CHAPTER 7

APPENDIX – A71.1

President Promises Funds for K-IV, DAWN, Tuesday January 15, 2008

A71.1 President Promises Funds for K-IV, DAWN Tuesday January 15, 2008

DAWN TUESDAY, JANUARY 15, 2008

Three projects inaugurated

President promises funds for K-IV

KARACHI, Jan 14: President Pervez Musharraf laid the foundation of three major development projects – the signal-free Corridor-II, Pakistan Steel Flyover and Bin Qasim Industrial Park – in the metropolis on Monday.

Speaking as chief guest at the 'foundation stone unveiling ceremony' of the corridor project at Governor's House, he described the ceremony somewhat between 'earth-breaking' and 'inauguration' and said that another milestone had been achieved. He hoped with the completion of this project transport problems would be reduced considerably.

In his discourse, the president dwelt at length on the problems of Karachi including new water supply project, solid waste management, mass transit, Lyari Expressway, affluent treatment and other issues including wheat flour and recent incidents of violence.

Recalling that federal government funded the K-III 100mgd water supply scheme worth Rs7-8 billion, he said that now K-IV must come up and assured that the federal government would certainly extend support.

He also lauded the efforts of Sindh Governor Dr Ishratul Ibad Khan and City Nazim Syed Mustafa Kamal for the fast-paced development. He had never seen work going on such a fast pace in the country, he remarked.

Referring to the beautification projects of Karachi in the shape of Quaid-i-Azam Mazar park, Bagh Ibn-i-Qasim and Askari Park, he noted with delight that never in the past such a large number of projects were accomplished here as were completed during the last five years.

Observing that Karachi has a variety of problems, more because all types of ethnic population lived here, Musharraf said that the country needed economic strength to solve these problems.

He said that the fiscal deficit was controlled and revenue generation was increased to transform and sustain the economy, which in reciprocal attracted foreign investment.

The president cited the example of the Cotton Export Corporation and Rice Export Corporation, which were running into losses, and said that the expenses were cut down and remittances and investments were enhanced during the transformation of economy.

Today again, he said, the country was faced with a challenge caused by soaring oil prices which were almost touching 100 dollars per barrel resulting in overburdening of national economy with the provision of annual subsidy of Rs140 billion.

Addressing the employees of Pakistan Steel Mills during a ceremony arranged at Pakistan Steel to unveil the plaques of the already operative flyover on the National Highway at Quaidabad and the planned Bin Qasim Industrial Park, he said the government believed in public-private partnership concept. The Industrial Promotion Boards with the government and private members had been set up to monitor industrial activity, he said, and hoped that the planned industrial park in Karachi would be another achievement under public-private partnership.

President Musharraf said the government had offered many incentives to local and foreign investors during the last five years and provided them with standard infrastructure and investment-friendly environment. Hundred per cent equity had been allowed to the investors and foreign investors were free for their remittances, he said adding that the government adopted zero customs policy for imports of machinery and certain raw materials to encourage industrialisation in the country. He said the procedure for acquisition of land for an industry has been simplified against the past practice in which an industrialist had to run from pillar to post for the land.

The president appreciated the Pakistan Steel management for providing 930 acres of land and extending all possible support to the National Industrial Parks Development and Management Company to make this project successful.

Among others, the ceremony was also attended by Federal Minister for Industries, Production and Special Initiatives Salman Taseer, Federal Information Minister Nisar A. Memon and Federal Defence Minister Saleem Abbas Jillani.—Agencies

APPENDIX – A72.1

Notification of the Sindh Government on the Extension of KW&SB Jurisdiction

A72.1 Notification of the Sindh Government on the Extension of KW&SB Jurisdiction

GOVERNMENT OF SINDH
LOCAL GOVERNMENT, KATCHI ABADIS &
SPATIAL DEVELOPMENT DEPARTMENT
Karachi dated the 23rd August, 2004

NOTIFICATION.

NO. SOVIII(LG)/KW&SB-2(17)/03: In exercise of the powers conferred by sub-section(3) of Section 3 of the Karachi Water & Sewerage Board Act 1996, the Government of Sindh is pleased to extend the jurisdiction of the Karachi Water and Sewerage Board to the area falling within the limits of the Union Councils Dhabeji and Gharo of Thatta District including industrial area in such Councils.

23/8/2004

(MUHAMMAD SALEEM KHAN)
ADDITIONAL CHIEF SECRETARY
GOVERNMENT OF SINDH

NO.SOVII/KW&SB/2(17)/2003, Karachi dated the 23rd August 2004,

A copy is forwarded for information and necessary action to:-

1. The City Nazim/Chairman KW&SB, CDG Karachi,
2. The District Nazim Thatta, District Government Thatta.
3. The District Coordination Officer, CDG Karachi.
4. The Executive District Officer (W&S) / MD ,Karachi Water & Sewerage Borad , K a r a c h i. (Water &Sanitation) / Managing Director, KW&SB, CDG Karachi.
5. The Cantonment Executive Officer, Cantonments Boards Karachi.
6. PS to ACS, Local Government Karachi.
7. The Superintendent Sindh Government Printing Press Karachi for publication of above notification in the next issue of Extra-ordinary gazette and supply 20 copies thereof

(ABDUL SATTAR MANGI)
SECTION OFFICER-VIII

APPENDIX – A73.1

Conditions of the Alternative Studies for Water Transmission

A73.1 Conditions of the Alternative Studies for Water Transmission

(1) General

The alternative studies for water transmission system of the three zones (Zone West, Zone Central and Zone East) separately shown in **Appendixes A73.2 to 733.4** are based on the conditions descried in the following sections (2) to (4).

Although some conditions are modified after the alternative studies for the preparation of master plan, it is confirmed that the modification does not affect the selection of the optimal alternative for each zone. Calculated cost of each alternative includes only major components of system for cost comparison between alternatives.

(2) Inter-zonal Water Balance

Additional water supply capability and future water demand in each zone in 2025 are calculated based on Karachi Master Plan 2020 (August 2007) and K-IV Project, Greater Karachi Water Supply Scheme (Executive Summary, May 2007). Required inter-zonal water transmission from Zone Central to Zone West is calculated at 21 mgd as seen in **Figure A73.1.1**.

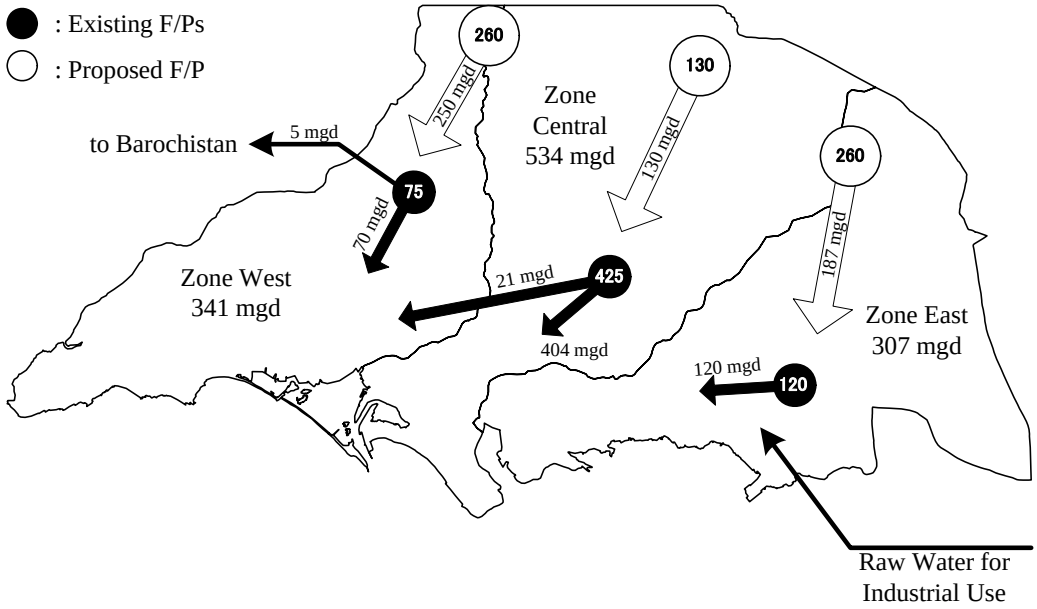

Figure A73.1.1 Zone-wise Water Balance in 2025

(3) Basic Concepts applied for the Planning

The basic concepts for planning of water transmission lines and distribution mains, which are applied and examined in the alternative studies, are as follows.

- To un-necessitate the use of several bulk pumping stations and a large number of small size distribution pumping stations for energy cost saving
- To supply water by gravity as much as possible
- To keep minimum dynamic water pressure of 10 m in distribution system.

Figure A73.1.2 shows a simplified diagram of typical water supply system to be proposed, which meets the basic concepts.

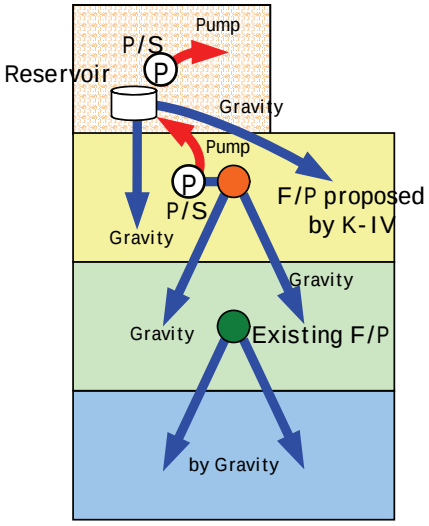

Figure A73.1.2 Proposed Typical Water Supply System

(4) General Conditions for Hydraulic Calculation

1) Formula for Hydraulic Calculation: Hazen-Williams Formula

There are a number of formulae available to calculate the velocity of flow (e.g. Hazen-Williams formula, Manning's formula, Darcy-Weisbach's formula and Colebrook-White formula). The Hazen-Williams formula is the best for situations involving pressure conduits.

The formula is:

$$V = 0.84935\ C\ R^{0.63}\ I^{0.54}$$

For circular conduits, the formula is restated as

$$hf = 10.666\ C^{-1.85}\ D^{-4.87}\ Q^{1.85}\ L$$

Where,
V = Velocity (m/s)
C = Hazen-Williams coefficient
R = Hydraulic Radius (m)
I = Hydraulic Gradient, hf/L
hf = Friction Head Loss (m)
D = Diameter of Pipe (m)
Q = Discharge (m^3/s)
L = Pipe Length (m)

2) Hazen-Williams Coefficient (C Value): 110 for all materials

The Hazen-Williams coefficient (C value) for new pipes made from cast iron, ductile iron or mild steel with cement mortar lining may be between 130 and 145. However, it is generally recommended that in the absence of specific data, a C value of 110 should be adopted. Therefore, a C value of 110 is adopted for new trunk distribution mains in the alternative studies.

3) Hourly Peak Factor: 1.5

When designing the distribution system hourly demand fluctuations must be considered. For example, during the night people use less water, but in the morning and evening people use much more water. Because of absence of flow data for determining current hourly peak factor

in Karachi, a peak factor of 1.5 was adopted referring to “Feasibility Study for future expansion of Karachi Water Supply System, December 1985”.

4) Minimum Dynamic Water Pressure: 10 m

A minimum pressure of 10 m in distribution network mains (in distribution blocks) has been adopted under peak flow conditions. This will provide sufficient pressure for 2 or 3-storey house.

5) Details of Water Supply System

It should be noted that since there is no recorded data or drawings of the existing transmission and distribution systems or details of the reservoirs, the modelling for the hydraulic analysis was prepared based on interviews with the KW&SB’s engineers, for the followings system components:

- routes, materials and diameters of transmission and distribution mains; and
- locations, capacities and water level of reservoirs.

APPENDIX – A73.2

Alternatives of Water Transmission for Zone West

A73.2 Alternatives of Water Transmission for Zone West

(1) Target Water Supply Area of Alternative Study

Prior to the alternative studies, the water supply system of Zone West in 2025 was divided into five water supply areas (W01 Pumping Gravity, West Gravity, Hub Gravity, Orangi Gravity, and Orangi Pumping as seen in **Figure A77.1.3** of **Appendix A77.1**) in consideration of elevation, other topological conditions, capacities of related facilities, current water supply areas and town boundaries.

Water can be distributed to the three middle-laying water supply areas (Grangi Gravity, Hub Gravity, and West Gravity) of Zone West by gravity directly from the locations of existing Hub FP, Orangi Reservior and West FP planned in K-IV project. However, the other two water supply areas (W01 Pumping Gravity and Orangi Pumping) require pumping due to their hilly terrains for either direct distribution or transmission to a new reservoir with an elevation enough for water distribution by gravity. It is proposed to construct a new distribution reservoir (Res. W01) to distribute water stably by gravity to the water supply area at the west end of Gadap Town (W01 Pumping Gravity), where a large population increase is expected, after transmitting water from West FP to the new reservoir by pumping. This water distribution system, as well as those for the three middle-laying water supply areas, is based on the basic concept of the proposed water supply system explained in **Figure A73.1.2** of **Appendix 73.1**, which is "distribute water by gravity as much as possible".

On the other hand, for the small water supply area at the west end (Orangi Pumping), where only a small increase in water demand is expected, direct water distribution from the proposed new booster pumping station in Keamari Town (originally from Orangi Reservoir) was selected. This is because there is no suitable location around the water supply area for an additional reservoir having enough height for gravity distribution to the area.

Since Central FP will be built before West FP as proposed in K-IV project, it is necessary to consider how to send a large amount of water from Central FP to Zone-West until the construction of West FP by 2021. After the construction of West FP, the inter-zonal water transmission from Zone Central to Zone West will be reduced to 21 mgd as already explained in **Figure A73.1.1** of **Appendix 73.1**.

The four towns of Zone-West (New Karachi, North Nazimabad, Gulberg, and Liaqatabad), were selected as the water supply area where water will be supplied from Central FP through the reservoir of NEK-Old in Zone-Central (shown as NEK-Old Gravity in 2016 in **Figure A77.1.1** of **Appendix A77.1**) because of their proximity to NEK-Old. Water will be supplied to the same water supply area (shown as West Gravity in 2021 and 2025 in **Figures A77.1.2** and **A77.1.3**) from West FP after 2021. Since this complication of changing water source, the alternatives for Zone West target only this water supply area of the four towns, three of which were selected as the water supply area of the priority project.

The following **Section (2)** shows alternatives for the target water supply area in 2016 as a case before starting the operation of West-FP, and **Section (3)** shows alternatives in 2025 as a case after starting the operation of West-FP. Both alternative studies are conducted based on the condition that new reserves, transmission mains and trunk distribution mains will be provided exclusively for covering the water demand of the target water supply area while existing facilities will be used only for covering the water demand of the other water supply areas. The basic conditions of hydraulic analysis used for the alternative studies are explained in **Appendix A73.1**.

(2) Alternative Study for 2016

Figures A73.2.1 and **A73.2.2** show two alternatives of supplying water in 2016 from the new reservoir of NKE-Old to the target water supply area in Zone-West (NEK-Old Gravity in **Figure A77.1.1** of **Appendix A77.1**). Alternative 1, which is shown in **Figure A73.2.1**, distributes water from NKE-Old to the target water supply area directly, while Alternative 2 shown in **Figure A73.2.2** transmits water from NKE-Old to a new reservoir at Hub-FP through Mangopir PS before distributing it to the area. Although Alternative 2 can distribute water with a residual pressure higher than that of Alternative 1, the estimated construction cost of Alternative 2 (PRs. 3.7 billion) is nearly twice the construction cost of Alternative 1 (PRs. 1.9 billion) as seen in **Tables A73.2.1** and **A73.2.2**. Therefore, Alternative 1 is selected for this water supply area in preparing the water supply system in 2016 of the proposed Master Plan.

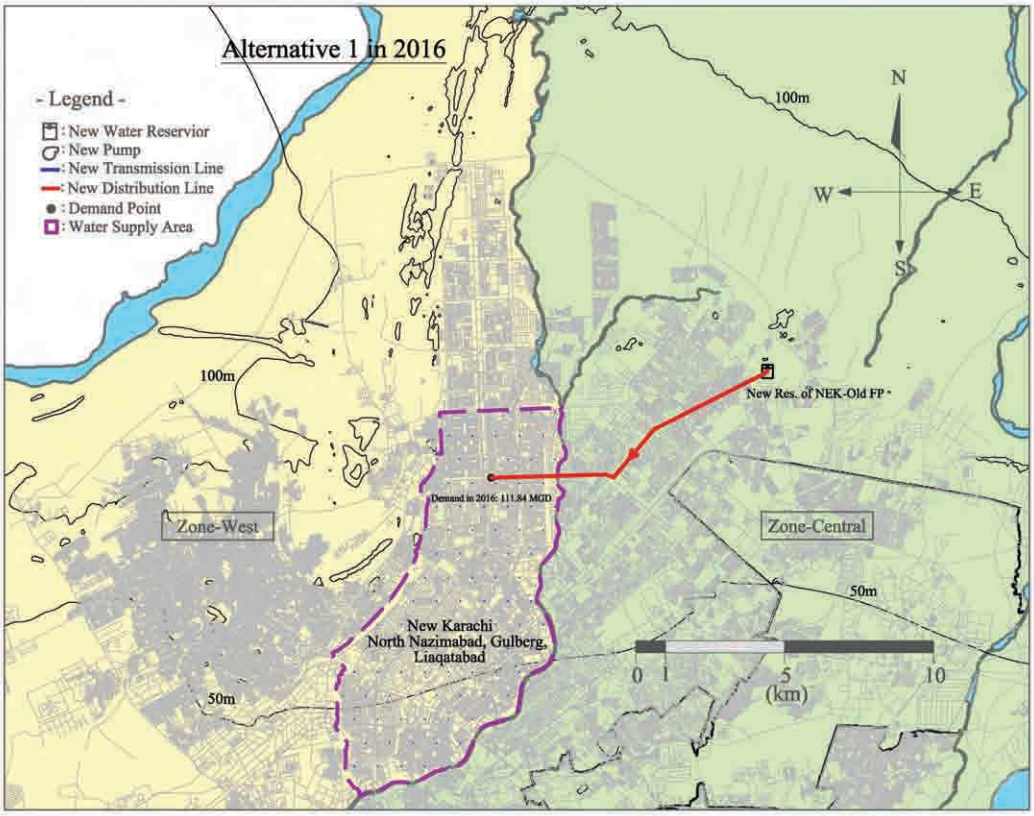

Figure A73.2.1 Alternative 1 in 2016 (Zone West)

Table A73.2.1 Cost of Alternative 1 in 2016 (Zone West)

Reservoir					
Name	V	Unit Price	Cost		
	(mg)	(PRp./m3)	(PRp.)		
NEK-Old New Res.	37.28	3,600	610,121,647		
		Sub-Total	610,121,647		
Distiribution Pipe					
Dia	L	Unit Price	Cost		
(Inch)	(m)	(PRp.)	(PRp.)		
100	10,500	121,500	1,275,750,000		
Sub-Total	10,500		1,275,750,000		
Total (PRp.)		***Initial Cost***	1,885,871,647	***Pump O/M Cost***	0

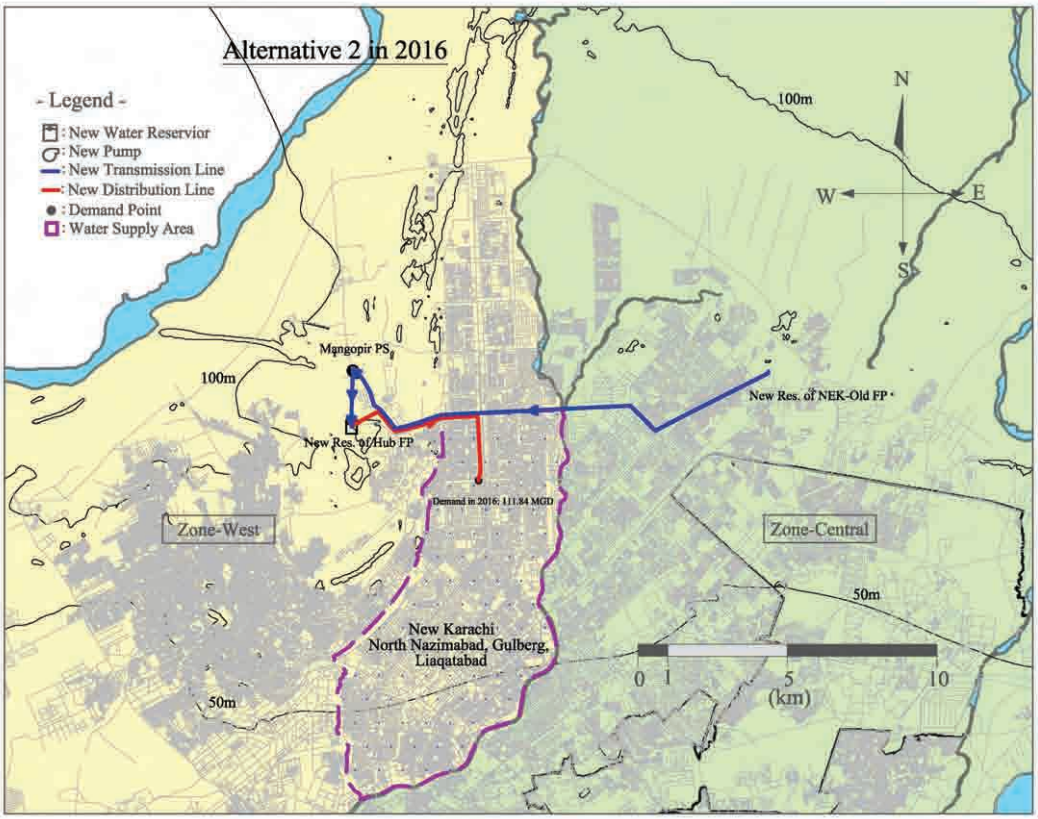

Figure A73.2.2 Alternative 2 in 2016 (Zone West)

Table A73.2.2 Cost of Alternative 2 in 2016 (Zone West)

Transmission Pipe					
Dia	L	Unit Price	Cost		
(Inch)	(m)	(PRp.)	(PRp.)		
100	15,900	121,500	1,931,850,000		
80	1,900	90,000	171,000,000		
Sub-Total	17,800		2,102,850,000		
Transmission Pump					
Name	Power	Unit Price	Cost	Unit O/M Cost	Cost
	(kW)	(PRp.)	(PRp.)	(PRp./kW-H)	(PRp./kW-Year)
Mongopir PS	2592.17	34,000	88,133,780	10	227,074,092
		Sub-Total	88,133,780	Sub-Total	227,074,092
Reservoir					
Name	V	Unit Price	Cost		
	(mg)	(PRp./m3)	(PRp.)		
Hub New Res.	37.28	3,600	610,121,647		
Mongopir Pump Well	2.33	3,600	38,132,603		
		Sub-Total	648,254,250		
Distiribution Pipe					
Dia	L	Unit Price	Cost		
(Inch)	(m)	(PRp.)	(PRp.)		
100	6,900	121,500	838,350,000		
Sub-Total	6,900		838,350,000		
Total (PRp.)		***Initial Cost***	3,677,588,030	***Pump O/M Cost***	227,074,092

(3) Alternative Study for 2025

Figures A73.2.3 to **A73.2.5** show three alternatives in 2025 for the target water supply area (West Gravity in **Figure A77.1.3**). These alternatives are based on the Alternative 1 of previous **Section (2)** which was selected for the year 2016.

Although West FP will be build within the geographical boundary of Zone Central as seen in **Figure A73.2.3**, the water produced in West FP will be mainly used for Zone West as a general rule of the proposed zone-wise water supply. Therefore, after the construction of West FP by 2021, water should be supplied to the target water supply area from West FP, but no longer from Central FP through the reservoir of NKE Old.

Alternative 1-1 shown in **Figure A73.2.3** distributes water from West FP to the target area directly. In this alternative, the feeder part of the trunk distribution mains from NKE Old to be constructed by 2016 will not be used as main trunk distribution mains for the target area. However, these trunk distribution mains will be utilized as part of the distribution network for the surrounding area in Zone Central although they will not to be used at their full capacities. This part of trunk distribution mains can also be used for emergency water supply when the proposed trunk distribution mains from West FP are damaged. If the construction of West FP delays, this part of trunk distribution mains will be used continuously for distributing water from NEK-Old to the target area.

Alternatives 1-2 and 1-3, which are shown in **Figures A73.2.4** and **A73.2.5** respectively, will continuously utilize the feeder part of the trunk distribution main constructed by 2016 for the target area. While Alternative 1-2 transmits 100% of the required water to NKE Old before distributing it to the target area, Alternative 1-3 is set to transmit only 50% of the required water to NEK Old and to distribute the other half to the target area directly. As for Alternative 1-3, since the distribution line from NEK Old will have relatively low water pressure, comparing to that of the distribution line from West FP at the same location (e.i. at the end of the trunk distribution main from West FP shown in **Figure A73.2.5**), the trunk distribution mains from NEK Old are set down to the lower side of the target area, from which water can be distribute with enough residual pressure due to a large difference in height between NEK Old and the lower side. .

As shown in **Tables A73.2.3** to **A73.2.5**, the construction costs of these three alternatives do not differ significantly (between PRs. 5.1 and 5.6 billion) although the cost of Alternative 1-1 includes the construction cost of the feeder part of trunk distribution mains to be installed by 2016 as well, for a fair comparison with the other two alternatives.

However, Alternative 1-2 can not distribute water at a residual pressure as high as those of Alternatives 1-1 and 1-3 (more than 15m in water head). Moreover, Alternatives 1-2 and 1-3 have a disadvantage over Alternative 1-1 in terms of their required institutional arrangement (i.e. Alternatives 1-2 and 1-3 are not meet the general rule of zone-based independent management) and their consequent efficiencies in O&M. This is because Alternatives 1-2 and 1-3 supply water from West FP through NEK Old that will be under the control of Zone Central, before distributing to the target area in Zone West. Alternative 1-1 also has another advantage over the other alternatives, in terms of simplicity of water supply system.

For these reasons, Alternative 1-1 is selected for this target water supply area in preparing the water supply system in 2025 of the proposed Master Plan.

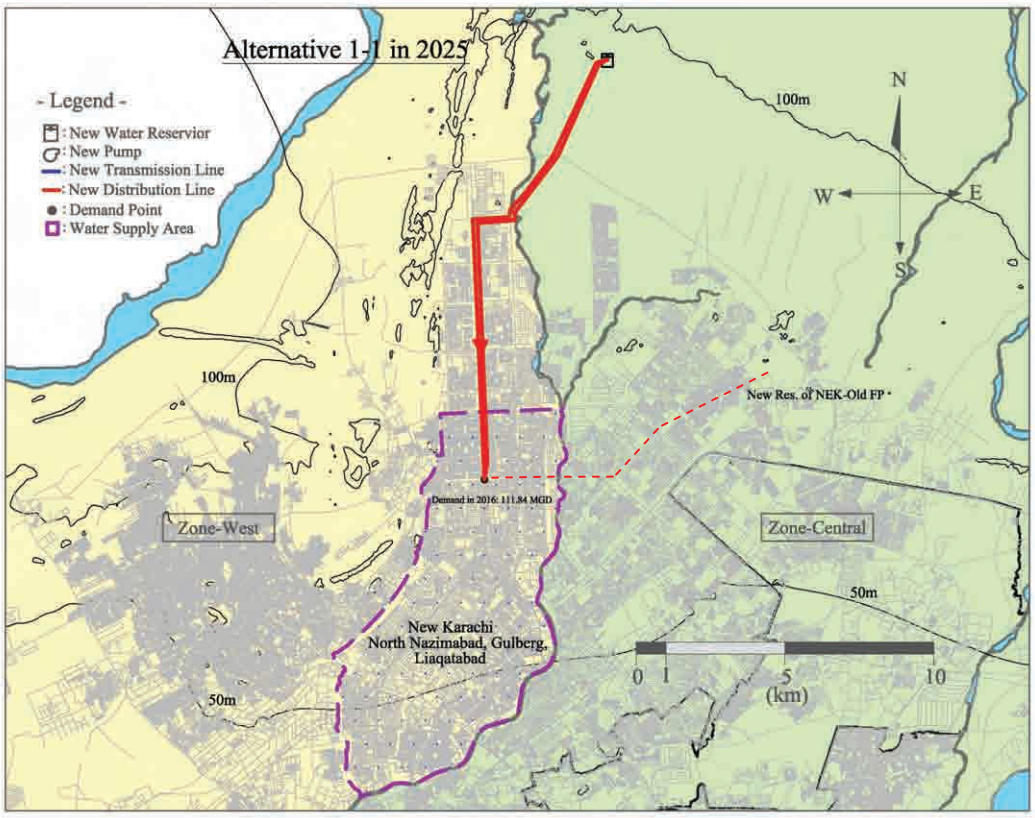

Figure A73.2.3 Alternative 1-1 in 2025 (Zone West)

Table A73.2.3 Cost of Alternative 1-1 in 2025 (Zone West)

Reservoir					
Name	V (mg)	Unit Price (PRp./m3)	Cost (PRp.)		
West New Res.	43.50	3,600	711,917,694		
		Sub-Total	711,917,694		
Distiribution Pipe					
Dia (Inch)	L (m)	Unit Price (PRp.)	Cost (PRp.)		
100	10,500	121,500	1,275,750,000		
88	32,000	109,000	3,488,000,000		
Sub-Total	42,500		4,763,750,000		
Total (PRp.)		***Initial Cost***	5,475,667,694	***Pump O/M Cost***	0

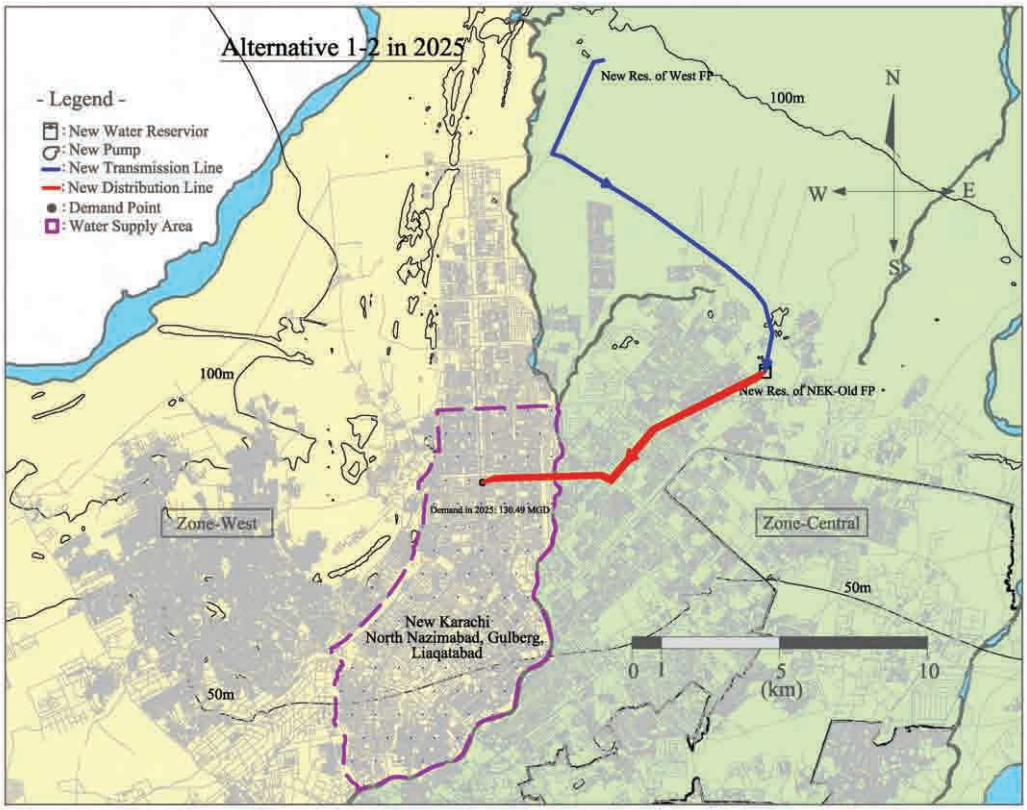

Figure A73.2.4 Alternative 1-2 in 2025 (Zone West)

Table A73.2.4 Cost of Alternative 1-2 in 2025 (Zone West)

Transmission Pipe					
Dia	L	Unit Price	Cost		
(Inch)	(m)	(PRp.)	(PRp.)		
100	14,900	121,500	1,810,350,000		
Sub-Total	14,900		1,810,350,000		
Reservoir					
Name	V	Unit Price	Cost		
	(mg)	(PRp./m3)	(PRp.)		
NEK-Old New Res.	43.50	3,600	711,917,694		
		Sub-Total	711,917,694		
Distiribution Pipe					
Dia	L	Unit Price	Cost		
(Inch)	(m)	(PRp.)	(PRp.)		
100	21,000	121,500	2,551,500,000		
Sub-Total	21,000		2,551,500,000		
Total (PRp.)		***Initial Cost***	5,073,767,694	***Pump O/M Cost***	0

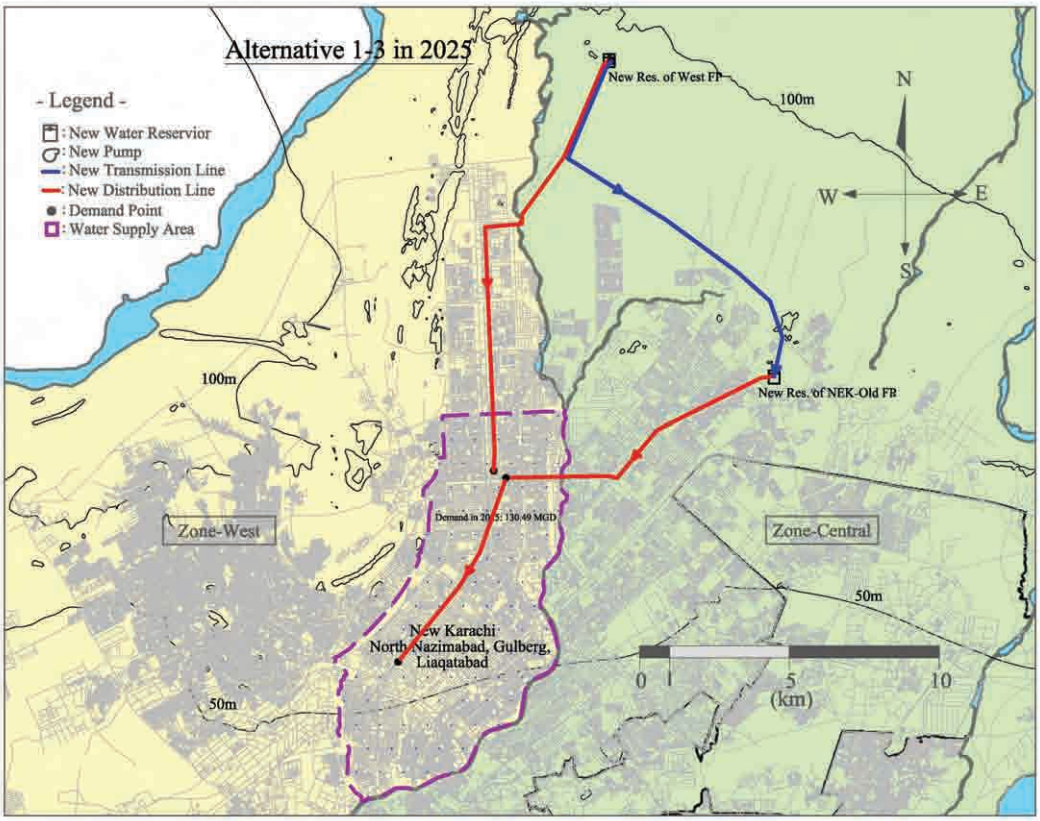

Figure A73.2.5 Alternative 1-3 in 2025 (Zone West)

Table A73.2.5 Cost of Alternative 1-3 in 2025 (Zone West)

Transmission Pipe					
Dia	L	Unit Price	Cost		
(Inch)	(m)	(PRp.)	(PRp.)		
80	14,900	90,000	1,341,000,000		
Sub-Total	14,900		1,341,000,000		
Reservoir					
Name	V	Unit Price	Cost		
	(mg)	(PRp./m3)	(PRp.)		
West New Res.	6.22	3,600	101,796,047		
NEK-Old New Res.	37.28	3,600	610,121,647		
		Sub-Total	711,917,694		
Distiribution Pipe					
Dia	L	Unit Price	Cost		
(Inch)	(m)	(PRp.)	(PRp.)		
100	10,500	121,500	1,275,750,000		
88	16,000	109,000	1,744,000,000		
72	7,200	71,000	511,200,000		
Sub-Total	33,700		3,530,950,000		
Total (PRp.)		***Initial Cost***	5,583,867,694	***Pump O/M Cost***	0

APPENDIX – A73.3

Alternatives of Water Transmission for Zone Central

A73.3 Alternatives of Water Transmission for Zone Central

(1) Target Water Supply Area of Alternative Study

Prior to the alternative studies, the water supply system of Zone Central in 2025 was divided into five water supply areas (Res-C01 Pumping, Res-C01 Pumping Gravity, NEK-Old Gravity, University Gravity, and COD & HSR Gravity as seen in **Figure A77.1.3** of **Appendix A77.1**) in consideration of elevation, other topological conditions, capacities of related facilities, current water supply areas and town boundaries.

Water can be distributed to the three lower-laying water supply areas (NEK-Old Gravity, COD & HSR Gravity, and University Gravity) of Zone Central by gravity from the locations of related existing reservoirs (the reservoirs of NEK-Old FP and COD FP, and University Reservoir). However, the other two supply areas (Res-C01 Pumping and Res-C01 Pumping Gravity) require pumping from Central FP planned in K-IV project, due to their high elevation, for either direct distribution by pumping or water transmission by pumping to a new reservoir at a higher location for water distribution by gravity. Therefore, alternatives of water transmission are considered for these two water supply areas in Zone Central.

The following **Section (2)** shows alternatives in 2025 for the water supply area in the west side of Central FP (Res-C01 Pumping Gravity) and **Section (3)** shows alternatives in 2025 for the water supply area at the northern hilly area (Res-C01 Pumping) that are based on the results of **Section (2)**. Both alternative studies are conducted based on the condition that new reservoirs, transmission mains and trunk distribution mains will be provided exclusively for covering the water demand of the target water supply area while existing facilities will be used only for covering the water demand of the other water supply areas. The basic conditions of hydraulic analysis used for the alternative studies are explained in **Appendix A73.1**.

(2) Fist Alternative Study for 2025 to Distribute Water from Central FP

Figures A73.3.1 and **A73.3.2** show two alternatives in 2025 of supplying water from Central FP to its nearest water supply area (Res-C01 Pumping Gravity in **Figure A77.1.3**) where relatively high population increase is expected. Alternative 1, which is shown in **Figure A73.3.1**, transmits water from Central FP to a new distribution reservoir located at a higher land (Res. 01) before distributing water to its target water supply area by gravity. Alternative 2 shown in **Figure A73.3.2** distributes water directly from Central FP to the target area by two groups of distribution pumps having different water heads that distribute water to the upper and lower sides of the area separately.

Although the construction cost of Alternative 1 (PRs. 2.3 billion) is about 20% higher than that of Alternative 2 (PRs. 1.9 billion) as seen in **Tables A73.3.1** and **A73.3.2**, Alternative 1 is more preferable for stable water supply. In the case of Alternative 1, water can be distributed stably from new Res. C01 by gravity even during power cuts of few hours without using power generators. On the other hand, Alternative 2 requires difficult operation of distribution pumps to adjust their pump discharges to the daily-fluctuating water demand of the target area. The operation of distribution pumps will be especially difficult for Alternative 2 because the two groups of distribution pumps having different water heads and capacities requires a complicated operation of pumps to distribute water separately to the upper and lower sides of the target areas as seen in **Figure A73.3.1**. Alternative 1 of gravity distribution also matches the basic concept, “distribute water by gravity as much as possible”, explained in **Appendix A73.1**.

Therefore, Alternative 1 is selected for this water supply area in preparing the water supply system in 2025 of the proposed Master Plan.

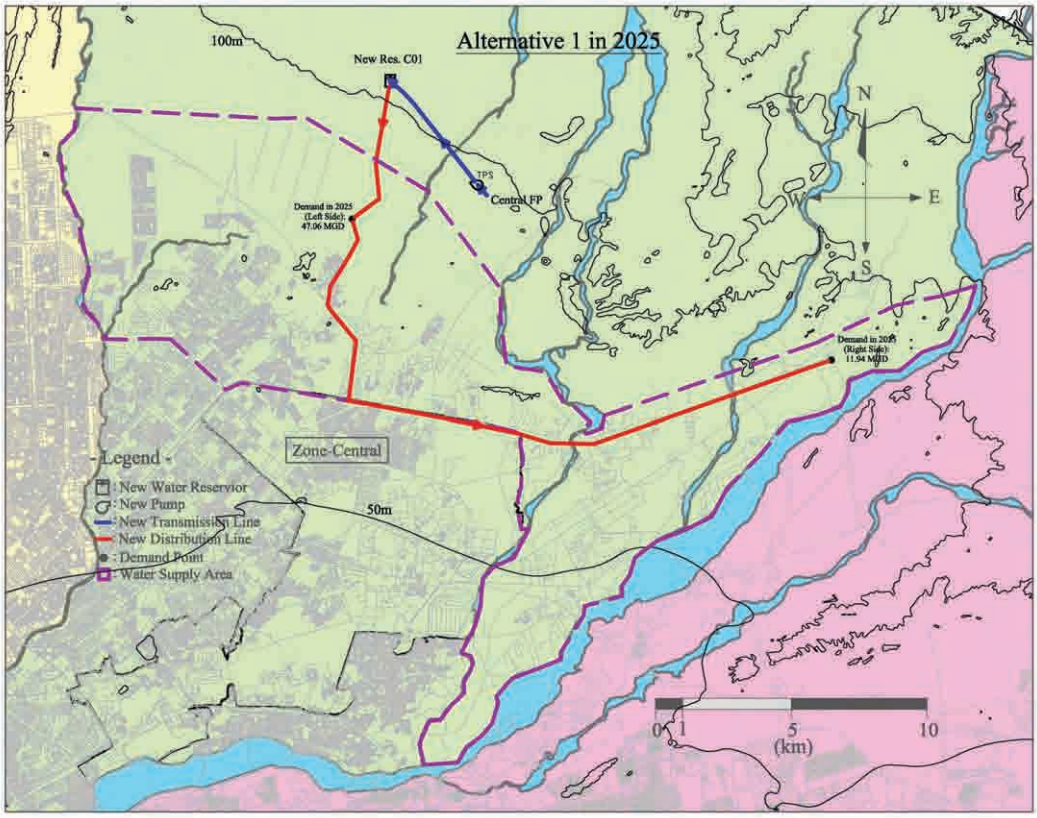

Figure A73.3.1 Alternative 1 in 2025 (Zone Central – Central FP)

Table A37.3.1 Cost of Alternative 1 in 2025 (Zone Central – Central FP)

Transmission Pipe					
Dia	L	Unit Price	Cost		
(Inch)	(m)	(PRp.)	(PRp.)		
56	5,500	50,000	275,000,000		
Sub-Total	5,500		275,000,000		
Transmission Pump					
Name	Power	Unit Price	Cost	Unit O/M Cost	Cost
	(kW)	(PRp.)	(PRp.)	(PRp./kW-H)	(PRp./kW-Year)
TPS	911.65	34,000	30,996,100	10	79,860,540
		Sub-Total	30,996,100	Sub-Total	79,860,540
Reservoir					
Name	V	Unit Price	Cost		
	(mg)	(PRp./m3)	(PRp.)		
New Res C01 Pump Well	1.23	3,600	20,130,087		
New Res C02	19.67	3,600	321,852,261		
		Sub-Total	341,982,348		
Distiribution Pipe					
Dia	L	Unit Price	Cost		
(Inch)	(m)	(PRp.)	(PRp.)		
72	5,700	71,000	404,700,000		
56	25,900	50,000	1,295,000,000		
Sub-Total	31,600		1,699,700,000		
Total (PRp.)		***Initial Cost***	2,347,678,448	***Pump O/M Cost***	79,860,540

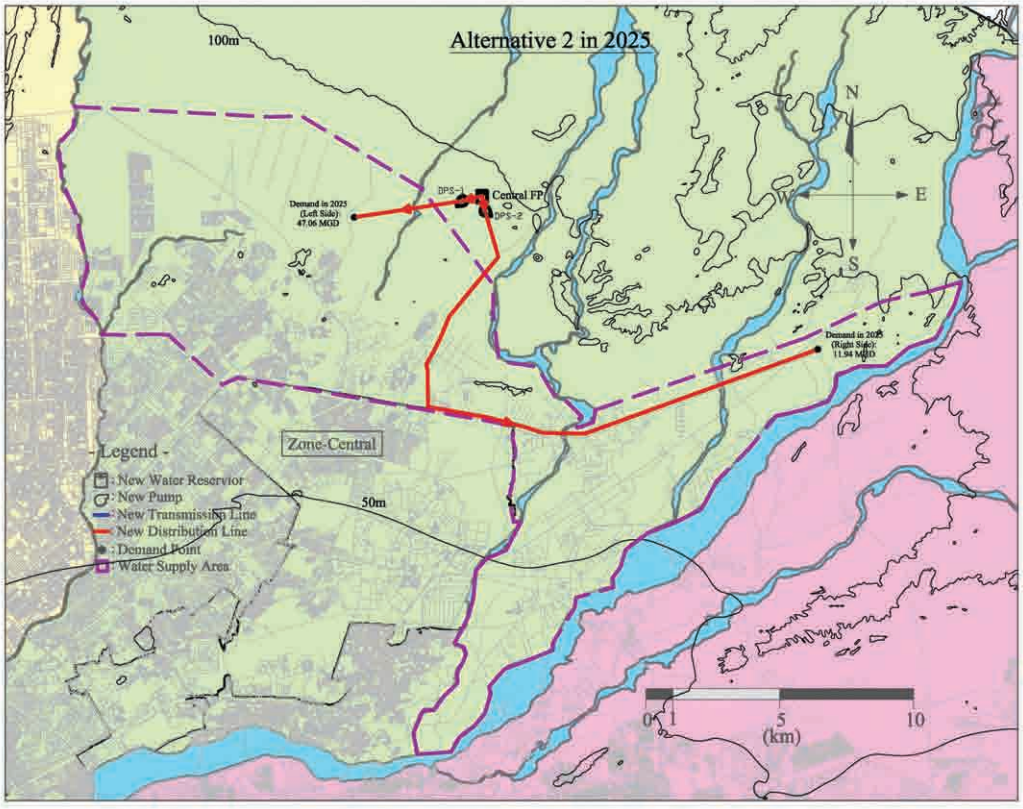

Figure A73.3.2 Alternative 2 in 2025 (Zone Central – Central FP)

Table A73.3.2 Cost of Alternative 2 in 2025 (Zone Central – Central FP)

Reservoir					
Name	V (mg)	Unit Price (PRp./m3)	Cost (PRp.)		
New Res 01	19.67	3,600	321,852,261		
		Sub-Total	325,943,742		
Distiribution Pipe					
Dia (Inch)	L (m)	Unit Price (PRp.)	Cost (PRp.)		
72	4,900	71,000	347,900,000		
56	24,100	50,000	1,205,000,000		
Sub-Total	29,000		1,552,900,000		
Distribution Pump					
Name	Power (kW)	Unit Price (PRp.)	Cost (PRp.)	Unit O/M Cost*1 (PRp./kW-H)	Cost (PRp./kW-Year)
DPS-1	606	34,000	20,602,640	12	63,698,515
DPS-2	62	34,000	2,091,000	12	6,464,880
		Sub-Total	22,693,640	Sub-Total	70,163,395
Power Generator					
Name	Power (kW)	Cost (PRp.)			
For DPS-1 and DPS-2	667		14,562,581		
		Sub-Total	14,562,581		
Total (PRp.)		***Initial Cost***	1,916,099,963	***Pump O/M Cost***	70,163,395

*1: including 20% increase to take the additional O/M cost of the generator for pump into account

(3) Second Alternative Study for 2025 to Distribute Water from New Res. C01

Since it is concluded in the previous alternative study of **Section (2)** that a new reservoir (Res. C01) will be constructed at the north of Central FP, it is planned to transmit the water for the second target area (for this second alternative study for Zone Central) in north (shown as Res-C01 Pumping in **Figure A77.1.3**) from Central FP to new Res. C01, as well as the water for the first target area of the previous alternative study.

From new Res. C01, the water can be future transmitted by pump to another distribution reservoir at a higher location, for consequent distribution by gravity or can be distributed directly from Res. C01 to households by distribution pumps. **Figures A73.3.3** and **A73.3.4** show these two alternatives in 2025 of supplying water from New Res. C01 to the northern water supply area (Res-C01 Pumping) where low future population is expected. Alternative 1 shown in **Figure A73.3.3** distributes water directly from new Res. C01 to the target area by distribution pump, while Alternative 2, which is shown in **Figure A73.3.4**, transmits water from new Res. C01 to another new distribution reservoir, Res. C02, located at a higher location than Res. C01 before distributing water to the target area by gravity.

The construction cost of Alternative 1 (PRs. 0.27 billion) is about 15% cheaper than that of Alternative 2 (PRs. 0.32 billion) as seen in **Tables A73.3.3** and **A73.3.4**. Since this whole water supply area is currently undeveloped and the locations of future settlements within the area cannot be predicted, it will be continuously difficult to finalize the suitable location for new Res. C02 of Alternative 2. Alternative 1 of direct pump distribution, on the other hand, can provide more flexibility to adjust to currently-unknown future development of the area.

For these reasons, Alternative 1 is selected for this water supply area in preparing the water supply system in 2025 of the proposed Master Plan.

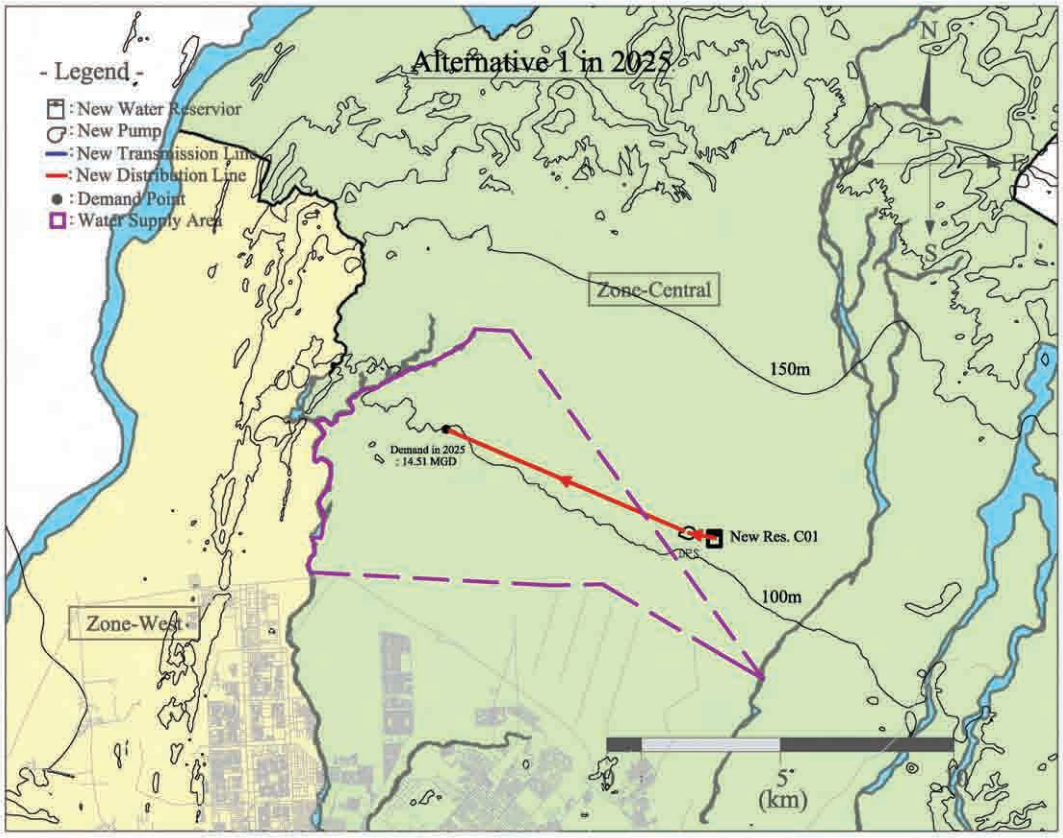

Figure A73.3.3 Alternative 1 in 2025 (Zone Central – Res. C01)

Table A73.3.3 Cost of Alternative 1 in 2025 (Zone Central – Res. C01)

Reservoir					
Name	V	Unit Price	Cost		
	(mg)	(PRp./m3)	(PRp.)		
New Res 01 Pump Well	4.84	3,600	79,161,974		
		Sub-Total	83,253,455		
Distiribution Pipe					
Dia	L	Unit Price	Cost		
(Inch)	(m)	(PRp.)	(PRp.)		
36	8,300	21,000	174,300,000		
Sub-Total	8,300		174,300,000		
Distribution Pump					
Name	Power	Unit Price	Cost	Unit O/M Cost*1	Cost
	(kW)	(PRp.)	(PRp.)	(PRp./kW-H)	(PRp./kW-Year)
DPS	299	34,000	10,177,333	12	31,465,920
		Sub-Total	10,177,333	Sub-Total	31,465,920
Power Generator					
Name	Power	Cost			
	(kW)	(PRp.)			
For DPS	299		6,332,232		
		Sub-Total	6,332,232		
Total (PRp.)		***Initial Cost***	274,063,021	***Pump O/M Cost***	31,465,920

*1: including 20% increase to take the additional O/M cost of the generator for pump into account

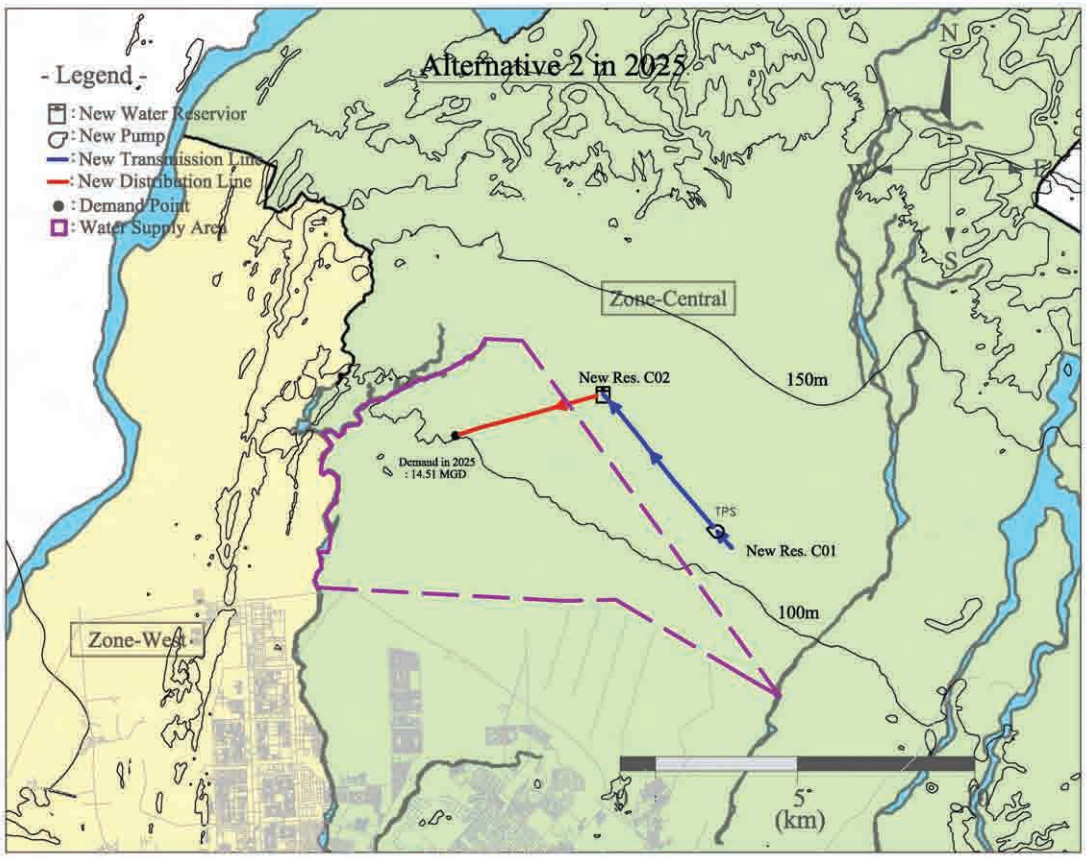

Figure A73.3.4 Alternative 2 in 2025 (Zone Central – Res. C01)

Table A73.3.4 Cost of Alternative 2 in 2025 (Zone Central – Res. C01)

Transmission Pipe					
Dia	L	Unit Price	Cost		
(Inch)	(m)	(PRp.)	(PRp.)		
32	5,600	20,000	112,000,000		
Sub-Total	5,600		112,000,000		
Transmission Pump					
Name	Power	Unit Price	Cost	Unit O/M Cost	Cost
	(kW)	(PRp.)	(PRp.)	(PRp./kW-H)	(PRp./kW-Year)
TPS	299	34,000	10,166,000	10	26,192,400
		Sub-Total	10,166,000	Sub-Total	26,192,400
Reservoir					
Name	V	Unit Price	Cost		
	(mg)	(PRp./m3)	(PRp.)		
New Res C01 Pump Well	0.30	3,600	4,942,509		
New Res C02	4.84	3,600	79,161,974		
		Sub-Total	84,104,483		
Distiribution Pipe					
Dia	L	Unit Price	Cost		
(Inch)	(m)	(PRp.)	(PRp.)		
40	4,300	25,500	109,650,000		
Sub-Total	4,300		109,650,000		
Total (PRp.)		***Initial Cost***	315,920,483	***Pump O/M Cost***	26,192,400

APPENDIX – A73.4

Alternatives of Water Transmission for Zone East

A73.4 Alternatives of Water Transmission for Zone East

(1) Target Water Supply Area of Alternative Study

Prior to the alternative studies, the water supply system of Zone East in 2025 was divided into six water supply areas (Pipri & Gharo Gravity, East Gravity, E01 Pump Gravity, E02 Pump Gravity, E03 Pump Gravity, and E03 Pumping as seen in **Figure A77.1.3** of **Appendix A77.1**) in consideration of elevation, other topological conditions, capacities of related facilities, current water supply areas and town boundaries.

Water can be distributed to the two lower-laying water supply areas (Pipri & Gharo Gravity and East Gravity) of Zone East by gravity directly from the locations of existing Pipri FP and Gharo FP and East FP planned in K-IV project. However, the other four supply areas require pumping from planned East FP, due to their high elevation, for either direct distribution by pumping or water transmission by pumping to a new reservoir at a higher land for consequent water distribution by gravity. It is planned to construct new reservoirs (Res. E02 and Res. E03) for the two water supply areas of small water demand around and above East FP (E02 Pumping Gravity and E03 Pumping Gravity) in accordance with the basic concept on gravity distribution. However, direct pump distribution from new Res. E03 is selected for the other water supply area of small water demand at the north end of Zone East (E03 Pumping) because its large difference in height within the area (gravity distribution from one additional reservoir cannot cover the whole area). Since this area is currently undeveloped and is DHA9 that will be a bulk water user, direct pump distribution will provide them with enough flexibility to develop their own stable distribution system covering all the future settlements within the area.

The remaining water supply area (E01 Pumping Gravity) is expected to have a large water demand of 36.93 mgd in 2025. The water distribution to this area requires pumping from East FP because hills are between East FP and this area. For these reasons, this water supply area is considered as the target area of alternative study for Zone East.

The following **Section (2)** shows an alternative study on two alternatives in 2025 for the target water supply area. The alternative study is conducted based on the condition that new reserves, transmission mains and trunk distribution mains will be provided exclusively for covering the water demand of the target water supply area while existing facilities will be used only for covering the water demand of the water supply areas. The basic conditions of hydraulic analysis used for the alternative study are explained in **Appendix A73.1**.

(2) Alternative Study for 2025

Figures A73.4.1 and **A73.4.2** show two alternatives in 2025 of supplying water from East FP to the target water supply area (shown as E01 Pumping Gravity in **Figure A77.1.3**) where relatively high population increase is expected. Alternative 1, which is shown in **Figure A73.4.1**, transmits water from East FP to a new distribution reservoir at the top of the hilly area (Res. E01) before distributing the water to the target area by gravity, while Alternative 2 shown in **Figure A73.4.2** distributes water directly from East FP to the target area by distribution pumps.

Both construction and O/M costs of Alternative 1 (PRs. 0.955 billion and PRs. 41 million/year) are lower than those of Alternative 2 (PRs. 0.964 billion and PRs. 71 million/year) as seen in **Tables A73.4.1** and **A73.4.2.** Alternative 1 of gravity distribution also has another significant advantage over Alternative 2 of direct pump distribution in terms of stable water supply. Therefore, Alternative 1 is selected for this water supply area in preparing the water supply system in 2025 of the proposed Master Plan.

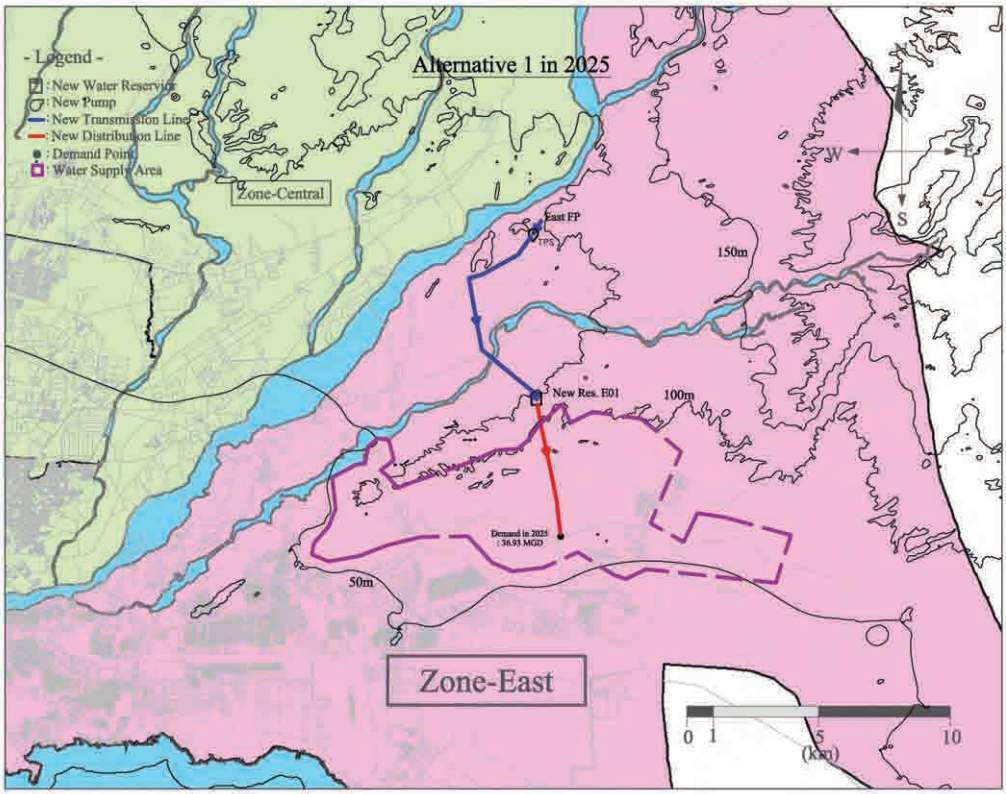

Figure A73.4.1 Alternative 1 in 2025 (Zone East)

Table A73.4.1 Cost of Alternative 1 in 2025 (Zone East)

Transmission Pipe					
Dia	L	Unit Price	Cost		
(Inch)	(m)	(PRp.)	(PRp.)		
56	9,200	50,000	460,000,000		
Sub-Total	9,200		460,000,000		
Transmission Pump					
Name	Power	Unit Price	Cost	Unit O/M Cost	Cost
	(kW)	(PRp.)	(PRp.)	(PRp./kW-H)	(PRp./kW-Year)
TPS	475.52	34,000	16,167,680	10	41,655,552
		Sub-Total	16,167,680	Sub-Total	41,655,552
Reservoir					
Name	V	Unit Price	Cost		
	(mg)	(PRp./m3)	(PRp.)		
New Res E01	12.31	3,600	201,464,524		
Eest FP Pump Well	0.77	3,600	12,585,396		
		Sub-Total	214,049,920		
Distiribution Pipe					
Dia	L	Unit Price	Cost		
(Inch)	(m)	(PRp.)	(PRp.)		
56	5,300	50,000	265,000,000		
Sub-Total	5,300		265,000,000		
Total (PRp.)		***Initial Cost***	955,217,600	***Pump O/M Cost***	41,655,552

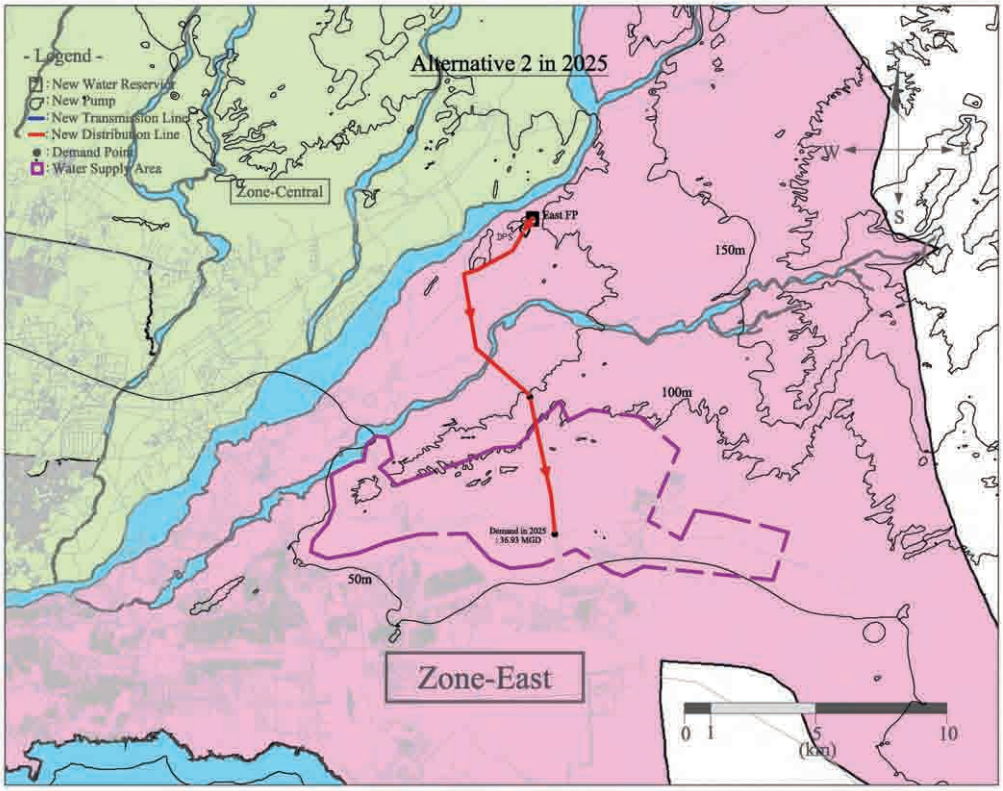

Figure A73.4.2 Alternative 2 in 2025 (Zone East)

Table A73.4.2 Cost of Alternative 2 in 2025 (Zone East)

Reservoir					
Name	V	Unit Price	Cost		
	(mg)	(PRp./m3)	(PRp.)		
New Res. of Eest FP	12.31	3,600	201,464,524		
		Sub-Total	201,464,524		
Distiribution Pipe					
Dia	L	Unit Price	Cost		
(Inch)	(m)	(PRp.)	(PRp.)		
56	14,500	50,000	725,000,000		
Sub-Total	14,500		725,000,000		
Distribution Pump					
Name	Power	Unit Price	Cost	Unit O/M Cost[*1]	Cost
	(kW)	(PRp.)	(PRp.)	(PRp./kW-H)	(PRp./kW-Year)
DPS	666	34,000	22,636,293	12	69,986,093
		Sub-Total	22,636,293	Sub-Total	69,986,093
Power Generator					
Name	Power	Cost			
	(kW)	(PRp.)			
For DPS	666		14,538,549		
		Sub-Total	14,538,549		
Total (PRp.)		***Initial Cost***	963,639,366	***Pump O/M Cost***	69,986,093

*1: including 20% increase to take the additional O/M cost of the generator for pump into account