared by: _____

Reviewed by: _____

Date: _____

Date: _____

Approved by: _____

Endorsed by: _____

Date: _____

Date: _____

ANNEX G: HOUSEHOLD QUESTIONNAIRE FOR SOCIO-ECONOMIC AND CULTURAL RESOURCES

Place and Respondent	Particulars	Code/ID
1. Name of Municipality	Biratnagar Metropolitan City	
2. Name of Settlement		
3. Ward No:		
4. Respondent's Name		
5. Sex	Male/ Female/other	
6. Contact Phone/Mobile Number		

A1. Demographic Information

1. Information on Social Condition

Name	Relation to HH head	Sex	Age(yrs)	Education (≥5 yrs)	Marital Status (≥10yrs)	Main Occupation (≥10yrs)
				Level		
	1. Head 2. Husband/wife 3. Son/Daughter 4. Grand children 4. Son/Daughter in law 5. Daughter/Son in law 6. Parent 7. Father/Mother in law 8. Brother/Sister in law 9. Household Widow 10. Others	1. Male 2. Female 3. Third Gender		1. Can read & write 2. Can read only 3. Can't read & write 4. Beginners 5. Primary (1-5) 6. L. Secondary (6-8) 7. Secondary (9-10) 8. SLC/Equivalent 10. Inter/Equivalent 11. Grad/Equivalent 12. PG/ Equi/above	1. Married 2. Divorced 3. Separate 4. Widower 5. Unmarried	1. Agriculture 2. Livestock 3. Horticulture 4. Fisheries 5. Salary/Wage 6. Own Enterprises 7. External job 8. Household Work 9. Student 7. No work 8. Others: _____ -
a	b	c	d	e	f	g

2	What is your ethnicity?
3	What is your religion?
4	Which Language you speak?
5	In last 12 months, how many members of your family have migrated and for what reason? (Multiple Choice)	Reason for migration
		Yes =1 No =2
		a
		b
		1. Family reason
		2. Education/Training
		3. Natural disaster
		4. Looking for work
5. Easier lifestyle		
6. No migration		
7. Other (specify).....		
6	Please give ownership of the house where you lived for last 12 months?	1. Own house
		2. Rented house
		3. Relative house
		4. Land owner's house (Included in rented land)
		5. Other institutional house (free provided by government)
7	What type of residential house do you live at present?	1. Concrete roof/Pakki/Cemented
		2. Semi-Pakki (tin/tile/slate roof)
		3. Kachhi-Thatched roof
		4. Others (specify).....
8	For how many months out of last 12 months, the produce from your farm was able to meet the food needs of your family?	1. Less than 3 months
		2. 3 to < 6 months
		3. 6 to < 9 months
		4. 9 to < 12 months
		5. 12 or surplus
9	What is the principle source of drinking water for your house hold?	1. Piped water
		2. Covered well
		3. Hand pipe/Tube-well
		4. Open well
		5. Spring
		6. River
		7. Other source
10	Is that water is sufficient?	1. Yes, 2.No

11	Please mention the type of toilet being used by your household since last 12 months?	1.Toilet with flush (connected to sewer) 2.Toilet with flush (connected to safety tank) 3.Toilet without flush 4.Public latrine 5.No toilet
----	--	---

A2. Health Facility

S.N	Question	Response/Answer	
12	Where do the family members go for treatment in case of health problem?	Government	Private
		1.Village Health Post/centre	6.Private hospital
		2.District Hospital	7.Pharmacy/Clinic
		3.Mobile Clinic	8.Health worker's home
		4.AyurvedaCentre	9. Others
		5.Other Govt. Institution	

A3. Education Facility

S.N	Question	Response/Answer
13	Where do your children go for education	1. Government School, 2. Private Boarding

B. Economic Condition

B.1. Expenditure and Income

S.N	Question	Response/Answer	
14	What are the expenditures of household over last 12 months?	Activities a	Amount (Rs.) b
		1.Food	
		2.Fuel	
		3.Apparel and personal items	
		4.Social and religious activities/Donation/Charity	
		5.Insurance and taxes	
		6.Repair and maintenance of house, vehicles, equipment	
		7.Transportation	
		8.Newspaper/communication	
		9.Disaster related expenses	
		10.Input cost for agriculture/livestock/other enterprises	
		11.Health	
		12.Education	
		13.Cash losses	
		14.Other (If any)	
15	What is your approximate annual household	Enterprises/Activities a	Gross Income (Rs) b
		1.Agricultural wages/labour	
		2.Nonagricultural wages/salary	

income of last year?	3.Sale of agricultural products	
	4.Livestock/fisheries sale	
	5.Milk and milk product sale	
	6.Remittances	
	7. Occupational work (tailoring, black smithy, carpentry etc.).	
	8.Forestry related products sale	
	9.Pension	
	10. Own enterprise	
	11. Others	

B.2 Land and Agriculture

S.N.	Question	Response/Answer	
16	Do you have your own agricultural land at present? (under cultivation)	1.Yes 2.No	
17	If yes area? B-K-D	B-K-D	Major Irrigation Source
		Khet	
		Bari	
		Orchard	
		Pond	
		Other	

Note : Area : B = bigaha, K = Kattha, D = Dhur.

Source of irrigation: 1= Tube well/Boring 2= Cont. flow canal 3=Natural flow canal 4= Pond, well 5= Mixed 6=NWSC supply, 7=Others

S.N	Question	Crop pattern	Area		
			B	K	D
18	In the past year, what crops did you grow in KHET land?	a	b		
		1.Rice- wheat			
		2.Rice- wheat-fallow			
		3.Rice- wheat-maize			
		4.Rice-wheat-vegetable			
		5. Rice-pulses-fallow			
		6. Rice-wheat-mungbean			
		7. Rice-wheat-dhaincha			
		8. Rice-potato-fallow			
		9. Rice-maize-fallow			
		10. Rice-fallow-fallow			
		11. Rice-barley-fallow			

S.N	Question	Crop pattern	Area		
			B	K	D
19	In the past year, what crops did you grow in BARI land?	a	b		
		1.Maize- upland rice-fallow			
		2.Maize-finger millet-fallow			
		3.Maize-finger millet-wheat			
		4.Upland rice-fallow-fallow			
		5.Maize-mustard-fallow			
		6.Maize-rice-wheat			
		7.Maize-barley			
		8.Jute-mustard-fallow			
		9.Jute-wheat-fallow			
		10.Vegetable - vegetable			
		11.Vegetable-maize			
		12.Off season vegetable			
		13. Other.....			

C. Opinion towards the Project

20. Please provide us your opinion on current situation within the area (Please use proving helps)

21. Please provide the land value currently prevails in the area.

22. Please provide the current activities along the Project Site.

23. How do you perceive the change after the rehabilitation/new construction of PS (Please use proving helps)

24. If the change is negative please provide how this can be mitigated? (Please use proving helps)

Thanks

Name of Enumerator...

Signature

Date

Name of Supervisor

Signature

Date

ANNEX H: BASELINE STATUS OF PROJECT AREA (PS NO 5)

Sex of Respondent by Settlements				
Sl. No	Name of Settlement	Sex of Respondent		Total
		Male	Female	
1	Damabandi	40	9	49
2	Damabandi, Karkhana tole	16	1	17
3	Damabandi, Kulharba	49	7	56
4	Damabandi, Prithivi chowk	4	0	4
5	Damabandi, Pulchowk	7	7	14
6	Damabandi, Shankarbari	38	25	63
7	Shankarbari, Keshaliya	12	1	13
Total		166	50	216

# of Family Members				
Sl. No	Name of Settlement	Total	Minimum	Maximum
1	Damabandi	258	3	9
2	Damabandi, Karkhana tole	104	4	10
3	Damabandi, Kulharba	310	2	9
4	Damabandi, Prithivi chowk	27	5	9
5	Damabandi, Pulchowk	78	2	9
6	Damabandi, Shankarbari	349	2	15
7	Shankarbari, Keshaliya	66	3	8
Total		1192	2	15

Relation of Respondents to Household Head by Sex of Respondent					
Sl. No	Relation to HH	Sex of Respondent			Total
		Male	Female		
1	Head (Respondent him/herself is Head)	137	7		144
2	Husband/Wife		31		31
3	Son/Daughter	20	10		30
4	Parent	9	1		10
5	Father/Mother in law		1		1
Total		166	50		216

Education Level of Household Head					
Sex of HHH	Education Level				Total
	Can't Read & Write	Can Read Only	Read & Write		
Male	64	14	129		207
Female	6	0	3		9
Total	70	14	132		216

Marital Status of Household Head				
Sex of HHH	Marital Status (>10yrs)			
	Married	Widow/Widower	Unmarried	Total
Male	207			207
Female	9			9
Total	216			216

Main Occupation of Household Head			
Occupation	Sex of HHH		Total
	Male	Female	
Agriculture	15	2	17
External job	32	2	34
Household Work	2		2
Livestock	1		1
Own Enterprises	44	4	48
Remittances	1		1
Salary/Wage	112	1	113
Total	207	9	216

Major Ethnicity by Settlement										
Sl. No.	Ethnicity	Name of Settlement								
		Damabandi	Damabandi, Karkhana tole	Damabandi, Kulharba	Damabandi, Prithivi chowk	Damabandi, Pulchowk	Damabandi, Shankarbari	Shankarbari, Keshaliya	Total	
1	Badahi	3	0	1	1	0	5	0	10	
2	Gaderi	0	0	0	0	0	0	0	1	
3	Hajam	0	0	0	0	0	1	0	1	
4	Hill Brahmin	3	0	0	1	0	3	0	7	
5	Hill Chhetri	3	0	5	0	0	3	0	11	
6	Hill Dalit	1	0	1	0	0	2	1	5	
7	Hill Janajati	0	0	1	0	4	1	0	6	
8	Jhangad	5	0	1	0	0	2	10	18	
9	Kamat	0	1	0	0	0	0	0	1	
10	Kewat	0	0	0	0	0	4	0	4	
11	Khawas	1	12	1	1	0	4	0	19	
12	Mahato	0	0	0	0	2	1	0	3	
13	Mandal	5	0	15	0	0	16	1	37	
14	Mechata	3	0	0	0	0	3	0	6	
15	Mushahar	0	0	2	0	0	0	0	2	
16	Muslim	2	0	4	0	1	2	0	9	
17	Pandit	1	0	0	0	0	0	0	1	

18	Poddar	0	0	0	0	0	2	0	2
19	Rai	1	0	0	0	0	0	0	1
20	Rajbansi	1	2	1	0	0	0	0	4
21	Ray	1	0	0	0	4	6	0	11
22	Satar	12	0	0	0	0	0	1	13
23	Teli	2	0	1	0	1	1	0	5
24	Terai Dalit	1	0	6	0	0	0	0	7
25	Tharu	1	2	0	0	0	3	0	6
26	Turaha	0	0	6	0	0	0	0	6
27	Yadav	3	0	11	0	2	4	0	20
Total		49	17	56	4	14	63	13	216

Major Religion by Settlement					
Sl. No.	Name of Settlement	Religion			Total
		Buddhist	Hindu	Muslim	
1	Damabandi	0	47	2	49
2	Damabandi, Karkhana tole	0	17	0	17
3	Damabandi, Kulharba	0	52	4	56
4	Damabandi, Prithivi chowk	0	4	0	4
5	Damabandi, Pulchowk	1	12	1	14
6	Damabandi, Shankarbari	0	61	2	63
7	Shankarbari, Keshaliya	0	13	0	13
Total		1	206	9	216

Major Language by Settlement						
Sl. No.	Name of Settlement	Language				Total
		Bangali	Matihili	Nepali	Tharu	
1	Damabandi	2	43	5	0	49
2	Damabandi, Karkhana tole	1	14	0	1	17
3	Damabandi, Kulharba	1	49	6	0	56
4	Damabandi, Prithivi chowk	0	3	1	0	4
5	Damabandi, Pulchowk	0	10	4	0	14
6	Damabandi, Shankarbari	0	53	7	3	63
7	Shankarbari, Keshaliya	0	12	1	0	13
Total		4	184	24	4	216

Migration by Settlement				
Sl. No.	Name of Settlement	Migration		Total
		Yes	No	
1	Damabandi	3	46	49
2	Damabandi, Karkhana tole	0	17	17
3	Damabandi, Kulharba	1	55	56
4	Damabandi, Prithivi chowk	0	4	4
5	Damabandi, Pulchowk	0	14	14

6	Damabandi, Shankarbari	2	61	63
7	Shankarbari, Keshaliya	0	13	13
Total		6	210	216

Reason for Migration by Settlement				
Sl. No.	Name of Settlement	Reason for Migration		Total
		Natural disaster	Looking for work	
1	Damabandi	1	2	3
2	Damabandi, Kulharba	0	1	1
3	Damabandi, Shankarbari	0	2	2
Total		1	5	6

Ownership of House by Settlement			
Sl. No.	Name of Settlement	Ownership of House	Total
		Own house	
1	Damabandi	49	49
2	Damabandi, Karkhana tole	17	17
3	Damabandi, Kulharba	56	56
4	Damabandi, Prithivi chowk	4	4
5	Damabandi, Pulchowk	14	14
6	Damabandi, Shankarbari	63	63
7	Shankarbari, Keshaliya	13	13
Total		216	216

Type of House by Settlement					
Sl. No.	Name of Settlement	Type of House			Total
		Concrete roof/Pakki/Cemented	Semi-Pakki (tin/tile/slate roof)	Kachhi-Thatched roof	
1	Damabandi	17	6	26	49
2	Damabandi, Karkhana tole	3	4	10	17
3	Damabandi, Kulharba	5	10	41	56
4	Damabandi, Prithivi chowk	2	0	2	4
5	Damabandi, Pulchowk	9	4	1	14
6	Damabandi, Shankarbari	15	7	41	63
7	Shankarbari, Keshaliya	0	0	13	13
Total		51	31	134	216

Food Sufficiency (months) by Settlement								
Sl. No.	Name of Settlement	Food Sufficiency months						Total
		Less than 3 months	3 to < 6 months	6 to < 9 months	9 to < 12 months	12 or surplus	No Own Product	
1	Damabandi	18	1	2	1	8	19	49

2	Damabandi, Karkhana tole	11	4	1	0	0	1	17
3	Damabandi, Kulkharba	12	7	2	1	3	31	56
4	Damabandi, Prithivi chowk	3	0	0	0	0	1	4
5	Damabandi, Pulchowk	10	1	0	1	0	2	14
6	Damabandi, Shankarbari	52	4	6	0	1	0	63
7	Shankarbari, Keshaliya	0	1	0	1	0	11	13
Total		106	18	11	4	12	65	216

Main source of drinking water by Settlement				
Sl. No.	Name of Settlement	Main source of drinking water		Total
		Hand pipe/Tube-well	Open well	
1	Damabandi	49	0	49
2	Damabandi, Karkhana tole	17	0	17
3	Damabandi, Kulkharba	55	1	56
4	Damabandi, Prithivi chowk	4	0	4
5	Damabandi, Pulchowk	14	0	14
6	Damabandi, Shankarbari	63	0	63
7	Shankarbari, Keshaliya	13	0	13
Total		215	1	216

Water Sufficiency by Settlement				
Sl. No.	Name of Settlement	Water Sufficiency		Total
		Yes	No	
1	Damabandi	49	0	49
2	Damabandi, Karkhana tole	17	0	17
3	Damabandi, Kulkharba	55	1	56
4	Damabandi, Prithivi chowk	4	0	4
5	Damabandi, Pulchowk	14	0	14
6	Damabandi, Shankarbari	62	1	63
7	Shankarbari, Keshaliya	13	0	13
Total		214	2	216

Type of toilet by Settlement							
Sl. No.	Name of Settlement	Type of toilet					Total
		Toilet with flush (connected to sewer)	Toilet with flush (connected to safety tank)	Toilet without flush	Public latrine	No toilet	
1	Damabandi	0	4	42	0	3	49
2	Damabandi, Karkhana tole	0	1	16	0	0	17
3	Damabandi, Kulkharba	0	2	52	0	2	56
4	Damabandi, Prithivi chowk	0	0	4	0	0	4
5	Damabandi, Pulchowk	1	4	9	0	0	14
6	Damabandi, Shankarbari	0	1	61	1	0	63
7	Shankarbari, Keshaliya	0	0	13	0	0	13
Total		1	12	197	1	5	216

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Health Facility by Settlement		Health Facility					Total
Sl. No.	Name of Settlement	Government Health Post/Health Centre	Government District Hospital	Government Other Institution	Private Hospital	Both District & Private Hospital	
1	Damabandi	0	7	1	21	20	49
2	Damabandi, Karkhana tole	0	7	0	1	9	17
3	Damabandi, Kulkharba	0	32	1	10	13	56
4	Damabandi, Prithivi chowk	0	2	0	1	1	4
5	Damabandi, Pulchowk	0	2	0	1	11	14
6	Damabandi, Shankarbari	4	22	0	4	33	63
7	Shankarbari, Keshaliya	0	11	0	2	0	13
Total		4	83	2	40	87	216

Education Facility by Settlement		Education Facility			Total
Sl. No.	Name of Settlement	Government School	Private Boarding	Both Government & Private School	
1	Damabandi	18	26	5	49
2	Damabandi, Karkhana tole	10	3	4	17
3	Damabandi, Kulkharba	33	12	11	56
4	Damabandi, Prithivi chowk	2	2	0	4
5	Damabandi, Pulchowk	2	10	2	14
6	Damabandi, Shankarbari	34	20	9	63
7	Shankarbari, Keshaliya	6	7	0	13
Total		105	80	31	216

Expenditure of the People in the Project Area (PS 5)			
Name of Settlement	Cases	Mean	Sum
Damabandi	49	803,387.76	39,366,000.00
Damabandi, Karkhana tole	17	877,976.47	14,925,600.00
Damabandi, Kulkharba	56	735,235.71	41,173,200.00
Damabandi, Prithivi chowk	4	630,000.00	2,520,000.00
Damabandi, Pulchowk	14	1,095,428.57	15,336,000.00
Damabandi, Shankarbari	63	798,171.43	50,284,800.00
Shankarbari, Keshaliya	13	900,000.00	11,700,000.00
Total	216	811,600.00	175,305,600.00

Income of the People in the Project Area (PS 5)			
Name of Settlement	Cases	Mean	Sum

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Damabandi	49	751,885.71	36,842,400.00
Damabandi, Karkhana tole	17	651,070.59	11,068,200.00
Damabandi, Kulkharba	56	648,685.71	36,326,400.00
Damabandi, Prithivi chowk	4	645,000.00	2,580,000.00
Damabandi, Pulchowk	14	923,271.43	12,925,800.00
Damabandi, Shankarbari	63	718,919.05	45,291,900.00
Shankarbari, Keshaliya	13	631,769.23	8,213,000.00
Total	216	709,480.09	153,247,700.00

Income Group by Settlement					
Sl. No.	Name of Settlement	Income Group			Total
		Low Income Group	Middle Income Group	High Income Group	
1	Damabandi	6	30	13	49
2	Damabandi, Karkhana tole	5	12	0	17
3	Damabandi, Kulkharba	7	45	4	56
4	Damabandi, Prithivi chowk	1	3	0	4
5	Damabandi, Pulchowk	1	10	3	14
6	Damabandi, Shankarbari	9	43	11	63
7	Shankarbari, Keshaliya	2	10	1	13
Total		31	153	32	216

Having own cultivating land				
Sl. No.	Name of Settlement	Having own cultivating land		Total
		Yes	No	
1	Damabandi	11	38	49
2	Damabandi, Karkhana tole	0	17	17
3	Damabandi, Kulkharba	7	49	56
4	Damabandi, Prithivi chowk	0	4	4
5	Damabandi, Pulchowk	0	14	14
6	Damabandi, Shankarbari	6	57	63
7	Shankarbari, Keshaliya	2	11	13
Total		26	190	216

Current Land Value/Kattha around the PS 5			
Name of Settlement	Cases	Maximum	Minimum
Damabandi	49	4,000,000	2,500,000
Damabandi, Karkhana tole	17	3,500,000	3,250,000
Damabandi, Kulkharba	56	5,000,000	2,250,000
Damabandi, Prithivi chowk	4	5,000,000	3,500,000
Damabandi, Pulchowk	14	3,750,000	3,500,000
Damabandi, Shankarbari	63	4,000,000	3,250,000
Shankarbari, Keshaliya	13	3,750,000	3,250,000
Total	216	5,000,000	2,250,000

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ANNEX I: RECOMMENDATION LETTERS FROM BIRATNAGAR METROPOLITAN CITY

श्री बिराटनगर महानगरपालिका
बिराटनगर महानगरपालिकाको कार्यालय
बिराटनगर, मोरङ ।
श्री STUP Project
बिराटनगर महानगरपालिका
बिराटनगर ।

उपरोक्त विषयमा, नेपाल खासगरी सस्थानको कार्यालयबाट प्राप्त भएको यस बिराटनगर महानगरपालिकाबाट विभिन्न बहुर्र्था खासगरी सस्थान तथा बिस्तार भएको लागि खासगरी सस्थानको निर्माण (आईसी, JICA) मार्फत जाकोजको करणमा यसको लागि बिराटनगर महानगरपालिकाको कार्यालयबाटको सस्था गरेको विषयको छिन्ति। यसको लागि निम्न प्रतिकोमा बातालोपत्र प्रदान गरीएको छ। साथै बिराटनगर महानगरपालिकाबाट प्राप्त भएको जानकारीको लागि यसको लागि आवश्यक पर्ने सूचना तथा तथ्याङ्कहरू तयार पारेकोमा जानकारी दिनुको लागि आवश्यक माहुरी गरि दिने हुन अनुरोध छ ।

१. श्री बिराटनगर महानगरपालिकाको कार्यालय प्रमुख
कार्यालय प्रमुख

सोपान :-
श्री ईन्जिनियरिङ्ग कार्यालय
नेपाल खासगरी सस्थान
कार्यालय, बिप्लवबजार, काठमाडौं ।
श्री YACHIO ENGINEERING CO. LTD.
काठमाडौं ।
श्री बिराटनगर महानगरपालिका
काठमाडौं ।

पत्र संख्या: २०७३/१९९९
मिति: ०६-०७-२०७३
Email: biratnagarwcc@gmail.com

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१०८१
 २०६८/१९/१६
 १०८१
 २०६८/१९/१६
 २०६८/१९/१६
 १०८१
 २०६८/१९/१६

ANNEX I: MINUTE OF THE DISCUSSION WITH THE MAYOR

आज दिनांक २०६८/१९/१६ रोजी मी शिवाजी नगर महानगरपालिकेसो कार्यवाही, जो
 महानगरपालिका को प्रमुख श्री शिवाजी नगर महानगरपालिका
 महानगरपालिका को प्रमुख श्री शिवाजी नगर महानगरपालिका
 महानगरपालिका को प्रमुख श्री शिवाजी नगर महानगरपालिका

क्र.सं.	नाम, पद	पद संस्था	हस्ताक्षर
१)	श्री शिवाजी नगर	प्रमुख, महानगरपालिका	[Signature]
२)	श्री शिवाजी नगर	उपप्रमुख, महानगरपालिका	[Signature]
३)	श्री शिवाजी नगर		
४)	श्री शिवाजी नगर	Team Leader, METCO CONSULTANT	
५)	श्री शिवाजी नगर	JICA (Business Consultant for Nepal Project)	
६)	श्री शिवाजी नगर	WATER SUPPLY EXPERT, METCO	
७)	श्री शिवाजी नगर	SOOD-ECONOMIST, METCO	
८)	श्री शिवाजी नगर	Environmental Research Consultant, METCO	
९)	श्री शिवाजी नगर	FORESTRY EXPERT, METCO	[Signature]
१०)	श्री शिवाजी नगर		[Signature]
११)	श्री शिवाजी नगर		[Signature]

२२) श्री शिवाजी नगर
 २३) श्री शिवाजी नगर

प्रस्तावना:
 १) शिवाजी नगर महानगरपालिका को कार्यवाही
 २) शिवाजी नगर महानगरपालिका को कार्यवाही

अनुभव तथा निर्णय:
 १) शिवाजी नगर महानगरपालिका को कार्यवाही
 २) शिवाजी नगर महानगरपालिका को कार्यवाही

ANNEX J: FOCUS GROUP DISCUSSION WITH MOTHERS GROUP AT PUMP NO 5

आज दिनांक २०६८ साल वैशाख ०८ गते प्रयोग नं ५ मा रहेको स्थान
 शिवाजी नगर महानगरपालिका को कार्यवाही

स्थान: श्री बिद्धवती बाजारस्थित शिवाजी नगर महानगरपालिका

नाम	उमेर	शिक्षा
१. जीता कर्णपात	२३	१५+
२. सोमा थापा	३०	-
३. अनिसा थापा	४०	-
४. आशा थापा	२५	४+
५. कर्मवीरा कर्णपात	४५	-
६. कुशुमी देवी थापा	३०	६+
७. रञ्जना शायर	२५	-

ANNEX K: SUPPORT LETTER FROM YACHICO



To,
Dr. Bhupendra Prasad
 General Manager,
 Nepal Water Supply Corporation
 Central Office, Tripureshwar,
 Kathmandu, Nepal

Subject: Request to provide support

Dear Sir,

I would like to inform you that Yachiyo Engineering Co. Ltd. have contracted **Meteon Consultants Pvt. Ltd.** of Kathmandu, Nepal on 26th February 2021 for "**Preparation works of Terms of Reference (TOR) of Initial Environmental Examination (IEE) Study and IEE Report for The Preparatory Survey for the Project for Improvement of Water Supply System in Biratnagar**".

Team of Meteon Consultants Pvt. Ltd. have planned to conduct the field survey and data collection works in Biratnagar from 13th April 2021. They are planning to conduct stakeholders meetings including several government and other organizations during their study period. Thus I would like to request you to provide us your valuable cooperation and support for the proposed study and provide them an official letter addressed to organizations listed below for their time for meetings, support and cooperation during the data collection and study period.

The list of organizations to be visited are as follows:

1. Biratnagar Municipality Office,
2. CDO Office, Morning, Biratnagar
3. 14 Ward Offices of Biratnagar Municipality
4. Department of Roads, Biratnagar
5. Department of Irrigation, Biratnagar

[Handwritten signature]
 Page 1 of 2



6. Nepal Electricity Authority, Biratnagar
7. Nepal Telecom, Biratnagar
8. Secondary Towns Integrated Urban Environmental Improvement Project, Biratnagar
9. Any other organizations/institutions, if required (will request later)

Thanking you for your kind support and cooperation.

With Sincere Regards,

[Handwritten signature]
Katsumi Fujii
 Team Leader
 Yachiyo Engineering Co., Ltd.
 Tokyo, Japan
 Email : kt-fuji@yachyo-eng.co.jp

- CC:
1. Mr. Iswari Prasad, Manager, NWSC Kathmandu
 2. Mr. Shalindra Shah, Office Chief, NWSC Biratnagar
 3. Mr. Niigata Rajbhandari, Managing Director, Meteon Consultants Pvt. Ltd.

ANNEX L: SUPPORT LETTERS



ANNEX M: PHOTOGRAPHS OF FGDS



FGD with the Mayor of Biratnagar Metropolitan City



FGD at the Regional Town Development Unit



FGD with the Mothers Group at the Pump No 5

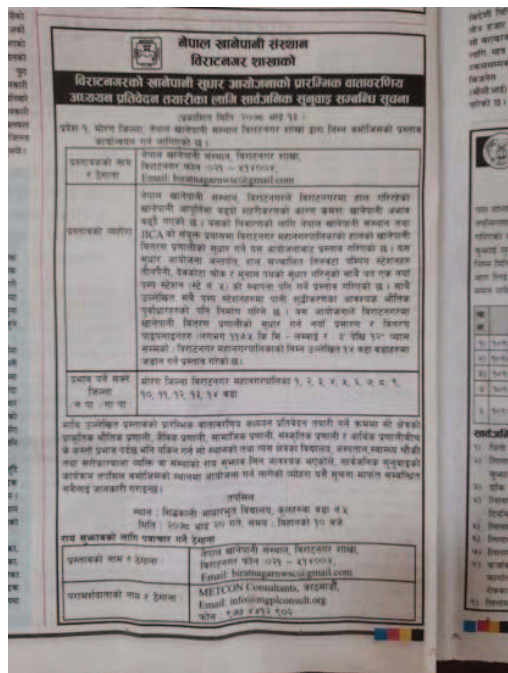


FGD with the residents of Pump No 5

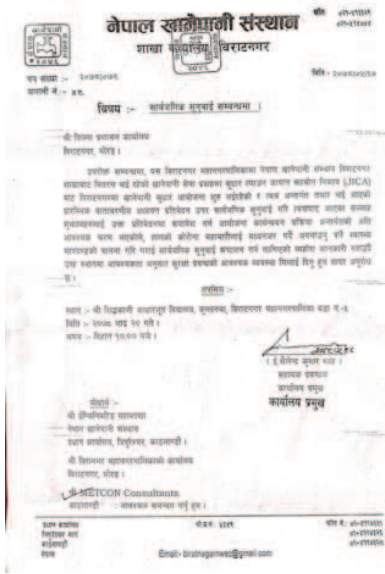


FGD with Nepal Khane Pani Sanstha Biratnagar

ANNEX N: PUBLICATION OF NOTICE FOR PUBLIC HEARING IN GORKHAPATRA (DATED: BHADRA 13, 2078)



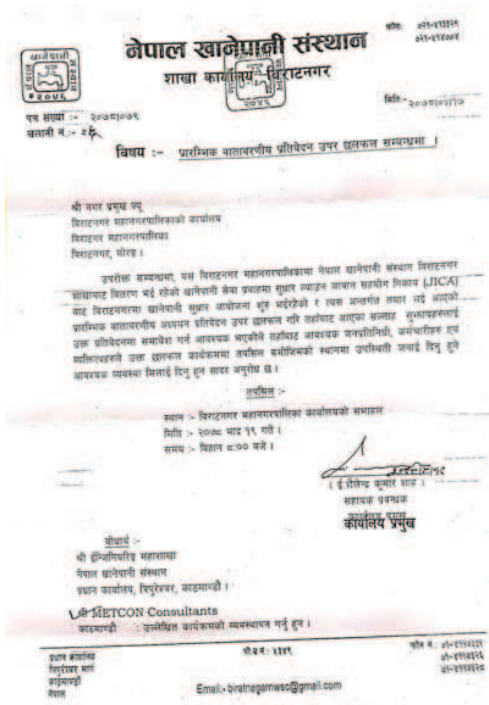
ANNEX O: NOTICES REGARDING PUBLIC HEARING



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ANNEX O: PICTURES OF PUBLIC HEARING



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ANNEX P: ATTENDANCE THE PUBLIC HEARING

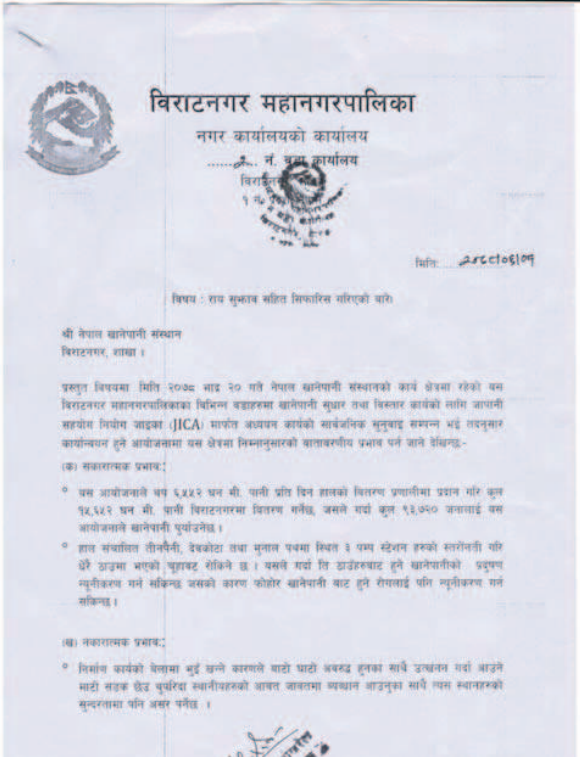
Date: / /

आज दिनांक 2022 साल माघ 28 गते सर्वोच्च न्यायालयको नयाँ न्यायालयको निर्माण गर्नका लागि माथिल्लो न्यायालयको निर्माण गर्ने योजनाको बारेमा जानकारी दिने कार्यक्रमको आयोजना गरिएको थियो। कार्यक्रममा सर्वोच्च न्यायालयका न्यायाधीशहरूको उपस्थितिमा कार्यक्रमको आयोजना गरिएको थियो।

क्र.सं.	नाम	पता	संकेत
1	श्री. रमेश कुमार शर्मा	काठमाडौं	1234
2	श्री. सुदीप शर्मा	काठमाडौं	5678
3	श्री. रमेश शर्मा	काठमाडौं	9012
4	श्री. सुदीप शर्मा	काठमाडौं	3456
5	श्री. रमेश शर्मा	काठमाडौं	7890
6	श्री. सुदीप शर्मा	काठमाडौं	1234
7	श्री. रमेश शर्मा	काठमाडौं	5678
8	श्री. सुदीप शर्मा	काठमाडौं	9012
9	श्री. रमेश शर्मा	काठमाडौं	3456
10	श्री. सुदीप शर्मा	काठमाडौं	7890
11	श्री. रमेश शर्मा	काठमाडौं	1234
12	श्री. सुदीप शर्मा	काठमाडौं	5678
13	श्री. रमेश शर्मा	काठमाडौं	9012
14	श्री. सुदीप शर्मा	काठमाडौं	3456
15	श्री. रमेश शर्मा	काठमाडौं	7890
16	श्री. सुदीप शर्मा	काठमाडौं	1234
17	श्री. रमेश शर्मा	काठमाडौं	5678
18	श्री. सुदीप शर्मा	काठमाडौं	9012
19	श्री. रमेश शर्मा	काठमाडौं	3456
20	श्री. सुदीप शर्मा	काठमाडौं	7890

Date: / /

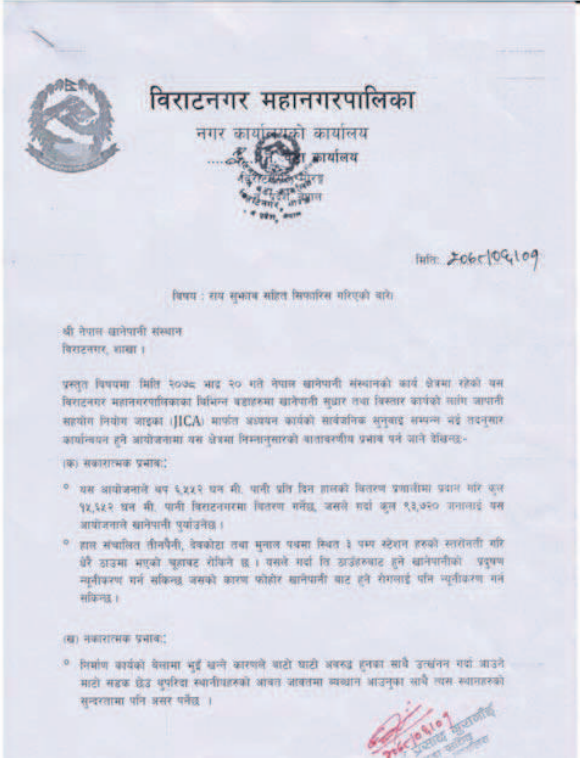
क्र.सं.	नाम	पता	संकेत
21	श्री. सुदीप शर्मा	काठमाडौं	1234
22	श्री. रमेश शर्मा	काठमाडौं	5678
23	श्री. सुदीप शर्मा	काठमाडौं	9012
24	श्री. रमेश शर्मा	काठमाडौं	3456
25	श्री. सुदीप शर्मा	काठमाडौं	7890



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विराटनगर महानगरपालिका
 नगर कार्यालयको कार्यालय
 न. चडा कार्यालय
 विराटनगर, मोरङ
 १ न. वडा, नेपाल
 मिति: ०६/११

विषय : रात सुजाब सहित निर्धारित गरिएको बाँचे

श्री नेपाल खानेपानी संस्थान
 विराटनगर, झापा ।

प्रस्तुत विषयमा मिति २०७८ भाद्र २० गते नेपाल खानेपानी संस्थानको कार्य क्षेत्रमा रहेको राम विराटनगर महानगरपालिकाका विभिन्न वडाहरूमा खानेपानी सुधार तथा विस्तार कार्यको लागि जापानी सहयोग निधिमा जाइका (JICA) मार्फत अग्रपथ कार्यको सांख्यिकीक अनुसंध समन्वय भई तदनुसार कार्यन्वयन हुने आयोजनामा राम क्षेत्रमा विमानतुसारको बातावरणीय प्रभाव पर्ने जाने देखिन्छ-

(क) सकारात्मक प्रभावः

- १. वन आयोजनाले राम ६,४४२ घन मी. पानी प्रति दिन हावाको विवरण प्रणालीमा प्रदान गरी कुल १४,४४२ घन मी. पानी विराटनगरमा विवरण गर्नेछ, जसले गर्दा कुल १३,७२० जनालाई राम आयोजनाले खानेपानी पुर्‍याउनेछ ।
- २. हाल संचालित तीर्थपानी, देवकोटा तथा मुनाल पथमा स्थित ३ पम्प स्टेशन हरूको सार्वजनिक सार्वजनिक क्षेत्रमा भएको चुनौत रोकिएको छ । यसले गर्दा ति डाइरेक्टबाट हुने खानेपानीको प्रदुषण म्यूनीकरण गर्न सकिन्छ जसको कारण फोहोर खानेपानी बाट हुने रोगलाई पनि म्यूनीकरण गर्न सकिन्छ ।

(ख) नकारात्मक प्रभावः

- १. निर्माण कार्यको वेलासा मुई खाने कार्याले बाटो धाँटो अवरुद्ध हुनका साथै उपखनन गर्दा आउने बाटो सडक छेउ सुपरिदा स्थानीयवासीको आवाज जासना सम्बन्ध आउनुका साथै त्यस स्थानहरूको सुन्दरतामा पनि असर पर्नेछ ।

06/11

० निर्माणको दौरान, बाधु प्रदुषण, तेज जलन र अन्य हवावा-परभाव सम्बन्धी समस्याहरू पर्ने संझन, विशेषगरी बातावरणीय र जोड नागरिकहरूमा यी समस्या बढी भएन जाँडन हुन सक्छ । त्यसैगरी अन्य प्रदुषणले स्थानीय जनता, वासिन्दाहरूलाई असर गर्न सक्नेछ । विशेष गरी रातको समयमा सामान्य अति धनि कर्म हुने हुनाले निर्माणको नोकका मासिहरूको निद्रा प्रभावित हुनसक्छ

उल्लेखित प्रभावको आधारमा सकारात्मक प्रभाव अतिपुष्टि गर्ने र नकारात्मक प्रभाव मूल गर्ने बातावरणीय व्यवस्थापनको योजना कार्यन्वयन गर्दा उल्लेखित प्रभावको सकारात्मक प्रभाव बढी हुने देखिएकोले उल्लेखित प्रस्ताव निम्न आधारमा कार्यन्वयन गर्न भिन्ने जसोत उल्लेख गरी यी निर्धारित गरिएको छ

प्रस्ताव कार्यन्वयन गर्न भिन्ने आधारः

१. प्राथमिक हिसावले उपयुक्त भएकोले ।
२. आयोजनाले बढ्दो जनसंख्यालाई स्वरुद्ध खानेपानी पुर्‍याउने छ ।
३. वन फाइती कम हुने भएकोले ।
४. स्थानीय जनताको यस संरचना निर्माणमा सकारात्मक सहभागिता तथा रचनात्मक सहयोग रहेकोले

प्रस्ताव कार्यन्वयन गर्न भिन्ने आधारः

१. खाँते उल्लेखनीय केही नभएको

दस्तावेजः *06/11*
 नामः *मि. सुजाब*
 पदः *सहायक प्रमुख*

सोझार्थः श्री METCON Consultant
 काठमाण्डौ, नेपाल ।

विराटनगर महानगरपालिका
 नगर कार्यालयको कार्यालय
 न. चडा कार्यालय
 विराटनगर, मोरङ
 १ न. वडा, नेपाल
 मिति: ०६/११/२०

विषय : रात सुजाब सहित निर्धारित गरिएको बाँचे

श्री नेपाल खानेपानी संस्थान
 विराटनगर, झापा ।

प्रस्तुत विषयमा मिति २०७८ भाद्र २० गते नेपाल खानेपानी संस्थानको कार्य क्षेत्रमा रहेको राम विराटनगर महानगरपालिकाका विभिन्न वडाहरूमा खानेपानी सुधार तथा विस्तार कार्यको लागि जापानी सहयोग निधिमा जाइका (JICA) मार्फत अग्रपथ कार्यको सांख्यिकीक अनुसंध समन्वय भई तदनुसार कार्यन्वयन हुने आयोजनामा राम क्षेत्रमा विमानतुसारको बातावरणीय प्रभाव पर्ने जाने देखिन्छ-

(क) सकारात्मक प्रभावः

- १. वन आयोजनाले राम ६,४४२ घन मी. पानी प्रति दिन हावाको विवरण प्रणालीमा प्रदान गरी कुल १४,४४२ घन मी. पानी विराटनगरमा विवरण गर्नेछ, जसले गर्दा कुल १३,७२० जनालाई राम आयोजनाले खानेपानी पुर्‍याउनेछ ।
- २. हाल संचालित तीर्थपानी, देवकोटा तथा मुनाल पथमा स्थित ३ पम्प स्टेशन हरूको सार्वजनिक सार्वजनिक क्षेत्रमा भएको चुनौत रोकिएको छ । यसले गर्दा ति डाइरेक्टबाट हुने खानेपानीको प्रदुषण म्यूनीकरण गर्न सकिन्छ जसको कारण फोहोर खानेपानी बाट हुने रोगलाई पनि म्यूनीकरण गर्न सकिन्छ ।

(ख) नकारात्मक प्रभावः

- १. निर्माण कार्यको वेलासा मुई खाने कार्याले बाटो धाँटो अवरुद्ध हुनका साथै उपखनन गर्दा आउने बाटो सडक छेउ सुपरिदा स्थानीयवासीको आवाज जासना सम्बन्ध आउनुका साथै त्यस स्थानहरूको सुन्दरतामा पनि असर पर्नेछ ।

06/11/20

० निर्माणको दौरान, बाधु प्रदुषण, तेज जलन र अन्य हवावा-परभाव सम्बन्धी समस्याहरू पर्ने संझन, विशेषगरी बातावरणीय र जोड नागरिकहरूमा यी समस्या बढी भएन जाँडन हुन सक्छ । त्यसैगरी अन्य प्रदुषणले स्थानीय जनता, वासिन्दाहरूलाई असर गर्न सक्नेछ । विशेष गरी रातको समयमा सामान्य अति धनि कर्म हुने हुनाले निर्माणको नोकका मासिहरूको निद्रा प्रभावित हुनसक्छ

उल्लेखित प्रभावको आधारमा सकारात्मक प्रभाव अतिपुष्टि गर्ने र नकारात्मक प्रभाव मूल गर्ने बातावरणीय व्यवस्थापनको योजना कार्यन्वयन गर्दा उल्लेखित प्रभावको सकारात्मक प्रभाव बढी हुने देखिएकोले उल्लेखित प्रस्ताव निम्न आधारमा कार्यन्वयन गर्न भिन्ने जसोत उल्लेख गरी यी निर्धारित गरिएको छ

प्रस्ताव कार्यन्वयन गर्न भिन्ने आधारः

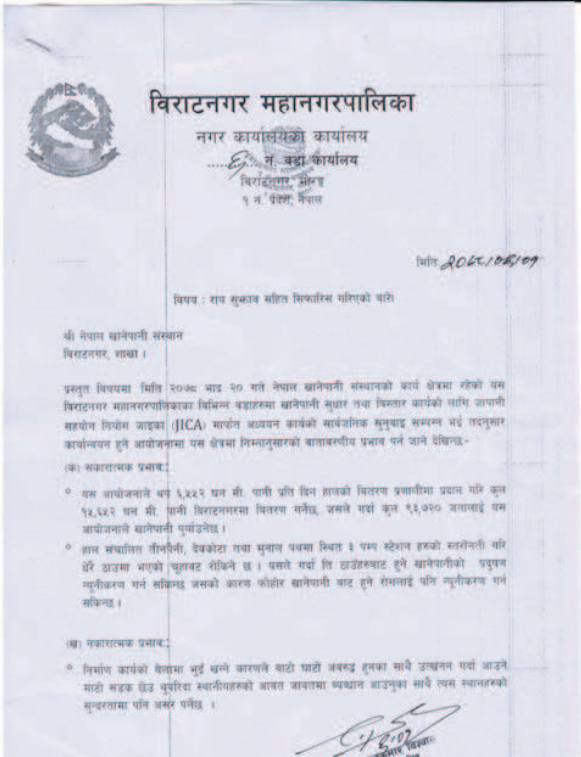
१. प्राथमिक हिसावले उपयुक्त भएकोले ।
२. आयोजनाले बढ्दो जनसंख्यालाई स्वरुद्ध खानेपानी पुर्‍याउने छ ।
३. वन फाइती कम हुने भएकोले ।
४. स्थानीय जनताको यस संरचना निर्माणमा सकारात्मक सहभागिता तथा रचनात्मक सहयोग रहेकोले

प्रस्ताव कार्यन्वयन गर्न भिन्ने आधारः

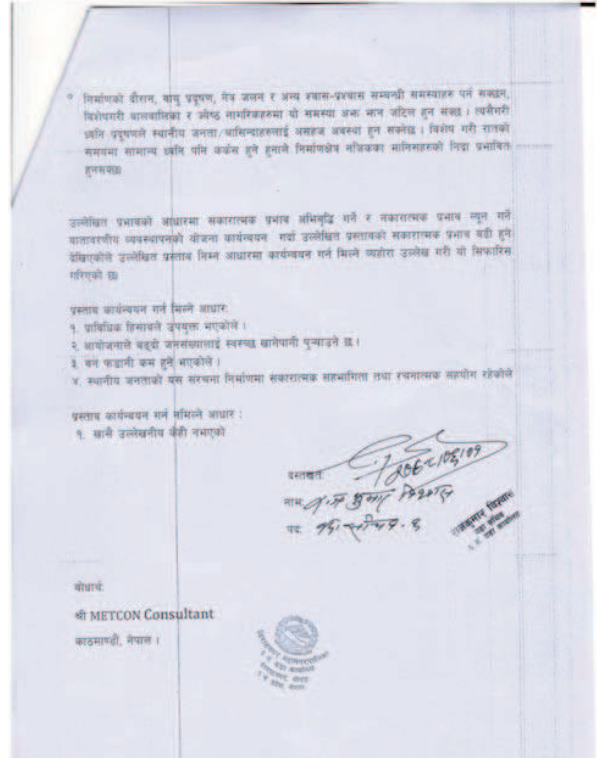
१. खाँते उल्लेखनीय केही नभएको

दस्तावेजः *मि. सुजाब*
 नामः *मि. सुजाब (अध्यक्ष)*
 पदः *सहायक प्रमुख*

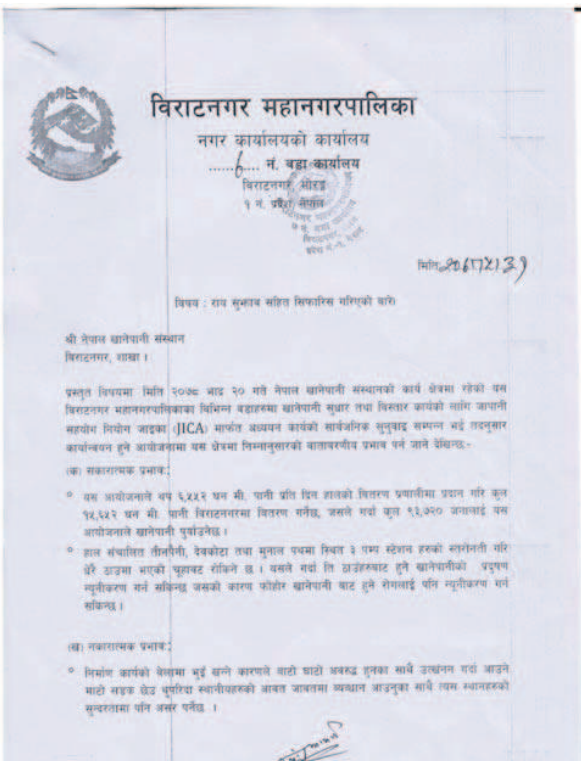
सोझार्थः श्री METCON Consultant
 काठमाण्डौ, नेपाल ।



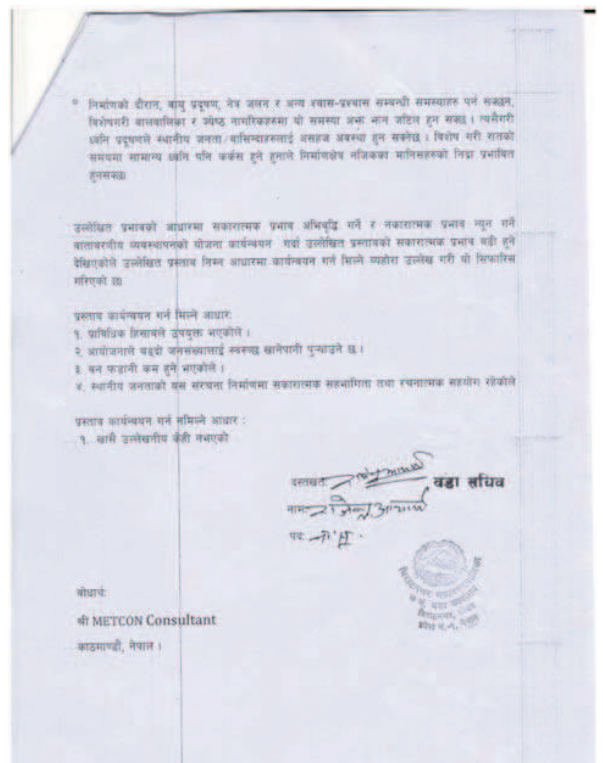
197



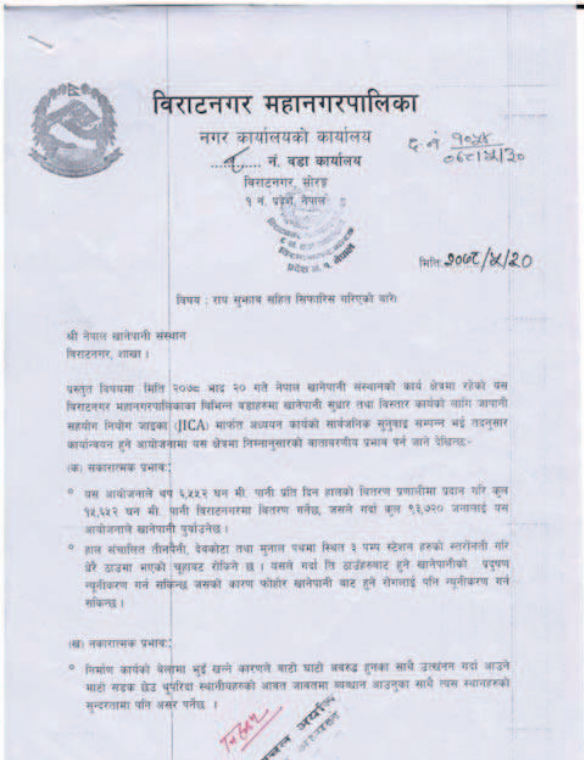
198



199



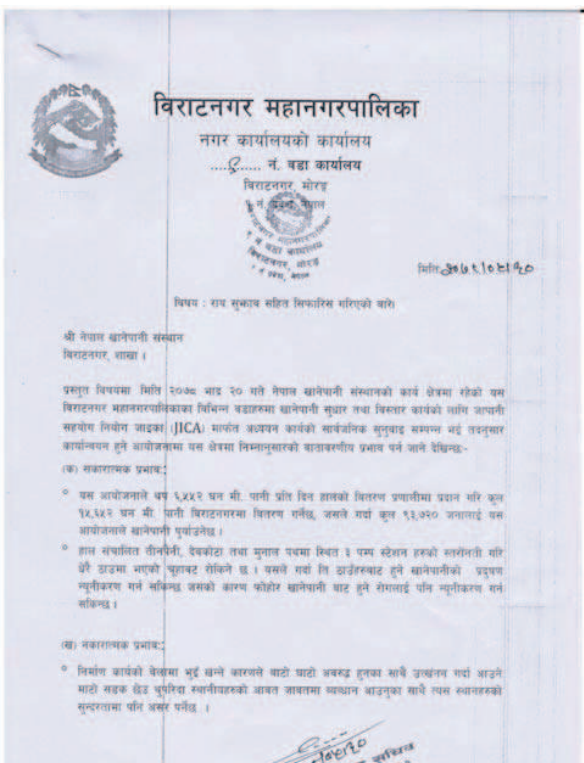
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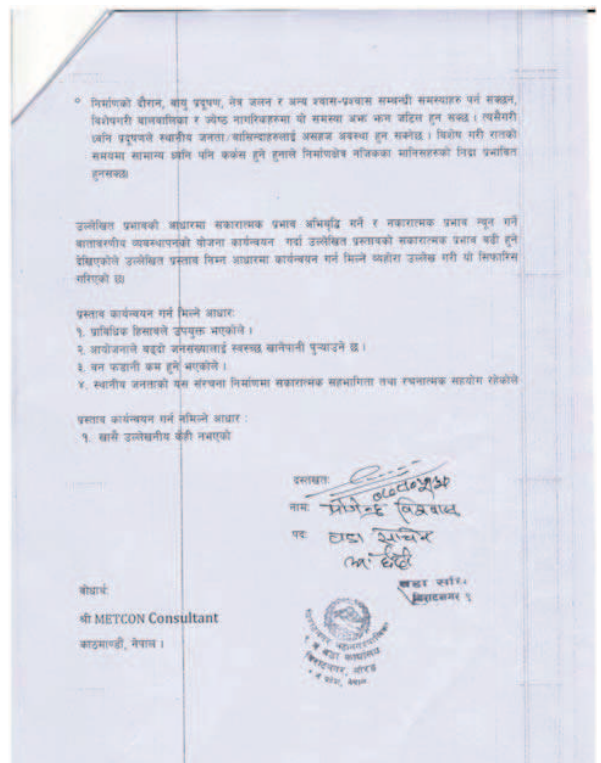
201



202



203



204

विराटनगर महानगरपालिका
नगर कार्यालयको कार्यालय
...१०... न. वडा कार्यालय
विराटनगर, मोरङ
३ न. प्रदेश, नेपाल

मिति: २०७८/०४/३०

विषय: राध मुस्ताव सहित विचारार्थ गरिएको बारे

श्री नेपाल खानेपानी संस्थान
विराटनगर, राधा।

प्रस्तुत विषयमा मिति २०७८ माघ २० गते नेपाल खानेपानी संस्थानको कार्य क्षेत्रमा रहेको यस विराटनगर महानगरपालिकाका विभिन्न वडाहरूमा खानेपानी सुधार तथा विस्तार कार्यको लागि जापानी सहयोग निधिमा जाइका (JICA) मार्फत अत्यन्तै कार्यको सार्वजनिक अनुबन्ध सम्पन्न भई तदनुसार कार्यान्वयन हुने आयोजनामा यस क्षेत्रमा निम्नानुसारको सातवर्षीय प्रभाव पर्ने जाने देखिन्छ-

(क) सकारात्मक प्रभाव:-

- यस आयोजनाले धेरै ६,२४२ घन मी. पानी प्रति दिन हावको विस्तारण प्रयासमा प्रदान गरि कुल १२,४८४ घन मी. पानी विराटनगरमा विस्तारण गर्नेछ, जसले गर्दा कुल १२,७२० जनालाई यस आयोजनाले खानेपानी पुर्‍याउनेछ।
- हाल संघारित तीनैबी, देबकोटा तथा मुस्ताव पथमा स्थित ३ पम्प स्टेशनहरूको स्तरोन्नती गरि उनी डाउनमा भारको घुटावट रोकिने छ। यसले गर्दा ति डाउनहरूबाट हुने खानेपानीको प्रदूषण न्यूनीकरण गर्न सकिन्छ जसको कारण फोहोर खानेपानी बाट हुने रोगलाई पनि न्यूनीकरण गर्न सकिन्छ।

(ख) सकारात्मक प्रभाव:-

- निर्माण कार्यको वेलामा भुईँ खाने कारणले बाटो धाटो अबरुड हुनका साथै उखान्न गर्दा आउने बाटो सडक छेउ चुनैरिहा स्थानीयहरूको आवाज जावामा व्यथान आउनुका साथै यस स्थानहरूको सुन्दरतामा पनि असर पर्नेछ।

श्री न. वडा कार्यालय
सुरेन्द्र उपाध्याय

निर्माणको दौरान, बाँध प्रदूषण, गैर जलत र अन्य रवात-प्रभाव सम्बन्धी परामर्शदाता पत्र ससहन, विशेषगरी बाह्यकारिका र जेट्टा मासिकहरूमा यी समस्या अत्र अत्र उल्लेख हुन सक्छ। त्यसैगरी अति प्रदूषणले स्थानीय जनता/वाणिज्यहरूलाई असरदा अबस्था हुन सक्नेछ। विशेष गरी रातको समयमा सामान्य अति पनि कर्बन हुने हुनाले निर्माणको नविकका मासिकहरूको विज्ञा प्रमावित हुनसक्छ।

उल्लेखित प्रभावको आधारमा सकारात्मक प्रभाव अतिवृद्धि गर्ने र नकारात्मक प्रभाव मूलतः गरी सातवर्षीय अवस्थानको योजना कार्यान्वयन गर्दा उल्लेखित प्रभावको सकारात्मक प्रभाव बढी हुने देखिएकोले उल्लेखित प्रस्ताव निम्न आधारमा कार्यान्वयन गर्न भिन्ने ध्याहार उल्लेख गरी यो विचारार्थ गरिएको छ।

प्रस्ताव कार्यान्वयन गर्न भिन्ने आधार:

1. प्राविधिक विस्तारले दुपयुक्त भएकोले।
2. आयोजनाले बढ्दो जनसंख्यालाई स्वस्थ खानेपानी पुर्‍याउने छ।
3. यस फाइदी कम हुने भएकोले।
4. स्थानीय जनताको यस संरचना निर्माणमा सकारात्मक सहभागिता तथा सकारात्मक सहयोग रहेकोले।

प्रस्ताव कार्यान्वयन गर्न भिन्ने आधार:

1. यारी उल्लेखनीय बढी नभएको।

दस्तावेज: [Signature]
नाम: सुरेन्द्र उपाध्याय
पद: न. वडा कार्यालय, मोरङ
सुरेन्द्र उपाध्याय

पेशार्थे
श्री METCON Consultant
काठमाण्डौ, नेपाल।

विराटनगर महानगरपालिका
नगर कार्यालयको कार्यालय
...११... न. वडा कार्यालय
विराटनगर, मोरङ
३ न. प्रदेश, नेपाल

मिति: २०७८/०४/३०

विषय: राध मुस्ताव सहित विचारार्थ गरिएको बारे

श्री नेपाल खानेपानी संस्थान
विराटनगर, राधा।

प्रस्तुत विषयमा मिति २०७८ माघ २० गते नेपाल खानेपानी संस्थानको कार्य क्षेत्रमा रहेको यस विराटनगर महानगरपालिकाका विभिन्न वडाहरूमा खानेपानी सुधार तथा विस्तार कार्यको लागि जापानी सहयोग निधिमा जाइका (JICA) मार्फत अत्यन्तै कार्यको सार्वजनिक अनुबन्ध सम्पन्न भई तदनुसार कार्यान्वयन हुने आयोजनामा यस क्षेत्रमा निम्नानुसारको सातवर्षीय प्रभाव पर्ने जाने देखिन्छ-

(क) सकारात्मक प्रभाव:-

- यस आयोजनाले धेरै ६,२४२ घन मी. पानी प्रति दिन हावको विस्तारण प्रयासमा प्रदान गरि कुल १२,४८४ घन मी. पानी विराटनगरमा विस्तारण गर्नेछ, जसले गर्दा कुल १२,७२० जनालाई यस आयोजनाले खानेपानी पुर्‍याउनेछ।
- हाल संघारित तीनैबी, देबकोटा तथा मुस्ताव पथमा स्थित ३ पम्प स्टेशनहरूको स्तरोन्नती गरि उनी डाउनमा भारको घुटावट रोकिने छ। यसले गर्दा ति डाउनहरूबाट हुने खानेपानीको प्रदूषण न्यूनीकरण गर्न सकिन्छ जसको कारण फोहोर खानेपानी बाट हुने रोगलाई पनि न्यूनीकरण गर्न सकिन्छ।

(ख) सकारात्मक प्रभाव:-

- निर्माण कार्यको वेलामा भुईँ खाने कारणले बाटो धाटो अबरुड हुनका साथै उखान्न गर्दा आउने बाटो सडक छेउ चुनैरिहा स्थानीयहरूको आवाज जावामा व्यथान आउनुका साथै यस स्थानहरूको सुन्दरतामा पनि असर पर्नेछ।

श्री न. वडा कार्यालय
सुरेन्द्र उपाध्याय

निर्माणको दौरान, बाँध प्रदूषण, गैर जलत र अन्य रवात-प्रभाव सम्बन्धी परामर्शदाता पत्र ससहन, विशेषगरी बाह्यकारिका र जेट्टा मासिकहरूमा यी समस्या अत्र अत्र उल्लेख हुन सक्छ। त्यसैगरी अति प्रदूषणले स्थानीय जनता/वाणिज्यहरूलाई असरदा अबस्था हुन सक्नेछ। विशेष गरी रातको समयमा सामान्य अति पनि कर्बन हुने हुनाले निर्माणको नविकका मासिकहरूको विज्ञा प्रमावित हुनसक्छ।

उल्लेखित प्रभावको आधारमा सकारात्मक प्रभाव अतिवृद्धि गर्ने र नकारात्मक प्रभाव मूलतः गरी सातवर्षीय अवस्थानको योजना कार्यान्वयन गर्दा उल्लेखित प्रभावको सकारात्मक प्रभाव बढी हुने देखिएकोले उल्लेखित प्रस्ताव निम्न आधारमा कार्यान्वयन गर्न भिन्ने ध्याहार उल्लेख गरी यो विचारार्थ गरिएको छ।

प्रस्ताव कार्यान्वयन गर्न भिन्ने आधार:

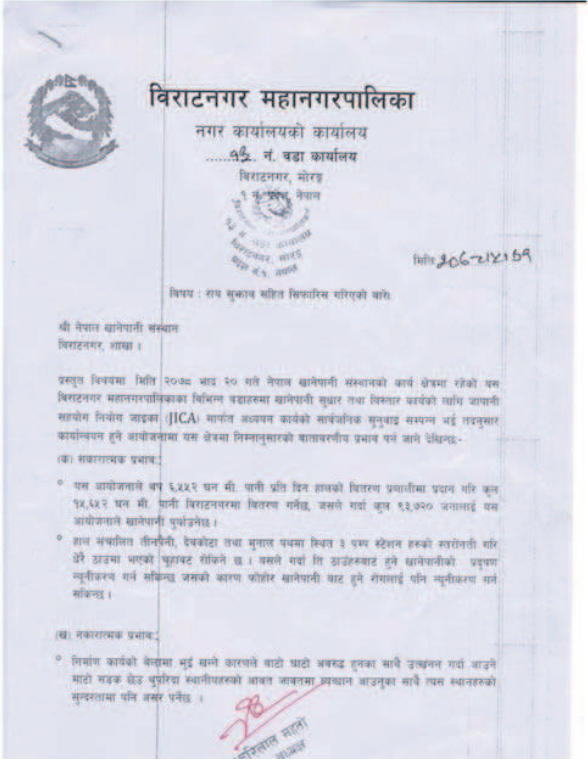
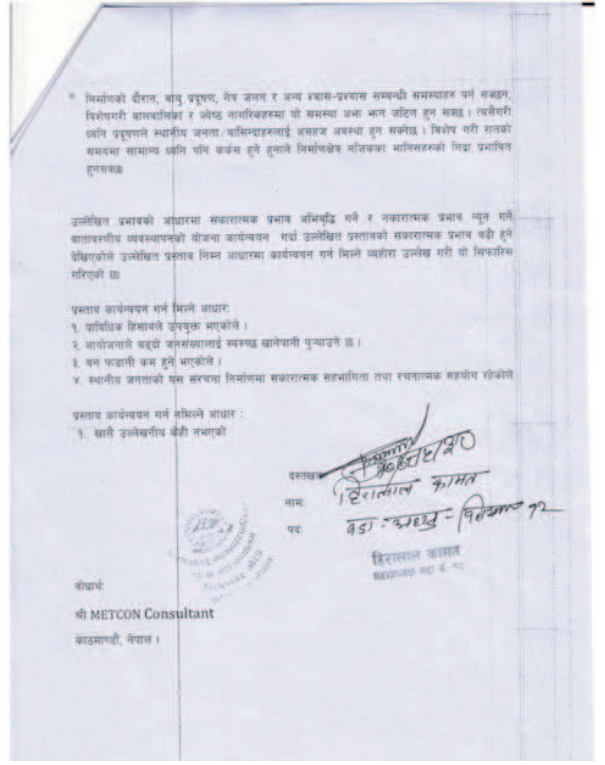
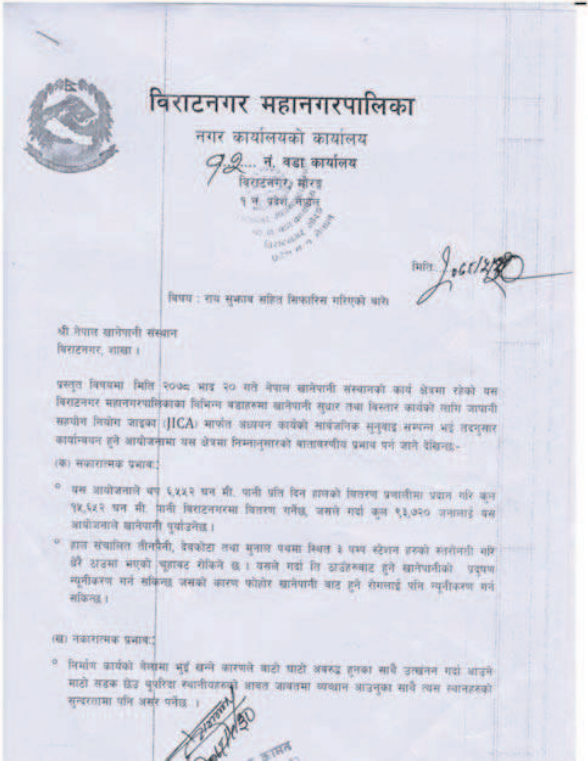
1. प्राविधिक विस्तारले दुपयुक्त भएकोले।
2. आयोजनाले बढ्दो जनसंख्यालाई स्वस्थ खानेपानी पुर्‍याउने छ।
3. यस फाइदी कम हुने भएकोले।
4. स्थानीय जनताको यस संरचना निर्माणमा सकारात्मक सहभागिता तथा सकारात्मक सहयोग रहेकोले।

प्रस्ताव कार्यान्वयन गर्न भिन्ने आधार:

1. यारी उल्लेखनीय बढी नभएको।

दस्तावेज: [Signature]
नाम: सुरेन्द्र उपाध्याय
पद: न. वडा कार्यालय, मोरङ
सुरेन्द्र उपाध्याय

पेशार्थे
श्री METCON Consultant
काठमाण्डौ, नेपाल।



विराटनगर महानगरपालिका
 नगर कार्यालयको कार्यालय
 ...
 विराटनगर, नेपाल
 मिति: ०६/१२/१९

विषय: राय मूलाव सँग विचारार्थ गरिएको बरो

श्री नेपाल खानेपानी संस्थान
 विराटनगर, नेपाल।

प्रस्ताव विषयमा मिति २०७६ भाद्र २० गते नेपाल खानेपानी संस्थानको कार्य क्षेत्रमा रहेको वन विराटनगर महानगरपालिकाका विभिन्न वडाहरूमा खानेपानी प्रसार तथा विस्तार कार्यको लागि आपसी सहयोग विधायक जाइका (JICA) मार्फत अर्जवन कार्यको सार्वजनिक सूचना सम्पन्न भई तपन्सार कार्यन्वयन हुने आशयको चर्चा क्षेत्रमा विभागतुल्यको बातावरणीय प्रभाव गर्न जाने देखिन्छ-

(क) सकारात्मक प्रभावः

- वन आशुवनको वन १,२४२ घन मी. पानी प्रति दिन शानको विवरण प्रणालीमा प्रदान गरि कुल १४,६२२ घन मी. पानी विराटनगरमा वितरण गर्नेछ, जसले गर्दा कुल ९३,९२० जनालाई वन आशुवनको खानेपानी पुर्‍याउनेछ।
- वन संचालन नीतिले, डेबकोटा तथा मुनाव पथमा ३ पम्प स्टेशन हरूको स्तरोन्ती गरि ड्रेन डाउनमा भएको घुनबट रोकिने छ। यसले गर्दा वि डाउनबाट हुने खानेपानीको प्रदूषण म्यूनीकरण गर्न सकिन्छ जसको कारण फोहोर खानेपानीबाट हुने रोगसार्इ पनि म्यूनीकरण गर्न सकिन्छ।

(ख) सकारात्मक प्रभावः

- निर्माण कार्यको वेलासा मुई बग्ने कारणले बाटो बाटो बन्दछ हुनका साथै उखान गर्न आउने बाटो सडक छेउ सुतीटा भन्तीपहरको आवन जावारा अथवा बाउनुका साथै त्यस स्थानहरूको मुनरालामा पनि असर पर्नेछ।

निर्माणको दौरान, बाँधु प्रदूषण, नैब शान र अन्य रचना-प्रयोग सम्बन्धी सम्बन्धित गर्न सक्छन, विशेषगरी बासबालिका र जेठ नागरिकहरूमा यो समस्या जस भए जति हुन सक्छ। त्यसैगरी खाने प्रदूषणको स्थानीय जनता/वाणिज्यहरूलाई असर गर्न सक्नेछ। विशेष गरी शानको समयमा सामान्य खाने पनि कर्म हुने हुनाले निर्माणको नजिकका मानिसहरूको निरा प्रभावित हुनसक्छ।

उल्लेखित प्रभावको आधारमा सकारात्मक प्रभाव अभिवृद्धि गर्ने र नकारात्मक प्रभाव त्युव गर्ने बातावरणीय व्यवस्थापनको योजना कार्यन्वयन गर्दा उल्लेखित प्रभावको सकारात्मक प्रभाव बढी हुने देखिएकोले उल्लेखित प्रभाव निम्न आधारमा कार्यन्वयन गर्न सिल्ने व्यहोरा उल्लेख गरी यो विचारार्थ गरिएको छ।

प्रस्ताव कार्यन्वयन गर्न सिल्ने आधारः

1. प्राविधिक हिसावले उपयुक्त भएकोले।
2. आयोजनाले बढ्दो जनसंख्यालाई स्वस्थ खानेपानी पुर्‍याउने छ।
3. वन फाइती कम हुने भएकोले।
4. स्थानीय जनताको यस संघर्षमा निर्माणमा सकारात्मक सहभागिता तथा रचनात्मक सहयोग रहेकोले।

प्रस्ताव कार्यन्वयन गर्न सिल्ने आधारः

1. खासै उल्लेखनीय बेसी नभएको।

विकासकर्ता: ...
 नाम: ...
 पद: ...

सोपार्थः
 श्री METCON Consultant
 काठमाडौं, नेपाल।

ANNEX S: APPROVED TOR

नेपाल खानेपानी संस्थान
 पदमार्ग विकास विभाग
 काठमाडौं, नेपाल

पत्र संख्या: ...
 मिति: २०७६/०६/०९

विषय: प्रारम्भिक बातावरणीय परिक्षणको कार्य सुची (TOR) स्वीकृत भएको सम्बन्धमा।

श्री **मेटकॉन कन्सल्टेंट**
 काठमाडौं, नेपाल।

उपरोक्त सम्बन्धमा विराटनगर खानेपानी सुदृढीकरण आयोजनाको प्रारम्भिक बातावरणीय परिक्षण तयार गरी स्वीकृतीको लागि पत्र हुन गएको कार्य सुची विषयमा बातावरणीय परिक्षण कार्य, जो मिति २०७६/०६/०९ को तयार अनुसन्धान स्वीकृत भएको हुदाँ तयारि प्रस्ताव गरेको schedule अनुसार Draft Report बाट प्रति प्रकाशन हुन सक्ने जानकारी सार्इएको।

सोपार्थः
 पाँचथरी इन्जिनियरिंग
 कम्पनी लिमिटेड,
 काठमाडौं, नेपाल।
 काठमाडौं, नेपाल
 नेपाल खानेपानी संस्थान
 विराटनगर

...
 ...
 ...

प्रदानकर्ताको
 विवरण यहाँ
 काठमाडौं, नेपाल

पति.नं. : १९९९
 पुराना नं. : ०१९९-९-९९९९९९
 ईमेल : www.metccon.com@gmail.com

फोन नं. : ९९९९९९
 ९९९९९९
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 ९९९९९९

資料-6-11 事業進捗報告書
(Project Monitoring Report) の初版

<p><u>Project Monitoring Report</u> on <u>The Project for Improvement of</u> <u>Water Supply System in Biratnagar</u> <u>Grant Agreement No. XXXXXXXX</u> 20XX, Month</p>

Organizational Information

Signer of the G/A (Recipient)	_____ Person in Charge (Designation) _____ Contacts Address: _____ Phone/FAX: _____ Email: _____
Executing Agency	<u>Nepal Water Supply Corporation</u> Person in Charge <u>Bhupendra Prasad, General Manager</u> _____ Contacts Address: <u>Tripureshowor, Marga, Kathmandu, Nepal</u> FAX: <u>+977-1-4255516</u> Email: <u>nwscgeneralmanager@gmail.com/</u> <u>prasadb@ntc.ne.np</u>
Line Ministry	_____ Person in Charge (Designation) _____ Contacts Address: _____ Phone/FAX: _____ Email: _____

General Information:

Project Title	The Project for Improvement of Water Supply System in Biratnagar
E/N	Signed date: Duration:
G/A	Signed date: Duration:
Source of Finance	Government of Japan: Not exceeding JPY _____ mil. Government of (_____): _____

1: Project Description

1-1 Project Objective

The objective of the Project is to improve living standards in Biratnagar city through construction and renovation of four (4) Pump Stations (PS) (incl. well facility, water treatment facility, water reservoir/pump building, overhead tank, administration building) and Water distribution networks.

1-2 Project Rationale

- Higher-level objectives to which the project contributes (national/regional/sectoral policies and strategies)
- Situation of the target groups to which the project addresses

Water supply is an important area of development in Nepal that has aimed for socioeconomic growth, and its development will enable enhancing the health and living standards of the people by providing drinking water with appropriate quality and accessibility. The Project will provide citizens with properly treated and safe water in line with the higher-level plan. Therefore, there is a high need to implement the Project. The impact of water supply facility development is great in the Project area located in the city centre, the effect as a steppingstone to recovery of citizens' trust to NWSC as well as the ripple effect to the surrounding area are also high.

1-3 Indicators for measurement of "Effectiveness"

Quantitative indicators to measure the attainment of project objectives		
Indicators	Baseline (Yr 2019)	Target (Yr 2027)
Drinking water quality (Residual chlorine, iron and manganese) (mg/l) ※1	Residual chlorine: Less than 0.1 Iron: Max. 0.53 Manganese: Max. 0.48 (Not meet to Nepal drinking water quality standard)	Residual chlorine: More than 0.1 Iron: Less than 0.3 Manganese: Less than 0.2 (Meet to Nepal drinking water quality standard)
Served Population (persons) ※2	Approx. 52,000	Approx. 93,000
Average water supply volume per day (m ³ /day) ※3	Approx. 9,000	Approx. 15,000
※1: The target is based on the target of Nepal drinking water quality standard. ※2: Value is estimated by population at four (4) distribution areas. ※3: Actual volume at the project area by operation hour of well pumps (exclude Kanchanbari pump station & Rani pump station).		
Qualitative indicators to measure the attainment of project objectives		
1) Decrease of water-borne diseases Morang District belonging to BMC has managed the data of water-borne diseases through information by hospitals since 2014. According to these data, water-borne diseases in Biratnagar city is not few number and it is reported that cases of typhoid fever is approx. 16,000 and cases of acute gastroenteritis is approx. 14,000 in 2019 for both. Safe water supply through the appropriate water quality management expects to decrease water-borne diseases.		

2) Recovery of satisfactory for NWSC's water

According to social survey in 2019, approx. 80% households of NWSC's customers are not satisfied for water quality, secondly supply duration, and thirdly water pressure. Many patients by viral hepatitis were found in April 2014. Since the cause of the occurrence were suspected of NWSC's water, the satisfactory of NWSC's water is low. Through implementation of the Project, water quality and water service will be improved, and recovery of satisfactory to NWSC's water is expected.

3) Improvement in living environment of Biratnagar citizens

Water supplied by NWSC and groundwater from privately-owned hand pumps contains a substantial amount of iron and manganese, so it is not satisfactory not only for drinking purpose but also for domestic use. Safe water supply with treatment will contribute to improvement in living environment of Biratnagar citizens.

2: Details of the Project

2-1 Location

Components	Original <i>(proposed in the outline design)</i>	Actual
1. Construction works of water supply facilities in Biratnagar City	Devkota PS, Tinpaini PS, Munal Path PS, No.5 PS, City centre area for Water distribution pipes	

2-2 Scope of the work

Components	Original* <i>(proposed in the outline design)</i>	Actual*
1. Construction works of water supply facilities in Biratnagar City	1.1 Construction at Existing Devkota PS, Tinpaini PS, Munal Path PS - Well facility - Water treatment facility - Water reservoir/pump building 1.2 Construction at New No.5 PS - Well facility - Water treatment facility - Water reservoir/pump building - Overhead tank - Administration Building 1.3 Water Distribution Pipe	
2. Procurement works of the Equipment	2.1 Water Quality Analysis Equipment: 1 lot 2.2 Small Size Excavator: 2 units	
3. Soft Component	3.1 O&M of Water Treatment Facility 3.2 O&M of Water Distribution System	

Reasons for modification of scope (if any).

(PMR)

2-3 Implementation Schedule

Items	Original		Actual
	<i>(proposed in the outline design)</i>	<i>(at the time of signing the Grant Agreement)</i>	
Detail Design and Bidding Process	10 months from June 2022		
Facility Construction and Procurement of Equipment	24 months from June 2022		
Soft Component	1.5 months from August 2024		

Reasons for any changes of the schedule, and their effects on the project (if any)

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2-4 Obligations by the Recipient

2-4-1 Progress of Specific Obligations

See Attachment 2.

2-4-2 Activities

See Attachment 3.

2-4-3 Report on RD

See Attachment 11.

2-5 Project Cost

2-5-1 Cost borne by the Grant(Confidential until the Bidding)

Components			Cost (Million Yen)	
	Original <i>(proposed in the outline design)</i>	Actual <i>(in case of any modification)</i>	Original ^{1),2)} <i>(proposed in the outline design)</i>	Actual
1.Facility Construction	1) Construction at Existing Devkota PS, Tinpaini PS, Munal Path PS - Well facility - Water treatment facility - Water reservoir/pump building 2) Construction at New No.5 PS - Well facility - Water treatment facility - Water reservoir/pump building - Overhead tank - Administration Building 3) Water Distribution Pipe			
2.Procurement of Equipment	1) Water Quality Analysis Equipment 2) Small Size Excavator			

3.Consultant Service	1) Detail Design 2) Supervision for facility construction and procurement of the Equipment 3) Soft Component			
4.Epidemic Prevention Cost for Covid-19				
5.Contingences	(1+2+3+4)x5%			
Total				

Note: 1) Date of estimation: October, 2020
2) Exchange rate: 1 US Dollar = 107.22 JPY
1 NPR = 0.89445 JPY
1 IDR = 1.5800 JPY

2-5-2 Cost borne by the Recipient

Components			Cost (1,000 Taka)	
	Original (proposed in the outline design)	Actual (in case of any modification)	Original ^{(1),(2)} (proposed in the outline design)	Actual
Facility Construction	Removing the existing facilities and retaining wall from the planned construction site and leveling the land prior to the commencement of construction by the Japanese side (Devtoka Pump Station and Tinpaini Pump Station)		196,000 NPR	
	Installing fences and gates around the yards for the new No.5 new pump station		5,912,000 NPR	
	Development of drainage channel from the new No.5 new pump station to discharge point		5,754,000 NPR	
	Connecting a power cable to pump stations and upgrading and/or new installing transforming equipment		17,057,000 NPR	
	House connection: Connecting the house inlet pipe to pipeline to be installed in the Project		20,369,000 NPR	
Bank commission	Advising commission of A/P		6,000 JPY/each issue 4,000 JPY/each amendment	
	Payment commission of A/P		0.1% of every	

			payment	

Note: 1) Date of estimation: October, 2020
 2) Exchange rate: 1 US Dollar = 107.22 JPY
 1 NPR = 0.89445 JPY
 1 IDR = 1.5800 JPY

Reasons for the remarkable gaps between the original and actual cost, and the countermeasures (if any)

(PMR)

2-6 Executing Agency

- Organization's role, financial position, capacity, cost recovery etc,
- Organization Chart including the unit in charge of the implementation and number of employees.

<p>Original (at the time of outline design) name: Nepal Water Supply Corporation : NWSC role: Management of water supply service in 22 cities in Nepal financial situation: Liabilities exceeds the assets and long term loan has been increasing every year due to the loan for facility investment from Government of Nepal. However, Operating income significantly increased year by year and income basically covers operation cost. institutional and organizational arrangement (organogram): NWSC is affiliated organization of Ministry of Water Supply (MoWS) human resources (number and ability of staff): 565 staff</p>
<p>Actual (PMR)</p>

2-7 Environmental and Social Impacts

- The results of environmental monitoring based on Attachment 5 (in accordance with Schedule 4 of the Grant Agreement).
- The results of social monitoring based on in Attachment 5 (in accordance with Schedule 4 of the Grant Agreement).
- Disclosed information related to results of environmental and social monitoring to local stakeholders (whenever applicable).

3: Operation and Maintenance (O&M)

3-1 Physical Arrangement

- Plan for O&M (number and skills of the staff in the responsible division or section, availability of manuals and guidelines, availability of spareparts, etc.)

<p>Original (at the time of outline design)</p> <p>NWSC will directly operate and maintain the facilities to be constructed. It, however, has no enough skilled staff member in Biratnagar. Moreover, additional chemicals and electricity power are necessary as well as materials for the facilities' maintenance. Manuals and guidelines are prepared in the Project.</p>
<p>Actual (PMR)</p>

3-2 Budgetary Arrangement

- Required O&M cost and actual budget allocation for O&M

<p>Original (at the time of outline design)</p> <p>-Personnel Expense ; 2,806,000 NPR -Electricity ; 10,888,000 NPR -Chemicals (chlorine) ;13,620,000 NPR -Spare Parts ; 706,000 NPR -Office Expenses / Consumables ; 421,000 NPR</p> <p>Total Cost: 28,441,000 NPR</p>
<p>Actual (PMR)</p>

4: Potential Risks and Mitigation Measures

- Potential risks which may affect the project implementation, attainment of objectives, sustainability
- Mitigation measures corresponding to the potential risks

Assessment of Potential Risks (at the time of outline design)

Potential Risks	Assessment
1. (Description of Risk) Not applicable	Probability: High/Moderate/Low
	Impact: High/Moderate/Low
	Analysis of Probability and Impact:
	Mitigation Measures:
	Action required during the implementation stage:
2. (Description of Risk)	Probability: High/Moderate/Low
	Impact: High/Moderate/Low
	Analysis of Probability and Impact:

	Mitigation Measures:
	Action required during the implementation stage:
	Contingency Plan (if applicable):
3. (Description of Risk)	Probability: High/Moderate/Low
	Impact: High/Moderate/Low
	Analysis of Probability and Impact:
	Mitigation Measures:
	Action required during the implementation stage:
Actual Situation and Countermeasures (PMR)	

5: Evaluation and Monitoring Plan (after the work completion)

5-1 Overall evaluation

Please describe your overall evaluation on the project.

5-2 Lessons Learnt and Recommendations

Please raise any lessons learned from the project experience, which might be valuable for the future assistance or similar type of projects, as well as any recommendations, which might be beneficial for better realization of the project effect, impact and assurance of sustainability.

5-3 Monitoring Plan of the Indicators for Post-Evaluation

Please describe monitoring methods, section(s)/department(s) in charge of monitoring,

frequency, the term to monitor the indicators stipulated in 1-3.

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Attachment

1. Project Location Map
2. Specific obligations of the Recipient which will not be funded with the Grant
3. Monthly Report submitted by the Consultant
- Appendix - Photocopy of Contractor's Progress Report (if any)
 - Consultant Member List
 - Contractor's Main Staff List
4. Check list for the Contract (including Record of Amendment of the Contract/Agreement and Schedule of Payment)
5. Environmental Monitoring Form / Social Monitoring Form
6. Monitoring sheet on price of specified materials (Quarterly)
7. Report on Proportion of Procurement (Recipient Country, Japan and Third Countries) (PMR (final) only)
8. Pictures (by JPEG style by CD-R) (PMR (final) only)
9. Equipment List (PMR (final) only)
10. Drawing (PMR (final) only)
11. Report on RD (After project)

Monitoring sheet on price of specified materials

1. Initial Conditions (Confirmed)

Items of Specified Materials	Initial Volume A	Initial Unit Price (¥) B	Initial total Price C=A×B	1% of Contract Price D	Condition of payment	
					Price (Decreased) E=C-D	Price (Increased) F=C+D
Item 1	●●t	●	●	●	●	●
Item 2	●●t	●	●			
Item 3						
Item 4						
Item 5						

2. Monitoring of the Unit Price of Specified Materials

(1) Method of Monitoring : ●●

(2) Result of the Monitoring Survey on Unit Price for each specified materials

Items of Specified Materials	1st month, 2015	2nd month, 2015	3rd month, 2015	4th	5th	6th
Item 1	●	●	●			
Item 2						
Item 3						
Item 4						
Item 5						

(3) Summary of Discussion with Contractor (if necessary)

-
-
-

Report on Proportion of Procurement (Recipient Country, Japan and Third Countries)
 (Actual Expenditure by Construction and Equipment each)

	Domestic Procurement (Recipient Country) A	Foreign Procurement (Japan) B	Foreign Procurement (Third Countries) C	Total D
Construction Cost	(A/D%)	(B/D%)	(C/D%)	
Direct Construction	(A/D%)	(B/D%)	(C/D%)	
Cost others	(A/D%)	(B/D%)	(C/D%)	
Equipment Cost	(A/D%)	(B/D%)	(C/D%)	
Design and Supervision Cost	(A/D%)	(B/D%)	(C/D%)	
Total	(A/D%)	(B/D%)	(C/D%)	