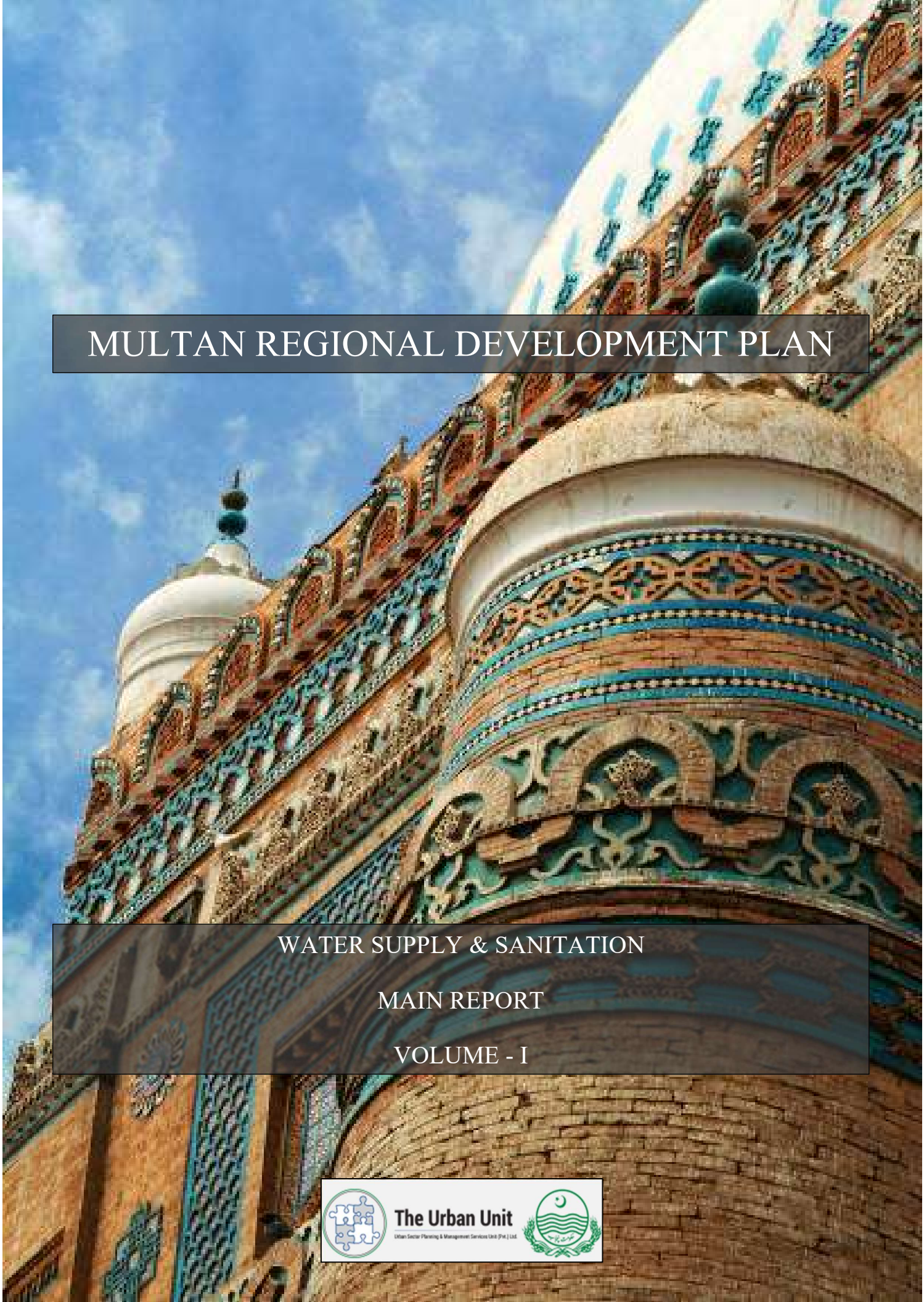

MULTAN REGIONAL DEVELOPMENT PLAN

WATER SUPPLY & SANITATION

MAIN REPORT

VOLUME - I

The Urban Unit

Urban Sector Planning & Management Services Unit (Pvt.) Ltd.

DISCLAIMER

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Executive Summary

With an enormous population of 12.2 million people and coverage area of 17,935 km^2, Multan Division stands first in row of divisions of South Punjab with respect to its population size and population density (684/km^2).

People residing in the division face some of the core issues related to Water Supply and Sanitation. To rate the services of Water, Sanitation and Hygiene (WASH), UNICEF rated all the areas on district level. Together, the overall sum of scores of accesses to WASH is defined as WASH Index. The WASH Index (Urban) for the cities of Multan, Vehari, Khanewal, & Lodhran is of 30, 24, 13, and, 36, respectively. To make a comparison with best and worst performing cities of Punjab, Narowal stands first in the row (best performing city) and Lodhran is last (36) in the row indicating worst performing city in Punjab. In the case of service delivery of Rural areas – Water Supply, Khanewal is relatively better performing district with rank of 7 whereas Vehari, Multan, and Lodhran stands 9, 10 and 30 in the row of 36, respectively. For Rural – Sanitation, WASH Sanitation Index for Khanewal, Vehari, Lodhran, and Multan is 19, 23, 29, and 35, out of 36, respectively.

In a public perception survey conducted for the division by the Urban Unit for Water Supply and Sanitation in Multan Division, it was unveiled that according to 102/140 (72%) respondents, tap water supplied by the relevant authorities is undrinkable and only 21 (15%) respondents reported drinkable tap water, where other being unclear about water quality. Survey also indicated that most of sewage is disposed-off directly into adjacent areas thus polluting ground water table and not properly disposed for waste water treatment, as reported by 77/140 (55%) respondents, whereas in other cases it was carried to far-off places via sewers and/or drains with final destination for treatment as unclear.

Multan City:

Multan is an ancient city, known for its Sufi heritage. It is located in the southern part of the Punjab province on the east bank of the Chenab River. The primary source of water supply in Multan is ground water extracted with the help of tube wells installed in different areas of the city. The supply of water in the city is based on direct pumping through distribution network of 1448 Km. It was assessed during the survey that nearly 63% of pipelines have expired their designed life which has resulted in water contamination, low pressure, and leakages. To curb the electricity expenses, the existing supply of water is merely 2 hours in a day. Similarly, in the context of sewerage services, frequent chocking, waste water flooding and challenges in disposal of waste water are observed due to outlived sewer network and allied machinery.

Khanewal City: Khanewal city is the 36th largest city of Pakistan in terms of population. The water supply system of the city is based on ten groundwater-based schemes being operated and managed by the Municipal Corporation (MC) Khanewal. Groundwater is extracted from tube wells and supplied to the city through water supply schemes. Two Overhead Reservoirs also exist that store and supply the water to the adjacent areas. These schemes provide water supply to 50% (spatially) of the city's population. The water pipeline network is mostly outlived and in deteriorated condition however the water is of drinkable characteristics. The sewerage system of Khanewal City constitutes of sewers and nine disposal stations for the disposal of wastewater to either canals or a Sewerage Treatment Plant. Spatially the coverage of sewers is around 60%.

Vehari City: Vehari is a city in the Multan Division, approximately 96 KM from the regional headquarters of Multan City and lies 37 KM on the northern side of River Sutlej. The MC owned water supply of the city consists of water works fed by tube wells, with an estimated 6,000 consumer connections. The water is available at the user end for mere 1 hour per day creating considerable service delivery gaps. The spatial coverage of water supply is about 60% of the city. In comparison the sewerage system of the city covers about 70% of the city. The sewers and disposals have exceeded their design life and issues like silting and choking remain a regular sight. There is currently no treatment facility in the city with waste water mostly used for broad irrigation.

Lodhran City: Lodhran city lies on the northern side of River Sutlej (around 20 kms away). City lacks proper water supply which is due to non-existent network spread as only 300 houses and 10 filtration plants are being served currently under MC owned schemes (comprising of three Tube wells and two OHRs). Almost all of the existing water supply pipeline (8.74 km) is in deteriorating condition (poor). The sewerage arrangement of city is relatively better as around 80% of current populated areas of the city are served with sewers (Fair condition) however there still remains various unserved pockets. Major issue relating to Sanitation is non-existent sewerage treatment arrangement as currently all six of its Disposal Station disposes their sewage in agriculture field or open fields.

Rural Areas: Provision of safely managed drinking water and sanitation services to divisional rural population (8.8 Million) is responsibility of the Government in achieving the Sustainable Development Goals (SDGs) target by 2030. PHED, CBOs and Rural Municipal Services Company are main responsible bodies striving to provide Water and Sanitation services to the inhabitants of rural areas of division. Data and statistics reflected that despite of all efforts and investments, water supply coverage is present only in 658/2389 villages (28%) and sewerage system exist in form of open drains in some of villages with disposal of wastewater in to Agriculture Land, Saim Nullah and Irrigation Drains. Presence of 14-28% brackish contamination of water, bearing lowest WASH index (30th and 35th ranking among 36 districts of Punjab), Avg 26% Non-Functional infrastructure and 72% unserved water supply villages and complete absence of wastewater treatment reflect the need of attention towards investment in rural WSS to uplift the quality of locals residing in villages.

About Proposed Plan: To uplift the current concerning situation relating to Water Supply & Sanitation in aforementioned cities (Multan, Khanewal, Vehari, and Lodhran), it requires around 37 Billion with respective cost of 21.1, 7.2, 4.3, and 4.2 Billion, for the planning period of 10 years (till Year 2033) which includes rehabilitating and extension of WSS services. For Rural areas, WSS plan requires the investment of approximately 20 Billion in next 10 years for rehabilitation & upgradation of huge quantity of already installed Non-Functional or devastated WSS assets; Need based new installation of water filtration plants in brackish zone; Solarization of water supply schemes and filtration plants; Provision of back up machinery for water supply operations; provision of public toilets; and open drains based sewerage system in 260 villages and last but not the least establishment of a prototype model village in each district. Total divisional level intervention for WSS would require around 57.4 Billion.

1 Scope of the Study and Methodology

Detail of Area of concern, Scope of Study, Planning Years, Field Visits, and relevant Methodology adopted is as follow:

1.1 Area of Concern

Areas covered under the Multan Regional Development were stretched to the whole division which includes all four urban headquarters which are, Multan, Vehari, Khanewal, and Lodhran, of its four districts and the all the rural areas.

1.2 Scope of the Study

Scope of this study was as under:

- Rehabilitation of WSS Infrastructure
- Replacement of Poorly Served WSS Piped Network
- Rural WSS Planning
- Extension to the Unserved Areas for WSS Services
- Machinery Proposal
- Establishment of Store for quick fix
- Drawing and Design of Wet Utilities
- Design Period of 10 Years (2033) with further prioritization of 2, 5, & 10 Years (Short, Medium, and long term)

1.3 Planning Year

Planning year opted for this plan are 2, 5, and 10 counted from the present year i.e., 2023. Detail of this as below:

Table 1 Planning Years

Term	Years	Planning Year
Short	2	2025
Medium	5	2028
Long	10	2033

1.4 Methodology

Adopted methodology for the development of Regional Development Plan was as follow:

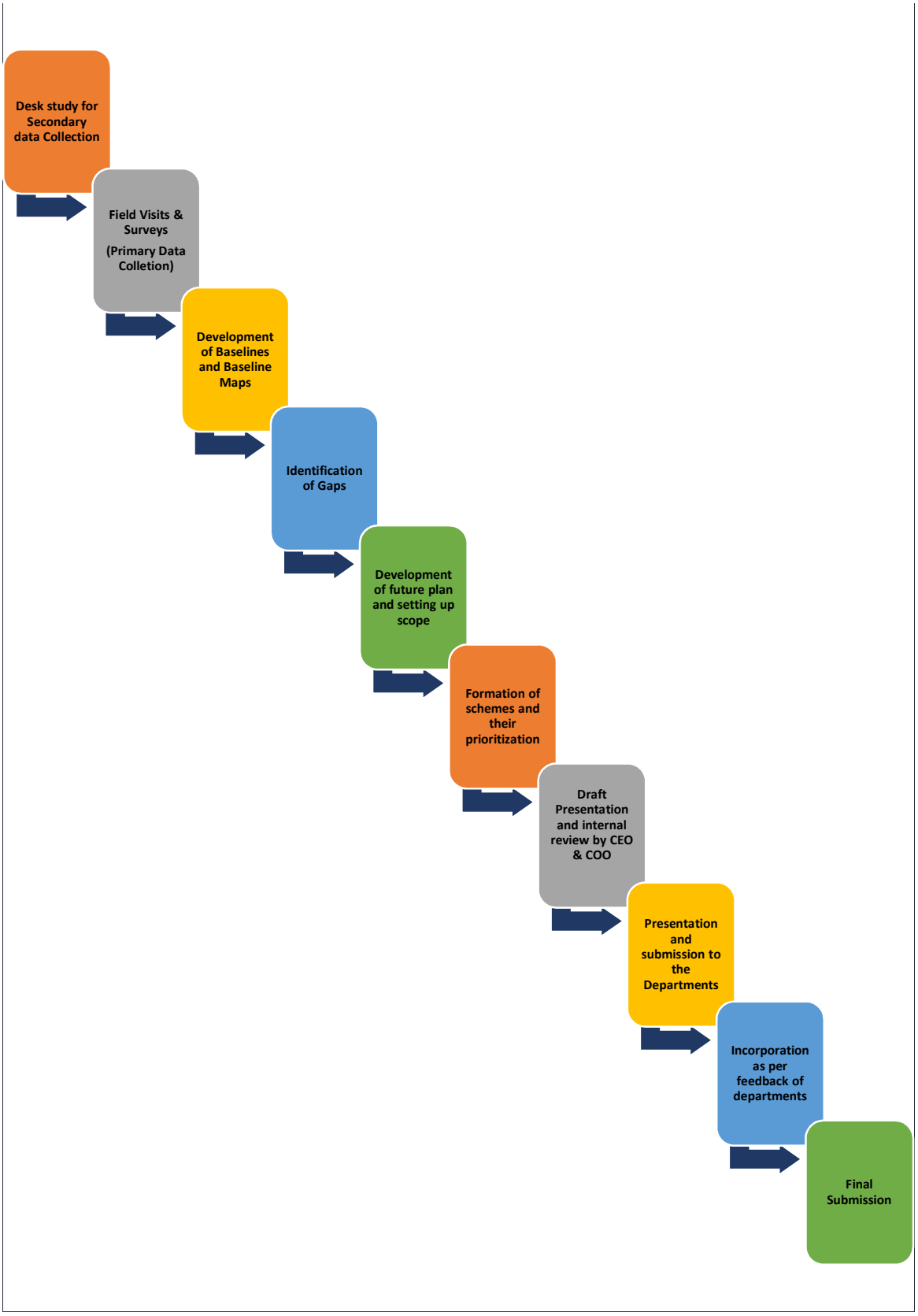


Figure 1 Steps Involved

1.5 Field Visits:

A total of two field visits were conducted, this includes inception visit, and then the detail field assessment, which included, Condition Asset mapping of WSS Infrastructure, GIS tagging of WSS service lines with attributes, Rapid Water Quality Testing, rehabilitation required assessment, and meeting with stakeholder for their take on the related issues, etc.

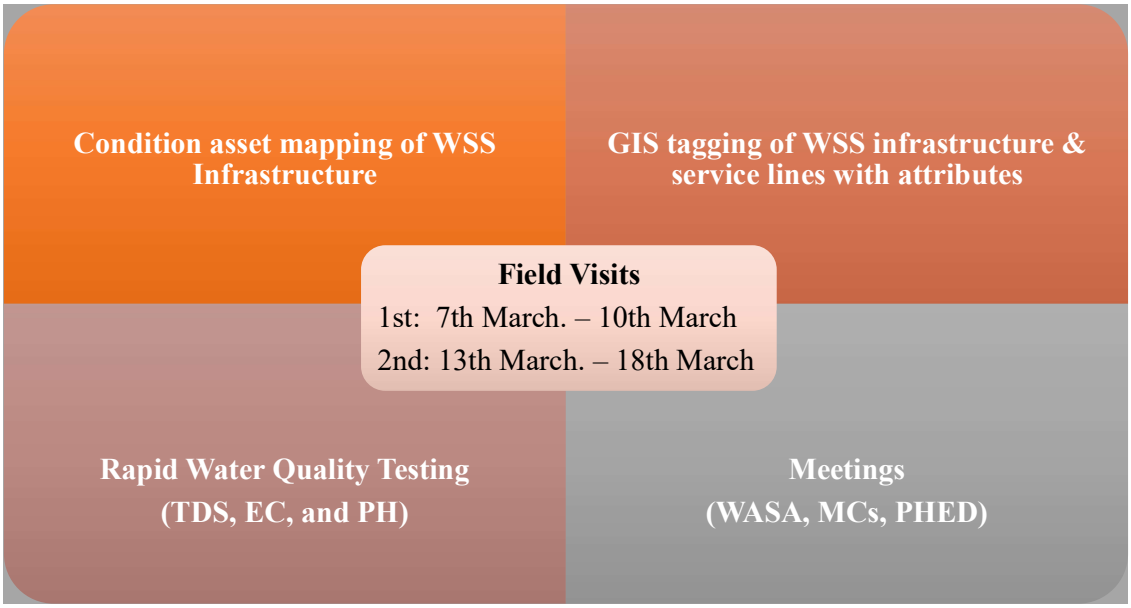


Figure 2 Detail of Field Visits

1.6 Framework for Asset Mapping

Following framework was adopted for the purpose of asset mapping of the existing WSS infrastructures (Civil, Electrical, & Mechanical). All of the existing WSS utilities were rated using below framework which is internationally accepted generalized framework for condition assessment.

Table 2 Asset Condition Assessment Framework

Rating	Asset Condition	Description
A	Excellent	No noticeable defects. Some aging or wear may be visible
B	Good	Only minor deterioration or defects are evident
C	Fair	Some deterioration or defects are evident, but function is not significantly affected
D	Poor	Serious deterioration in at least some portion of the structure. Function is inadequate
F	Failing	No longer functional. General failure or complete failure of a major structural component

2 Existing Situation

UNICEF rated all the areas in Pakistan, district-wise, to rate the services of (Water, Sanitation and Hygiene (WASH). Together, the overall sum of scores of access to WASH is defined as WASH Index. Three main components of this WASH Index Rating are as below:

1. Water Indicators
    - Improved Source Piped, Hand Pump/ Motorized
    - Located in Premises
    - Water Available 24 Hours
    - Free from Contamination
    - Safely Managed Water
2. Sanitation Indicators
    - Improved Sanitation
    - Safe disposal in Situ (On site excreta treatment)
    - Safely Managed Sanitation
3. Hygiene Indicators
    - The dedicated place for Hand-Washing with water and soap

2.1 Urban WASH Index

The WASH Index (Urban) for the cities of Multan, Vehari, Khanewal, & Lodhran is of 30, 24, 13, and, 36, respectively. To make a comparison, best and worst performing cities of Punjab with WASH Index are also shown in graph below. Narowal stands first in the row (best performing city) and Lodhran is last in the row (worst performing city).

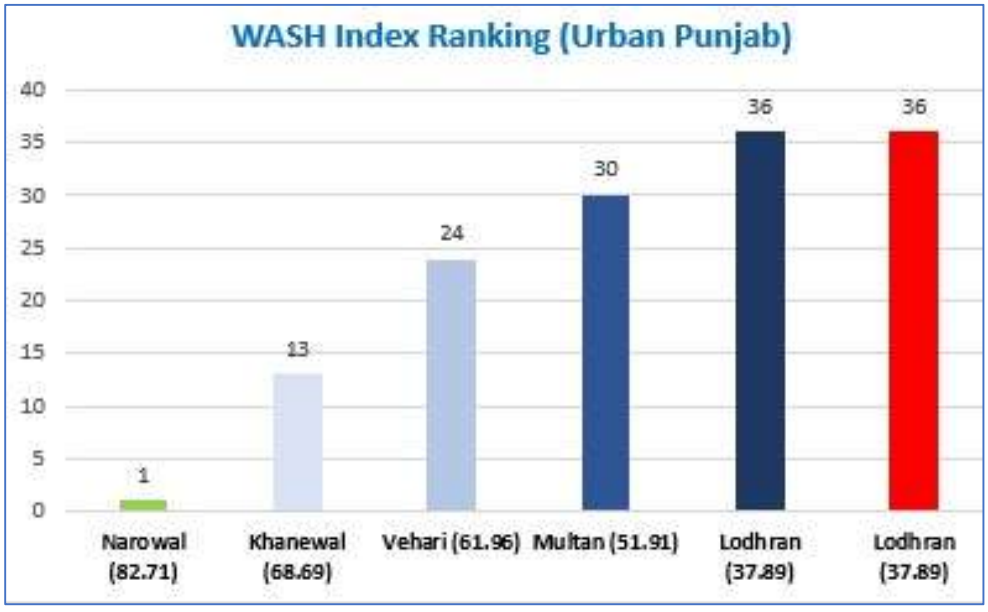


Figure 3 WASH Index Ranking (Urban)

2.2 Rural WASH Index

In the case of service delivery of Water Supply of Rural areas, Khanewal is relatively better performing district with rank of 7 whereas Vehari, Multan, and Lodhran stands 9, 10 and 30 in the row, respectively.

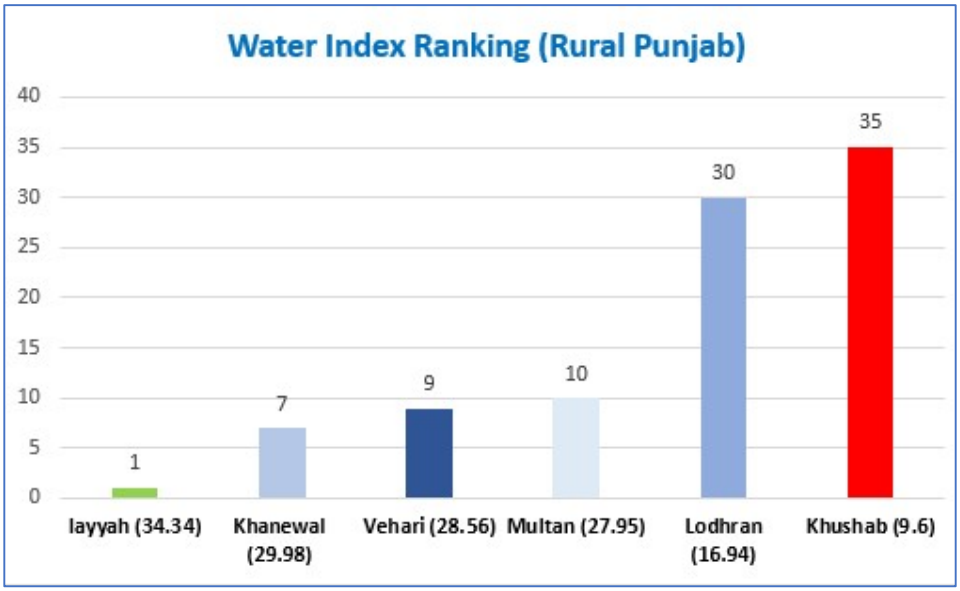


Figure 4 Water Index Ranking (Rural)

For Rural – Sanitation, WASH Sanitation Index for Khanewal, Vehari, Lodhran, and Multan is 19, 23, 29, and 35, respectively.

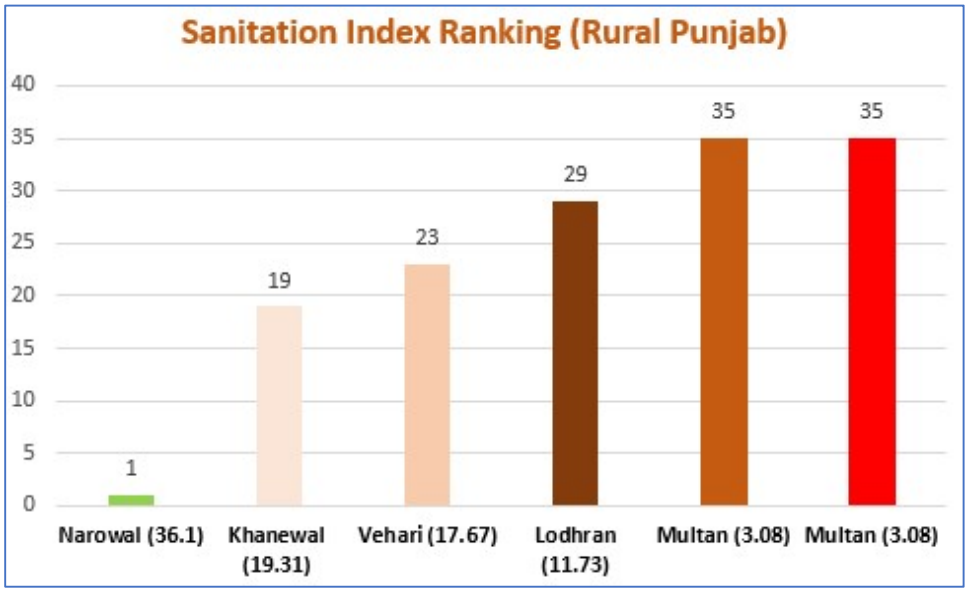


Figure 5 Sanitation Index Ranking

2.3 Public Perception – WSS

In regional planning for water supply and sanitation services, perceptions of the community are very important. For effective and long-term water management strategies to be developed, it is essential to comprehend the community's perspectives and requirements in their respective areas. In April 2023, the planning team went to Multan's four districts—Multan, Khanewal, Lodhran, and Vehari for obtaining opinions from the general public regarding Multan Division's water supply services and green spaces. The team went to each of the four districts' tehsils to assess the present issues and challenges which were already faced by communities and to see how the plan would hold up over time. The public effectively participated in the survey and shared their concerns, potential solutions, and requirements regarding water supply and sanitation services. The data from the perception survey was analyzed and the results were considered in the prioritization of need-based development projects. The sample size was assigned on the basis of the population of districts of Multan, as 23% were females and 77% were male participants in the perception survey.

The empirical analysis of the survey helped to conclude the perception and expectations regarding urban green spaces in Multan. The details of the survey are given below:

2.3.1 Existing Water Supply and Quality

Almost 67% of respondents reported that they used to drink water more than once a day and filtration plants and public tap water were the major drinking water sources of more than 50% of participants.

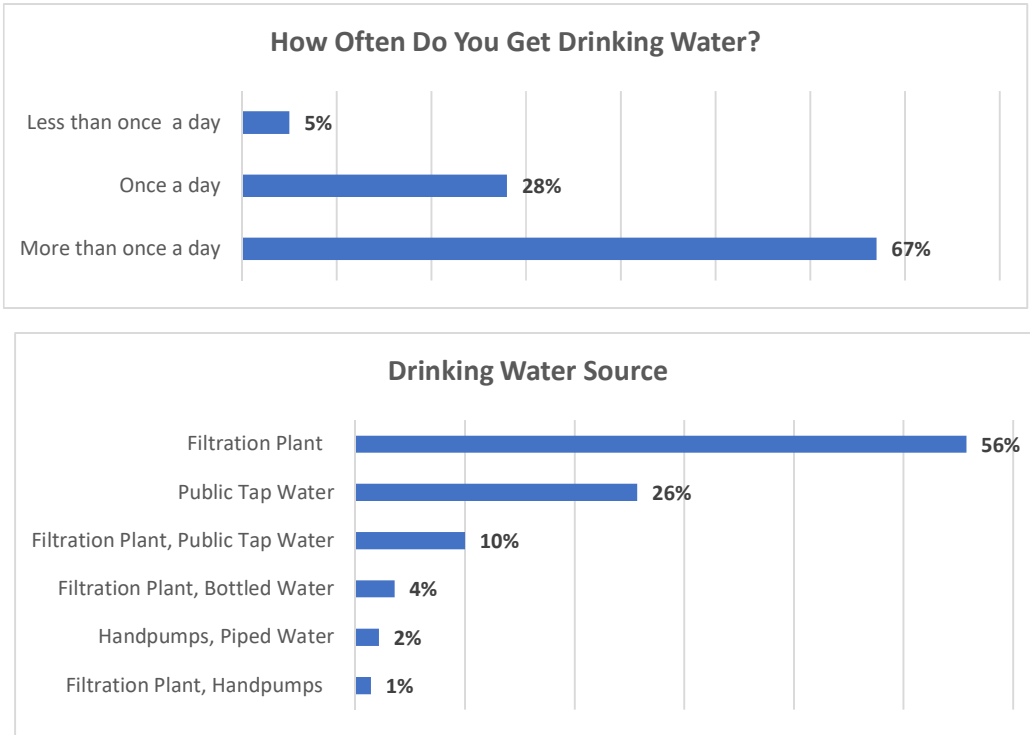


Figure 6 Drinking Water Resource

According to 45%, they faced poor water quality instances during past years. 59% of these (45%) respondents bought mineral water bottles from nearby shops and 36% of them used the nearby filter plants for drinking purposes.

According to 72% of respondents, their tap water is undrinkable and only 15% of respondents reported the taste of their tap water is drinkable.

Therefore, 44% reported a history of sickness as saline water can have adverse health effects on individuals. It has been assessed through this survey that 54% of respondents are satisfied with the water supply services in their areas.

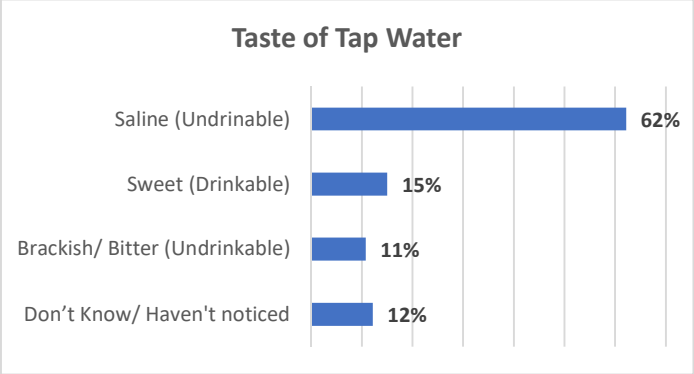


Figure 7 Taste of Tap Water

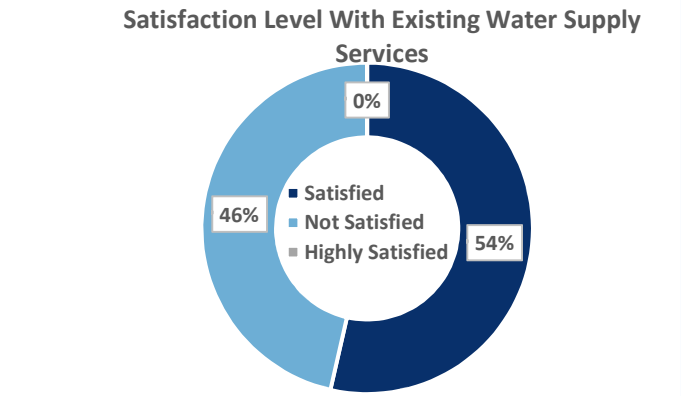


Figure 8 Satisfaction Level of Existing Water Services

2.3.2 Existing Sewerage and Sanitation Services

More than 55% of respondents have that disposal in the adjacent areas is available as respondents reported the type of sewerage system 70% of respondents have reported the sewerage ponding due to poor sewerage system of their area which stays on the roads for more the 3 to 4 days. Most of the areas have very poor drainage systems and due to lack of maintenance public faced the urban flooding. 76% also reported the rainfall ponding in their areas which is a major cause of urban flooding along the roads and especially in low-lying areas of Multan division.

According to 51% of respondents, the ultimate disposal of sewerage is in the canals and according to 19%, it is in open drains.

More than 93% of the participants have reported that their participation is much important to improve water supply and sanitation services in their areas.

Another crucial component of the survey to the determination of a hypothetical value to find the respondents' willingness to pay for existing water supply and sanitation services.

After inquiring and analyzing the survey results more than 70% of respondents are willing to pay Rs. 200-300/- for improving the water supply and sanitation infrastructure in the area and 24 % of low-income groups are willing to pay Rs. 100/-. The survey highlighted that those who are willing to pay can contribute a small share of their income for the enhancement or provision of WSS infrastructure and services.

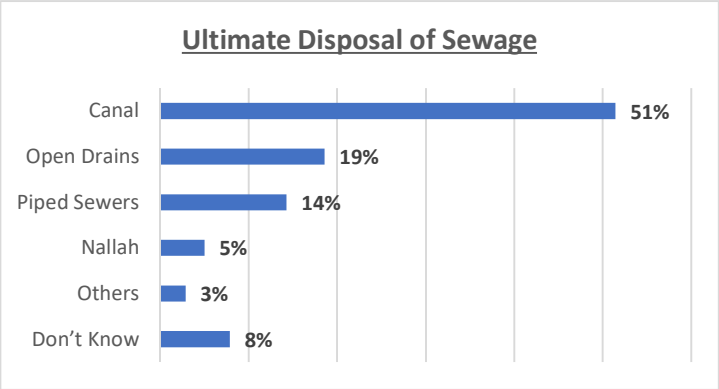


Figure 9 Ultimate Disposal of Sewage

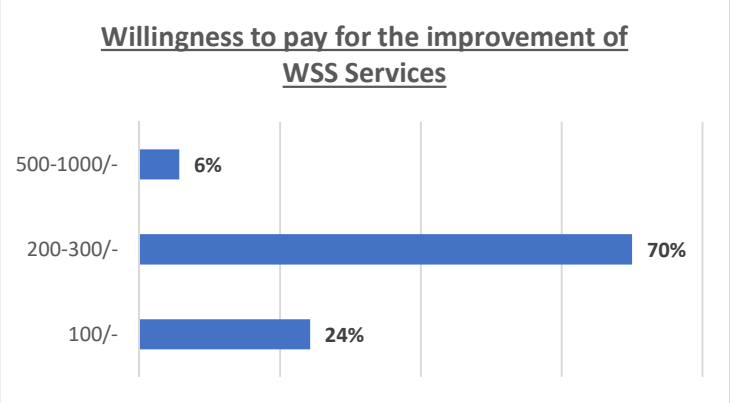


Figure 10 Willingness to pay

Figure 11 Public Survey

3 Design Parameters and Considerations

The design criteria of Public Health & Engineering Department (PHED) have been broadly opted for this exercise however, any different factors, wherever used, are rationalized, and referred to, in relevant sections.

3.1 Population Projection

Population projection is based on assumption that the past trends (growth rate of census) will continue to operate in the future. The reliability and usefulness of projections depend on the assumptions and their closeness to reality. In general, population projections are treated as predictions and should never be termed as final and fully accurate population. Following equation of Arithmetic Increase Method has been used in order to project population.

$Pn = P0 (1 + R) n$

Where:

Pn = Population in the required year
P0 = Population in the base year (known year)
R = Annual rate of growth in percentage
N = No. of years counted from base year (Census 2017 Population)

3.2 Water Supply

For Water Supply following parameters are considered for planning or cost estimation purposes. It must be mentioned here that these parameters or any improved substitute values should be made sure of in the detail design phase of proposed schemes prior to their execution.

3.3 Water Demand

For Water Demand Calculation, 30 Gallons Per Capita Per Day may be considered as an appropriate figure to fulfil the demand[1] however for divisional headquarter i.e. Multan City, 35 gallons per capita per day (GPCD) is taken for calculations. These figures are inclusive of unaccounted for water and are aligned with the United Nations Human Right guidelines (Rapporteur) which recommends minimum of 11 to 22 GPCD of water supply to ensure full realization of right of water.

3.4 Variations in Water Demand

The Following standers to be followed for computation of variations in Water Demand:

A. Maximum day demand is to be taken as 1.5 times the average day demand
B. Peak hour demand to be taken as 1.5 times the maximum day demand

3.5 Operational Hours

Working or operational hours for water supplying source is proposed to be 16 Hours however in case of high or low demand, working hours can be adjusted accordingly.

[1] Design Standards for Water Supply Schemes in Pakistan by Iqbal Ahmad Beg

3.6 Velocity Flow in Pipes

The following standards shall be adopted for the maintaining velocity of water in pipes in the detail design phase, prior to installation of any water supply scheme.

- Distribution mains 0.5 to 2 m/sec
- Rising mains 0.3 to 1.5 m/sec

3.7 Earth Cover

The minimum depth of cover for water distribution systems and sanitary force mains shall be 0.9 meters or 3 feet, measured from the top of the pipe to the established finished grade above the pipe however all road cuts are to be filled in with pit sand / river sand. During detail design, site layout of other infrastructure (i.e., storm sewer, gravity sanitary sewer, etc.) shall be considered in minimizing the need to have deep pressure mains.

3.8 Minimum Size of Pipe

Minimum size recommended for distribution mains is taken as 3 inches however exact sizing can only be determined after the detail design of the area while installing any water supply scheme.

3.9 Sluice Valves

Sluice valves will be located at main control points for balancing and regulating the flows. The sluice valves shall be Cast Iron Flanged or non-rising stem.

3.10 Non-Retune Valves

The Non-Return valve shall meet the following minimum standards:

- Outside the delivery main of the Tubewells
- In the rising main after every 1000 meters or as per site requirement of the area

3.11 Air Relief Valve

The Air relief valve shall meet the following minimum standards:

- At the summits and after 2000 meters intervals in straight reaches to facilities escape of trapped air or as per site requirement of the area
- The material of the air relief valve shall be Cast Iron

3.12 Washout

Washout to be located at the lowest points to wash out all kinds of debris.

3.13 Tubewells Design Specification

The Tubewells will be designed to meet Maximum day demand. Following parameters are suggested for detail design.

- **Entrance Velocity:** The Entrance Velocity 0.05 ft / sec in the strainer is recommended against the allowable value of 0.1 ft /sec to 0.2 ft / sec to check the entry of fine sand into the screen

- **Opening Area of the Strainer:** Opening area normally ranges from 10% to 12%, the lower limit of 10% is recommended for design purposes
- **Slot Size:** Slot size 1" x 1/30" is recommended for the screen. Shrouding shall be provided
- **House Pipe:** The diameter of House Pipe will be based on the design discharge of tube well
- **Sanitary Seal:** To control and check the surface and ground contamination at shallow depths sanitary seal consisting 1:2:4 plain cement concrete is recommended
- **Shrouded Material**: The shrouding material will be of pea gravels having size 1/8" to 3/8" and its thickness will be in the range of 3" to 6", however the later one is preferred and used
- **Shrouding Pipes:** Shrouding shall be done through 3" diameter P.V.C. Pipe or equivalent. Suitable values of the parameters shall be carefully selected
- **Delivery Pipes**: Length of delivery pipe in pump house should be 6-9ft to have proper installation of measuring instruments like portable Ultrasonic flow meter for energy audit purpose. Pressure gauge should be installed on the delivery pipe for pressure head measurements

3.14 Storage Tanks (Ground Storage Tank and Overhead Reservoir)

- Ground storage tank at intermediate point to be provided due to excessive head
- Capacity of ground water storage tank @ $1/4^{th}$ of average daily demand will be provided
- Overhead Reservoir (OHR) should be essentially provided in all urban water supply schemes except in cases of such hilly / semi hilly areas where appropriately located ground storage reservoirs can provide and maintain requisite minimum terminal pressure in the system. For provision of OHR, $1/10^{th}$ of average daily demand is considered

3.15 Sewage Generation

Design Flow will be the summation of Peak Sewerage Flow, Industrial / Non-domestic flow, Infiltration, and Storm Water allowances.

a) The sewage contribution of the water consumed will be as follows:
   - For Urban area: 80%-85%

b) Infiltration Rate:
   - 5% is assumed for infiltration of open drains and sullage carrier

c) Peak Factor:
   - 2.00 as projected population is 100-200 thousand

d) Allowance for industrial waste as per actual assessment on treated industrial waste as per National Environmental Quality Standards (NEQS) is also to be allowed. 5% is taken as industrial / non-domestic sewerage flow

e) Storm water allowance: 33% of Peak Sewage Flow (Southern side areas of Punjab)

3.16 Sewage Conveying Medium

Sewers of Reinforced Concrete (RC) are proposed as sewage conveying medium as they are cost effective and have following benefits:

- Cement pipes are corrosion resistant
- Asbestos cement pipes have smooth internal face providing less hinderance to flow
- They can provide working pressures up to 1.25 MPa (12.5 kgf/cm2)

Conduits i.e., open drains and sullage carriers are also have been opted for sewage conveying purpose where it is not possible to lay sewers.

3.17 Sullage Carrier Sizing

For sizing and opting the right size of sewers and of sullage carriers, Manning's equation is used to calculate the Maximum carrying discharge and flow velocity against a slope which is assumed. This has been done for main sewers and where possible. Detail Hydraulic Statement must be made part of detail design for proper sizing of the sewers of the schemes prior to their execution.

$$\mathbf{Q = A\ V = (\frac{1.00}{n})AR^{\frac{2}{3}}\sqrt{S}\ \ (SI\ Units)}$$

Where:
R= Hydraulic Radius in meters
P= Wetted Perimeter in meters
S= Slope in m/m
n= Manning's coefficient of roughness of flow carrying material (here it is assumed as 0.013 for brickwork with rough plaster)
Q= Maximum Flow Carrying capacity in m^3/sec
V= Velocity of flow in m/s against assumed slope

3.18 Drains and Sullage Carriers Top Cover / Grating

As per the Urban Stormwater Management Manual of Malaysian Standards, drains or sullage carrier of depth more than 0.6 m or 2 ft shall be covered. For this following may also be established according to the aforementioned standard. Two types of covering are mentioned:

1- Drains subjected to traffic loading or inflow of surface runoff can be covered with precast reinforced concrete covers. Covers should be sized such that the weight is limited to what can be easily carried by 2 workmen to gain access for maintenance
2- Drains subject to vehicular traffic flow or inflow of surface runoff shall be covered using solid plate, metal grating. Traffic loading shall be calculated as per the future traffic flow of the area in order to provide grating accordingly

Social behavior i.e., stealing of metal grating should also be considered while provision of grating.
The depth of drain shall include minimum freeboard of 50 mm (2 inches) as per criteria however around 6 inches have been provided for sullage carrier as they are often subject to silting and/or solid waste accumulation. Minimum size of drain is opted as 9 x 9 inches (inside) considering the common practices in Pakistan and available width of the pathways or roads.

3.19 Waste Water Treatment Criteria

Stabilization ponds are proposed for the domestic waste water treatment purposes. All unit processes and unit operations may be carried out in the same unit, or a combination of similar units may be used. If only one stage of treatment is used, the pond will normally be anaerobic. However, if required, a secondary pond for additional aerobic biological treatment should follow an anaerobic pond which is termed as facultative pond. If required, mutation pond may also be provided after facultative pond however this in-turn causes high land acquisition cost. The design criteria for each of the above three ponds are given below.

a) Anaerobic Ponds

From the available literature, all existing procedures adopt one of the following three criteria as basis:

- Surface loading rate (in term of kg BOD/ha/d)
- Volumetric loading rate (in term of BOD5 or volatile solids as g/m3/d)
- Hydraulic retention time

Table 3 Anaerobic Ponds Design Criteria

Loading	280-4500 kg BOD5/ha/d
Depth of pond	2.5-5 m
BOD removal	50-80 %

- Volumetric loading is expressed in term of grams BOD5 per cubic meter per day

Table 4 Volumetric Loading

Loading	300 g BOD5/m3/d
Depth of pond	2.5-5 m
BOD removal	50%

Table 5 Hydraulic Retention Time

Hydraulic Retention Time	5 Days
BOD removal	80 %

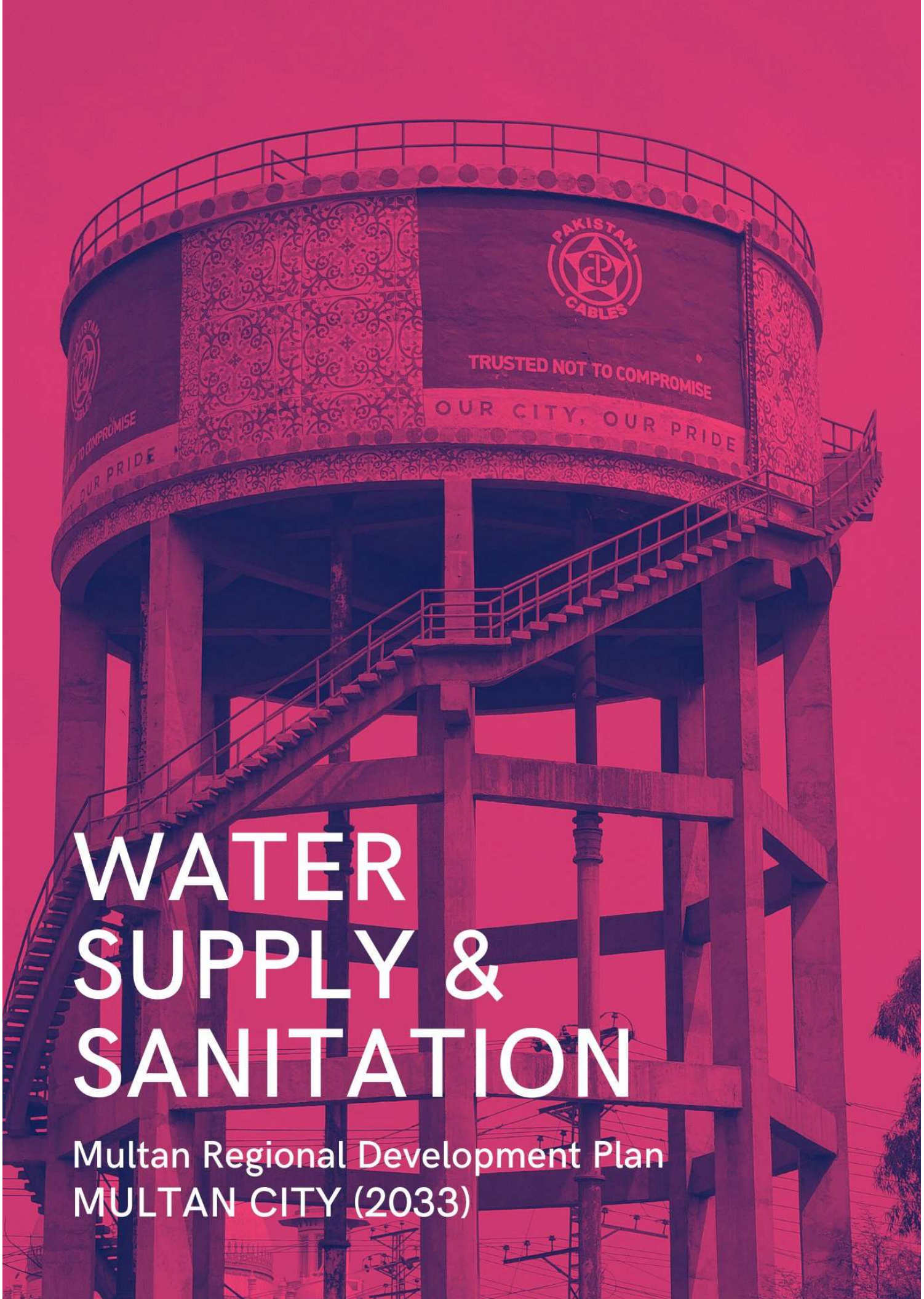
- The BOD5 removal efficiency also depends on the ambient air temperature
- Coliform Removal = Negligible

b) Facultative Ponds

Design criteria adopted for facultative pond plan is as follow:

Table 6 Facultative Ponds Design Criteria

Surface Area Loading (Temp 20-25 degree C)	200 -- 400 kgBOD5/ha/day
Surface Area Loading (Temp 30 degree C)	300-- 400 kgBOD5/ha/day
Depth of facultative pond	1.5 m
BOD5 removal efficiency	80 %
Settled sludge accumulation	30 liters per person per year
Retention time	5 Days
Coliform Removal	99 %
Volume Evaporation	10 %



WATER SUPPLY & SANITATION

Multan Regional Development Plan
MULTAN CITY (2033)

4 Multan City

Multan is an ancient city, known for its Sufi heritage. It is located in the southern part of the Punjab province on the east bank of the Chenab River. In the National Population Census (2017), the population published under the municipal limits was 1.8 million; however, Multan declared metropolitan corporation city in 2019 under new Local Government (LG) Act, 2019. The Asian Development Bank (ADB) prepared a Benchmarking Report on Operational Design and Business Model (ODBM) under Punjab Intermediate Cities Investment Improvement Program (PICIIP) which mentioned that population in the urban limits has reached 2,381,984 people. This rapid growth has made it difficult for the service providers to provide adequate quantity of basic necessities to the residents of city. Water and Sanitation Agency (WASA) Multan, established in 1992, is responsible to provide portable water, sewerage and drainage services to the inhabitants of Multan city. The agency has the mandate to plan, design, construct, operate and maintain water supply, sewerage & drainage facilities for the city.

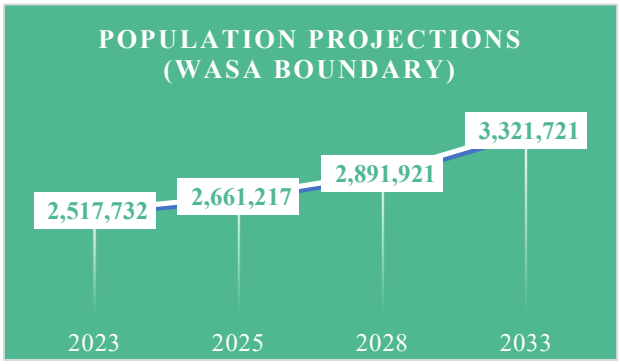


Figure 12 Population Projections (Source: ADB Report ODBM)

The primary source of water supply in Multan is ground water extracted with the help of tube wells installed in different areas of the city. The supply of water in the city is based on direct pumping through distribution network of 1448 Km. It was assessed during the survey that nearly 63% of pipelines have expired their designed life which has resulted in water contamination, low pressure, and leakages. To curb the electricity expenses, the existing supply of water is merely 2 hours in a day. Similarly, in the context of sewerage services, frequent chocking, waste water flooding and challenges in disposal of waste water are observed due to outlived sewer network and allied machinery.

Keeping in view the above issues, Water Supply and Sanitation plan is proposed for the next ten years (2033) for an estimated projected population of around 3.2 million.

4.1 Asset Management- Maturity Assessment of WASA Multan

Asset management maturity assessment is a process that evaluates an organization's level of maturity in managing its assets effectively and efficiently. It involves assessing various aspects of asset management practices, including policies, processes, systems, and culture, to determine the organization's current state and identify areas for improvement. The Regional Development Plan of Multan city also included maturity assessment exercise targeting to identify the key areas of improvement for management of assets effectively.

4.1.1 Methodology

In the context of WASA Multan, a concrete methodology was developed to carry out maturity assessment exercise. It involved identification of target areas in the first step. The areas were identified by keeping in mind the scope of operation and activities in WASA Multan. The next step in the methodology was development of Maturity Assessment Tool. The tool will be used in the consultation sessions with the relevant stakeholders which included multiple questions related to the target areas and criteria for the assessment of maturity level. In the end, the collected feedback will be analyzed and major areas of improvement will be identified to cater in the Regional Development Plan. The steps of methodology are displayed in the figure below.

Figure 13 Maturity Assessment Methodology

4.1.2 Maturity Assessment Criteria & Target Areas

To assess the organizational maturity in the mentioned target areas for WASA Multan, an assessment criterion was formulated in line with the guidelines of Asset Management protocols. The criterion clearly defines the levels of maturity along with the score ranges starting from Aware to Advanced levels. The table below explains the developed criterion for the assessment.

Table 7 Maturity Assessment Criterion

Key Areas	Questions	Maturity Assessment Levels				
		Aware	Basic	Core	Intermediate	Advanced
		(0-20)	(21-40)	(41-60)	(61-80)	(81-100)
Analyzing the Strategic Direction	How well does the organization articulate its AM Policy and AM objectives in alignment with the organization's strategic direction?	The organization demonstrates an awareness of its external and internal strategic direction.	Strategic organizational planning may be in place but not integrated with asset management.	The AM policy and objectives cover all aspects of the asset lifecycle. The AM policy and objectives are being actively applied.	The AM Policy and Objectives have been implemented with analysis of the strategic context and asset portfolio to determine fitness-for-purpose (current and future).	Achievements against AM Objectives and delivery of the AM Policy are regularly monitored and reported.

Level of Service	How well does your organization: · Determine the appropriate level of service for its customers? · Ensure that asset performance measures are appropriate and aligned to those service levels? · Incorporate levels of service criteria into decision making?	The organization recognizes the benefits of defining levels of service, but they are not yet documented or quantified	Potential Customer Groups identified and requirements informally understood. Key level of measures has been defined for the activity.	The needs and expectations of the customers are analyzed and documented. The attributes of Level of Service are aligned with the organizational service planning and performance management processes are periodically measured and reviewed. Also, Level of service and cost relationship understood and described in the AMP.	Levels of service are integral to decision making and business planning, with evidence that AM strategies and decision frameworks are aligned to the levels of service framework. Asset (technical) performance measures are aligned to service (customer) performance measures.	A customer and stakeholder communications plan is in place outlining processes for engaging with customers and stakeholders, with evidence the plan is implemented. Key customers and stakeholders are presented with, and consulted on, significant service levels and options, with key outcomes documented in the AMP.
Asset Management Information System (AMIS)	How well does your organization ensure appropriate information systems are in place and fit-for-purpose considering complexity of assets and AM maturity level required?	The organization Intends to develop an electronic asset register / AMIS. A financial fixed asset register may be in place but only captures accounting data.	Manual Asset register in-place which is capable of recording all core asset attributes – capacity, type, size, material, etc.	Industry-recognized AMIS or asset register system being used that provides basic AM reporting capability - condition / performance, renewal forecasts, valuations.		All advanced AM functions are available, including asset risk assessment, predictive maintenance and renewal modelling for different level of service scenarios.
Financial Planning and Management	How well does your organization: · plan for asset-related expenditure and funding? · Revalue the assets and consider depreciation	Financial planning of asset related expenditure is largely an annual budget process, but there is intention to develop longer term forecasts.	Asset related financial forecasts prepared according to asset life expectancies. Financial budgets for separate	Depreciated replacement cost valuations aligned to asset information used in renewal forecasts. Asset-related financial forecasts are	Long term asset funding options are regularly reviewed and evaluated with consideration of distribution of benefits. Major expenditure	Advanced financial modelling developed which demonstrates whole of life costing and cost analysis for level of service options. Formal risk-

	in its funding strategy? · Consider the whole of life cost of asset investments?		operational and capital planning expenditure are prepared.	aligned to operational and capital planning and forecasting processes. Funding strategies are developed and documented.	proposals incorporate whole of life costing.	based sensitivity analysis of financial forecast scenarios is carried out. Asset and financial data and reporting are fully integrated or regularly reconciled.
Continual Improvement	How well does your organization ensure that it continues to develop its asset management capability towards an appropriate level of maturity?	Recognition of the need for AM improvement process, evident in responses to review questions.	Improvement actions identified and allocated to appropriate staff and progress monitored.	Current and future AM maturity assessed (gap analysis) and used to identify improvement actions. Improvement plans as per identified action developed and implemented, deliverables, resources and responsibilities and are monitored by the AM team.	Formal periodic monitoring of the AM improvement plan is in place with reporting to appropriate levels of the organization. Major improvement actions are managed within the organization's project management framework. A formal audit and review framework is established.	A regular cycle of audit and maturity assessment is undertaken with actions fed back into improvement planning. KPIs for monitoring the effectiveness of AM improvement plan outcomes are reported.

4.1.3 Key Findings for Improvement

After consultation with the relevant stakeholders, their feedback was recorded and analysis was performed to assess the existing situation. It was noted that WASA Multan falls between Aware to Basic category as a whole. The assessment denotes that WASA Multan is aware of their strategic direction, recognizes the benefits of enhances level of service, intends to develop AMIS system & long-term financial planning and recognizes the need for continual improved but the agency has not been able to achieve any goal. Furthermore, WASA Multan anticipates to achieve the target score between Intermediate to Advance level in all areas. The table below shows area-wise current and target scores.

Table 8 Analysis of Maturity Assessment

Target Areas	Current Score	Target Score
Analyzing the Strategic Direction	30	80
Level of Service	35	90
Asset Management Information System	25	85
Financial Planning and Management	18	70
Continual Improvement	20	80

Based on the analysis, key issues were also identified which need immediate attention for improving maturity in the assessed area. This exercise has provided a clear picture of major intervention areas which are of utmost importance in order to achieve higher as an organization. In this plan, recommendations for some of the issues are also included to improve the overall level of maturity for WASA Multan. These issues are listed as follows:

- Insufficient human resource and capacity building issues
- No dedicated cost centers & weak financial system
- Non-existent Asset Management and GIS Sections
- Financial instability and unsustainable planning

4.2 Existing Water Supply Infrastructure

The depth of the water table in the city ranges from 60 ft. to 80 ft. It is shallow in north and north west towards the river side and deep in the center of city due to over extraction of groundwater and high elevation of the city. Water Supply coverage in the Multan City ranges between 60% to 70%. Tube wells are mostly providing water on direct pumping basis. Currently there are 109 tube wells in total, out of which, 13 are non-functional, 7 have been abandoned and 15 are under construction. On the other hand, there are 65 filtration plants operating in the city which are based on direct supply. Overhead storage tanks in the city are no more operational due to low supply hours and outlived structures. The water distribution infrastructure, despite several replacement projects, needs immediate improvement to reduce water losses and low-pressure issues.

The charts below represent the exiting status of water supply infrastructure in Multan city.

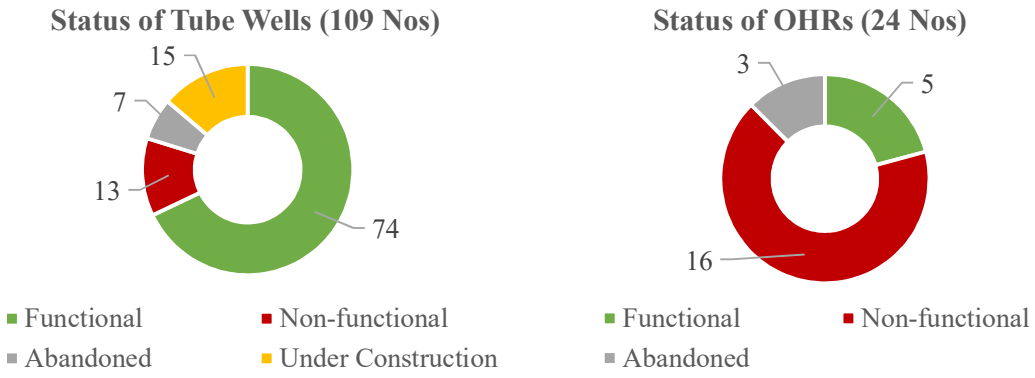


Figure 14 Existing Status of Water Supply Infrastructure

4.3 Water Supply versus Water Demand

The water demand of the city is estimated at 35 gpcd inclusive of non-domestic water demands. The exiting installed capacity of water supply infrastructure is around 155 MGD but the actual water supply is merely 20 MGD (2 hours in a day) to curb the exorbitant electricity expenses. It can be said that the existing capacity of water supply infrastructure is sufficient to provide the water services to the current population of Multan. However, the estimated water needs show that demand will increase rapidly with the passage of time with increase in population. This indicates need of new tube wells to carter to the demand of the current and future augmented population.

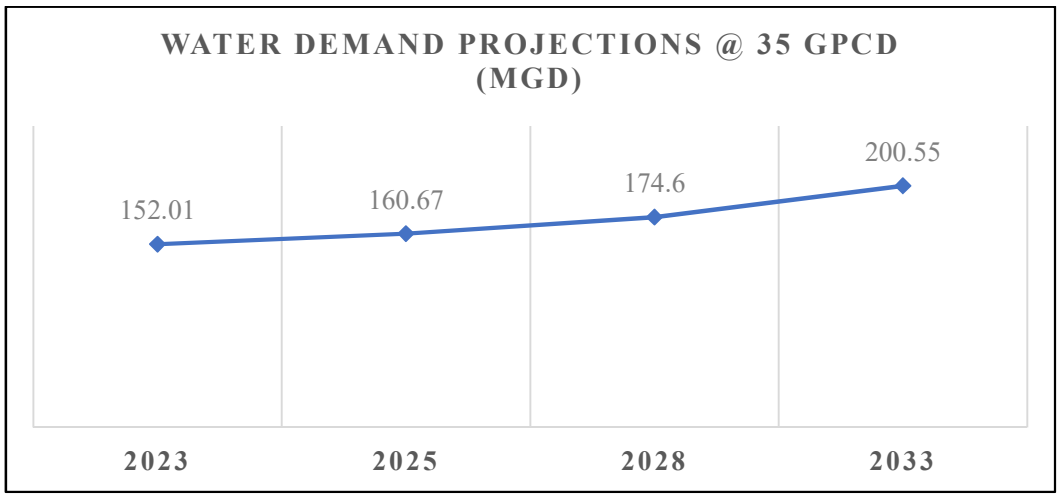


Figure 15 Water Demand Projections

4.4 Condition Assessment of Water Supply Infrastructure

The Urban Unit team surveyed the water supply infrastructure of the city and major gaps were identified during the detail condition assessment of assets. It was noted that tube wells are not

working on their optimal efficiency and leakages were also evident at multiple facilities. More than 90% of the water storage infrastructure has expired its designed life. The water distribution network faces the issues of water contamination, leakages and negative pressures.

Figure 16 Field Survey and Assessment

After detailed condition assessment, following analysis is established based on the information collected and feedback from WASA staff.

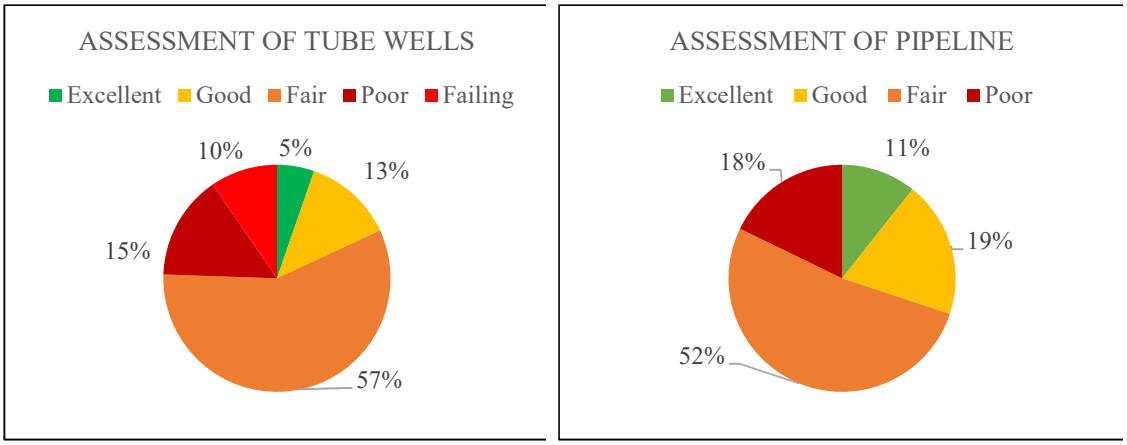


Figure 17 Condition Assessment of Water Supply Infrastructure

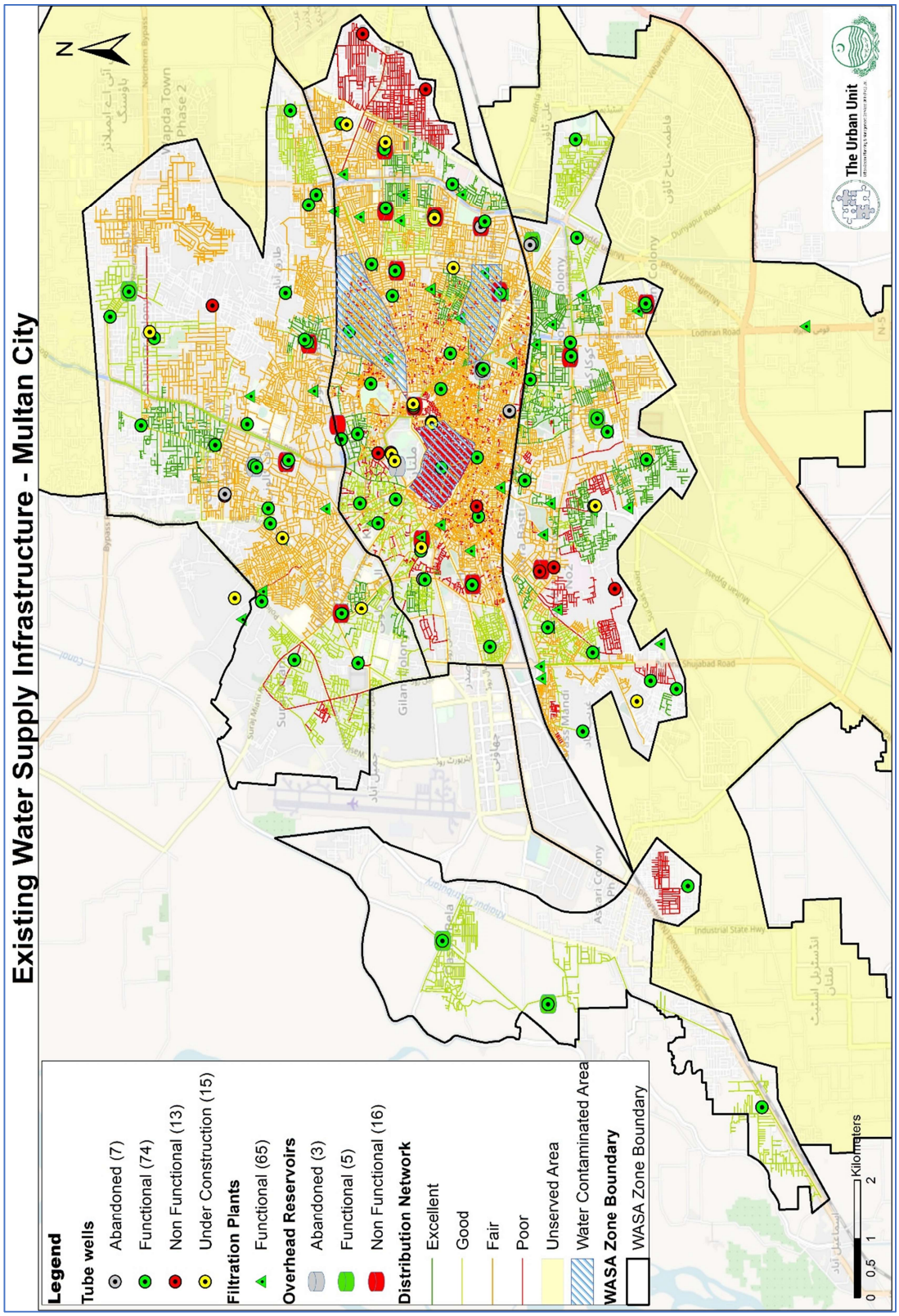


Figure 18 Water Supply Baseline

4.5 Water Supply Interventions

Afore-described gaps relating to the water supply are filled in the planning exercise in detail. Prioritization of these gaps is also done and hence schemes are proposed based on various factors such as essence of intervention, duration required to execute them, cost required, and their impact on general public.

For rough cost estimation MRS, 1st Bi-Annual-2023 District Multan has been Applied. The 2% contingencies and 5% PST are also added in estimates. This is further subject to detail design of the proposed schemes upon PC-1 formation.

Total cost required to uplift the current water supply situation is 10,663 million.

- **Short Term Plan**

In the first phase, the existing water supply infrastructure will be rehabilitated and made functional. This will include the condition improvement of existing tube wells, rehabilitation of filtration plants and reconstruction of overhead reservoirs mentioned in next section. It mainly targets the major problematic areas in the city for the improvement of existing infrastructure. Therefore, replacement of water distribution lines with HDPE in the city center is catered in the short-term plan. Furthermore, it also includes the solarization of WASA regional office to promote clean & green energy.

Total Cost required for Short Term Plan for water supply is 1,410 million.

- **Medium Term Plan**

In Medium term, Water supply services are planned to be improved by expanding services to the unserved areas. This intervention will include installation of 18 new tube wells along the filtration plants. It is also envisaged that with the construction of water bottling plant in the southern and northern part of the city, WASA Multan will be able to generate revenue by selling bottled drinking water to the commercial customers. Furthermore, establishment of GIS and Asset Management Cell is also planned to promote digitalization and effective planning & monitoring of assets in the organization. Replacement of existing distribution lines with HDPE pipes is also part of the plan. Addressed areas in medium term plan are marked in the map below.

Total Cost required for Medium Term Plan for water supply is 3,340 million.

- **Long Term Plan**

In long-term plan, water supply services are planned to be improved by expanding services to the further unserved areas. The services are planned to be expanded by installing new tube well stations (28 Nos), construction of water storage tanks and extension of water distribution network to the unserved areas.

Total Cost required for Long Term Plan for water supply is 5,913 million.

Following are the list of proposed interventions for water supply infrastructure.

Table 9 Proposed Interventions

Sr. #	Planning Term	Proposed Schemes	Scope	Cost (Million)
1	Short (2025)	Rehabilitation of 13 (Nos) non-functional tube wells in Qasim Pur Colony, Baghchi Mirza Jan, Sadiqabad,Shalimar Colony, Lohari Gate, Grass Mandi, Mamtazabad, Board Office, Zaid Town, Chain Mari, Farooq Pura, Lodhi Colony and Naqshband Colony	▸ Rehabilitation of Civil Structure, Replacement of pump and provision of Chlorinator, bulk meters and electrical distribution board for Existing 13 Tube Wells	91
2		Dismantling and reconstruction of 7 (Nos) Overhead Reservoirs (OHRs) in Eid Gah, Mumtazabad, G Block SRA, Aam Khas Bagh, W Block SRA, Hassan Parwana and MDA Chowk	▸ Dismantling and reconstruction of 7 (Nos) Overhead Reservoirs (OHRs) in Eid Gah, Mumtazabad, G Block SRA, Aam Khas Bagh, W Block SRA, Hassan Parwana and MDA Chowk	561
3		Rehabilitation of 32 (Nos) filtration plants located in central sub division of WASA Multan (Phase-I)	▸ Repair and maintenance work along with storage tanks	346
4		Augmentation of outlived and poor water distribution network in Peran Ghaib, Old City Area and Abdali Road	▸ Replacement of 154 Km exiting water distribution network of diameter 3” to 8” with HDPE pipe	391

5		Solarization of WASA Multan Regional Office	▸ Complete rooftop solar setup of 75 kW (Estimated) for WASA Regional Office Multan	20
6	Medium (2028)	Replacement & Augmentation of water distribution network (Problematic Areas) in Shamsabad Colony, Wahdat Colony, Khushal Colony, Jan Muhammad Colony, Muslim Town, Almujahid Colony, Old City, Mohallah Qadirabad and Mohallah Mohammadi	▸ Replacement of 444 Km existing distribution network with HDPE pipe	1,773
7		Construction of 18 (Nos) new tube wells (4 Cusec each) along with filtration plants (2000 lph) and reconstruction of 12 OHRs (200,000 gallons) in priority areas of the city	▸ New tube well (18 Nos) of 4 cusecs each along with filtration plants and 12 Nos of OHRs (200,000 gallons)	1,333
8		Construction of two Water Bottling Plants at Gulgasht Colony and New Shah Shams Colony	▸ Water Bottling Plants along with distribution vehicles	8
9		Establishment of Asset Management and GIS Cell at WASA Multan	▸ Provision of IT equipment, Computers, software and trained Staff	23
10		Rehabilitation of 33 (Nos) filtration plants located in north and south sub division of WASA Multan (Phase-II)	▸ Repair and maintenance work along with installation of storage tanks	204
11		Construction of 28 (Nos) new tube wells (4 Cusec each) along with filtration plants (2000 lph) and 15 OHRs	▸ New tube well (28 Nos) of 4 cusecs each complete in all respects along with filtration plants and	1,759

	Long (2033)	(200,000 gallons) in the unserved areas of the city	15 Nos of OHRs (200,000 gallons)	
12		Extension of distribution network and services to the unserved areas of the city under WASA Multan boundary	▸ Extension of services and distribution network of 496 Km for future extensions of sub division boundaries.	1,731
13		Replacement of distribution network in New Nazimabad, Timber Market, Chah Jummunwala, Ghouspura, Walayatabad No. 1 & 2, Yaqoob Town, Kumhar Mandi, Abbaspura, Madina Colony, Pir Colony and Nazimabad	▸ Replacement of 644 Km WS distribution with HDPE (8"-12" mains and 4" distributions)	2,344
14		Establishment of warehouse/store with computerized inventory management system	▸ New warehouse with spares and computerized Inventory Management System	79
14				**10,663 Million**

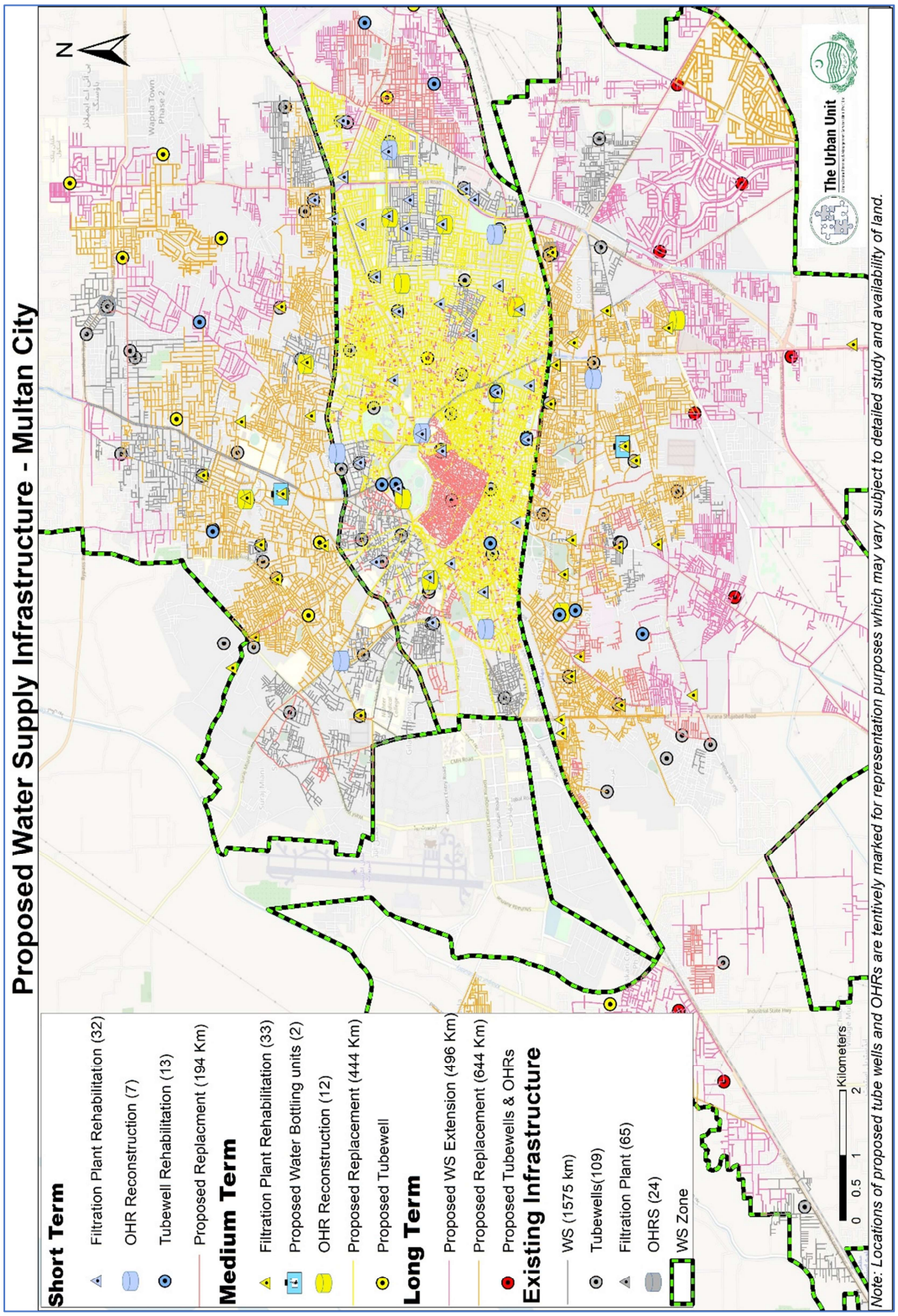


Figure 19: Water Supply Interventions Map

4.6 Existing Sewerage Infrastructure

The Multan city has a combined system collecting domestic, industrial and storm water. The sewerage network comprises trunk, sub-main and lateral sewers of approximately 2,055 Km. Presently, the sewerage network for households and other uses caters about 65-70% coverage of the population. The existing trunk sewers laid by WASA Multan, in most of the areas are in poor condition and have outlived their life. The sewage disposal system comprises of 12 lift stations and 18 disposal stations along with mobile machinery. The existing sewerage system of Multan city does not have any proper arrangement for ultimate treatment and disposal of sewage. At present, the raw sewage wastewater is being pumped into the Chenab River/ Nobahar Canal without treatment thus endangering the river life. There is a small-scale sewage treatment plant located on the outfall of Suraj Miani disposal station constructed around 15 years ago. The plant has never been desilted/cleaned throughout the years hence the treatment process is compromised.

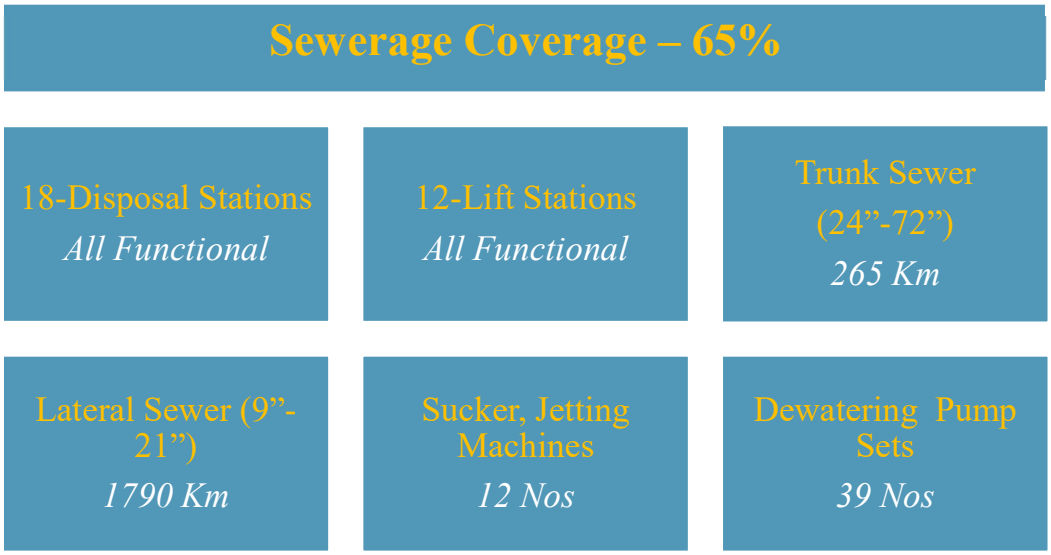


Figure 20: Status of Sewerage Infrastructure

4.7 Condition Assessment of Sewerage Infrastructure

The Urban Unit team surveyed the sewerage infrastructure of the city and major gaps were identified during the detail condition assessment of assets. It was noted that disposal stations are not working on their optimal efficiency due to non-functional pumping machinery and low

power factor issues. It was noted that more than 60% of the waste water conveyance network has expired its designed life. The allied machinery was also found in deteriorated condition.

The analysis on condition assessment data is as follows:

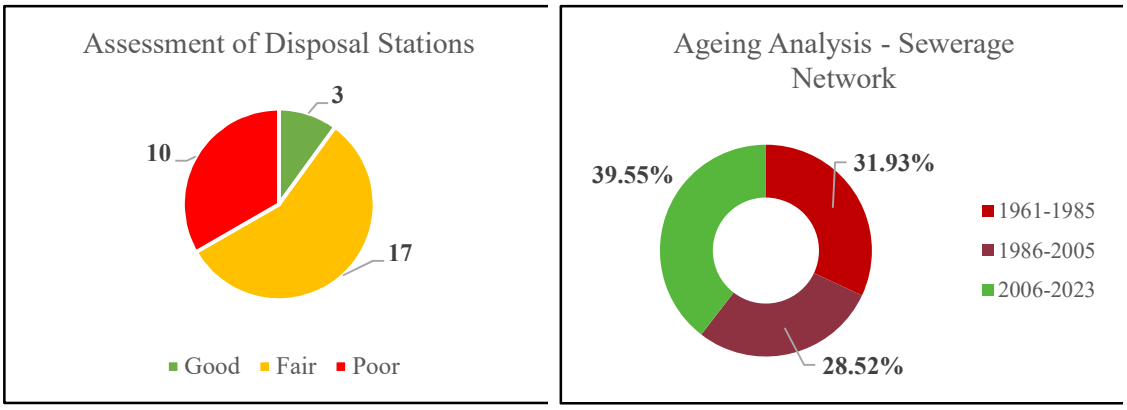


Figure 21: Condition Assessment of Sewerage Infrastructure

Figure 22: Field Survey and Assessment

4.8 Sewage Generation

The sewage generation have been made corresponding to the 30 gallons per capita per day water demand i/c 20% unaccounted for water (NRW). A contribution of 33% for storm-water flow, 5% infiltration & 5% non-domestic flows have been included during the calculation of the total sewerage flow. The current (2023) sewage generation and of the future (2025, 2028 and 2033) sewage generation are shown in the table below.

Table 10 Sewage Flow Estimations

Sewage Generation				
Years	**2023**	**2025**	**2028**	**2033**
Population	141,682	150,690	165,288	192,826
Peak Sewage Flow (MGD-I)	172.28	182.09	197.88	227.29
Storm Water Flow (MGD-I)	86.14	91.05	98.94	113.64
Infiltration Flows (MGD-I)	4.31	4.55	4.95	5.68
Non-Domestic Flows (MGD-I)	4.31	4.55	4.95	5.68
Total Sewage Flow (MGD-I)	**267.03**	**282.25**	**306.71**	**352.30**

Currently all the disposal and lift stations are functional but are incapacitated hence need various replacement and/or repairment of pumps and provision of basic services and civil structure improvement and waste water disposal mechanisms. The estimated flow generation is as follows:

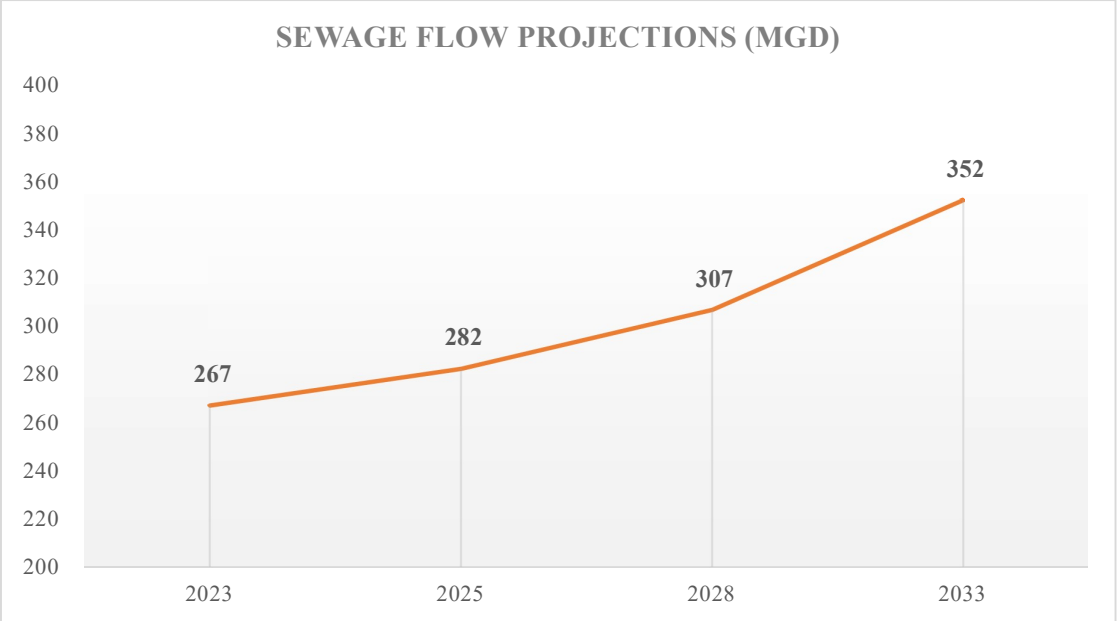


Figure 23: Sewage Flow Projections

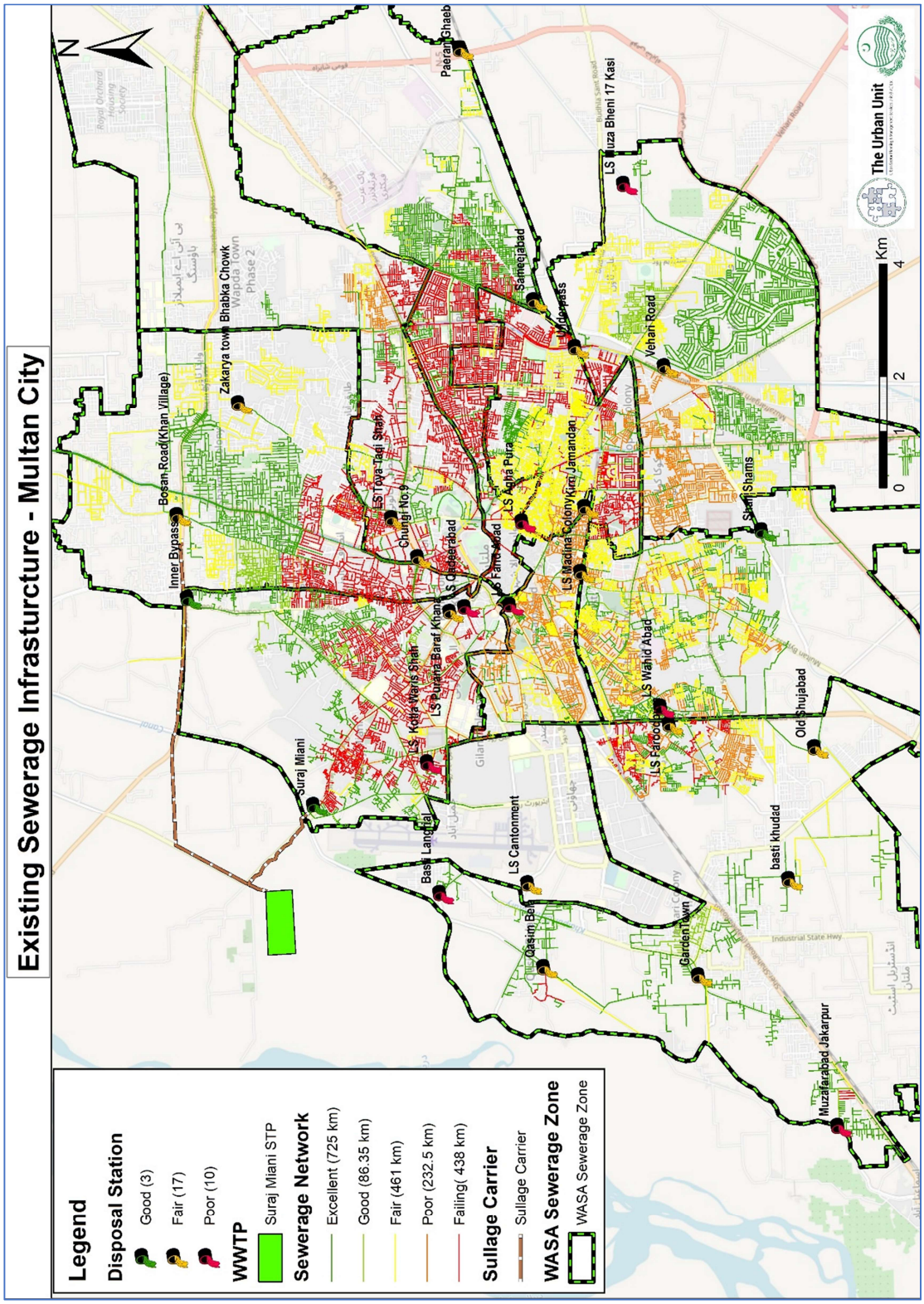


Figure 24: Existing Sewerage Infrastructure

4.9 Sewerage Interventions

Afore-described gaps relating to the sewerage issues are filled in the planning exercise in detail. Prioritization of these gaps is also done and hence schemes are proposed based on various factors such as essence of intervention, duration required to execute them, cost required, and their impact on public. Total cost required to uplift the current sewerage situation is 12,176 million.

For rough cost estimation MRS, 1st Bi-Annual-2023 District Multan has been Applied. The 2% contingencies and 5% PST are also added in estimates. This is further subject to detail design of the proposed schemes upon PC-1 formation.

Short Term Plan

To improve the sewerage condition of the city, it is important to first fully capacitate the existing system. Therefore, five major disposal stations are proposed to be rehabilitated in all respects in this term (Phase-I). Replacement of outdated and/or undersized main sewers is also proposed including areas: New Multan Colony, Qadirabad, Chungi No. 9, Kirri Jamandan and Gulgasht Colony with total length 159 km. It also includes the cleaning/desilting of existing Suraj Miani STP.

A total of 2,026 million will be required to make these interventions in short-term.

Medium Term Plan

In Medium term, sewerage infrastructure is planned to be improved by replacement of conveyance network and augmentation of disposal pumping stations (Phase-II). Replacement of outdated and/or undersized main sewers is also proposed including areas: Eidgah, Garden Town, Gulgasht Town, Hassan Parwana, Mumtazabad, Suraj Miani, Qasimpur, New Multan and Walaytabad. Furthermore, solarization of old shujabad disposal stations and provision of portable machinery are also included in this plan.

Total cost required for medium-term plan for sewerage system is 5,281 million.

Long Term Plan

In the Long term, replacement of main and lateral sewer network in Mumtazabad, Qasimpur, New Multan, Garden Town, Walayatabad, Hassanparwana and Gulgasht Colony are proposed. Solarization of two disposal stations at Suraj Miani and Sameejabad are identified where land is already available. Treatment plants are already proposed in Multan Master Plan, therefore not included in this plan. To cater the needs of future population, extension of sewerage services is also proposed in the long-term plan.

Total cost required for long-term plan for sewerage system is 4,869 million.

The list of proposed schemes for Multan city is shown in the table below:

Table 11 Proposed Schemes

Sr. #	Planning Term	Proposed Schemes	Scope	Cost (Million)
1	Short (2025)	Augmentation of pumping machinery and repair works of disposal stations (Phase-I)	▸ Replacement of electromechanical machinery, construction of dedicated electrical room and repair of civil works at 05 major disposal stations at	750
2		Replacement of outlived sewerage network in New Multan Colony, Qadirabad, Chungi No. 9, Kirri Jamandan and Gulgasht Colony	▸ Replacement of outlived and under capacity trunk and lateral sewers of 159 Km	1,076
3		Rehabilitation and desilting of Suraj Miani Sewage Treatment Plant	▸ De-silting/cleaning of ponds, replacement of gates and carpeting of service pathways	200
4	Medium (2028)	Augmentation of pumping machinery and repair works of disposal stations (Phase-II)	▸ Replacement of machinery, construction of dedicated electrical room and repair of civil works	768
5		Replacement of sewerage network in the following areas: Eidgah, Garden Town, Gulgasht Town, Hassan Parwana, Mumtazabad, Suraj Miani, Qasimpur, New Multan and Walaytabad	▸ Replacement of outlived and failing branch sewer infrastructure. (511 Km)	3584

6		Solarization of Old Shujaabad Disposal Station	▸ Ground mounted 800 kW Solar plant along with structure and electrical works (Excluding Land Acquisition)	215
7		Provision of Portable Machinery and Equipment for O&M of Sewerage system.	▸ 9 Sucker Machines, 9 Jetting Machines, 15 Dewatering pumps (4 cfs) and 3 mobile workshop units	714
8	Long (2033)	Replacement of main and lateral sewer network in Mumtazabad, Qasimpur, New Multan, Garden Town, Walayatabad, Hassanparwana and Gulgasht Colony.	▸ Replacement of problematic and failing sewer infrastructure. (461 Km)	3,452
9		Extension of sewerage network and services to the unserved areas of the city under WASA Multan boundary	▸ Main and branch sewers of 131 Km for future extensions of sub division boundaries.	917
10		Solarization of Suraj Miani and Sameejabad Disposal Stations	▸ Ground mounted 1400 kW & 550 kW Solar plants (respectively) along with structure and electrical works (Excluding Land Acquisition)	500
10				**12,176 Million**

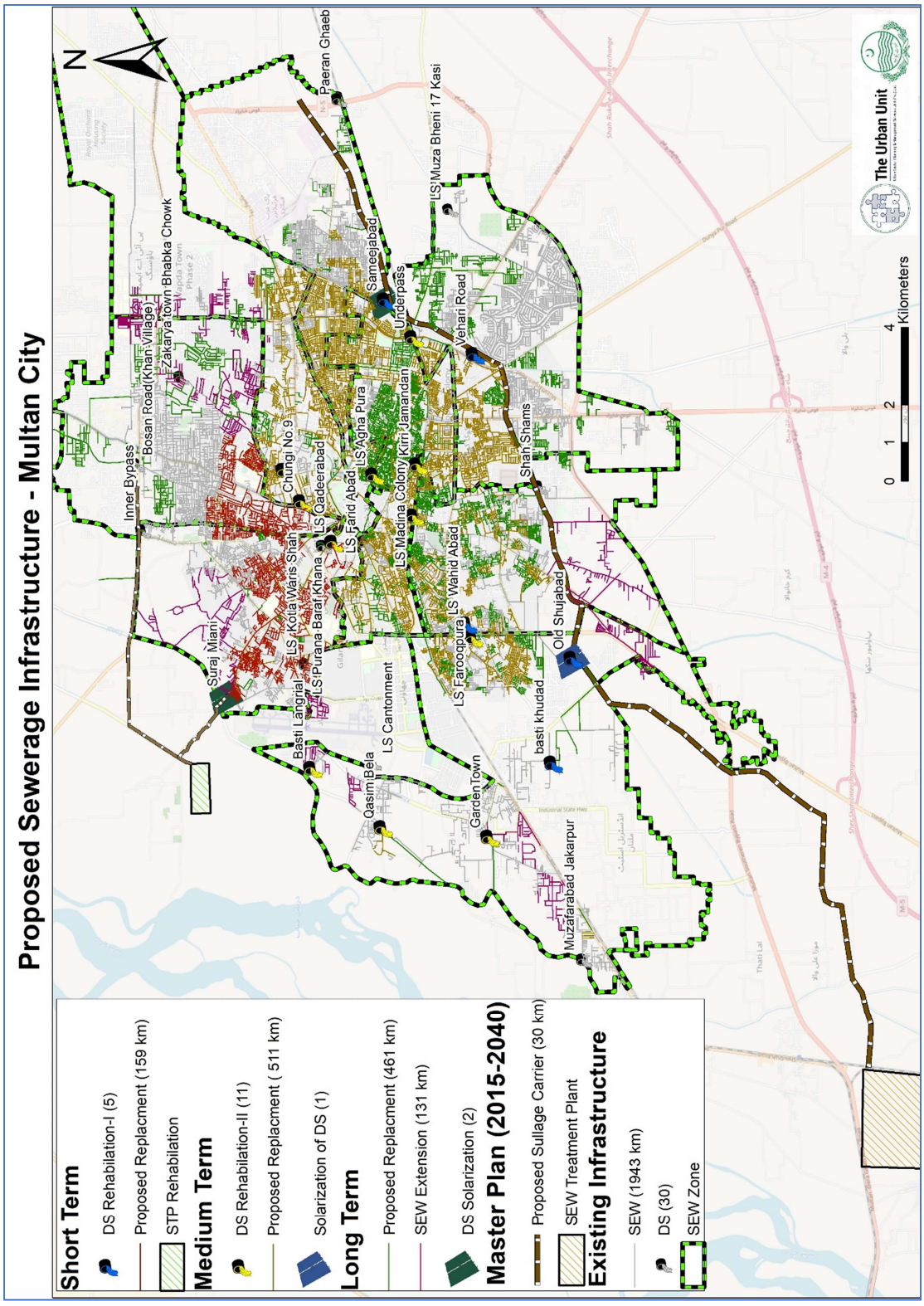


Figure 25: Sewerage Intervention Map

KHANEWAL CITY

5 Khanewal City

Khanewal City is the 36th largest city of Pakistan in terms of population. The city's estimated population (year 2023) is 304,195 which will further increase to 422,103 in 2033, which is decided as a planning year for this regional development plan.

The water supply of Khanewal City is based on number of groundwater-based schemes being operated and managed by the Municipal Corporation (MC) Khanewal. Groundwater is extracted from tube wells and supplied to the city through water supply schemes. Two Overhead Reservoirs also exist that store and supply the water to the adjacent areas. These schemes provide water supply to 50% (spatially) of the city's population. The water pipeline network is mostly outlived and in deteriorated condition however the water is of drinkable characteristics.

The sewerage system of Khanewal City is gravity based and uses a number of disposal stations for the disposal of wastewater to the outskirts of the city. The system is being operated and maintained by Municipal Corporation (MC) Khanewal. Spatially the coverage of sewers is 60%. Most of the sewage is disposed-off into open land and/or agricultural fields. However, there is one STP in the industrial estate where industrial and domestic wastewater is treated before its disposal. Nonetheless, the sewerage system lacks a proper integrated solution for safe disposal of sewage. Sewer network in Khanewal City is mix of fair and poor condition.

5.1 Existing Water Supply Infrastructure

The existing water supply infrastructure consists of tube wells and overhead reservoirs. WS coverage is around 50% (spatially). The Water Quality of Khanewal MC is mostly drinkable. Where tested, it showed (average) pH 7.2, TDS 5.5 & EC 1099. Water Supply Pipeline is in deteriorated condition (D or Poor) and needs replacement as per the demand of the area. There are ten tube wells in the city with no dysfunctional tube well however two of these tube wells are problematic and need major repair and rehabilitation. The Detail of MC-owned water supply infrastructure is as under.

Table 12 Existing Water Supply Schemes

Sr. No.	Tube-well Name	Pump Detail	Year	Tube-well Condition	OHR (Capacity in G-Imp.)	OHR Condition	Pipeline length	Pipeline Condition
1	T Chowk	1 @ 2 Cusecs	1990	B (Good)	36,000	D (Poor)	length 60KM of varying dias (4", 6", 8" & 10")	Mix of C (Fair), D (Poor) & F (Failing)
2	People Colony	1 @ 2 Cusecs	1977	D (Poor)	30,000	D (Poor)		
3	Thana Ground	1 @ 1.5 Cusecs	2022	A (Excellent)	None	NA		
4	Purani Sabzi Mandi	1 @ 1.5 Cusecs	2022	B (Good)	None	NA		
5	Shabbir Stadium	1 @ 1.5 Cusecs	2022	B (Good)	None	NA		
6	Colony No. 2	1 @ 2 Cusecs	2006	C (Fair)	None	NA		

7	Camp Chowk	1 @ 1.5 Cusecs	2022	A (Excellent)	None	NA		
8	Colony No. 1	1 @ 2 Cusecs	2006	D (Poor)	None	NA		
9	Daftar Highway	1 @ 2 Cusecs	1990	D (Poor)	None	NA		
10	Lahore Morr	1 @ 1.5 Cusecs	2017	B (Good)	None	NA		

Following is the status of the tube wells in Khanewal City

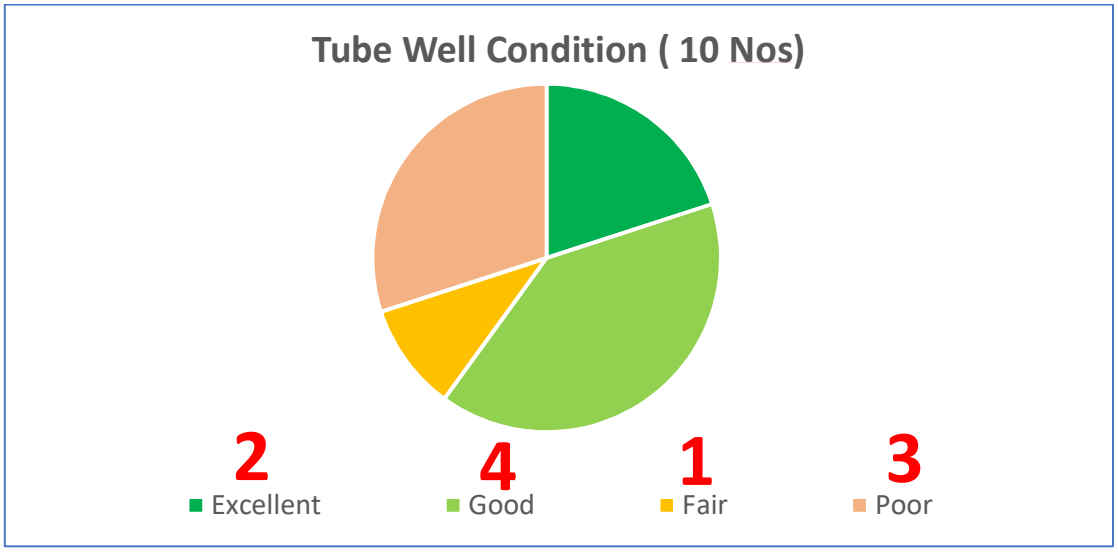


Figure 26 Tube-well Status

5.2 Water Supply versus Water Demand

Water Supply in terms of maximum day demand is calculated and compared with water demand. The existing water supply capacity is analyzed and it stands out at 4.3 MGD-I maximum for all water supply appurtenances.

Table 13 Water Demand

Water Demand				
Year	**2023**	**2025**	**2028**	**2033**
Population	304,195	324,792	358,331	422,102
Average Day Demand (MGD)	9	10	11	13
Max Day Demand (MGD)	14	15	16	19
Peak Demand (MGD)	21	22.5	24	28.5

In current year the deficit is 9.7 MGD-I which is expected to reach 14.7 MGD-I in the year 2023. This has been based on 16 hours of water pumping. This gap indicates the need for new tube wells to cater the demand for current and future projected population.

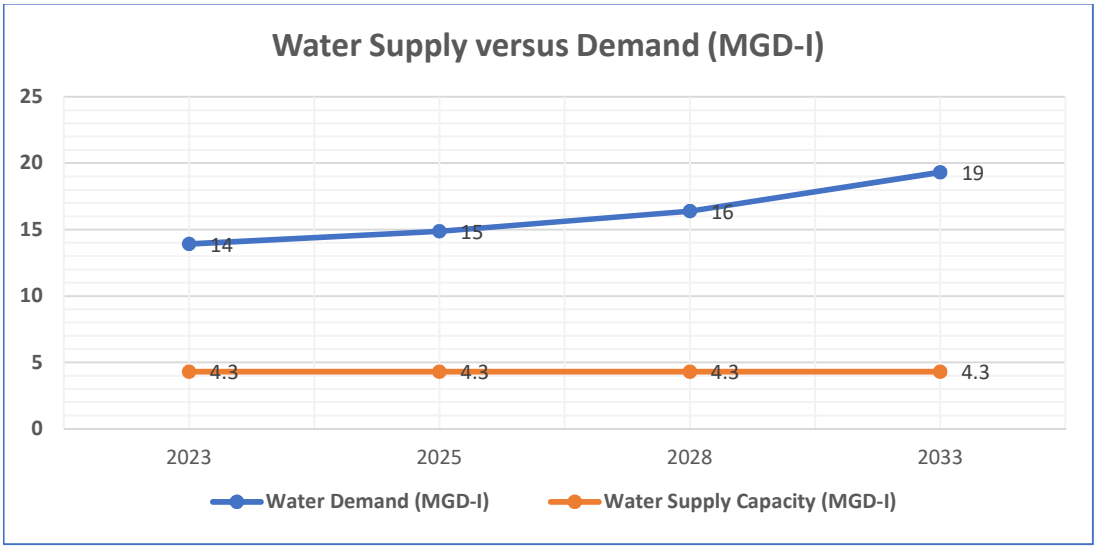
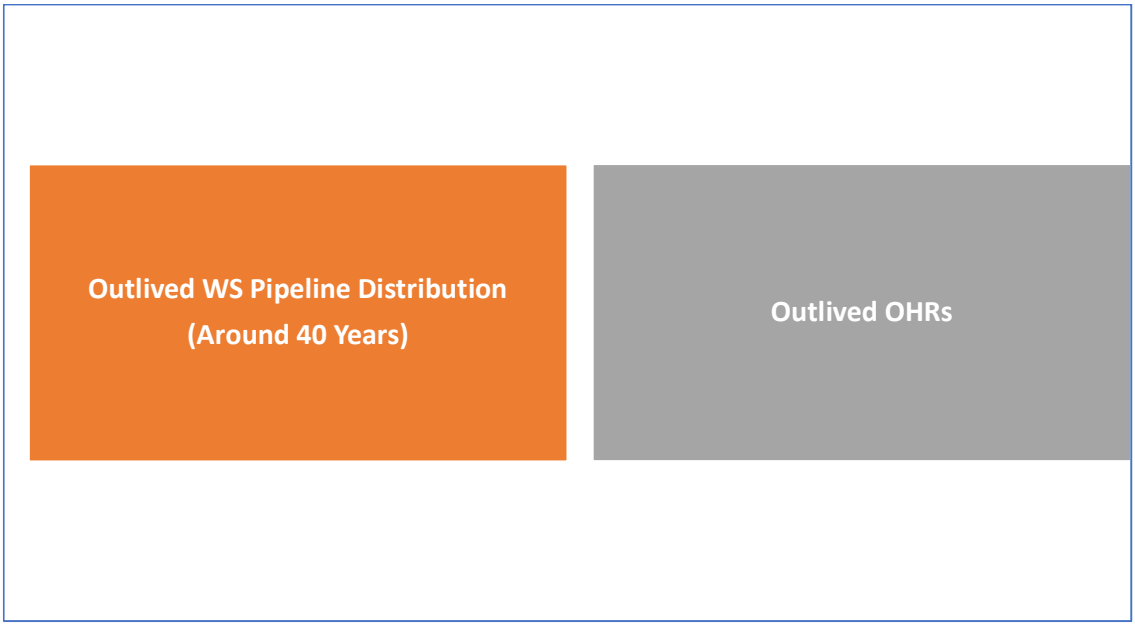


Figure 27 Water Supply versus Demand

5.3 Condition Assessment of Water Supply Infrastructure

Following were major gaps identified during the detailed condition assessment of the existing Water Supply infrastructure.



	
Power Factor Assessment	Consultation with MOI
	
Water Quality Testing	Tube Well Survey

Figure 28 Field Survey and Assessment

After a detailed condition assessment, the following was established as the overall condition and respective rating.

Table 14 Condition Assessment Outcome

Asset Attribute	Rating
Civil Structures	**C (Fair)**
Distribution Network	**D (Poor)**
Electro-Mechanical	**C (Fair)**

As per the condition assessment of the water supply infrastructure in Khanewal City, the overall condition of pump houses of tube wells, the structure of overhead reservoirs and electrical & mechanical components have been rated as “C” which indicates that some deterioration or

defects are evident, but functionality is not significantly affected. The condition of the water supply distribution network has been rated as “D” which shows that serious deterioration in at least some portion of the structure is present. Over-ageing and neglected maintenance are the reasons for the poor condition of pipelines.

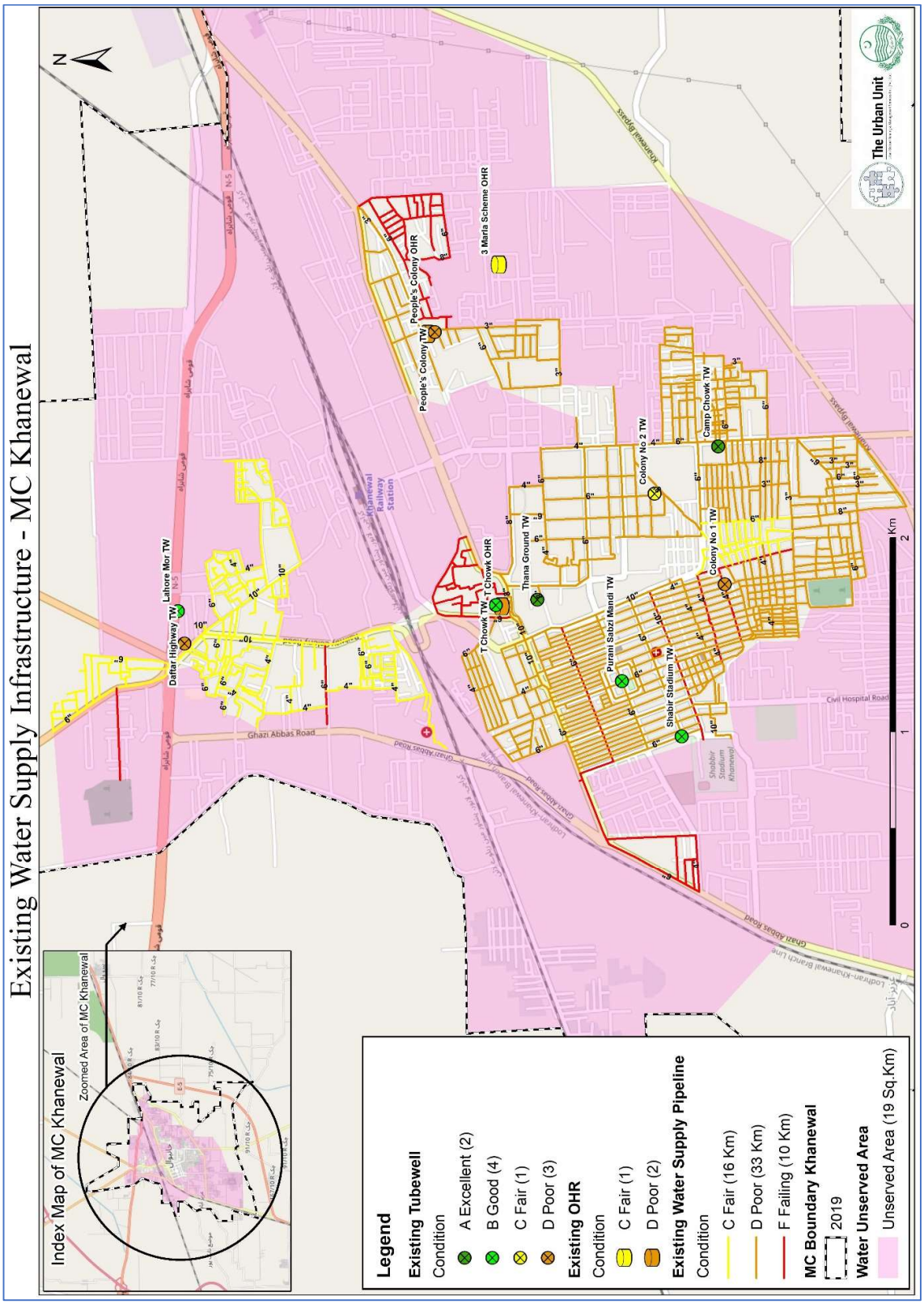


Figure 29 Water Supply Baseline

5.4 Water Supply Interventions

The conditional assessment of existing water supply infrastructure and its comparison with present and future projected demand has resulted in the identification of service delivery gaps that exists within the system. Afore-described gaps relating to the Water Supply are filled in the planning exercise in detail. Prioritization of these gaps is also done and hence schemes are proposed based on various factors such as essence of intervention, duration required to execute them, cost required, and their impact on general public. Total cost required to uplift the current water supply situation is 2,334 Million.

Short Term Plan

The existing water supply infrastructure of MC Khanewal is currently not being operated at its full capacity which in turn limits the efficiency and delivery of the system. Thus, to cater it and to make the system efficient, the short-term plan involves the rehabilitation of the existing water supply infrastructure. This includes the reconstruction of outlived Overhead Reservoirs & tube wells and the rehabilitation of problematic tube wells. Existing Water supply pipelines at Usama Road, Timber Market, Islam Park, Block 1, Irshad Colony and People Colony Y Block are in deteriorated condition, replacement of these pipelines is proposed. This plan will cost around 456 million.

Medium Term Plan

The Medium-term plan involves the extension of water supply services to the unserved areas of the MC. Since, the water unserved area is around 50% so this term involves planning for the extension of water supply services to Basti Khalil Wali, Farm Road, Bilal Colony, District Civil Defense Road, and Nizamabad Road. This includes the construction of 10 Tube wells (2 cusecs each), 05 OHRs (100,000 Gallons each), and WS pipeline varying dias (10”, 6” and 4” HDPE material) of length 64 KM. This plan will cost around Rs. 711 million.

Long Term Plan

Long-term plan involves the extension of water supply services in Ahmed Nagar, Basti Yosaf Wali, Zahoorabad, Irshad Colony, Canal Colony, Bukhtayari Garden, Chak 88 10 R, near Ahmed Flour Mills, near Distt Head Quarter Hospital and all neighboring areas. This includes construction of 17 Tube wells (2 cusecs each), 6 OHRs (100,000 Gallons each), and WS pipeline varying dias (10”, 6” and 4” pipeline HDPE material) of length 208 KM. This plan may cost around Rs. 1167 million.

The following are proposed schemes for the Khanewal (MC):

Table 15 Proposed Schemes

Sr. #	Planning Term	Sector	Proposed Schemes	Scope	Cost (Million)
1	Short (2025)	Water Supply	Rehabilitation of Water Supply System in Khanewal City	▸ Reconstruction of two Tube Wells (2 Cusecs each) at People Colony Y Block and Colony No. 1 including Civil works (pump house and bore), Electro-mechanical machinery and panel)	17
				▸ Major Rehabilitation of one Tube Well at Lahore Morr Daftar (Rehabilitation of Civil Structure, Replacement of pump and provision of electrical distribution board for Existing Tube Well)	5
				▸ Dismantling of 02 existing OHRs and their Reconstruction with capacity of 150,000 Gallons each at T Chowk and People	147

				Colony Y Block WS Schemes	
				▸ Replacement of outdated WS Pipelines of total length 96.5 KM having varying dias (3", 4", 6", 8" & 10") for Areas: Usama Road, Timber Market, Islam Park, Block 1, Imam Barghah Road, Minar Masjid Road, Stadium Road, Irshad Colony, Makki Masjid Road, College Road, and People Colony Y Block	287
2	Medium (2028)		Extension of Water Supply System in Khanewal City – Phase I (Areas: Basti Khalil Wali, Farm Road, Bilal Colony, District Civil Defense Road, and Nizamabad Road	▸ Construction of 10 Tube wells (2 cusecs each), 05 OHRs (100,000 Gallons each), and WS pipeline (10", 6" and 4" pipeline HDPE distributions) of length 64 KM	711

3	Long (2033)		Extension of Water Supply System in Khanewal City – Phase II (Areas: Ahmed Nagar, Basti Yosaf Wali, Zahoorabad, Irshad Colony, Canal Colony, Bukhtayari Garden, Chak 88 10 R, Near Ahmed Flour Mills and Near Distt Head Quarter Hospital)	▸ Construction of 17 Tube wells (2 cusecs each), 6 OHRs (100,000 Gallons each), and WS pipeline (10", 6" and 4" pipeline HDPE distributions) of length 208 KM	1,167
Total Water Supply – Khanewal MC					**2,334**

For Rough Cost Estimation, MRS 1st BI-ANNUAL-2023 (01.01.2023 to 30.06.2023) District Khanewal has been Applied. The 2% Contingencies and 5% PST are also added to the estimates. This is further subject to the Detail Design of the proposed schemes upon PC-1 formation.

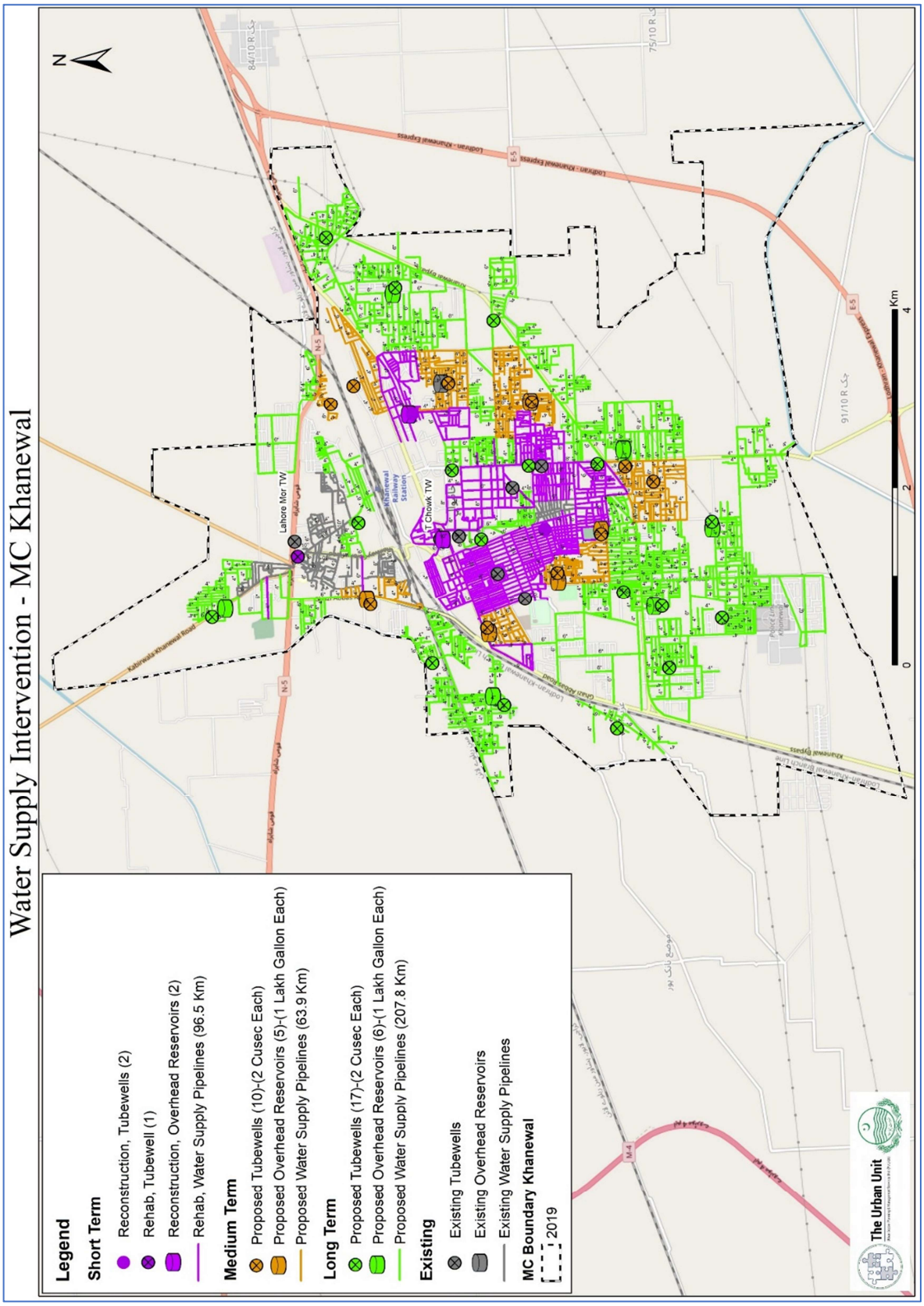


Figure 30 Water Supply Intervention

5.5 Existing Sewerage Infrastructure

The existing sewerage infrastructure of Khanewal City constitute of sewers of Reinforced Concrete (RC) and nine disposal stations. Sewers collect the sewage from the city and carry it to disposal stations which ultimately dispose of to open ponds, drains and agricultural fields. There is one active Sewerage Treatment Plant in the industrial estate where industrial and domestic sewage is being disposed.

The detail of the MC-owned sewerage infrastructure is tabulated below.

Table 16 Sewerage Infrastructure Detail

Sr. No.	Disposal Station	DS Condition	Comments	Ultimate Disposal Station	Sewers Dias (Overall)	Sewer Condition (Overall)
1	Lahore Morr DS	D (Poor)	Needs Pump replacements for failed pumps	Drain	Length 116 KM of varying dias (6", 9", 12", 15", 18", 21", 24", 27", 33", 36", 42" 48")	C (Fair)
2	People Colony DS	D (Poor)	Needs Pump replacements for failed pumps	Open Ponds		
3	Nizamabad DS	D (Poor)	Needs Pump replacements for failed pumps	Open Ponds		
4	Malikabad DS	D (Poor)	Needs Pump replacements for failed pumps	Agricultural Fields & Open Ponds		
5	Tariqabad New DS	C (Fair)	Fully Functional	STP		
6	Tariqbad Old DS	C (Fair)	Needs Pump replacements for failed pumps	STP		
7	Jahanian Bypass DS	C (Fair)	Needs Pump replacements for failed pumps	STP		
8	Ahmad Nagar DS	C (Fair)	Fully Functional	Agricultural Fields & Drain		
9	Addi Wala	C (Fair)	Fully Functional	Drain		

5.6 Condition Assessment of Sewerage Infrastructure

The overall condition of sewerage infrastructure was assessed based on developed rating criteria. During the field visit each of the components of the existing sewerage infrastructure was evaluated and a grade was granted accordingly.
Following is the status of the current disposal stations.

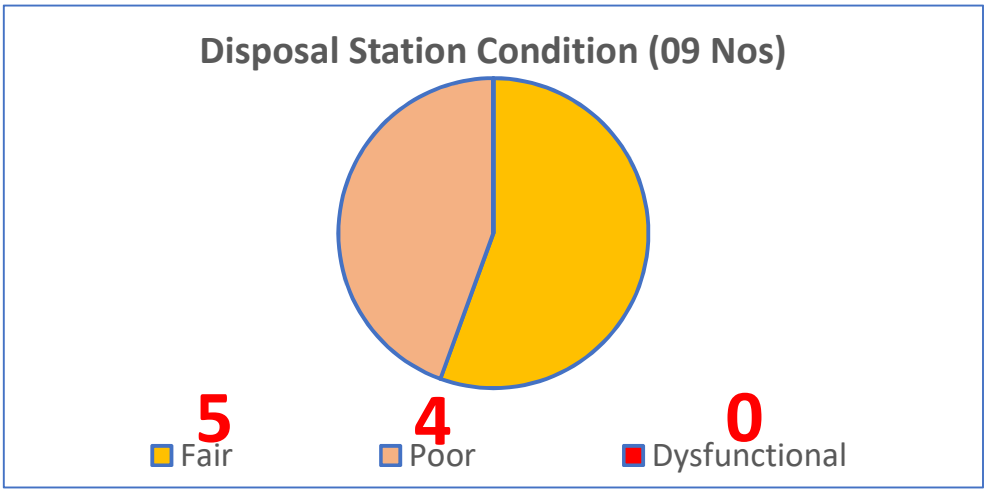
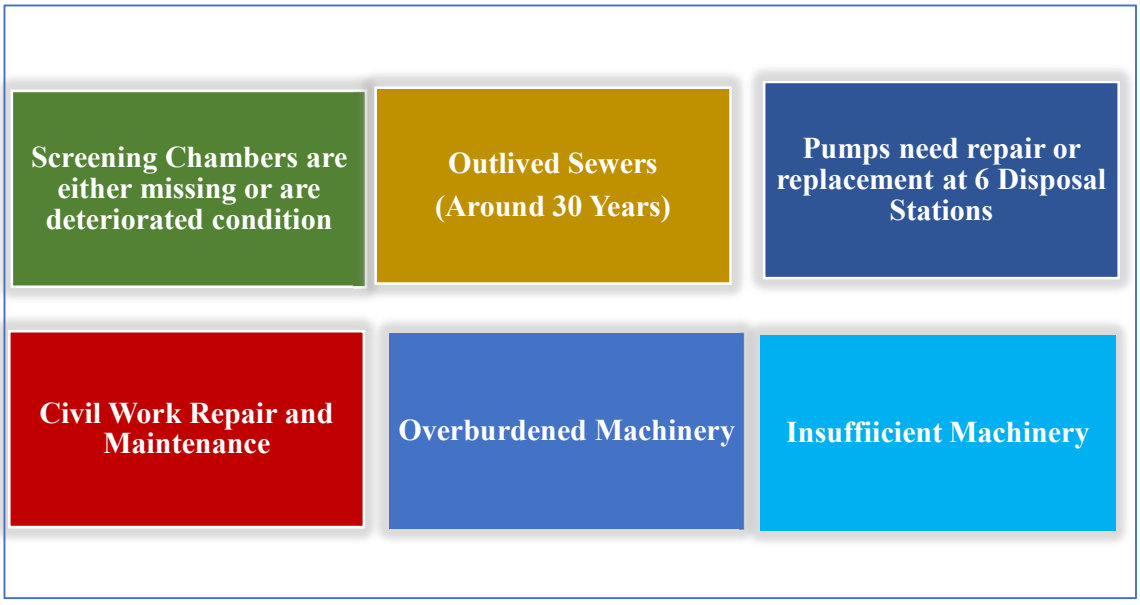


Figure 31 Disposal Stations Status

The condition of the sewerage infrastructure was evaluated during the field visit and major gaps were identified. Currently, 6 disposal stations need pump repair or replacement. Following were major gaps identified during the detailed condition assessment of the existing Sewerage infrastructure.



<table>
<tr><td>  </td><td>  </td></tr>
<tr><td>Disposal Station Survey</td><td>Civil Structure Condition of Dry Well DS</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>Condition of Electrical Component</td><td>Meeting with MOI</td></tr>
</table>

Figure 32 Field Survey and Assessment

After a detailed condition assessment, the following was established as the overall condition and respective rating.

Table 17 Condition Assessment Outcome

Asset Attribute	Rating
Civil Structures	**C (Fair)**
Electro-Mechanical	**C (Fair)**
Sewer	**C (Fair)**

5.7 Sewage Generation

The sewage generation has been made corresponding to the 30 gallons per capita per day water demand i/c 20% unaccounted for water (NRW). A contribution of 33% for storm-water flow, 5% infiltration & 5% non-domestic flows have been included during the calculation of the total sewerage flow. The current (2023) sewage generation and the future (2025, 2028 and 2033) sewage generation are shown in the table below.

Table 18 Sewage Generation

Sewage Generation				
Year	**2023**	**2025**	**2028**	**2033**
Population	304,195	324,792	358,331	422,102
Avg. Waste Water Generation (MGD)	7	8	9	10
Peak Sewage Flow (MGD-I)	14.84	15.85	17.49	20.60
Storm Water Flow (MGD-I)	4.90	5.23	5.77	6.80
Infiltration Flows (MGD-I)	0.37	0.40	0.44	0.51
Non-Domestic Flows (MGD-I)	0.37	0.40	0.44	0.51
Total Sewage Flow (MGD-I)	**20**	**22**	**24**	**28**

Currently, all the Disposal Stations are functional and in operation but need rehabilitation in the form of pump replacement, minor civil work repairs and provision of the necessary components.

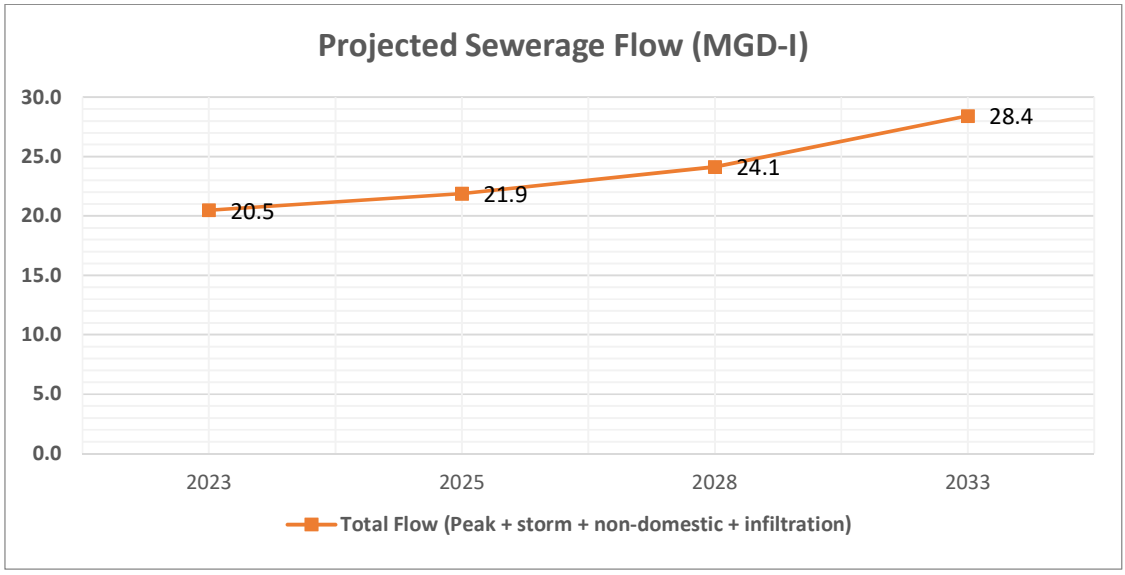


Figure 33 Projected Sewage

An elevation Map has been developed for planning purposes which indicates the elevation level of the terrain and appropriate natural flow for the drainage system and sewage pipelines. The highest and lowest level of the Khanewal city is approximately 145 meters and 123 meters respectively. The maximum difference in city elevation is around 22 meters.

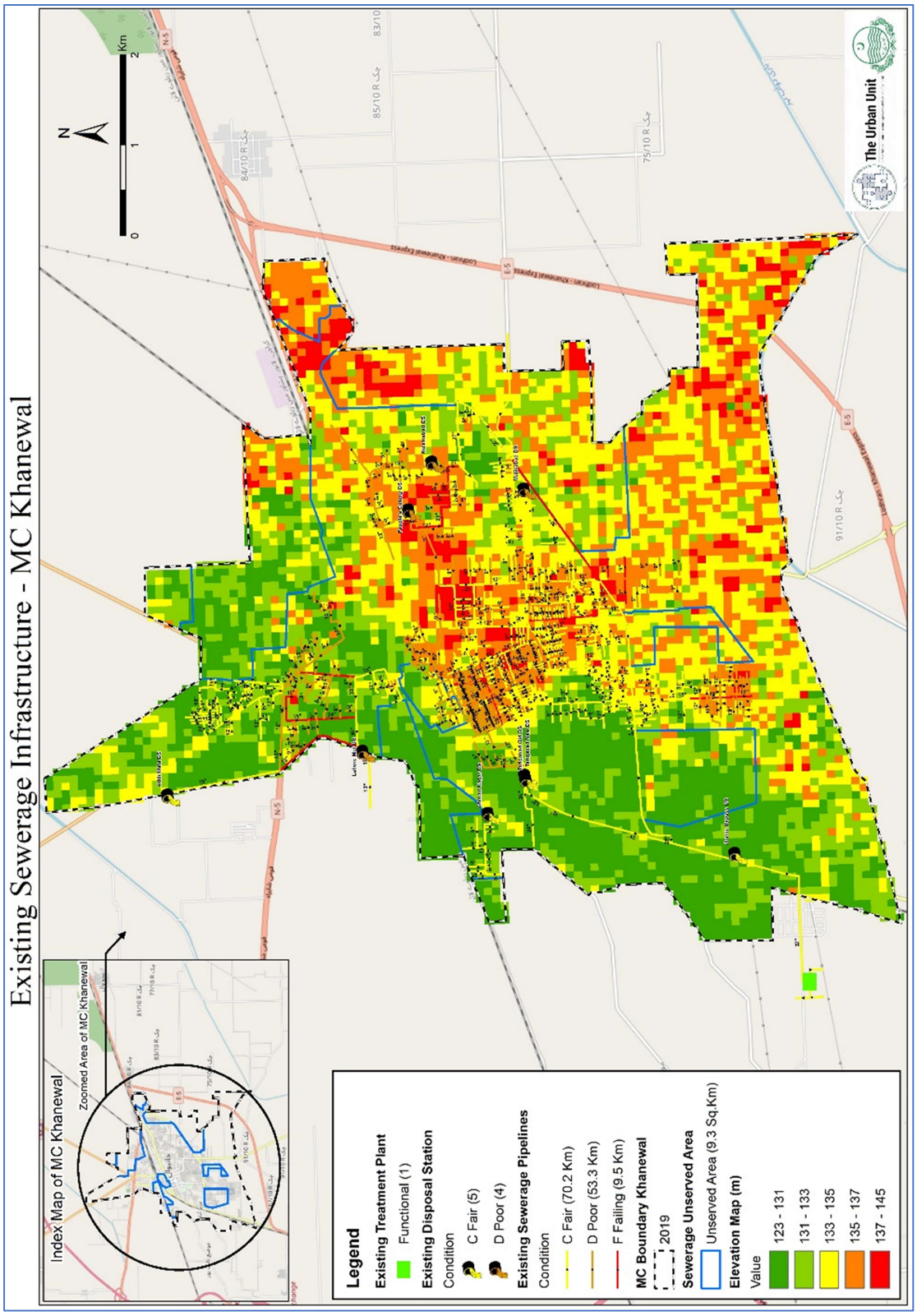


Figure 34 Elevation Map

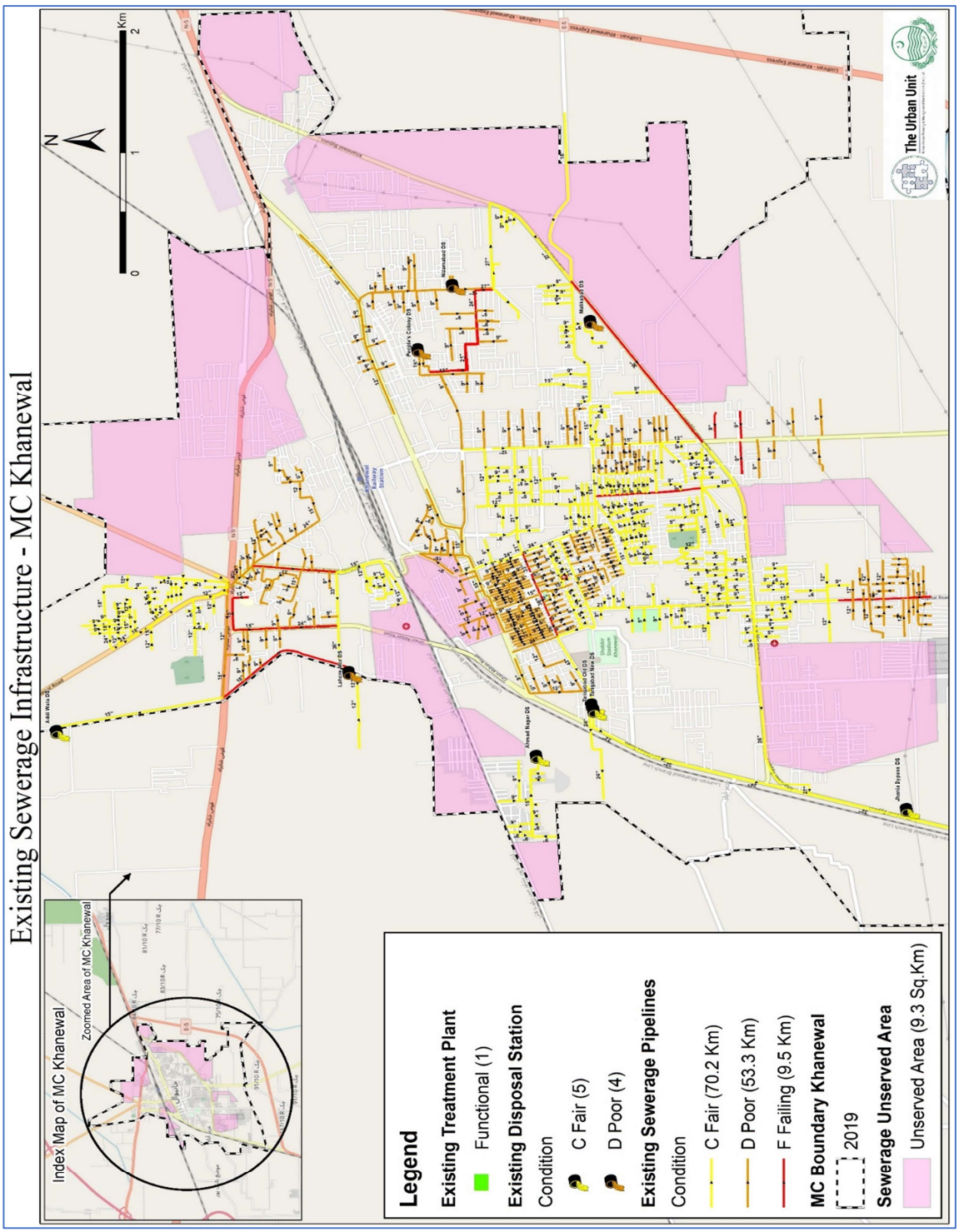


Figure 35 Sewerage Baseline

5.8 Sewerage Interventions

Afore-described gaps relating to the Sewerage issues are filled in the planning exercise in detail. Prioritization of these gaps is also done and hence schemes are proposed based on various factors such as essence of intervention, duration required to execute them, cost required, and their impact on public. Total cost required to uplift the current water supply situation is 4,946 Million.

Short Term Plan

In the Short term, to improve the existing sewerage condition of the city rehabilitation of the existing sewerage infrastructure is proposed. This includes Pump replacement of failed pumps, provision of electrical distribution board, installation of failing screening chambers, minor civil work repairs and construction of New Washroom & Quarter Rooms at DS (where required)) of the existing seven disposal stations at Lahore Morr, Nizamabad, Malikabad, Tariqabad Old & New, Jahanian Bypass and Ahmad Nagar, Disposal Station. This also involves the replacement of problematic and undersized main sewers and the procurement of sewerage machinery for cleaning sewers. This plan may cause around Rs. 824 Million.

Medium Term Plan

The Medium-term plan for the sewerage system involves the replacement of poor, failing and/or undersized sewers and new sewers to augment the service areas and connecting the network to proposed future sewerage treatment plants. A total of 65 Km of problematic sewers is planned to be replaced at Block 1, Stadium Road, Timber Market, Canal Colony, Irshad Colony and S.P Chowk. It also involves the extension of sewers to new and future sewerage treatment plants. This plan may require around Rs. 1035 Million.

Long-Term Plan

In the Long term, to cater for the future sewage (2033) capacity enhancement of 5 Disposal Stations at Lahore Morr, Nizamabad, Malikabad, Jahanian Bypass and Ahmad Nagar, Disposal Station is planned. Extension of sewerage system at unserved areas of Ahmed Nagar, Islam Park, Bakhtiyari Garden, Zahoorabad, Basti Khalil Wali, Hakeemabad, Khanewal Garha Morr Road and Near District Jail is also proposed. Two new Sewerage Treatment Plans (Anaerobic and Facultative Type) having areas of 25 Acres each with 7 MGD capacity each, are also included in this plan. These interventions may require around Rs. 3,087 million.
The following are proposed schemes for the Khanewal (MC):

Table 19 Proposed Projects

Sr. #	Planning Term	Sector	Proposed Schemes	Scope	Cost (Million)
1	Short (2025)	Sewerage	Rehabilitation of Sewerage Infrastructure in Khanewal City and Procurement of related Machinery	▸ Rehabilitation of 07 Disposal Station at Lahore Morr, Nizamabad, Malikabad, Tariqabad Old & New, Jahanian Bypass and Ahmad Nagar, Disposal Station (Pump replacement of failed pumps, provision of electrical distribution board, installation of failing screening chambers, minor civil work repairs and construction of New Washroom & Quarter Rooms at DS (where required))	338
				▸ Replacement of outdated or undersized main sewers in Areas: Canal Road, Old Lodhran Road, Khanewal Lodhran Road, and Bukhtiyari Garden (Replacement of problematic and/or undersized main sewers (28.3 Km) Dia 12”,15”,18”,24”,27”,33”,36”& 42”)	445
				▸ Sewerage Machinery Procurement of one Sucker and one Jetting machinery (Procurement of one Sucker and one Jetting machine)	41

2	Medium (2028)		Extension of Sewerage System in Khanewal City – Phase I (Areas: Block 1, Stadium Road, Timber Market, Canal Colony, Irshad Colony and S.P Chowk)	▸ New Main Sewers connection to (two future and one existing) Sewerage Treatment Plant (STP)	70
				▸ Replacement of 9” sewers with Poor or Failing status (65 Km) Dias: 9”,12”,15”,18”21”24”,27”,33”,36” & 48”	965
3	Long (2033)		Extension of Sewerage System in Khanewal City – Phase II (Areas: Ahmed Nagar, Islam Park, Bakhtiyari Garden, Zahoorabad, Basti Khalil Wali, Hakeemabad, Khanewal Garha Morr Road and Near District Jail)	▸ Capacity Enhancement of 5 Disposal Stations (Lahore Morr, Nizamabad, Malikabad, Jahanian Bypass and Ahmad Nagar, Disposal Station)	677
				▸ Sewer laying in unserved areas with 9” sewers (158.80 Km)	877
				▸ Two new Sewerage Treatment Plant (STP) of 25 Acres each (Anaerobic and Facultative Type) with 7 MGD capacity (each)	1,533
				Total Sewerage – Khanewal MC	**4,946**

For Rough Cost Estimation, MRS, 1st BI-ANNUAL-2023 (01.01.2023 to 30.06.2023) District Khanewal has been Applied. The 2% Contingencies and 5% PST are also added in the estimates. This is further subject to the Detail Design of the proposed schemes upon PC-1 formation.

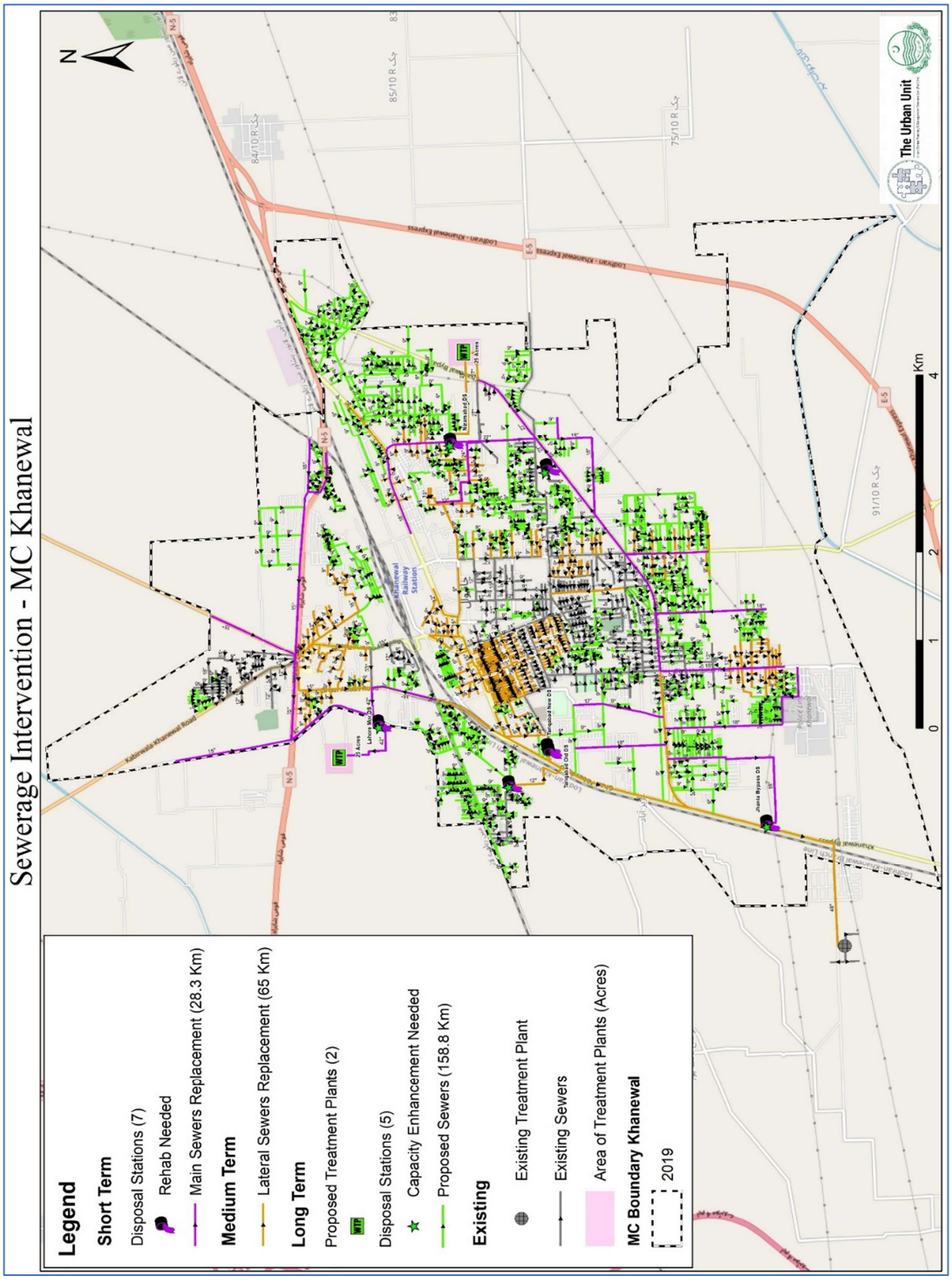


Figure 36 Sewerage Interventions

LODHRAN CITY

6 Lodhran City

Lodhran City lies on the northern side of River Sutlej (around 20 kms away). City lacks proper water supply which is due to non-existent network spread as only 300 houses and 10 filtration plants are being served currently under MC owned schemes (comprising of three Tube wells and two OHRs). Almost all of the existing water supply pipeline (8.74 km) is in deteriorating condition (poor). The sewerage arrangement of city is relatively better as around 80% of current populated areas of the city are served with sewers (Fair condition) however there still remains various unserved pockets. Major issue relating to Sanitation is non-existent sewerage treatment arrangement as currently all six of its Disposal Station disposes their sewage in agriculture field or open fields.

Keeping in view the above issues, Water Supply and Sanitation plan is proposed for the next ten years (2033) for an estimated projected population of around 192,826.

6.1 Existing Water Supply Infrastructure

Water Supply coverage in the Lodhran City is as less as around 5% as only ten filtration plant and around 300 house-hold connections are being served through mean of three tube wells and two OHRs. Resident of the city fulfil their water needs from house-hold bores. The Water Quality of the schemes in Lodhran MC is mostly sweet and drinkable. Where tested, it showed (average) pH of 7.1, TDS of 436, and EC of 876.

Detail of the aforementioned schemes is as below:

Table 20 Water Supply Infrastructure

Sr. No.	Scheme / Tube Well info	Year	Pump Detail	Overall Condition	OHR (Capacity in Gallons)	OHR Detail	Pipeline length	Pipeline Condition
1	Water Works Railway Road	1980	1 @ 0.5 Cusecs (30 HP)	D (Poor)	20,000	D (Poor) Age back to 1965	length 8.74 KM of varying dias (3", 4", 6", and 8")	Mostly D (Poor)
2	Basti Gher	1990	1 @ 0.5 Cusecs (30 HP)	C (Fair)	75,000	C (Fair) R.C.C 2013		
3	Dhangaybwala	2013	1 @ 0.5 Cusecs (30 HP)	C (Fair)	-	-		

Following is the status of current Tubewells of aforementioned capacity.

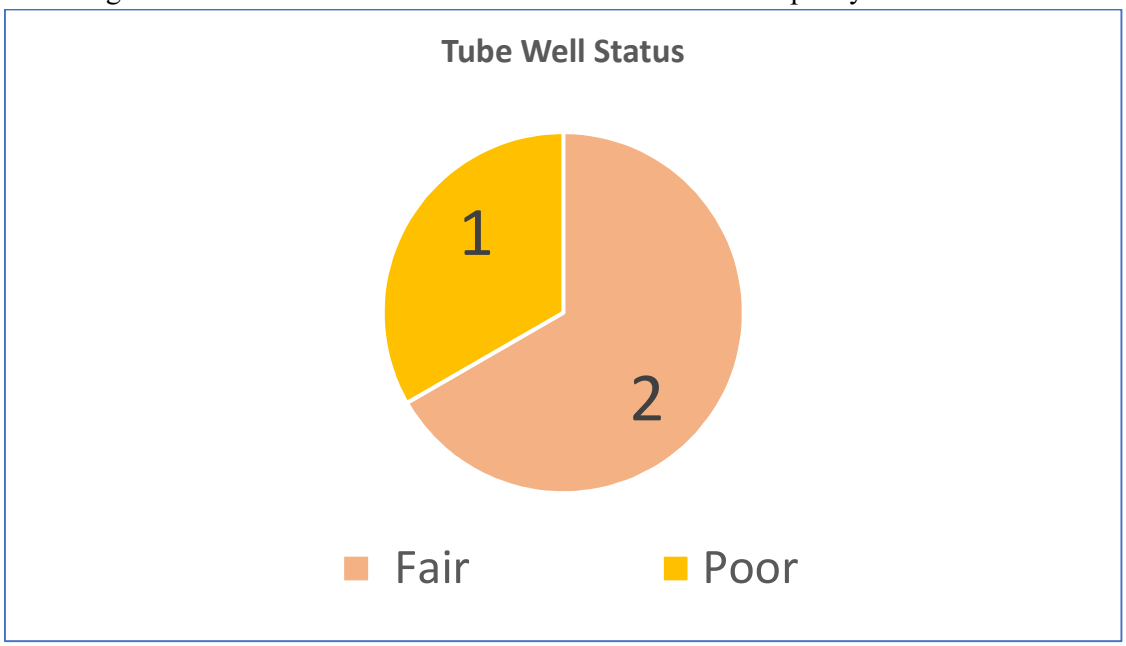


Figure 37 Tube-wells status

6.2 Water Supply versus Water Demand

In quantified terms, Water Demand versus Water Supply can be illustrated from graph below which indicates water production is 16 times lower than the water demand and only 6% of demand is being meet at the present (2023). This decrease to further 4.5% keeping in view the population augmentation.

Table 21 Water Demand

Water Demand Estimation				
Years	**2023**	**2025**	**2028**	**2033**
Population	141,682	150,690	165,288	192,826
Per Capita Demand (GPCD)	30	30	30	30
Average Daily Demand (MGD-I)	4.3	4.5	5.0	5.8
Maximum Daily Demand (MGD-I)	6.5	6.9	7.6	8.8
Peak Hourly Demand (MGD-I)	9.6	10.2	11.2	13.0

This indicates need of new tube wells to carter to the demand of the current and future augmented population.

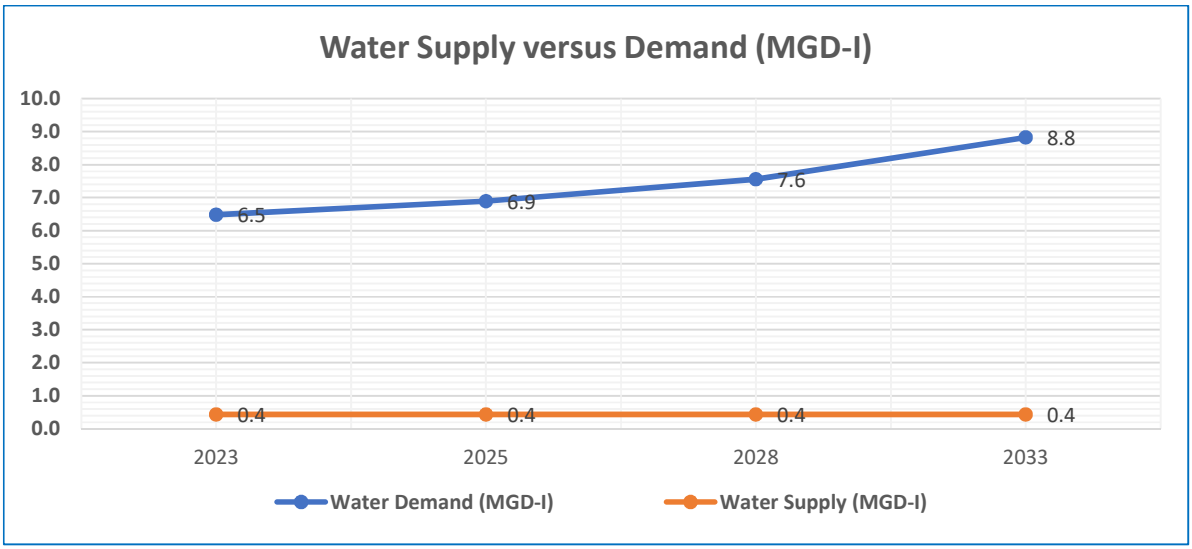


Figure 38 Water Supply versus Demand

6.3 Condition Assessment of Water Supply Infrastructure

Following were major gaps identified during the detail condition assessment of the existing Water Supply infrastructure.

	
Railway Road TW - Condition of Installed Motor	OHR at Railway Road, Lodhran (Evident leakages)

Figure 39 In Pictures: Field Survey and Assessment

After detail condition assessment, following was established as overall condition and respective rating.

Table 22 Condition Assessment

Asset Attribute	Rating
Civil Structures	**D (Poor)**
Distribution Network	**D (Poor)**
Electro-Mechanical	**C (Fair)**

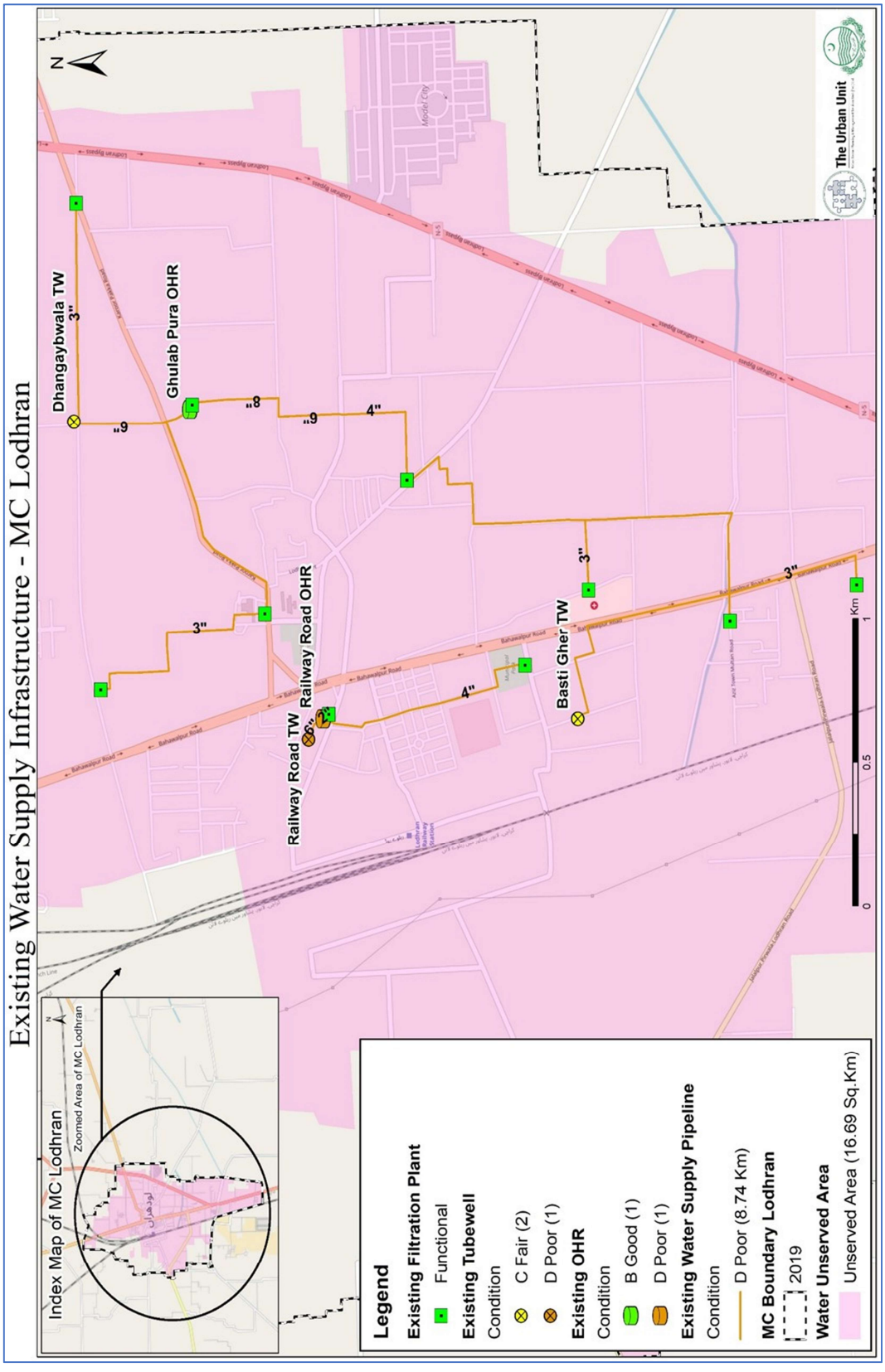


Figure 40 Water Supply Baseline

6.4 Water Supply Interventions

Afore-described gaps relating to the Water Supply are filled in the planning exercise in detail. Prioritization of these gaps is also done and hence schemes are proposed based on various factors such as essence of intervention, duration required to execute them, cost required, and their impact on general public. Total cost required to uplift the current water supply situation is 1,039 Million.

Short Term Plan

Current coverage of Lodhran City is around 5% hence it is of utmost essence to strengthen water supply network starting from the areas which will have high impact. As such, Major rehabilitation of one existing tube well at Railway Road is proposed which is currently in Poor condition and have lessen yield. Reconstruction of existing one OHR (20,000 gallons capacity) is also proposed to 100,000 Gallons as this OHR is incapacitated w.r.t. future population and currently have evident leakages probably due to over-aging effect (constructed in 1965). Laying of Water Supply pipeline in Railway Road and adjacent areas is also proposed of total 4 km length (varying dia 4" and 6").
Total Cost required for Short Term Plan for water supply is 84 Million.

Medium Term Plan

In Medium term, Water supply services are planned to be improved by expanding services to the unserved areas. As un-served area is around 95%, service expansion is planned in two phases (Phase-I and Phase-II). Phase-I is proposed in Medium term intervention plan with service targeted for Korray Wala, Basti Ghhair and Liaqt Abbad and all of the adjacent areas. Infrastructure proposed for this includes, five tube wells (1.5 cusecs each), one OHR (50,000 Gallons), one OHR (100,000 Gallons) and laying of WS pipeline of 39.20 km having varying dias (4", 6", and 10").
Total Cost required for Medium Term Plan for water supply is 204 Million.

Long Term Plan

In Long term, Water supply services are planned to be improved by expanding services to the further unserved areas (Phase-II). Phase-II is proposed in Long term intervention plan with service targeted for Basti Pirwala, Naiwala, Mahram Wala, Basti Dahana, Sufi Nazar Hussain Road, Basti Nawan Khoo, Basti Ghareeb Abad, Bahoo Wala, New Faizabad, Essa Wala, Ranjha Wala, 5 Marla Scheme, Aziz Town, B Colony and Al Noor Garden and all of the adjacent areas.

Infrastructure proposed for this includes, 15 tube wells (1.5 cusecs each), six OHRs (50,000 Gallons), two OHRs (25,000 Gallons) and laying of WS pipeline of 110.60 km having varying dias (4", 6", and 10").

Total Cost required for Long Term Plan for water supply is 751 Million.

6.5 Water Supply Interventions

Following are proposed schemes for the Lodhran (MC):

Table 23 Proposed Schemes

Sr. #	Planning Term	Sector	Proposed Schemes	Scope	Cost (Million)
1	Short (2025)	Water Supply	Rehabilitation of Water Supply System in Lodhran City	▸ Rehabilitation of Civil Structure, Replacement of pump and provision of Chlorinator, bulk meters and electrical distribution board for Existing Tube Well ▸ Dismantling of 01 existing OHRs, its Reconstruction having capacity 100,000 Gallons and Construction of New Washrooms & Quarter Rooms at Railway Road WS Scheme ▸ Laying of WS Pipelines of total length 3.9 km having dias of 6" and 4"	84
2	Medium (2028)		Extension of Water Supply System in Lodhran City – Phase I (Areas: Korray Wala, Basti Ghhair and Liaqat Abbad)	▸ Construction of five Tube Wells (1.5 Cusecs each) ▸ Construction of one Overhead Water Tank	204

				(50,000 Imperial Gallons) and one Overhead Water Tank (100,000 Imperial Gallons) ▸ Laying of WS Pipelines of total length 39.20 km having dias of 10", 6" and 4"	
3	Long (2033)		Extension of Water Supply System in Lodhran City – Phase I (Areas: Basti Pirwala, Naiwala, Mahram Wala, Basti Dahana, Sufi Nazar Hussain Road, Basti Nawan Khoo, Basti Ghareeb Abad, Bahoo Wala, New Faizabad, Essa Wala, Ranjha Wala, 5 Marla Scheme, Aziz Town, B Colony and Al Noor Garden)	▸ Construction of 15 Tube Wells (1.5 Cusecs each) ▸ Construction of six Overhead Water Tank (50,000 Imperial Gallons) and two Overhead Water Tank (25,000 Imperial Gallons) ▸ Laying of WS Pipelines of total length 110.60 km having dias of 10", 6" and 4"	751
3				**Total Water Supply – Lodhran MC**	**1,039**

For Rough Cost Estimation MRS, 1st BI-ANNUAL-2023 District Lodhran has been Applied. The 2% Contingencies and 5% PST are also added in estimates. This is further subject to Detail Design of the proposed schemes upon PC-1 formation.

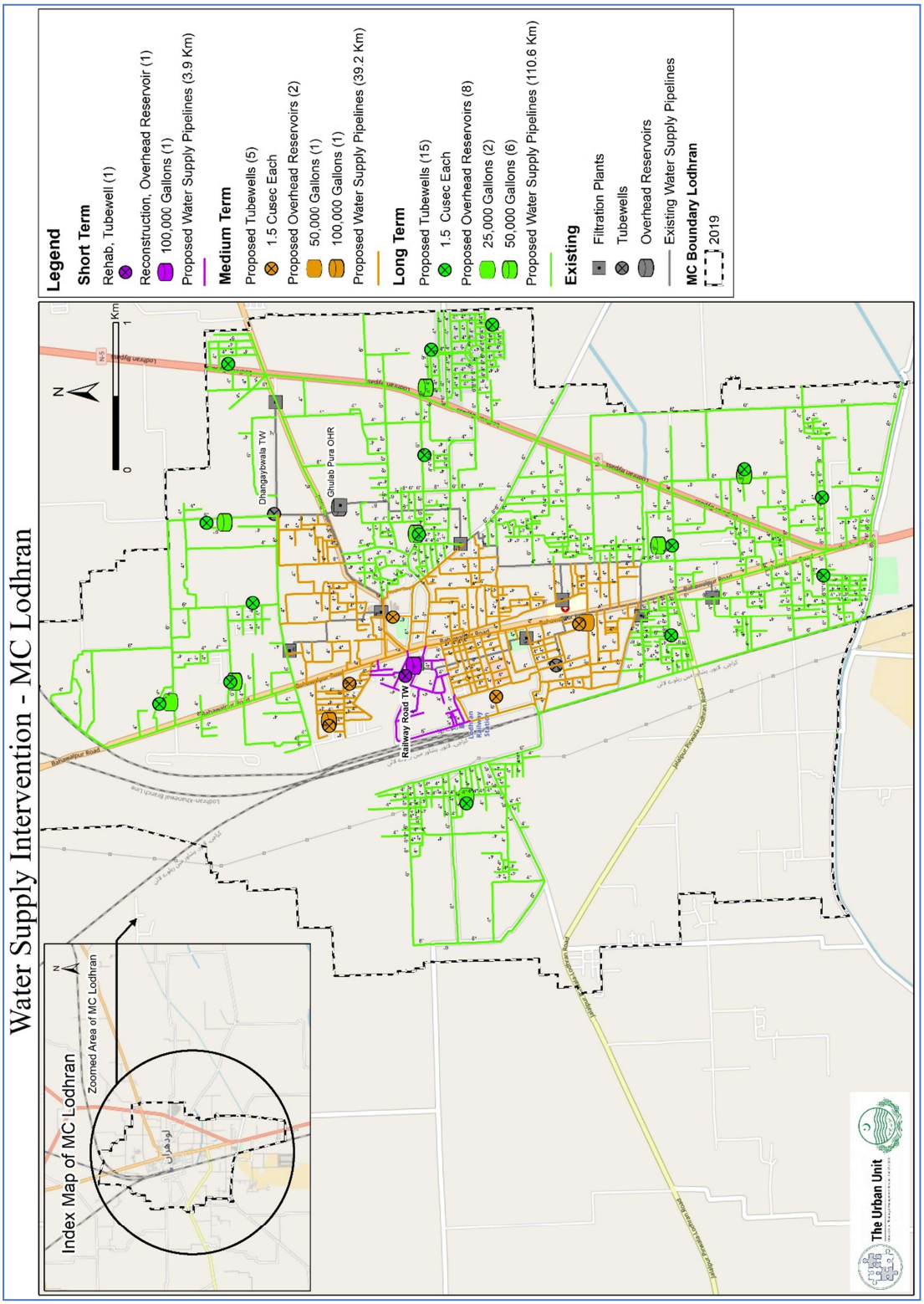


Figure 41 Water Supply Intervention

6.6 Existing Sewerage Infrastructure

Sewerage arrangements in the Lodhran City is carried mostly through sewers of RC (Reinforced Concrete) material which dispose sewage to the six functional disposal stations which further ultimately dispose it off to agriculture land or open fields through either small nullah or sullage carriers. It is alarming that city currently have no Sewerage Treatment Plant (STP) for sewage treatment mechanism which is direct breach of environmental policy of Pakistan and poses threat to agricultural food grown in fields.
Detail of mentioned six disposal stations is as below:

Table 24 Sewerage Infrastructure

Sr. No.	Disposal Station	DS Condition	Comments	Ultimate Disposal Station	Sewers Dias (Overall)	Sewer Condition (Overall)
1	Hassan Wala DS	C (Fair)	Functional	Agriculture Land or Open Fields	Length around 87 KM of varying dias (9", 12", 15", 18", 21", 24", and 54")	C (Fair)
2	Jat Wala DS	C (Fair)	Functional			
3	Havelo Naseer Kharot Khan DS	C (Fair)	Functional			
4	Thakar Wala	C (Fair)	Functional			
5	Masoodabad DS	C (Fair)	Functional			
6	Jinnah Colony DS DS	D (Poor)	Functional			
-	100 Chak DS	Abandoned	Abandoned			

6.7 Condition Assessment of Sewerage Infrastructure

Following was major gaps identified during the detail condition assessment of the existing Sewerage infrastructure.

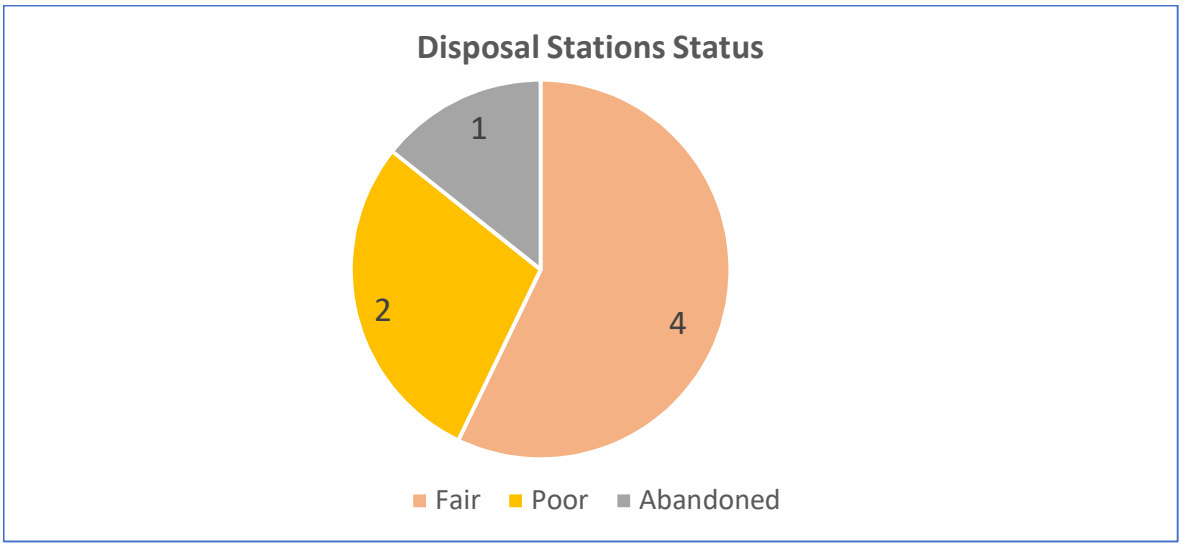


Figure 42 Disposal Station Status

	
Disposal Station Survey	Pump placed in open space at DS

Figure 43 In Pictures: Field Survey and Assessment

After detail condition assessment, following was established as overall condition and respective rating.

Table 25 Condition Assessment Outcome

Asset Attribute	Rating
Civil Structures	**C (Fair)**
Electro-Mechanical	**D (Poor)**
Sewers	**C (Fair)**

6.8 Sewage Generation

The sewage generation have been made corresponding to the 30 gallons per capita per day water demand i/c 20% unaccounted for water (NRW). A contribution of 33% for storm-water flow, 5% infiltration & 5% non-domestic flows have been included during the calculation of the total sewerage flow. The current (2023) sewage generation and of the future (2025, 2028 and 2033) sewage generation are shown in the table below.

Table 26 Sewage Generation

Sewage Generation				
Years	**2023**	**2025**	**2028**	**2033**
Population	141,682	150,690	165,288	192,826
Peak Sewage Flow (MGD-I)	6.91	7.35	8.07	11.76
Storm Water Flow (MGD-I)	2.28	2.43	2.66	3.88
Infiltration Flows (MGD-I)	0.17	0.18	0.20	0.29
Non-Domestic Flows (MGD-I)	0.17	0.18	0.20	0.29
Total Sewage Flow (MGD-I)	**9.5**	**10.1**	**11.1**	**16.2**

Currently all the Disposal Stations are functional but are incapacitated hence need various replacement and/or repairment of pumps and provision of basic services and Civil Structure improvement.

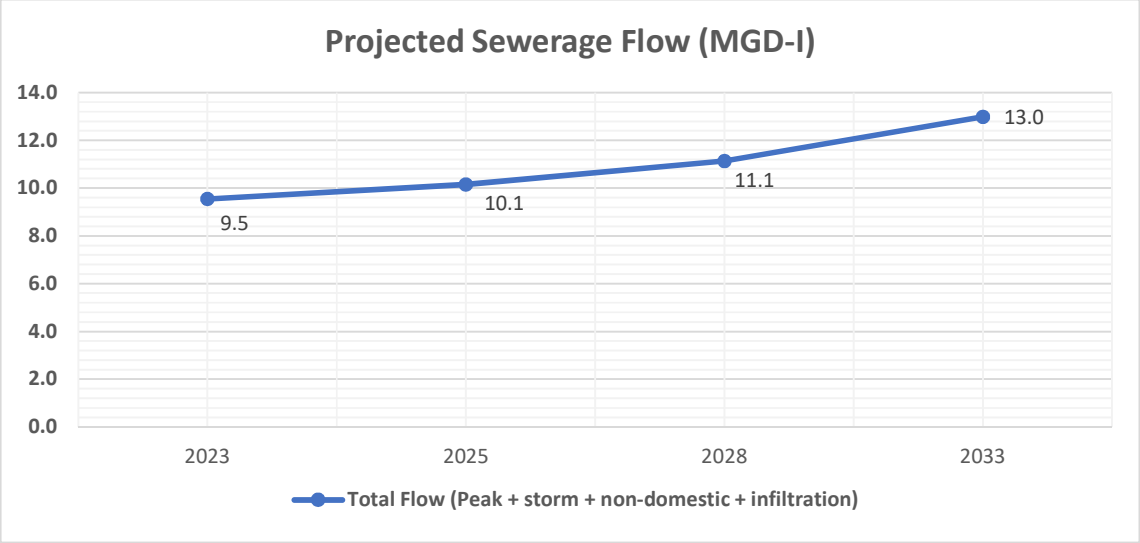


Figure 44 Projected Sewage

Elevation Map was also used for planning purposes. Elevation data shows that elevation of 111 to 122 meters from Mean Sea Level (MSL). All of the current Disposal Stations are stationed rightly w.r.t. elevation profile as all these areas are relatively depressed in terrain.

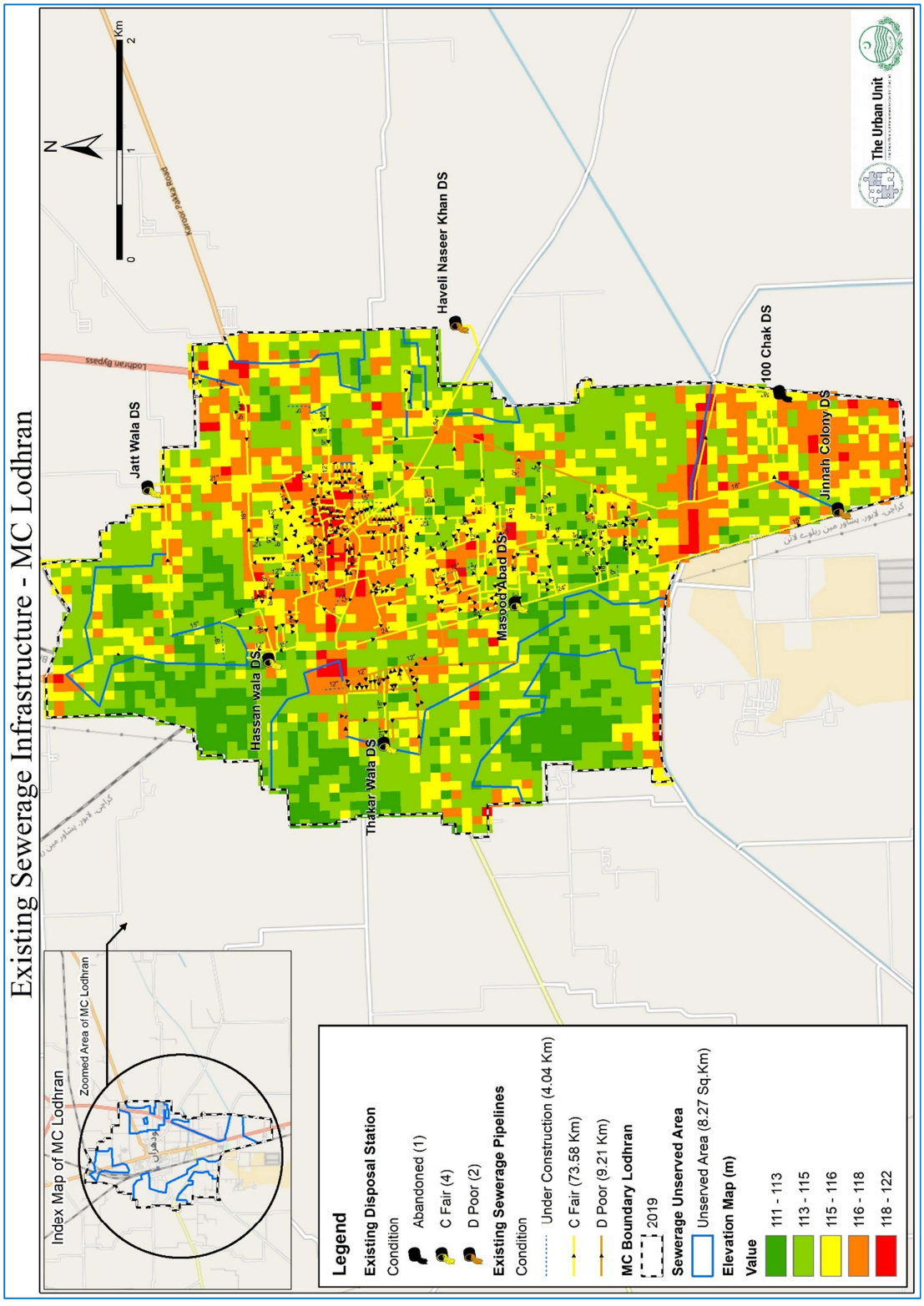


Figure 45 Elevation Map

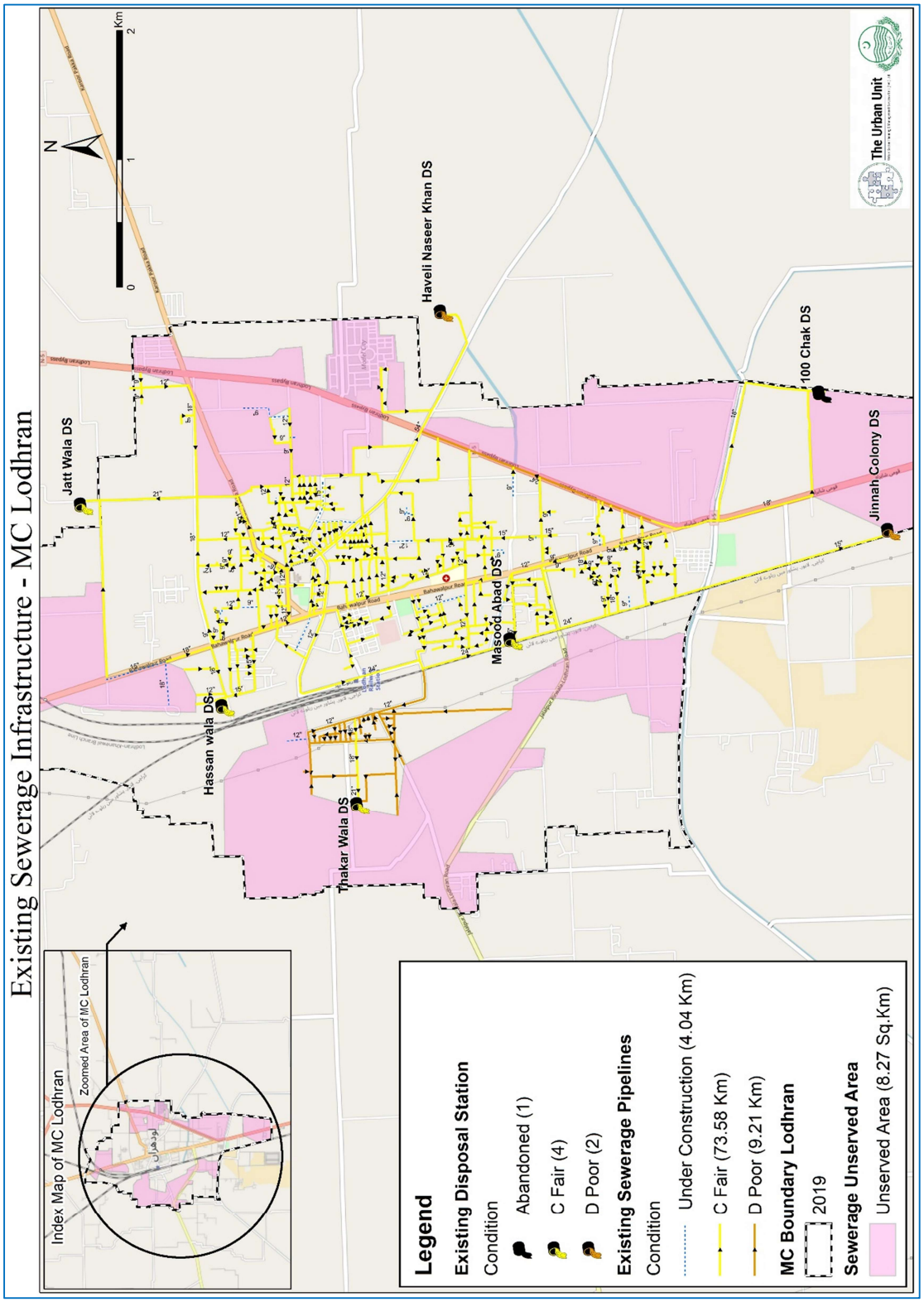


Figure 46 Sewerage Infrastructure

6.9 Sewerage Interventions

Afore-described gaps relating to the Sewerage issues are filled in the planning exercise in detail. Prioritization of these gaps is also done and hence schemes are proposed based on various factors such as essence of intervention, duration required to execute them, cost required, and their impact on public. Total cost required to uplift the current sewerage arrangement is 3,169 Million.

Short Term Plan

To improve the sewerage condition of the city, it is important to first fully capacitate the current system first but do that so as it can also carter to the need to the future years i.e. planning horizon year (2033). As such, all six Disposal Stations (Hassan Wala, Jat Wala, Havelo Naseer Kharot Khan, Thakar Wala, Masoodabad, and Jinah Colony) are proposed to be rehabilitated. Replacement of outdated and/or undersized main sewers is also proposed including areas: Bihari Colony, Essa Wala, Thaker Wala Road, Kundi Road, Old Jalalpur Pirwala Road, and Railway Road with total length 14.15 km. Sewerage cleaning machinery is also proposed which includes one sucker and one jetting machine.
A total of 423 Million will be required to make these interventions in Short Term.

Medium Term Plan

In Medium term, Sewerage services are planned to be improved by expanding services to the unserved areas. This is done in two phases (Phase-I and Phase-II). Phase-I is included in Medium term plan with serving areas: Jalalpur Pirwala Road, Ali Wah Minor, Old Jalalpur Pirwala Road, Agha Nadeem Colony, and Near Muslim Town. Sewer proposed are of 12", 18" and 24" dia of total length of 8 km and will be lay as to integrate the network with respective Disposal Station.

Total Cost required for Medium Term Plan for Sewerage is 83 Million.

Long Term Plan

In the Long term, Phase - II of outdated sewers is planned in which length of 54.6 KM is proposed to be lay. For the safe disposal of sewage, three waste water treatment plants (Stabilization Ponds) are also proposed for existing six disposal stations. Detail of mentioned three Waste Water Treatment Plants – Stabilization Ponds (Anaerobic and Facultative Type) is as follow:

- 8 MGD STP of 27 Acres (Shared: Jatt Wala DS and Haveli Naseer Khan DS)
- 5 MGD STP of 17 Acres (Shared: Thakar Wala DS and Hassan Wala DS)
- 3.3 MGD STP of 11 Acres (Shared: Masood Abad DS and Jinnah Colony DS)

Total Cost required for Long Term Plan for Sewerage is 2,663 Million.

Following are proposed schemes for the Lodhran (MC):

Table 27 Proposed Schemes

Sr. #	Planning Term	Sector	Proposed Schemes	Scope	Cost (Million)
1	Short (2025)	Sewerage	Rehabilitation of Sewerage Infrastructure in Lodhran City and Procurement of related Machinery	▸ Rehabilitation of 06 Disposal Station at Hassan Wala, Jat Wala, Havelo Naseer Kharot Khan, Thakar Wala, Masoodabad, and Jinah Colony (Pump replacement of failed pumps, provision of electrical distribution board, installation of failing screening chambers, minor civil work repairs and construction of New Washroom & Quarter Rooms at DS (where required)) ▸ Replacement of outdated or undersized main sewers (Areas: Bihari Colony, Essa Wala, Thaker Wala Road, Kundi Road, Old Jalalpur Pirwala	423

				Road, Railway Road) ▸ Sewerage Machinery Procurement of one Sucker and one Jetting machinery	
2	Medium (2028)		Extension of Sewerage Services in Lodhran City – Phase I (Areas: Jalalpur Pirwala Road, Ali Wah Minor, Old Jalalpur Pirwala Road, Agha Nadeem Colony, and Near Muslim Town)	▸ New Main Sewers in unserved areas (7.9 Km) (dias 12", 18" & 24")	83
3			Extension of Sewerage Services in Lodhran City – Phase II (Areas addressed: Model City, Baqawala, Bastipirwala, Shadman City, Basti Ghangiwala, Ismail Town Lodhran, District Jail Road, 5 Marla Scheme (only Main Road), Essawala, Kundi Road, Near Thadda Distributory, Basti Ghareebabad, Kahror Pakka Road, Jaat Wala Road, Basti Gangiwala)	▸ Capacity Enhancement of six existing Disposal Stations Hassan Wala, Jat Wala, Havelo Naseer Kharot Khan, Thakar Wala, Masoodabad, and Jinah Colony ▸ Sewer laying in unserved areas with 9" sewers (54.60 Km) ▸ Three new Sewerage Treatment Plants (STPs) of Anaerobic and Facultative Type ▪ I: 27 Acres with 8 MGD capacity	2663

				▪ II: 17 Acres with 5 MGD capacity ▪ III: 11 Acres with 3.3 MGD capacity)	
3				**Total Sewerage – Lodhran MC**	**3,169**

For Rough Cost Estimation MRS, 1st BI-ANNUAL-2023 District Lodhran has been Applied. The 2% Contingencies and 5% PST are also added in estimates. This is further subject to Detail Design of the proposed schemes upon PC-1 formation.

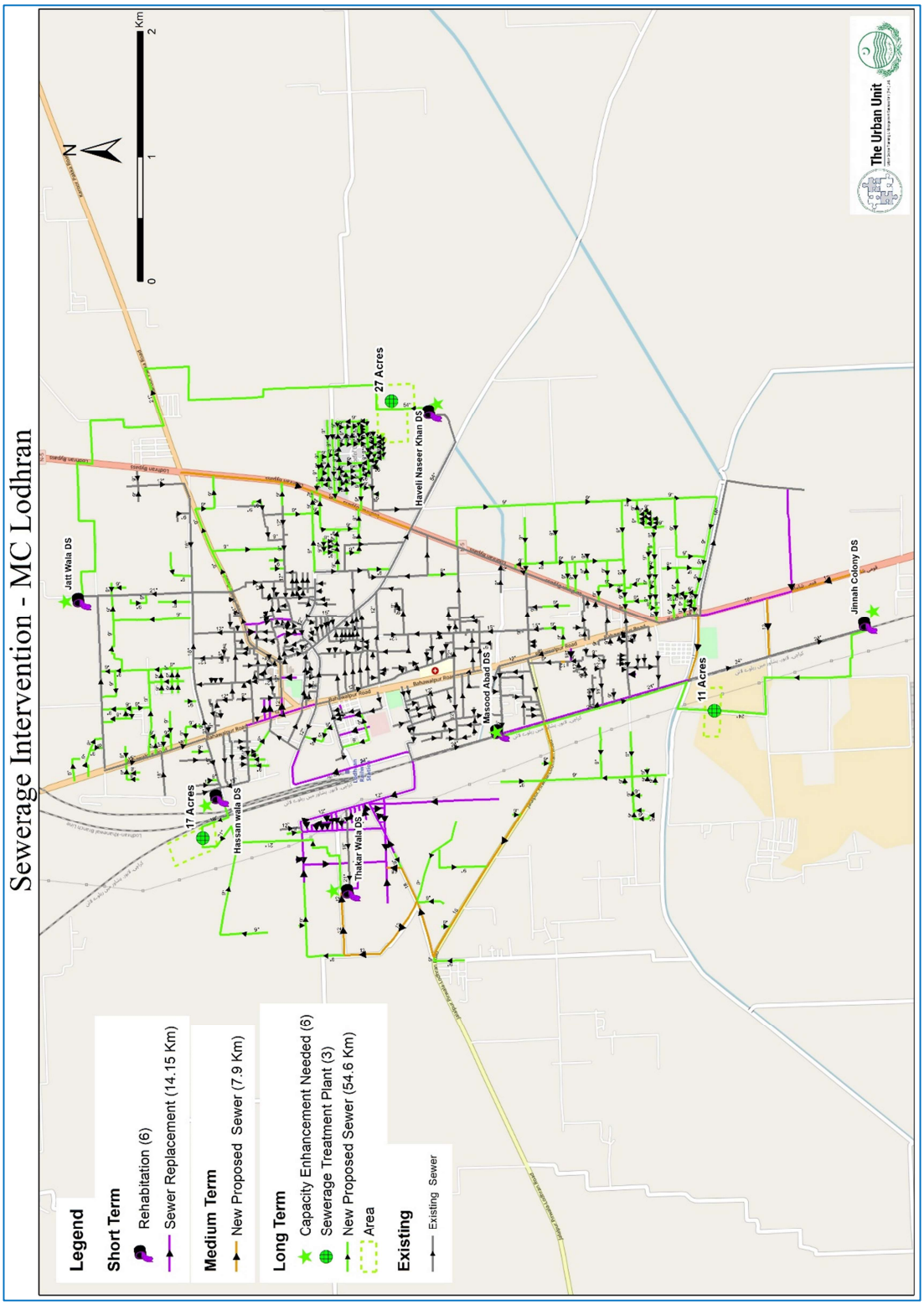
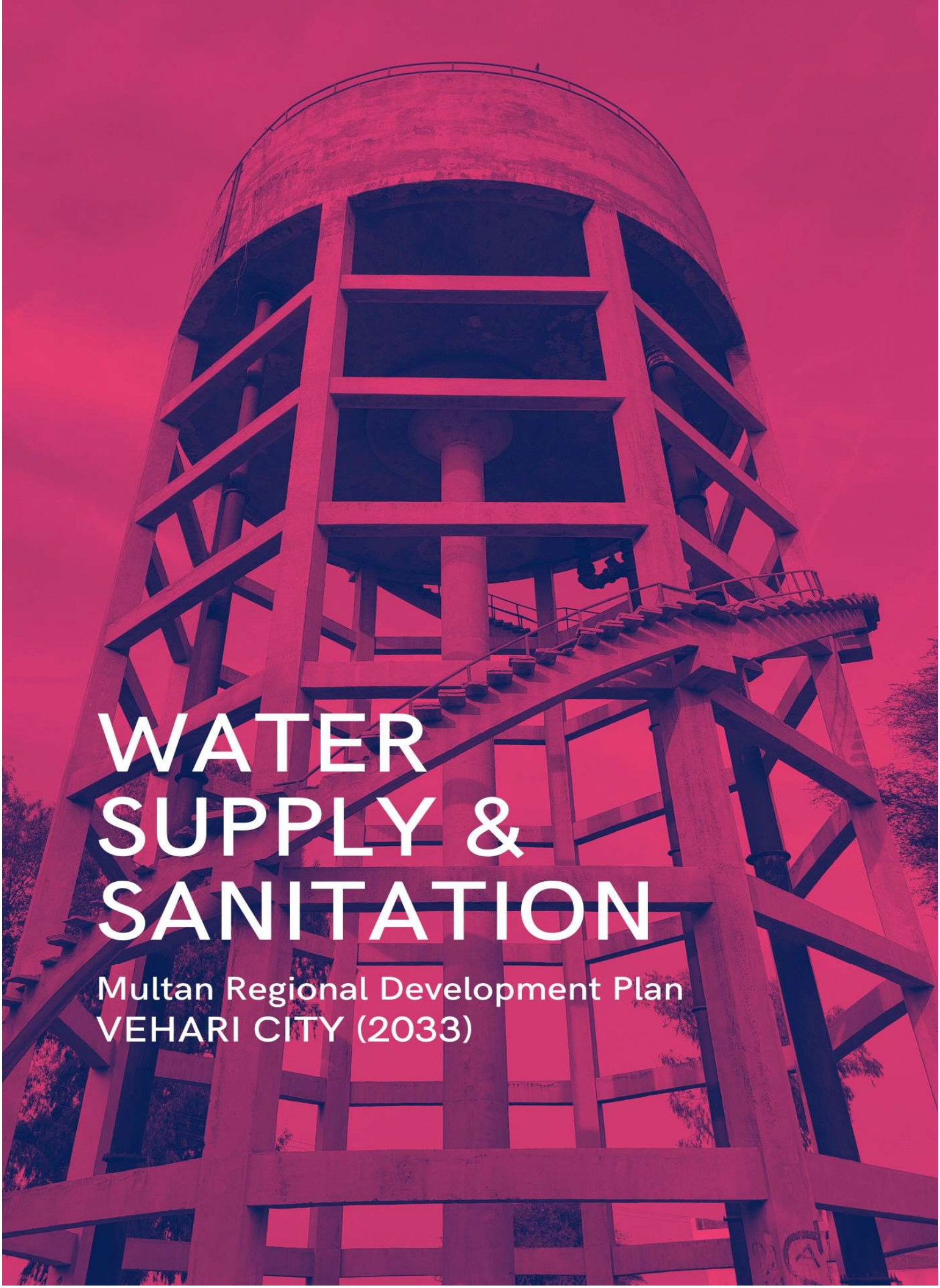


Figure 47 Sewerage Intervention



WATER SUPPLY & SANITATION

Multan Regional Development Plan
VEHARI CITY (2033)

7 Vehari City

Vehari is a city in the Multan Division, approximately 96 KM from the regional headquarters of Multan City and lies 37 KM on the northern side of River Sutlej. The MC owned water supply of the city consists of water works fed by tube wells, with an estimated 6000 consumer connections. The water is available at the user end for mere 1 hour per day creating considerable service delivery gaps. The spatial coverage of water supply is about 60% of the city. In comparison the sewerage system of the city covers about 70% of the city. The sewers and disposals have exceeded their design life and issues like silting and choking remain a regular sight. There is currently no treatment facility in the city with waste water mostly used for broad irrigation.

Keeping in view the above issues, Water Supply and Sanitation plan is proposed for the next ten years (2033) for an estimated projected population of around 209,890.

7.1 Existing Water Supply Infrastructure

Considerable water supply infrastructure exists in Vehari city. The water supply system has a spatial coverage of about 60% of the city with about 6000 consumer connections. Seepage tube wells (23 Nos.) along the Pakpattan canal feed various water works across the city. Water is initially pumped to Ground Storage Tanks (10 Nos.) from where it is further pumped to Overhead Reservoirs (08 Nos.) before distribution to adjacent areas. The water quality of the tube wells when tested showed satisfactory results with average pH of 7.04, TDS of 358 and EC of 723. However, TDS issues are reported by the MC staff during the canal closure days.

Major issue for water supply remains the service delivery gaps, primarily the average daily water supply at user end being a mere 1 hour. Non-functional infrastructure specially the tube wells also remain a hindrance to the streamline supply of water. 15 of the 23 tube wells were non-functional at the time of visit by the team.

Detail of the aforementioned water supply schemes is as below:

Table 28 Water Supply Infrastructure in Vehari

Attribute	Tube Well	OHR	GST	Water Lines
Total Nos.	23	10	08	Approx. 201 KM
Functional Status	Functional 8 / 23	Functional 7 / 8	Functional 9 /10	–
Installation Year	1974 – 2020	1962 – 2012	1974 – 2012	–
Installed Capacity	0.5 – 1 cusecs	10,000 – 100,000 Gallons	20,000 – 125,000 Gallons	4” – 16” Diameter
Condition of Assets	B = 05 Nos. C = 03 Nos. D = 15 Nos.	C = 04 Nos. D = 04 Nos.	C = 05 Nos. D = 05 Nos.	C = 168 KM D = 33 KM

The following graph indicates the condition of tube wells installed in Vehari.

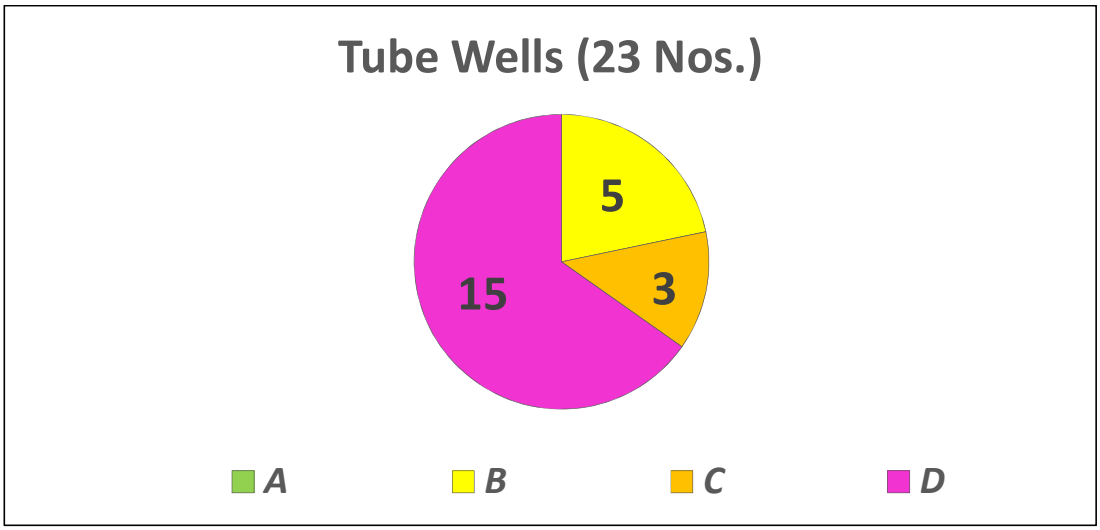


Figure 48 Tube-wells status

7.2 Water Supply versus Water Demand

The water demand estimation has been made corresponding to the 30 gallons per capita per day water demand i/c 20% unaccounted for water (NRW). The current (2023) average daily demand and of the future (2025, 2028 and 2033) daily demands are shown in the table below.

Table 29 Water Demand

Water Demand Estimation				
Years	**2023**	**2025**	**2028**	**2033**
Population	167,036	174,842	187,241	209,890
Per Capita Demand (GPCD)	30	30	30	30
Average Daily Demand (MGD-I)	5.01	5.25	5.62	6.30
Maximum Daily Demand (MGD-I)	7.52	7.87	8.43	9.45
Peak Hourly Demand (MGD-I)	11.27	11.80	12.64	14.17

In quantified terms, Water Demand versus Water Supply can be illustrated from graph below which indicates a considerable gap between the supply and demand of water. It should be noted that the reduced supply is due to lower working hours and incapacitated machinery at the assets. The need of new tube wells and accompanying infrastructure is felt to cater to the demand of the current and future augmented population.

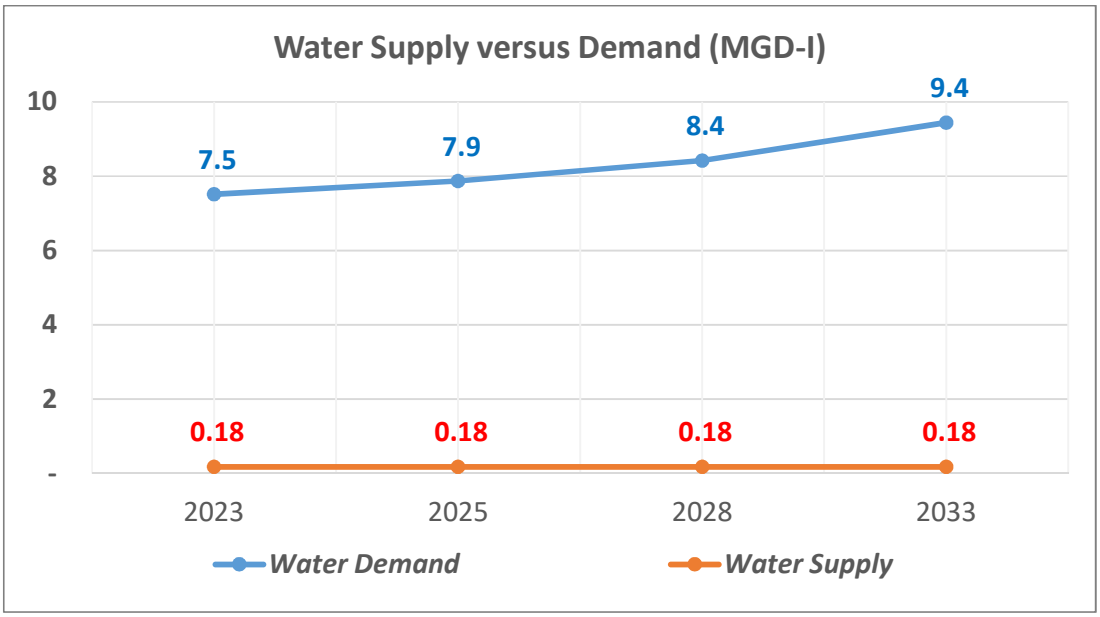


Figure 49 Water Supply versus Demand

7.3 Condition Assessment of Water Supply Infrastructure

Following were major gaps identified during the detail condition assessment of the existing Water Supply infrastructure in Vehari:

- Outlived Tube Wells Infrastructure (around 50 years)
- Mechanical components most assets in Poor condition
- Outlived Ground Storage Tanks at most Water Works
- Water available at user end for only 1 hour a day

Tube Well along Pakpattan Canal, Vehari

Overhead Reservoir, Vehari

Inside a pump house, H Block Water Works

Ground Storage Tanks, Vehari

Figure 50 In Pictures: Field Survey and Assessment

After detail condition assessment, following was established as overall condition and respective rating.

Table 30 Condition Assessment

Asset Attribute	Rating
Civil Structures	**D (Poor)**
Distribution Network	**C (Fair)**
Electro-Mechanical	**D (Poor)**

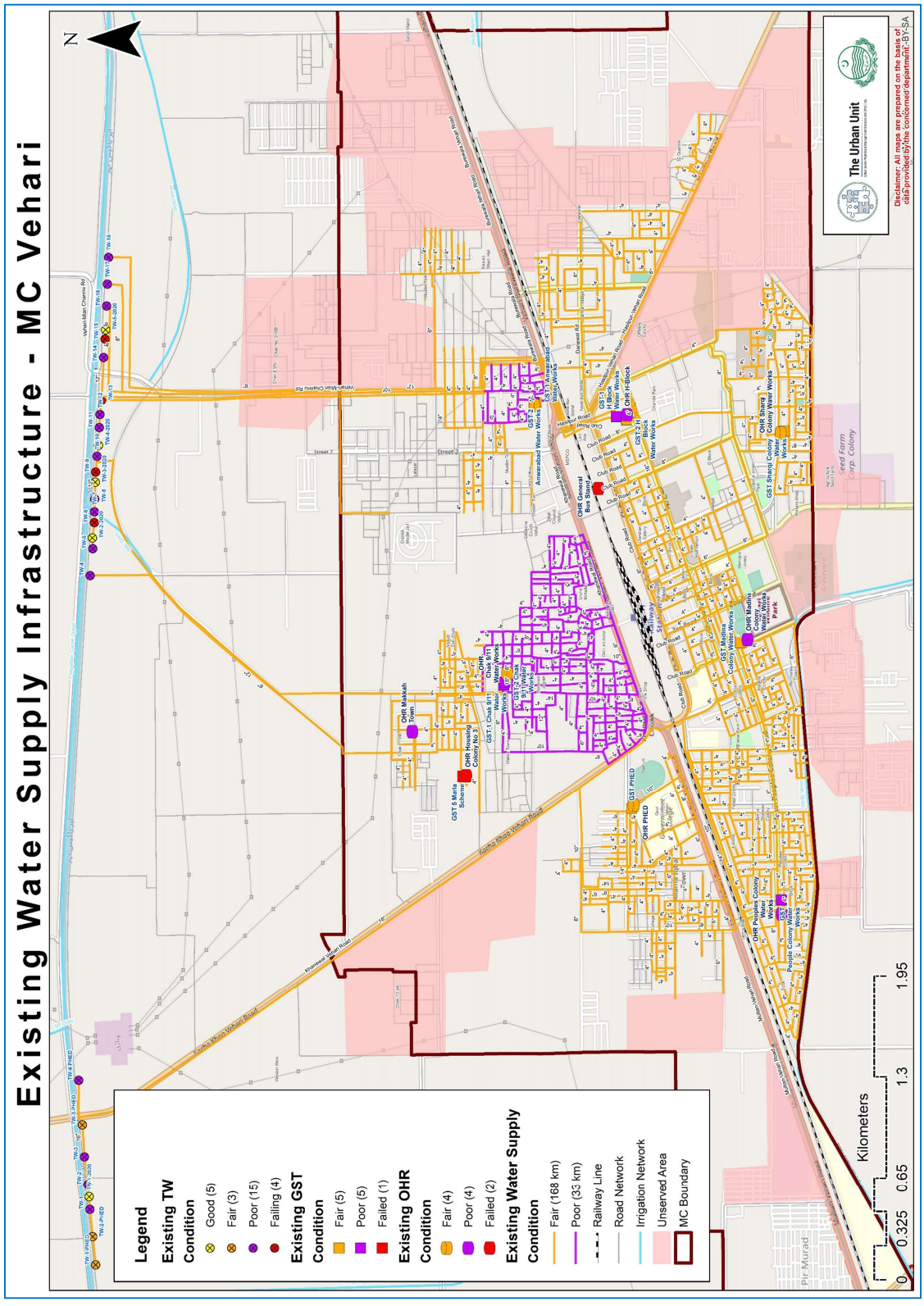


Figure 51 Water Supply Baseline

7.4 Water Supply Interventions

Afore-described gaps relating to the Water Supply are filled in the planning exercise in detail. Prioritization of these gaps is also done and hence schemes are proposed based on various factors such as essence of intervention, duration required to execute them, cost required, and their impact on general public. Total cost required to uplift the current water supply situation is 1,873 Million.

Short Term Plan

Despite a fair coverage of water supply in the city, majority of the assets in Vehari are currently non-functional. The short term plan of the city majorly focusses on rehabilitation and repairs of existing infrastructure in the city. Major measures to rehabilitate 15 tube wells and minor repairs for the other 8 tube wells is proposed during this phase. Repairs for the GSTs and OHRs of the existing water works in the city is also proposed during this phase.

One water works is also proposed to be constructed in the city to cater for the unfulfilled demand of the city. The water works would consist of one new OHR of 50,000 Gallons and one new GST of 100,000 Gallons, which will be fed by four new Tube Wells of 1 cusec each. This intervention will be paired by an extension of water supply lines to the unserved areas of the city (70 KM estimated), with water lines of diameter ranging from 4" to 10" as per the site requirements.

Total Cost required for Short Term Plan for water supply is 715 Million.

Medium Term Plan

One water works is also proposed to be constructed in the city to cater for the unfulfilled demand of the city during the medium term. The water works would consist of one new OHR of 50,000 Gallons and one new GST of 100,000 Gallons, which will be fed by four new Tube Wells of 1 cusec each. This intervention will be paired with replacement of outlived water supply lines of the city (estimated 32 KM), to keep the system intact and running in a streamlined manner.

Total Cost required for Medium Term Plan for water supply is 333 Million.

Long Term Plan

One water works is also proposed to be constructed in the city to cater for the unfulfilled demand of the city during the long term. The water works would consist of one new OHR of 50,000 Gallons and one new GST of 100,000 Gallons, which will be fed by four new Tube Wells of 1 cusec each. This intervention will be paired with replacement of outlived water supply lines of the city (estimated 146 KM), to keep the system intact and running in a streamlined manner.

Total Cost required for Long Term Plan for water supply is 824 Million.

Following are proposed schemes for the Vehari (MC):

Table 31 Proposed Schemes

Sr. #	Planning Term	Sector	Proposed Schemes	Scope	Cost (Million)
1	**Short (2025)**	Water Supply	Rehabilitation & Extension of Water Supply System in Vehari City – Phase I	▸ Rehabilitation of 15 Tube Wells (1 Cusecs each) including Civil works (pump house and bore), Electro-mechanical (machinery and panel) ▸ Repair of Civil Structure, Maintenance of pump and repair of electrical distribution board for Existing Tube Well ▸ Extension of new WS Pipelines of total length 70 having varying diameters (3", 4", 6", 8" & 10") ▸ Repairs for 07 existing Water Works in city ▸ Construction of new water works (04 Nos Tube wells @1 cusecs & 01 No OHR @50,000 Gallons & 01 No GST @100,000 Gallons)	715

2	**Medium (2028)**		Rehabilitation & Extension of Water Supply System in Vehari City – Phase II	▸ Replacement of outlived WS Pipelines of total length 31.9 having varying dias (3", 4", 6", 8" & 10") ▸ Construction of new water works (04 Nos Tubewells @1 cusecs & 01 No OHR @50,000 Gallons & 01 No GST @100,000 Gallons)	333
3	**Long (2033)**		Rehabilitation & Extension of Water Supply System in Vehari City – Phase III	▸ Replacement of outlived WS Pipelines of total length 146 km having varying dias (3", 4", 6", 8" & 10") ▸ Construction of new water works (04 Nos Tubewells @1 cusecs & 01 No OHR @50,000 Gallons & 01 No GST @100,000 Gallons)	824
	Total Water Supply – Vehari MC				**1,873**

For Rough Cost Estimation MRS, 1st BI-ANNUAL-2023 District Vehari has been Applied. The 2% Contingencies and 5% PST are also added in estimates. This is further subject to Detail Design of the proposed schemes upon PC-1 formation.

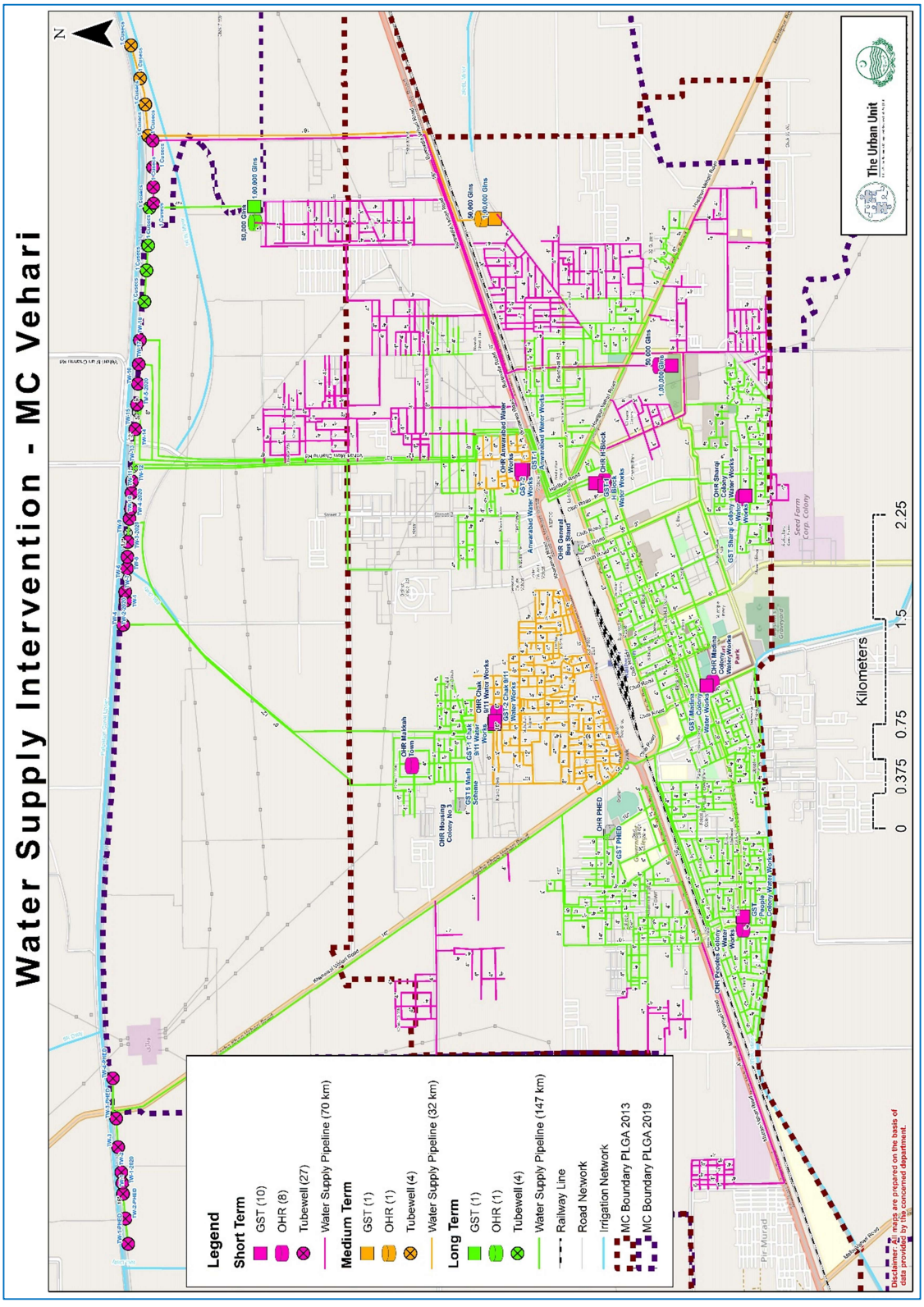


Figure 52 Water Supply Intervention

7.5 Existing Sewerage Infrastructure

Existing sewerage system in Vehari has an estimated spatial coverage of 70%. RCC sewers have been laid under almost all the main roads in the city, which carry the sewage to 8 disposal stations in the city. The waste water is carried via sullage carriers to dispose it off to agricultural lands or open fields. Currently no waste water treatment mechanism exist for the city and untreated water is being used for broad irrigation creating a nexus of environmental problems and thus in direct breach of the environmental policy of Pakistan.
Detail of mentioned eight disposal stations is as below:

Table 32 Sewerage Infrastructure

Disposal Station Name	Status	Condition	Ultimate Disposal	Sewer Lines	Sewer Condition Overall
DS Bhatta Ikram Ul Haq	Functional	D	Agricultural Land or Open Fields	137 KM	C = 85 KM D = 52 KM
DS 32 Quarters	Functional	D			
DS Taimoor Shaheed Colony	Functional	C			
DS 9-11/WB	Functional	C			
DS Peer Murad	Functional	C			
Mini DS Anwarabad	Functional	C			
Mini DS Bhatta Ikram Ul Haq	Functional	C			
DS Muslim Town	Functional	B			

The following graph indicates the condition of disposals installed in Vehari.

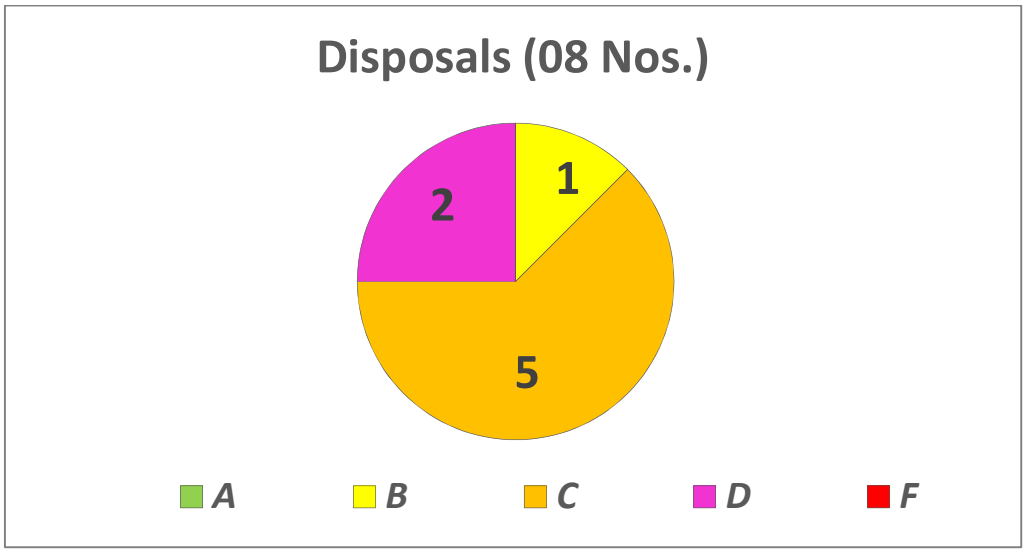


Figure 53 Disposal Station Status

7.6 Sewage Generation

The sewage generation have been made corresponding to the 30 gallons per capita per day water demand i/c 20% unaccounted for water (NRW). A contribution of 33% for storm-water flow, 5% infiltration & 5% non-domestic flows have been included during the calculation of the total sewerage flow. The current (2023) sewage generation and of the future (2025, 2028 and 2033) sewage generation are shown in the table below.

Table 33 Sewage Generation

Sewage Generation				
Years	**2023**	**2025**	**2028**	**2033**
Population	167,036	174,842	187,241	209,890
Peak Sewage Flow (MGD-I)	8.52	8.92	9.55	10.70
Storm Water Flow (MGD-I)	2.81	2.94	3.15	3.53
Infiltration Flows (MGD-I)	0.21	0.22	0.24	0.27
Non-Domestic Flows (MGD-I)	0.21	0.22	0.24	0.27
Total Sewage Flow (MGD-I)	**11.76**	**12.31**	**13.18**	**14.77**

The table above has been plotted graphically to visualize the increase in the sewage flow for the city over the planning period of the project. It should also be noted that although all the disposal stations in the city are currently functional, they have outlived their design life and face several issues lowering the overall service delivery of the system.

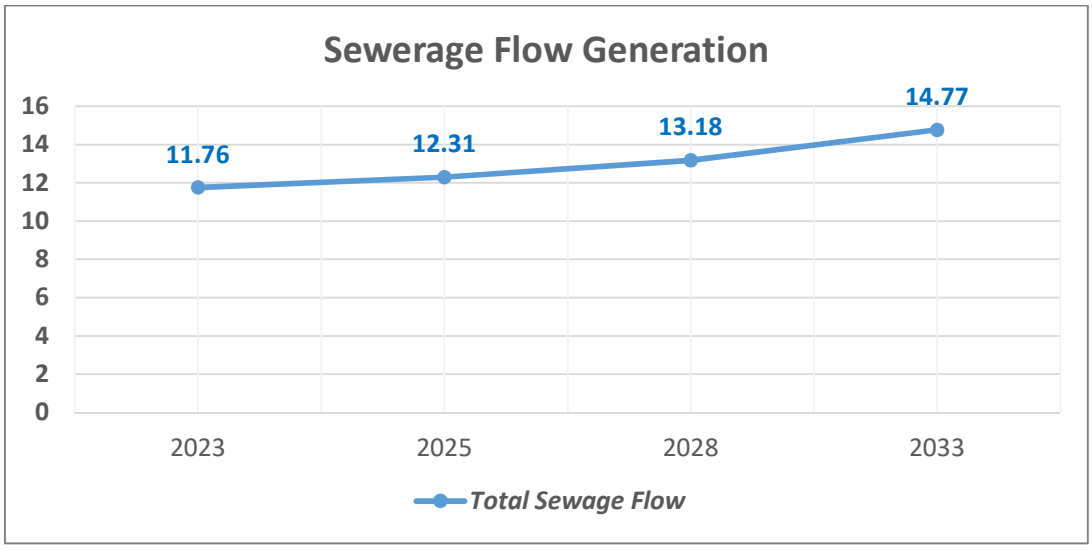


Figure 54 Projected Sewage

Elevation Map was also used for planning purposes. Elevation data shows that elevation of 133 to 144 meters from Mean Sea Level (MSL). All of the current Disposal Stations are stationed rightly w.r.t. elevation profile as all these areas is relatively depressed in terrain.

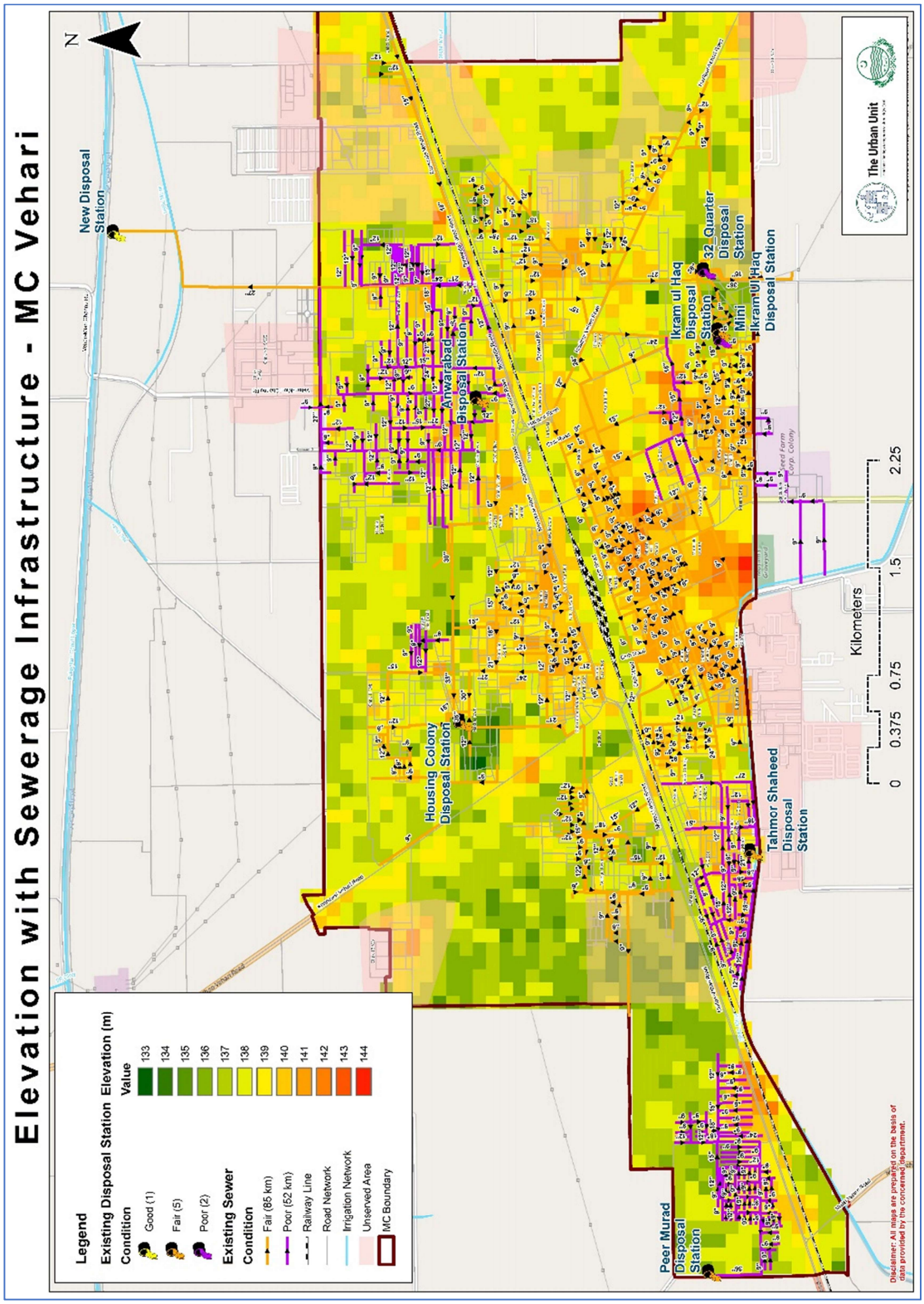


Figure 55 Elevation Map

7.7 Condition Assessment of Sewerage Infrastructure

Following was major gaps identified during the detail condition assessment of the existing Sewerage infrastructure.

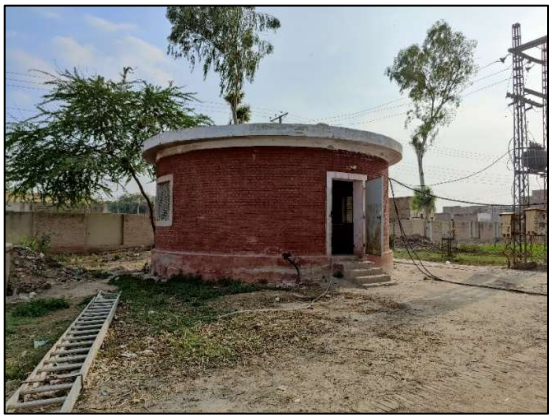
Most disposals in poor condition due to aging

Flooding issues due to silting of sewer lines

Capacity enhancement required for Peer Murad DS

Repairs/Rehab required for older disposal stations

Sullage carrier carrying water for irrigation



Pump house of 9-11/WB Disposal, Vehari

Collecting Tank of Muslim Town disposal

Sucker Machine owned by MC Vehari

Figure 56 In Pictures: Field Survey and Assessment

After detail condition assessment, following was established as overall condition and respective rating.

Table 34 Condition Assessment Outcome

Asset Attribute	Rating
Civil Structures	**C (Fair)**
Electro-Mechanical	**C (Fair)**
Sewers	**D (Poor)**

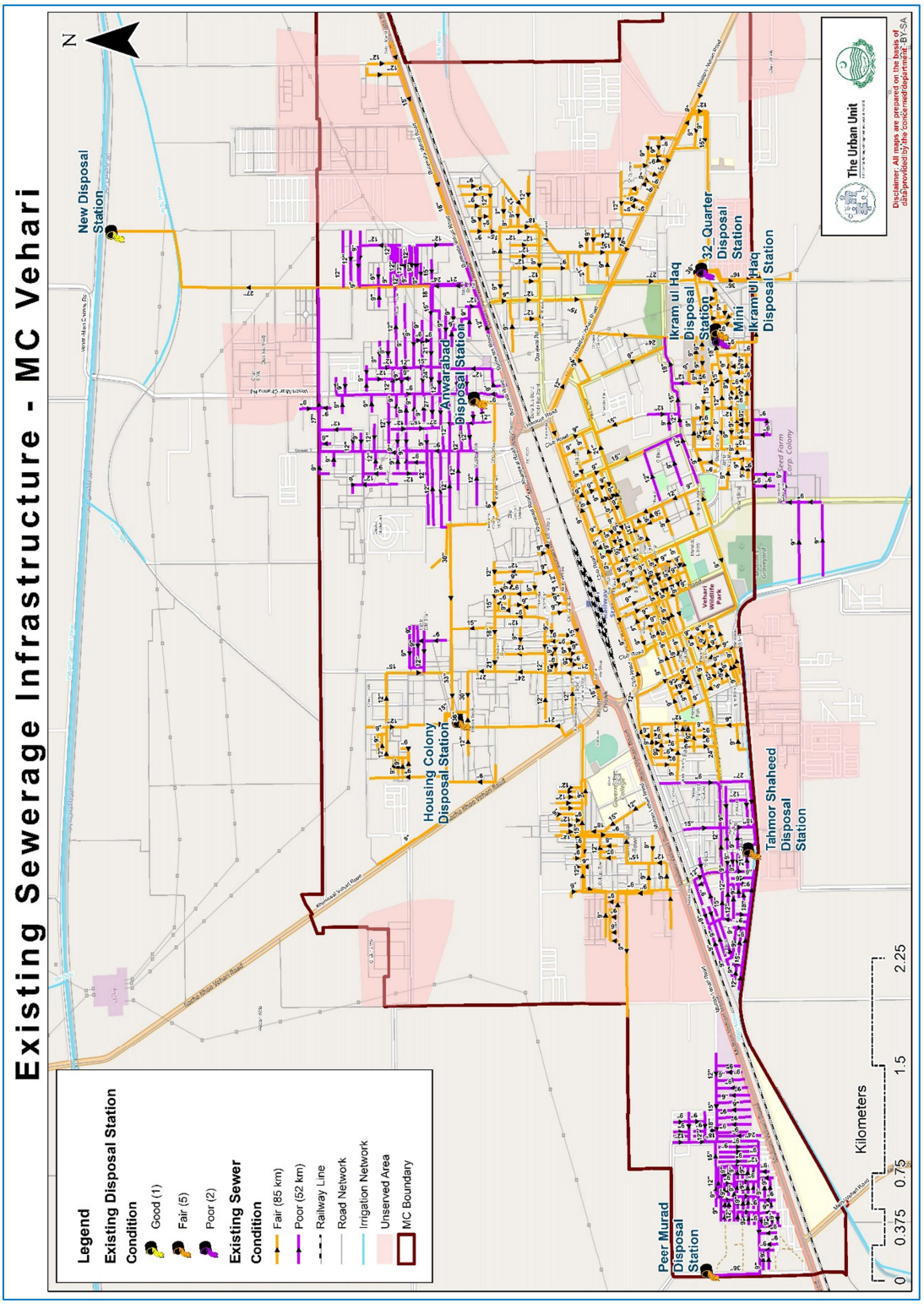


Figure 57 Sewerage Infrastructure

7.8 Sewerage Interventions

Afore-described gaps relating to the Sewerage issues are filled in the planning exercise in detail. Prioritization of these gaps is also done and hence schemes are proposed based on

various factors such as essence of intervention, duration required to execute them, cost required, and their impact on public. Total cost required to uplift the current sewerage situation is 2,493 Million.

Short Term Plan

The Short term phase of project is focused on improving the overall coverage of sewerage system in the city. Extension of sewer lines to unserved and partially served areas of the city is thus proposed during this phase, with provision of up to 28 KM of new sewer lines in the unserved areas of the city. Two older disposal stations; DS 32 Quarter and DS Bhatta Ikram ul Haq; are also proposed to be rehabilitated and repaired to improve their service and extend their life.
A total of 419 Million will be required to make these interventions in Short Term.

Medium Term Plan

In Medium term, the replacement of over lived sewers in the city is planned to reduce the flooding and choking issues in the sewerage system. 51.5 KM of sewers are proposed to be replaced during this phase, drastically improving the overall working of sewerage system in the city. General repairs are proposed at two disposal stations at Tamoor Shaheed Colony and 9-11/WB whereas capacity enhancement of DS Peer Murad is also proposed during this phase of the project.

Total Cost required for Medium Term Plan for sewerage is 764 Million.

Long Term Plan

In the Long term, replacement of outdated sewers is planned in which length of 79.5 KM is proposed to be replaced. For the safe disposal of sewage, three waste water treatment plants (Stabilization Ponds) are also proposed during the long term plan with an estimated area of 50 acres. Sucker and Jetting machines are proposed to be procured during this phase for improved capacity for maintenance of the system.
Total Cost required for Long Term Plan for water supply is 1,310 Million.

Following are proposed schemes for the Vehari (MC):

Table 35 Proposed Schemes

Sr. #	Planning Term	Sector	Proposed Schemes	Scope	Cost (Million)
1	Short (2025)	Sewerage	Rehabilitation & Extension of Sewerage System in Vehari City – Phase I	▶ Extension of sewer lines of total length 27.39 KM having varying diameters (12” to 21”) ▶ Pump replacement of old pumps, provision of	419

				electrical distribution board, installation of screening chambers, minor civil work repairs at mentioned Disposal Stations.	
2	Medium (2028)		Rehabilitation & Extension of Sewerage System in Vehari City – Phase II	▶ Replacement of outdated Sewers of dia's 9", 12", 15", 18", 21", 24" 33" & 36" having total length of 51.5 KM ▶ Pump maintenance, repair of electrical distribution board, installation of screening chambers, civil work repairs at mentioned Disposal Stations. ▶ Installation of new pumps, repair of electrical distribution board, installation of screening chambers, civil work repairs at mentioned Disposal Stations.	764
3			Rehabilitation & Extension of Sewerage System in Vehari City – Phase III	▶ Replacement of outdated Sewers of diameters 9", 12", 15", 18", 21", 24" 33" & 36" having total length of 79.5 KM ▶ Procurement of One Sucker and One Jetting machine ▶ New WWTP – Waste Stabilization type with auxiliary	1310

				facilities and an estimated area of 50 Acres	
				Total Sewerage – Vehari MC	2493

For Rough Cost Estimation MRS, 1st BI-ANNUAL-2023 District Vehari has been Applied. The 2% Contingencies and 5% PST are also added in estimates. This is further subject to Detail Design of the proposed schemes upon PC-1 formation.

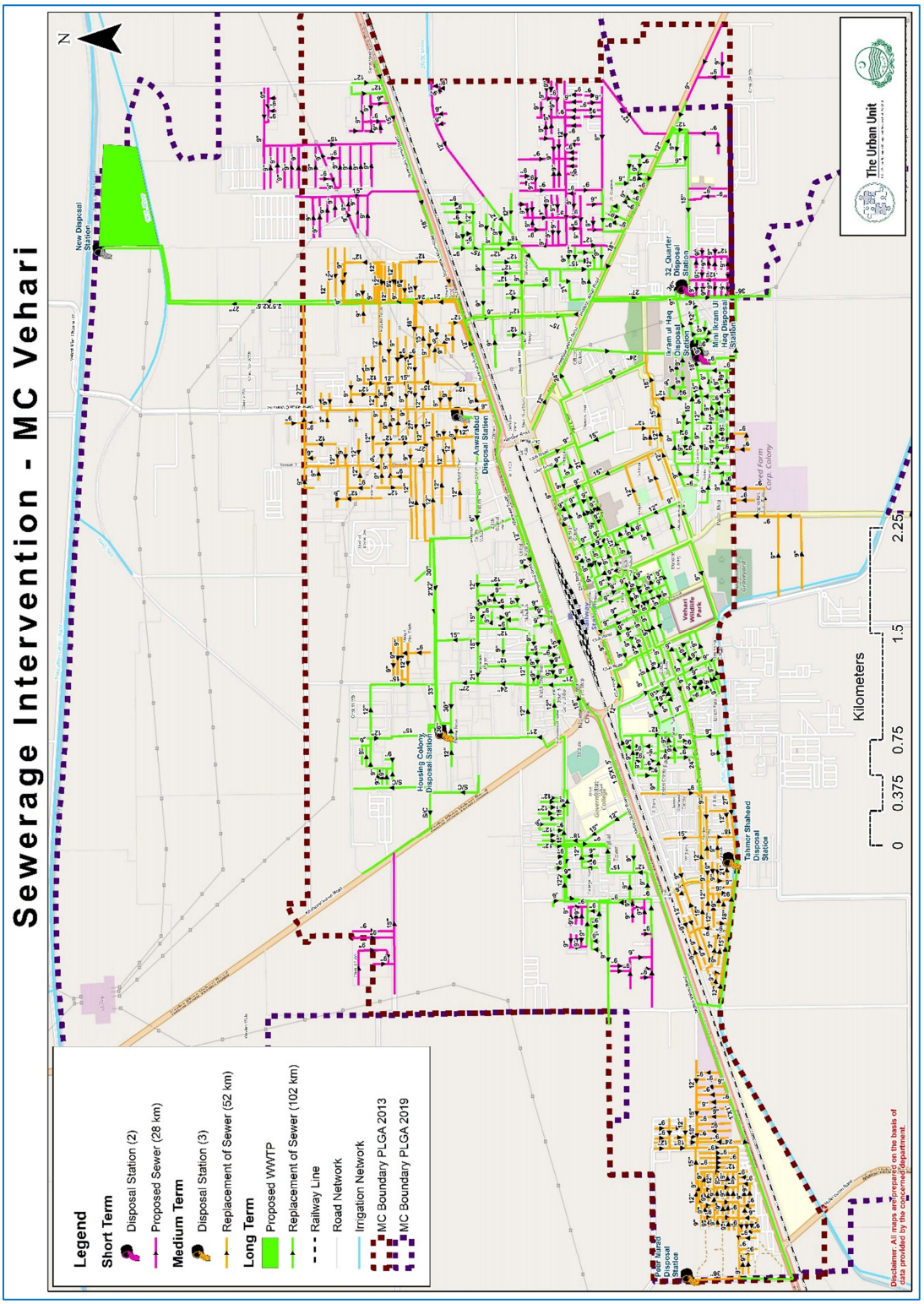
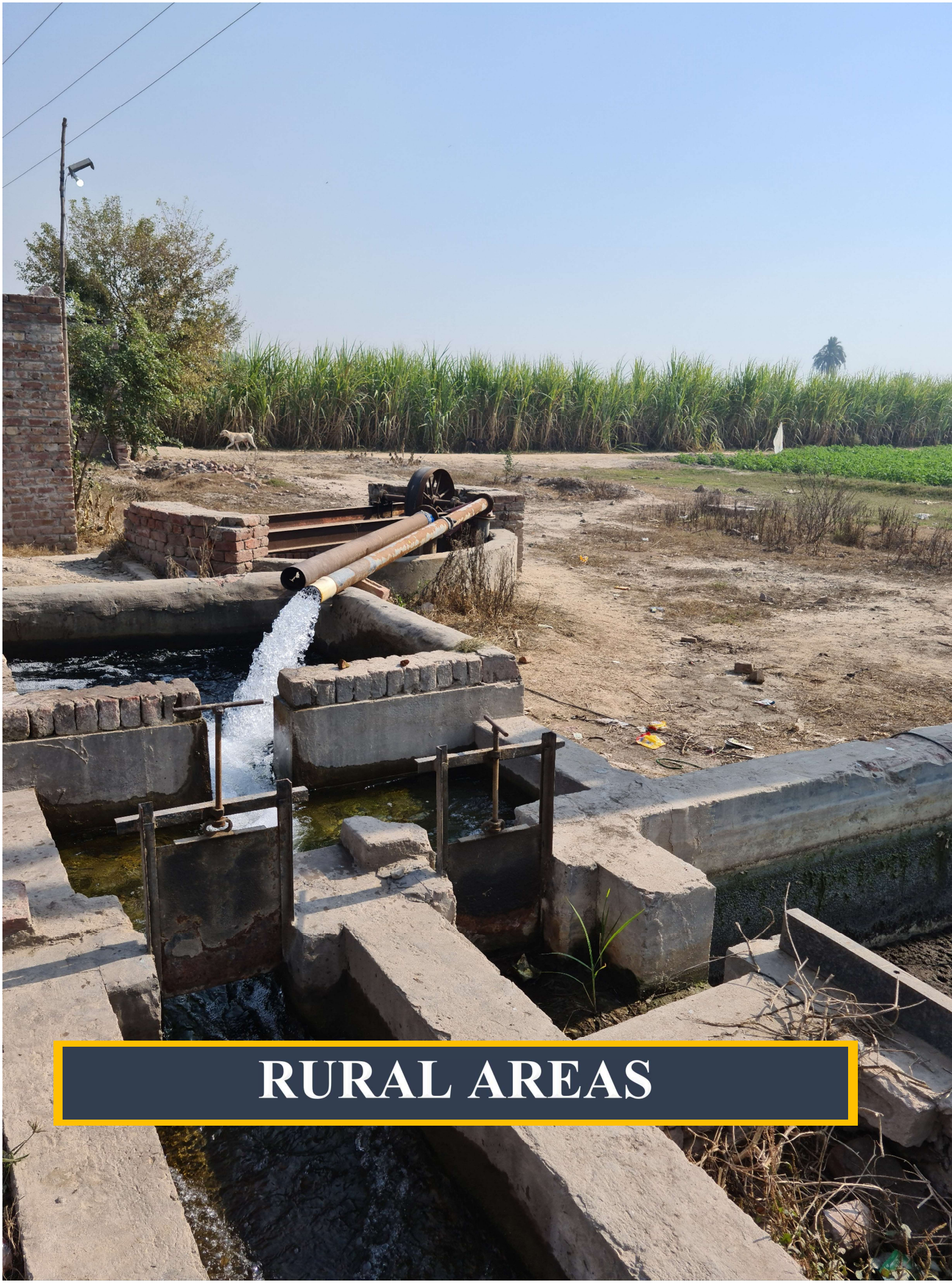


Figure 58 Sewerage Intervention


RURAL AREAS

8 Rural Areas - Multan Division

Drinking Water and Sanitation are the most essential elements for human life and its dignity. The Government of Punjab also envisions providing safe drinking water and sanitation facilities to the entire rural and urban communities in an equitable, efficient, and sustainable manner.

Poverty and Shared Prosperity Report, 2020 revealed that 4 out of 5 people live below the international poverty line in rural areas. Studies conducted in different periods of time have linked improved water and sanitation facilities with the alleviation of poverty and urged governments to provide high quality water and sanitation facilities in order to uplift the people from the marshes of poverty and devastating socio-economic conditions. According to published data, currently only 48% Rural Punjab population is reported to have access to safely managed water supply services, which seems to be far behind in achieving SDG 6 targets and this clearly needs intervention by the higher end in order to improve the current situation of service delivery in rural settlements. By 2018, only 13 percent of rural households had access to piped water, as compared to 29 percent of urban households, but even where piped water was available, less than 4% was piped into dwellings. These figures bring attention towards existing disparities among urban and rural areas.

Similarly, the situation of sanitation is also immensely deplorable. Basic sanitation facilities are available to only 73% rural population which means that every 8th household in Punjab uses open-defecation owing to the absence of basic sanitation facilities. Resultantly, 36 out of 100 children under the age of 5 have impaired growth due to malnutrition. Every 5th child under 5 years of age is too thin of his age, and every 7th child is too short for his height. For every 1000 children born alive, 69 die before their 5th birthday and 41 within their one month of birth.

It goes without saying that the need of the hour is the need of addressing the prevalent disparities and inequalities of basic services in rural and urban settlements. This can truly stimulate significant progress in course of achieving equitable growth and actualizing our SDG commitments. Furthermore, Reliable and appropriate water infrastructure that allows for easy access to a safely managed water supply and sanitation services will lead to an improved lifestyle of rural people, produce resultantly fit and dynamic labor, escalate rural economies and create jobs.

Stakeholder Consultation with concerned departments representatives, Primary data collection from Public Health Engineering Department (PHED) and secondary data available on Water and Sanitation Sector (WSS) gave an insight about the existing state of WSS in rural areas of Multan Division in Punjab. Current situational analysis stating average 19% water and sewerage coverage pronounce that minimum level focus has been given in the past to invest for the provision of efficient municipal service delivery and improve the living condition of people in rural areas.

8.1 Existing Situation of Rural WSS System

Punjab is the most populous province of Pakistan with almost population of 110 million, out of which 63% (70 million) reside in the rural areas. Multan is one of the administrative divisions of Punjab having 14 tehsils and rural population of approximately 8.8 million as per census of 2017, which is intended to reach 11 Million by 2033. Rural area segment is very significant to be analyzed and considered while developing the regional sectoral plan as major chunk i.e. 75% population of division lie in rural settlements as compare to 25% in urban areas. Division comprises of four districts with Multan district encompasses largest while Vehari and Lodhran both least proportion of rural divisional population. This section is written to cover the current situation as well as future endeavors of water and sewerage sector in rural areas of four districts namely Multan, Khanewal, Lodhran and Vehari that lie in Multan Division.

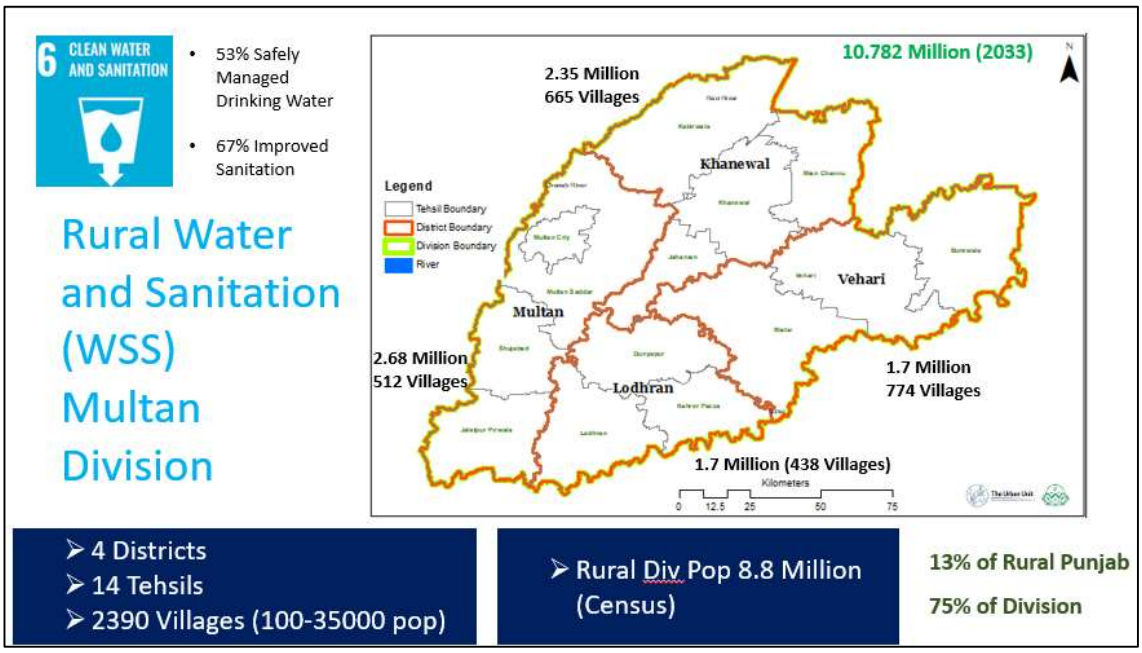


Figure 59: Districts of Multan with Rural Population

The aspect of disparities and inequities in services are always found among districts as highlighted in one of the published WASH Scorecard reports of UNICEF in 2019. Multiple indicators govern the WASH situation contribute towards the overall ranking of the districts with respect to water and sanitation. Lodhran and Multan fall in to lowest rank of 30 and 35 among all districts of Punjab with respect to rural water and sanitation index respectively, which highlights the need of immediate planning and respective interventions in the mentioned districts. Overall, allocated water and sanitation index and respective ranking of rural areas of four districts as depicted in figure below urge the need of planning and implementing WASH interventions in the region.

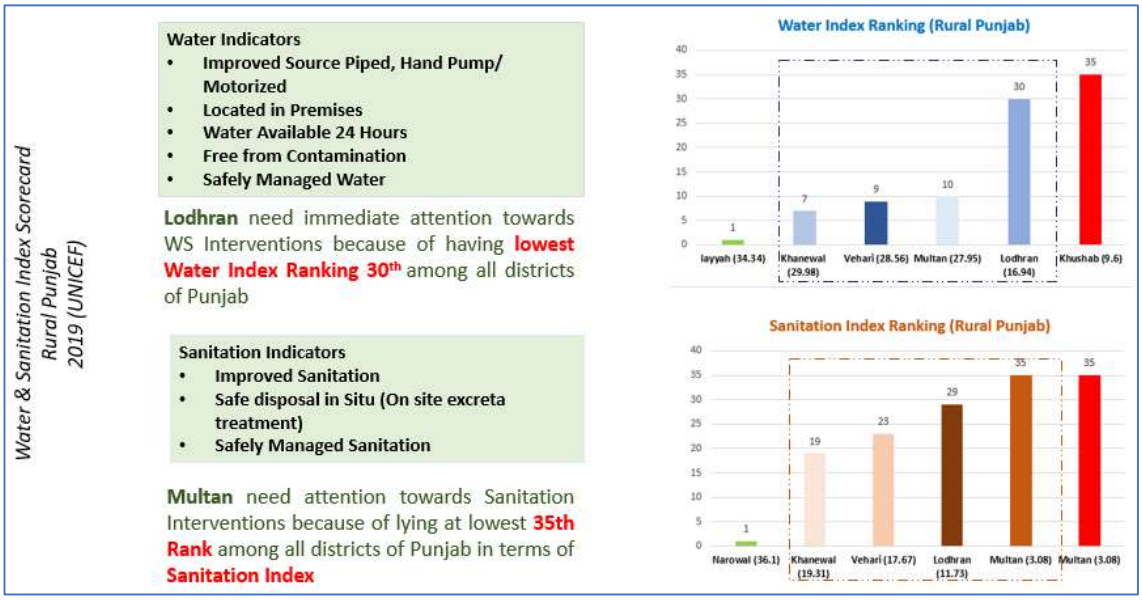


Figure 60: Rural Water and Sanitation Index in Multan Division

Public Health Engineering Department (PHED) is the main department responsible for the installation or execution of water supply and sanitation schemes in rural areas of Punjab. One of the major challenges of Service Delivery in rural areas is the distribution of responsibilities to execute and operate the infrastructure. PHED is responsible for execution or installation of the municipal services infrastructure, which is currently handed-over to Community Based Organizations (CBOs) for its operation and maintenance (O&M).

8.2 Rural Water Supply Infrastructure

Groundwater is used as source of water for domestic usage and especially for drinking purposes. Water is provided to the rural community through installed 400 **Rural Water Supply Schemes** (each of 0.25-1.0 cusecs capacity) installed by PHED and maintained by CBOs in division. According to data provided by PHED, currently there are total 296 water schemes in functional condition from total installed water schemes indicating that 26% of the infrastructure is Non-Functional. Functional schemes provide water for 1-9 hours (Avg 4.5 h/d). Community pay 300-400 PKR/month in these four districts.

Figure 61: Water Supply Service Delivery in Division

It is noted that water schemes are in non-working condition due to multiple reasons including failure of machinery, damaged rising main & distribution network, transformer burnt & stolen, bore failure, outlived status, community conflicts and non-payment of WAPDA dues. Non-Functional status of Infrastructure varies from district to district with highest in Vehari and lowest in Khanewal. These non-functional assets need to be rehabilitated or replaced to revive the water supply for community.

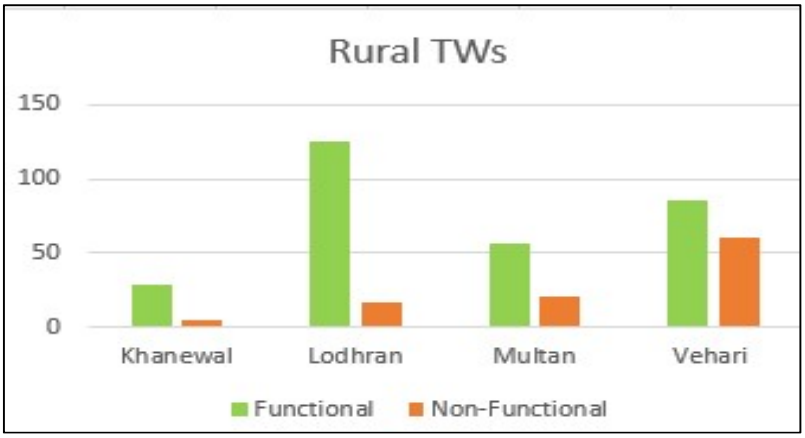


Figure 62: Functional Status of WS Schemes

Design life of infrastructure especially Tube Wells is usually kept 15 years as proposed in PHED design criteria for efficient operation and maintenance. According to ageing analysis carried out on data received from PHED revealed that there exist large infrastructure whose service life has already surpassed the tube well standard design life. However, sometimes 20-25 years age is also acceptable in case of well maintenance and proficient operations. Graph below depicts that 5-65% of tube wells are those whose to-date (2023) service life is outlived with existing age of 26-50 years which is of quite concern and need immediate attention as continuous operation of tube wells not only causes overburdening of machinery but also affects the water table as well.

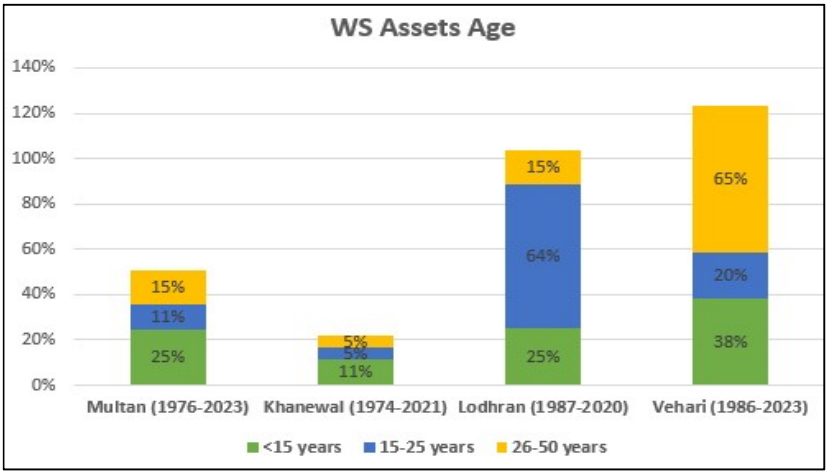


Figure 63: Tube wells ageing analysis

Along with water supply schemes, a large number of **Rural Water Filtration Plants** are present in the region because of presence of brackish zone in division. PHED has installed total of 259 water filtration plants (UF/RO) during 2016-2022 in the whole division among which 68 plants are non-functional. These filters plants of either 1000 or 2000 l/h capacity with total capacity of 281000 l/h are operated at 3-8 h/d in the region which accounts for approx. 11% water coverage in division.

Summary of water supply infrastructure in rural areas of all districts of Multan is given in table while detailed attributes of all water schemes and water filtration plants are presented in Annexure.

Table 36 Summary of Rural Water Infrastructure

	Multan	Khanewal	Lodhran	Vehari
No. of Villages	512	665	438	774
Total Water Supply Schemes	77	34	142	146
Functional WS Schemes	56	29	125	86
Operational Hours (Hours/day)	Avg 6	Avg 2	Avg 6	Avg 4
Avg Life (Yrs) of Tube Wells	14	14	15	17
Total Water Filtration Plants	96	50	37	76
Functional Water Filter Plants	65	50	31	45
Avg Life (Yrs) of Filter Plants	5	3	7	1

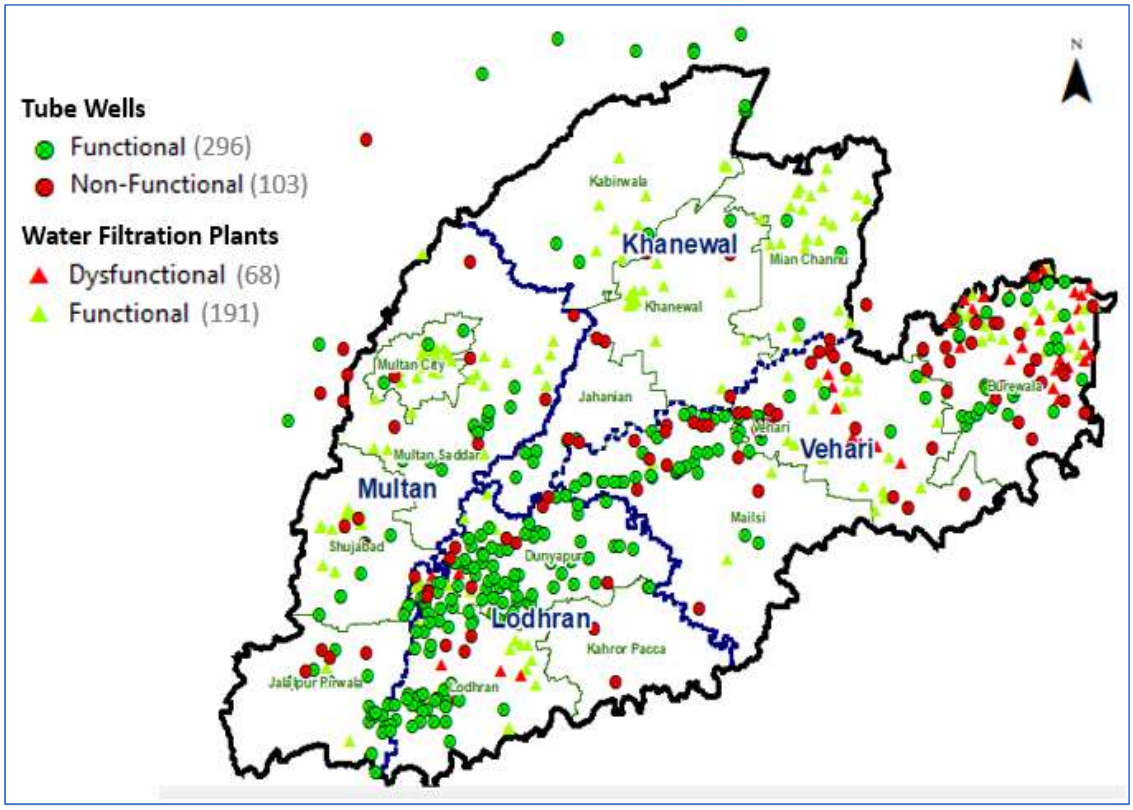


Figure 64: Rural Water Schemes and Filtration Plants

8.3 Water Demand & Supply

Analysis of provided data and water needs of rural population while considering only 10 GPCD water demand indicated that existing assets possess the capacity of supplying only 88 Cusecs of water against 278 cusecs water demand as per 2023. It is pertinent to mention that there exist 102 MGD water demand and supply gap, which is of quite concern that huge population especially residing in poor water quality areas are deprived of basic necessity of water.

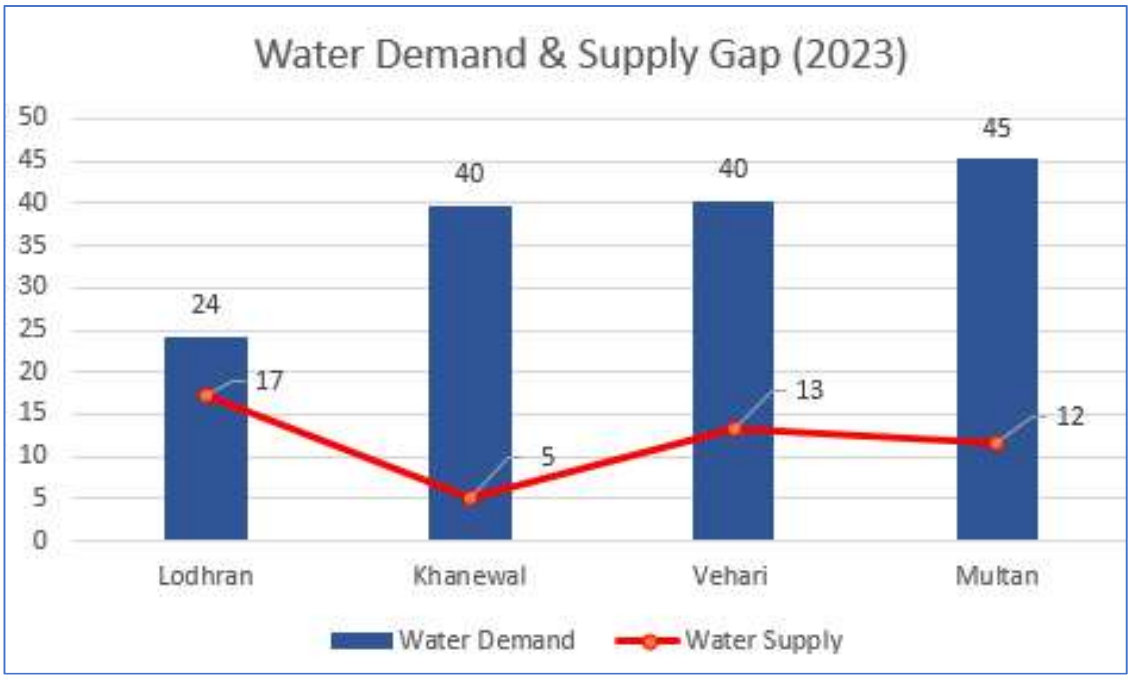


Figure 65: Rural Water Demand and Supply Analysis (MGD)

8.4 Rural Water Quality

The Urban Unit has carried out an analysis of available UNICEF Water Quality Data, PSLM & MICS data about WASH in Punjab Spatial Strategy, which resulted in to Spatial Mapping of districts of Punjab. According to that analysis, medium level WASH Interventions are needed among districts of Multan division.

UNICEF & PHED carried out detailed screening of water quality in rural areas of whole Punjab in 2014-16. This is only recent data set available on such a large scale in Punjab. Samples were taken from multiple sources and analysis of multiple water quality parameters was carried out at that time. Presence of 14-28% TDS pollution in water of Multan division with minimum contamination of 14% in Khanewal & Vehari districts and max of 28% in Lodhran require the need of immediate mitigation interventions. Water quality condition with extremely high concentration of TDS say 9000 ppm in groundwater aquifer due to presence of salt rock aquifer in the region is alarming as imposes the serious health threats to human population residing and drinking that contaminated water.

Spatial overview of water quality situation presented in map with indication of Identified hotspots of brackish villages need attention towards the need of immediate interventions of

installation of respective filtration plants to protect the human health. It is noted that PHED has its own water quality testing laboratory facility in each of its district but water testing is carried out only on water schemes sources or on demand basis.

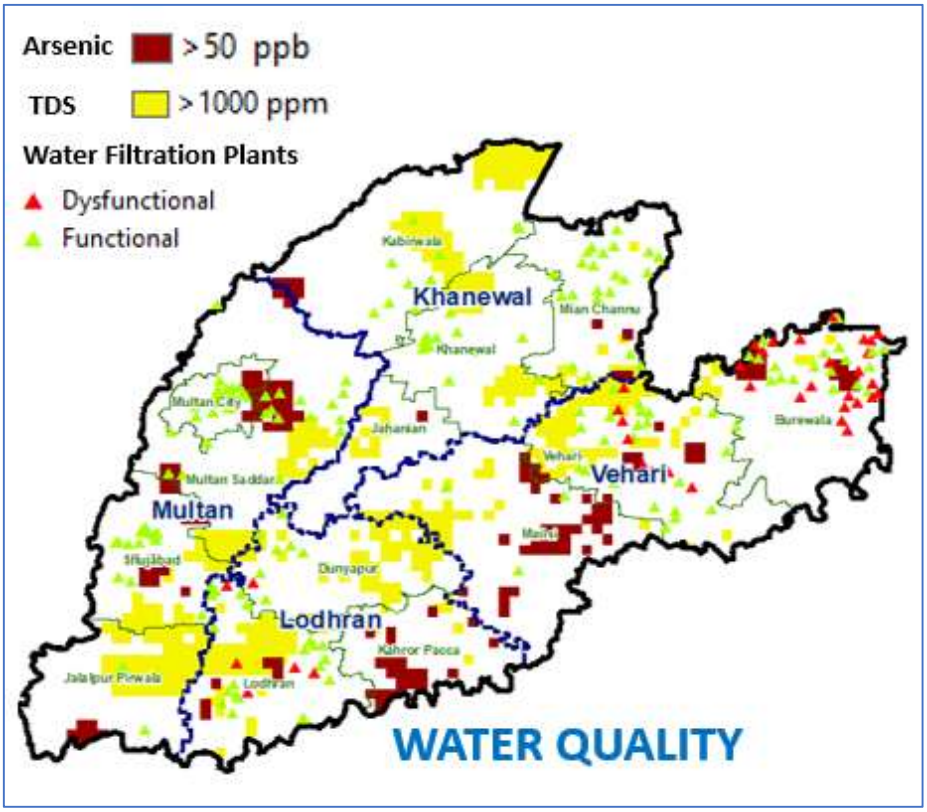


Figure 66: Rural Water Quality (TDS)

8.5 Rural Sanitation Situation

Rural areas make major part of the districts because of having considerable population. It is very unfortunate to mention that usually rural extents are neglected in comparison to urban areas in terms of sanitation as indicated from disparity and inequity figures reported by UNICEF in its published reports. The negligence in investment consequently result in to the poor health and lower standard of living. Provision of proper sewerage and drainage system in rural areas seems to be neglected because of multiple reasons such as absence of any company/organization responsible for proper operation and maintenance (O&M) of infrastructure, lack of funds, poor revenue collection, absence of technical expertise and machinery. Currently PHED plan, design and execute the sewerage and drainage schemes in rural areas whereas its operation and maintenance is mostly over-looked by concerned CBOs. Sewerage system in rural areas is normally consist of open drains while underground covered conduit system is rarely present in some villages.

The baseline data summary collected from concerned PHED regarding existing situation of sewerage and drainage in villages of four districts of Multan Division is presented in table while disparity of rural sewerage coverage among districts can be seen in Map as well.

Table 37 Overview of Sewerage Situation in Rural Multan

Description	Multan	Khanewal	Lodhran	Vehari
Total S&D Schemes	87	303	12	156
Open Drains (No)	53	288	10	135
Underground S Schemes (No)	34	15	2	21
Served Villages	17%	46%	3%	20%

It is important to note that currently sewerage system with Avg of 80% open drain type and 20% underground sewers is present in approximately 558/2389 villages of Multan division which make total of only approx. 23% coverage in rural areas. Khanewal is only district where appropriate coverage is present as compare to remaining ones which demand the need of attention and investment. Wastewater collected through these open drains is normally drained and dumped in to agriculture fields and nearly water bodies without any treatment which is also of concern regarding environmental pollution and human health.

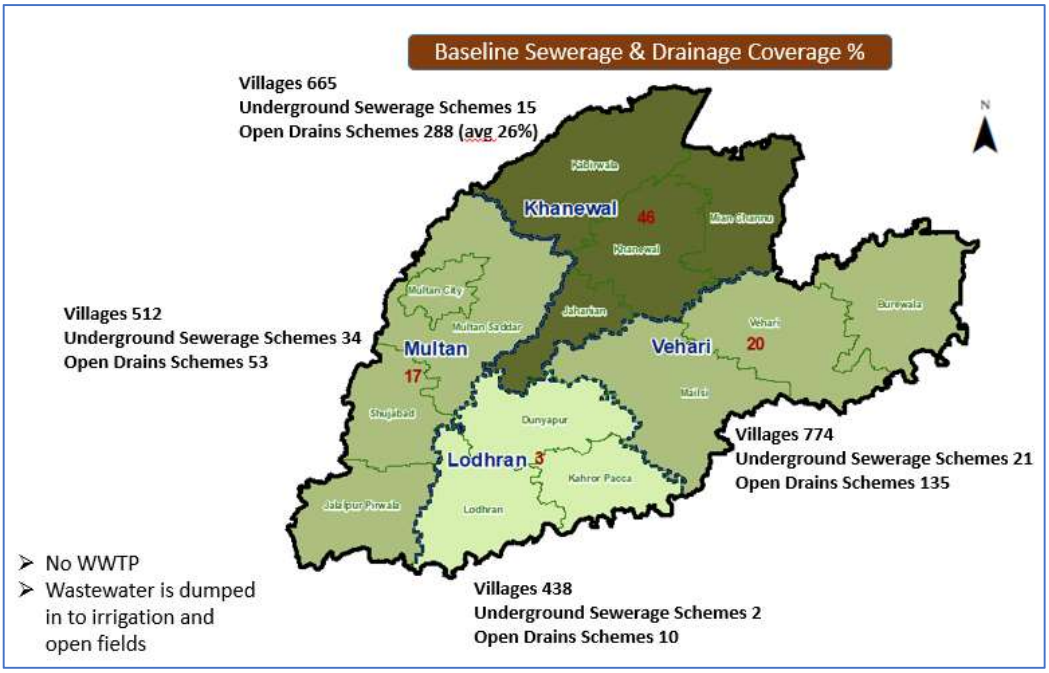


Figure 67: Sewerage Coverage in Rural Areas of Multan Division

8.6 Rural Water and Sanitation Interventions

The major broadly challenges in rural WSS sector articulated are huge quantity of abandoned Infrastructure, poor water quality- Brackish Zone, high electricity cost, less WSS coverage and financial & ownership issues. Large number of populations residing in these areas are badly affected or deprived of safe WSS facilities. These some of the challenges are taken in to account and resultant actions of interventions are identified to cater the issues as water and sanitation

are considered basic services that need to be provided for health environment and human well-being.

Interventions are proposed by considering the existing infrastructure/assets and gaps present to meet the service delivery requirement. Interventions revolve around rehabilitation of existing non-functional assets and installation of new requisite infrastructure to provide WSS coverage in unserved and deprived areas. The summary of proposed interventions of Approximately PKR 20 Billion are reflected in figure below.

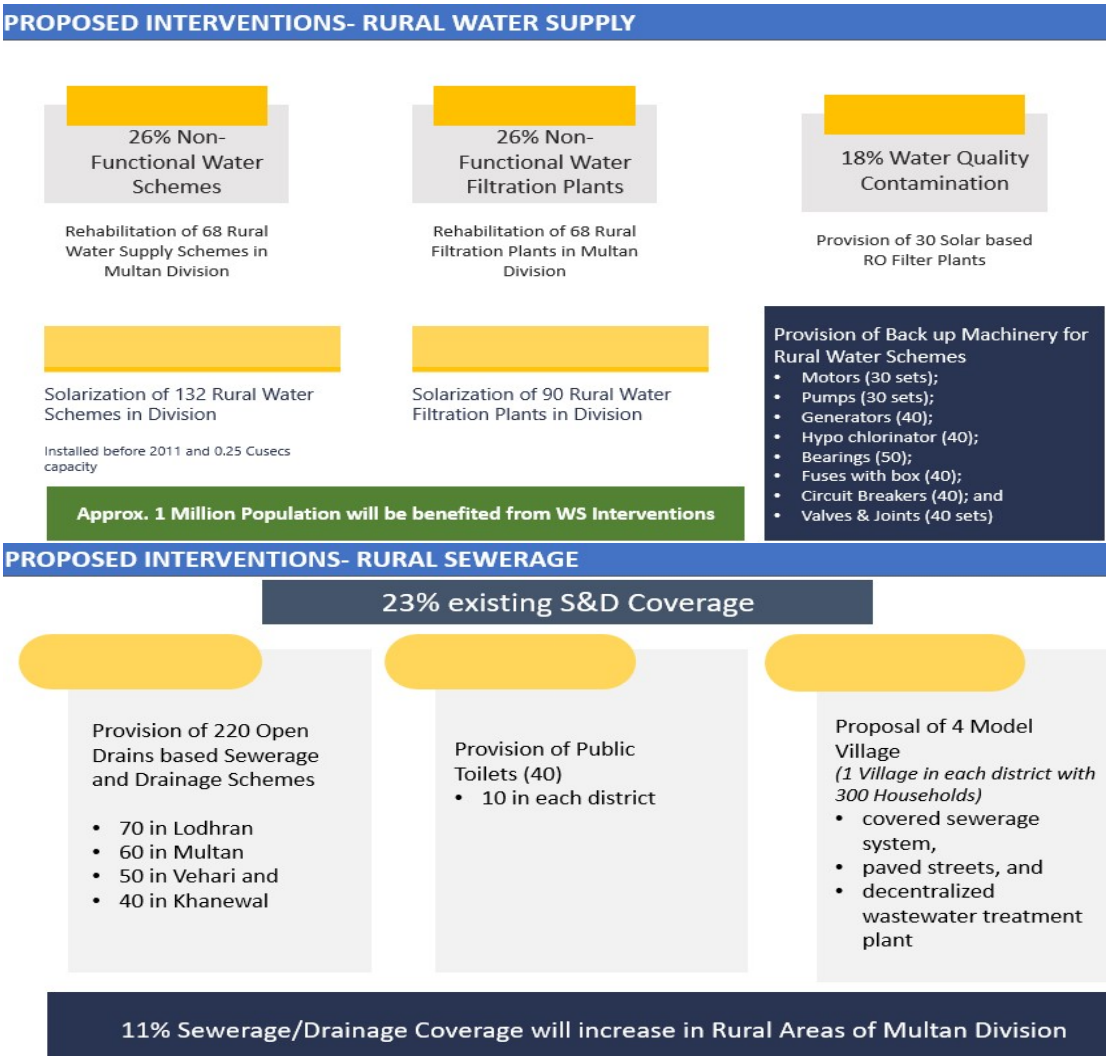


Figure 68: Proposed Rural WSS Interventions

8.7 Rural Water Supply projects

Water Supply interventions include rehabilitation of non-functional water filtration plants which are present in Multan division. These are RO and UF plants of 1000 or 2000 l/h capacity installed by PHED. Similarly, huge cost was incurred on installation of water supply schemes and major chunk of that (68 Nos are non-functional) due to many reasons articulated in above

section. Rehabilitation of 68 priority water supply schemes is proposed to revive the already installed assets by investing on upgradation of machinery, new rising mains, new borehole, repair of distribution lines and provision of transformer & chlorinators etc.

Some water filtration UF/RO plants are selected for installation by considering unserved coverage and brackish zones area. The concept of renewable energy is also proposed by proposing the installation of solar panels on some existing RO plants and water schemes to save electricity cost. Water Schemes and Filter Plants are selected by considering multiple parameters of age and condition and cost. Furthermore, provision of back up machinery for water supply system is also proposed for PHED in their districts for smooth running and operation of system and assets.

List of Rural Water Supply Projects or Interventions in Multan division is given in table while detailed names of villages along with coordinates is mentioned at Annexure. It is envisaged that approximately 1 Million population will be benefitted from proposed interventions.

Table 38 Rural Water Supply Interventions

Phase	Proposed Schemes	Cost (Million)
SHORT	Rehabilitation of 68 Rural Water Supply Schemes in Multan Division	2,153.84
	Rehabilitation of 68 Rural Water Filtration Plants in Multan Division	669.80
	Short Term Cost: 2,823	
MEDIUM	Provision of 30 Solar based RO 2000 l/h plants (5 in tehsil mailsi in vehari), (5 in Jahanian in Khanewal), (10 in tehsil shujabad & jalalpur pirwala in Multan) and (10 in dunyapur & Karorpacca in Lodhran)	475.50
	Solarization of 90 Rural Water Filtration Plants in Division (Each of 2000 l/h)	1,296.00
	Medium Term Cost: 1,771	
LONG	Solarization of 132 Rural Water Schemes in Division (Each of 0.25 Cusecs)	5,940.00
	Provision of Back up Machinery for Rural Water Schemes (each of 0.25 capacity) Motors (30 sets); Pumps (30 sets); Generators (40); Hypo chlorinator (40); Bearings (50); Fuses with box (40); Circuit Breakers (40); and Valves & Joints (40 sets)	530.00
	Long Term Cost: 6,470	
	TOTAL WATER SUPPLY COST RURAL (10 Years) = 11,065 Million	

Spatially marked WS interventions/projects are reflected in below presented map. It is envisaged that these proposed interventions having worth of PKR 11 Billion will benefit approximately 1 Million residents of rural areas in Multan division over next 10 years.

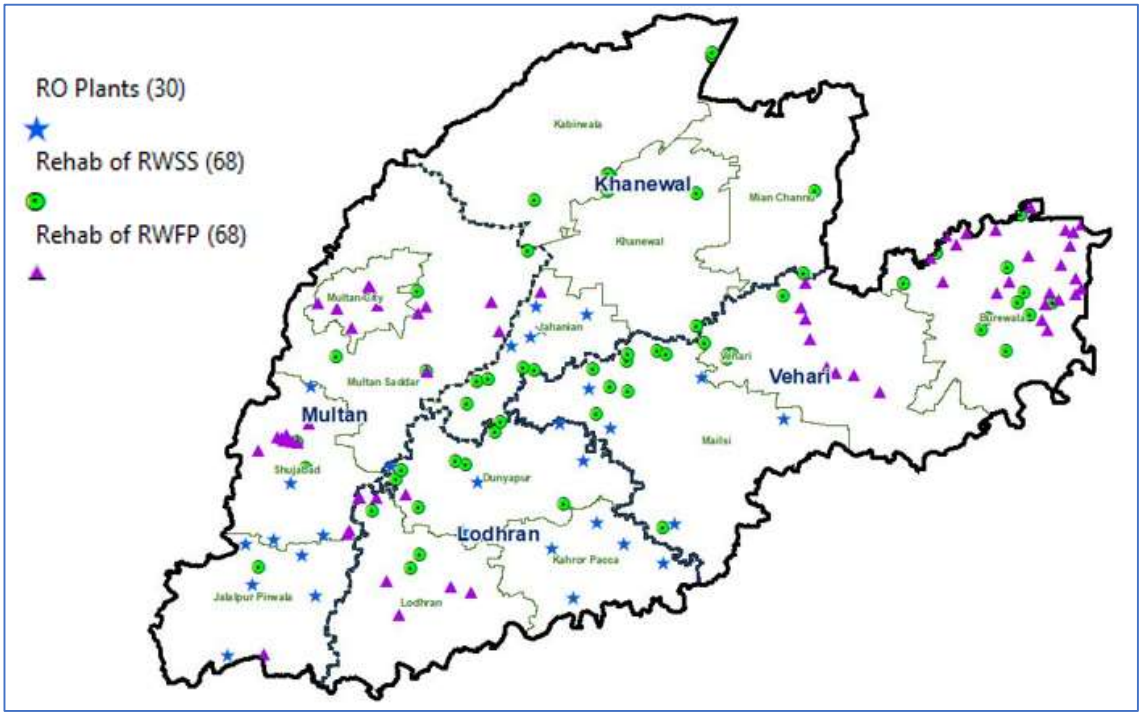


Figure 69: Spatial Representation of Rural Water Supply Interventions

8.8 Rural Sewerage Projects

It includes the execution of open drains-based sewerage drainage schemes, installation of public toilets and development of model villages in all districts of division.

Sewerage and Drainage schemes may include installation of open drains, Tuff tiles, PCC, Soling, Resoling, Drains and Sullage carrier, open ponds-based treatment before final disposal. These schemes are proposed in a manner by considering existing coverage in districts. It is envisaged that 11% S&D coverage will be increased in division through execution of these schemes. Villages are selected spatially by considering unserved settlements or villages in an equitable manner. Comprehensive schemes with open drain-based network are proposed in each district covering number of villages. List of villages are attached at Annexure. These schemes network are proposed to be executed and maintained by PHED as per their mandate.

The whole rural region is too large to be covered in one go, as only approx. 220 villages are covered in proposed above mentioned comprehensive sewerage and drainage schemes package. Therefore, public toilets are also proposed on the other hand initially in 10 villages in each of district where currently no access or sewerage system is present.

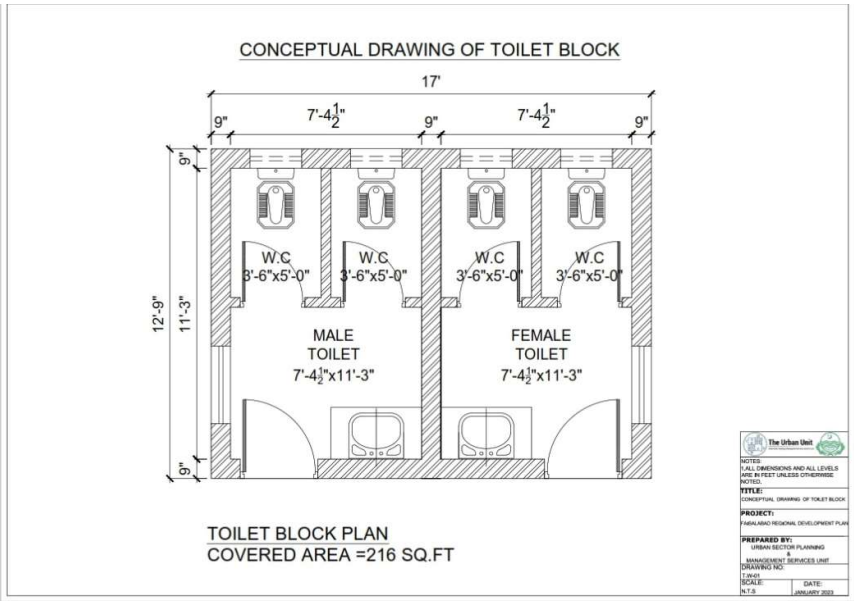


Figure 70: Conceptual Drawing of Public Toilet:

The concept of Model Village is introduced in which it is envisaged that underground sewerage lines will be laid along with paved soling streets and establishment of its associated decentralized wastewater treatment plant. A single village having 300 households and 2100 population in every district is selected as a prototype for establishment of a model village. Decentralized WWTP for 300 HH is proposed with anaerobic treatment requiring 4 Kanal with worth PKR 25 Million in each Model Village. NGO is recommended to be engaged for making a village as model prototype for O&M and sustainability.

Table 39 Wastewater Production in Decentralized WWTP

Total number of households	300
Design population	2400
Water consumption	360000 L/ day (150 L/capita/day)
Wastewater generation	80% of water consumption
Wastewater flow	288 m^3/day
Wastewater Flow (including Population Growth Rate)	324 m^3/day
No of treatment trains	02
Wastewater Flow for single train	162 m^3/day (6.75 m^3/hr.)
Total Cost (Design + Construction):	Rs. 23 Million

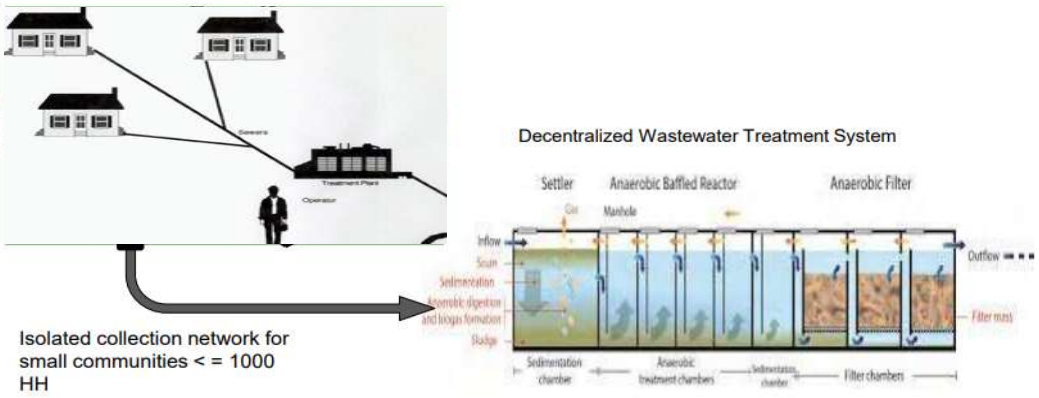


Figure 71: Conceptual Diagram of WWTP:

List of Rural Sanitation Projects or Interventions in Multan division is given in table while detailed names of villages along with coordinates is mentioned at Annexure.

Table 40 Rural Sanitation Interventions

Phase	Proposed Schemes	Cost (Million)
SHORT	Provision of 40 Public Toilets (10 in each district)	5
	Short Term Cost: 5	
MEDIUM	Proposal of 4 Model Village (each in district with 300 Households) with covered sewerage system, paved streets, and decentralized wastewater treatment plant	340
	Medium Term Cost: 340	
LONG	Provision of 220 Open Drains based Sewerage and Drainage Schemes (70 in Lodhran), (60 in Multan), (50 in Vehari) and (40 in Khanewal)	8,976
	Long Term Cost: 8,976	
	TOTAL SANITATION COST RURAL (10 Years) = 9,321 Million	

Spatially marked Sewerage and Drainage interventions are reflected on projects map below. It is envisaged that these proposed interventions will increase S&D coverage up to 34% in the rural areas of division.

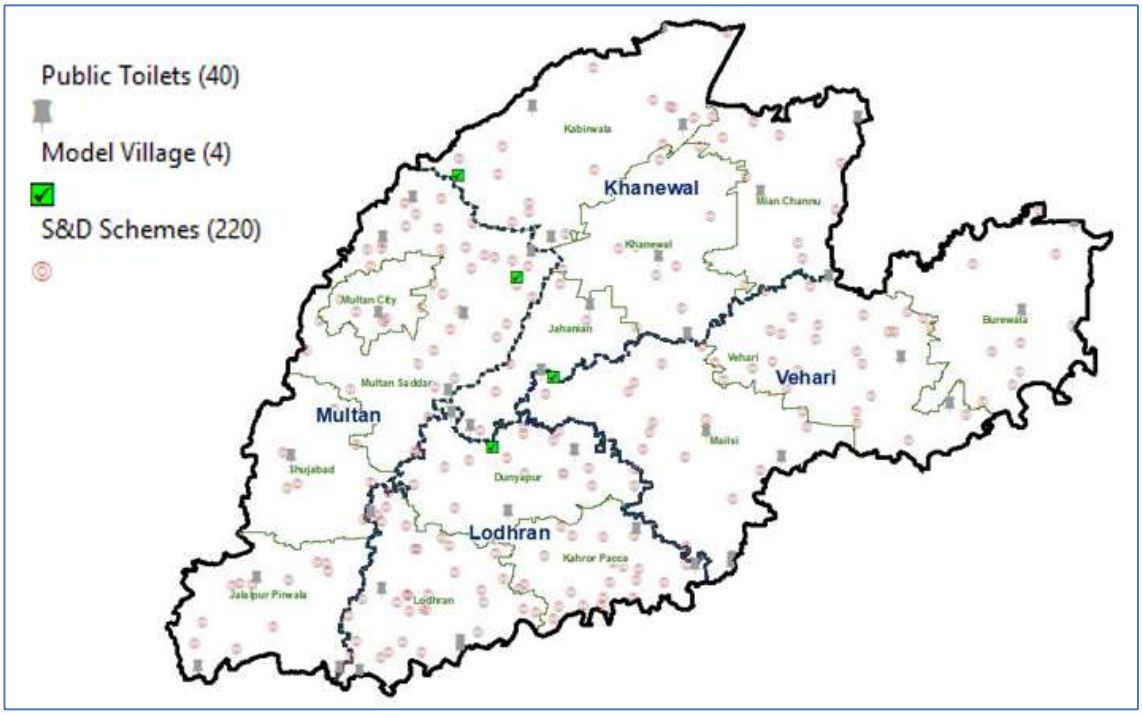


Figure 72: Spatial Representation of Rural Sanitation Interventions

8.9 Cost Summary Rural WSS

Summarized identified intervention projects of worth PKR 20 Billion over the next 10 years is presented in table.

Table 41 Summary of Rural WSS Interventions

	Water Supply PKR Million	Sewerage PKR Million
SHORT	2,823	5
MEDIUM	1,771	340
LONG	6,470	8,976
TOTAL 20 Billion	**11,065**	**9,321**

9 Further Recommendations

Following are few further recommendations which are proposed for further improving the WSS services in the planned regions.

9.1 Establishment of GIS-based Asset Management Units

The rising trend of population in cities of Punjab has resulted in ever-expanding urban centers. The surge in population is leading to hap-hazard and unplanned formation of municipal infrastructure, to cater to the needs of these growing cities, mostly due to lack of information which can also be made possible through GIS based system and officials proficient enough to perform analysis related to the planning of these emerging and densely populated urban centers. More infrastructure has made information availability indispensable for the successful management and operation of city's services i.e. Water Supply & Sanitation.

All of the Operating Agencies for Water Supply & Sanitation in Multan Division lack the necessary resources and expertise for mapping and planning of their water and sanitation systems. Lack of availability of resources for important analysis i.e., GIS Mapping, slope analysis, elevation profiling, etc. are also one of the reasons for poor services in visited areas even after hefty investments.

Establishment of GIS Cell (GIS-based Asset Management Units) in the offices of Operating Agencies like WASA-M and Municipal Committees is thus proposed. This would result in capacity enhancement of these departments and enable them to map, organize and manage their water and sanitation assets in a self-sustained manner. GIS inventories would be developed, which can be used for planning of new or assessment of proposed projects.

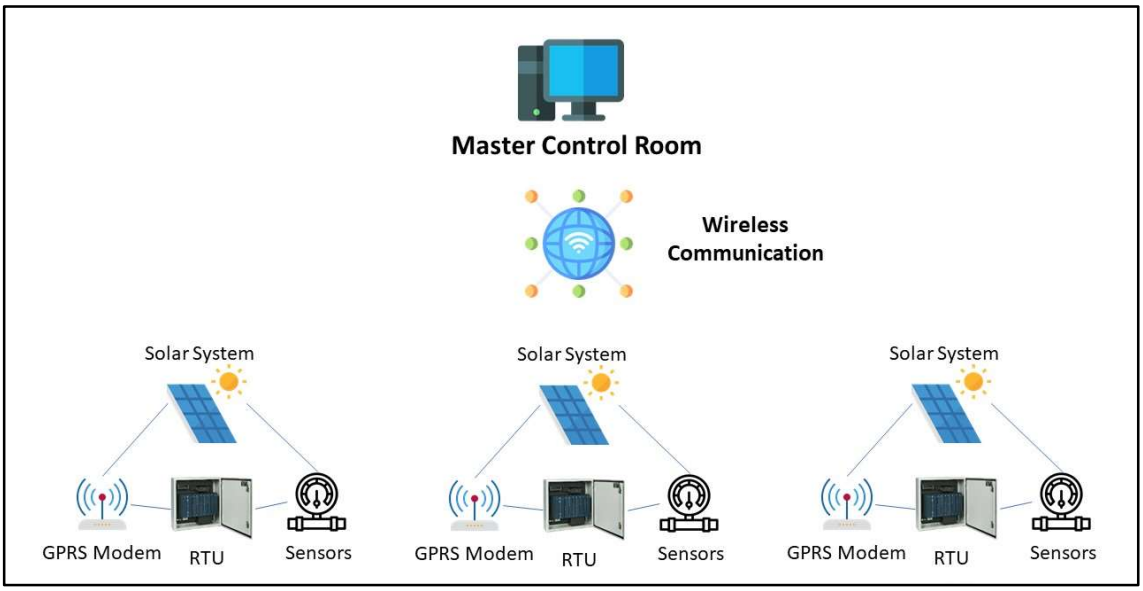


Figure 73 Concept of GIS Based Monitoring System

An advantage of geo-tagging and mapping is the ease with which information can be analyzed. Graphical and pictorial representations of data can be generated in minimal time and with minimal effort. The output can be configured to appear on specified portals or dashboards, increasing the effectiveness for operational and maintenance capabilities of these institutions.

Integration of GIS and SCADA-based resources is another frontier that can be explored for real-time monitoring of system. The system can be calibrated with advanced data collection (SCADA enabled) sensors that can transmit data to a centralized control unit, for a real-time analysis of different features of the system. Water demand-supply, NRW analysis, Complaint redressal systems, Energy Analysis etc. are just some of the features that can be explored through this technology. This may in-turn help while imperializing the WSS services and hence investing accordingly.

9.2 Capacity Building Plan

During field assessment and consultation sessions, various issues were brought to light related to Capacity Building gaps in the organization which have operation and maintenance responsibility. As such, following is recommended as a Capacity Building program for all the operating agencies in order for them to get further capacitate.

- **Al-Jazari Water & Sanitation Academy**

The Government of the Punjab acknowledged these issues and realized the need of improvement of the O&M and management capabilities of WASAs and all other service providers (MCs and TCs) for better and improved Water Supply and Sanitation services. Training of management and field staff is essential in order to keep them updated with the recent developments in their field and to enhance their professional abilities. This have been made possible with establishment of Al-Jazari Water & Sanitation Academy in Lahore.
Al-Jazari Water & Sanitation Academy was established by the collaboration of WASA-Lahore, Government of Punjab and Government of Japan for the training and capacity building of WASAs & other operating agencies of Water Supply & Sanitation services. Under the project titled, “Project for Improving the Capacity of WASAs in Punjab Province”, Al-Jazari Academy has been working on the capacity building of the five (05) WASAs and operating agencies from all over Pakistan by conducting trainings and workshops to improve the capability for effective management of water and sanitation assets and Human Resources (HR).

Figure 74 Al-Jazari Water & Sanitation Academy

Modules Offered

The institute offers multitude of courses and trainings modules in multiple disciplines the detail of few of which is tabulated below:

Table 42 Al-Jazari Courses Offered

Course	Module
O&M of Tube-well and Pump Facility	1. O&M of Water Distribution System
Leakage Detection	1. Basic knowledge of Leakage Prevention Work
	2. Leakage detection and repair at the site (OJT)
	3. Installation & operation of equipment at the site (OJT)
O&M of Sewer and Storm Water Drainage	1. Safety control and measure for sewerage and drainage

	2. Operation & Maintenance of sewer system
	3. Operation & Maintenance of drainage system
O&M of Electrical and Mechanical Equipment	1. Centrifugal Pumps, Induction Motors and Valves
	2. Electrical Panel and Instrumentation Equipment
	3. Generators
	4. Chlorinators and Filtration Systems
	5. Heavy Machines
	6. Supervisory Control and Data Acquisition System (SCADA)
	7. Water Meter Maintenance and Repair
Asset Management	1. Introduction to Asset Management
	2. Creating & Updating Asset Database in Asset Management Information System
	3. Asset Database Analysis
	4. Asset Replacement Plan
	5. Asset Conditions Survey & Analysis
	6. Use of GIS System in Asset Management
Business Planning	1. Business Plan & Operation of WASAs
	2. Strategies for Water and Sanitation Service Delivery Improvement
	3. Human Capita Development
	4. Financial Management System
	5. Implementation of Business Plan

		
Training on Energy Audit for staff members of WASA Rawalpindi	Hands on training of leakage detection of pipe	On-site assessment to measure the flows and evaluate the Condition of Pump House

Figure 75 In Pictures: Training Sessions

These diversified training includes multiple genre of courses which can help Capacity Building of operating agencies. Example of this is the GIS based software for Asset Management course. This course is aimed at training staff to mark and update the water supply and sewerage infrastructure with multiple attributes which includes its installation year and other technical properties. Lack of this capacity was also felt during the visit. These programs which are offered are customized to assist in planning of Operation & Maintenance and Asset Management. It is thus strongly recommended for all the operating agencies relevant officials to attend these courses which can further improves it service delivery in a more improved fashion.

9.3 Institutional Reformation

As per laws and regulations, Local Government & Community Development Department (LG&CDD) is responsible for provision of water and sanitation services in the cities. MCs are currently managing the Operation & Maintenance (O&M) of Water Supply and Sanitation (WSS) along with many other delegated functions in all of four districts of Multan Division.
MC consists of the Administrator, Chief Officer (CO), 5 Municipal Officers (MO) and other officials of the Local Council Service and officials of the offices delegated to the Municipal Committee. Administrator is the head of Municipal Committee and exercises all functions and powers as have been assigned to him. The Chief Officer is acting as coordinating and administrative officer in-charge of the Municipal Officers. Furthermore, Municipal Officers (MO), Deputy MOs and Assistant MOs support the above staff. These officers are looking into Infrastructure and Services (I&S), Finance, Regulation, Information Technology (IT), Planning & Architecture (P&A) head functions.

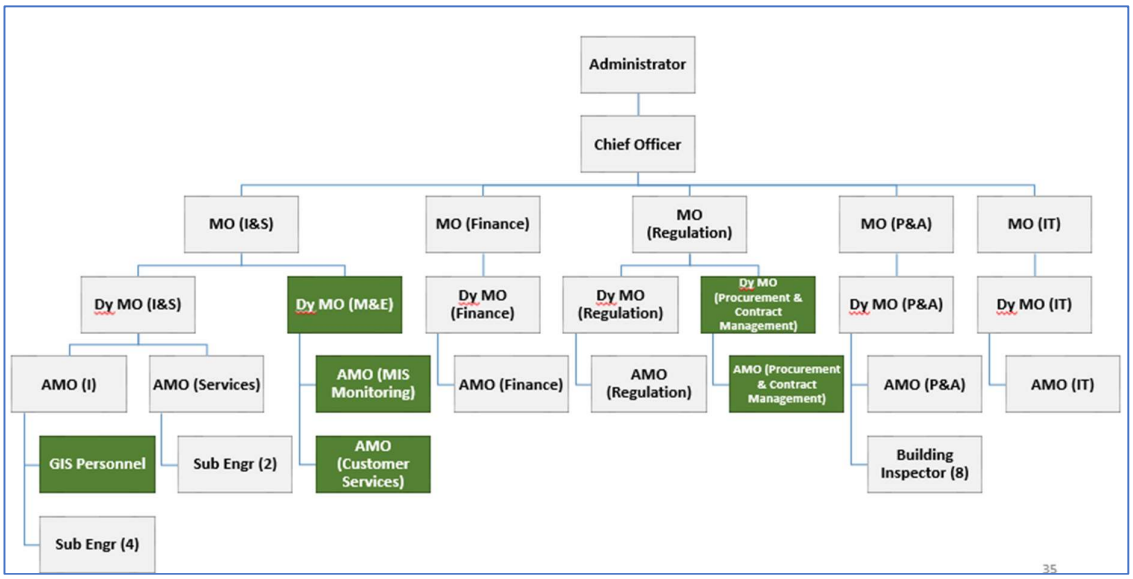


Figure 76 Proposed Institutional Structure for MCs

It is observed that some of the essential components of municipal services are neglected by the existing staff due to lack of proper relevant Human Resource (HR). The embedding of aspects of Asset Management, geo-tagging, mapping, and monitoring along with Complaint Management in service delivery results in to efficient management, accountability, and customer satisfaction. Geographical information System (GIS), Monitoring & Evaluation (M&E), Customer Services, MIS based Monitoring and Procurement & Contract Management are identified and proposed in green color to be added in the existing structure.

10 Conceptual Design and Drawings

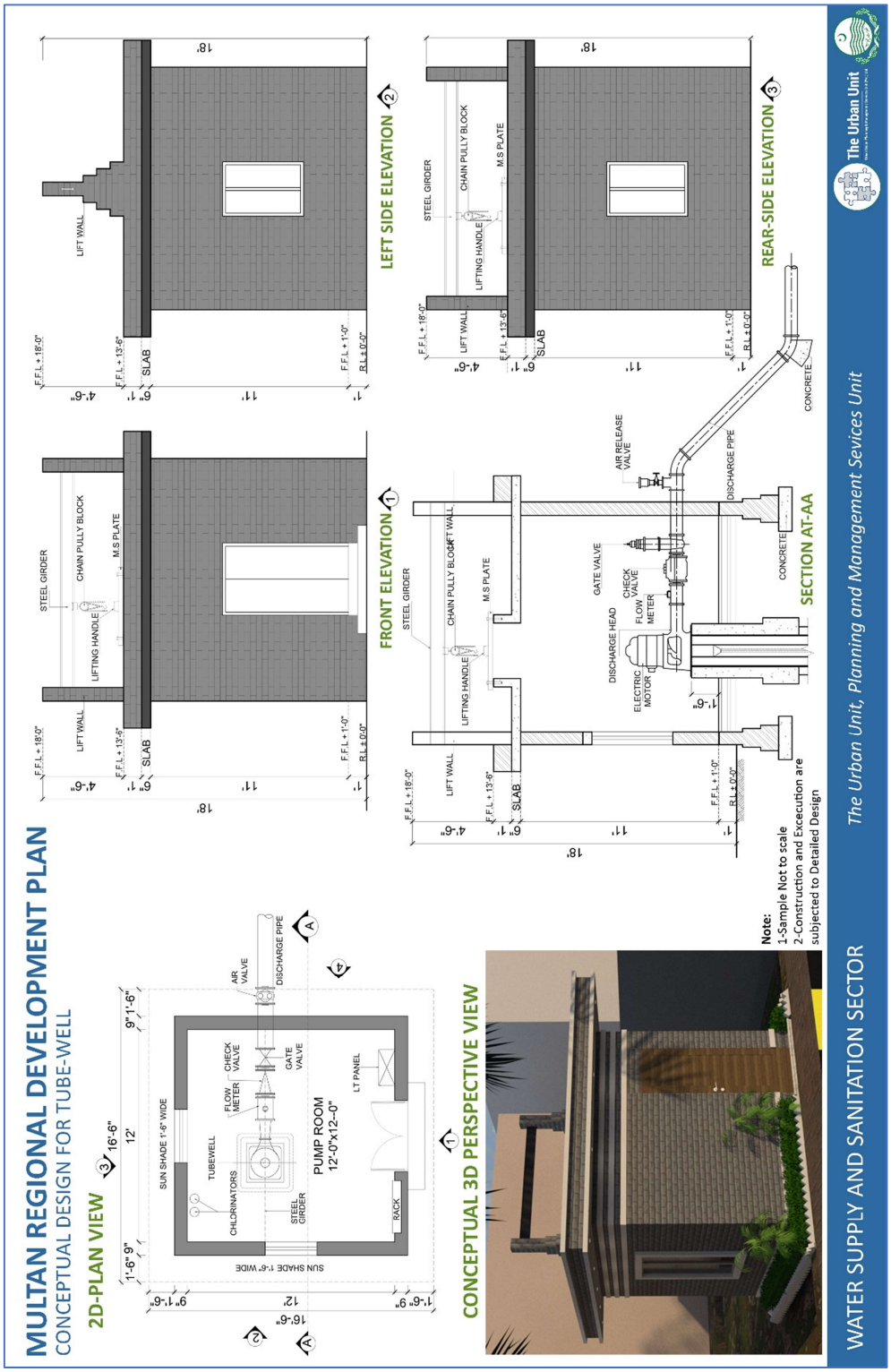


Figure 77: Design of Tube well

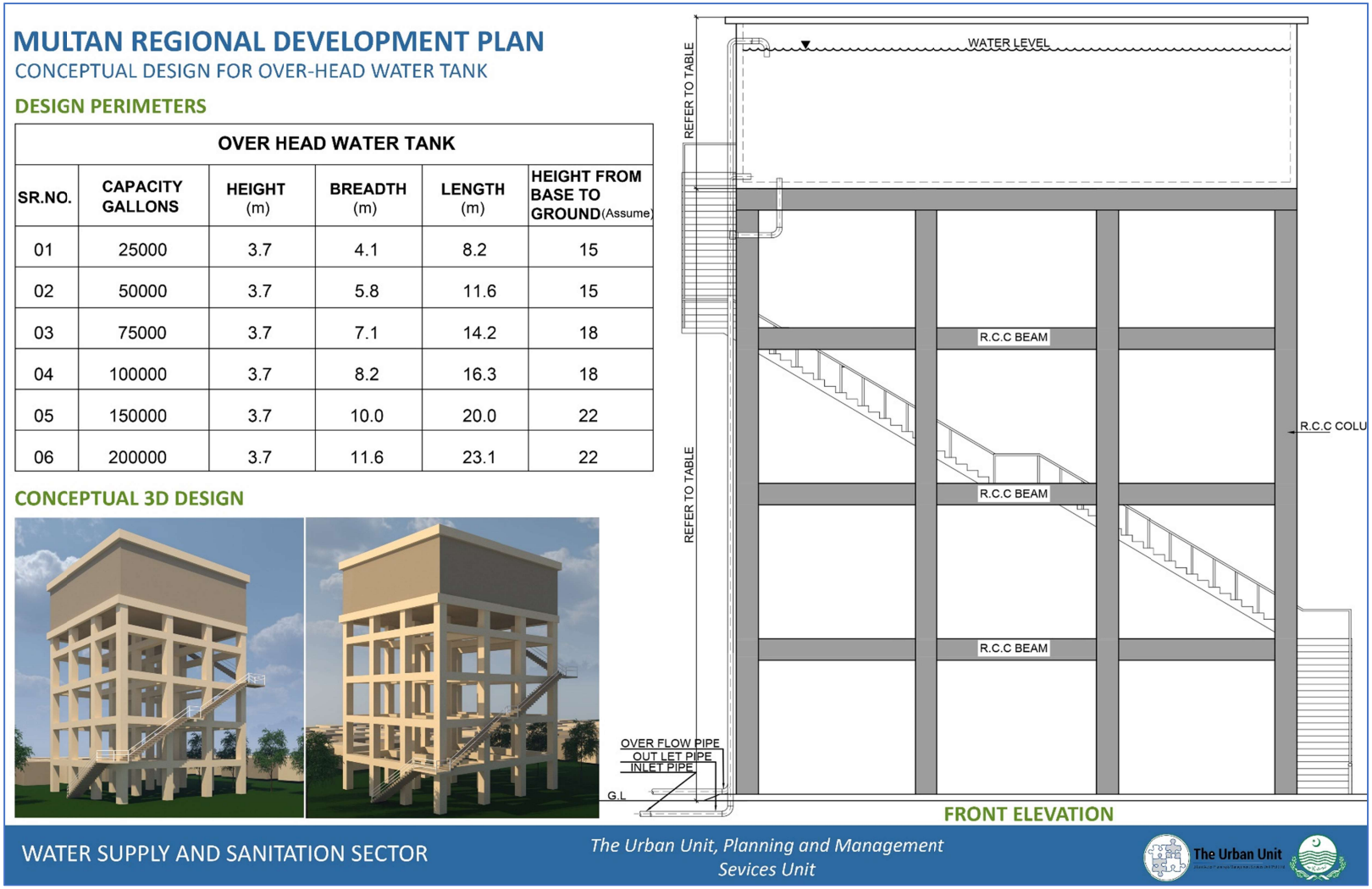


Figure 78: Design of OHR

Figure 79: Design of GST

Figure 80: Design of Filtration Plant

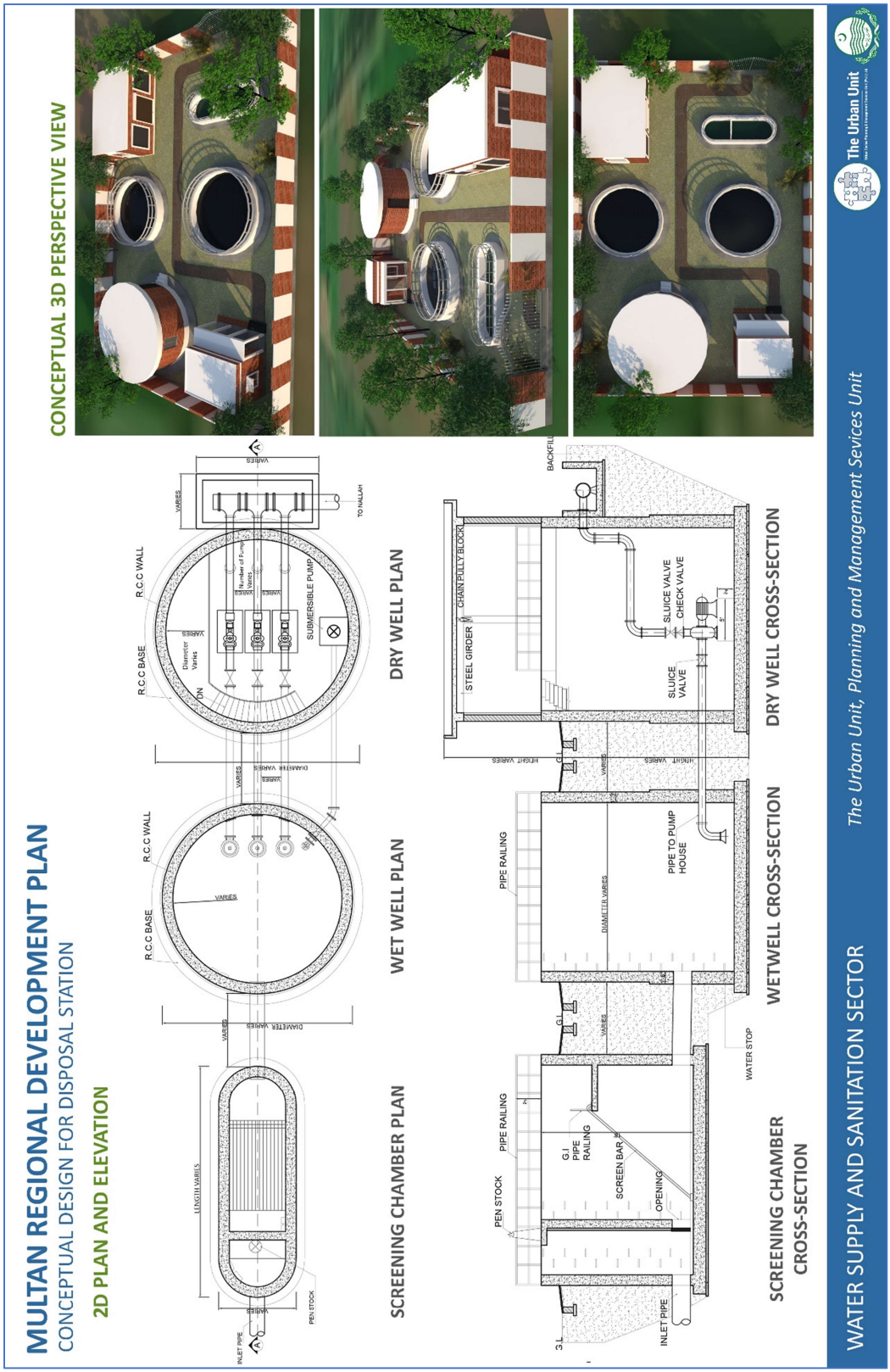


Figure 81: Design of Disposal Station

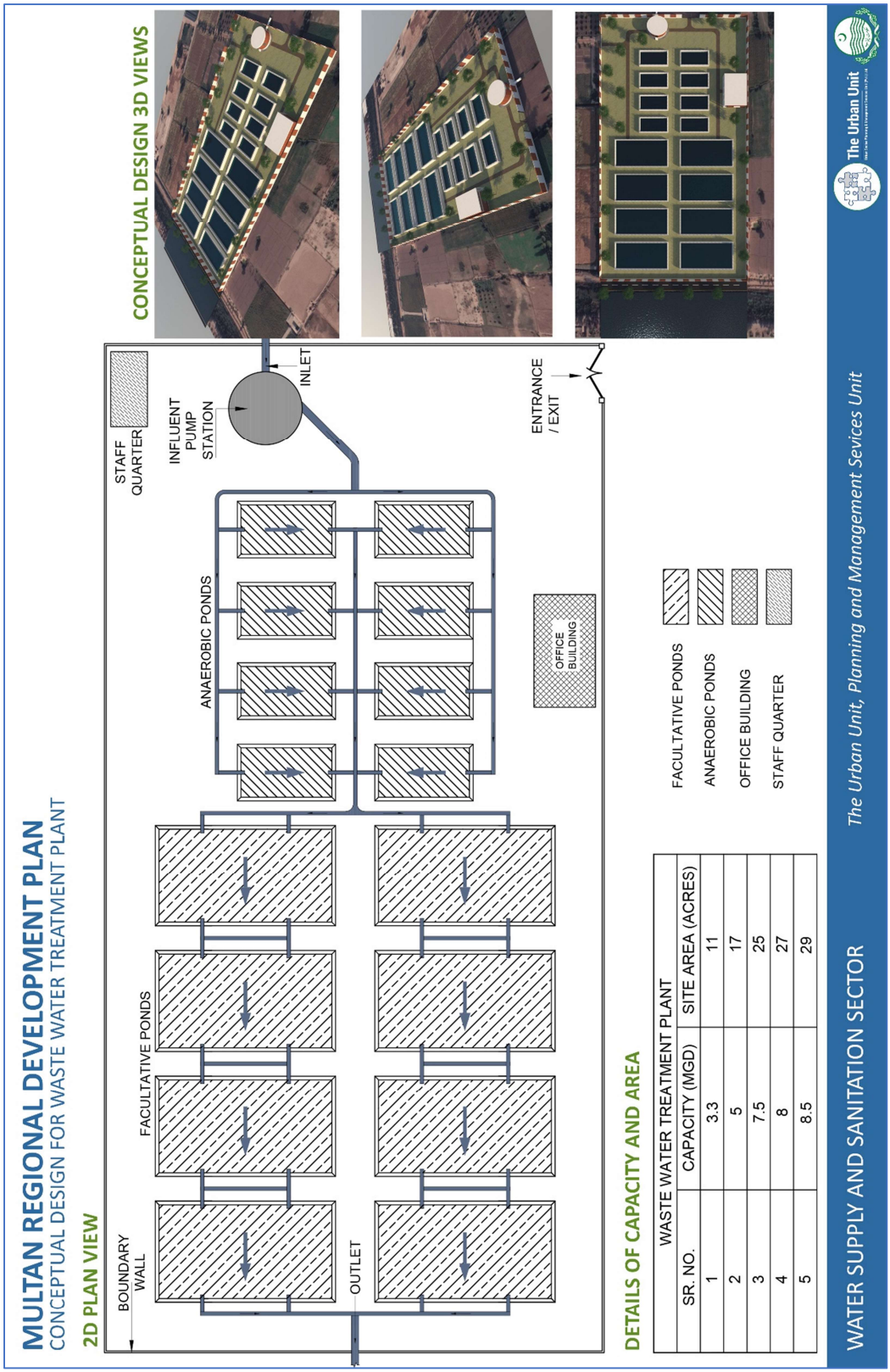
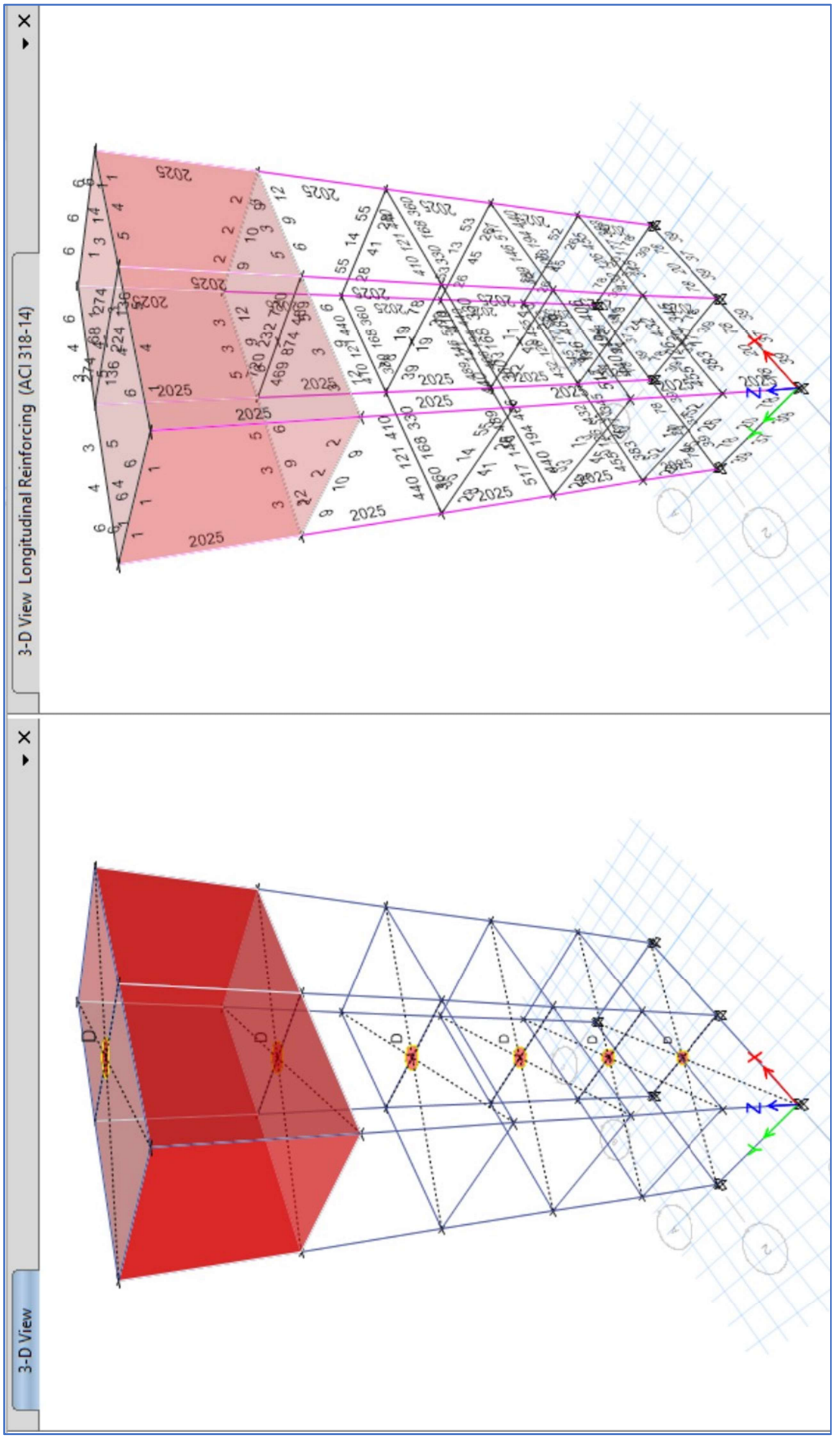


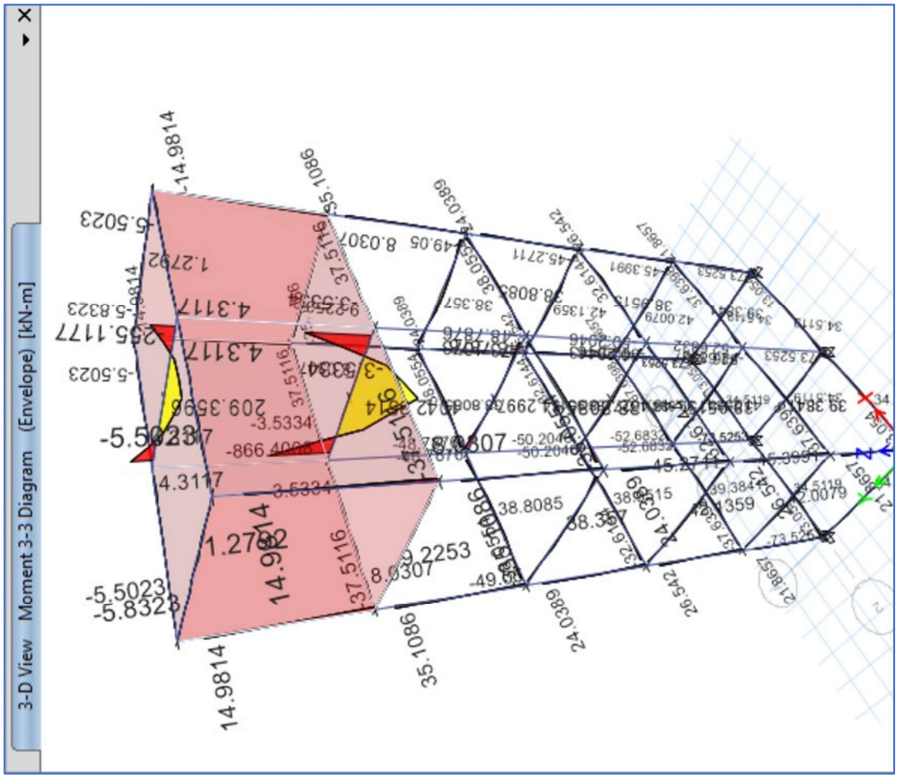
Figure 82: Design of Sewerage Treatment Plant

11 Overhead Water Reservoir Design

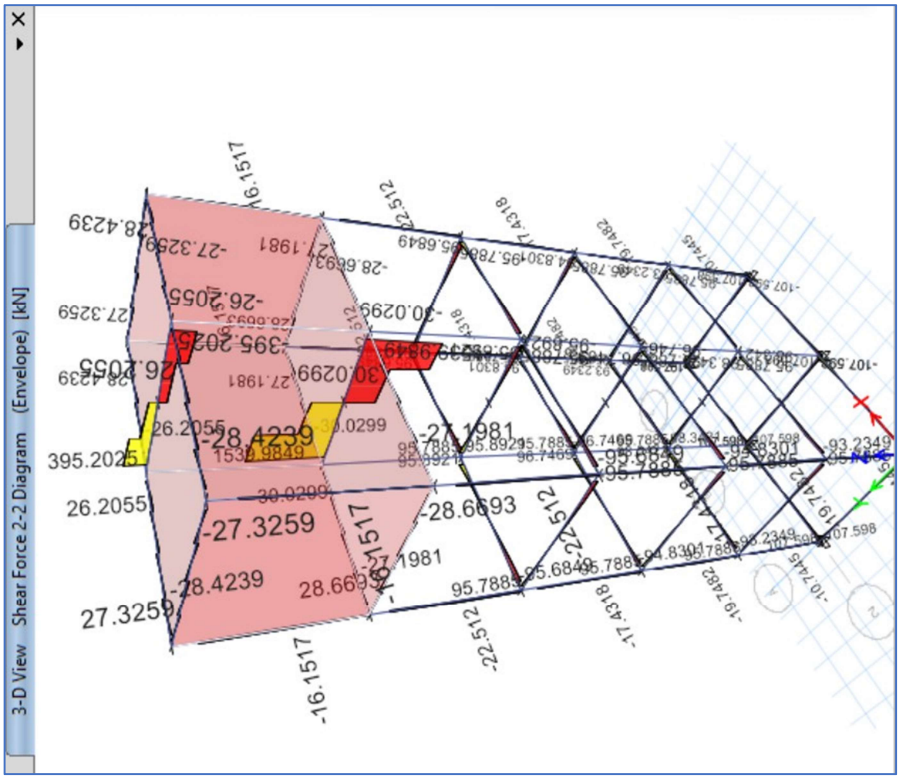
25,000 Gallons (Imperial) OHR Design



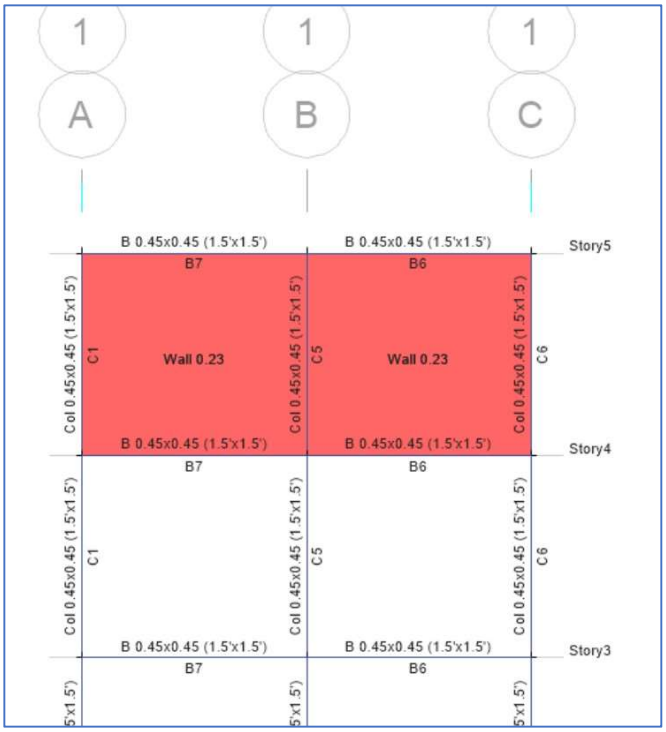
25,000 Gallons OHR Rebar Requirement in mm-sq.



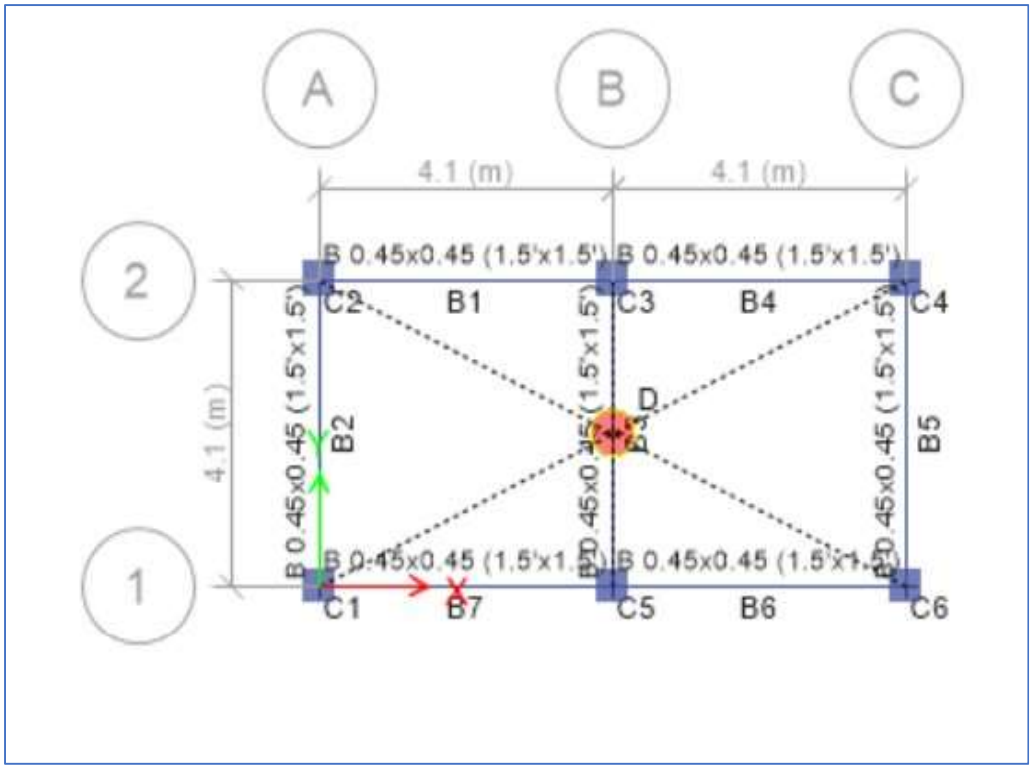
25,000 OHR Moment 3/3



25,000 Gallons OHR Shear 2/2

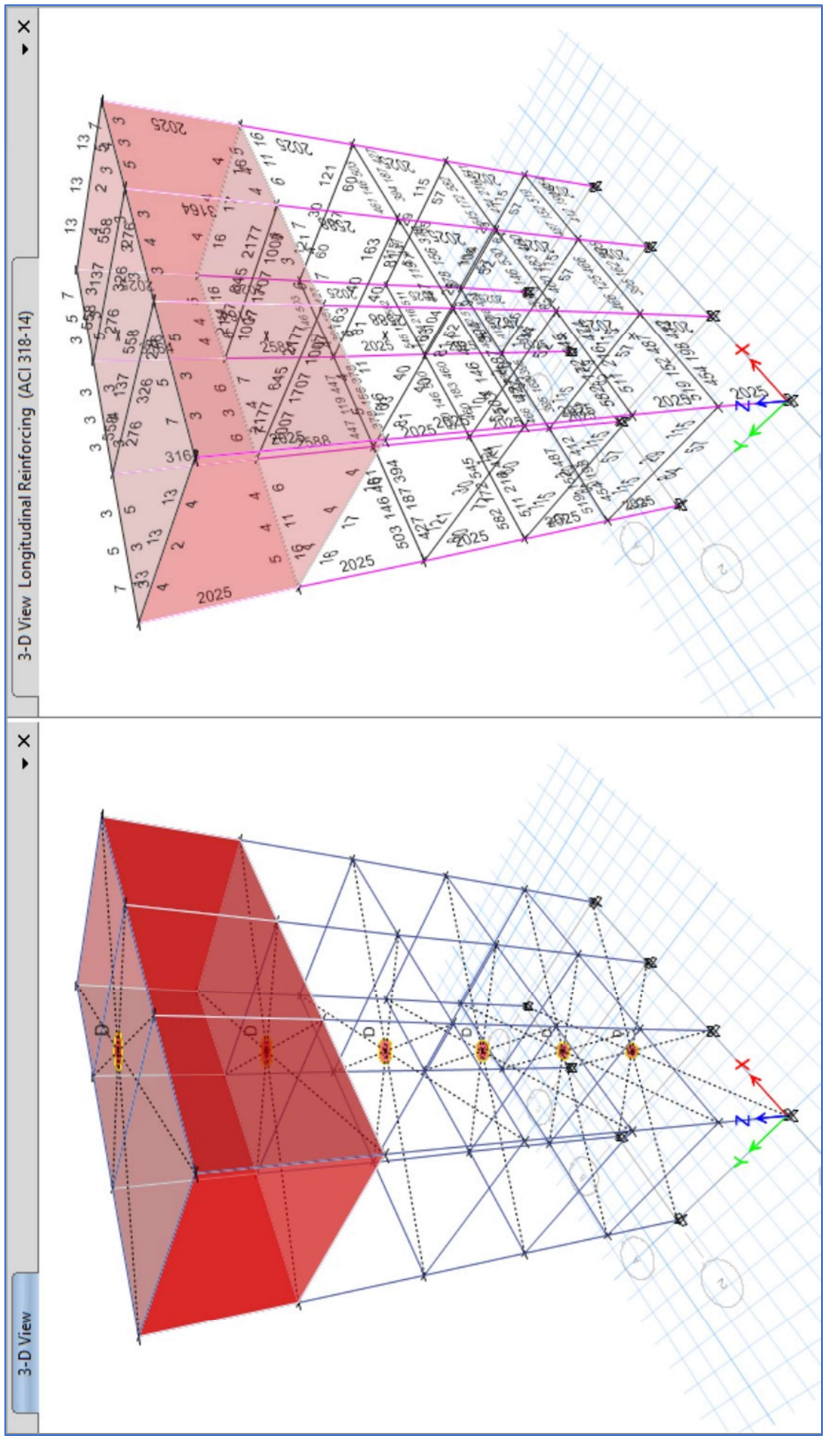


25,000 Gallons OHR Frame Elevation

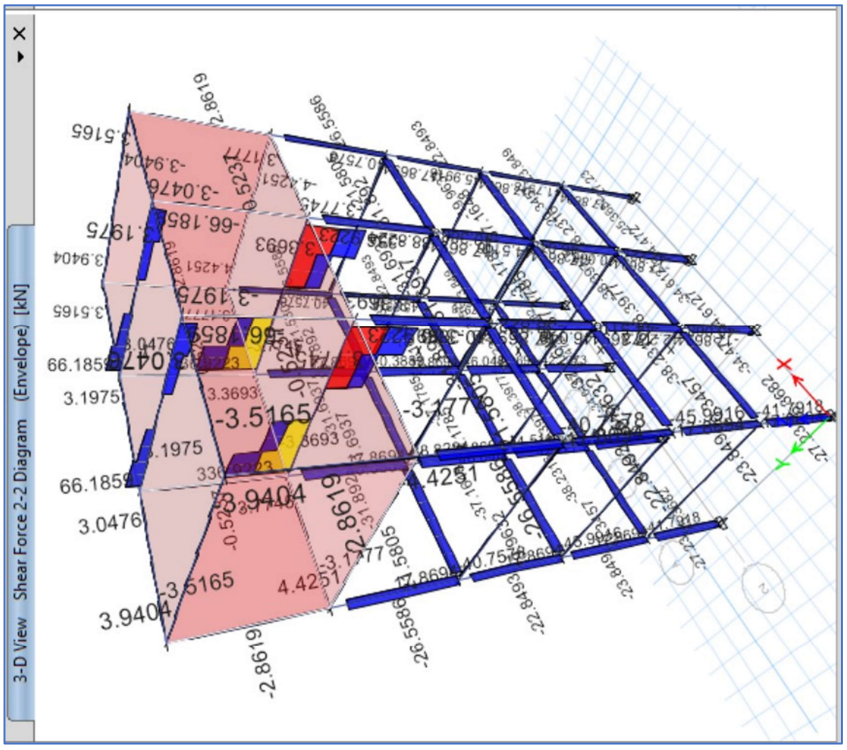


25,000 Gallons OHR Frame Plan

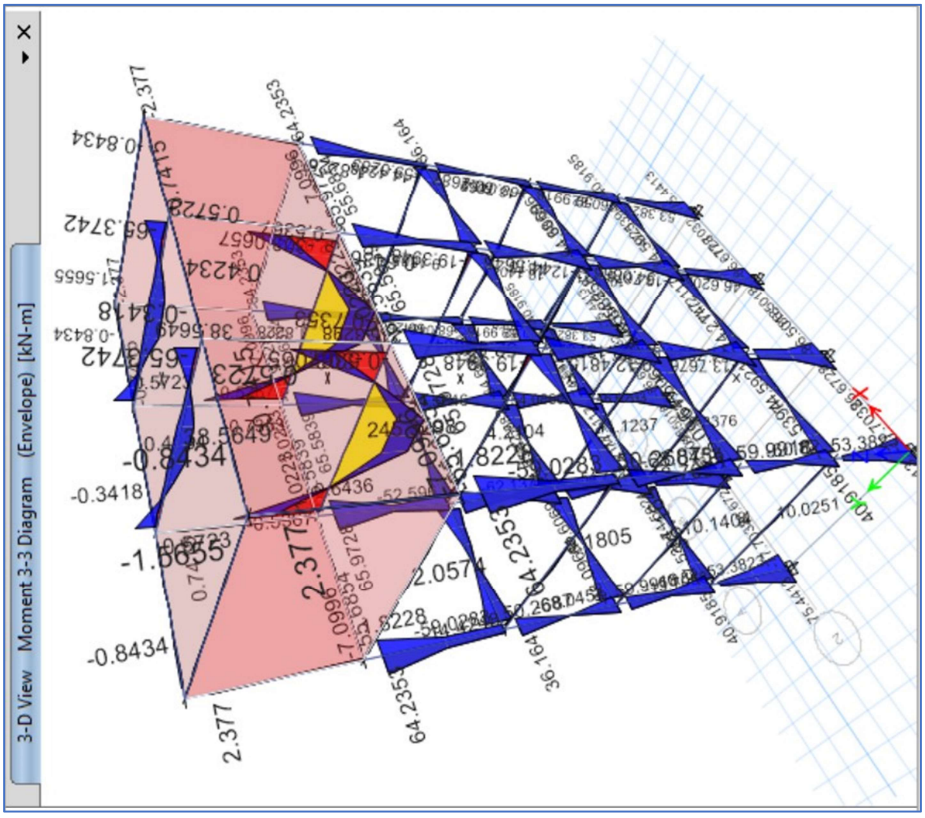
50,000 Gallons (Imperial) OHR Design



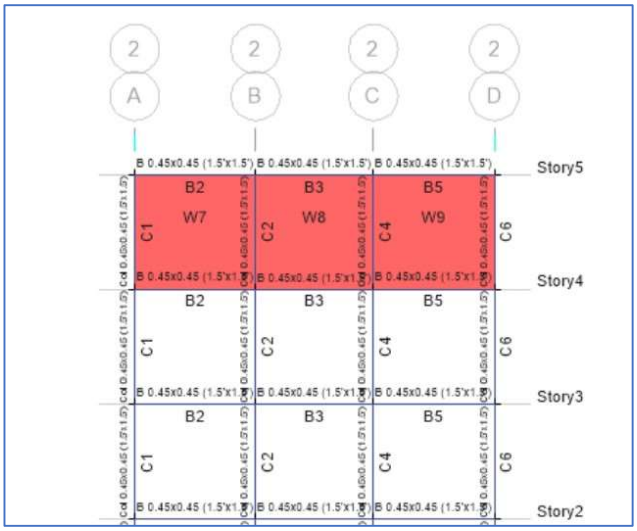
50,000 Gallons OHR Rebar Requirement in mm-sq.



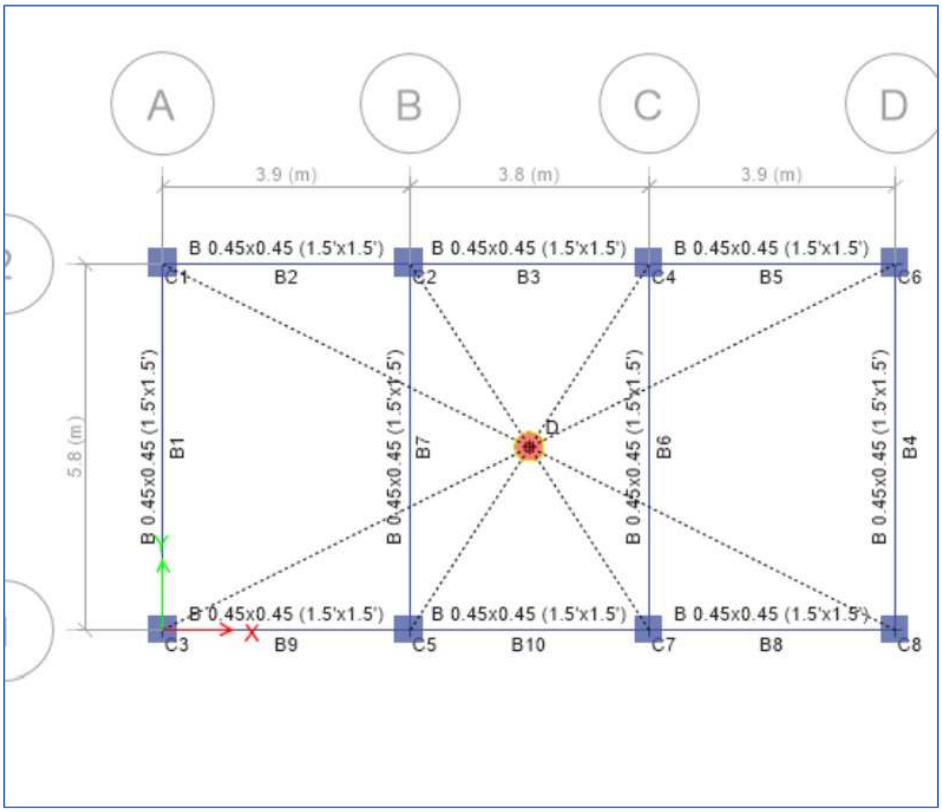
50,000 Gallons OHR Shear 2/2



50,000 OHR Moment 3/3

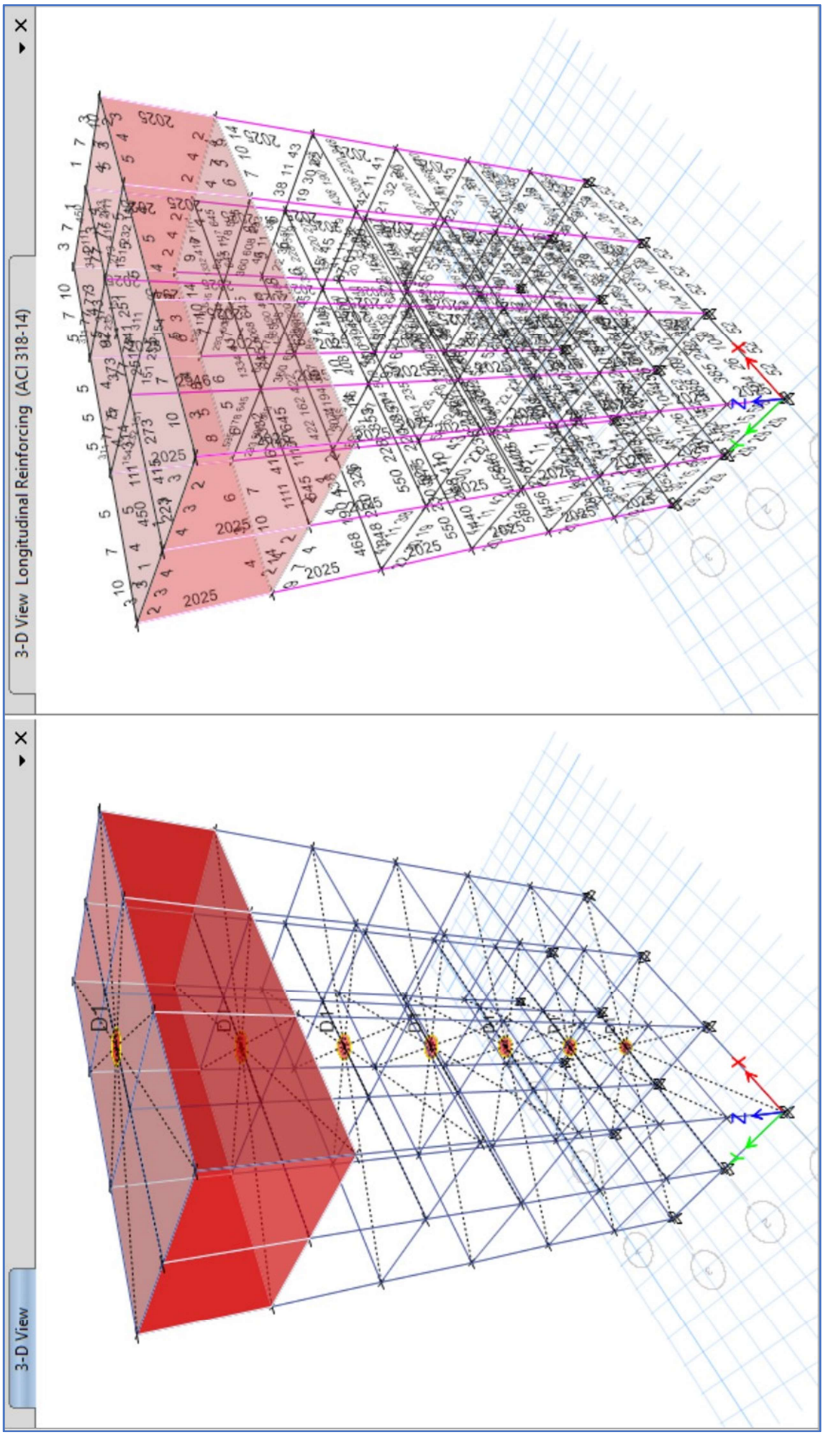


50,000 Gallons OHR Frame Elevation

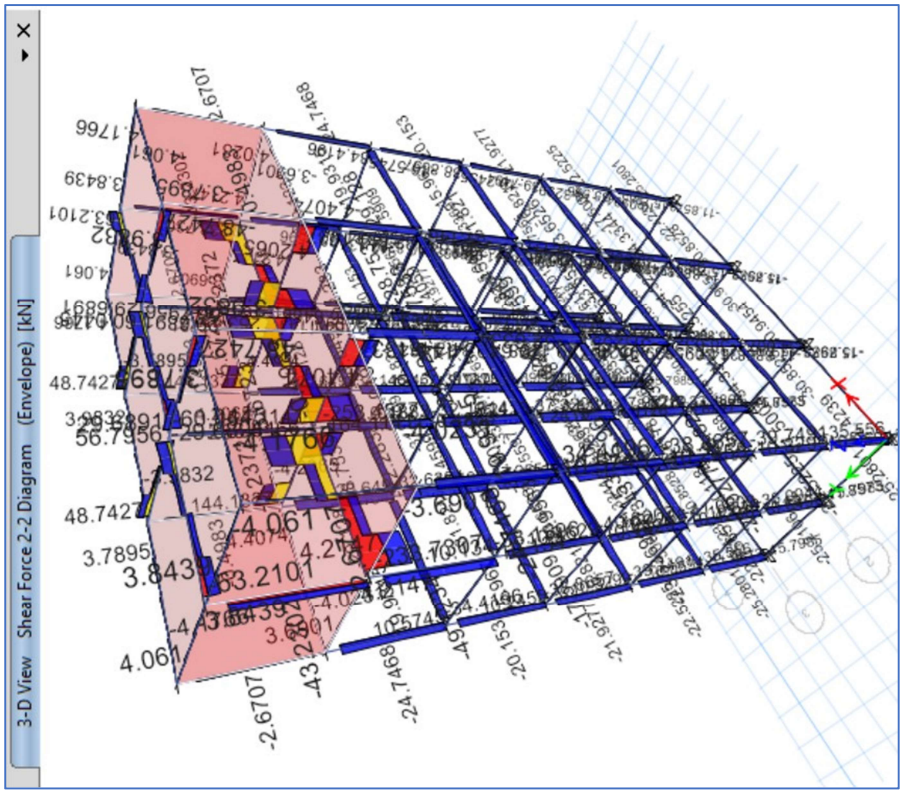


50,000 Gallons OHR Frame Plan

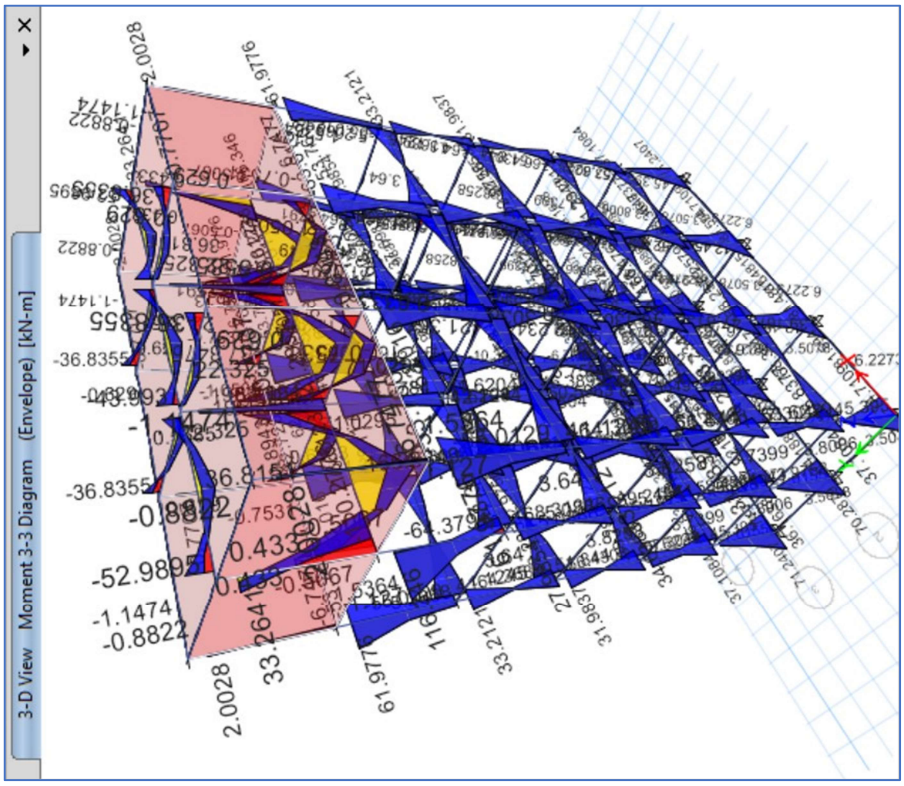
75,000 Gallons (Imperial) OHR Design



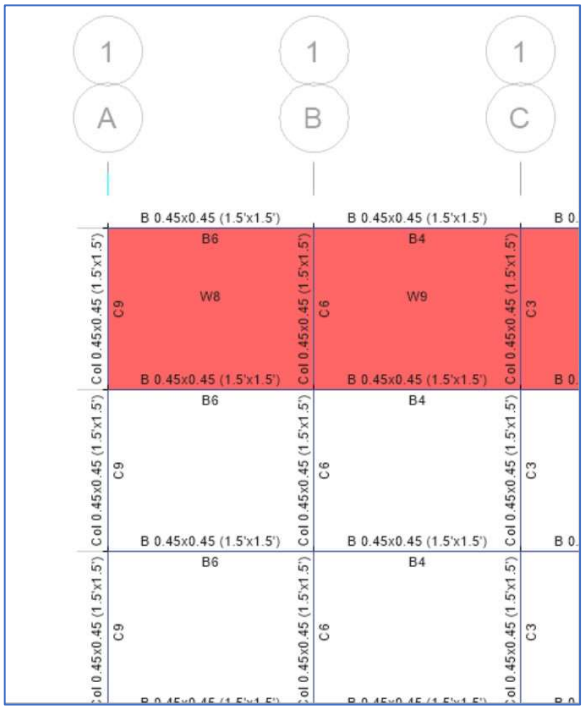
75,000 Gallons OHR Rebar Requirement in mm-sq.



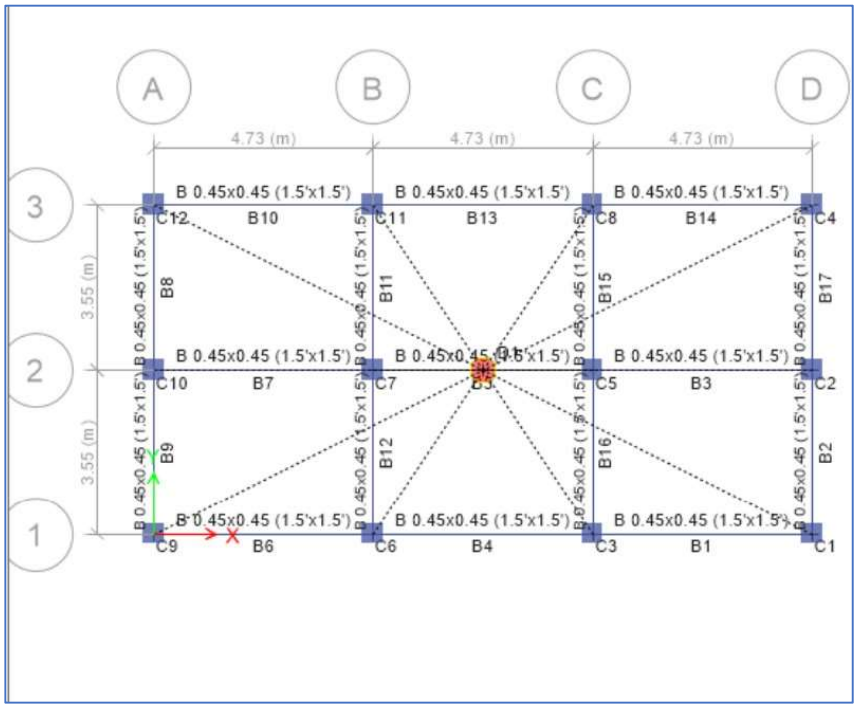
75,000 Gallons OHR Shear 2/2



75,000 OHR Moment 3/3

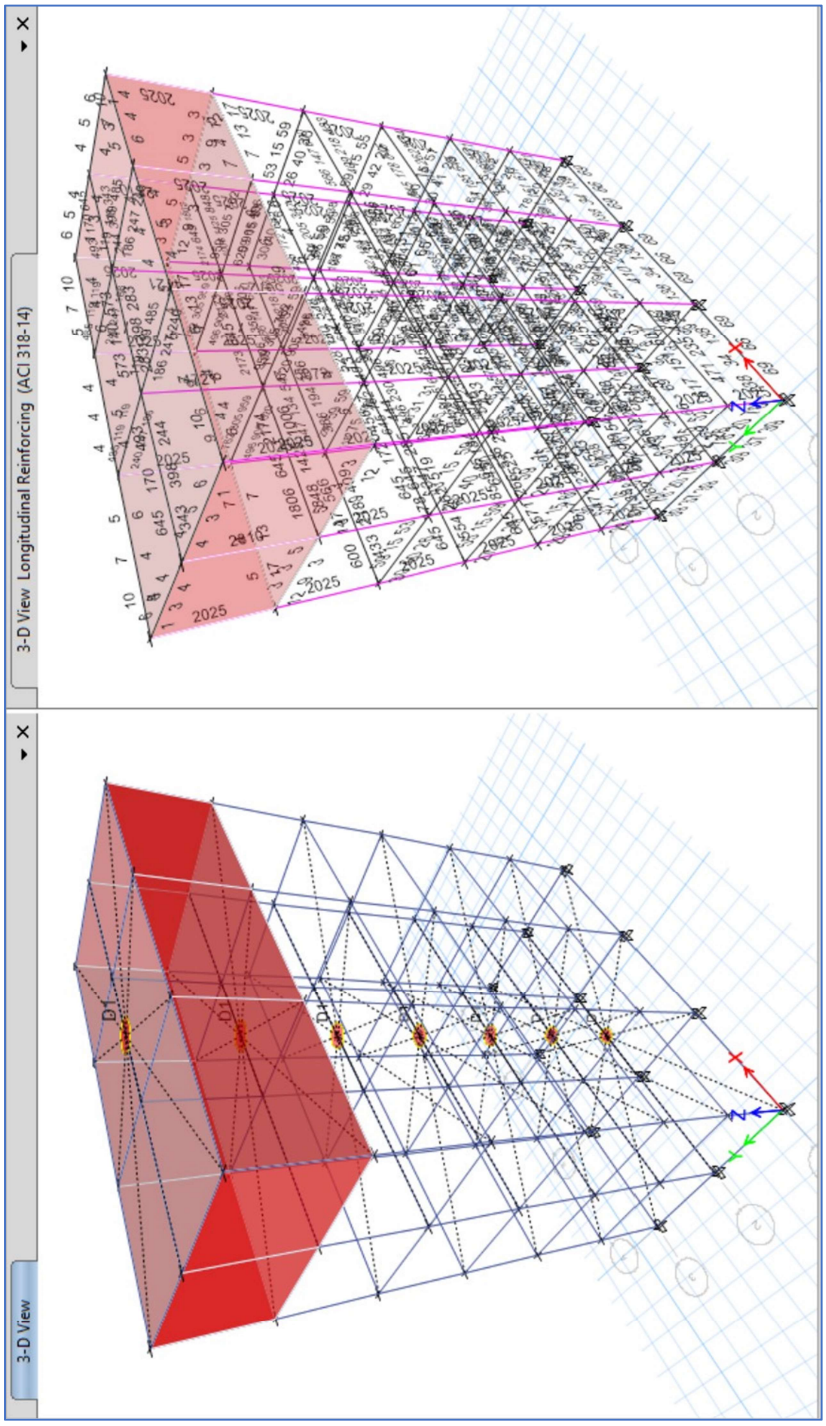


75,000 Gallons OHR Frame Elevation

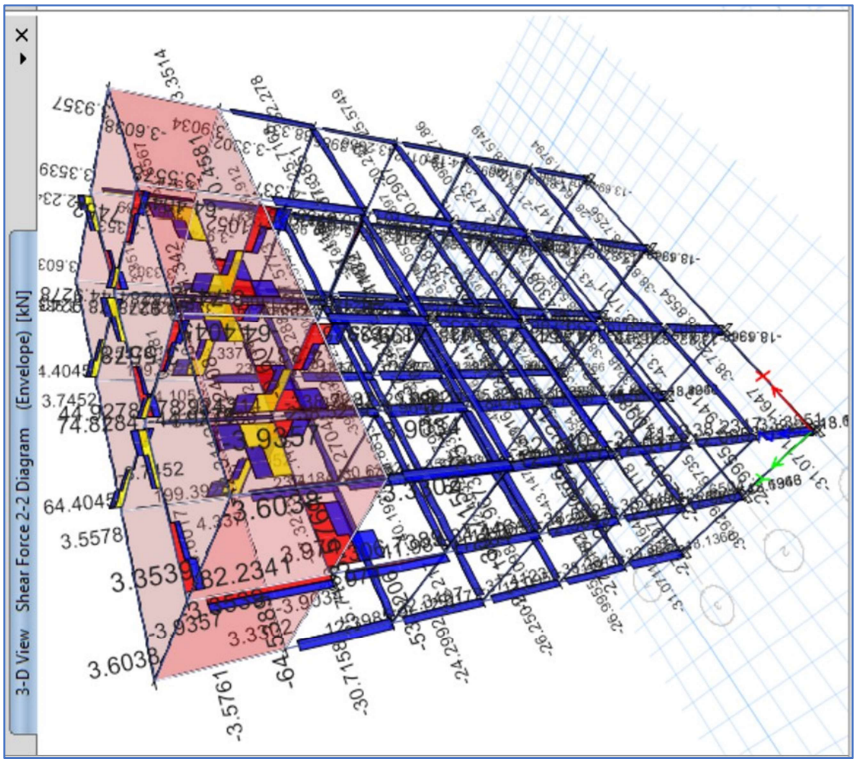


75,000 Gallons OHR Frame Plan

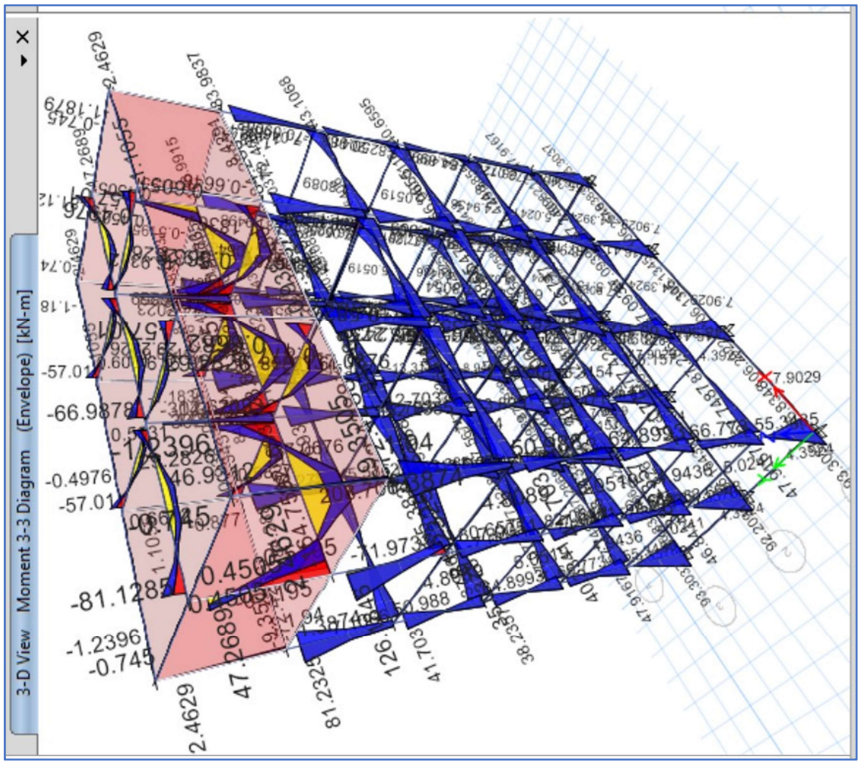
100,000 Gallons (Imperial) OHR Design



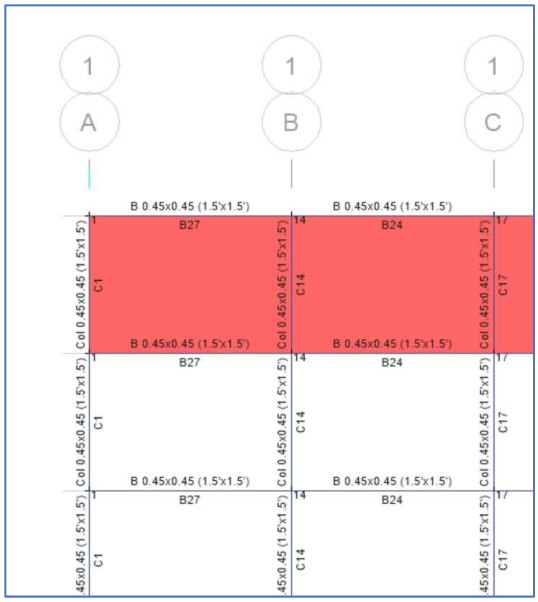
100,000 Gallons OHR Rebar Requirement in mm-sq.



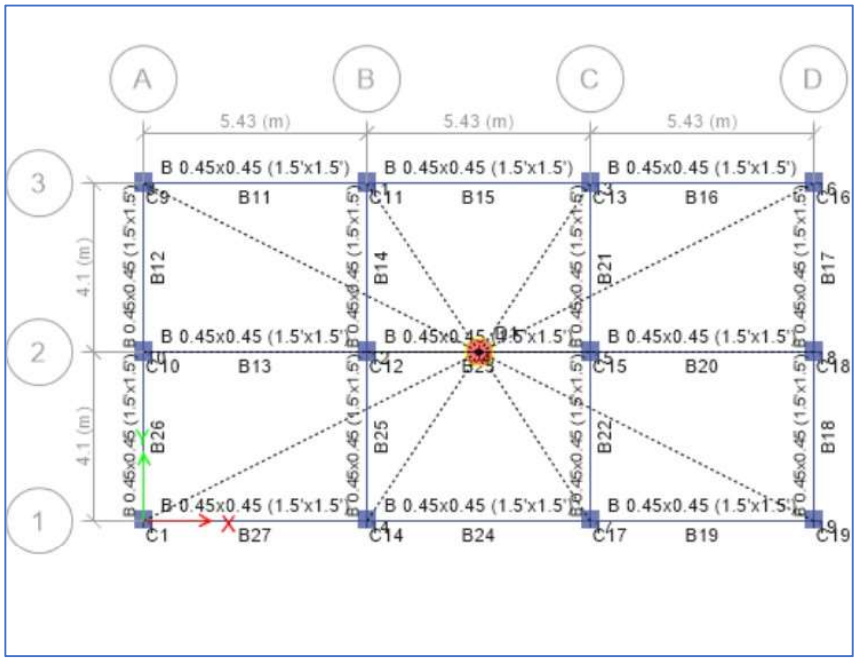
100,000 Gallons OHR Shear 2/2



100,000 OHR Moment 3/3

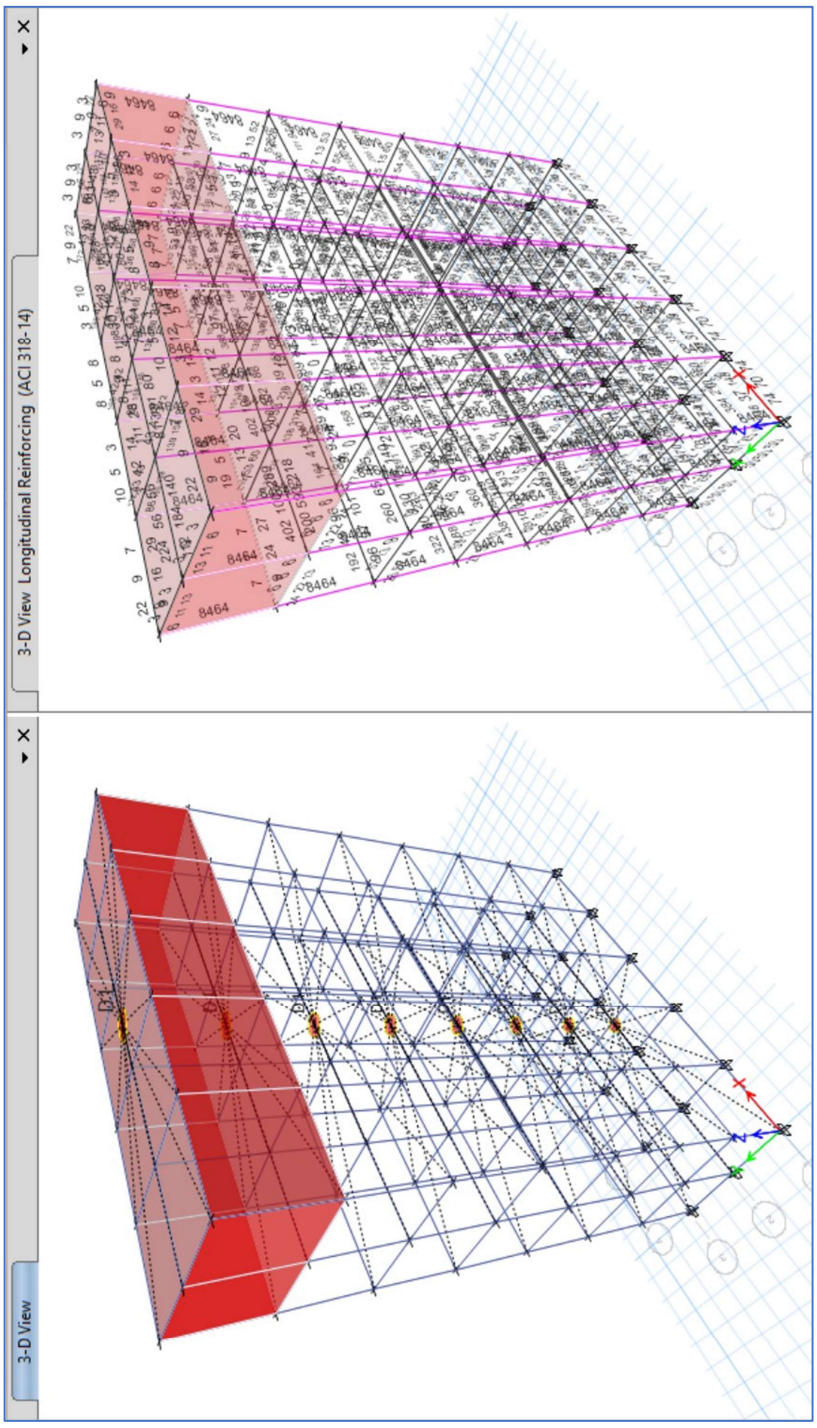


100,000 Gallons OHR Frame Elevation

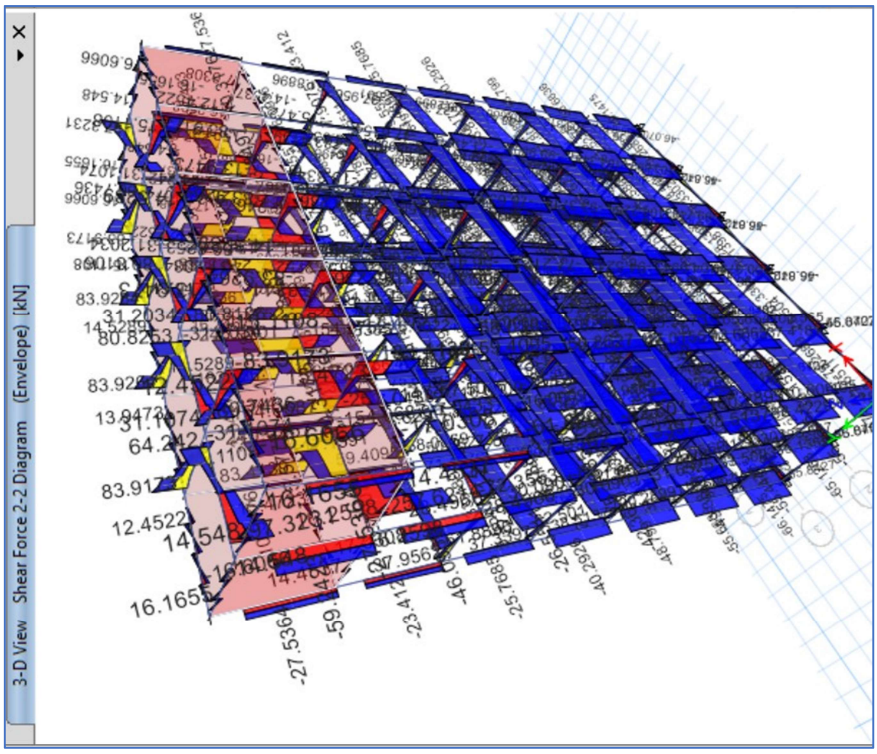


100,000 Gallons OHR Frame Plan

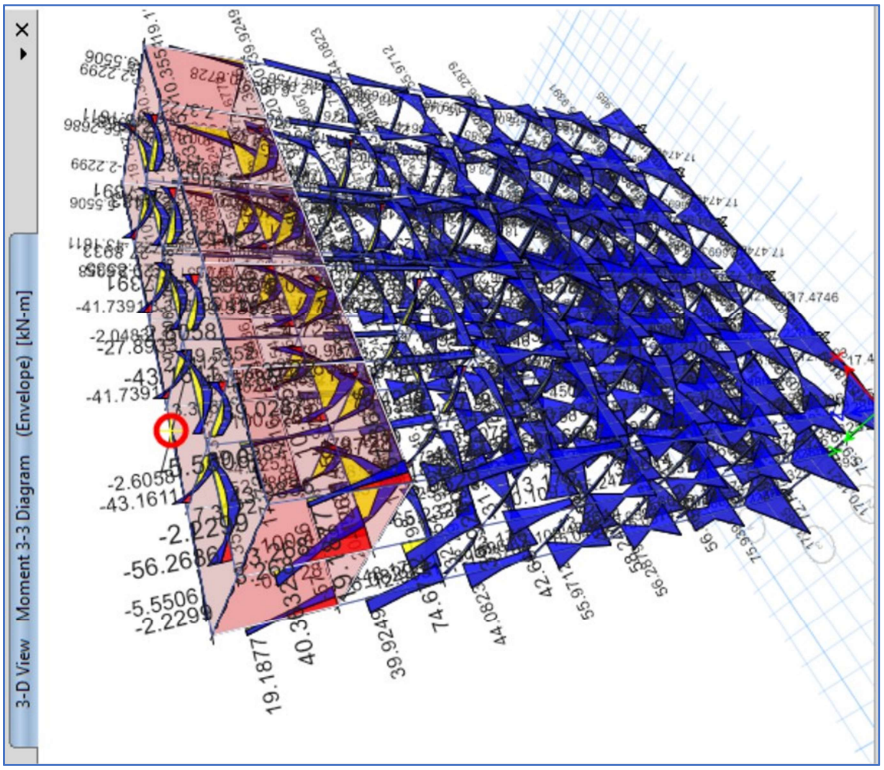
150,000 Gallons (Imperial) OHR Design



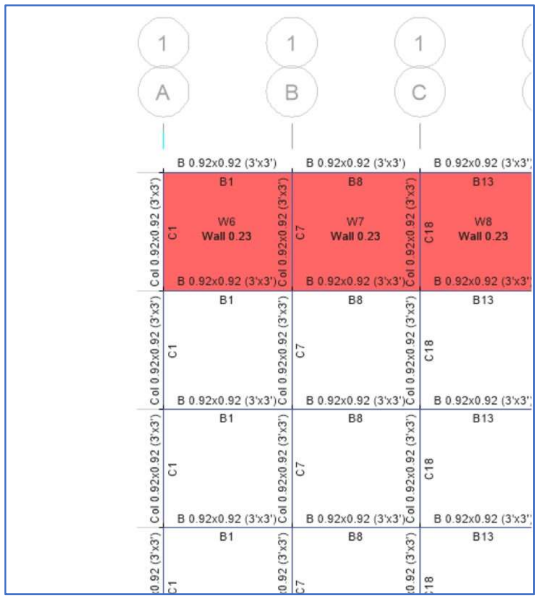
150,000 Gallons OHR Rebar Requirement in mm-sq.



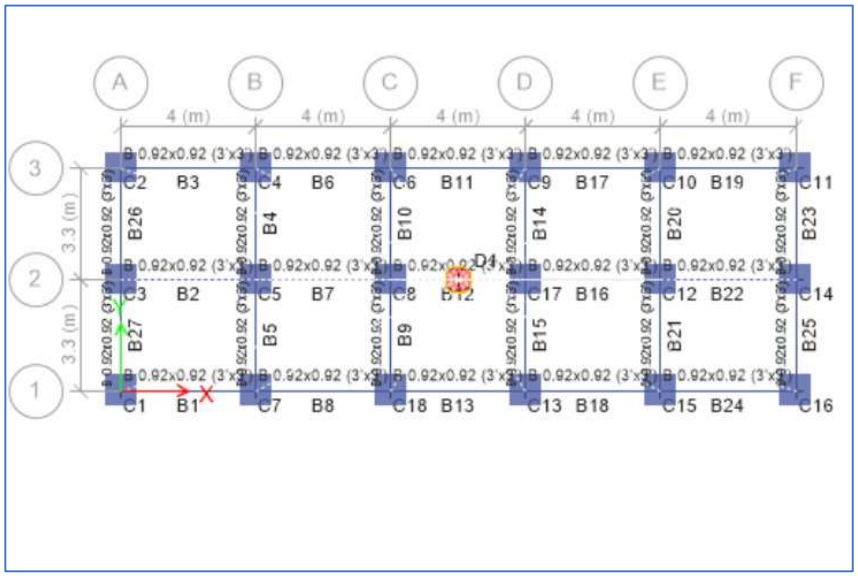
150,000 Gallons OHR Shear 2/2



150,000 OHR Moment 3/3

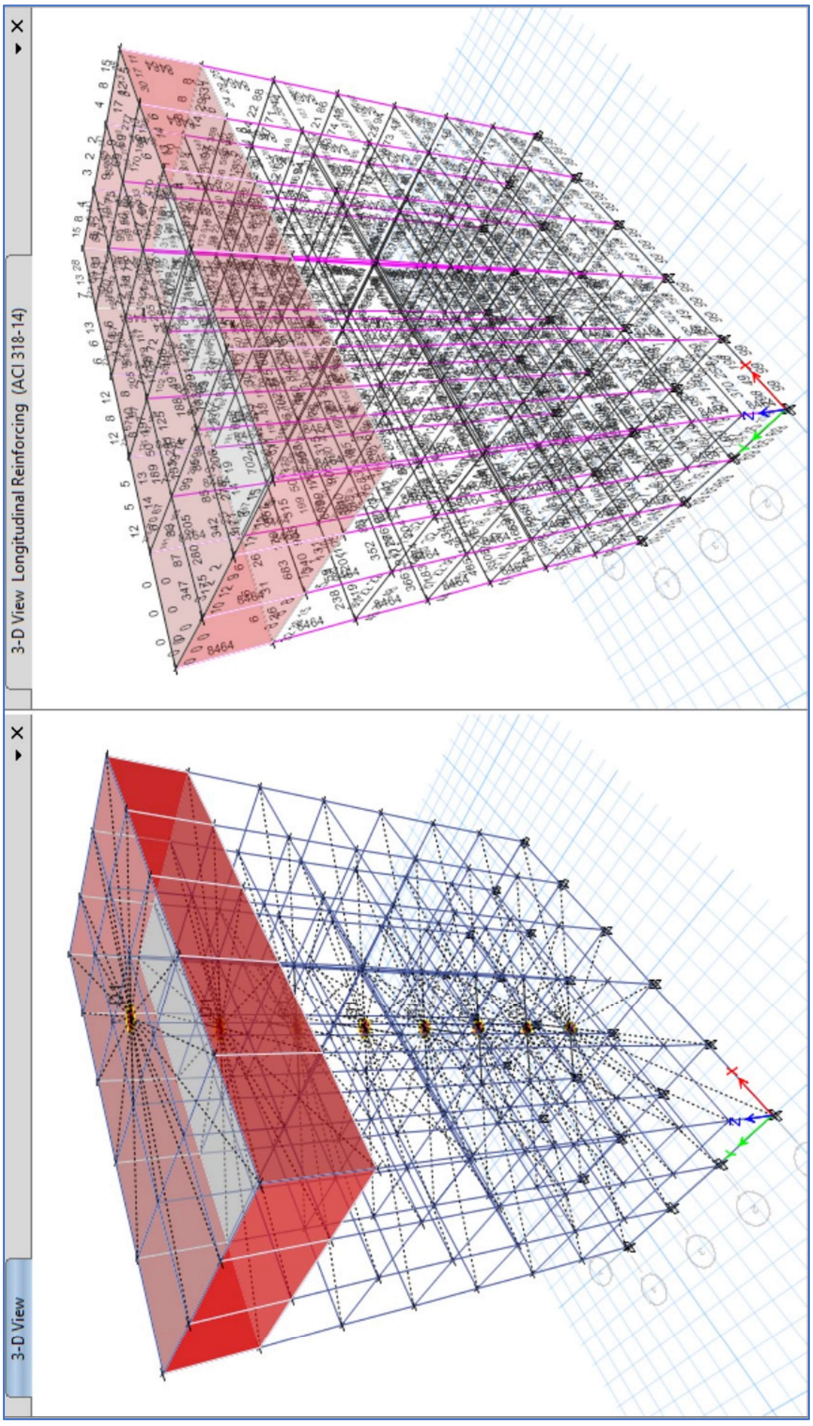


150,000 Gallons OHR Frame Elevation

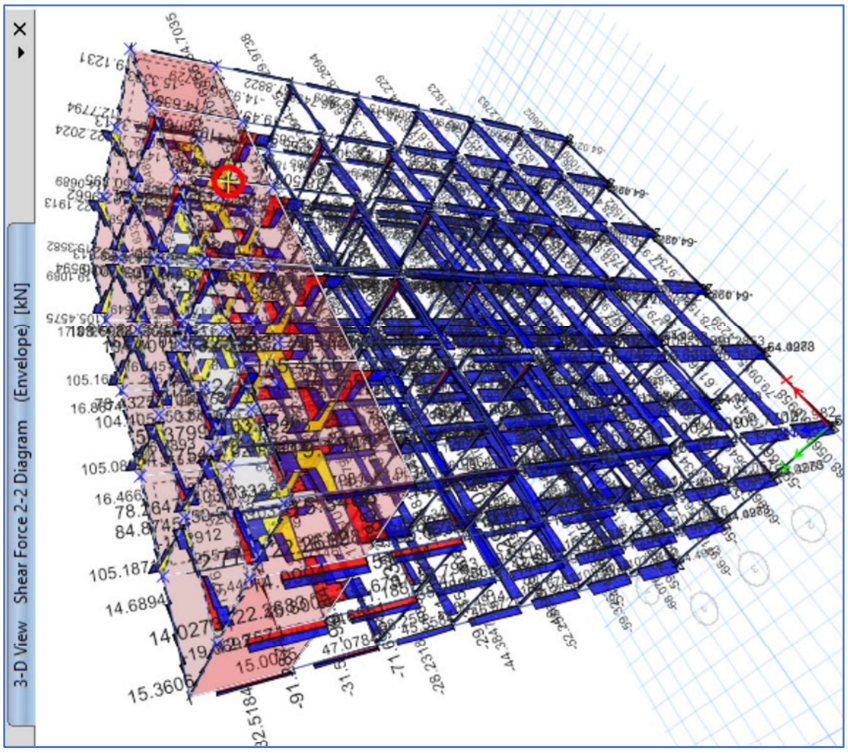


150,000 Gallons OHR Frame Plan

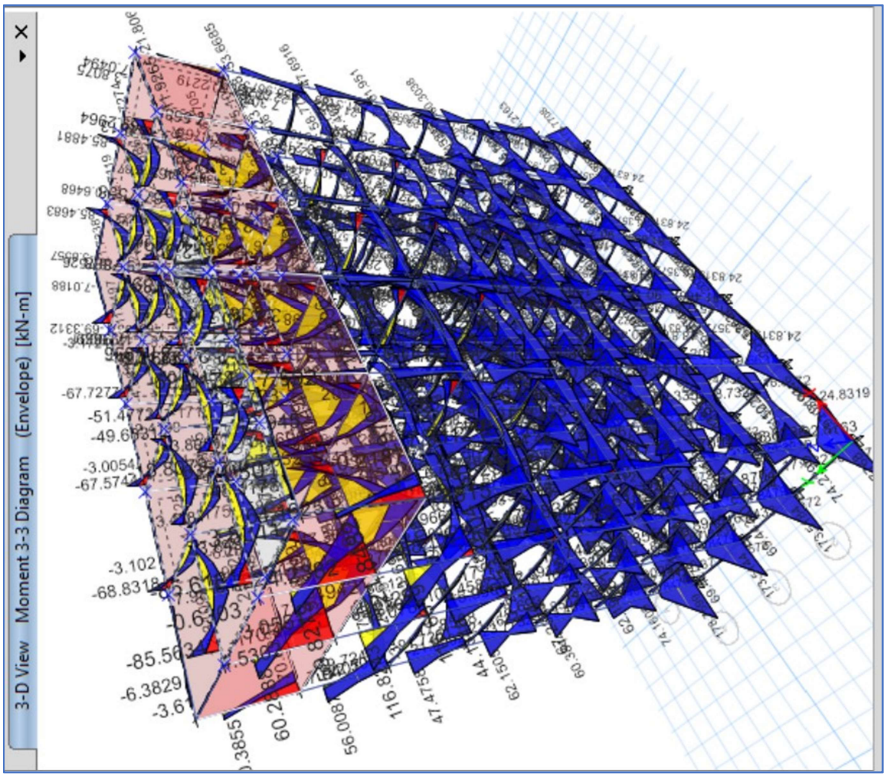
200,000 Gallons (Imperial) OHR Design



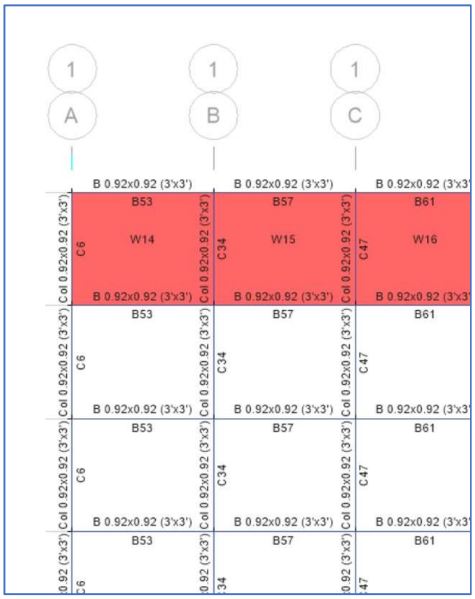
200,000 Gallons OHR Rebar Requirement in mm-sq.



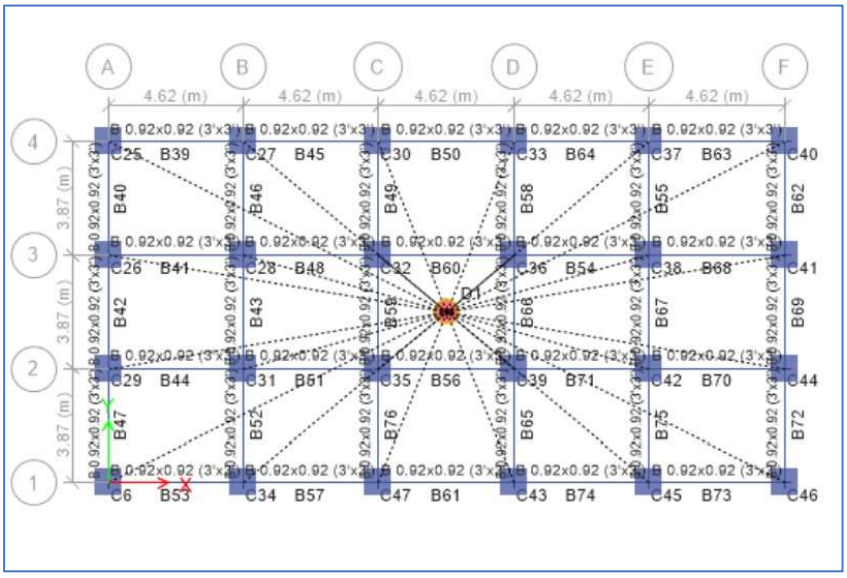
200,000 Gallons OHR Shear 2/2



200,000 OHR Moment 3/3



200,000 Gallons OHR Frame Elevation



200,000 Gallons OHR Frame Plan

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