# CHAPTER 7

# WATER SUPPLY MASTER PLAN

# 7 WATER SUPPLY MASTER PLAN

## 7.1 PLANNING ASSUMPTIONS

This section discusses the planning assumptions, based upon which our master plan for the water supply system in Karachi has been formulated.

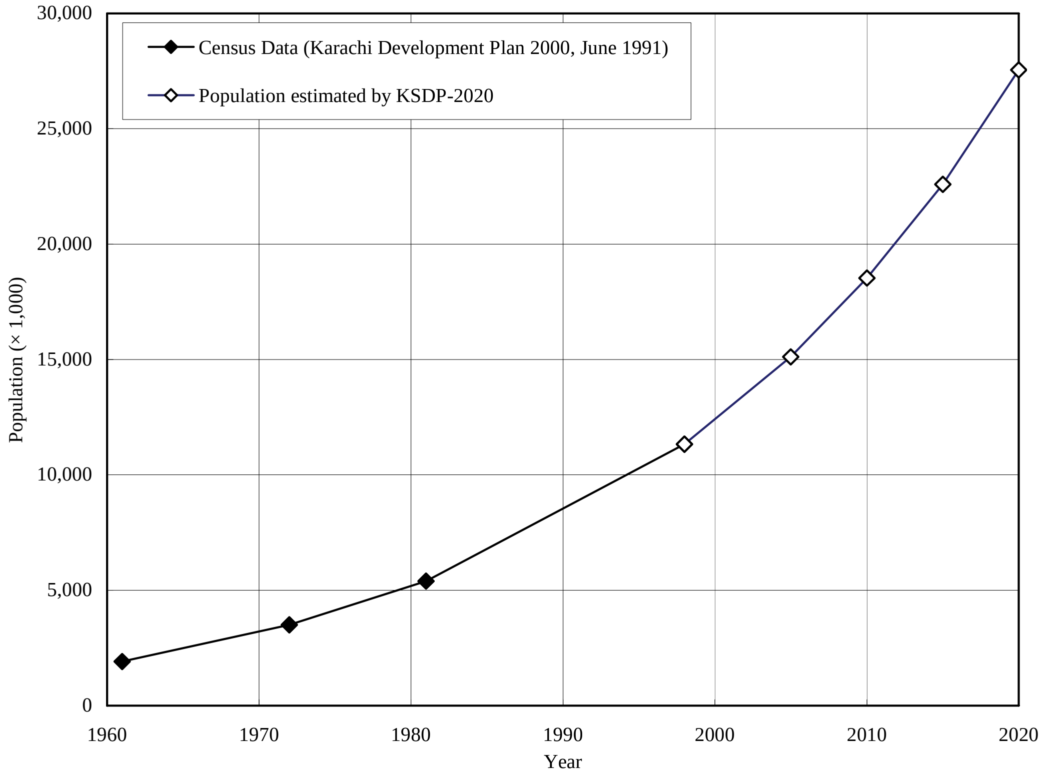
### 7.1.1 Population and Development Patterns

In August 2007, CDGK issued the final report on Karachi Strategic Development Plan 2020 (Final Report, August 2007). This report indicated that the total population of Karachi was 15.2 million in 2005 and it would increase to 27.5 million in 2020. The report also predicted that more than 45% of the projected population increase during the 15 years from 2005 to 2020 would occur in the three towns located on the outskirts of the Karachi City, namely Keamari, Gadap and Bin Qasim whereas the other 55% would occur in the remaining 15 towns. This was based on the perception that during the next 15 years significant developments would take place on the outskirts of the city in particular in the southern part of Gadap Town. **Figure 71.1.1** shows the population projections made in the Karachi Strategic Development Plan 2020 (Final Report, August 2007). **Figure 71.1.2** illustrates the future land use envisaged by the same plan.

**Karachi's total population was 15.2 million in 2005 and it would increase to 27.5 million in 2020.**

We believe that the Karachi Strategic Development Plan 2020 (KSDP-2020), once it is approved and authenticated by higher authorities, will serve as a guiding principle, based on which all infrastructure development schemes for all public service sectors, such as water supply, sewerage, solid waste disposal, electricity, gas, telecommunication and roads will be developed. For this reason, we decided to develop a water supply and sewerage master plan for Karachi based on the population projection, future land use patterns and other basic data provided in the KSDP-2020 (Final Report, August 2007).

**It has been predicted that 45% of the population increase during the 15 years from 2005 to 2020 would occur in the three towns located on the outskirts of the Karachi City, namely Keamari, Gadap and Bin Qasim while the other 55% would occur in the remaining 15 towns.**




| Year | 1981 | 1998 | 2005 | 2010 | 2015 | 2020 |
|---|---|---|---|---|---|---|
| Population (1,000) | 5,395.4 | 11,335 | 15,120 | 18,529 | 22,594 | 27,550 |
| Average Annual Growth Rate (%) | | 4.46% | 4.20% | 4.15% | 4.05% | 4.05% |

**Figure 71.1.1 Population Projection in KSDP-2020 (Final Report - August 2007)**

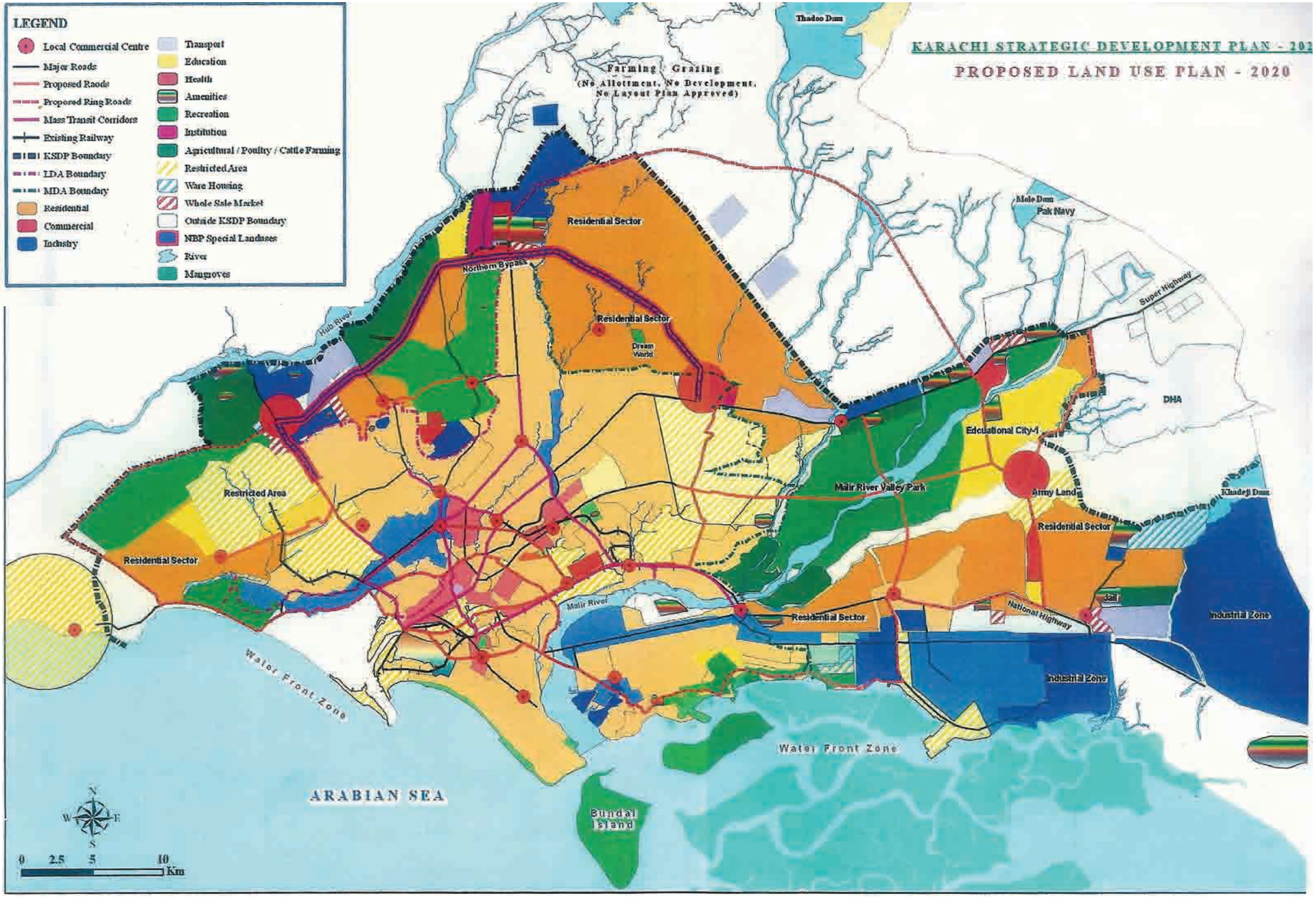



**Figure 71.1.2 Land Use Plan Proposed in KSDP-2020 (Final Report - August 2007)**

### 7.1.2 Water Sources

Despite the significant population increase envisaged by the KSDP-2020 (Final Report-August 2007), there has been no definite plan for increasing the capacity of water sources to meet the increasing water demand. In this respect, the KSDP-2020 has proposed the use of several modern technologies to increase the water supply capacity. They include the construction of sea water desalination plants, reuse of effluents from sewage treatment plants for recharging groundwater aquifers, and the development of dual water supply systems and dual sewerage systems. However, most of these technologies are not considered financially viable both at present and in the foreseeable future.

Sea water desalination will not provide a viable solution for a mega city like Karachi unless there is a remarkable technical breakthrough that substantially reduce both CAPEX and OPEX of desalination. Our review of existing studies on the development of regional groundwater resources indicated that the exploitability of groundwater in the region is very low.

In the light of the immense size of the water demand in the city, there is no doubt that the Indus River will continue to remain as the only viable water source for Karachi in the foreseeable future. This view was first indicated by the 1985 water supply master plan study for Karachi conducted by Sir M. MacDonald and Partners (principal consultant) and Associated Consulting Engineers (local associated consultant). The study made a review of all potential water sources in the Karachi region, which included the Indus River and other surface water and groundwater sources, seawater desalination, and the indirect reuse of treated sewage effluents for the recharge of aquifers and substitution of existing non-potable uses. As a result, the study indicated that the Indus River and desalination are the only two sources that could technically meet a large water demand in Karachi. The study also indicated that the cost of desalination for the foreseeable future was prohibitive and that desalination should therefore be considered as a last resort. The study then concluded that the Indus River was the only viable water source for Karachi.

This view was endorsed by a special committee formulated by GOS in 2002. The committee which was comprised of representatives from the Planning and Development Department of GOS, Irrigation and Power Department of GOS, and Karachi Water & Sewerage Board (KW&SB), prepared a report on long term water supply plan for Karachi up to the year 2025. The committee submitted the report to the Central Development Working Party (CDWP) on November 14, 2002, which was evaluating the PC-I of the scheme "Assured Water Supply for Karachi – upgrading Kinjhar Lake System" at that time. In summary, the report provided the following major findings and recommendations.

(Findings)

- The existing allocation of 1,200 cusecs from the Indus River would be fully utilized in 2005 with completion of the 100 mgd K-III project. The population of Karachi was ever growing and additional requirement up to the year 2025 was estimated to be another 1,200 cusecs thus the total requirement would be 2,400 cusecs.
- The present scheme for assuring a water supply for Karachi is considered as Phase-I. This phase is to cater for short-term assured water for Karachi up to the year 2005. Phase-II of this scheme would be required for long-term requirements of water supply in Karachi beyond 2005 and up to 2025.

(Recommendations)

- To meet the growing water demand of Karachi the water allocation for Karachi up to Vision 2025 may be increased by another 1,200 cusecs raising the total allocation to 2,400 cusecs by the Government under a national cause without affecting the water supply quota of the Thatta District for agriculture purposes. Once additional allocation was allowed then a 2-stage study programme for system expansion would have to be initiated.

- Stage-I: Study by the Irrigation and Power Department of GOS for increasing capacity in the system from the KB Feeder Upper up to the Kinjhar Lake without affecting the stability of the Kotri Barrage.
- Stage-II: Feasibility study by KW&SB in consultation with the Irrigation and Power Department for determining the most economically viable, technically feasible and secure route to bring additional 1,200 cusecs of water from the Kinjhar Lake to Karachi.

Based on the committee's recommendations, CDGK requested the GOP to grant an additional quota of 1,200 cusecs (650 mgd) from the Indus River to meet the future water demand of the Karachi City. Furthermore, KW&SB since October 2005 has been conducting the K-IV Study, the main objective of which is to recommend on the most economical and technically viable route for conveying additional 1,200 cusecs of Indus water from the Kinjhar Lake to Karachi. The study examined several alternative routes and recommended the most economical route as a result of the comparison of capital and annual operating costs to be required for each alternative. Further, the study also identified the sites for construction of three water treatment plants each having an ultimate treatment capacity of 260 mgd, 260 mgd and 130 mgd. **Figure 71.2.1** shows the locations of the raw water conveyance route and three water treatment plants proposed by the study. In January 2008, President Pervez Musharaff while presiding at the 'foundation stone unveiling ceremony' of the 'Corridor Project' at Governor's House assured the Federal Government's supports towards the implementation of the K-IV Project. A newspaper article describing this event is attached as **Appendix A71.1**.

In developing a water supply master plan for Karachi, the JICA Study assumed that Karachi would be granted an additional quota of 1,200 cusecs from the Indus River and a total of 2,400 cusecs of Indus River water would be made available at the Kinjhar Lake for extraction by KW&SB. This is based on our strong belief that if this additional quota is not granted, then there will be no such a large population increase or significant developments in Karachi as have been envisaged by the KSDP-2020 (Final Report-August 2007).

**Karachi would be granted an additional quota of 1,200 cusecs from the Indus River and a total of 2,400 cusecs of Indus River water would be made available at the Kinjhar Lake for abstraction by KW&SB. If this additional quota is not granted, then there will be no such a large population increase or significant developments in Karachi as have been envisaged by the KSDP-2020 (Final Report - January 2007).**

The Department of Irrigation and Power of GOS is currently responsible for the operation and maintenance of the Kotri Barrage, KB Feeder Upper and Kinjhar Lake while KW&SB's responsibility for the operation and maintenance of the bulk water supply system starts from the KG Canal that withdraws the impounded water of the Kinjhar Lake. It is likely that this demarcation of responsibilities will remain unchanged in the future, and as such, it is assumed that any infrastructure development required for enabling KW&SB to withdraw additional 1,200 cusecs from the Kinjhar Lake would be planned, designed and implemented by GOS and that GOS would also be responsible for the operation and maintenance of such additional infrastructure. Instead, it is assumed that KW&SB would pay GOS a raw water charge at the rate of Rs.0.5 per 1,000 gallons (Rs.0.11 per $m^3$) to compensate GOS for part of the costs incurred with respect to the construction, operation and maintenance of such infrastructure.

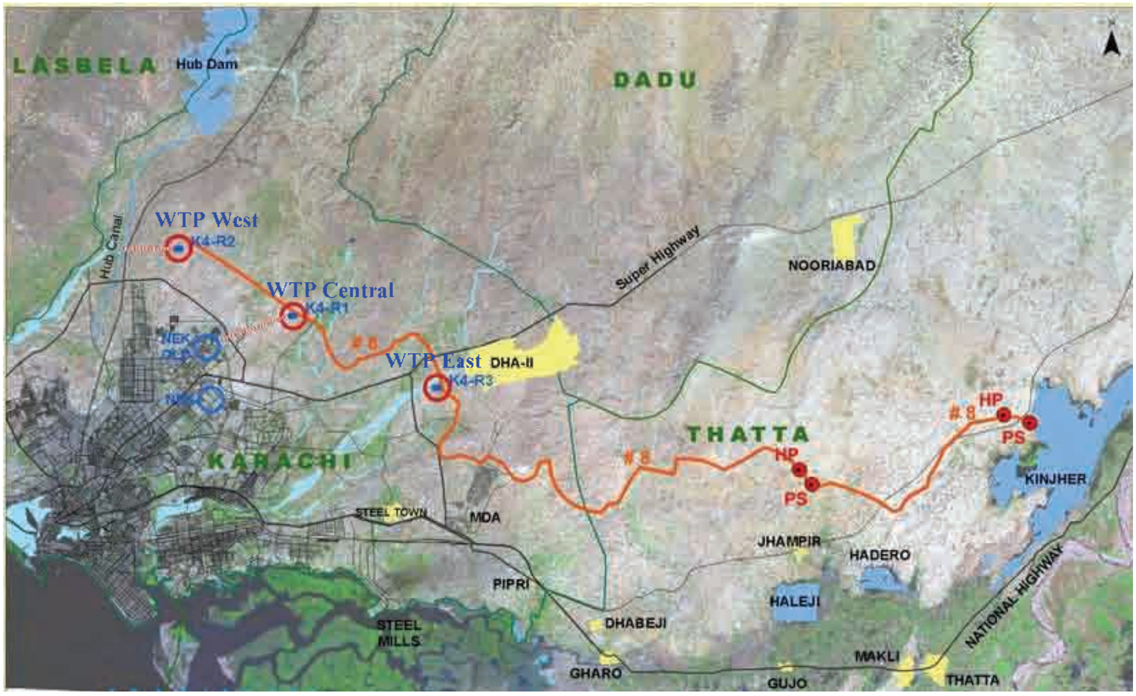



**Figure 71.2.1 K-IV Project** (Source: K-IV Project Executive Summary, OSMANI May 2007)

## 7.2 BASIC POLICIES, GOALS AND STRATEGIES

This section discusses the following basic policies adopted for the formulation of the water supply master plan.

- Demand Management Approaches
- Separation of Bulk and Retail Supplies
- Zone-wise Management of Retail Supply
- Implementation of Distribution Network Improvement (DNI) on a Financially Sustainable Basis

**Basic Policies Adopted for the Formulation of the Water Supply Master Plan**
**(1) Demand Management Approaches**
**(2) Separation of Bulk and Retail Supplies**
**(3) Zone-wise Management of Retail Supply**
**(4) Implementation of DNI on a Financially Sustainable Basis**

### 7.2.1 Demand Management Approaches

It is estimated in **Section 6.2** that at present the volume of the actual bulk water supply to Karachi is 630 mgd, and that the current per capita bulk water supply capacity is about 40 gallons or 182 litres. Multiplying this by the total population of 15.12 million in 2005, the total volume of bulk water conveyed to Karachi through the bulk water supply system in the same year is estimated at 604.8 mgd. Assuming 10% water losses in the bulk water supply system (including evaporation in open canals and losses at water purification plants), the volume of water that was actually made available for Karachi in 2005 is estimated at 549.8 mgd (604.8/1.1). With the leakage in the distribution system being assumed at 35%, the volume of water actually used by customers is estimated to be 357.4 mgd (549.8 × 0.65). Further, if 40% of this volume is used for non-domestic purposes, water used for domestic purpose is estimated at 214.4 mgd (357.4 × 0.60). Dividing this by the total served population of 13.608 million, which is 90% of the city's total population in 2005 (15.12 million) estimated by the KSDP-2020 (Final Report-August 2007), the domestic per capita consumption rate in 2005 is estimated at 15.76 gallons (71.6 litres) per day. No accurate assessment of leakage in the distribution network is possible at present. The per capita consumption rate will further reduce if the actual leakage is greater than 35%.

KSDP-2020 estimated that Karachi had a total population of 15.2 million in 2005 and also projected that the total population would increase to 27.5 million by 2020. It is envisaged from this projection that Karachi's total population could reach 32.0 million in 2025, which is almost double of the present total population. On the other hand, the possible increase in the capacity of water sources over the same period is estimated to be only 1,200 cusecs (650 mgd) as discussed in **Section 7.1**, which is less than the capacity of existing water sources i.e.720 mgd. These observations suggest that Karachi will continuously be subjected to severe water constraints over the planning horizon of 2025.

**Our observations suggest that Karachi will continuously be subjected to severe water constraints over the planning horizon of 2025.**

Karachi is located in the arid region where annual precipitation is as small as 200 mm. There is no prospective surface or underground water source available within or in the vicinity which can be developed in a large scale to cater for the enormous water demand of the mega city. Karachi seems to be one of the few cities in the world, which lies in the arid region, yet accommodates as many as 16 million people.

With the exploding population and limited availability of water resources, one must choose whether (a) to provide rather abundant supplies to a limited number of people in the city or (b) to provide essential supplies to as many people in the city as possible. Given the public nature of water supply service, it is obvious that one should choose the latter option. It is therefore extremely important to ensure that this option is successfully implemented through **'Demand Management Approaches'** which provide both general public and business entities with strong incentives to voluntarily restrict their water consumption for essential purposes only. There should be a consensus reached by all stakeholders that making future water supply development plans based on unconstrained water demands is not a proper approach in the case of Karachi.

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The central part of the demand management approaches will be the introduction of measured supplies with a volumetric charging system whereby all retail and bulk customers will be charged based on their actual consumption. This will be further reinforced by the introduction of a new water tariff structure which will provide both domestic and non-domestic customers with strong incentives for efficient use of water. Tariffs will be structured to differentiate essential water needs from non-essential water needs. A low tariff would be applied to essential water needs while those who consume beyond essential needs should be severely penalized. Minimizing leakage, wastage and illegal connections will also constitute the core part of the demand management approaches.

**Demand Management Approaches**

**Goals**

**All consumers in the city including government and business entities are being highly conscious about water conservation and voluntarily restrict their consumption for essential purposes only.**

**Strategies**

- **Introduction of measured supplies with a volumetric charging system whereby all retail and bulk customers will be charged based on this actual consumption**
- **Introduction of a new water tariff structure which will provide both domestic and non-domestic customers with strong incentives for efficient use of water**
- **Implementation of efficient meter reading, billing and collection**
- **Minimizing leakage, wastage and illegal connections**
- **Implementation of mass media campaigns for enhancing consumers' awareness on water conservation**
- **Mandatory use of water-saving equipment and devices in newly constructed houses and buildings such as low-volume toilets, low-flow showerheads, water faucets with flow restrictors or aerators.**
- **Subsidizing large-scale commercial and industrial users part of their investment costs for water conservation including internal recycling of used water.**

### 7.2.2 Separation of Bulk and Retail Supplies

KW&SB is currently supplying water to the entire Karachi District and two union councils in the Thatta District of the Sindh Province. In the near future, KW&SB is also expected to supply treated water to the Lasbela District of the Balochistan Province. This demonstrates that KW&SB is playing a role of the regional bulk water supplier.

The bulk water supply to two union councils in the Thatta District was initiated based on the notification issued by the GOS on August 23, 2004, which expanded the administrative area of KW&SB to include two union councils in the Thatta District, namely Dhabeji and Gharo. A copy of this notification is attached as **Appendix A72.1**.

The bulk water supply to the Lasbela District of the Balochistan Province was decided by the GOP during the approval process of the K-III project. The PC-1 documents of the project stipulated that out of 100 mgd of Indus water transferred from the Kinjhar Lake to Karachi under the K-III project, 95 mgd would be distributed to Karachi while the remaining 5 mgd to the Lasbela District. In accordance with this PC-1, a 27 km-long, 24-inch diameter water transmission pipeline was constructed from the Hub Filtration Plant to Lasbela as part of the K-III project. GOS and Government of Balochistan (GOB) are currently negotiating over (a) who should be responsible for the operation and maintenance of the transmission pipeline, and (b) the water tariff KW&SB will charge GOB for water it receives from KW&SB.

Under the Pakistani constitution, water is a provincial subject. However, GOP also performs a number of functions and responsibilities in the water sector, mostly relating to inter-provincial matters. The water supply to Balochistan under the K-III project is a good example of this. Because of the inclusion of the supply to Balochistan, the K-III project was given a status of an inter-provincial project and the entire project cost was subsidized by GOP. Both GOP and GOS have legitimate roles in shaping of policies and strategies for the water and sanitation sector in the region. It is obvious that the bulk water supplies to the Thatta and Lasbela Districts are the consequence of these policies and strategies. However, it should be noted that these policies and strategies often conflict with sound business and commercial principles.

Development of a new bulk water supply scheme to bring water from the Indus River to Karachi requires a large-scale investment which would inevitably exceed the financial capability of the service provider. Thus, part of the investment cost would have to be subsidized either by GOP or GOS. The reality is that in the past the entire capital costs required for the development of the bulk water supply system were subsidized either by GOP or GOS. The cost required for operation and maintenance of the bulk water supply system is also significantly large because of the long distances covered by the system. All these considerations lead to a conclusion that managing the bulk water supply system on a full cost recovery basis would not be feasible - at least within the planning horizon of 2025. On the contrary, retail water supply in Karachi can be managed on a full cost recovery basis with sound business and commercial principles. This is why we recommend the separation of bulk and retail supplies.

**Managing the bulk water supply system on a full cost recovery basis would not be feasible – at least within the planning horizon of 2025. On the contrary, retail water supply in Karachi can be managed on a full cost recovery basis with sound business and commercial principles. This is why we recommend the separation of bulk and retail supplies.**

**Figure 72.2.1** demonstrates the basic concept of the proposed separation. **Figure 72.2.2** illustrates the relationship between the bulk and retail suppliers after the separation. It is recommended that in the long run bulk and retail supplies should be managed and operated by different organisations.

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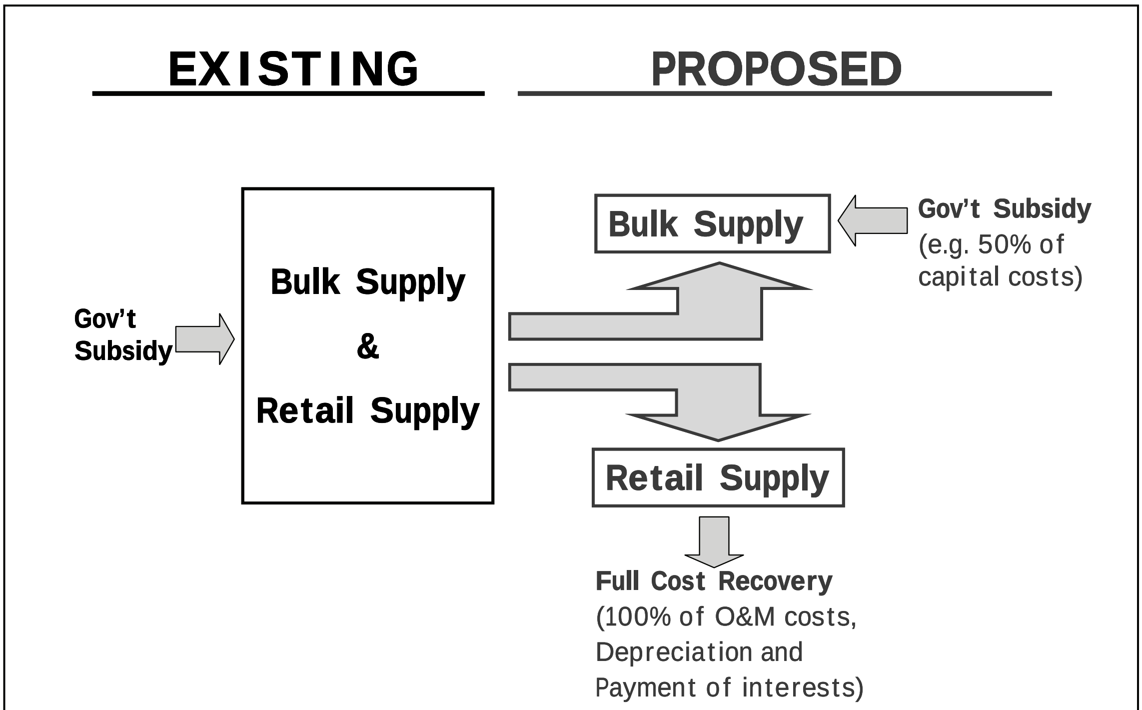



**Figure 72.2.1 Separation of Bulk and Retail Supplies**

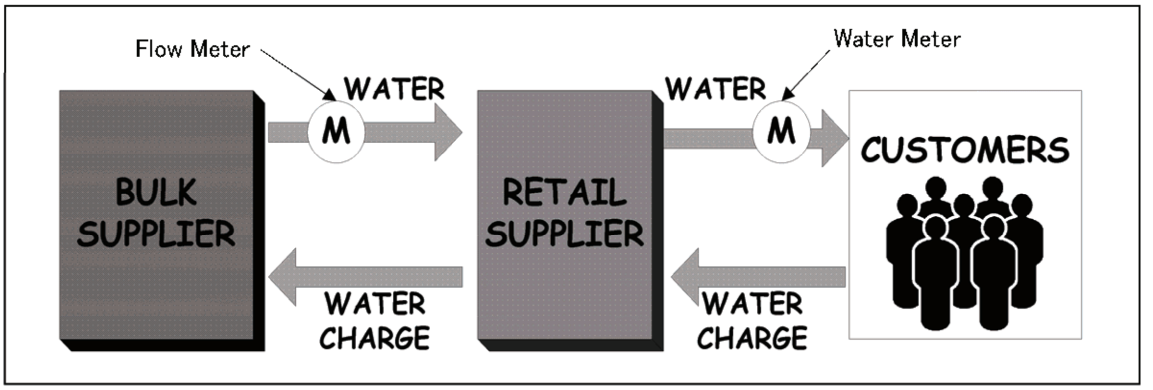



**Figure 72.2.2 Bulk and Retail Suppliers after Separation**

The ultimate objective of the proposed separation is to enable the retail supplier to provide customer-focused, efficient water supply and sewerage services on a financially sustainable basis. This requires the insulation of the retail supplier from external interference in the micromanagement aspects of its operation, including the employment of staff, disciplining workers for poor performance, offering rewards and promotions based on good performance, handling of payment defaulters and illegal/unauthorized connections, recovery of arrears, etc. Experience indicates that as long as retail suppliers are dependent on government subsidies they will remain vulnerable to political interference in the day-to-day management of the services and in the technical execution of projects.

**The ultimate objective of the proposed separation is to enable the retail supplier to provide customer-focused, efficient water supply and sewerage services to its customers.**

**This requires the insulation of the retail supplier from external interference in the micromanagement aspects of its operation.**

**Experience indicates that as long as retail suppliers are dependent on government subsidies, they will remain vulnerable to political interference in the day-to-day management of services and in the technical execution of projects.**

It is expected that the proposed separation would enhance the overall efficiency in the operation and maintenance of the water supply system. Since KW&SB in the past has been the only organization responsible for the management and operation of both bulk and retail water supply systems, there has been no absolute necessity for measuring flows at key strategic locations in the system. However, with the separation of the bulk and retail supplies, there will be an absolute necessity for accurately measuring flows at the locations where water is delivered to the retail supplier as shown in **Figure 72.2.2**.

**Separation of Bulk and Retail Supplies**

**Goals**

**An institutional framework is in place whereby a competent retail supplier (or suppliers) can provide water supply and sewerage services on a full cost recovery basis with sound business and commercial principles.**

**Strategies**

- ❑ **All stakeholders agree to the separation of the bulk and retail supplies.**
- ❑ **Conduct a separate study to identify necessary changes to existing laws, ordinances and regulations and draft detailed legal provisions to put the separation into effect.**
- ❑ **Propose such changes for approval of legislators.**

### 7.2.3 Zone-wise Management of Retail Supply

KW&SB has divided the entire Karachi City into five distribution zones, namely Zone I, Zone II-A, Zone II-B, Zone III-A and Zone III-B. This division was made for administrative purposes only, and from the hydraulic point of view each zone is not completely separated from others. **Figure 72.3.1** shows the locations of the existing five distribution zones. Zone I straddles the Malir River, and so do Zone II-A and Zone II-B the Lyari River. Zone III-A straddles both rivers. Retail service in each distribution zone is managed by a Zonal Chief Engineer. However, bulk customers in the zone such as cantonments, DHA, PSM, PQA and industries do not fall under his responsibility; they fall under the responsibility of the bulk transmission department. The same department is also responsible for operation and maintenance of water trunk mains that are passing through these distribution zones. **Table 72.3.1** presents the towns included in each of these five distribution zone.

KSDP-2020 (Final Report-August 2007) discussed in **Section 7.1** proposed that the water and wastewater services in Karachi should be managed and operated by each town. This however would not be a feasible option at least in the foreseeable future because of (a) the complexity of the existing water distribution system in which one water trunk main is supplying a number of towns whereas many towns are supplied by more than one water trunk main, and (b) the significant economic disparities between towns, making it difficult for some towns (such as Orangi, Baldia and Lyari) to cross-subsidize tariffs from the rich to the poor because of their weak revenue bases.

**Table 72.3.1 Existing Distribution Zones**

| Zone | Town |
|---|---|
| Zone I | Shah Faisal |
| | Landhi |
| | Korangi |
| | Malir |
| | Bin Qasim |
| Zone II-A | Keamari |
| | Lyari |
| | Saddar |
| Zone II-B | Jamshed |
| | Gulshan-e-Iqbal |
| | Liaquatabad |
| Zone III-A | S.I.T.E. |
| | Baldia |
| | Orangi |
| Zone III-B | North Nazimabad |
| | New Karachi |
| | Gulberg |
| | Gadap |

Instead, we propose that Karachi should be divided into three distinct hydraulic zones each separated from the others by two major rivers in Karachi i.e. Malir and Lyari Rivers. The rationale is that there is only a limited number of exiting water mains and sewer pipes that have been laid across these rivers and they can easily be located for installation of isolation valves or bulk flow meters. Further, separation of hydraulic zones by rivers would allow for more prudent approaches for planning of the sewerage system than by the administrative boundaries of the towns. **Figure 72.3.2** shows the locations of the proposed three hydraulic zones. **Table 72.3.2** presents the towns and cantonments included in each hydraulic zone. Because of its immense size, Gadap town is separated into the three hydraulic zones with its major part being in the Zone Central. Although the main part of Keamari town is located in the Zone West, a small fraction of the town on the left bank of the Lyari River is included in the Zone Central. The other 16 towns are not divided either by the Malir or Lyari River.

**Karachi should be divided into three distinct hydraulic zones by the two major rivers in Karachi i.e. Malir and Lyari Rivers.**

**Table 72.3.2 Proposed Hydraulic Zones**

| Hydraulic Zone | Town | Cantonment / DHA |
|---|---|---|
| Zone West | Keamari (Main) | |
| | S.I.T.E. | |
| | Baldia | |
| | Orangi | |
| | North Nazimabad | |
| | Gulberg | |
| | Liaquatabad | |
| | New Karachi | |
| | Gadap (Fraction) | |
| Zone Central | Lyari | Malir |
| | Saddar | Faisal |
| | Jamshed | Karachi |
| | Gulshan-e-Iqbal | Clifton |
| | Shah Faisal | Manora |
| | Malir | DHA |
| | Gadap (Main) | |
| | Keamari (Fraction) | |
| Zone East | Landhi | Korangi Creek |
| | Korangi | |
| | Bin Qasim | |
| | Gadap (Fraction) | |

The size of the city is too large for a single retail entity to manage and operate water supply and sewerage services efficiently. It is therefore recommended that water supply and sewerage services in each hydraulic zone be managed and operated by an independent organization. Each organization will be responsible for operation and management of water supply and sewerage services within its own hydraulic zone, including the operation and maintenance of water trunk mains, leakage and NRW reduction, collection of tariffs, employment of staff and dealing with customer complaints. It will purchase treated water in bulk from the bulk supplier at the immediate downstream of filtration plants, service reservoirs, or pumping stations as the case may be, and distribute it through water trunk mains into various towns located within its hydraulic zone. The organization will also be accountable for collection, transportation and proper treatment of sewage generated in its hydraulic zone. Its revenue base would include not only retail consumers but also bulk consumers such as cantonments, DHA, and other industrial, commercial and governmental entities within the zone. Tariffs would be different from one zone to another reflecting the actual revenue requirements of each zone, providing they obtain prior approval of an independent regulatory body.

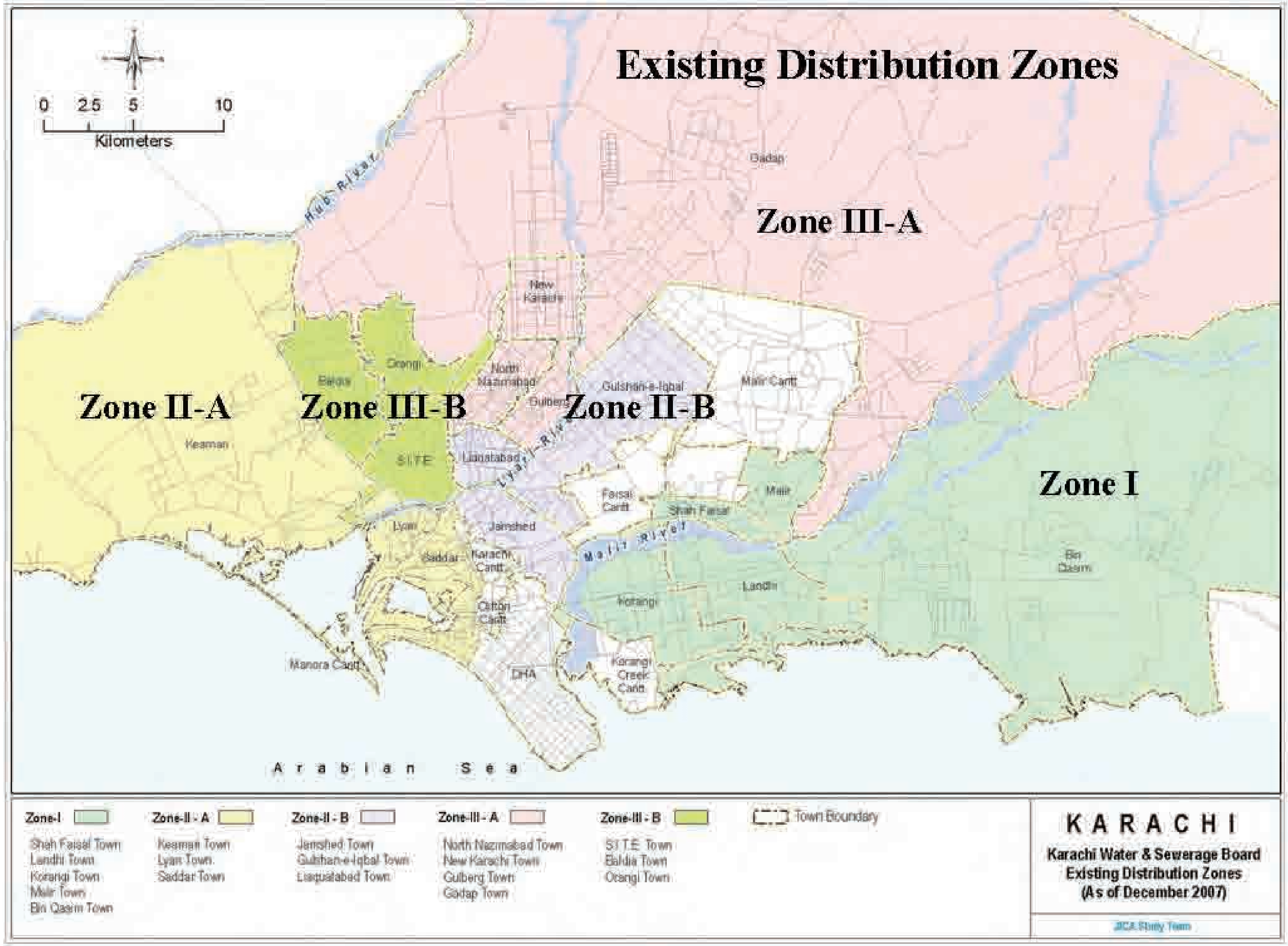



**Figure 72.3.1 Existing Distribution Zones**

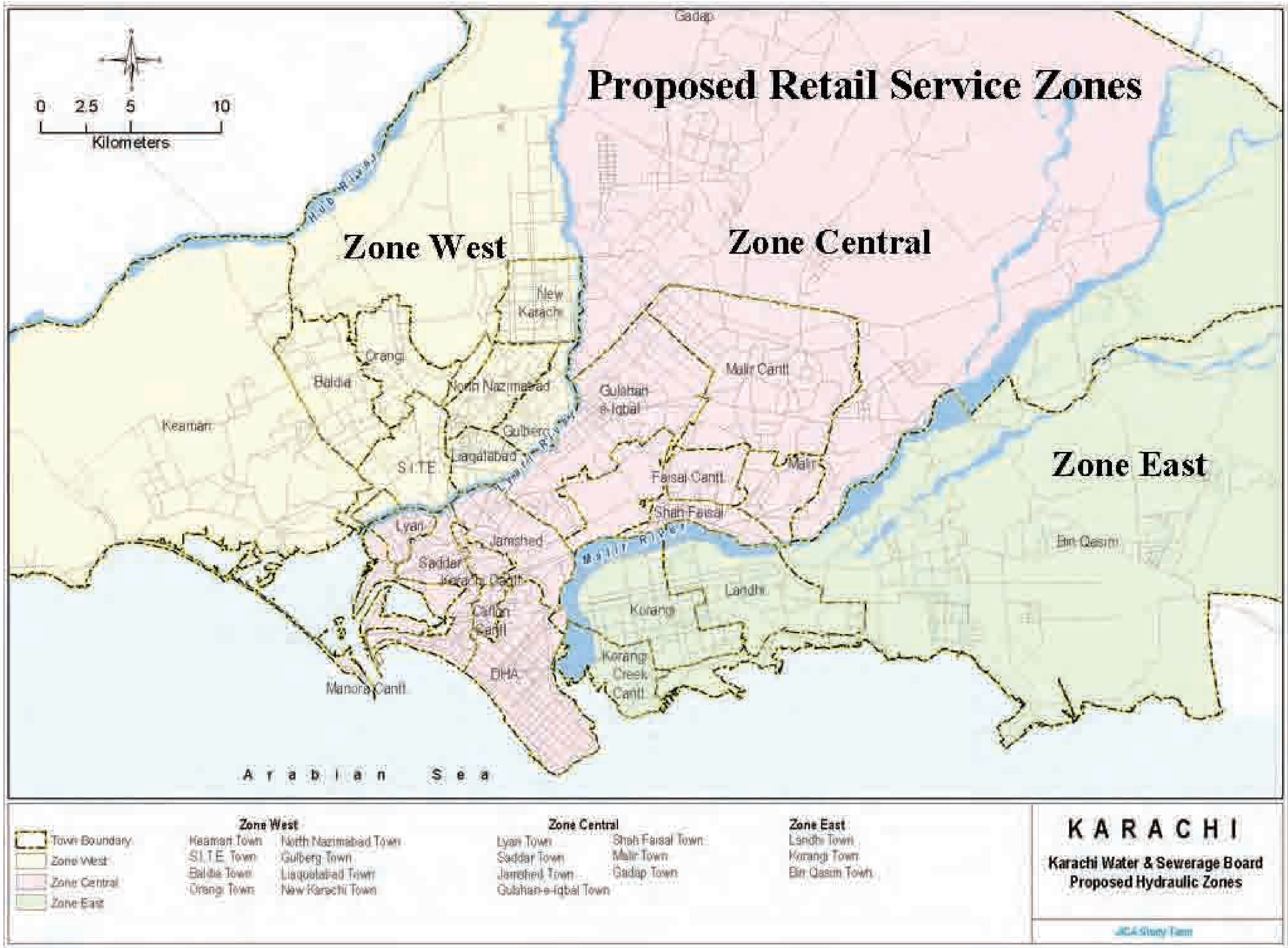



**Figure 72.3.2 Proposed Hydraulic Zones**

**The size of the city is too large for a single retail entity to manage and operate water supply and sewerage services efficiently. It is therefore recommended that water supply and sewerage services in each hydraulic zone should be managed and operated by an independent organization.**

The advantages of having zone-wise management will be as follows:

- Each organization will be held directly accountable for the quality of the services it provides including the levels of leakage and NRW occurring in its zone
- Water supply and sewerage services can be managed and operated on a competitive basis in which each organization's performance will be evaluated on the basis of common performance indicators (PIs)
- Increase the ease with which equitable distribution can be attained
- Increase the ease with which both technical and non-technical losses can be monitored and reduced. Each zone will be further divided into a number of leakage/NRW control districts, which can be hydraulically isolated whenever necessary to monitor or control leakage and NRW.
- Increase the ease with which customer focused approaches can be implemented. For example, the time required to respond to customers' problems/complaints can be shortened.

**Zone-wise Management of Retail Supply**

**Goals**

**Retail entities provide efficient water supply and sewerage services to their customers on a competitive basis and with accountability. This relates not only to the quantity and quality of water supplied but also to the improved efficiency in revenue collection, system maintenance, and response to customer problems/complaints.**

**Strategies**

- ❑ **All stakeholders agree to the zone-wise management of water supply and sewerage services.**
- ❑ **Conduct a separate study to identify necessary changes to existing laws, ordinances and regulations and draft detailed legal provisions to put the proposed zone-wise management into effect.**
- ❑ **Propose such changes for approval of legislators.**

### 7.2.4 Implementation of DNI on a Financially Sustainable Basis

Assessment of the existing water supply conditions in **Section 5.1** revealed that:

- While the basic cost of piped water in Karachi may be cheap, the indirect costs associated with its use are unreasonably high;
- The overall picture is that there are many more urgent problems in the water distribution system than in the bulk water supply system;
- In the light of the poor water supply situation, many residents in Karachi have a very negative impression of KW&SB and the service it provides and are therefore reluctant to pay water charges;
- Many problems have either directly or indirectly emanated from KW&SB's financial constraints; and
- A substantial improvement to water service quality is the only way to break the 'vicious circle' as depicted in **Figure 51.2.1**.

It is the considered opinion of this JICA Study team that a substantial improvement to water service quality can be achieved by significantly reducing leakage and other water losses and introducing metered supplies with a volumetric tariff to all consumers. This view is shared by ADB in its Draft Karachi Sustainable Mega City Water & Wastewater Roadmap, May 2007.

It is only if customers are satisfied with the quality of the service they receive that they find themselves willing to pay for the service. The water awareness survey conducted as part of the JICA study indicated that many households were willing to pay higher charges for a reliable supply of good quality water. With regard to the actual supply of water, the clear targets for the improved quality of the service can be summarized as follows:

- satisfy the customers' water demands so that they no longer need to utilize secondary sources (such as shallow wells and tanker supplies)
- water should be of a potable standard (this would make filtering and boiling of water unnecessary) and be aesthetically pleasing
- water should be supplied at an adequate pressure (this would make the use of suction/booster pumps and roof-top storage tanks unnecessary)
- water should be available on a 24-hour continuous basis to keep the supply system always full of water and under pressure to avoid both contamination and excessive air entrainment (this would make the use of ground-level water reservoirs unnecessary)

These improvements can only be attained through the implementation of Distribution Network Improvements (DNI). The existing water distribution net work comprises about 4,850 km of pipelines of which about 65% is asbestos cement pipes and 26% cast iron. Much of the system is old and in very poor condition. Many pipelines in the system have already been undersized and deteriorated, and the current levels of leakage and non-revenue water are unacceptably high. DNI will embrace the rehabilitation of water trunk mains and distribution network and the refurbishment of service connections including installation of revenue meters. Where necessary, it will also include improvements to the existing sewerage system. Since DNI would require huge investments and more than 10 years of timeframe to complete it across all areas of Karachi, it can only be implemented on an area-by-area basis in a progressive way. In the short to medium term, the costs associated with DNI will have to be recovered from the tariffs charged to customers. This is necessary to implement DNI on a financially sustainable basis.

**DNI can only be implemented on an area-by-area basis in a progressive way.**

**In the short to medium term, the costs associated with DNI will have to be recovered from the tariffs charged to customers. This is necessary to implement DNI on a financially sustainable basis.**

It is therefore recommended that customers in areas where DNI has already been completed (and receiving an improved service under which they are guaranteed that water will be available for 24 hours per day on a regular basis) would pay a water charge that is some multiple of the current level of water charges, whereas customers in areas where DNI has not been completed (and continuously receiving the current level of service with intermittent supply) would continue to pay the current level of water charges. This dual pricing structure is necessary: (a) to generate the revenues in the short to medium term that will be needed to service the loans taken to finance DNI (and thereby implement DNI on a financially sustainable basis); (b) to provide a strong incentive for the efficient use of water in areas where DNI has been completed (and customers are receiving an improved service); and (c) to avoid creating an impression that an improvement in service in one neighbourhood is at the expense of the level of service in other neighbourhoods.

**Customers in areas where DNI has already been completed would pay a water charge that is some multiple of the current level of water charges. On the other hand, customers in areas where DNI has not been completed would continue to pay the current level of water charges.**

**This dual pricing structure is necessary: (a) to generate the revenues in the short to medium term that will be needed to service the loans taken to finance DNI (and thereby implement DNI on a financially sustainable basis); (b) to provide a strong incentive for the efficient use of water in areas where DNI has been completed (and customers are receiving an improved service); and (c) to avoid creating an impression that an improvement in service in one neighbourhood is at the expense of the level of service in other neighbourhoods.**

The current level of sewerage service charge is well below the level that would be necessary to ensure cost recovery in the medium and longer term, i.e. including the costs of building or extending the sewer network. With the introduction of a measured water supply, the current approach, whereby the charge for sewerage service is a proportion (25%) of the charge for clean water supply, will have the effect of linking the sewerage charge directly to the volume of clean water supplied. As such it will be in line with international practice. However, the 25% premium for sewerage service is certainly not sufficient to cover the costs of operating and maintaining the sewer network and sewage treatment plants. We suggest that this should be increased to 50% of the charge for clean water supply once the quality of sewerage service has been improved. The evidence from the water awareness survey mentioned above suggested that the priority need of the public with respect to the sewerage service is the smooth, uninterrupted removal of sullage and excreta from their home and their vicinity. For this reason, we recommend that DNI should also include improvements to the existing sewage system wherever it is found necessary. Meanwhile, customers in areas where the sewage system has already been improved through DNI would pay a sewerage service charge that is 50% of the charge for the improved service level of clean water supply which, as has been stated above, is already some multiple of the current level of water charges. In contrast, customers in areas where the sewage system has not been improved would continue to pay the current level of sewerage service charge, which is 25% of the charge for clean water supply.

**DNI should include improvements to the existing sewage system wherever it is found necessary.**

**Meanwhile, customers in areas where the sewage system has already been improved through DNI would pay a sewerage service charge that is 50% of the charge for the improved service level of clean water supply, which is already some multiple of the current level of water charges. In contrast, customers in areas where the sewerage system has not been improved would continue to pay the current level of sewerage service charge, which is 25% of the charge for clean water supply.**

The examination of the financial statements of KW&SB for recent years shows an extremely worrying trend as regards its short term financial positions. Over recent years, KW&SB has continuously been operating in deficit. The annual deficit ranges from Rs.2,000 to 2,700 million (US$33.3 to 45.0 million) as shown in **Table 72.4.1** below. **Figure 72.4.1** illustrates these deficits as compared with annual revenues. At the end of the fiscal year 2004/05, the accumulated deficit totalled to Rs. 10,435 million (US$173.9 million). These deficits have eventually been subsidised by GOP and GOS.

**Table 72.4.1 Accumulated Deficit of KW&SB** Rs.million

| Fiscal Year | 2000/01 | 2001/02 | 2002/03 | 2003/04 | 2004/05 |
|---|---|---|---|---|---|
| Profit/Loss of the Fiscal Year | -820.70 | -2,029.65 | -2,693.09 | -2,536.39 | -2,358.71 |
| Accumulated Surplus/Deficit at start of Fiscal Year | 3.00 | -817.70 | -2,847.36 | -5,540.44 | -8,076.83 |
| Accumulated Surplus/Deficit at end of Fiscal Year | -817.70 | -2,847.36 | -5,540.44 | -8,076.83 | -10,435.54 |

Source: Profit and Loss Statements, KW&SB

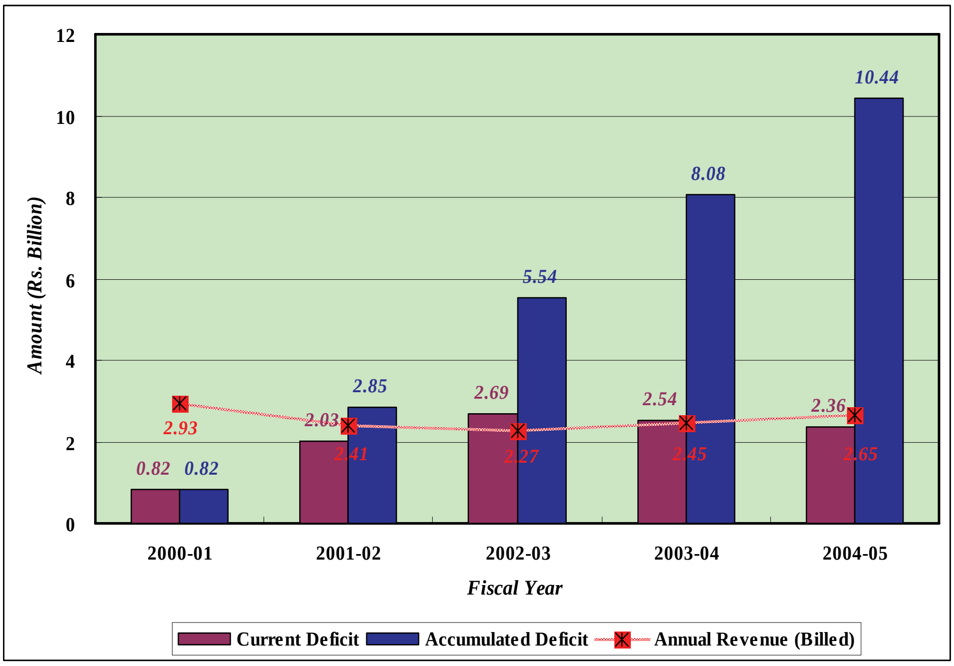



**Figure 72.4.1 Revenues and Deficits of KW&SB**

This demonstrates that KW&SB is not financially capable of taking new loans for the implementation of DNI. DNI will involve not only physical improvement works; it will also include improvements to many institutional aspects, such as the introduction of a dual pricing system, elimination of illegal and unauthorised connections, and the strict enforcement of laws on payment defaulters. As such, it is very likely that the implementation of DNI would face severe political interference if it is financed by Government subsidies. It is therefore necessary to create a new institutional framework, whereby DNI can be implemented on a loan financing basis without any Government subsidies.

**<u>Implementation of DNI on a Financially Sustainable Basis</u>**

**Goals**

**In the short to medium term, retail entities will generate the revenues sufficient to service the loans taken to finance DNI (and thereby implement DNI on a financially sustainable basis).**

**Strategies**

- ❑ **Implement DNI on an area-by-area basis in a progressive way.**
- ❑ **Introduce a dual pricing structure in that customers in areas where DNI has already been completed (and receiving an improved level of service) would pay a water charge that is some multiple of the current level of water charges.**
- ❑ **Include improvements to the sewerage system in the scope of DNI.**
- ❑ **Increase the level of sewerage service charge to 50% of the charge for clean water supply in areas where an improvement to the sewerage system has already been made.**
- ❑ **Create a new institutional framework whereby DNI can be implemented on a loan financing basis without any Government subsidies.**

## 7.3 SYSTEM DEVELOPMENT PLAN

### 7.3.1 Expansion of Filtration Plants

As explained previously the bulk water source availability from the Indus River and Hub Dam for the Karachi Water Supply System in 2025 is 1,332 as listed below.

| | | | |
|---|---|---|---|
| Future Bulk Water Availability | | | : 1,365 mgd |
| Indus River | : 1,290 mgd | (2,400 cusecs: $ft^3/s$) | |
| Hub Dam | : 75 mgd | | |
| Supply to Pakistan Steel Mills, Port Qasim, etc. | | | : 33 mgd |
| Bulk Water Availability for Water Supply System | | | : 1,332 mgd |

Of the bulk water of 1,332 mgd, about 630 mgd is being supplied to customers as of the end of year 2006. About 420 mgd of water is supplied after filtration and the remaining water is directly supplied without filtration.

At present two projects are being conducted for adding the filtration capacity. One is ADB Project and the other is K-IV Project. ADB Project is considering to construct two filtration plants at NEK Old (100 mgd) and COD (85 mgd). K-IV Project has proposed three filtration plants (260 mgd × 2 plants and 130 mgd × 1 plant = 650 mgd) for next 20 years. As of the end of the December 2007, PC-1 for first phase of the K-IV Project is in the process of approval. Therefore, the JICA study takes these two projects into account for preparation of water supply master plan as shown in **Table 73.1.1**. The filtration capacity of the Karachi Water Supply System is expected to be 1,270 mgd.

**Table 73.1.1 Future Water Supply Capacity**

| Filtration Plant | Capacity | Remarks |
|---|---|---|
| Gharo Filtration Plant | 20 mgd | existing |
| Pipri Filtration Plant | 100 mgd | existing |
| NEK Old Filtration Plant | 25 mgd | existing |
| NEK New Filtration Plant | 100 mgd | existing |
| COD Filtration Plant | 115 mgd | existing |
| COD Filtration Plant (expansion) | 85 mgd | ADB Project |
| Hub Filtration Plant * | 75 mgd | existing |
| K-III Filtration Plant at NEK Old | 100 mgd | ADB Project |
| K-IV Filtration Plants | 650 mgd | K-IV Project |
| Total | 1,270 mgd | |

source: KW&SB
* : considered to "95% level of reliability of the Hub River Yield"

Two proposed plants to be constructed at COD and NEK Old (K-III) by ADB Project are for treating water which is directly supplied to customers without filtration now and that is not to say that the supply capacity increases due to the construction of these two filtration plants. Therefore, for the planning purpose, total capacity of these two plants of 185 mgd is considered to be included in the existing capacity regardless of those completions. These plants are expected to be constructed by the year 2011.

### 7.3.2 Stage-wise Development Plan

#### (1) Construction Schedule of Bulk Water Supply Facilities proposed by K-IV Project

K-IV Project has proposed 3 filtration plants located in the western part, central part and eastern part of Gadap Town in accordance with its implementation schedule as shown in **Table 73.2.1**. Constructions of three plants are divided into 5 stages (130 mgd each). On the other hand, canals & conduits will be constructed by three stages, which capacities are 260 mgd respectively.

**Table 73.2.1 Implementation Schedule of K-IV Project**

| Timeframe | Staging | Supply Capacity to be increased | Filtration Plant | | Canal & Conduit |
|---|---|---|---|---|---|
| | | | Capacity | Location | |
| 2007-2011 | 1 A | 130 mgd | 130 mgd | Central | 260 mgd for Zone Central |
| 2011-2015 | 1 B | 130 mgd | 130 mgd | Central | - |
| 2015-2019 | 2 A | 130 mgd | 130 mgd | West | 260 mgd for Zone West |
| 2019-2023 | 2 B | 130 mgd | 130 mgd | West | - |
| 2023-2027 | 3 A | 130 mgd | 130 mgd | East | 260 mgd for Zone East |

source: K-IV Project, Greater Karachi Water Supply Scheme (Executive Summary, May 2007)

The K-IV Project has recommended a construction of new filtration plant with a capacity of 130mgd at Zone Central first. **Figure 73.2.1** shows a stage-wise development plan proposed by K-IV Project against the water demand projected by JICA study mentioned in **Section 6.2 "Water Demand"**. In this case, however, Karachi City is facing a water shortage almost the every year in the future.

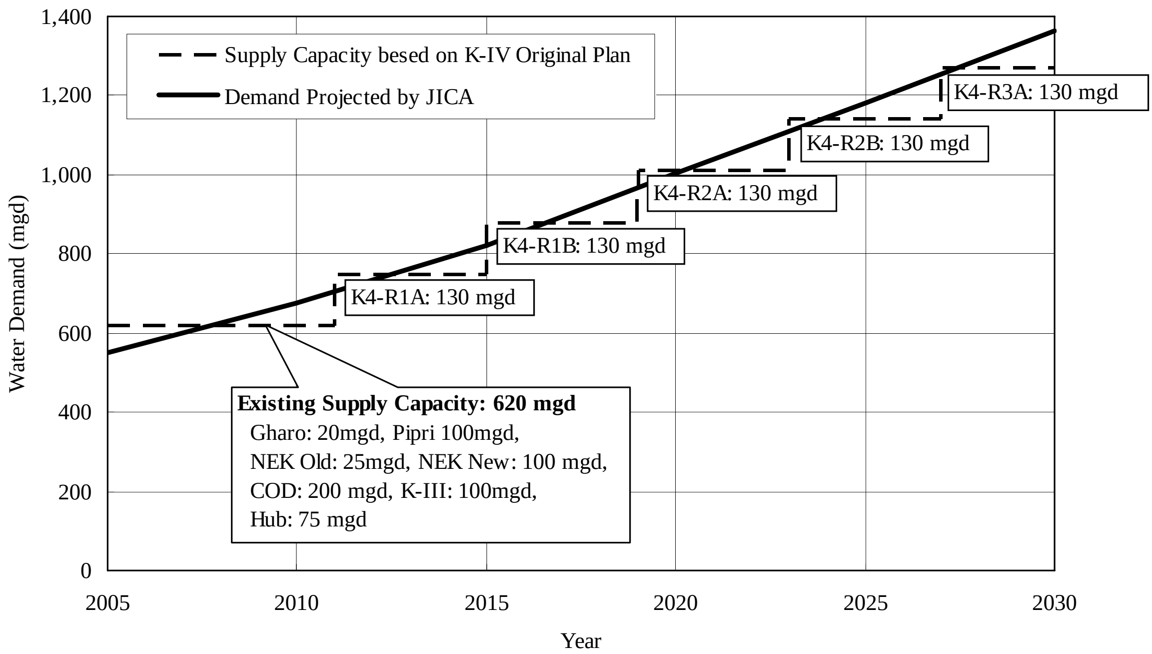



**Figure 73.2.1 Stage-wise Development Plan proposed by K-IV Project**

### (2) Proposed Construction Schedule of Bulk Water Supply Facilities

As of the end of the December 2007, PC-1 for the first phase of the K-IV Project is in the process of approval. The first phase of the K-IV project includes land acquisitions for all canals and conduits to be constructed by K-IV Project, bulk water transmission facilities (260 mgd) from Kinjhar Lake and filtration plant (130 mgd). The filtration plant will be constructed at the central area of Gadap Town. The first phase project has been already ongoing and its components can not be changed by the JICA Study. Therefore, the first filtration plant with a capacity of 130 mgd will be constructed at the central.

**Table 73.2.2** shows a zone-wise water balance in 2025 which is a target year of the study. As seen in **Table 73.2.2**, if the filtration plant with a capacity of 130 mgd would be constructed at the zone central, the further expansion of its capacity should not be needed anymore. Instead, it is necessary for zone west and zone east to construct a filtration plant with a capacity of 260 mgd respectively considering a balance between the water demand and the supply capacity.

**Table 73.2.2 Water Balance of Each Zone in 2025**

| Zone | West | Central | East |
|---|---|---|---|
| Zone-wise Demand (mgd) | 346 | 534 | 307 |
| Zone-wise Supply Capacity (mgd) | 75 | 425 | 120 |
| List of the Existing Filtration Plants* | Hub: 75 mgd | NEK Old: 25 mgd<br>NEK New: 100 mgd<br>COD: 200 mgd<br>K-III: 100 mgd | Pipri: 100 mgd<br>Gharo: 20 mgd |
| Balance(mgd) | -271 | -109 | -187 |

*: Data from KW&SB

JICA Study proposes an alternative stage-wise development plan against the original implementation schedule of K-IV Project, as shown in **Table 73.2.3** and **Figure 73.2.2** under the following conditions.

- Completion year of the first stage, which is the year of 2011, should be kept.
- Project components of the first stage should be kept.

- Interval of each stage should be at least 4 years which is original intervals of staging proposed by K-IV Project as shown in **Table 73.2.1**.
- Canal construction for bulk water supply to filtration plant, which capacity is 260 mgd, should not be double and more at one stage.
- Water supply capacity in 2025 should exceed the demand in 2025.
- Period of water shortage (supply shortfall) should be minimised.

**Table 73.2.3 Proposed Implementation Schedule**

| Timeframe (Construction Period) | Stage | Filtration Plant | Bulk Transmission | Remarks |
|---|---|---|---|---|
| 2009-2011 | Stage I | 130 mgd × 1 plant at Zone Central | 260 mgd for Zone Central | Same Plan as the K-IV Project |
| 2014-2016 | Stage II | 130 mgd × 2 plants at Zones West and East | 260 mgd for Zone West | Modified Plan from the K-IV Project |
| 2019-2021 | Stage III | 130 mgd × 2 plants at Zones West and East | 260 mgd for Zone East | |

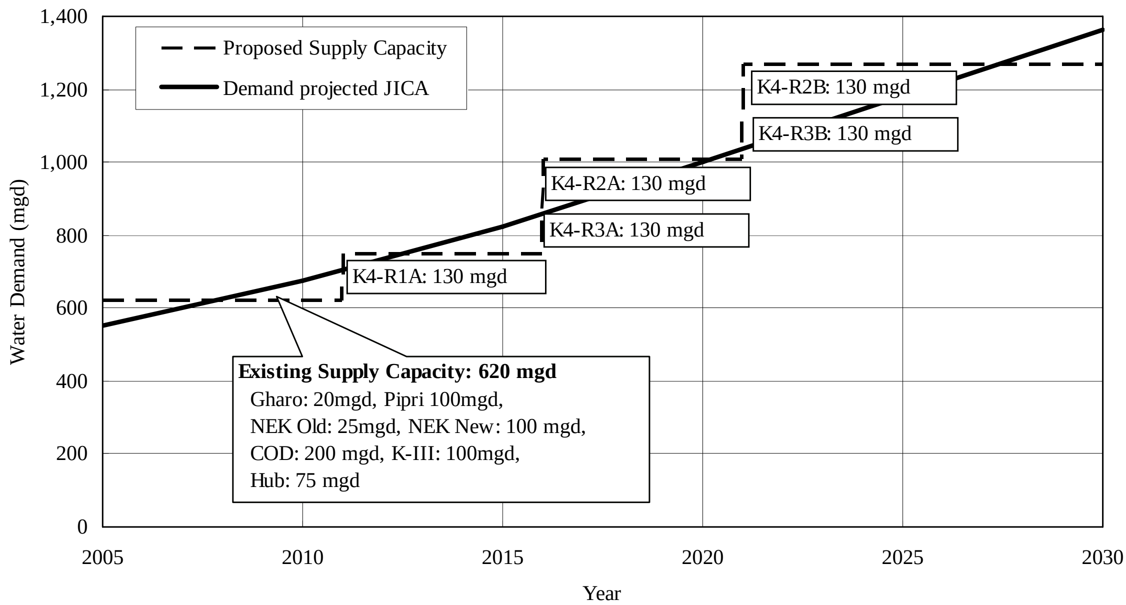



**Figure 73.2.2 Recommended Stage-wise Development Plan**

### (3) Proposed Development Plan

To meet the increasing water demand in Karachi, the water supply capacity of the filtration plants is proposed to be expanded in three stages as shown in **Figure 73.2.2**. Target year of each stage is as follows:

| | |
|---|---|
| Stage I (Short term) | : 2016 |
| Stage II (Medium term) | : 2021 |
| Stage III (Long term) | : 2025 |

Under Stage I the capacity will be expanded by 130 mgd to meet the water demand in year 2016. However, the increased capacity will meet only the demand of 2012 as shown in **Figure 73.2.2**. Considering the magnitude of the development scale, water right of the Indus River, future water supply situation and time frame, this is the best choice for the Karachi Water Supply System. Stage II and stage III consist of an expansion of 260 mgd respectively. The increased capacities of those stages are to meet the water demand in 2021 and 2025 respectively. **Table 73.2.4** shows a water balance between future water demand and planned supply capacity of the proposed water supply development plan. In 2011 just before the completion of a new filtration plant of 130 mgd by K-IV Project, the system will face a water shortage of 88 mgd.

**Table 73.2.4 Water Balance of the Proposed Plan**

| Year | 2006 | 2011 | 2016 | 2021 | 2025 |
|---|---|---|---|---|---|
| Total Demand (mgd) * | 580 | 708 | 863 | 1,043 | 1,187 |
| Supply Capacity (mgd) | 620 | 620 | 750 | 1,010 | 1,270 |
| Balance(mgd) | 40 | -88 | -113 | -33 | 83 |

*: including a water supply to Barochistan of 5 mgd

**Table 73.2.5** shows a water balance between future water demand and planned supply capacity at each zone.

**Table 73.2.5 Water Balance of Each Zone**

| Target Year | | 2006 | 2011 | 2016 | 2021 | 2025 |
|---|---|---|---|---|---|---|
| Zone West | | | | | | |
| Supply Capacity | mgd | 75 | 75 | 75 | 205 | 335 |
| Water Demand* | mgd | 191 | 222 | 264 | 310 | 346 |
| Balance | mgd | -116 | -147 | -189 | -105 | -11 |
| Zone Central | | | | | | |
| Supply Capacity | mgd | 425 | 425 | 555 | 555 | 555 |
| Water Demand | mgd | 286 | 338 | 401 | 475 | 534 |
| Balance | mgd | +139 | +87 | +154 | +80 | +21 |
| Zone East | | | | | | |
| Supply Capacity | mgd | 120 | 120 | 120 | 250 | 380 |
| Water Demand | mgd | 104 | 148 | 198 | 258 | 307 |
| Balance | mgd | +16 | -28 | -78 | -8 | +73 |

*: including a water supply to Barochistan of 5 mgd

In conclusion, the stage-wise development plan is proposed as shown in **Figure 72.2.3**.

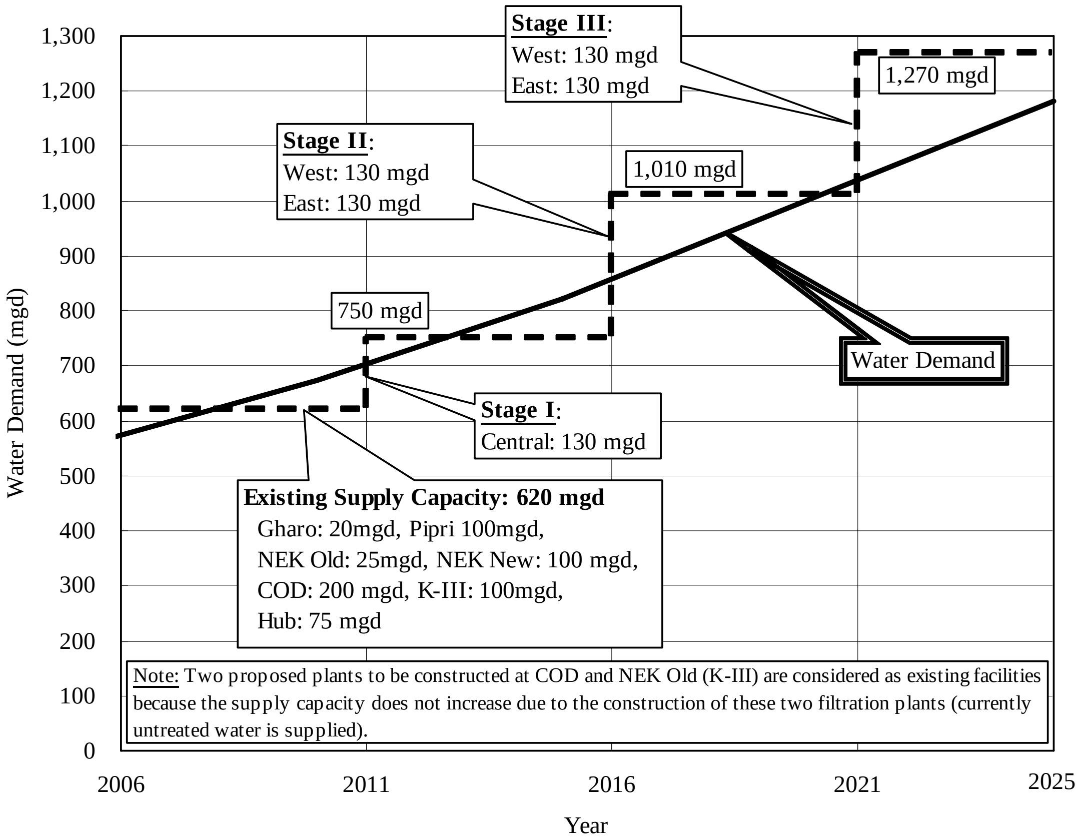



**Figure 73.2.3 Stage-wise Development Plan for the Target Year of 2025**

### 7.3.3 Water Supply Plan

Considering the magnitude of the future Water Supply System in Karachi and topographical features of Karachi City, JICA study recommends the zone-wise management of the retail supply in where water supply area will be divided into 3 zones (Zone West, Zone Central and Zone East) by two main rivers flowing through Karachi City, namely Lyari River and Malir River. Each zone will be managed and operated by an independent organization or by a different business unit of the same organization. Zone-wise water demand is shown in **Table 73.3.1**. **Figure 73.3.1** shows the schematic water supply plan for the system in 2025.

**Table 73.3.1 Zone-wise Water Demand**

| | 2006 | 2011 | 2016 | 2021 | 2025 |
|---|---|---|---|---|---|
| Total Demand | 580 | 708 | 863 | 1,043 | 1,187 |
| Zone West* | 191 | 222 | 264 | 310 | 346 |
| Zone Central | 286 | 338 | 401 | 475 | 534 |
| Zone East | 104 | 148 | 198 | 258 | 307 |

*: including a water supply to Barochistan of 5 mgd

Water supply plan for each zone was formulated based on the following policies:

- eliminating the use of several bulk pumping stations and a large number of small size distribution pumping stations for energy cost saving,
- supplying water by gravity as much as possible, and
- keeping minimum dynamic water pressure of 10 m in distribution system.

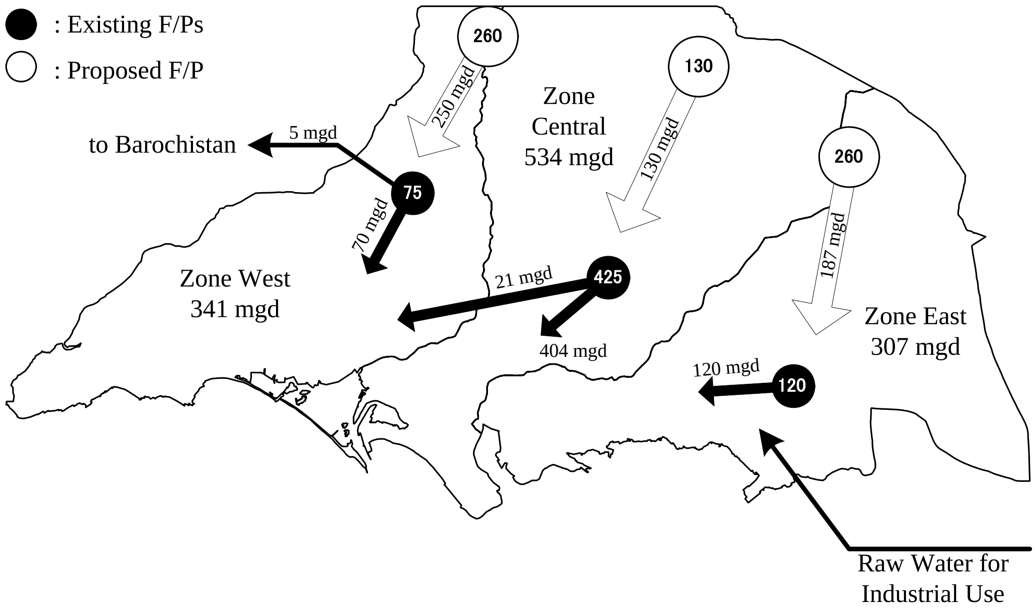



**Figure 73.3.1 Schematic Water Supply Plan for Each Zone in 2025**

As a result the proposed water supply system in 2025 is shown in **Figure 73.3.2** and detailed hereinafter. The alternative studies related to water supply system are attached to **Appendixes A73.1** to **A73.4**.

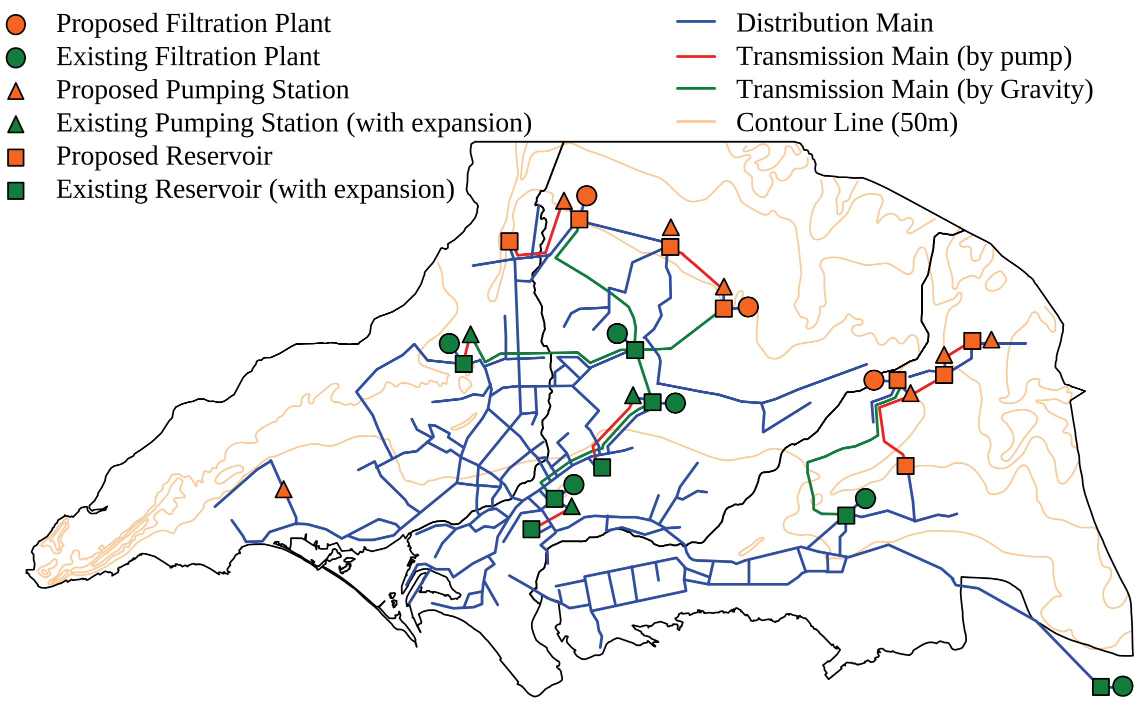



**Figure 73.3.2 Proposed Water Supply System in 2025**

For reference, definitions of water supply facilities are illustrated in **Figure 73.3.3**. Especially transmission and distribution systems are defined as follows:

Transmission System (transmission pumping station and transmission main) transfers filtered water to reservoirs by pumping or by gravity, not to supply water directly to customers. Transmission main should not have any branches for distribution or bulk supply. Flow rate of the transmission system is equal to daily water demand.

Distribution System (distribution pumping station, trunk distribution main and distribution network main) supplies filtered water from reservoirs to customers. The design capacity of distribution system is needed to be 1.5 – 2.0 times of daily water demand considering hourly demand fluctuation. For example, during the night people use less water, but in the morning and evening people use much more water.

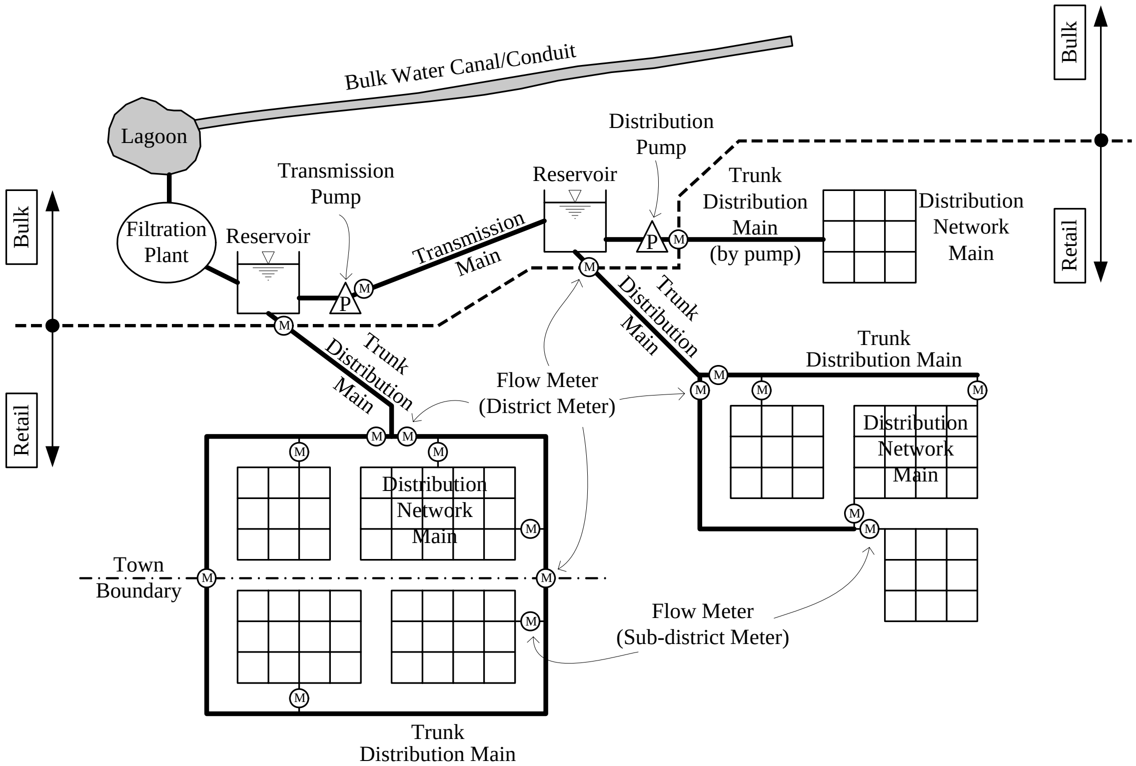



**Figure 73.3.3 Typical Water Supply System**

## 7.4 WATER SOURCES

**Table 74.1.1** summarises planned future water sources of the KW&SB's water supply.

**Table 74.1.1 Water Sources for the Target Year of 2025**

| Water Source | Capacity | Remarks |
|---|---|---|
| Kinjhar Lake (The Indus River) | 645 mgd (1,200 cusecs; $ft^3/s$) | Existing |
| Kinjhar Lake (The Indus River) | 645 mgd (1,200 cusecs; $ft^3/s$) | Additional planned by K-IV Project |
| Hub Dam | 75 mgd | Existing |
| Dumlottee Wells | 0 mgd | To be abandoned |
| Total | 1,365 mgd | |

In addition to the current bulk water of 1,200 cusecs (645 mgd) from Kinjhar Lake, another 1,200 cusecs (645 mgd) will be also taken from Kinjhar Lake for 2025 by the implementation of K-IV Project. It is estimated that 75 mgd can be taken from Hub Dam at the probability of 95% based on a hydrologic analysis, for the KW&SB's water supply including water supply to part of Barochistan District. For reference, flow data of the Indus River above the Kotri Barrage and withdrawals at the Kotri Barrage from 1976 to 1984 (Feasibility Study for future expansion of Karachi Water Supply System, December 1985) are attached to **Appendix A32.1**. On the other hand, existing Dumlottee Wells will not be suitable for the KW&SB's water source any more, since its production has been decreasing year by year. At present it is used only in a limited period of rainy season.

CDGK have requested the Federal Government for granting an additional water right of 1,200 cusecs from Indus River for Karachi Water Supply System. As of the end of December 2007, however, an additional water right from the Indus River of 1,200 cusecs has not been approved yet. In developing a water supply system, Karachi would be granted additional 1,200 cusecs of quota from the Indus River and a total of 2,400 cusecs of the Indus River water would be made available at the Kinjhar Lake for abstraction of KW&SB. This is based on a strong belief that if this additional quota water were not granted, then there would be no such large population increase or significant developments in future as has been envisaged by KSDP – 2020 (August 2007).

## 7.5 BULK WATER SUPPLY SYSTEM

### 7.5.1 Existing Bulk Water Supply System

Present bulk water supply system for Karachi City has a capacity of 600 mgd as shown in **Table 75.1.1**. This figure does not include bulk water supply of bulk water from Gujjo Headworks to Pakistan Steel Mills and Port Qasim Authority which have their own bulk water transmission facilities (canals and pumping stations) and filtration plants. Actually as of the end of year 2006 KW&SB supplied bulk water of about 630 mgd beyond the capacity as shown in **Table 75.1.1** and detailed in **Section 3.3.1**. **Figure 75.1.1** shows a schematic diagram of the existing bulk water supply system.

**Table 75.1.1 Bulk Water Supply Capacity**

| Bulk Water System | Capacity | Actual Supply |
|---|---|---|
| GK System | 280 mgd | 300 mgd |
| Haleji System | 20 mgd | 30 mgd |
| K-II System | 100 mgd | 120 mgd |
| K-III System | 100 mgd | 100 mgd |
| Dumlottee Wells | 20 mgd | 0 mgd |
| Hub System | 80 mgd | 80 mgd |
| Total | 600 mgd | 630 mgd |

source: KW&SB

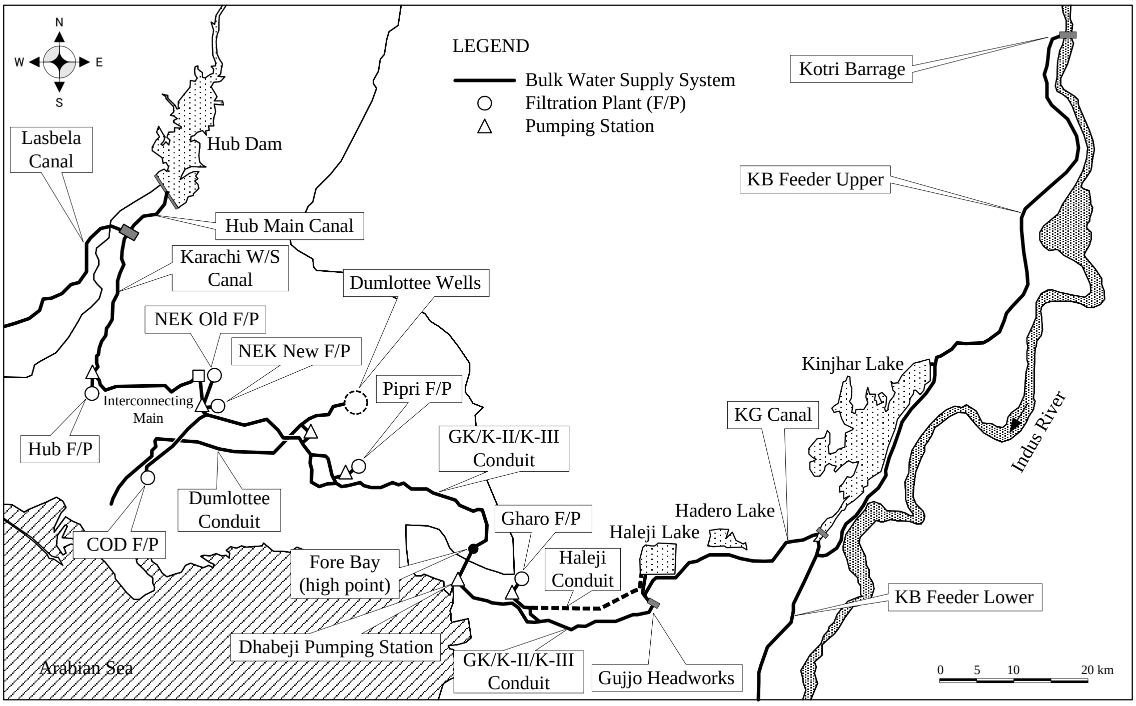



**Figure 75.1.1 Existing Bulk Water Supply System**

### 7.5.2 Proposed Bulk Water Supply System

#### (1) Canal and Conduit

Existing bulk water supply systems including GK, K-II and K-III bulk water supply systems will be continuously used for the future system. The existing bulk water supply system from Hub Dam to Manghopir Pumping Station (P/S) will be also used continuously. The periodical and proactive rehabilitation and repair works for the existing bulk water canals and conduits are proposed, since the existing bulk water canals and conduits are very old. It is also recommended that KW&SB should measure the actual flow rates of these canals and conduits for identifying current status of the bulk water supply system. As a result KW&SB may need to review and improve those capacities.

On the other hand, Dumlottee Conduit will be abandoned by 2025 because of the permissible yield of the Dumlottee Wells. At present K-III system transfers bulk water to Manghopir P/S through K-III Pumping Station (P/S), NEK Old Reservoir and NEK-Hub Link Main for making up for the water shortage of Hub Dam. In the proposed system, water pumped up from K-III P/S will be filtered at new F/P (K-III F/P) near NEK Old F/P and then distributed to customers. Therefore, no water goes to Manghopir P/S from the K-III system. **Figure 75.2.1** shows a proposed Greater Karachi Bulk Water Supply System from Kinjhar Lake to Karachi City considering actual bulk supply amount and on-going projects of the expansion of COD F/P and construction of K-III F/P which have been proposed by KW&SB by using ADB Loan.

In addition to the existing bulk water supply system, three canals with a total capacity of 780 mgd (260 mgd × 3 canals) will be constructed by K-IV Project. Those canals will transfer bulk water from Kinjhar Lake to three filtration plants which will be also proposed by K-IV Project. The capacity of future bulk water supply system is summarised in **Table 75.2.1**. **Figure 75.2.2** shows a proposed arrangement between bulk water canals and filtration plants which will be constructed by K-IV project.

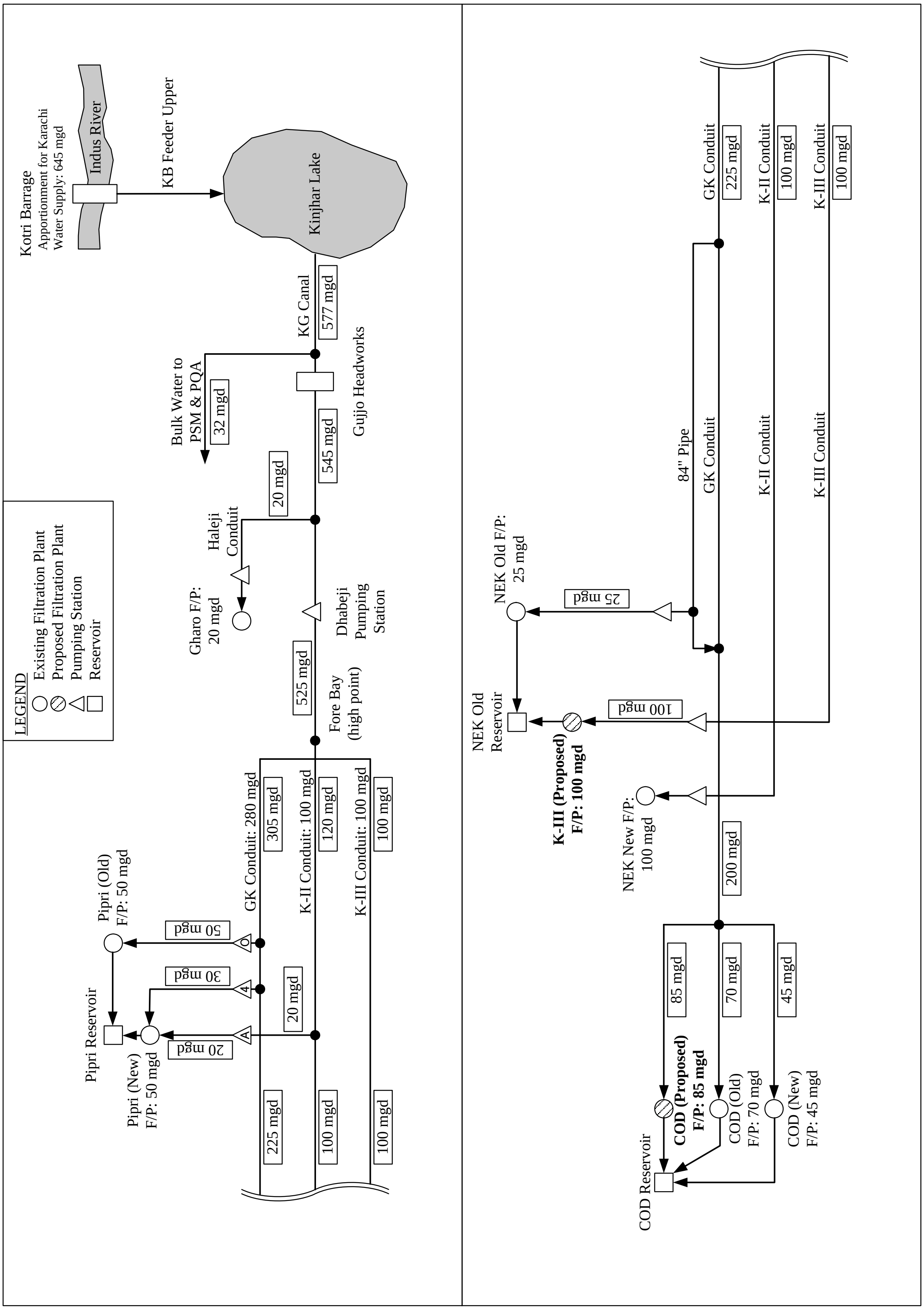



**Figure 75.2.1 Future Greater Karachi Bulk Water Supply System**

**Table 75.2.1 Future Bulk Water Supply Capacity**

| Bulk Water System | Existing Capacity | Future Capacity | Remarks |
|---|---|---|---|
| GK System | 280 mgd | 305 mgd | Existing |
| Haleji System | 20 mgd | 20 mgd | Existing |
| K-II System | 100 mgd | 120 mgd | Existing |
| K-III System | 100 mgd | 100 mgd | Existing |
| Dumlottee Wells | 20 mgd | 0 mgd | to be abandoned |
| Hub System* | 80 mgd | 75 mgd | Existing |
| K-IV System | - | 780 mgd | Proposed |
| Total | 600 mgd | 1,400 mgd | |

source: KW&SB
* : considered to "95% level of reliability of the Hub River Yield"

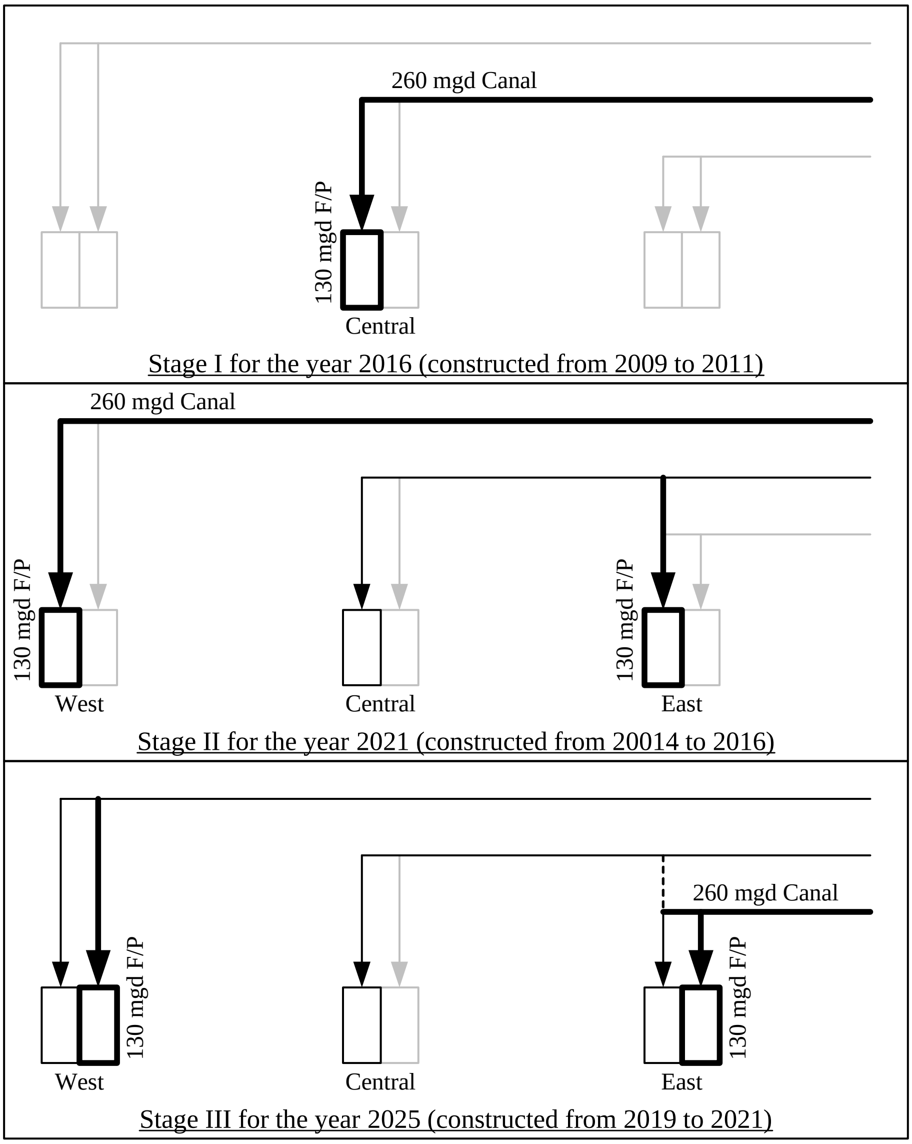



**Figure 75.2.2 Proposed Arrangement between Canals and Filtration Plants constructed by K-IV Project**

### (2) Bulk Transmission Pumping Station

The bulk transmission pumping stations for the target year of 2025 which are used mainly as intake pumping station at filtration plants except Dhabeji P/S are listed in **Table 75.2.2**. The life span of the pumping equipment is assumed to be 15 years. Therefore, the pumping equipment in all the existing pumping stations should be replaced by 2025.

Among the KW&SB's facilities, NEK Old Pumping House near NEK New F/P is well maintained and operated. Mechanical and electrical equipment at this pumping house is being kept in good condition. This is able to become a model for others to emulate for operation and maintenance of mechanical and electrical equipment not only at other P/Ss but also at F/Ps.

**Table 75.2.2 Bulk Transmission Pumping Stations in 2025**

| Sr.No. | Name of Pumping Station | Year of Construction | Total Capacity (MGD) | Running Capacity (MGD) | Pumps & Motors | | | | | Generator |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Total No. of Pumps | No, of Stand-By Pumps | Capacity of Each Pump (MGD) | Pump Head (ft) | Electric Motor (KW) | Capacity (MW) |
| 1 | Dhabeji (Phase-I) | 1959 | 120 | 48 | 5 | 3 | 24 | 210 | Diesel+Gas | 0.25 |
| 2 | Dhabeji (Phase-II) | 1971 | 125 | 100 | 5 | 1 | 25 | 210 | 1050 | -- |
| 3 | Dhabeji (Phase-III) | 1978 | 125 | 100 | 5 | 1 | 25 | 210 | 1050 | -- |
| 4 | Dhabeji (Phase-IV) | 1997 | 125 | 100 | 5 | 1 | 25 | 210 | 1050 | 4.52 |
| 5 | K-II (Dhabeji) | 1998 | 175 | 140 | 5 | 1 | 35 | 210 | 1635 | -- |
| 6 | K-III (Dhabeji) | 2006 | 210 | 140 | 6 | 2 | 35 | 210 | 1635 | -- |
| 7 | Gharo (Old) | 1943 | 37 | 23 | 3 | 1 | 5 | 170 | Diesel | 0.5 |
| | | 1982 | | | 6 | 2 | 2.0 | 170 | 74.6 | |
| | | 2002 | | | 2 | 1 | 5.0 | 170 | 149.1 | |
| 8 | Gharo (New) | 1953 | 40 | 21 | 2 | 1 | 10 | 170 | Diesel | 0.5 |
| | | 1997 | | | 5 | 2 | 2.0 | 170 | 93.2 | |
| | | 2002 | | | 2 | 1 | 5.0 | 170 | 186.4 | |
| 9 | Pipri (old) | 1971 | 75 | 50 | 6 | 2 | 12.5 | 100 | 260 | 1.5 |
| 10 | Pipri (Phase IV) | 1994 | 50 | 37.5 | 4 | 1 | 12.5 | 56 | 132 | 1.25 |
| 11 | Pipri (New) | 2000 | 60.48 | 51.84 | 14 | 2 | 4.32 | 100 | 111.9 | 0.6 |
| 12 | Hub (New) | 2006 | 175 | 105 | 4 | 1 | 35 | 168 | 1350 | - |
| | (Manghopir) | | | | 2 | 2 | 17.5 | 168 | 750 | |
| 13 | NEK (Old) | 1978 | 80 | 35 | 4 | 2 | 12.5 | 160 | 372.9 | 1.25 |
| | | | | | 6 | 4 | 5 | 160 | 111.9 | |
| 14 | Low Lift (at NEK New) | 1998 | 175 | 105 | 5 | 2 | 35 | 40 | 232.7 | - |
| 15 | K-III (at NEK New) | 2006 | 135 | 90 | 6 | 2 | 22.5 | 160 | 391.5 | - |

In addition to the existing bulk pumping stations, two bulk pumping stations between Kinjhar Lake and Filtration Plants are proposed for new bulk water transmission system to be constructed by K-IV Project. Details of new pumping stations are summarised in **Table 75.2.3**.

**Table 75.2.3 Details of New Bulk Pumping Station**

| Pumping Station | Stage | Capacity | Total Dynamic Head (m) | Power Plant Required (MW) |
|---|---|---|---|---|
| 1st Stage Pumping Station | Stage I | 130 mgd | 41 | 3.9 |
| | Stage II | 260 mgd | 41 | 7.8 |
| | Stage III | 260 mgd | 41 | 7.8 |
| 2nd Stage Pumping Station | Stage I | 130 mgd | 74 | 7.1 |
| | Stage II | 260 mgd | 74 | 14.2 |
| | Stage III | 260 mgd | 74 | 14.2 |

source: K-IV Project, Greater Karachi Water Supply Scheme (Executive Summary, May 2007)

On the other hand, the study proposes that the following seven existing bulk pumping stations are eliminated for future bulk water supply system for energy cost saving.

- 9th Mile Pumping Station
- Low Service Reservoir Old Pumping Station

- Low Service Reservoir New Pumping Station
- Ajmer Nagri Pumping Station
- Temple and Currie Pumping Station
- Dumlottee Pumping Station
- Board Office Pumping Station

## 7.6 WATER FILTRATION PLANTS

### 7.6.1 Proposed Filtration Plants

**Table 76.1.1** shows a list of zone-wise filtration plants (F/Ps) proposed in 2025. Production of all the F/Ps is expected to keep their design capacities without overload operation.

**Table 76.1.1 Filtration Plants in 2025**

| Filtration Plant | Zone | Capacity (mgd) | Remarks |
|---|---|---|---|
| Hub F/P | West | 75 | Existing |
| West F/P | West | 260 | proposed by K-IV Project |
| **Sub-Total of Zone West** | | **335** | |
| NEK Old F/P | Central | 25 | Existing |
| NEK New F/P | Central | 100 | Existing |
| COD F/P | Central | 115 | Existing |
| | Central | 85 | expansion by ADB Project |
| KIII F/P | Central | 100 | proposed by ADB Project |
| Central F/P | Central | 130 | proposed by K-IV Project |
| **Sub-Total of Zone Central** | | **555** | |
| Gharo F/P | East | 20 | Existing |
| Pipri F/P | East | 100 | Existing |
| East F/P | East | 260 | proposed by K-IV Project |
| **Sub-Total of Zone East** | | **380** | |
| **Total** | | **1,270** | |

At present water for K-III F/P and COD F/P to be expanded is supplied directly to customers without filtration. It is, therefore, recommended that such water should be treated at filtration plant. Asian Development Bank proposes the construction of K-III F/P and expansion of COD F/P (Draft Karachi Sustainable Mega City Water and Wastewater Roadmap, May 2007, ADB). K-III F/P with a capacity of 100 mgd will be constructed at/near the site of NEK Old F/P and COD F/P with a capacity of 85 mgd will be expanded at the existing COD F/P. It is, however, noted that the construction of K-III F/P (100 mgd) and the expansion of COD F/P (85 mgd) are not the increase of water supply capacity because water of 100 mgd for K-III F/P and 85 mgd for COD expansion is being supplied directly to customers without filtration.

New F/Ps (260 mgd × 2 plants at Zone West and Zone East and 130 mgd × 1 plant at Zone Central) are proposed for future water supply system. As described in **Section 7.3 "System Development Plan",** West F/P, Central F/P and East F/P are expected to start its production by year 2016, 2011 and 2016 respectively.

New F/Ps will consist of large capacity lagoon (520 mg) for storing 2 days bulk (raw) water and for grit chamber in case of coming turbid water from the Kinjhar Lake (K-IV Project, Greater Karachi Water Supply Scheme, Executive Summary, May 2007). As well as the existing process, the rapid sand filtration system is recommended for the proposed treatment process. The proposed treatment process consists of receiving chamber, sand filtration and chlorination and is shown in **Figure 76.1.1**. This process was designed with consideration of the bulk water quality (see **Table 76.1.2**) and the existing process. In addition the space for rapid mixing basin and flocculation/sedimentation basin should be kept for future treatment process due to deterioration of bulk water quality. If the turbidity is found as high level continuously, it is recommended constructing rapid mixing basin and flocculation/sedimentation basin as pre-treatment to remove turbidity.

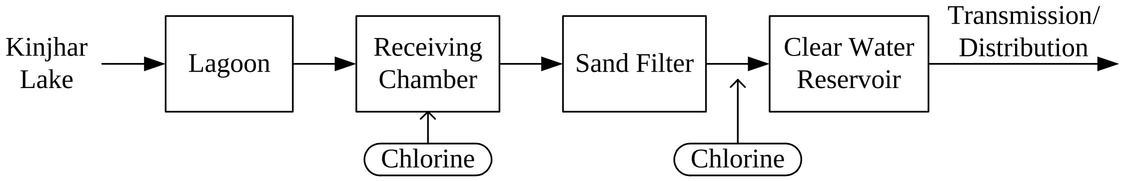



**Figure 76.1.1 Proposed Water Treatment Process for New Filtration Plant**

**Table 76.1.2 Bulk Water Quality of KG Canal before Gujjo Headworks**

| Parameters | Unit | Dry Season (June 2006) | Wet Season (August 2006) |
|---|---|---|---|
| pH | | 8.20 | 8.11 |
| Turbidity | NTU | 0.19 | 0.55 |
| Iron | mg/l | 0.11 | 0.165 |
| Manganese | μg/L | 7.40 | 10.81 |
| Ammonia-Nitrogen | mg/l | 0.096 | ND |
| Faecal Coliform | count/dl | 43 | 1,100 |

source: Progress Report No.1, September 2006

### 7.6.2 Rehabilitation and Improvement of Existing Filtration Plants

The design life for the filtration plants is generally shown in **Table 76.2.1**. The design life for concrete structures is 50 years and the design life for mechanical and electrical equipment is 15 years. Once the design life is exceeded, the facilities will be abandoned and new facilities will be constructed, if necessary.

**Table 76.2.1 Design Life for the Filtration Plants**

| | Life Time (years) |
|---|---|
| Intake Facilities | Life Time (years) |
| Pump House (concrete structure) | 50 |
| Mechanical and electrical equipments | 15 |
| Filtration Plant | |
| Tank and basin (concrete structures) | 50 |
| Mechanical and electrical equipments | 15 |

At present (as of 2007) KW&SB are proposing PC1 for the rehabilitations of the existing plants including Gharo F/P, Pipri (old 25 mgd × 2 plants) F/P, COD F/P and NEK Old F/P. The rehabilitations to the existing plants should include not only repair of the existing facilities and equipment but also some improvements based on plant safety, process control, and the need for continuous water supply. Plant safety is the most important aspect of the proposed improvements. Most filtration plants do not have safety measurement equipment for chlorine gas and some plants do not use a chlorinator for chlorination. Therefore safety and health improvements have been set as the highest priority. Process control improvements such as installing flow meters are set as the second priority. Therefore the rehabilitation and improvement of the existing filtration plants include, but are not limited to;

- Replacement of a top layer of filter media
- Rehabilitation of all valves, fittings and other accessories for filter basin
- Rehabilitation of backwashing system for filter basin
- Replacement of chlorinators and accessories and improvement of safety measurement equipment for chlorination system

- Replacement and repair of chemical dozing equipment including pipelines and other accessories
- Installation of level indicators at reservoirs
- Installation of flow meters at outlet of reservoirs
- Rehabilitation of standby generating set
- Repair of steel structure
- Repair of leakages from the water retaining structures and pipelines
- Repair and replacement of damaged flooring, walls, doors and windows where ever required.
- Arrangement of lighting system for security along the boundary line

Other F/Ps of NEK New F/P, Hub F/P and Pipri (new 50 mgd plant) are recommended to be rehabilitated at Stage III from 2019 to 2021.

## 7.7 WATER TRANSMISSION SYSTEM

### 7.7.1 General

Existing water transmission system will be improved by dividing water supply areas of Karachi into three zones of Zone-West, Zone-Central, and Zone-East. The estimated zone-wise demands in 2016, 2021, and 2025 are shown in **Tables 77.1.1** and **77.1.2**.

The future land use map in 2025 including future roads proposed in Karachi Strategic Development Plan 2020 (Final, August 2007) is shown in **Figure 77.1.1**. A contour map of Karachi is generated using GIS software from Digital Elevation Model developed based on 1:50,000 topographic maps prepared by Survey of Pakistan during 1991~1995. The created contour map is shown in **Figure 77.1.2**.

Based on these basic conditions and information, new filtered water transmission system including trunk distribution mains for the three zones is proposed as seen in **Figure 77.1.3** in consideration of;

- eliminating the use of several bulk pumping stations and a large number of small size distribution pumping stations for energy cost saving,
- supplying water by gravity as much as possible, and
- keeping minimum dynamic water pressure of 10 m in distribution system.

Flow diagram of the proposed system in 2025 is shown in **Figure 77.1.4**. Flow diagrams of the proposed systems for intermediate years of 2016 and 2021 are attached to **Appendix 77.1**. As the result of a preliminary hydraulic analysis, pumping will be required only for transferring water from filtration plants to the distribution reservoirs in order to supply water to relatively high altitude area.

The details of proposed reservoirs, filtered water transmission mains, transmission pump stations and network analysis are further explained in the following sub-sections.

# Table 77.1.1 Zone-Wise Water Demand (1/2)

## Zone-Wise Water Demand in 2011

### Zone-West

| | |
|---|---|
| **Demand** | |
| ***Town*** | |
| 1 Keamari (West) | 17.64 mgd |
| 2 SITE | 34.56 mgd |
| 3 Baldia | 18.59 mgd |
| 4 Orangi | 28.00 mgd |
| 12 North Nazimabad | 26.34 mgd |
| 13 New Karachi | 26.11 mgd |
| 14 Gulberg | 23.47 mgd |
| 15 Liaquatabad | 29.43 mgd |
| 18 Gadap (West) | 12.87 mgd |
| ***Canttonment*** | |
| ***Other Authority*** | |
| ***Other District*** | |
| Barochistan | 5 mgd |
| Total Demand | 222.01 mgd |
| **Production** | |
| ***FP*** | |
| Hub | 80 mgd |
| Total Production | 80 mgd |
| Remainded Production | -142.01 mgd |

### Zone-Central

| | |
|---|---|
| ***Town*** | |
| 3 Keamari (Port) | 10.20 mgd |
| 5 Lyari | 22.65 mgd |
| 6 Saddar | 70.72 mgd |
| 7 Jamshed | 36.86 mgd |
| 8 Gulshan-e-Ibal | 60.92 mgd |
| 9 Shah Faisal | 23.40 mgd |
| 16 Malir | 40.46 mgd |
| 18 Gadap (Central) | 22.64 mgd |
| ***Canttonment*** | |
| ① Manora | 0.39 mgd |
| ② Malir | 15.27 mgd |
| ③ Karachi | 1.00 mgd |
| ④ Crifton | 0.89 mgd |
| ⑤ Faisal | 6.88 mgd |
| ***Other Authority*** | |
| DHA | 25.88 mgd |
| ***Other District*** | |
| Total Demand | 338.16 mgd |
| ***FP*** | |
| NEK Old | 25 mgd |
| NEK New | 100 mgd |
| COD | 115 mgd |
| K-III | 100 mgd |
| Total Production | 340 mgd |
| Remainded Production | 1.84 mgd |

### Zone-East

| | |
|---|---|
| ***Town*** | |
| 10 Landhi | 38.56 mgd |
| 11 Korangi | 37.70 mgd |
| 17 Bin Qasim | 64.52 mgd |
| 18 Gadap (East) | 3.78 mgd |
| ***Canttonment*** | |
| ⑥ Korangi | 3.60 mgd |
| ***Other Authority*** | |
| ***Other District*** | |
| Thatta (as Low Water) | |
| Total Demand | 148.16 mgd |
| **Grand Total of Demand** | **708.33 mgd** |
| ***FP*** | |
| Gharo | 20 mgd |
| Pipri | 100 mgd |
| Total Production | 120 mgd |
| **Grand Total of Production** | **540 mgd** |
| Remainded Production | -28.16 mgd |

## Zone-Wise Water Demand in 2016

### Zone-West

| | |
|---|---|
| **Demand** | |
| ***Town*** | |
| 1 Keamari (West) | 32.34 mgd |
| 2 SITE | 36.36 mgd |
| 3 Baldia | 25.63 mgd |
| 4 Orangi | 31.06 mgd |
| 12 North Nazimabad | 28.71 mgd |
| 13 New Karachi | 27.88 mgd |
| 14 Gulberg | 25.83 mgd |
| 15 Liaquatabad | 29.42 mgd |
| 18 Gadap (West) | 21.76 mgd |
| ***Canttonment*** | |
| ***Other Authority*** | |
| ***Other District*** | |
| Barochistan | 5 mgd |
| Total Demand | 263.98 mgd |
| **Production** | |
| ***FP*** | |
| Hub | 75 mgd |
| Total Production | 75 mgd |
| Remainded Production | -188.98 mgd |

### Zone-Central

| | |
|---|---|
| ***Town*** | |
| 3 Keamari (Port) | 11.83 mgd |
| 5 Lyari | 23.06 mgd |
| 6 Saddar | 71.68 mgd |
| 7 Jamshed | 43.79 mgd |
| 8 Gulshan-e-Ibal | 79.66 mgd |
| 9 Shah Faisal | 24.38 mgd |
| 16 Malir | 43.19 mgd |
| 18 Gadap (Central) | 42.95 mgd |
| ***Canttonment*** | |
| ① Manora | 0.47 mgd |
| ② Malir | 18.52 mgd |
| ③ Karachi | 1.21 mgd |
| ④ Crifton | 1.07 mgd |
| ⑤ Faisal | 8.34 mgd |
| ***Other Authority*** | |
| DHA | 30.73 mgd |
| ***Other District*** | |
| Total Demand | 400.88 mgd |
| ***FP*** | |
| NEK Old | 25 mgd |
| NEK New | 100 mgd |
| COD | 200 mgd |
| K-III | 100 mgd |
| Central | 130 mgd |
| Total Production | 555 mgd |
| Remainded Production | 154.12 mgd |

### Zone-East

| | |
|---|---|
| ***Town*** | |
| 10 Landhi | 45.36 mgd |
| 11 Korangi | 46.59 mgd |
| 17 Bin Qasim | 94.79 mgd |
| 18 Gadap (East) | 6.68 mgd |
| ***Canttonment*** | |
| ⑥ Korangi | 4.36 mgd |
| ***Other Authority*** | |
| ***Other District*** | |
| Thatta (as Low Water) | |
| Total Demand | 197.77 mgd |
| **Grand Total of Demand** | **862.64 mgd** |
| ***FP*** | |
| Gharo | 20 mgd |
| Pipri | 100 mgd |
| Total Production | 120 mgd |
| **Grand Total of Production** | **750 mgd** |
| Remainded Production | -77.77 mgd |

# Table 77.1.2 Zone-Wise Water Demand (2/2)

## Zone-Wise Water Demand in 2021

### Zone-West

| | | |
|---|---|---|
| **Demand** | | |
| ***Town*** | | |
| 1 | Keamari (West) | 47.69 mgd |
| 2 | SITE | 38.83 mgd |
| 3 | Baldia | 31.11 mgd |
| 4 | Orangi | 34.76 mgd |
| 12 | North Nazimabad | 32.13 mgd |
| 13 | New Karachi | 30.36 mgd |
| 14 | Gulberg | 28.88 mgd |
| 15 | Liaquatabad | 30.53 mgd |
| 18 | Gadap (West) | 30.21 mgd |
| ***Canttonment*** | | |
| ***Other Authority*** | | |
| ***Other District*** | | |
| | Barochistan | 5 mgd |
| | Total Demand | 309.50 mgd |
| **Production** | | |
| ***FP*** | | |
| | Hub | 80 mgd |
| | West | 130 mgd |
| | Total Production | 210 mgd |
| | Remainded Production | -99.50 mgd |

### Zone-Central

| | | |
|---|---|---|
| ***Town*** | | |
| 3 | Keamari (Port) | 12.52 mgd |
| 5 | Lyari | 23.87 mgd |
| 6 | Saddar | 74.53 mgd |
| 7 | Jamshed | 50.03 mgd |
| 8 | Gulshan-e-Ibal | 103.06 mgd |
| 9 | Shah Faisal | 25.79 mgd |
| 16 | Malir | 48.11 mgd |
| 18 | Gadap (Central) | 64.06 mgd |
| ***Canttonment*** | | |
| ① | Manora | 0.57 mgd |
| ② | Malir | 22.37 mgd |
| ③ | Karachi | 1.46 mgd |
| ④ | Crifton | 1.30 mgd |
| ⑤ | Faisal | 10.07 mgd |
| ***Other Authority*** | | |
| | DHA | 37.64 mgd |
| ***Other District*** | | |
| | Total Demand | 475.36 mgd |
| ***FP*** | | |
| | NEK Old | 25 mgd |
| | NEK New | 100 mgd |
| | COD | 200 mgd |
| | K-III | 100 mgd |
| | Central | 130 mgd |
| | Total Production | 555 mgd |
| | Remainded Production | 79.64 mgd |

### Zone-East

| | | |
|---|---|---|
| ***Town*** | | |
| 10 | Landhi | 54.75 mgd |
| 11 | Korangi | 58.61 mgd |
| 17 | Bin Qasim | 129.36 mgd |
| 18 | Gadap (East) | 10.03 mgd |
| ***Canttonment*** | | |
| ⑥ | Korangi | 5.27 mgd |
| ***Other Authority*** | | |
| ***Other District*** | | |
| | Thatta (as Low Water) | |
| | Total Demand | 258.01 mgd |
| | **Grand Total of Demand** | **1,042.87 mgd** |
| ***FP*** | | |
| | Gharo | 20 mgd |
| | Pipri | 100 mgd |
| | East | 130 mgd |
| | Total Production | 250 mgd |
| | **Grand Total of Production** | **1,015 mgd** |
| | Remainded Production | -8.01 mgd |

## Zone-Wise Water Demand in 2025

### Zone-West

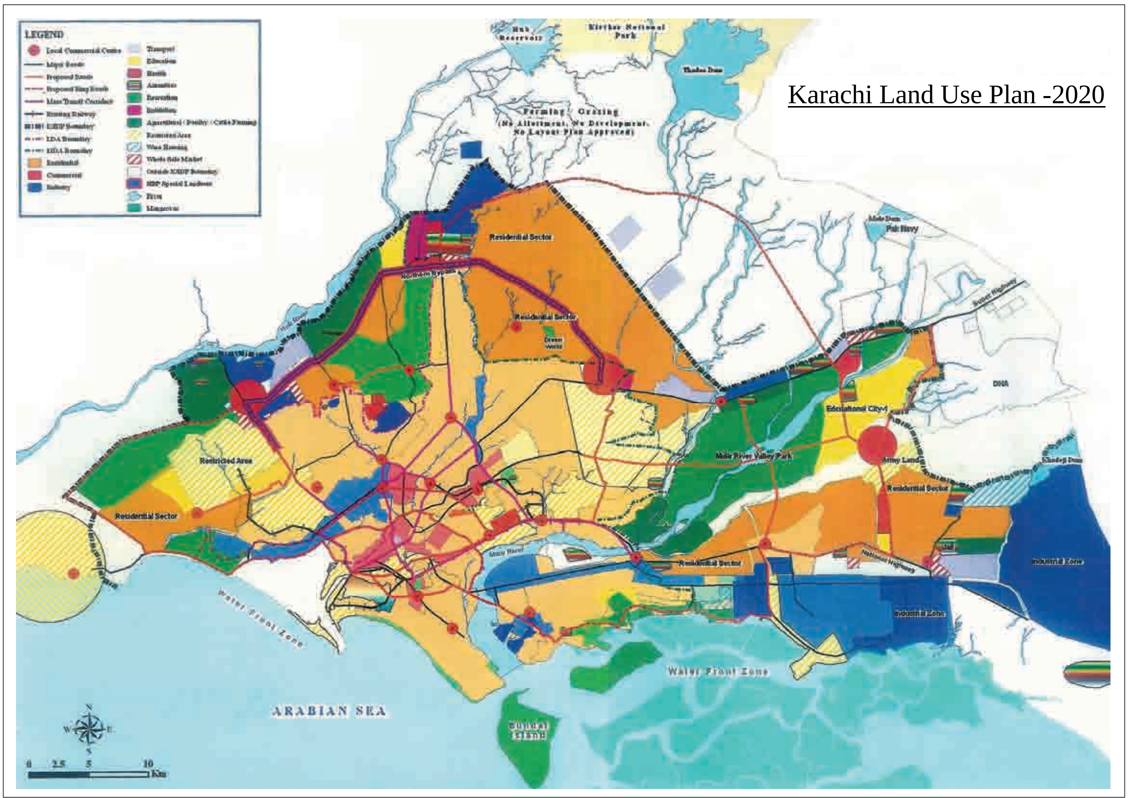
| | | |
|---|---|---|
| **Demand** | | |
| ***Town*** | | |
| 1 | Keamari (West) | 60.22 mgd |
| 2 | SITE | 40.79 mgd |
| 3 | Baldia | 35.63 mgd |
| 4 | Orangi | 37.91 mgd |
| 12 | North Nazimabad | 35.03 mgd |
| 13 | New Karachi | 32.47 mgd |
| 14 | Gulberg | 31.48 mgd |
| 15 | Liaquatabad | 31.51 mgd |
| 18 | Gadap (West) | 36.22 mgd |
| ***Canttonment*** | | |
| ***Other Authority*** | | |
| ***Other District*** | | |
| | Barochistan | 5 mgd |
| | Total Demand | 346.27 mgd |
| **Production** | | |
| ***F/P*** | | |
| | Hub | 75 mgd |
| | West | 260 mgd |
| | Total Production | 335 mgd |
| | Remainded Production | -11.27 mgd |

### Zone-Central

| | | |
|---|---|---|
| ***Town*** | | |
| 3 | Keamari (Port) | 13.09 mgd |
| 5 | Lyari | 24.59 mgd |
| 6 | Saddar | 76.71 mgd |
| 7 | Jamshed | 55.27 mgd |
| 8 | Gulshan-e-Ibal | 121.99 mgd |
| 9 | Shah Faisal | 26.93 mgd |
| 16 | Malir | 51.84 mgd |
| 18 | Gadap (Central) | 79.84 mgd |
| ***Canttonment*** | | |
| ① | Manora | 0.65 mgd |
| ② | Malir | 25.33 mgd |
| ③ | Karachi | 1.66 mgd |
| ④ | Crifton | 1.47 mgd |
| ⑤ | Faisal | 11.41 mgd |
| ***Other Authority*** | | |
| | DHA | 43.48 mgd |
| ***Other District*** | | |
| | Total Demand | 534.25 mgd |
| ***F/P*** | | |
| | NEK Old | 25 mgd |
| | NEK New | 100 mgd |
| | COD | 200 mgd |
| | K-III | 100 mgd |
| | Central | 130 mgd |
| | Total Production | 555 mgd |
| | Remainded Production | 20.75 mgd |

### Zone-East

| | | |
|---|---|---|
| ***Town*** | | |
| 10 | Landhi | 62.40 mgd |
| 11 | Korangi | 68.30 mgd |
| 17 | Bin Qasim | 155.34 mgd |
| 18 | Gadap (East) | 14.53 mgd |
| ***Canttonment*** | | |
| ⑥ | Korangi | 5.97 mgd |
| ***Other Authority*** | | |
| ***Other District*** | | |
| | Thatta (as Low Water) | |
| | Total Demand | 306.54 mgd |
| | **Grand Total of Demand** | **1,187.05 mgd** |
| ***F/P*** | | |
| | Gharo | 20 mgd |
| | Pipri | 100 mgd |
| | East | 260 mgd |
| | Total Production | 380 mgd |
| | **Grand Total of Production** | **1,270 mgd** |
| | Remainded Production | 73.46 mgd |




source: Karachi Strategic Development Plan 2020 (Final, August 2007)

**Figure 77.1.1 Future Land Use in 2025**

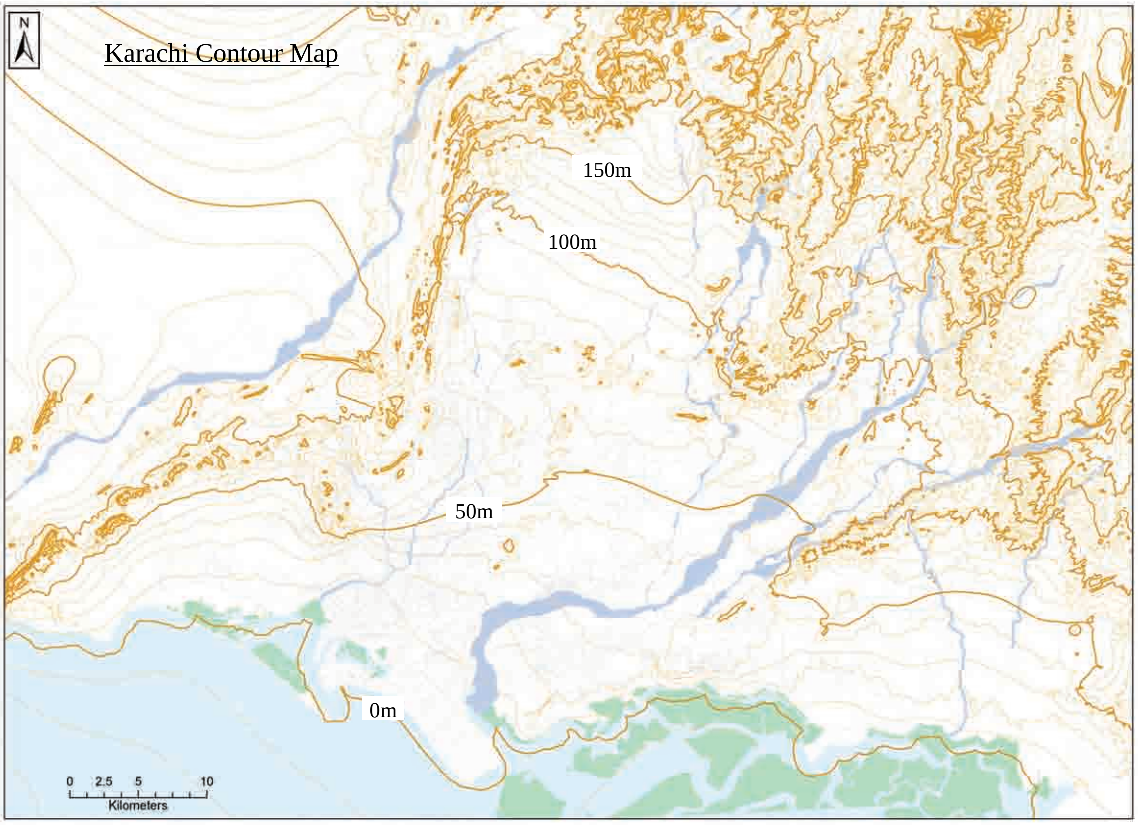



**Figure 77.1.2 Karachi Contour Map**

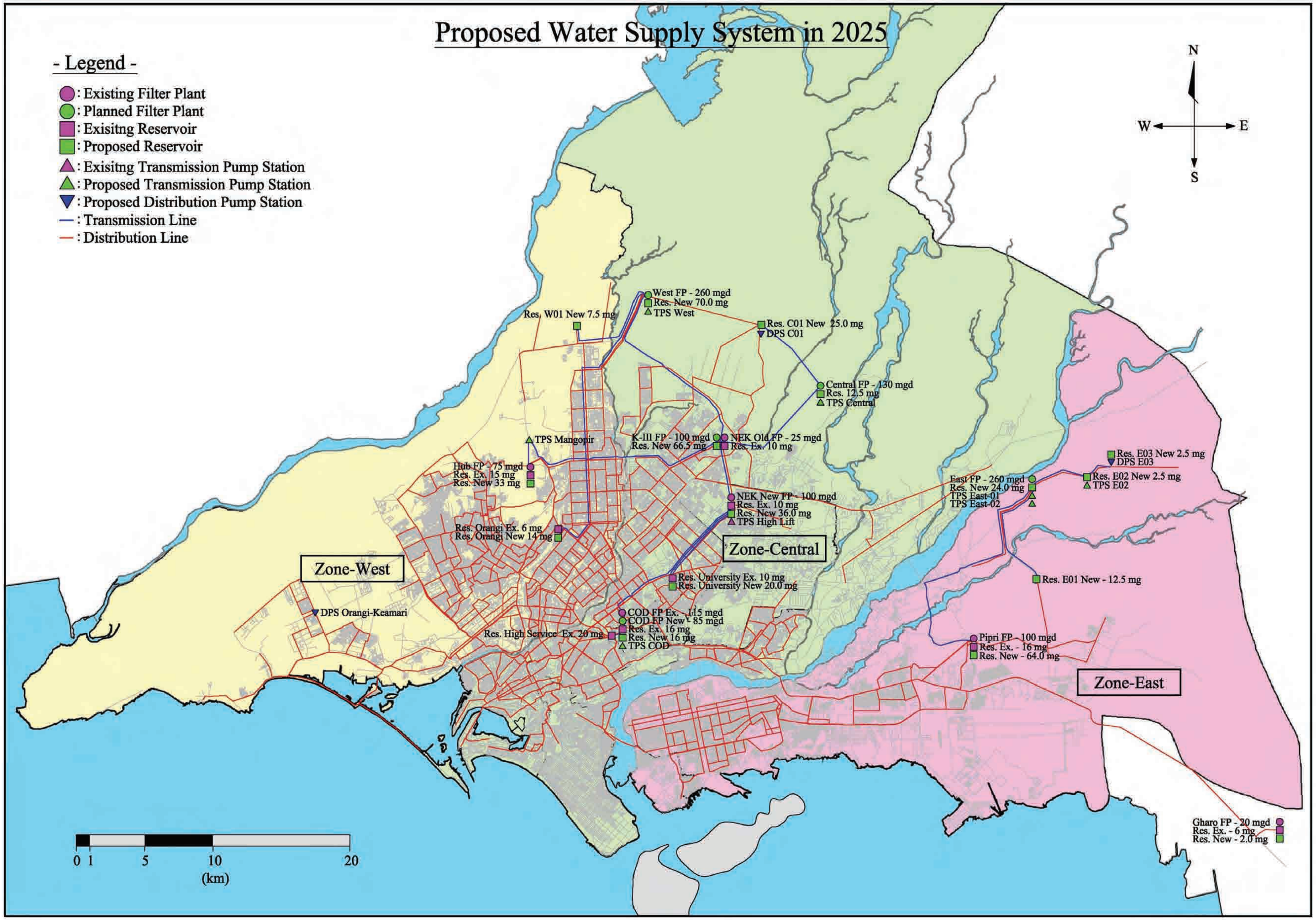



**Figure 77.1.3 Proposed Water Supply System in 2025**

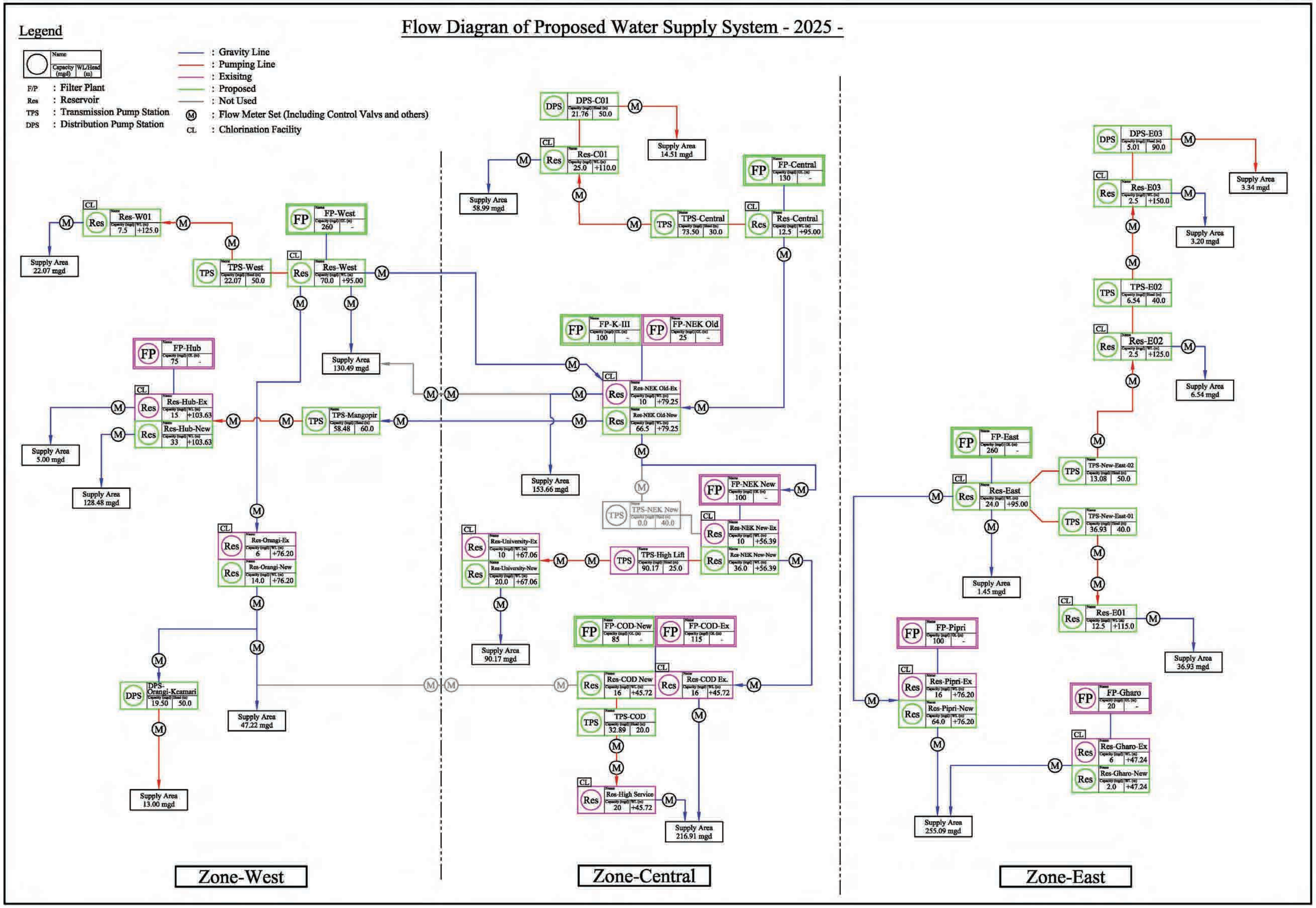



**Figure 77.1.4 Flow Diagram of Proposed System in 2025**

### 7.7.2 Network Analysis

#### (1) Conditions of Network Analysis

**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)

For confirmation, Darcy-Weisbach's formula with a friction factor of e=0.45mm which is calculated with Colebrook-White formula was also used for checking hydraulic analysis. There was no much difference between the results. Therefore, the Hazen-Williams formula has been adopted for this study.

**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 was adopted when designing the transmission and distribution system, including the existing pipelines.

**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". It is, however, difficult to review the time factor of 1.5 because water flow has not been measured properly.

**4) Minimum Dynamic Water Pressure: 10 m**

A minimum pressure of 10 m in the distribution system has been adopted under peak flow conditions. This will provide sufficient pressure for 2 or 3 storey house.

**5) Details of the Existing 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 trunk distribution mains; and
- locations, capacities and water level of reservoirs.

#### (2) Results of Network Analysis

**Appendix A77.1** shows the results of the analysis in detail.

### 7.7.3 Transmission Pumping Stations

Proposed transmission pump stations will deliver filtered water to distribution reservoirs through transmission mains for supplying water mainly to new developing area of three fringe towns, Keamari, Bin Qasim and Gadap. These areas are relatively high altitude area where is higher than the filtration plant or almost the same altitude as the filtration plant. The proposed pumping stations for the target year of 2025 including two existing pumping stations (Manghopir PS and High Lift PS) are shown in **Table 77.3.1**.

**Table 77.3.1 Proposed Transmission Pumping Station in 2025**

| Type | Zone | Name | Q (mgd) | | | Pump Head (m) |
|---|---|---|---|---|---|---|
| | | | 2016 | 2021 | 2025 | |
| Transmission Pumping Station | West | TPS-W-Mangopir | 40.98 | 52.53 | 58.48 | 60 |
| | | TPS-W-West | - | 6.69 | 22.07 | 50 |
| | Central | TPS-C-COD | 26.06 | 29.76 | 32.89 | 20 |
| | | TPS-C-NEK New | 18.65 | 0.00 | 0.00 | 40 |
| | | TPS-C-Central | 24.41 | 47.48 | 73.50 | 30 |
| | | TPS-C-High_Lift | 75.91 | 83.97 | 90.17 | 25 |
| | East | TPS-E-East-01 | - | 28.67 | 36.93 | 40 |
| | | TPS-E-East-02 | - | - | 13.08 | 50 |
| | | TPS-E-E02 | - | - | 6.54 | 40 |

### 7.7.4 Water Transmission Mains

#### (1) Proposed Water Transmission Mains

The dimensions of proposed water transmission mains are listed in **Table 77.4.1**. **Figure 77.1.3** and **Figure 77.1.4** include the routes and flow diagram of the proposed filtered water transmission system respectively. Proposed filtered water transmission mains should not have any branches for distribution or bulk supply. Routes of transmission mains pass through mainly new developing area of three fringe towns, Keamari, Bin Qasim and Gadap. For future system, the existing water trunk mains except the trunk mains between NEK New F/P and University Reservoir and NEK Old and Manghopir P/S (NEK Hub Main) will not be used as the water transmission mains, but utilised for the trunk distribution mains. However, the water trunk mains between NEK New F/P and University Reservoir (about 16.7 km in total) are proposed to be rehabilitated and replaced, which are included in **Table 77.4.1**.

**Table 77.4.1 Proposed Water Transmission Mains in 2025**

| Zone | Year | Dia. (in) | Length (m) |
|---|---|---|---|
| **West** | **2016** | 72 | 141 |
| | | Sub-Total | 141 |
| | **2021** | 36 | 20,364 |
| | | 44 | 2,448 |
| | | Sub-Total | 22,812 |
| | **2025** | 100 | 37,390 |
| | | Sub-Total | 37,390 |
| | **Zone-Total** | | **60,343** |
| **Central** | **2016** | 48 | 5,425 |
| | | 56 | 11,348 |
| | | 64 | 22,700 |
| | | 88 | 9,275 |
| | | Sub-Total | 48,748 |
| | **Zone-Total** | | **48,748** |
| **East** | **2021** | 56 | 9,651 |
| | | 100 | 20,364 |
| | | Sub-Total | 30,015 |
| | **2025** | 24 | 2,078 |
| | | 32 | 4,157 |
| | | Sub-Total | 6,235 |
| | **Zone-Total** | | **36,250** |
| **Total** | | | **145,341** |

### (2) Water Management between Zones

Considering water demands in three zones, some water should be managed across zone boundaries as shown in **Figure 77.4.1**. Some water should be supplied from Zone Central to Zone West because Zone Central has enough supply capacity for its demand. On the other hand, there is no water exchange between Zone Central and Zone East.

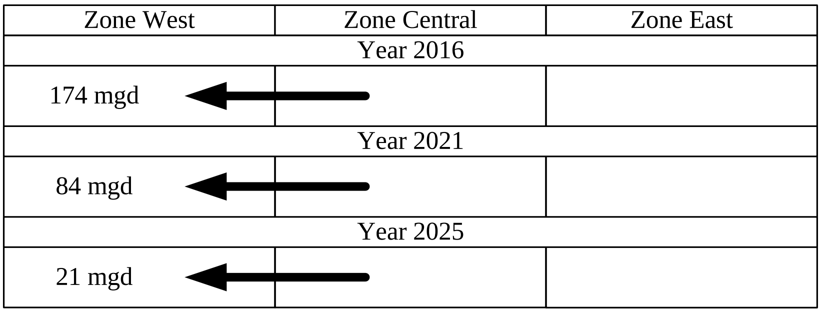



**Figure 77.4.1 Water Management between Zones**

## 7.7.5 Distribution Reservoirs

### (1) Proposed Distribution Reservoirs

Distribution reservoirs should have enough capacity to cope with water demand fluctuation in a day. In general peaks in water demand appear in the morning, at noon and in the evening. However, hourly demand fluctuation is difficult to accurately quantify because the metering system does not exist in the current system. Based on engineering experiences, the capacity of distribution reservoir is proposed to be eight hours of daily demand.

Distribution reservoirs should be located at suitable place to supply water with enough pressure of minimum 10 $kgf/cm^2$ at the end of distribution network. To monitor and control the flow, flow meters and flow control valves should be installed at the outlet pipes at the reservoirs. And chlorination equipment should be installed in the all distribution reservoirs to increase the safety of water supply.

Proposed reservoirs for 2025 are listed in the **Table 77.5.1** and supply areas of each reservoir are shown in **Figure.77.5.1**.

**Table 77.5.1 Proposed Distribution Reservoirs in 2025**

| Zone | Res | HWL | LWL | H | Req. Total V (mg) | | | Existing | Planned Total V (mg) | | | Planned New V (mg) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | (+m) | (+m) | (m) | 2016 | 2021 | 2025 | (mg) | 2016 | 2021 | 2025 | 2016 | 2021 | 2025 |
| West | Hub | +103.63 | +99.36 | 4.27 | 42.0 | 45.9 | 47.9 | 15.0 | 48.0 | 48.0 | 48.0 | 33.0 | 0.0 | 0.0 |
| | Orangi | +76.20 | +71.32 | 4.88 | 0.0 | 0.0 | 20.1 | 6.0 | 0.0 | 0.0 | 20.0 | 0.0 | 0.0 | 20.0 |
| | West* | +95.00 | +90.00 | 5.00 | 0.0 | 51.7 | 65.7 | 0.0 | 0.0 | 50.0 | 70.0 | 0.0 | 50.0 | 20.0 |
| | W01* | +125.00 | +120.00 | 5.00 | 0.0 | 2.3 | 7.4 | 0.0 | 0.0 | 2.5 | 7.5 | 0.0 | 2.5 | 5.0 |
| | Mangopir PS** | +64.00 | +61.00 | 3.00 | 0.9 | 1.1 | 1.2 | 0.0 | 1.5 | 1.5 | 1.5 | 1.5 | 0.0 | 0.0 |
| Centarl | COD | +45.72 | +40.23 | 5.49 | 32.0 | 32.0 | 32.0 | 16.0 | 32.0 | 32.0 | 32.0 | 16.0 | 0.0 | 0.0 |
| | NEK Old | +79.25 | +74.37 | 4.88 | 76.5 | 57.1 | 61.5 | 10.0 | 76.5 | 76.5 | 76.5 | 66.5 | 0.0 | 0.0 |
| | NEK New | +56.39 | +51.51 | 4.88 | 45.6 | 45.6 | 45.6 | 10.0 | 46.0 | 46.0 | 46.0 | 36.0 | 0.0 | 0.0 |
| | University | +67.06 | +62.18 | 4.88 | 25.4 | 28.0 | 30.1 | 10.0 | 30.0 | 30.0 | 30.0 | 20.0 | 0.0 | 0.0 |
| | High Service | +45.72 | +40.84 | 4.88 | 8.7 | 9.9 | 11.0 | 20.0 | 11.0 | 11.0 | 11.0 | 0.0 | 0.0 | 0.0 |
| | Central* | +95.00 | +90.00 | 5.00 | 11.4 | 11.9 | 12.4 | 0.0 | 12.5 | 12.5 | 12.5 | 12.5 | 0.0 | 0.0 |
| | C01* | +110.00 | +105.00 | 5.00 | 8.2 | 15.9 | 24.6 | 0.0 | 10.0 | 15.0 | 25.0 | 10.0 | 5.0 | 10.0 |
| East | Gharo | +47.24 | +45.72 | 1.52 | 6.7 | 6.7 | 6.7 | 6.0 | 8.0 | 8.0 | 8.0 | 2.0 | 0.0 | 0.0 |
| | Pipri | +76.20 | +71.32 | 4.88 | 33.3 | 66.8 | 78.5 | 16.0 | 35.0 | 70.0 | 80.0 | 19.0 | 35.0 | 10.0 |
| | East* | +95.00 | +90.00 | 5.00 | 0.0 | 11.9 | 23.2 | 0.0 | 0.0 | 12.0 | 24.0 | 0.0 | 12.0 | 12.0 |
| | E01* | +115.00 | +110.00 | 5.00 | 0.0 | 9.6 | 12.4 | 0.0 | 0.0 | 12.5 | 12.5 | 0.0 | 12.5 | 0.0 |
| | E02* | +125.00 | +120.00 | 5.00 | 0.0 | 0.0 | 2.4 | 0.0 | 0.0 | 0.0 | 2.5 | 0.0 | 0.0 | 2.5 |
| | E03* | +150.00 | +145.00 | 5.00 | 0.0 | 0.0 | 2.2 | 0.0 | 0.0 | 0.0 | 2.5 | 0.0 | 0.0 | 2.5 |

*: new reservoirs
**: suction well for PS

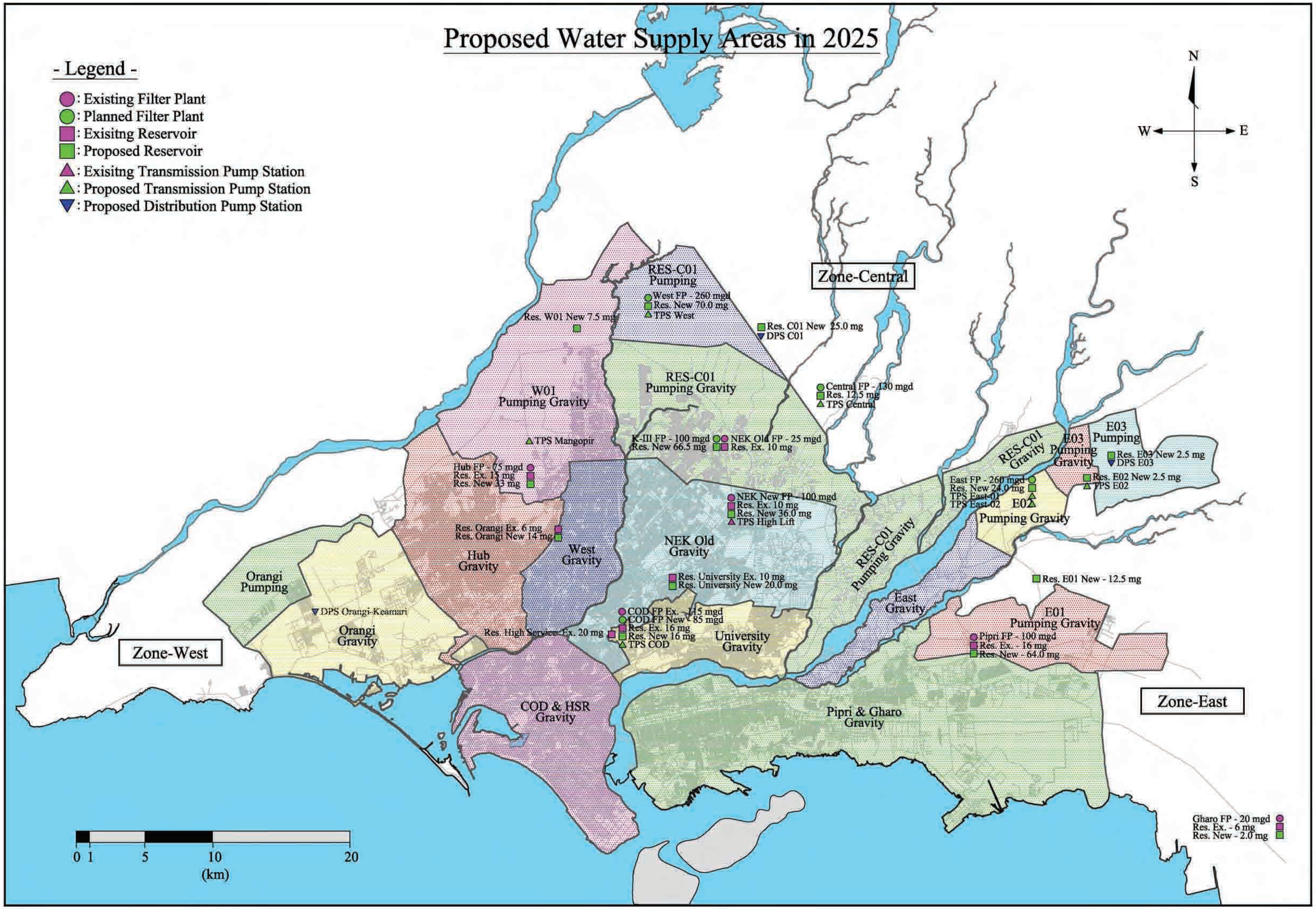



**Figure 77.5.1 Proposed Supply Area from Each Reservoir in 2025**

### (2) Rehabilitation of the Existing Reservoirs

The Karachi Water Supply System has 16 existing distribution reservoirs including reservoirs at filtration plants, as listed in **Table 77.5.2**. Since the design life of the concrete structure is 50 years, this master plan proposes that 8 existing reservoirs constructed before 1975 will be rehabilitated by 2025. On the other hand, 4 reservoirs will be eliminated for future water supply system, since water from these reservoirs should be supplied by using distribution pumps. The area presently supplied from these reservoirs to be eliminated will be covered by other reservoirs by gravity. KW&SB are preparing to rehabilitate two reservoirs, High Service Reservoir and Orangi Reservoir. Especially, Orangi Reservoir is needed to be reconstruct at the existing site, since the existing reservoir has been destroyed.

**Table 77.5.2 List of Existing Reservoirs**

| Name of Exiting Reservoirs | Construction Year* | Need for Rehabilitation | Elimination by 2025 | Need for Expansion |
|---|---|---|---|---|
| Gharo F/P (Plant-1) | 1942 | × | - | × |
| Pipri F/P (Plant-1) | 1968 | × | - | × |
| Pipri F/P (Plant-2) | 1971 | × | - | |
| NEK Old F/P | 1980 | - | - | × |
| NEK New F/P | 1998 | - | - | × |
| COD F/P (Plant-1) | 1962 | × | - | × |
| COD F/P (Plant-2) | 1971 | × | - | |
| Hub F/P | 1982 | - | - | × |
| University | 1971 | × | - | × |
| High Service | 1945 | × | - | - |
| Low Service | 1942 | - | × | - |
| Temple | 1880 | - | × | - |
| Currie | 1896 | - | × | - |
| Sydenham | 1942 | - | × | - |
| Orangi | 1982 | × | - | × |
| Kidney Hill | 1978 | - | - | - |

*: information from KW&SB

### 7.7.6 Distribution Pumping Stations

In the areas where water can not be supplied by gravity flow, water should be supplied by pumping from distribution reservoirs. The capacity of distribution pumps is needed to be 1.5 times of daily demand considering the time factor of demand fluctuation.

Proposed distribution pumping stations will deliver water to customers who inhabit mainly at new developing area of three fringe towns, Keamari, Bin Qasim and Gadap. These areas are relatively high altitude area where is higher than the filtration plant or almost the same altitude as the filtration plant. The proposed pumping stations for the target year of 2025 are shown in **Table 77.6.1**.

**Table 77.6.1 Proposed Distribution Pumping Station in 2025**

| Type | Zone | Name | Ave. Q (mgd) | | | Max. Q (mgd) | | | Pump Head (m) |
|---|---|---|---|---|---|---|---|---|---|
| | | | 2016 | 2021 | 2025 | 2016 | 2021 | 2025 | |
| Distribution Pumping Station | West | DPS-W-Orangi-Keamari | - | - | 19.5 | - | - | 29.3 | 50 |
| | Central | DPS-C-C01 | - | - | 21.76 | - | - | 32.6 | 50 |
| | East | DPS-E-E03 | - | - | 5.01 | - | - | 7.5 | 90 |

On the other hand, a large number of the existing small size distribution pumping stations will be abandoned in the future system.

### 7.7.7 District Meter

In order to improve the efficiency of transmission and distribution system and to supply water equitably to the service area, it is necessary to understand how much water is flowed into which area. For that purpose, installation of flow meters (district meters) for transmission mains and trunk distribution mains is proposed mainly at the following locations. The number of flow meters required for the system in 2025 is listed in **Table 77.7.1**.

- Outlet of filtration plants, pumping stations and reservoirs
- Downstream of branch points of transmission and trunk distribution mains
- Boundary of towns

**Table 77.7.1 Proposed District Flow Meters**

| Diameter (in) | Transmission Mains | | | | Distribution Mains | | | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | West | Central | East | Sub-Total | West | Central | East | Sub-Total | |
| 12 | | | | 0 | | 4 | 1 | 5 | 5 |
| 14 | | | | 0 | 3 | 15 | 3 | 21 | 21 |
| 16 | | | | 0 | 1 | | 4 | 5 | 5 |
| 18 | | | | 0 | 5 | 8 | 2 | 15 | 15 |
| 20 | | | | 0 | | 1 | | 1 | 1 |
| 24 | | | 2 | 2 | 11 | 21 | 3 | 35 | 37 |
| 28 | | | | 0 | 2 | 2 | | 4 | 4 |
| 32 | | | 2 | 2 | 7 | 10 | 3 | 20 | 22 |
| 36 | 2 | | | 2 | 4 | 4 | 1 | 9 | 11 |
| 48 | | 3 | | 3 | 11 | 14 | 3 | 28 | 31 |
| 54 | | | | 0 | 1 | 2 | | 3 | 3 |
| 56 | | 6 | 2 | 8 | 1 | 5 | 2 | 8 | 16 |
| 60 | | | | 0 | | 1 | | 1 | 1 |
| 64 | | 2 | | 2 | | 2 | | 2 | 4 |
| 66 | | | | 0 | 2 | 1 | | 3 | 3 |
| 72 | 3 | | | 3 | 2 | 3 | 1 | 6 | 9 |
| 80 | | | | 0 | | 4 | | 4 | 4 |
| 88 | | 2 | | 2 | 2 | 1 | 4 | 7 | 9 |
| 100 | 2 | | 2 | 4 | 1 | 5 | | 6 | 10 |
| **Total** | **7** | **13** | **8** | **28** | **53** | **103** | **27** | **183** | **211** |

## 7.8 DISTRUBUTION NETWORK AND SERVICE CONNECTION

### 7.8.1 Proposed Distribution Network and Service Connection

#### (1) Trunk Distribution Mains

The existing water trunk mains as listed in **Table 78.1.1** are proposed to be used as trunk distribution mains for future water supply system, except the trunk mains between NEK New F/P and University Reservoir and NEK Old and Manghopir P/S (NEK Hub Main) which will be used as the water transmission mains. At present KW&SB use these water trunk mains mainly as transmission mains from filtration plants to reservoirs or trunk distribution mains. In future proposed system these water trunk mains will be mainly used as trunk distribution mains from reservoirs, since they already have many brunch connections.

In addition some large diameter's pipelines of the existing distribution pipes shown in **Table 78.1.2** will be used as the trunk distribution mains.

**Table 78.1.1 Existing Water Trunk Mains**

| Diameter | | Length |
|---|---|---|
| in | mm | (m) |
| 12 | 300 | 5,720 |
| 15 | 375 | 4,266 |
| 18 | 450 | 36,106 |
| 24 | 600 | 72,268 |
| 32 | 800 | 27 |
| 33 | 825 | 77,235 |
| 36 | 900 | 15,311 |
| 40 | 1,000 | 2,644 |
| 42 | 1,050 | 2,631 |
| 48 | 1,200 | 88,113 |
| 54 | 1,350 | 39,667 |
| 64 | 1,600 | 6,112 |
| 66 | 1,650 | 30,960 |
| 72 | 1,800 | 13,693 |
| 84 | 2,100 | 10,409 |
| Total | | 405,163 |

*Source: KW&SB

**Table 78.1.2 Existing Distribution Pipes**

| Diameter | | Length |
|---|---|---|
| in | mm | (km) |
| 3 | 75 | 1,636.2 |
| 4 | 100 | 1,531.9 |
| 5 | 125 | 60.0 |
| 6 | 150 | 609.0 |
| 8 | 200 | 199.0 |
| 9 | 225 | 34.6 |
| 10 | 250 | 130.6 |
| 12 | 300 | 317.0 |
| 15 | 375 | 107.1 |
| 16 | 400 | 20.1 |
| 18 | 450 | 96.8 |
| 21 | 525 | 1.0 |
| 24 | 600 | 58.1 |
| 27 | 675 | 5.2 |
| 30 | 750 | 2.5 |
| 33 | 825 | 25.2 |
| 36 | 900 | 6.3 |
| 48 | 1,200 | 8.9 |
| 54 | 1,350 | 3.0 |
| 60 | 1,500 | 2.0 |
| Total | | 4,854.4 |

*Source: KW&SB

The proportions of PRCC pipes used in the existing water trunk mains are more than 80 %. Therefore the study recommend that the existing trunk mains to be used as the trunk distribution mains are replaced with steel pipes or ductile cast iron pipes for future system. Because in general steel pipes and ductile cast iron pipes are widely used for pressured and treated water pipeline of large diameters (300 mm and more) in other countries. PRCC has disadvantages of workability, difficulty of field modifications due to differing site conditions and difficulty of repairs for leakages and damages.

Total length of trunk distribution mains required for future water supply system in 2025 is about 1,600 km as listed in **Tables 78.1.3** and **78.1.4** including about 685 km of the existing water trunk mains and parts of large diameters of distribution mains.

# Table 78.1.3 Proposed Trunk Distribution Mains (1/2)

| Zone | Supply Area | Type | Year | Dia. (in) | Length (m) |
|---|---|---|---|---|---|
| West | HUB | Replacement of Existing Pipeline | 2016 | 14 | 11,321 |
| | | | | 16 | 9,949 |
| | | | | 18 | 15,563 |
| | | | | 24 | 20,925 |
| | | | | 32 | 26,626 |
| | | | | 36 | 4,249 |
| | | | | 48 | 25,265 |
| | | | | 64 | 10,363 |
| | | | Existing-Total | | 124,262 |
| | | Installation of Proposed Pipeline | 2016 | 18 | 2,967 |
| | | | | 24 | 5,078 |
| | | | | 32 | 2,039 |
| | | | | 36 | 4,014 |
| | | | | 48 | 84 |
| | | | | Sub-Total | 14,183 |
| | | | 2021 | 14 | 74,028 |
| | | | | 16 | 2,908 |
| | | | | 18 | 6,323 |
| | | | | 24 | 4,558 |
| | | | | Sub-Total | 87,817 |
| | | | 2025 | 14 | 27,673 |
| | | | | 18 | 559 |
| | | | | 28 | 1,407 |
| | | | | Sub-Total | 29,639 |
| | | | Proposed-Total | | 131,638 |
| | | | | **Area-Total** | **357,899** |
| | West | Installation of Proposed Pipeline | 2025 | 14 | 91,484 |
| | | | | 18 | 784 |
| | | | | 24 | 1,585 |
| | | | | 36 | 452 |
| | | | | 48 | 2,318 |
| | | | | 56 | 14 |
| | | | | 72 | 753 |
| | | | | 88 | 32,547 |
| | | | Proposed-Total | | 129,937 |
| | | | | **Area-Total** | **129,937** |
| | W01 | Installation of Proposed Pipeline | 2016 | 14 | 10,091 |
| | | | | 32 | 3,328 |
| | | | | Sub-Total | 13,419 |
| | | | 2021 | 14 | 11,999 |
| | | | | 18 | 2,620 |
| | | | | 20 | 4,492 |
| | | | | 24 | 5,683 |
| | | | | 28 | 3,294 |
| | | | | Sub-Total | 28,088 |
| | | | Proposed-Total | | 41,507 |
| | | | | **Area-Total** | **41,507** |
| | NEK Old | Replacement of Existing Pipeline | 2016 | 14 | 11,018 |
| | | | | 16 | 4,965 |
| | | | | 18 | 15,258 |
| | | | | 24 | 16,513 |
| | | | | 32 | 6,579 |
| | | | | 48 | 25,716 |
| | | | | 56 | 985 |
| | | | Existing-Total | | 81,035 |
| | | Installation of Proposed Pipeline | 2016 | 16 | 442 |
| | | | | 18 | 2,870 |
| | | | | 24 | 1,916 |
| | | | | 28 | 89 |
| | | | | 32 | 13 |
| | | | | 36 | 3,121 |
| | | | | 48 | 1,823 |
| | | | | 56 | 3,829 |
| | | | | 64 | 34 |
| | | | | 72 | 2,198 |
| | | | | 88 | 2,316 |
| | | | | 100 | 1,763 |
| | | | Proposed-Total | | 20,414 |
| | | | | **Area-Total** | **101,449** |
| | Orangi | Installation of Proposed Pipeline | 2025 | 14 | 938 |
| | | | | 18 | 3,291 |
| | | | | 24 | 7,287 |
| | | | | 28 | 10,887 |
| | | | | 36 | 239 |
| | | | | 88 | 8,093 |
| | | | Proposed-Total | | 30,735 |
| | | | | **Area-Total** | **30,735** |
| | COD | Replacement of Existing Pipeline | 2016 | 12 | 5,680 |
| | | | | 14 | 2,395 |
| | | | | 18 | 31,531 |
| | | | | 24 | 21,316 |
| | | | | 32 | 2,322 |
| | | | | 36 | 11 |
| | | | | 48 | 4,367 |
| | | | Existing-Total | | 67,622 |
| | | Installation of Proposed Pipeline | 2016 | 18 | 2,908 |
| | | | | 24 | 1,984 |
| | | | | 36 | 15,514 |
| | | | | 48 | 5,946 |
| | | | | 56 | 4,067 |
| | | | | Sub-Total | 30,420 |
| | | | 2021 | 14 | 11,279 |
| | | | | 16 | 6,771 |
| | | | | 36 | 3,058 |
| | | | | Sub-Total | 21,107 |
| | | | Proposed-Total | | 51,527 |
| | | | | **Area-Total** | **119,149** |

| Zone | Supply Area | Type | Year | Dia. (in) | Length (m) |
|---|---|---|---|---|---|
| West | | Replacement of Existing Pipeline | | 12 | 5,680 |
| | | | | 14 | 24,735 |
| | | | | 16 | 14,914 |
| | | | | 18 | 62,353 |
| | | | | 24 | 58,754 |
| | | | | 32 | 35,527 |
| | | | | 36 | 4,260 |
| | | | | 48 | 55,348 |
| | | | | 56 | 985 |
| | | | | 64 | 10,363 |
| | | | Exisitng Zone-Total | | 272,918 |
| | | Installation of Proposed Pipeline | | 14 | 227,491 |
| | | | | 16 | 10,121 |
| | | | | 18 | 22,322 |
| | | | | 20 | 4,492 |
| | | | | 24 | 28,091 |
| | | | | 28 | 15,676 |
| | | | | 32 | 5,379 |
| | | | | 36 | 26,398 |
| | | | | 48 | 10,171 |
| | | | | 56 | 7,911 |
| | | | | 64 | 34 |
| | | | | 72 | 2,951 |
| | | | | 88 | 42,957 |
| | | | | 100 | 1,763 |
| | | | Proposed Zone-Total | | 405,760 |
| | | | **Zone-Total** | | **678,678** |
| East | Gharo | Installation of Proposed Pipeline | 2016 | 88 | 25,151 |
| | | | | - | - |
| | | | Proposed-Total | | 25,151 |
| | | | | **Area-Total** | |
| | Pipri | Replacement of Existing Pipeline | 2025 | 12 | 5,769 |
| | | | | 14 | 43,610 |
| | | | | 18 | 12,410 |
| | | | | 24 | 13,062 |
| | | | | 32 | 26,203 |
| | | | | 48 | 25,283 |
| | | | | 56 | 18,791 |
| | | | | 64 | 5,988 |
| | | | | 72 | 2,220 |
| | | | Existing-Total | | 153,335 |
| | | Installation of Proposed Pipeline | 2021 | 14 | 8,312 |
| | | | | 18 | 1,266 |
| | | | | 24 | 4,373 |
| | | | | 48 | 2,138 |
| | | | | 56 | 2,639 |
| | | | | 64 | 11,680 |
| | | | | 72 | 9,714 |
| | | | | 88 | 13,859 |
| | | | | Sub-Total | 53,980 |
| | | | 2025 | 14 | 23,948 |
| | | | | 18 | 444 |
| | | | | 20 | 629 |
| | | | | 28 | 1,239 |
| | | | | Sub-Total | 26,259 |
| | | | Proposed-Total | | 80,239 |
| | | | | **Area-Total** | **80,239** |
| | East | Installation of Proposed Pipeline | 2021 | 14 | 8,903 |
| | | | | - | - |
| | | | Proposed-Total | | 8,903 |
| | | | | **Area-Total** | **8,903** |
| | E01 | Installation of Proposed Pipeline | 2021 | 14 | 1,815 |
| | | | | 18 | 5,234 |
| | | | | 32 | 3,616 |
| | | | | 36 | 6,193 |
| | | | | 56 | 4,923 |
| | | | Proposed-Total | | 21,781 |
| | | | | **Area-Total** | **21,781** |
| | E02 | Installation of Proposed Pipeline | 2025 | 24 | 8,821 |
| | | | | - | - |
| | | | Proposed-Total | | 8,821 |
| | | | | **Area-Total** | **8,821** |
| | E03 | Installation of Proposed Pipeline | 2025 | 18 | 7,057 |
| | | | | - | - |
| | | | Proposed-Total | | 7,057 |
| | | | | **Area-Total** | **7,057** |
| | | Replacement of Existing Pipeline | | 12 | 5,769 |
| | | | | 14 | 43,610 |
| | | | | 18 | 12,410 |
| | | | | 24 | 13,062 |
| | | | | 32 | 26,203 |
| | | | | 48 | 25,283 |
| | | | | 56 | 18,791 |
| | | | | 64 | 5,988 |
| | | | | 72 | 2,220 |
| | | | Exisitng Zone-Total | | 153,335 |
| | | Installation of Proposed Pipeline | | 14 | 42,978 |
| | | | | 18 | 14,001 |
| | | | | 20 | 629 |
| | | | | 24 | 13,194 |
| | | | | 28 | 1,239 |
| | | | | 32 | 3,616 |
| | | | | 36 | 6,193 |
| | | | | 48 | 2,138 |
| | | | | 56 | 7,561 |
| | | | | 64 | 11,680 |
| | | | | 72 | 9,714 |
| | | | | 88 | 39,010 |
| | | | Proposed Zone-Total | | 151,951 |
| | | | **Zone-Total** | | **305,286** |

# Table 78.1.4 Proposed Trunk Distribution Mains (2/2)

| Zone | Supply Area | Type | Year | Dia. (in) | Length (m) |
|---|---|---|---|---|---|
| **Central** | **NEK Old** | Replacement of Existing Pipeline | **2021** | 14 | 2,116 |
| | | | | 18 | 35,771 |
| | | | | 24 | 8,064 |
| | | | | 32 | 7,200 |
| | | | | 36 | 12,170 |
| | | | | 56 | 3,666 |
| | | | | 64 | 4,177 |
| | | | Existing-Total | | 73,164 |
| | | Installation of Proposed Pipeline | **2016** | 18 | 12,457 |
| | | | | 24 | 3,390 |
| | | | | 32 | 9,033 |
| | | | | 36 | 1,959 |
| | | | | 48 | 1,747 |
| | | | | 56 | 1,972 |
| | | | | 72 | 2,193 |
| | | | | 80 | 975 |
| | | | | 100 | 17,994 |
| | | | | Sub-Total | 51,720 |
| | | | **2021** | 14 | 20,284 |
| | | | | 18 | 2,635 |
| | | | | 24 | 2,477 |
| | | | | 36 | 1,759 |
| | | | | 48 | 8,429 |
| | | | | Sub-Total | 35,584 |
| | | | **2025** | 14 | 23,841 |
| | | | | Sub-Total | 23,841 |
| | | | Proposed-Total | | 111,144 |
| | | | | **Area-Total** | **184,309** |
| | **COD** | Replacement of Existing Pipeline | **2021** | 12 | 9,615 |
| | | | | 14 | 10,029 |
| | | | | 18 | 21,847 |
| | | | | 20 | 2,579 |
| | | | | 24 | 42,290 |
| | | | | 28 | 4,423 |
| | | | | 32 | 12,974 |
| | | | | 36 | 1,915 |
| | | | | 48 | 11,496 |
| | | | | 56 | 4,806 |
| | | | | 60 | 1,666 |
| | | | | 64 | 4,662 |
| | | | | 72 | 1,278 |
| | | | Existing-Total | | 129,579 |
| | | Installation of Proposed Pipeline | **2016** | 14 | 1,143 |
| | | | | 16 | 1,750 |
| | | | | 18 | 3,066 |
| | | | | 24 | 4,970 |
| | | | | 28 | 1,667 |
| | | | | 36 | 2,082 |
| | | | | 48 | 8,070 |
| | | | | 56 | 4,912 |
| | | | | 72 | 4,829 |
| | | | | 80 | 6,840 |
| | | | | 100 | 1,040 |
| | | | | Sub-Total | 40,368 |
| | | | **2021** | 14 | 5,065 |
| | | | | 16 | 2,006 |
| | | | | 18 | 301 |
| | | | | 24 | 2,277 |
| | | | | 36 | 3,343 |
| | | | | Sub-Total | 12,992 |
| | | | **2025** | 14 | 1,458 |
| | | | | Sub-Total | 1,458 |
| | | | Proposed-Total | | 54,817 |
| | | | | **Area-Total** | **184,397** |
| | **University** | Replacement of Existing Pipeline | **2021** | 16 | 3,468 |
| | | | | 18 | 5,980 |
| | | | | 24 | 14,326 |
| | | | | 32 | 6,873 |
| | | | | 36 | 201 |
| | | | | 48 | 9,114 |
| | | | Existing-Total | | 39,962 |
| | | Installation of Proposed Pipeline | **2016** | 18 | 3,818 |
| | | | | 24 | 2,580 |
| | | | | 28 | 713 |
| | | | | 32 | 5,186 |
| | | | | 36 | 3,928 |
| | | | | 48 | 2,209 |
| | | | | 56 | 4,773 |
| | | | | 80 | 1,042 |
| | | | | 88 | 8,054 |
| | | | | Sub-Total | 32,302 |
| | | | **2021** | 14 | 8,310 |
| | | | | 24 | 1,258 |
| | | | | 28 | 959 |
| | | | | 36 | 1,749 |
| | | | | Sub-Total | 12,276 |
| | | | **2025** | 14 | 5,315 |
| | | | | 18 | 1,170 |
| | | | | 24 | 565 |
| | | | | Sub-Total | 7,050 |
| | | | Proposed-Total | | 51,628 |
| | | | | **Area-Total** | **91,590** |
| | **HSR** | Replacement of Existing Pipeline | **2021** | 12 | 1,084 |
| | | | | 14 | 5,092 |
| | | | | 18 | 6,469 |
| | | | | 24 | 3,657 |
| | | | | Sub-Total | 16,302 |
| | | Installation of Proposed Pipeline | **2016** | 14 | 1,388 |
| | | | | 16 | 6,643 |
| | | | | 18 | 4,591 |
| | | | | 20 | 63 |
| | | | | 24 | 3,003 |
| | | | | 28 | 3,060 |
| | | | | 32 | 4,161 |
| | | | | 48 | 316 |
| | | | | Sub-Total | 23,225 |
| | | | Proposed-Total | | 23,225 |
| | | | | **Area-Total** | **39,527** |

| Zone | Supply Area | Type | Year | Dia. (in) | Length (m) |
|---|---|---|---|---|---|
| **Central** | **C01** | Installation of Proposed Pipeline | **2016** | 18 | 17,207 |
| | | | | 24 | 8,831 |
| | | | | 28 | 3,267 |
| | | | | 48 | 19,212 |
| | | | | 56 | 3,623 |
| | | | | 64 | 5,766 |
| | | | | Sub-Total | 57,907 |
| | | | **2021** | 14 | 16,490 |
| | | | | 18 | 4,507 |
| | | | | 20 | 1,104 |
| | | | | 24 | 3,140 |
| | | | | 28 | 1,293 |
| | | | | 32 | 8,309 |
| | | | | 44 | 2,728 |
| | | | | Sub-Total | 37,570 |
| | | | **2025** | 14 | 18,854 |
| | | | | 36 | 8,619 |
| | | | | Sub-Total | 27,473 |
| | | | Proposed-Total | | 122,949 |
| | | | | **Area-Total** | **122,949** |
| | | Replacement of Existing Pipeline | | 12 | 10,698 |
| | | | | 14 | 17,237 |
| | | | | 16 | 3,468 |
| | | | | 18 | 70,066 |
| | | | | 20 | 2,579 |
| | | | | 24 | 68,337 |
| | | | | 28 | 4,423 |
| | | | | 32 | 27,047 |
| | | | | 36 | 14,287 |
| | | | | 48 | 20,610 |
| | | | | 56 | 8,473 |
| | | | | 60 | 1,666 |
| | | | | 64 | 8,839 |
| | | | | 72 | 1,278 |
| | | | Exisitng Zone-Total | | 259,008 |
| | | Installation of Proposed Pipeline | | 14 | 102,147 |
| | | | | 16 | 10,399 |
| | | | | 18 | 49,751 |
| | | | | 20 | 1,167 |
| | | | | 24 | 32,490 |
| | | | | 28 | 10,958 |
| | | | | 32 | 26,689 |
| | | | | 36 | 23,439 |
| | | | | 44 | 2,728 |
| | | | | 48 | 39,983 |
| | | | | 56 | 15,279 |
| | | | | 64 | 5,766 |
| | | | | 72 | 7,021 |
| | | | | 80 | 8,858 |
| | | | | 88 | 8,054 |
| | | | | 100 | 19,034 |
| | | | Proposed Zone-Total | | 363,764 |
| | | | **Zone-Total** | | **622,772** |
| **TOTAL** | | Replacement of Existing Pipeline | | 12 | 22,147 |
| | | | | 14 | 85,581 |
| | | | | 16 | 18,383 |
| | | | | 18 | 144,828 |
| | | | | 20 | 2,579 |
| | | | | 24 | 140,154 |
| | | | | 28 | 4,423 |
| | | | | 32 | 88,776 |
| | | | | 36 | 18,547 |
| | | | | 48 | 101,240 |
| | | | | 56 | 28,249 |
| | | | | 60 | 1,666 |
| | | | | 64 | 25,190 |
| | | | | 72 | 3,498 |
| | | | Exisitng Total | | 685,261 |
| | | Installation of Proposed Pipeline | | 14 | 372,616 |
| | | | | 16 | 20,520 |
| | | | | 18 | 86,074 |
| | | | | 20 | 6,288 |
| | | | | 24 | 73,775 |
| | | | | 28 | 27,874 |
| | | | | 32 | 35,684 |
| | | | | 36 | 56,030 |
| | | | | 44 | 2,728 |
| | | | | 48 | 52,292 |
| | | | | 56 | 30,751 |
| | | | | 64 | 17,480 |
| | | | | 72 | 19,686 |
| | | | | 80 | 8,858 |
| | | | | 88 | 90,021 |
| | | | | 100 | 20,798 |
| | | | Proposed Total | | 921,475 |
| | | | | 12 | 22,147 |
| | | | | 14 | 458,198 |
| | | | | 16 | 38,903 |
| | | | | 18 | 230,902 |
| | | | | 20 | 8,867 |
| | | | | 24 | 213,929 |
| | | | | 28 | 32,297 |
| | | | | 32 | 124,460 |
| | | | | 36 | 74,577 |
| | | | | 44 | 2,728 |
| | | | | 48 | 153,532 |
| | | | | 56 | 59,000 |
| | | | | 60 | 1,666 |
| | | | | 64 | 42,670 |
| | | | | 72 | 23,185 |
| | | | | 80 | 8,858 |
| | | | | 88 | 90,021 |
| | | | | 100 | 20,798 |
| | | | **Grand Total** | | **1,606,736** |

### (2) Distribution Network Main and Service Connection

The required length of the new distribution network main that will be installed when the supply area expands or improves was estimated from the length of the existing distribution network main and the existing number of domestic connections, giving a unit length of about 7.3 m per connection. This means 7.3 m of distribution network main is needed to provide one additional service connection. The number of domestic service connections was based on the increase in the population served.

The proposed length of distribution network mains were calculated by multiplying the number of service connections to be installed (which reflects the increase in population served) by the unit pipeline length per connection (which is 7.3 m as mentioned above). **Table 78.1.5** shows the proposed number of service connections and length of distribution network mains.

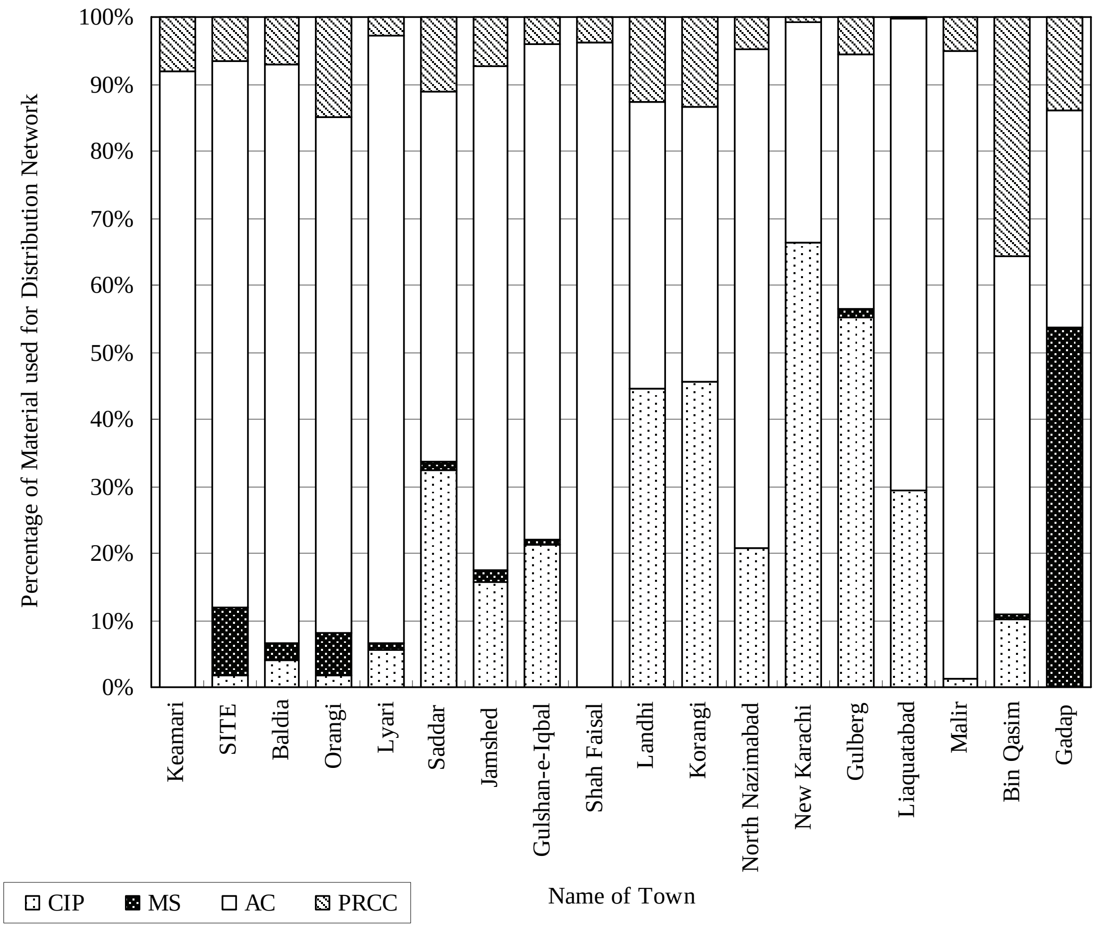
**Table 78.1.5 Proposed Number of Service Connections and Length of Distribution Network Mains (incremental basis)**

| Year | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|---|
| Distribution Network Main (km) | 372.0 | 372.0 | 372.0 | 465.9 | 465.9 | 465.9 | 465.9 |
| Number of Service Connection | 66,525 (15,729) | 66,525 (15,729) | 66,525 (15,729) | 83,322 (19,701) | 83,322 (19,701) | 83,322 (19,701) | 83,322 (19,701) |
| Year | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
| Distribution Network Main (km) | 465.9 | 459.5 | 459.5 | 459.5 | 459.5 | 459.5 | 459.5 |
| Number of Service Connection | 83,322 (19,701) | 82,179 (19,430) | 82,179 (19,430) | 82,179 (19,430) | 82,179 (19,430) | 82,179 (19,430) | 82,179 (19,430) |
| Year | 2022 | 2023 | 2024 | 2025 | Total | | |
| Distribution Network Main (km) | 459.5 | 459.5 | 459.5 | 459.5 | 8,040.6 | | |
| Number of Service Connection | 82,179 (19,430) | 82,179 (19,430) | 82,179 (19,430) | 82,179 (19,430) | 1,437,976 (339,993) | | |

Note: Figures in parenthesis are number of non-domestic service connections.

### 7.8.2 Rehabilitation of Existing Distribution Network and Service Connection

For rehabilitation of the existing distribution system, the life span of the distribution network mains is estimated at about 50 years. Considering the present water supply service and materials used for distribution network mains as shown in **Figure 78.2.1**, however, it should be necessary to improve the entire present distribution network system. Material mainly used for the existing distribution system is AC pipe (about 65%). It is, therefore, proposed that the existing distribution network mains need to be improved / replaced by a distribution network improvement (DNI) town by town. On the other hand, service connections especially water meters need to be rehabilitated / replaced after at least 10 years because of those life times. It should be noted that even if new service connection is installed, water meter is not installed at area where DNI has not been implemented.




Source: Details of Length Size & Material of Existing Water Distribution Lines, Water Distribution Wing, KW&SB

**Figure 78.2.1 Proportions of Materials for Distribution Network Mains**

Concept of rehabilitation and replacement of the existing distribution network main and service connection are as follows.

- The existing distribution network mains will be intensively replaced by Distribution Network Improvement (DNI).
- At the same time water meters will be installed to all the existing service connections and service pipes branched from distribution network mains to customers will be also rehabilitated or replaced if necessary.
- Before the implementation of DNI water meters will not be installed not only to the existing connection but also to new connections.
- After the implementation of DNI water meters will be installed at the same time providing new service connections.
- For new residential areas to be developed especially at Keamari, Bin Qasim and Gadap Towns, water meters will be installed at the same time providing new service connections.

And the distribution network improvement (DNI) will may include;

- replacement and rehabilitation of the existing distribution network mains,
- installation of additional distribution network mains if necessary,

- replacement and rehabilitation of service pipes branched from distribution network main to customers,
- installation of water meters,
- replacement and rehabilitation of the existing trunk distribution mains (at present used as water trunk mains) for distribution network if necessary,
- construction of distribution reservoirs if necessary,
- installation of district/sub-district meters, and
- leakage control including leakage survey.

**Table 78.2.1** and **Figure 78.2.2** show an implementation schedule of DNI. DNI of towns in zone west is prioritised and proposed to be implemented at stage I from 2012 to 2016 just after the completion of construction of proposed Central F/P (130 mgd). Prioritization of DNI is based on present water supply condition, service ratio, income level of customers and magnitude of the existing distribution network mains.

**Table 78.2.1 Implementation Schedule of DNI**

| No. | Town | Implementation Schedule of DNI | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 |
| Stage | | Stage I, Phase 2 | | Stage I, Phase 3 | | | Stage II, Phase 2 | | | Stage II, Phase 3 | | Stage III, Phase 2 | | | |
| 1 | Keamari | | | | | | | | | | | | | | |
| | Zone West | | | | | | | | | | | | | | |
| | Zone Central | | | | | | | | | | | | | | |
| 2 | SITE | | | | | | | | | | | | | | |
| 3 | Baldia | | | | | | | | | | | | | | |
| 4 | Orangi | | | | | | | | | | | | | | |
| 5 | Lyari | | | | | | | | | | | | | | |
| 6 | Saddar | | | | | | | | | | | | | | |
| 7 | Jamshed | | | | | | | | | | | | | | |
| 8 | Gulshan-e-Iqbal | | | | | | | | | | | | | | |
| 9 | Shah Faisal | | | | | | | | | | | | | | |
| 10 | Landhi | | | | | | | | | | | | | | |
| 11 | Korangi | | | | | | | | | | | | | | |
| 12 | North Nazimabad | | | | | | | | | | | | | | |
| 13 | New Karachi | | | | | | | | | | | | | | |
| 14 | Gulberg | | | | | | | | | | | | | | |
| 15 | Liaquatabad | | | | | | | | | | | | | | |
| 16 | Malir | | | | | | | | | | | | | | |
| 17 | Bin Qasim | | | | | | | | | | | | | | |
| 18 | Gadap | | | | | | | | | | | | | | |
| | Zone West | | | | | | | | | | | | | | |
| | Zone Central | | | | | | | | | | | | | | |
| | Zone East | | | | | | | | | | | | | | |

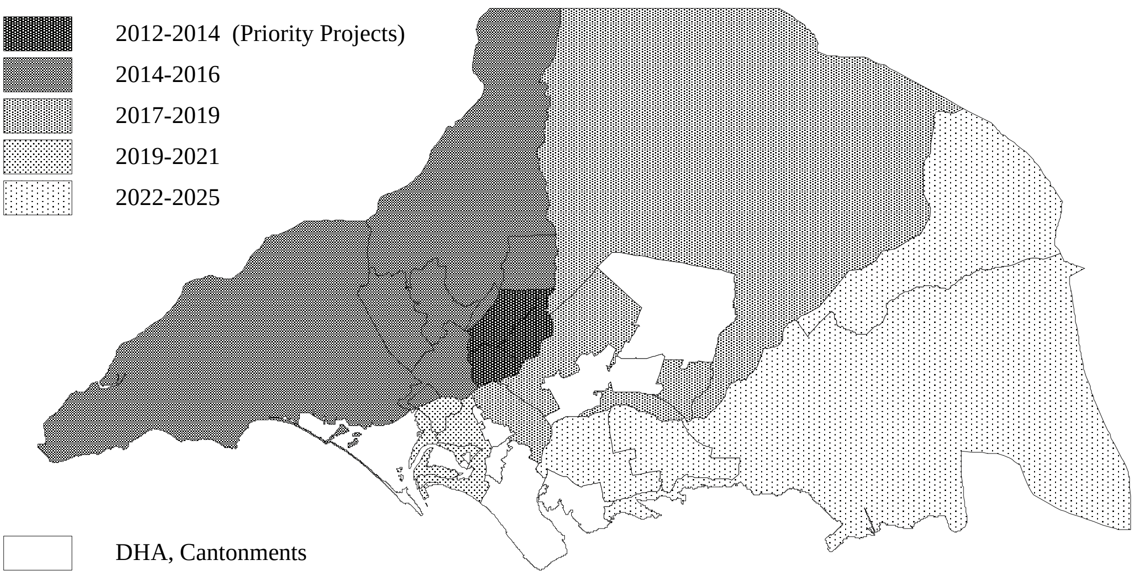



**Figure 78.2.2 Implementation Schedule of DNI**

**Table 78.2.2** shows the number of service connections and length of distribution network mains which will be rehabilitated or replaced during DNI including installation of water meters to the existing service connections. Number of service connection includes the following two kinds of connections;

- existing connections as of 2005
- new connections from 2006 to the commencement of DNI, since before the DNI water meters will not be installed even to new connections

**Table 78.2.2 Rehabilitation/Replacement of Service Connections and Distribution Network Mains by DNI (incremental basis)**

| Year | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|---|
| Distribution Net-work Main (km) | - | - | - | - | 273.9 | 547.9 | 570.5 |
| Number of Service Connection | - | - | - | - | 54,266 (13,060) | 108,532 (26,119) | 121,479 (26,705) |
| Year | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
| Distribution Net-work Main (km) | 593.1 | 593.1 | 438.6 | 877.2 | 701.6 | 526.0 | 526.0 |
| Number of Service Connection | 134,426 (27,291) | 134,426 (27,291) | 115,170 (23,393) | 230,340 (46,786) | 179,773 (45,757) | 129,206 (44,727) | 129,206 (44,727) |
| Year | 2022 | 2023 | 2024 | 2025 | Total | | |
| Distribution Net-work Main (km) | 97.3 | 194.7 | 194.7 | 194.7 | 6,329.0 | | |
| Number of Service Connection | 40,439 (8,164) | 80,878 (16,329) | 80,878 (16,329) | 80,878 (16,329) | 1,619,897 (383,006) | | |

Note: Figures in parenthesis are number of non-domestic service connections.

**Table 78.2.3** shows the number of service connections which will be replaced after 10 years and length of distribution network mains which will be rehabilitated as the routine works including repairs of leakage.

**Table 78.2.3 Rehabilitation/Replacement of Service Connections and Distribution Network Mains by other than DNI (incremental basis)**

| Year | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|---|
| Distribution Net-work Main (km) | 69.9 | 77.4 | 84.8 | 92.2 | 87.1 | 96.4 | 91.9 |
| Number of Water meter | - | - | - | - | - | - | - |
| Year | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
| Distribution Net-work Main (km) | 123.2 | 132.5 | 156.9 | 166.1 | 170.4 | 214.7 | 223.9 |
| Number of Water meter | - | 26,612 (6,292) | 26,612 (6,292) | 26,612 (6,292) | 26,612 (6,292) | 26,612 (6,292) | 37,734 (8,922) |
| Year | 2022 | 2023 | 2024 | 2025 | Total | | |
| Distribution Net-work Main (km) | 251.9 | 261.1 | 270.3 | 279.5 | 2,850.1 | | |
| Number of Water meter | 95,637 (22,841) | 149,903 (35,901) | 174,411 (39,220) | 187,358 (39,806) | 778,103 (178,150) | | |

Note: Figures in parenthesis are number of non-domestic service connections.

## 7.9 SUMMARY OF PLANNING

**Tables 79.1.1** and **79.1.2** present a summary of improvement works included in the master plan for the Karachi Water Supply System which are briefly itemised below. **Table 79.1.1** shows the components for bulk water supply system by stages and **Table 79.1.2** shows the components of retail water supply system by zones.

**Stage I** (2009-2016):
1. Development of Bulk Water Supply System (additional capacity of 130 mgd) including;
    a. Construction of Bulk Water Canal/Conduit (260 mgd),
    b. Construction of 2 Bulk Pumping Stations,
    c. Construction of 3 Filtration Plants of K-III (100 mgd), COD (85 mgd) and K-IV Central (130 mgd),
    d. Construction of 3 Transmission Pumping Stations,
    e. Expansion of Pump Capacity of 2 Transmission Pumping Stations,
    f. Installation of Transmission Mains of 32 km,
    g. Construction of 2 Distribution Reservoirs and
    h. Expansion of 7 Distribution Reservoirs.
2. Improvement of Existing Distribution Network System of Zone West (DNI)
    a. North Nazimabad, Gulberg, Liaquatabad (2012-2014)
    b. Keamari, SITE, Baldia, Orangi, New Karachi, Gadap (2014-2016)
3. Development of New Distribution Network System for New Residential Areas
4. Rehabilitation and Replacement of the Existing Water Supply System

**Stage II** (2014-2021):
1. Development of Bulk Water Supply System (additional capacity of 260 mgd) including;
    a. Construction of Bulk Water Canal/Conduit (260 mgd),
    b. Construction of 2 Bulk Pumping Stations,
    c. Construction of 2 Filtration Plants of K-IV West and K-IV East (130 mgd each),
    d. Construction of 2 Transmission Pumping Stations,
    e. Expansion of Pump Capacity of 4 Transmission Pumping Stations,
    f. Installation of Transmission Mains of 53 km,
    g. Construction of 4 Distribution Reservoirs and
    h. Expansion of 2 Distribution Reservoirs.
2. Improvement of Existing Distribution Network System of Zone Central (DNI)
    a. Jamshed, Gulshan-e-Iqbal, Shah Faisal, Malir, Gadap (2017-2019)
    b. Keamari, Lyari, Saddar (2019-2021)
3. Development of New Distribution Network System for New Residential Areas
4. Rehabilitation and Replacement of the Existing Water Supply System

**Stage III** (2019-2025):
1. Development of Bulk Water Supply System (additional capacity of 260 mgd) including;
    a. Construction of Bulk Water Canal/Conduit (260 mgd),
    b. Construction of 2 Bulk Pumping Stations,
    c. Construction of 2 Filtration Plants of K-IV West and K-IV East (130 mgd each),
    d. Construction of 2 Transmission Pumping Stations,
    e. Expansion of Pump Capacity of 6 Transmission Pumping Stations,
    f. Installation of Transmission Mains of 44 km,
    g. Construction of 2 Distribution Reservoirs,
    h. Expansion of 6 Distribution Reservoirs and
    i. Construction of 3 Distribution Pumping Stations.
2. Improvement of Existing Distribution Network System of Zone East (DNI)
    Landhi, Korangi, Bin Qasim, Gadap (2022-2025)

3. Development of New Distribution Network System for New Residential Areas
4. Rehabilitation and Replacement of the Existing Water Supply System

**Table 79.1.1 Components of Bulk Water Supply System**

| Facility | | Proposed | | | | Rehabilitation / Replacement of Existing Facilities |
|---|---|---|---|---|---|---|
| | Stage | Stage I | Stage II | Stage III | Total | |
| | Target Year | 2016 | 2021 | 2025 | | |
| | Construction | 2009-2011 | 2014-2016 | 2019-2021 | | |
| Bulk Water Canal/Conduit | | 260 mgd | 260 mgd | 260 mgd | 780 mgd | 620 mgd |
| | | K-IV | K-IV | K-IV | K-IV | GK, K-II, K-III, Hub |
| Bulk Pumping Station | | 2 P/Ss: 3.9MW, 7.1 MW | 2 P/Ss: 7.8MW, 14.2 MW | 2 P/Ss: 7.8MW, 14.2 MW | 6 P/Ss | 15 P/Ss |
| | | K-IV | K-IV | K-IV | K-IV | Dhabeiji×6, Gharo×2, Pipri×3, NEK New×3, Hub×1, |
| Filtration Plant | | 3 F/Ps: 315 mgd | 2 F/Ps: 260 mgd | 2 F/Ps: 260 mgd | 5 F/Ps: 835 mgd | 6 F/Ps: 435 mgd |
| | | K-III: 100<br>COD: 85<br>K-IV(C): 130 | K-IV(W): 130<br>K-IV(E): 130 | K-IV(W): 130<br>K-IV(E): 130 | K-III: 100<br>COD: 85<br>K-IV(W): 260<br>K-IV(C): 130<br>K-IV(E): 260 | Gharo: 20<br>Pipri: 100<br>COD: 115<br>NEK Old: 25<br>NEK New: 100<br>Hub: 75 |
| Transmission Pumping Station | | 3 P/Ss (2 P/Ss) | 2 nos. (4 P/Ss) | 2 nos. (6 P/Ss) | 7 P/Ss | 2 P/Ss |
| | | Central, COD, NEK New (Manghopir, High Lift) | West, East01 (Central, COD, Manghopir, High Lift) | East02, E02 (West, Central, East01, COD, Manghopir, High Lift) | West, Central, East01, East02, COD, NEK New, E02 | Manghopir, High Lift |
| Transmission Main | | 32 km | 53 km | 44 km | 129 km | 17 km |
| Distribution Reservoir | | 2 nos. (7 nos.) | 4 nos. (2 nos.) | 2 nos. (6 nos.) | 8 nos. | 6 nos. (8 nos.) |
| | | Central, C01 (Hub, COD, NEK Old, NEK New, Univ., Gharo, Pipri) | West, W01, East, E01 (C01, Pipri) | E02,E03 (Orangi, West, W01, C01, Pipri, East) | Central, C01, West, W01, East, E01, E02, E03 | Gharo, Pipri, COD, Univ., High S., Orangi (Gharo, Pipri, COD, NEK Old, NEK New, Hub, Univ., Orangi) |
| Distribution Pumping Station | | - | - | 3 P/Ss | 3 P/Ss | - |

Note: Numbers in parenthesis are expansion of capacity.

**Table 79.1.2 Components of Retail Water Supply System**

| Facility | Proposed | | | | Rehabilitation/ Replacement | | | |
|---|---|---|---|---|---|---|---|---|
| Zone | West | Central | East | Total | West | Central | East | Total |
| Trunk Distribution Main (km) | 406 | 364 | 152 | 922 | 273 | 259 | 153 | 685 |
| Distribution Network Main (km) | 2,539 | 3,152 | 2,349 | 8,041 | 3,751 | 4,208 | 1,220 | 9,179 |
| by DNI | - | - | - | - | 2,578 | 3,069 | 681 | 6,329 |
| by other than DNI | - | - | - | - | 1,173 | 1,139 | 539 | 2,850 |
| Service Connection (×1,000) | 454 | 564 | 420 | 1,438 | 1,119 | 900 | 378 | 2,398 |
| by DNI | - | - | - | | 553 | 784 | 283 | 1,620 |
| by other than DNI | - | - | - | | 566 | 116 | 95 | 778 |