NATIONAL RIVER CONSERVATION DIRECTORATE,
GOVERNMENT OF INDIA (NRCD)
PUNE MUNICIPAL CORPORATION (PUNE MC)

PREPARATORY SURVEY
ON
PROJECT FOR
'POLLUTION ABATEMENT OF RIVER MULA-MUTHA IN PUNE'

FINAL REPORT

Advance Version

(Main Report)

FEBRUARY 2015

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

NJS CONSULTANTS CO., LTD. (NJS)

NIPPON KOEI CO., LTD. (NK)

< Structure of Final Report >

PART I: Main Report

PART II: Supporting Report

PART III: Data Report

PART IV: Basis of Cost Estimates

1 USD = 119.4 Yen
1 INR = 1.90 Yen
(As of January 2015)

Table of Contents

List of Tables and Figures

<List of Tables>

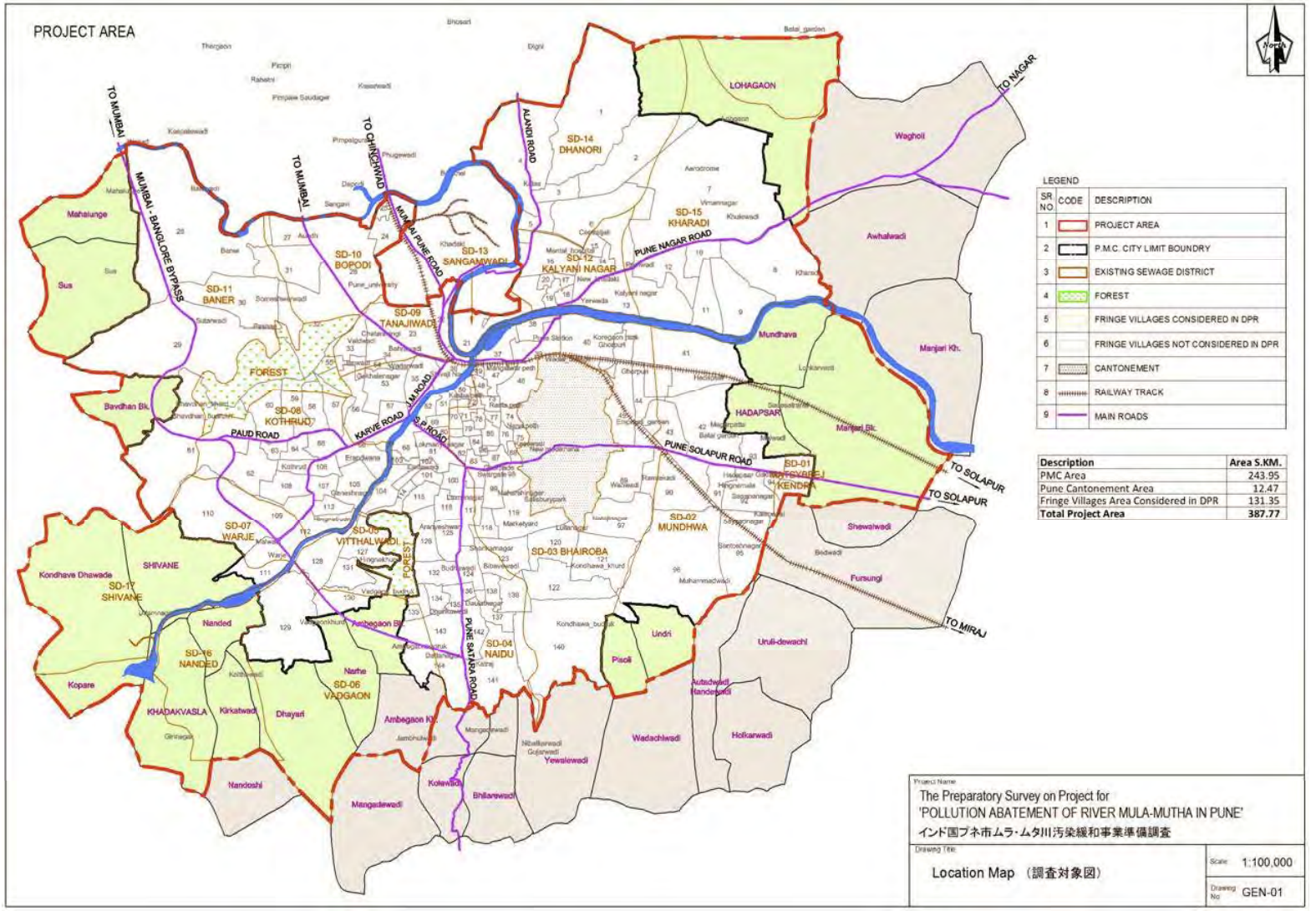
<List of Figures>

DEFINITION OF SEWERAGE TERMS AND ABBREVIATIONS

Main/Sub-Main Sewer	Same as Trunk sewer and Conveyance Main
Branch Sewer	Same as sewage collection pipe/lateral sewer
House connection	Sewer connected from house/building to public branch sewer
Sewer Network	including House connections, Branch sewers, Main/Sub-main sewers and Intermediate Pump Stations: Same as Sewage collection network
Sewage collection facility	Including House connections, branch sewers, main/sub-main sewers and intermediate pump stations
Sewage Treatment Plant (STP)	Wastewater treatment plant for the treatment of sewage from households and similar pollution sources, without inflow of industrial wastewater.
ADP	Area Development Plan
ASP	Activated Sludge Process
BGL	Below Ground Level
BHP	Break Horse Power
BOD	Biochemical Oxygen Demand
CDM	Clean Development Mechanism
CER	Certified Emission Reduction
COD	Chemical Oxygen Demand
CPCB	Central Pollution Control Board
CPHEEO	Central Public Health Environmental Engineering Organization
CSP	City Sanitation Plan
CTC	Community Toilet Complex
CW	Civil Works
CWC	Central Water Commission
DA	Drainage Area
DBO	Design, Build & Operate
DG	Diesel Generator
DO	Dissolved Oxygen
DPR	Detailed Project Report
EM	Electrical and Mechanical Works
FAB	Fluidized Aerated Bed
FR	Feasibility Report
GAP	Ganga Action Plan
GIS	Geology Investigation Survey-Geographical Information System
GL	Ground Level
GoI	Government of India
GRP / DI	Glass Reinforced Plastic / Ductile Iron
HRD	Human Resource Development
HUDCO	Housing and Urban Development Corporation Ltd.
IPS	Intermediate Pumping Station
IWBC	Integrated Wood Based Crematoria
JNNURM	Jawahar Lal Nehru National Urban Renewable Mission
LCC	Life Cycle Cost

LCS	Low Cost Sanitation
MLD	Million Liters Per Day
MoA	Memorandum of Agreement
MoEF	Ministry of Environment and Forests , Govt. of India
MNRE	Ministry of New and Renewable Energy Sources, Govt. of India
MoUD	Ministry of Urban Development , Govt. of India
MPS	Main Pumping Station
MSW	Municipal Solid Waste
NGRBA	National Ganga River Basin Authority
NIT	Notice Inviting Tender
NRCD	National River Conservation Directorate
NRCP	National River Conservation Plan
O&M	Operation and Maintenance
PERT / CPM	Programmed Evaluation Review Technique/ Critical Path Method
PHED	Public Health Engineering Department
PMU	Project Management Unit
PS	Pumping Station
SBR	Sequential Batch Reactor
SOR	Schedule of Rates
SPCB	State Pollution Control Board
SPMU	State Project Management Unit
SPS	Sewage Pumping Station
SS	Suspended Solids
STP	Sewage Treatment Plant
SWM	Solid Waste Management
SWM	Sewerage Water Management
TF	Trickling Filter

LOCATION MAP



EXECUTIVE SUMMARY

CHAPTER 1 Background and Outline of the Project

This report was prepared in provision of updating, revisions and additions to the existing Detailed Project Report (DPR) for Pollution Abatement of Mula-Mutha River in Pune through Preparatory Survey by JICA Technical Assistance. Comparison table on the study items between this report and the DPR is included in Chapter 1, Supporting Report.

The studies in this report covers the requirements to evaluate the feasibility of project implementation as an ODA loan project and implementation arrangements, in full consideration of those included in the existing DPR. This Final Report consists of Summary Report, Main Report, Supporting Report and Data Report.

The water pollution of Mula-Mutha River has been a major concern of the Pune City in recent years. The pollution is primarily caused by the PMC's sewage being discharged into the rivers without treatment. The total sewage volume treated at the existing sewage treatment plants is 476 Million Liter per Day (MLD) by its public STPs with 392 MLD (treatment capacity: 477 MLD) and individual private STPs with 84 MLD (treatment capacity: 84 MLD). The generated sewage volume at present (in 2011), however, is estimated at 728 MLD which indicates a discharge of 252 MLD untreated sewage directly into the rivers. Presently about 65% of generated sewage in the Project area is treated either by public or private STPs. The pollution can be worsening considering the City’s growing population.

To improve the situation “The Project for Pollution Abatement of River Mula-Mutha in Pune” under National River Conservation Plan (NRCP) was proposed in January, 2014 by the Government of India through the rolling plan for the projects utilizing Japanese Government ODA loan. The objective of the Project is to improve the water quality in the Mula, Mutha and Mula-Mutha rivers by augmenting sewage collection systems and sewage treatment facilities in PMC. It also includes other countermeasures required for the pollution abatement and thereby improving the sanitation and living conditions of people who reside in Pune City and in the watershed of the downstream area. The preparatory survey work for the Project by JICA commenced on July 29th, 2014 and Draft Report for Revised DPR was completed by the middle of December, 2014.

The main objective of the Preparatory Survey is to provide information necessary for feasibility evaluation of the proposed Project, as a Japanese Government ODA loan project. Among others, such information includes the outline of the Project, Project cost estimates, economic and financial viability

of the Project, the Project implementation schedule, manner of procurement and construction, organization of Project implementation, operation and maintenance (O&M) arrangements, and social and environmental considerations.

The Preparatory Survey will cover the jurisdiction area of PMC, located in State of Maharashtra, as well as the fringe areas of the City (13 villages) and Cantonment area with a total area of 387.77 Km^2. Seven villages in the fringe areas are located in direct upstream of Mula or Mutha rivers. The upstream areas that affect the water pollution of Mula-Mutha River are identified to be Pimpri Chinchward Municipal Corporation (PCMC), upstream of the Mula River.

Target years for the Project by design purpose in application of the base year 2017 are as follows:

(1) Design of sewers: year 2047 (30 years)
(2) Design of intermediate Pump stations: year 2032 for pump and mechanics (15 years) and year 2047 for civil/architectural (30 years)
(3) Design of sewage treatment plant: Phase I- year 2027, Phase II- year 2037 (10-20 years)

The scope of work for the Preparatory Survey covers basic study such as generated and treated sewage volume, existing sewerage facilities, and the existing future water supply and a detailed study such as the design of the Project, cost estimation, and environmental and social considerations. The Preparatory Survey was conducted through review of the DPR (prepared by PMC) and collection of additional information, if required. This Chapter provides more details on the scope of work.

CHAPTER 2 General Description of the Project Area

2.1 Natural Conditions

PMC is surrounded by hills, and has steep slopes near the boundaries on southern and eastern parts. The general slope progressively becomes moderate as drains approach river plains. Also, there are number of natural drains flowing in the city which ultimately discharge in Mula and Mutha rivers.

PMC is located in a subtropical zone that experiences three seasons, i.e., summer season, monsoon season and winter season. The temperature is significantly cooler comparing with those in most other parts of this region owing to the high altitude. The mean annual rainfall is around 982 mm and about 90% of the annual rainfall is recorded during the monsoon season. The mean annual relative humidity is 56 % and the annual average of wind speed is 4.4 km per hour.

The rivers flow on as the Mula-Mutha River to join the Bhima River, which is a major river in southern India. It flows southeast for approximately 860 km through other states. River water is contaminated with sewage flow discharged from residential areas and production factories. While the flood control of Mula and Mutha River is managed functionally with the dam gate switching operation by Irrigation Department, the adverse effect on the construction progress along the primary drain shall be considered in project implementation plan in the Monsoon season. The ground water qualification test was carried out, and the results show that the ground water quality is suitable for drinking as per the standard.

Almost entire area is underlain by basalt layer formed at ancient era. Alluvium occurs as thin layer in small areas along banks and flood plains of major rivers. Standard penetration and soil sampling tests were conducted, and the results show that the proposed STP sites are generally located on the stiff ground and are suitable for the construction of the STP.

2.2 Legislative Conditions

The Pollution Control Board (PCB) was established under the Central Government and the State Government for each state. The Ministry of Environment, Forest and Climate Change has drafted various rules and regulations to control the pollution.

As of now only criteria available for classification of water bodies are as per the “Designated Best Use” (DBU) prescribed by Bureau of Indian Standards and Central Pollution Control Board (CPCB). These criteria are followed by various agencies responsible for management and control of water quality in the country.

Effluent discharge standards are specified with reference to the type of industry, process or operations and in relation to the receiving environment or water body such as inland surface water, sewers, land or sea. However, the rules specify that the discharge limits can be made stringent if the concerned State Pollution Control authority finds it appropriate depending on the condition of the receiving environment and severity of the discharges from various sources. CPCB has notified the National Ambient Air Quality Standards (NAAQS), and the standards for ambient air quality in respect of noise are given under the rules.

Relevant organizations to the project at Central Government, State and Local Level are Ministry of Environment, Forest and Climate Change (MoEFCC), National River/ Lake Conservation Directorate (NRCD), Central Pollution Control Board (CPCB), Maharashtra Pollution Control Board (MPCB), and PMC.

The first environment protection act was introduced in 1986. This act comprises discharge standards for wastewater/ sewage and not amended till now for any of standards. However, CPHEEO manual suggested some modifications for treated sewage, discharging to water bodies to be used as drinking water resource.

2.3 Socio-Economic Profile

Pune was originally a small temple village situated on a raised plateau slightly away from the Mutha River. With population of over 3,000,000, PMC is consistently growing fast by 3.5% per year. Majority of people are engaged in full time jobs and the per capita income of PMC has increased to Rs 60,000 in year 2008-09. 37% of the City houses as slums and same percentage of 37% are apartment units followed by Bungalows and Wada (old housing complexes) as the traditional housing. Nowadays percentage of Bungalows and Wada is decreasing as these units are getting redeveloped into apartment units.

PMC is known as cultural capital of Maharashtra state. 83.63% of the population of PMC is literate, while 16.36% are illiterate which shows improve in literacy level. Hinduism with 92.20% is the most commonly practiced religion in PMC although many other religious buildings are found in the City including mosques, churches, and temples. PMC has large number of cultural organizations including literature Art and History. Also, there are many religious places which have been declared as heritage buildings.

There are a total of 564 slums in which 353 declared and 211 undeclared. If a slum has been declared,

its existence is considered to be officially recognized by the local government. Undeclared slums, regardless of their conditions, are not considered eligible for basic service provision. Most of the slums are lack of basic amenities and sanitation with high population density.

PMC is highly commercialized city being prime center of trade and commerce. It serves as regional wholesale market for food, and one of the largest centers of engineering and automobile industries. PMC includes nine organized industrial estates, which house 234 industries. PMC is also one of the most important educational centers in the country. There are more than 600 institutes of higher educational and research.

At the water supply sector, there are many issues such as the lack of full coverage ratio, limited water supply hour, and inadequate water pressure. The customers are also not fairly charged for their water consumption. Currently the water consumption is charged based on the area rate but not based on the consumed amount of water. Also, at the sewerage treatment sector, there are issues such as insufficient facilities operation and shortage of community toilets.

PMC is in charge of the civic needs and infrastructure of the metropolis. At present, PMC houses an elected body with 152 Ward Councilors, who are headed by a Mayor and has a total of 18,000 staff, including 500 engineers carrying out variety of functions related with buildings, roads, street electrification, water supply, and, sewerage, etc. There are seven departments in the PMC: (1)Development and Planning, (2) Building permission, (3) Water Supply and sewerage, (4) Slum improvement, (5) Tax and collection, (6) Finance and Audit, and (7) Land records.

2.4 Existing and Future Land Use

As per the Development Plan, the survey has identified the existing use of the land as residential, commercial, public, defense, industrial, transport, recreation, agricultural, water bodies, hill slope, forest, vacant, slum, roads, etc.

PMC has been developed as a major center for higher education and research, commerce and industry, particularly automobile and IT services. PMC has also a large number of defense establishments.
In addition, PMC has established Metro and Wada policy for the city development, which will affect the population growth rate in the wards. In Metero Rail Project, PMC has taken a decision to construct Metro Corridor for a distance of 72km in the city within 500m on both sides of the proposed route. In Wada policy, PMC has put in a concept of cluster development that come together to form land area exceeding minimum cluster size, and grant the floor space index.

CHAPTER 3 Existing Water Supply and On-going/Planned Water Supply Projects

3.1 Existing Water Supply

The water supply to Pune city is provided by four dams with a total storage capacity of 815.36 million m^3. There are also nine water treatment plants (WTPs) with a combined capacity of 1,263 MLD. A WTP with a planned capacity of 200 MLD is under construction. The present arrangement of transmission of raw water and the existing water treatment capacity in the PMC is described in Table 3.1.

Table 3.1 Arrangement of Raw Water Transmission to WTPs

WTP/Water Works	Transmission System	Facilities
Parvati water treatment plants	Mutha Right Bank canal	Two pipes of 1200mm & 1600mm diam. for drawing water to Stage 1 WTP of 220 MLD
	3030mm diam. MS gravity main, up to receiving chamber of WTP	Gravity supply to Parvati stage 2 WTP of 315 MLD
Pune Cantonment water works	3030mm diam. MS gravity main, up to receiving chamber of WTP	Raw water pumping to MBR (in the premises of Parvati water works), and further gravity supply to Pune Cantonment water works for stage 1 WTP of 240 MLD
	Mutha Right Bank canal	Supply to stage 2 WTP of 100 MLD capacity
Warje water works	Jack well at Khadakwasla dam, 1524mm diameter pumping main	- Supply to Warje stage 1 (9 MLD) WTP by 406mm branch; - 1524mm pumping main for supply to Warje stage 2 WTP of 180 MLD
Holkar water works	Jack well at Khadakwasla dam, 1524mm diameter pumping main	1000 mm branch pumping main for 45 MLDWTP
Vadgaon stage 1	3030mm diam. MS gravity main, from Khadakwasla	- 1524 mm branch gravity main - Raw water PS - 1524mm diam. pumping main to stage 1 WTP of 125 MLD.
Chikhali WTP	Jack well at Ravet on Pavana river	711mm diam. pumping main to Chikhali WTP

Source: Water DPR, PMC, 2014

There are 85 distribution reservoirs with a combined capacity of 290 thousand m^3. There are 67 water supply zones in the city with pipeline network of about 2,700 km long.

The average water supply in the city level seems to be adequate, but spatial distribution is uneven and in some areas below average. The network in some areas of the city is very old and high leakages are prevalent. The water meters are fixed for bulk consumers and commercial and industrial establishments. There are very few residential premises with metering system in place. Overall percentage of the metered supply is less than 30 percent.

For cost recovery, up to March 2000, a metered system was in existence in some areas of Pune city. However, both PMC and consumers were facing many problems with metered water supply including failures of water meter, no timely receipt issuance, etc. Considering these problems, PMC decided to discontinue metered water supply to domestic consumers and started charging water tax as a component of Property Tax. Namely, water charges were recovered on the basis of quantum of water consumed by the consumers. PMC recovers water tax/charges from the consumers in the City, Pune Cantonment and Khadki Cantonment using different methods for domestic consumers, institutional consumers, commercial establishments, and the consumers in slums, flood affected colonies, and resettlement colonies.

3.2 Total Water Demand

PMC provides water supply to a large number of non-domestic consumers as well. The water demand for domestic use and non-domestic use was projected by taking into account of the consumption levels recommended by CPHEEO, the daily average consumption rate of 150 lpcd and the leakage gradual reduction by year 2027. Table 3.2 shows the water demand projection.

Table 3.2 Water Demand Projection Unit: thousand m^3/d

Year	2012	2017	2027	2032	2042	2047
Domestic	718.95	839.73	830.69	1,018.54	1,224.62	1,301.53
Non-Domestic	154.48	179.58	329.00	431.56	460.35	576.85
Cantonment	36.46	33.86	29.63	27.88	27.88	27.88
Total	909.89	1,053.17	1,189.31	1,477.99	1,712.86	1,906.26

Source: Water DPR, PMC, 2014

In addition to existing nine WTPS, one WTP with a capacity of 200 thousand m^3/d is presently under construction at Warje to be completed in 2014, beside the existing 180 thousand m^3/d WTP. Upon completion of the WTP, total treatment capacity of the City will reach to 1,463 thousand m^3/d.

3.3 Pune CDP and Proposed Infrastructure Projects

The City development plan was prepared in 2012 for the target year 2041, which includes projects related to infrastructure improvement and some water supply improvement projects in the City with a total cost of 488.5 INR Crores including water source development/ intake augmentation, new pipelines, distribution reservoirs, water treatment plants, and system refurbishment.

The projected water demand is distributed in the supply areas of the six water treatment plants, as shown in Table 3.3.

Table 3.3 TWTP-wise Projected Water Demand

Description	Installed Capacity in MLD		Water Allocation in MLD		Remarks	
	2032	2047	2032	2047	2032	2047
Parvati	500	500	456.25	390.73	Parvati zone-212.46 Cantonment zone-229.04 Pune Cantonment-14.75	Parvati zone-280.36 Warje zone-110.37
Pune Canton-ment	100	100+300	70.87	357.47	BA zone-54.46 Cantonment zone-16.41	Cantonment zone-357.47
Warje	389	389	428.49	461.96	Holkar zone-17.01 Khadki Cantonment-14.18	Holkar zone-18.83 Khadki Cantonment-14.18
Vadgaon	387	387	277.45	356.71		
Holkar	45	45	31.19	33.01		
Bhama Ashked	200	285	214.68	306.54		
Chikhali	22	22				
Total	1,643	2,028	1,478.93	1,906.42		

Source: Water DPR, PMC, 2014

Other projects for improvement of Pune water supply which are under construction include:

- Augmentation of intake works at Khadakwasla dam, jack well, pump station and 2,500 mm dia pumping main up to Parvati water works
- Augmentation of intake works at Khadakwasta dam, jack well, pump station and 1,626 mm dia pumping main up to Warje water works
- 200 thousand m^3/d water treatment plant at Warje water works

The types of water consumer meters are recommended with AMR (automatic metering recording).

SCADA project is also proposed to establish continuously pressurized water supply system with universal metering. It automatically follows that an “Active Leakage Control System” is put in place, to continuously monitor the water balance and reduce the NRW to an acceptable level.

Therefore a highly interactive SCADA system is absolutely essential. This has essentially two parts, one is to monitor and improve the performance of the water supply system components and the other is to have a real time access to all the critical parameters at the PMC headquarters.
The list of main instruments in various system components as recommended in the SCADA are summarized in the Chapter as well.

CHAPTER 4 Existing Storm water Drainage System

4.1 Drainage Condition

The general topography of ridges and valleys has resulted in formation of independent watersheds, each of which is draining in one of the two Mula and Mutha rivers. These rivers are principal carriers of storm water. The Project area is divided into 23 watersheds or basins, each of which has one or more primary natural drains (Nallas) to convey the storm water into the rivers. The slopes of these networks are generally good enough to carry reasonable storm water volumes.

Recent years, the frequency of localized flooding has increased in PMC. Development of the land area could increase the paved areas substantially and result in increased runoff and floods with widespread losses in terms of traffic interruptions, damage to roads and loss of property. Accordingly, PMC invested large amount to repair the damaged road surface after monsoon season.

4.1.1 Primary Drainage Channels

Mula and Mutha are the two rivers which flow within the city area. These two rivers meet within the city area forming Mula-Mutha River. The length of Mutha and Mula River in the PMC areas is 15 Km and 22 Km, respectively. The length Mula-Mutha river from confluence to PMC boundary is 11Km.
The primary drainage channels are essentially natural Nallas and their tributaries. The total length of Nalla in PMC is about 362 km. The slopes of the Nallas network are generally good enough to carry reasonable storm water volumes. The constructed Nallas generally have masonry walls with bed concrete in the central portion.

4.1.2 Road Side Drains

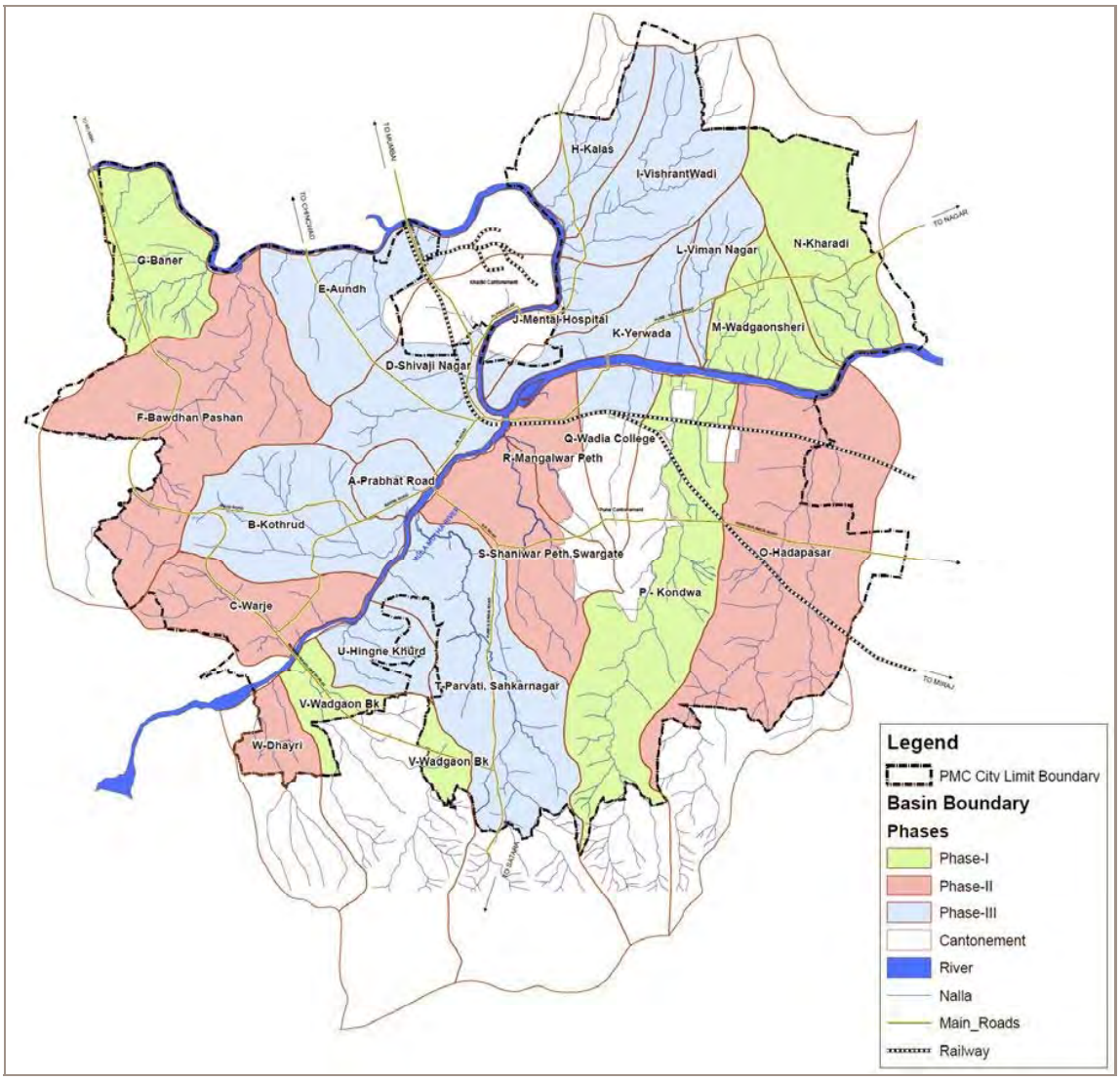
Though the roadside drains are available for the PMC roads, there are a few issues that need to be noted. One is that roadside drains are not provided to all, but only to the major arterial roads and in part of the old city area. While the total length of the city roads is about 1,800km, the total length of roadside drains is estimated at about 155km. On the other hand, blockage of road drains by water pipes crossing the Nallas and the sewerage chambers within the water way are seen in many locations which cause problems.

4.1.3 Drainage Maintenance System

The maintenance of Nallas and cross drainage works lies with respective ward offices, however the maintenance of roadside drains are undertaken by the PMC's Road Department.

4.2 Proposed Drainage System in Master Plan

In Pune Strom Water Management Master Plan, 23 drainage basins in the Project area are classified and prioritized based on the degree of flooding and damages. Total 6 basins are identified as Phase-I for the proposed works to be funded under JNNURM. The scope of work includes improvement of Nallas and roadside drains, and modification of cross drainage. The proposed drainage system was designed to meet the standard of CPHEEO. Phase-I work was planned to be commenced in September, 2008 and completed in September 2010 in Drainage Master Plan. However, the progress of the construction work is approximately 80% as of November 2014. Plan of the improvement with phased demarcation is shown in Figure 4.1.



Source: Pune Strom Water Management Master Plan

Figure 4.1 Phased Demarcation for Drainage Improvement

CHAPTER 5 Existing Sewerage Facilities and on-going Sewerage Projects

5.1 Sewage Collection System

Sewer installation coverage in PMC is reported at 92% at present. In the slum areas all house connections are connected to public branch sewers, however, functioning sewers are reported to be limited at present. No records on "as-built plan of sewers" are maintained by PMC.

The total length of sewers is 2,200 Km with pipe diameters ranging from 150 mm to 1,800 mm. The sewer materials are RCC of NP2 /NP3 class. Presently most of the roads are covered by existing sewers (total length of roads is 2,400 Km).

Presently, there is no on-going STP/IPS projects. However, there are an on-going sewer construction projects in the PMC as follows:

Project contents	Fund Source	Present Status (as of November, 2014)	Expected Completion Time of Construction
Main sewer for 2,500 m with dia. of 1,800mm from Bund Garden to New Bhairroba STP	PMC	90 %	June 2015 Problem with Garden Dep. of PMC

5.2 Intermediate Pump Station (IPSs)

At present there exist six IPSs. Capacities on these IPSs are shown in Table 5.1.

Table 5.1 Capacities of Existing Intermediate Pump Stations

Name of IPS		Sewerage District	Year of Commissioning	Design Capacity (m^3/d)	Remarks
1	Old Kasba (Old)	SD4	1930	86.40	
	Old Kasba(New)	SD4	1995	60.48	
2	New Kasba	SD4	2008	135.36	
3	Topkhana	SD4	2010	94.46	
4	Kalyani Nagar	SD12,14	2002	60.00	
5	Mental Hospital	SD14	2007	40.08	
6	Botanical Garden	SD10	2004	10.56	

Source: JICA Survey Team

5.3 Sewage Treatment Plants (STPs)

5.3.1 Capacities of existing STPs

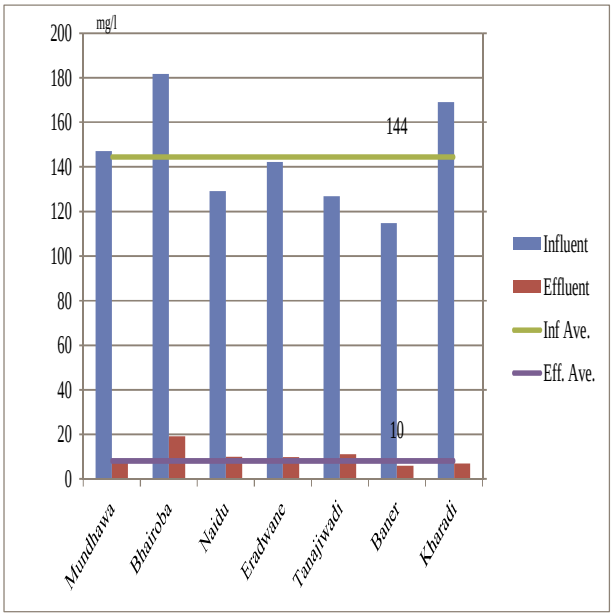
There are ten sewage treatment plants at present. Capacities of these treatment plants are shown in Table 5.2. All sewage treatment plants except Naidu (Old) STP are functional.

Table 5.2 Capacities of Existing Sewage Treatment Plants

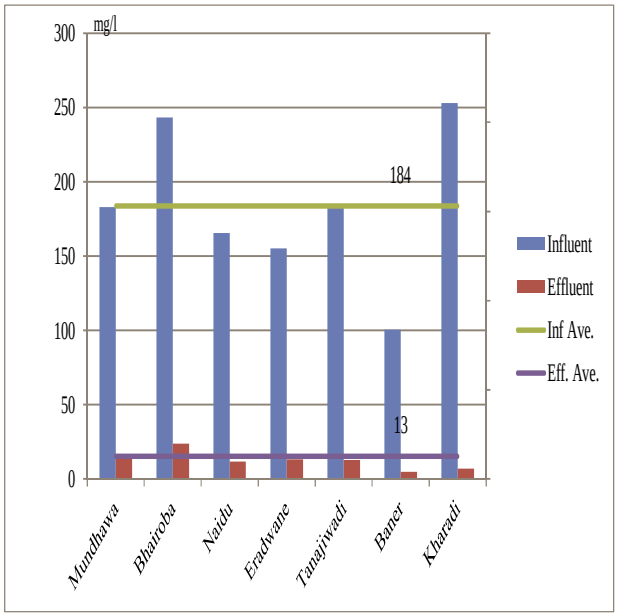
Name of STP		Sewer District	Year of Commissioning	Design Capacity (MLD)	Treatment Process	Present Inflow (MLD)	Remarks
1	Mundhawa	SD2	2010	45.0	SBR	42.0	
2	Bhairoba	SD3	2003	130.0	ASP + Dig.	80.0	
3	Naidu Old	SD4	1988	(90.0)	ASP	-	Defunct
4	Naidu	SD4	2010	115.0	ASP	94.0	
5	Vithalwadi	SD5	2010	32.0	ASP	25.0	
6	Eradwane	SD8	2004	50.0	ASP	50.0	
7	Tanajiwadi	SD9	2004	17.0	Bio-Tow + EA	13.0	
8	Bopodi	SD10	2003	18.0	EA	15.0	
9	Baner	SD11	2010	30.0	SBR	31.0	
10	Kharadi	SD15	2012	40.0	SBR	42.0	

Source: JICA Survey Team

The BOD_3 and TSS of influent and treated effluent are shown in Figure 5.1. The figures are averaged from September 2013 to August 2014 recorded by PMC. The influent BOD_3 ranges from 115mg/l to 182mg/l, while TSS ranges from 100mg/l to 253mg/l. Both BOD_3 and TSS of Bhairoba and Kharadi are comparatively high, but effluent quality meets standards (BOD_3 of Bhairoba is nearly general standard level).



BOD_3



TSS

Source: PMC

Figure 5.1 Influent and Effluent in BOD_3 and TSS

CHAPTER 6 Water Pollution Status in Public Water bodies

PMC is located in the Western Ghats at elevations ranging from EL 674.77 m and EL 530.10 m in the Bhima basin. There are about 55 drainage channels which drain into Mula and Mutha rivers. The total length of natural drainage in the city is about 362 km.

Water pollution of the rivers has been a major concern in PMC these days, which is mainly caused by discharge of sewage from the PCMC, PMC and upstream fringe villages in the catchment. For the purpose of determining the quality and quantity of polluted water entering the river directly, the JICA Preparatory Survey referred to Sewerage DPR, Environmental Status Reports (ESR) and other available documents.

Flow measurement data is not available with PMC for the Mula, Mutha and Mula-Mutha rivers. However, sewage flow measurements were conducted for Sewerage DPR in 2012, and showed that total of 355MLD enters the rivers through six nallas in the city. Major pollution load in Mutha River enters through Kothrud, Ambil Odha and Nagzari Nallas. Generally speaking, water quality in Mutha River is poorer than Mula River due to no dry weather discharge into Mutha River from upstream dams. However, the values of BOD are much higher in the both rivers comparing with the permissible limits prescribed by CPHEEO.

As per PMC's ESR reports from 2009 to 2013, BOD concentrations in nallas were observed from 100 to 115mg/l until 2011 and then dipped to 70 to 80mg/l after 2011. Similar observation of reduction in pollution load was also observed in Mutha and Mula Rivers from 2009. This is because five STPs with a total treatment capacity of 262,000m^3/d were commissioned between 2009 and 2012 and have been discharging effluent meeting the design effluent quality.

In the last 10 years, STPs have been constructed with a total capacity of 477,000 m3/day and organic load reduction of about 62000kg/day BOD has been achieved. This BOD load reduction is the main cause of improvement of water quality in Mula and Mutha Rivers. However, the water quality has been observed to deteriorate again in 2013 as per the Environmental Status Report. This is attributed to additional polluted flow entering the river from Nallas.

As PCMC is upstream of PMC on Mula River, it is important to study the situation of sewage treatment in Mula River basin of PCMC. Total sewage generated in PCMC at present is estimated at 291 MLD, of which 225 MLD is collected by sewer systems and transferred to respective pumping stations. The collected sewage is treated at STPs in application of various kinds of treatment processes,

and is then discharged into the three rivers flowing through PCMS (Mula, Pavana and Indrayani). Effluent from existing10 STPs in PCMC is discharged into Mula River.

One new STP (Pimple Nilakh Phase II STP) with 20,000m^3/d capacity is proposed in the Mula River basin. The project is planned to start in 2015 to complete in 2020. Upon completion of this STP in year 2020, all sewage generated in PCMC area of Mula River basin would be treated, and then the BOD load into the River will be reduced from 1,465 kg/d to 563 kg/d. It is expected that BOD in Mula river water at the entrance of the PMC will be less than 10 mg/l without dilution by river water itself.

There are more than 100,000 people in the direct downstream area of PMC (about 80 Km from the boundary of PMC), and these people draw water from the Mula-Mutha River. No static data on the river water use for drinking purpose is available, but it was confirmed through JICA Preparatory Survey that some villages use the surface water as drinking water source. Therefore, it is important to improve the river water quality to meet CPCB standards so that the river water suits for the use by the downstream villages.

A quick comparison of the observed water quality (2009 to 2014) with that specified by CPCB as standards is shown in Table 6.1.

Table 6.1: Water Quality Comparison

Parameters	Water Quality Standards	Observed Water Quality in the River
BOD	Maximum 3mg/l	Ranging from 15 to 80mg/l
DO	Minimum 5mg/l	Ranging from 0.1 to 3.6 mg/l

As all the sewage generated in the Mula River basin in the PCMC will be treated by year 2020 with expected effluent BOD of 10mg/l, expansion of sewerage system in the PMC and its fringe area is a priority requirement to improve the water quality of the Mula-Mutha River.

Under the proposed sewerage project, the sewage treatment capacity will increase from 477,000 m^3/d in 2014 to 873,000 m^3/d in 2027, and this will reduce the BOD load discharge into Mula-Mutha River by about 90,000 kg/d. All planned STPs are designed to meet effluent BOD of 10mg/l, and therefore, after completion of the Project, BOD in Mula-Mutha River is expected to be less than 10mg/l.

CHAPTER 7 Sewage Volume Generated and Treated, and Projection of Sewage Volume by Design Year

The Project area for the sewerage improvement includes the entire area of the PMC, rapidly urbanizing 13 fringe villages and the Pune Cantonment Board area. The entire Project Area is divided into 17 sewerage districts (SDs) based on the conditions including topography, existing main sewers and locations of sewage treatment plants in the PMC.

The population in the project area (PMC and its fringe areas, and Cantonment areas) was projected in the sewerage DPR for "Pollution Abatement of Mula Mutha River in Pune". However, the projection was based on Census results up to the year 2001. Now 2011 Census results are available. In addition, PMC has established new policy for land development including "Wada and Metro Corridor policy" in its jurisdiction, which was considered in the Pune Water Supply Plan prepared in 2014. Under these conditions, population projection was revised using the updated information for the PMC, 13 fringe villages and the Pune Cantonment Board. The projected population are shown in Table 7.1 along with those in the sewerage DPR, and the comparison shows that the revised population are smaller by 15% to 20%.

Table 7.1 Population Projection by Sewerage DPR and Revised DPR (Preparatory Survey)

Year	Revised DPR (Preparatory survey)				DPR		
	PMC	Related Villages	Cantonment	Total	PMC + Fringe Villages	PCB	Total
2017	3,918,763	294,758	90,600	4,304,121	4,776,668	91,506	4,868,174
2027	5,101,037	544,863	99,660	5,745,560	6,533,212	100,657	6,633,869
2037	6,355,642	718,396	109,627	7,183,665	8,267,599	110,722	8,378,321
2047	7,375,348	886,091	120,589	8,382,028	9,902,531	121,685	10,024,216

Source: DPR and JICA Preparatory Survey

The PMC population was developed using the ward-wise population data for the 144 wards, and the population for each sewerage district was calculated using the wards and fringe villages or their parts located within respective sewerage districts.

The water consumption rate of 150 lpcd as per CPHEEO standard was used, and sewage generation was considered at 120 lpcd (at 80% of water consumption) in areas with no groundwater infiltration and at 126 lpcd (at 84% of water consumption) in areas with groundwater infiltration to calculate the domestic sewage volume. Sewage generation from non-domestic water consumers such as educational institutes, commercial units, cultural centers, transport terminals etc. was added to the domestic sewage volume to calculate the total sewage flow in each sewerage district.

According to MOEF guidelines, PMC stipulated that housing developments with more than 20,000 m^2

and/or apartments with more than 150 tenements shall have individual STPs for the treatment of sewage to meet inland discharge standards. The effluent from these individual (private) STPs is discharged to nearby channels/rivers. Existing individual (private) STPs are obliged to continue their operation through the future under current laws and regulations. Therefore, generated sewage to be treated at individual STPs is not considered, in principle, for the plan of public sewerage systems.

Comparison of the sewage volume calculated for the Project area with that in the sewerage DPR shows that the sewage volume in this study increased by 7% to 8% against sewerage DPR, though target year between the two cases is different by only one year, and though the population estimated in this study for 2017 and 2047 are smaller by 10% and 20%, respectively than those in the sewerage DPR. The larger sewage volume estimated in this study is caused by the consideration for sewage generation from water supply to non-domestic consumers.

The location of planned STP by SD are determined in the sewerage DPR based on the geography in the project area. The same arrangements are adopted for this study. The STP capacities calculated in this study are presented in Table 7.2 together with those in the sewerage DPR.

Table 7.2 Comparison of STP capacities by SD

SD	STP	Preparatory Survey			Sewerage DPR		
		2027	2037	2047	2026	2036	2046
1	Matsya Beej Kendra	7	4	3	8	5	0
2	Mundhwa	20	48	94	45	49	75
3	Bhairoba	75	0	0	74	0	0
4	Naidu	127	27	57	125	55	0
5	Vitthalwadi	0	0	0	0	5	7
6	Vadagaon	26	13	14	18	16	16
7	Warje	28	8	8	27	0	0
8	Erandawane	-	-	-	0	0	0
9	Tanajiwadii	15	11	6	16	0	0
10	Botanical Garden	10	14	13	19	11	10
11	Baner	25	25	30	0	19	12
12	Kalyani Nagar	-	27	-	0	27	0
13	Sangamwadi	-	-	-	0	13	28
14	Dhanori	33	8	7	32	9	9
15	Kharadi	30	15	10	0	15	14
16	Nanded						
17	Shivane						
Total		396	200	243	364	224	171

CHAPTER 8 Scope of Work for Pollution Abatement of Mula-Mutha River in PMC

8.1 Plan of Sewers

Figure 8.1 shows locations of the planned main/sub-main sewer routes distributed in the entire PMC.

8.2 Intermediate Pump Stations

Among four (4) IPSs proposed in DPR, three (3) IPSs of Old Kasba, New Kasba and Kalyaninagar are necessary to replace/expand in this project, while Mangalwar Peth IPS was cancelled. Additionally, Topkhana IPS needs improvement to increase its capacity. Table 8.1 summarizes the requirements.

Table 8.1 Scope of Work for IPS

Name of IPS	Design Peak Flow (MLD)	Scope of Work	Remarks
Old Kasba	90	4 (replace)	Replace of 4 pumps Incl. Rising Main Pipe(Dia1400mm,L=50m) and Rehabilitation of Civil structure
New Kasba	270	6 (add)	Add 6 pumps Incl. Rising Main Pipe(Dia1400mm, L=150m)
Topkhana	187	6 (add)	Add 6 pumps
Kalyani-nagar	79	3 (replace)	Plan is replace but add 3 pumps and existing 3 pumps are not removed

Source: JICA Survey Team

8.3 Sewage Treatment Plants

8.3.1 Target quality of the effluent

Target quality of the effluent to be discharged from planned STPs is assumed according to recommended standards by CPHEEO as shown in Table 8.2.

Table 8.2 Target Effluent Quality (Recommended by CPHEEO)

Item	BOD	SS	T-N	T-DP
Target standard	10 mg/l	10 mg/l	10 mg/l	2 mg/l

Source: JICA Survey Team

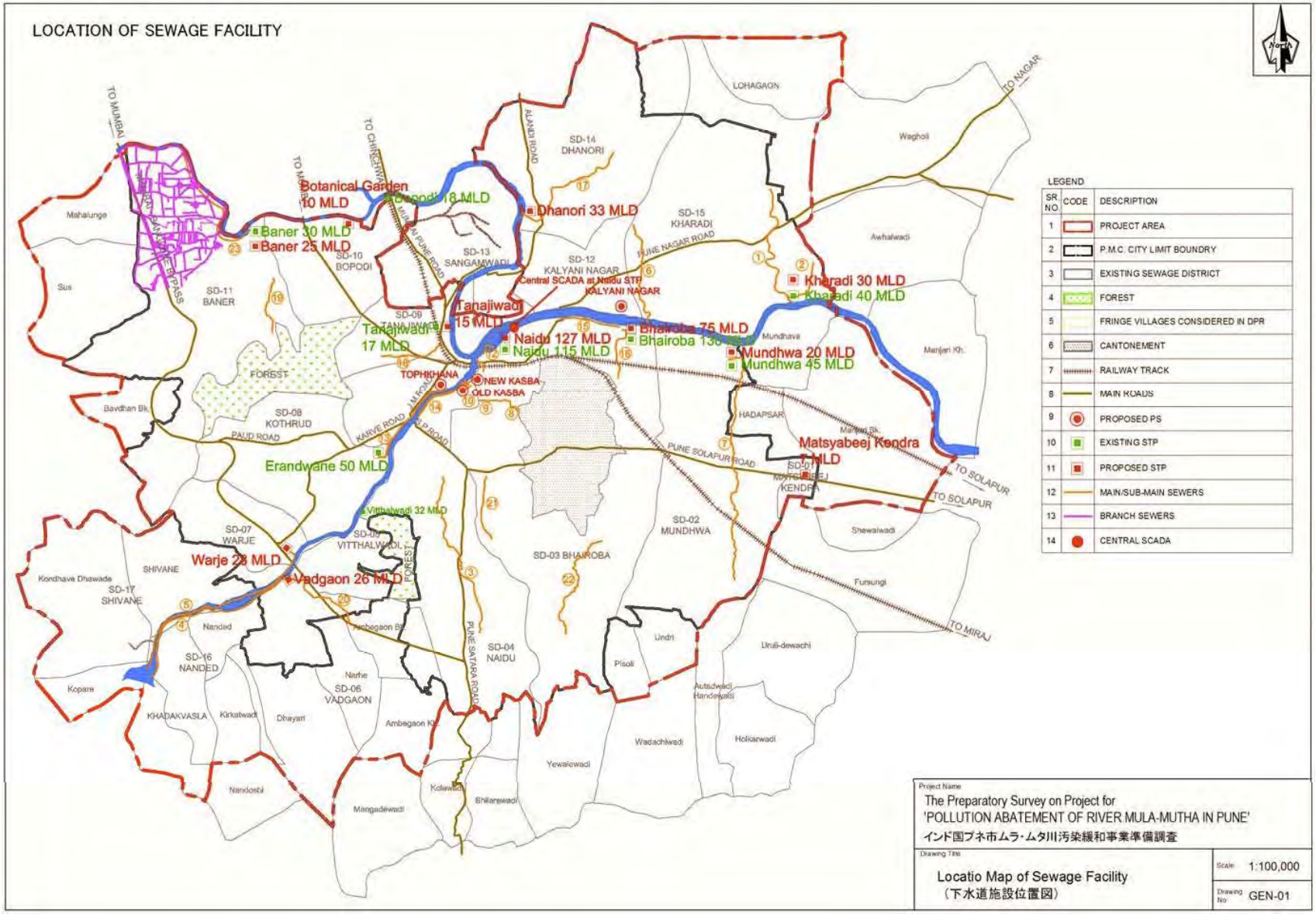


Figure 8.1 Location of Planned Main/Sub-Main Sewers

8.3.2 Selection of Treatment Method and Scope of Work

The following conditions shall be considered for the selection of the sewage treatment methods by planned STP, aside from requirement of biological nutrient removal process.

- Denitrification is considered.
- Experiences in India and PMC.
- Biogas generation system for larger STPs.
- Omitting primary sedimentation tank in case of smaller STPs to reduce O&M requirements.
- Simplifying O&M of STP

Treatment plan of sewage treatment plants is summarized in Table 8.3.

Table 8.3 Summary of Sewage Treatment Plant Plan

No.			1	2	3	4	5	6	7	8	9	10	11
SD			SD4	SD3	SD2	SD6	SD7	SD10	SD9	SD14	SD1	SD11	SD15
Name of STP			Naidu	Bhairoba	Mundhawa	Vadgaon	Warje	Botanical Garden	Tanajiwadi	Dhanori	Matsya Beij kendra	Baner	Khradi
Influent Flow		MLD	127	75	20	26	28	10	15	33	7	25	30
Influent Quality	BOD	mg/l	250	250	250	250	250	250	250	250	250	250	250
	TSS	mg/l	350	350	350	350	350	350	350	350	350	350	350
	T-N	mg/l	45	45	45	45	45	45	45	45	45	45	45
	T-DP	mg/l	5	5	5	5	5	5	5	5	5	5	5
Effluent Quality	BOD	mg/l	10	10	10	10	10	10	10	10	10	10	10
	TSS	mg/l	10	10	10	10	10	10	10	10	10	10	10
	T-N	mg/l	10	10	10	10	10	10	10	10	10	10	10
	T-DP	mg/l	2	2	2	2	2	2	2	2	2	2	2
Treatment Process	Sewage		A2O	A2O	SBR	EA	EA	EA	EA	EA	SBR	SBR	SBR
	Sludge		Mechanical Thickener + Anaerobic Digester + Centrifuge		Centrifuge								
	Biogas		Generator	Generator	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

Source: JICA Survey Team

8.4 Re-Use of Effluent from STPs

The current quantity of treated sewage (effluent) available for reuse is about 450MLD (95% of 477MLD existing STP joint capacity). About 370MLD (95% of proposed 390MLD) additional treated sewage would be available after the completion of this sewerage project for the design year 2027. Hence the total quantity of treated sewage available would be about 820MLD for the design year 2027.

8.5 Utilization of Biogas for Generating Electricity

PMC is interested in developing energy through anaerobic digestion at the two of the planned STPs. Sewage treatment method of A2O is recommended for these two STPs at Bhairoba and Naidu. As a

result of financial analysis for the biogas electricity generation, it is concluded that introduction of biogas generation plant is feasible for the two STPs, since the initial investment cost will be recovered within about six (6) years.

8.6 Latest IT Application including GIS, MIS and SCADA systems

With the challenges facing to rapid growth of PMC, there is an urgent need for creation of reliable baseline data and support for utilities in PMC using IT. The creation of IT infrastructure through this Project will enable utilities to integrate other business processes such as GIS, MIS, and SCADA Systems.

8.7 Possible Components other than sewerage facilities for pollution abatement of the rivers

8.7.1 Social Consideration (Community Participation)

From the view point of sustainable implementation of the project, people's participation is essential in addition to the expansion of sewerage facilities. To achieve this, a well-planned public awareness and participation program will play a significant role. There are some points with reference to the locality that should be considered when preparing the public engagement program.

8.7.2 Public Toilet

This component of the project is planned as a pilot trial to promote people's participation. The beneficiaries shall be involved in the project from planning stage and O&M of the facilities shall be undertaken by themselves. In this context, the number of facilities is limited to 24 (about 3 % of existing community toilet units). One unit of the facilities shall consider a total of ten-sitters to accommodate 20 to 30 households.

8.7.3 Environmental Considerations

The purpose of the project is to improve sanitation conditions and living standards in PMC through the improvement of water environment in provision of sewerage systems. Thus, the Project would not cause significant adverse impact on environment. With regard to this, preparation of EA (Environmental Assessment) document is not required for sewerage projects in the Indian EIA regulations.

CHAPTER 9 Preliminary Design of Sewerage Facilities

9.1 Sewers

Outlines of preliminary design for sewers and IPS are summarized in Table 9.1 and Table 9.2.

Table 9.1 Required Sewers in Baner

Diameter	Length of sewers (m)		
	Existing	Proposed	Total
150mm	2,016	35,202	37,218
200mm	444	1,747	2,191
250mm	6,582	3,680	10,262
300mm	4,224	2,032	6,256
450mm	4,074	370	4,444
600mm	1,512	-	1,512
Total	18,852	43,031	61,883

Source: JICA Preparatory Survey

Table 9.2 Proposed Main/Sub-main Sewers

Line	Description	Length (m)	Diameter (mm)
1	Trunk sewer in Darga Nalla extend full length (one side only)	3,047	600-1200
2	Kharadi S. no. 63 to Eeon Mall to Darga Nalla	1,662	450-600
3	Trunk sewer along Ambil odha from Katraj to sarasbaug	8,825	600-1200
4	Conveyance main from Khadakwasla Dam to Vadgaon Bk STP	6,150	600-900
5	Conveyance main from Kondhave Dhavde to Warje STP	6,490	450-1400
6	Conveyance Main from Vadgaon Sheri to airport	1,500	450-1200
7	Trunk main along Hadapsar nalla	7,547	900-1800
8	Rehab of lines in Manik Nalla from PCB boundary to Kasba Power house	1,500	600-900
9	Trunk sewer from Kasba Power house to Nagzari nalla's line of 1800mm	700	600-900
10	Connecting line to divert Old Kasba flow to New Kasba	250	1200
12	Lining of 1400mm RM from old Kasba to Naidu	2,100	1400
13	Erandawana STP to Tophkhana - .	5,610	1200-1800
14	Conveyance main from Bhide pool to New Kasba on right bank of Mutha river	2,400	1200
15	Conveyance main from Bund Garden to Bhairoba STP	1,828	1200
16	Trunk sewer line along Bhairoba nalla from PS to U/S 2km	850	1800
17	Trunk sewer along Nalla to Dhanori STP	4,130	450-900
18	Trunk sewer from Agricultural College to Railway Line leading to Tanajiwadi stp	1,955	900
19	Trunk sewer LamanTanda To Bhairavi Hotel	1,540	600-900
20	Trunk sewer along Paunjai nalla from Ambegaon to Vadgaon STP	2,850	900-1200
21	Trunk sewer from Mira Society to Golden Bakery	2,024	600-900
22	Trunk sewer from Katraj Byepass to Kondwa Smashan Bhoomi	3,450	900-1200
23	Conveyance main from Balewadi to Baner STP (from boundary after 2km upto baner	4,126	900-1200
	Total	70,534	

Source: JICA Preparatory Survey

9.2 Intermediate Pumping Station (IPS)

Table 9.3 summarizes improvement plan for the proposed IPSs.

Table 9.3 Outline of IPS Improvement

Name of IIPS	Items	Specifications	Remarks
Old Kasba	Replace of Coarse Screen	Mechanical Screen 1.5mW×1.05mSWD×2units	Corse screen house renovation included 2 Screens will be removed.
	Replace of Sewage Pumps	Horizontal Centrifugal Pump 1,875m^3/h×13mH×132kW×4units Valves and pipes : 1 lot	Existing Pumps will be re-moved.
New Kasba	Addition of Coarse Screen	Mechanical Screen 1.4mW x 1.0mSWD x 2 units MCC for mechanical screen	
	Addition of Sewage Pumps	Submersible Sewage Pump 1,100m^3/h×19mH×110kW×6units Valves and Pipes : 1 lot	
Topkhana	Addition of Sewage Pumps	Submersible Sewage Pump 1,000m^3/h×35mH×200kW×6units Valves and Pipes : 1 lot	
Kalyani Nagar	Replace of Coarse Screen	Mechanical Screen 2.0mW x 3.7kW x 2uints	Existing 2 Screens will be re-moved.
	Replace of Fine Screen	Mechanical Screen 2.0mW x 3.7kW x 2units	Existing 2 Screens will be re-moved.
	Replace of Belt Conveyer	0.6mW x 9.0mL x 2units	Existing 2 Conveyers will be removed.
	Replace/Expansion of Sewage Pump	Submersible Sewage Pump 1,650m^3/hr x 18mH x160kW x3units Valves and pipes : 1 lot	

9.3 Sewage Treatment Plants

The design values of the STPs are shown in Table 9.4Table 9.4.

Table 9.4 Design Values for Sewage Treatment Plants

Facility	Unit	A2O	EA	SBR	Remarks
1 Pump Sump					
(1) Duration	min	5 – 10			
2 Grit Chamber					
(1) Surface Load	$m^3/m^2/day$	960			at peak flow
(2) Maximum Velocity	m/sec	Less than 0.3			
3. Primary Clarifier					
(1) Surface Load	$m^3/m^2/day$	50	N.A.	N.A.	
4. Reactor					
(1) BOD-SS Load	kg/kg/day	0.15	0.1	0.1	
(2) MLSS	mg/L	3,000	4,000	4,000	
(3) Return Sludge Rate	%	100 – 200	100 - 200	100 - 200	
(4) Water Depth	m	8.0 –10.0	5.5 - 10.0	5.5 – 6.0	
(5) Temperature	℃	25	25	25	
(6) HRT	Hr	9	17	17	
5. Secondary Clarifier					or Equivalent
(1) Surface Load	$m^3/m^2/day$	20	15	N.A.	Tube settler
6. Chlorination Tank					
(1) Contact time	min	more than 30			
(2) Injection rate	mg/L	5.0			
7. Thickener					
(1) Type		Mechanical Thickener	N.A.	N.A.	
8. Digester					
(1) Type		Mesophilic Anaerobic	N.A.	N.A.	
(2) Duration	Days	20			Bio-gas generator
9. Dewatering					
(1) Type		Centrifuge			
(2) Water Contents	%	80 – 85			

CHAPTER 10 Operation and Maintenance of Sewerage Facilities

Sewerage facilities to be operated and maintained include sewers, IPSs and STPs. Presently, O&M of existing IPSs and STPs are undertaken by contractors with minimal involvement of the PMC, while for sewers there is a team in PMC to conduct O&M work, as required basis.

10.1 Sewers

Sewers in this project will be constructed using a standardized detailed design-bid-build approach. Sewers are categorized into two from the view point of different O&M activities. These are main/sub-main sewers and sewer networks including house connections. The former shall be managed by technical monitoring team of PMC, while for the latter not only technical countermeasures, but also the activities for the development of the relationship with people by the team of PMC shall be considered to get understanding from beneficiary residents on sewerage requirements with proper sewerage user payment. The O&M of main/sub-main sewers shall be conducted at three existing zones which are currently adopted.

10.2 STP and IPS

Currently O&M of the majority of existing STPs and IPSs has been undertaken by the Contractors who were awarded the Construction Contract. The contractor usually operate and maintain the STPs/IPSs for an initial period of 5 years upon completion of construction work and at the end of the 5th year the Contractor is required to handover the STP/IPS for future operation either to PMC and/or to a newly selected Contractor. This arrangement is common for PMC, even in India (private sector participation), and existing 9 STPs have been operated by the Contractors.

10.3 Monitoring and Control of Sewerage System in use of SCADA System

It is anticipated that all of the STPs and IPSs would be connected under a centralized SCADA system to monitor the effectiveness of treatment and overall operation and management of the STPs and ISPs through an Asset Management Program. The water quality and other pertinent data including routine maintenance issues would be transferred to this centralized SCADA system for better control.

10.4 Sewage Treatment Plant and Additional Facilities for Effluent re-use and gas utilization

Recycle and reuse facilities -if included in the Contract, shall be constructed by the Contractor as part of STP Construction as well as operated by the same contractor. Once it is implemented, the contractor who operates the STP will also be responsible for the operation and maintenance of the recycle and/or reuse facility. As part of this project, it is anticipated that electrical power generation facility would be

constructed to use bio-gas for the production of electricity. The electricity generated through bio-gas will offset the electricity costs that PMC will have to pay to Maharashtra State Electricity Distribution Company Limited (MSEDCL). To get the capital cost to operating benefit, the power generation facility is to be constructed only at two STP; Naidu and Bhairoba. Both of these facilities could be designed as composite facilities taking sludge not only from the STPs where it will be situated, but also from other STPs.

During the entire contracted operation and maintenance period, PMC shall nominate their official/counterparts for the inspection of specific STPs on a weekly basis. PMC shall also nominate a qualified person to carry out periodical inspection of the STPs and to conduct surprise checks, without prior notice to the Contractor.

10.5 Institutional Structure and Technical Capacity needs for PMC to manage sewerage systems

Once the project components are constructed and ready for operation and maintenance, the STP/ISP packages will be maintained and operated for five years by the same contractor who constructed these packages. However, for the sewerage network facilities, which will be operated and maintained by PMC along with the existing sewer networks in the City and would require additional staff for addressing complaints and other operation issues. Initially, it is envisaged that the operation and management team would be required to address complaints on connection and sewage flow issues for the newly constructed area, while the existing sewerage team would continue to provide O&M services. After a period of say 5 years, the operation and management team would require additional crews to maintain the sewers for cleaning and de-gritting/flow maintenance as well routine maintenance of sewers.

Local offices comprise of 4 kinds of groups broken down into “Sewer”, “STP and IPS”, “Community Toilet Facility” and “Central SCADA System”. One Project Manager (equivalent of Junior Civil Engineer JEC,) shall be assigned to 2 STPs/ISPs, suggesting a total of 5 JECs for the existing STPs and 6 JECs for new STPs that are being constructed by the year 2027. The project Managers shall be supported by Junior Mechanical and electrical engineers – one junior mechanical engineer per 5 STPs. Similarly 1 electrical engineer per 5 STPs is required. This approach is considered for their newly constructed STPs as well, that are total 10 in numbers. Recommended institutional arrangement is presented in Figure 10.1.

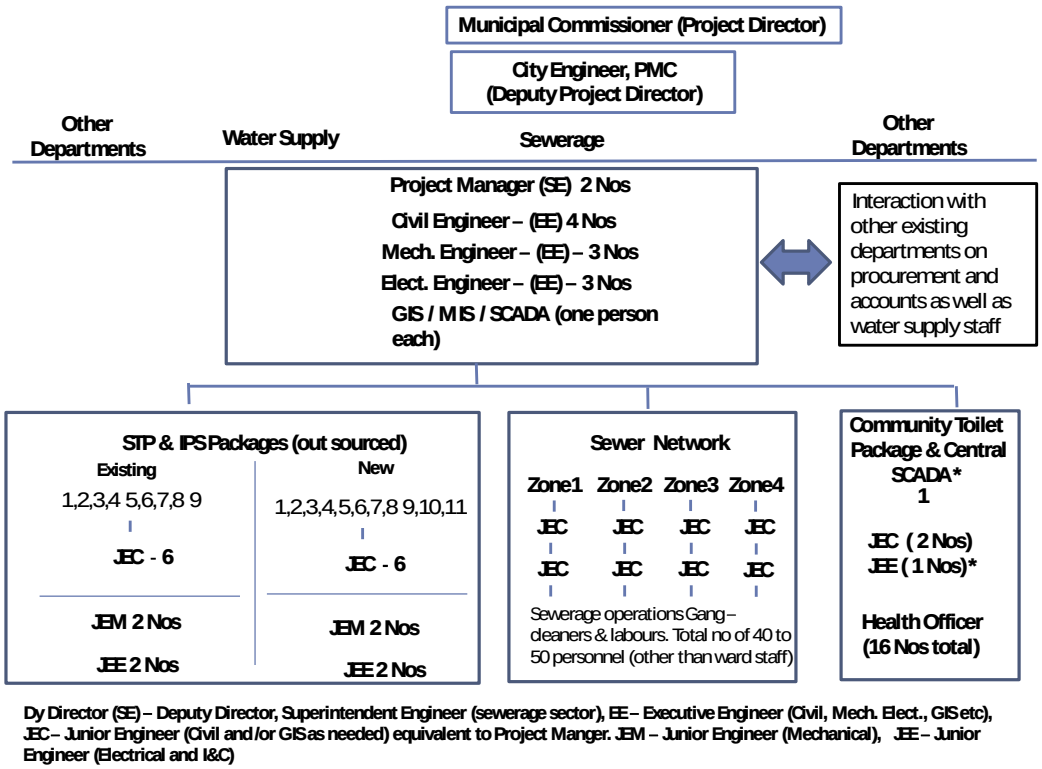


Figure 10.1 Recommended Operation and Maintenance Unit

As part of this project, additional major focus of the "capacity building" component under the project is to improve the capabilities of PMC staff working in both water and sewerage sectors including planning, implementation and more importantly the sustainable management of the sewerage facilities.

Management Information System (MIS) will be also developed, that would be linked to project management activities during construction for various packages and monitor project activities for effective project management. This task would include efficient data management (i.e., drawings, communications, decisions, etc.) so that all the information can be logged appropriately and effectively communicated to each part, - be it a contractor or consultant or owner (PMC).

It is also envisaged that during the project implementation phase, a GIS based Asset Management system would be developed. The asset management system would involve entire itinerary of all the equipment, including pipe sizes, valves, to pumps to STP operational parts that would provide effective information to the operator and owner on all of the assets. This information would then be used to determine the weakest link in operating the sewerage systems – sewer as well as STPs/ISPs. This asset management data would also help PMC to determine when particular equipment needs to be rehabilitated or maintained and up to when it will be maintained and whether it has any operational issues.

Lastly, the same asset management data base could be used for assessing what would be capital improvement cost in the future as and when the assets starts getting closer to their normal life span and operational limits.

CHAPTER 11 Environmental and Social Considerations

11.1 Project Requirements for Environmental Procedures in India

EIA Notification 2006 is a legal basis for regulating environmental clearance for development of projects. Sewerage projects do not require EIA report nor undertake public consultation meetings. As for the clearances other than environmental clearance, PMC will have to obtain the NOCs (No Objection Certificate) from relevant authorities as shown below.

- NOC for Crossing of Main / Sub Main sewers in R/W of Railway Line
- NOC for Main / sub main sewers Laying along river side
- NOC for Main / sub main sewers Laying under Road Area
- NOC for Main / sub mains La sewers Laying Sewer Lines along Nalla
- NOC for Tree Cutting or Re-plantation in Project Sites
- NOC for Effluents outflow from STPs
- Other clearances

11.2 Specific Environmental and Social Aspects in the Project Area

11.2.1 Social Aspect

The social condition survey indicated that almost all households are connected to the water supply and sewer networks. The result, however, does not reflect an proper hygienic sanitation status, especially in the slum areas. The survey result showed that 1/3rd of the respondents especially the slum residents and business establishments do not have any toilets in their premises. Limited number of public toilets and poor maintenance give no option other than open defecation and urination by those without access to private or public toilets. As a result of low sanitary condition, the public particularly the slum residents are suffering from occurrence of waterborne diseases.

The survey data analysis also showed that the future connections to the sewer network will not be so challenging for the Project especially for new household connections, but further efforts will be needed for business establishments' connections. The survey also revealed that though most of the residents would like to pay extra fee if the sewer system improves, yet the Project have a challenging work because the surveyed residents are only interested in a very small increase in the fee.

In terms of public awareness on the River pollution and the Project, most of the surveyed population is aware of the problems but need further awareness. The future public awareness program should be provided to equally pay attention to all groups of the City residents. The Project also should provide opportunity for the public's participation within a planned framework by setting goals, strategy, and defined participation level and activities for the stakeholders.

11.2.2 Physical Environmental Aspect

The transport, domestic and industrial sectors are the major contributors to the air pollution in PMC. PM_{10} (Particulate Matters) of 99μg/m^3 which exceeds the permissible limit of 60μg/m^3 was monitored in PMC. Mula-Mutha river falls under Class A- IV, and the water quality of the river is fit for agriculture but not at all fit for drinking purposes. The riverine water on the entire stretch that is from Vadgaon to Mundhwa and Aundh to upstream of Tanajiwadi STP is not suitable for drinking purpose. Nallas are polluted due to human interference.

11.3 Identification of Possible Environmental Impacts and Necessary Measures

11.3.1 Anticipated Environmental Impacts

The following adverse impacts are anticipated for the development of the STPs, IPSs and main / sub mains.

<u>During Construction Stage</u>

- Ecosystem
- Geology
- Resettlement / Land
- Social Infrastructure
- HIV / AIDs
- Occupational Health & Safety
- Air Pollution (Dust)
- Water Pollution (Turbid Water)
- Waste (Excavation, Construction Debris, Littering)
- Noise
- Accidents

<u>During Operation Stage</u>

- Occupational Health & Safety
- Water Pollution
- Waste (Sludge)
- Soil Contamination (Leakage or Spill-out of Sewage)
- Accidents
- Noise
- Odor

11.3.2 Mitigation, Environmental Management / Monitoring Plan

The following measures including preparation of environmental management / monitoring plan will be taken for the adverse impacts potentially to be caused by the project.

<u>During Construction Stage</u>

- Contractor's construction plan
- Adoption of Pipe-Jacking Method at the geologically weak area or the sites which open excavation cannot be applied (e.g. Crossing with Railway Line)
- Contractor's safety and health management
- Environmental monitoring (Noise)

During Operation Stage

- PMC's education on Occupational Health and safety
- Regular maintenance
- Complaints handling (Odor, noise)
- Environmental monitoring (Influent / Effluent sewage, noise, odor)

11.4 Land Acquisition and Resettlement

The proposed STP sites of Naidu, Bhairoba, Mundha and Dhanori are located in the existing PMC's STP facility areas and do not require LA (Land Acquisition) or has already been in the final process of the LA. Other STP sites are under process of LA to be acquired by PMC. Land availability for planned 24 Public Toilets are confirmed by PMC.

11.5 Assessment on the Mitigation of CO2 Emission by Biogas Power Plant

The assessment of the GHGs reduction amount through the development of the biogas power generation plant in the project was carried out. The reduction amount of GHGs by the implementation of the project was estimated as 18,115 t-CO_2.

CHAPTER 12 Implementation Plan and Construction Cost Estimates

12.1 General

Issues and problems experienced in India and recommended countermeasures for timely completion of the projects from bidding to construction stages were refereed to for preparation of the plan. Weather conditions in PMC were considered to assume working period/months, especially for the construction of sewers.

Preliminary cost was estimated based on preliminary design of sewerage facilities. The items for the cost estimates are referred to for the project assisted by National Government (approval requirements of Expenditure Finance Committee of Government of India). In addition, the cost requirements as a project assisted by Japanese ODA loan are also prepared and included in Supporting Report.

12.2 Scope of Work for the Project

The scope of work for the Project is tabulated in Table 12.1 including Consulting Services.

Table 12.1 Project Components for Water Pollution Abatement of Mula-Mutha River in Pune

Category	Component	Details (Specifications)
A. Sewer	1. Construction of Main/Sub-main and Branch sewers in Baner area	43.0 Km
	2. Construction of Main sewers in the left bank area of Mutha River and Mula-Mutha River and Central area of PMC	33 Km: Sewer No. 1, 2, 6, 8a, 8b, 9, 10, 12, 13a, 13b, 14a, 14b, 15, 16, 17, 18, 19, 23
	3. Construction of Main sewers in the right bank area of Mutha River and Mula-Mutha River	37.6 Km: Sewer No. 3, 4, 5, 7, 20, 21, 22; Sewer No 5 is arranged to include in this group, though located in item 2
B. Intermediate Pump Station (IPS)	4. Rehabilitation of Kalyani Nagar IPS	
	5. Rehabilitation of New Kasba IPS	
	6. Rehabilitation of Old Kasba IPS	
	7. Rehabilitation of Topkhana IPS	
C. Sewage Treatment Plant (STP)	8. Construction of STP at Mastya Beij Kendra	Treatment capacity: 7 MLD, SBR
	9. Construction of STP at Mundhwa	Treatment capacity: 20 MLD; SBR
	10. Construction of STP at Bhairoba Nallah including Bio-gas power generation plant	Treatment capacity: 75 MLD; A_2O
	11. Construction of STP at Naidu including	Treatment capacity: 127 MLD; A_2O

	Bio-gas power generation plant	
	12. Construction of STP at Vadgaon Bk	Treatment capacity: 26 MLD; EA
	13. Construction of STP at Warje	Treatment capacity: 28 MLD; EA
	14. Construction of STP at Botanical Garden	Treatment capacity: 10 MLD; EA
	15. Construction of STP at Tanajiwadi	Treatment capacity: 15 MLD; EA
	16. Construction of STP at Dhanori	Treatment capacity: 33 MLD; EA
	17. Construction of STP at Baner	Treatment capacity: 25 MLD; SBR
	18. Construction of STP at Kharadi	Treatment capacity:30 MLD; SBR
	19. Installation of Central SCADA System	Located at Naidu STP site
D. Community Toilet Facility	20. Construction of Community Toilet Facilities in the slum areas and fringe villages	24 units
E. GIS & MIS	Capacity Development for PMC in application of GIS and MIS for sewers and STPs/ISPs	
F. Public participation, Institutional Capacity & Environmental management	Strengthening in Public awareness/participation and institutional capacity, and facilitation of implementation of Environmental Management Plan (EMP), and Environmental Monitoring Plan (EMoP)	
G. Consulting Services	(1) Detailed Design, Bidding and construction for Sewers (2) Design Built: Basic Design, Bidding and Construction Supervision for IPS and STPs, Community Toilet Facility, and Central SCADA System	(1) Sewers: Detailed design, assistance for Bidding and construction supervision (2) IPSs & STPs, Community Toilet facilities and Central SCADA: Basic Design, assistance for Bidding and Construction Supervision (3) GIS& MIS and Public Part., Institutional Capacity & Environment: Supervise Contractors

Note: Sewer Numbers in item “A is refereed to those in sewerage DPR

12.3 Packaging for Project Component

The packaging of the Project for the major components was made in consideration of geography and package size to achieve financial efficiency during bidding and construction. The following are the

required packages by component for the Project

(1) Package 1: Construction of Main/Sub-main and Branch sewers in Baner area including the crossings of rivers/bridges and others using pipe-jacking method
(2) Package 2: Construction of Main sewers in the left bank area of Mutha River and Mula-Mutha River, and Central area of the PMC including the crossings of rivers/bridges and others using pipe-jacking method
(3) Package 3: Construction of Main sewers in the right bank of Mutha River and Mula-Mutha River including the crossings of rivers/bridges and others using pipe-jacking method
(4) Package 4: Construction of 2 STPs at Mastya Beij Kendra and Mundhwa with respective treatment capacities of 7 MLD and 20 MLD
(5) Package 5: Construction of STP at Bhairoba with the treatment capacity of 75 MLD including Bio-gas generation facilities and rehabilitation of Kalyani Nagar IPS
(6) Package 6: Construction of STP at Naidu with the treatment capacity of 127 MLD including Bio-gas generation facilities and New Kasba, Old Kasba and Topkhana IPSs
(7) Package 7: Construction of 2 STPs at Vadgaon and Warje with respective treatment capacities of 26 MLD and 28 MLD
(8) Package 8: Construction of 2 STPs at Tanajiwadi and Dhanori with respective treatment capacities of 15 MLD and 33 MLD
(9) Package 9: Construction of 3 STPs at Botanical Garden, Baner and Kharadi with respective treatment capacities of 10 MLD, 25 MLD and 30 MLD
(10) Package 10 Construction of Community toilet Facility in Slum areas and fringe villages
(11) Package 11 Installation of the Central SCADA system
(12) Package 12 Capacity Development for PMC in application of GIS and MIS for sewers and STPs/IPSs
(13) Package 13 Strengthening in Public awareness/participation and institutional capacity, and facilitation of implementation of Environmental Management Plan (EMP), and Environmental Monitoring Plan (EMoP)
(14) Package 14 Consulting Services

The contractors' work for Packages 4 to 9 and Package 11 will include O&M of STPs for five years after construction/installation of the facilities.

12.4 Procurement Method for the Implementation of the Project

For the construction/rehabilitation work for STPs and IPSs, and community toilet facilities, design-build method is recommended following current practices in the similar projects in India. While for the construction of sewers, Design-Bid-Construction method shall be adopted, since this work needs to adjust/arrange right of way for sewer laying and is an item rate contract in India.

Except for construction of community toilets which will be procured through local competitive bidding (LCB), all other items of works are to be procured through international competitive bidding (ICB) due to technical nature of the works. The Consultants for the Project will be procured by NRCD (MOEF&CC) and all the other items of work will be procured by the PMC. If the Loan Agreement is signed by March 2015, it is expected that the Consultant will be appointed by March 2016, and the construction will be completed by April 2021.

12.5 Project Implementing Unit

In the current institutional structure of PMC the functions of policy making, and service provision are not clearly delineated, and lead to conflicting objectives, political interference and lack of incentives and accountability. There is lack of clarity on institutional arrangements, particularly with regard to functions such as planning, financing, regulation, and management, etc. Therefore, to manage the project efficiently, a well-defined management structure has to be in place well before the first activity can begin. This management structure will comprise of 1) Project Steering Committee (PSC) and 2) Project Implementation Unit (PIU).

The Project Steering Committee will be formed to monitor and guide the performance of PIU. The committee members will meet every three (3) months for the total duration of the project, and meetings will be held at Pune and Delhi, alternatively. Participation of Project Consultant (Design Supervision and Management) in the meetings will be by invitation, as required.

PMC has to ensure that the PIU is in place before the start of the project. The PIU will be responsible for execution of the project works and manage the funds flow and the Consultant. The PIU will consist of central and local offices. The central office shall reserve specialist/engineer team, which can contribute to not only project component works, but also commonly to overall water sector of PMC; while staff assigned to local office will work for specific packages of the Project. Four local offices are planned, one office per type of works: “Sewer”, “STP and IPS”, “Community Toilet Facility” and “Central SCADA System”. However, a dedicated Project Engineer shall be assigned to each of the 11 packages. Figure 12.1 illustrates the organization of the PIU.

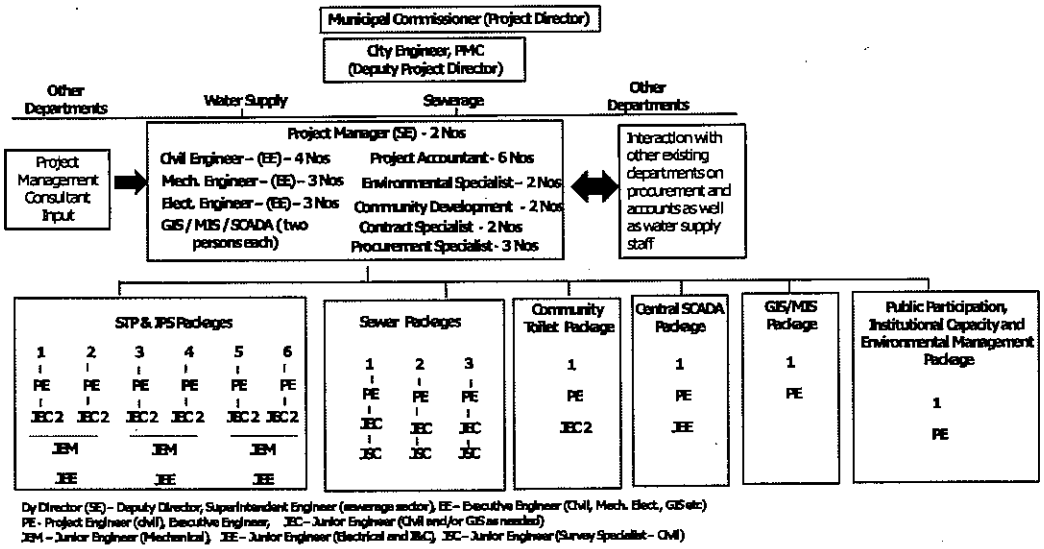


Figure 12.1 Organizational Structure for Project Implementing Unit

12.8 Project Effectiveness

Performance indicators for the project will mainly be the sewage quantity being treated and final effluent quality for each of the STPs constructed under the project and the water quality in Mutha River, Mula River and Mula-Mutha River.

The projected indicators by target year are shown in Table 12.2. Service coverage will increase from 65 % in 2011 to 100 % in 2027. Although increasing service coverage is 35 %, but population to be served in 2027 against present population is about 2.6 times (5,746,000/3,425,000 x 0.65).

Table 12.2 Operation and Effect Indicators

Indicator	2014	2027
Treated sewage amount (m^3/day) average of the year	561,000	948,800
Serviced population (person) and service coverage (%)	2,226,000 (65 %)	5,746,000 (100%)
Inflow BOD_5 concentration (mg/L) to STP	144	250
Effluent BOD_5 concentration (mg/L)	10	10
Inflow SS concentration (mg/L) to STP	184	350
Effluent SS concentration (mg/L)	13	10
Operating rate of facility (%)	80	100
Water quality of Mula-Mutha River; BOD (mg/L)	15-80	Less than 10
Water quality of Mula-Mutha River; DO (mg/L)	0.1-3.6	Minimum 5

CHAPTER 13 Economic and Financial Considerations

13.1 Stakeholder's Financial Capability of Water Supply and Sewerage Sector

(1) Financial Capability of the PMC

PMC's capital budget is designed to be covered by the revenue from special taxes such as consolidated property tax and property tax. Total revenue from these taxes is enough to cover capital cost required for this Project.

On the other hand, according to present practices, operational budget shall be covered by the revenue from special purpose taxes for sewerage, namely sewerage tax and sewerage benefit tax. PMC also uses the revenue from these sewerage related taxes for storm water drainage and conservancy. Since O&M cost will be rapidly increased by the implementation of this Project, present budget allocation to Sewerage Division may not be sufficient enough to cover O&M cost of newly constructed facilities. To cope with this problem, the following measures are recommended; 1) PMC may need to increase sewerage tax and sewerage benefit tax until the revenue from taxes meet demand of operational cost supported by increased population, 2) allocate more budget to Sewerage Division, or 3) shift sewerage charge system to volumetric charge system.

13.2 Budget of the Project and cost sharing

11,812 million Rupee is totally necessary for implementing this Project. The Project cost will be covered by grants from NRCD and the contribution by PMC. NRCD will shoulder 85% and PMC shoulder 15% of the required cost. While, rehabilitation and operation cost for the sewerage facilities are shouldered by PMC.

13.3 Financial analysis

Financial analysis revealed that Financial Internal Rate of Return is positive (2.7%) and sufficient to carry on this Project.

13.4 Economic analysis

(1) Factors related to economic impact

Economic analysis considered the impact to the following items being brought by this Project:

- Reduction of medical cost for water born/related diseases by improving quality of river water
- Reduction of water treatment cost for villages in the downstream area of PMC
- Saving cost for the construction of septic tank, when this project is implemented.
- Without urbanization in provision of infrastructures including mass transportation, road network, water supply, power supply and sewerage system, land for residential use may not trade with

present price.

(2) Economic analysis

Economic analysis (EIRR: Economic Internal Rate of Return) concluded that implementation of this Project is expected to have a significant impact to Indian economy (+6.9%).

As a result of financial and economic analysis, it was confirmed that this Project is financially feasible with two reasons; FIRR is positive and EIRR shows significant positive impact to the economy, thus, this project is worth to carry on.

CHAPTER 14 Institutional Improvement

This chapter analyzes the roles and responsibilities of various stakeholders in Government of India (MoEF, Urban Development), Government of Maharashtra (Urban Development) and Local level stakeholders including customers and public from the perspective of sewerage management. This brings out few interdependent issues in sewerage management especially in sewage and storm water collection, O&M of STPs and pumping stations, slum sanitation, and municipal solid waste management (which is the major cause of choking of sewerage networks) indicating that for effective sewerage management, all need to be addressed in an comprehensive manner. It then brings out various challenges faced by existing functionality of sewerage management as well as upcoming challenges.

While analyzing present mode of functioning vis a vis organizational limitations in undertaking future development (proposed), it has been considered necessary to support segregation of few functions and increased corporatization. It is inferred that PMC can continue to pursue planning, monitoring and quality management functions besides maintenance of sewer lines and construction and operation and maintenance of STPs and IPSs can be increasingly outsourced.

To develop a business plan for the PMC, a mission statement for sewerage management of PMC has been developed, from where mid- term (next 8 years) and long term (about 20 Years) goals have bene evolved. Based on these goals, analysis of PMC has been undertaken on its institutional, operational and financial capabilities. It was observed that it shall be able to meet its mid-term goal of O&M sustainability, whereas it need to develop its HR competences and introduce tools like automation, GIS, MIS, SCADA for its sustained functioning.

For overall improvement, a number of institutional strengthening measures along with suggested outputs, step wise actions and performance indicators have been developed along with lead agency to implement the same so as to address various institutional challenges. These mainly include:

- Policies and Planning, and their Implementation
- Delivery of Sewerage Infrastructure
- Sewerage Asset Management
- Safety in Sewerage Management
- Capacity Building of PMC Staff
- Sensitizing the department towards social and environmental needs
- Community Participation
- Customer satisfaction
- Financial Sustainability

CHAPTER 1 Background and Outline of the Project

1.1 Introduction

India is facing severe water, groundwater, and subsoil pollution due to discharge of untreated sewage into the nation's public waterbody. The growing population and economic development have generated higher volume of untreated sewage. At present (as of year 2011) only about 30% of the generated sewage is treated. On the other hand about 40% of households use the septic tanks with water sealed toilets. Under these conditions, people are exposed to unsanitary living conditions which need to be improved. This is not possible without improving India's insufficient sewerage services which suffer from lack of efficient management both in technical and financial aspects including operation and maintenance.

The Government of India (hereinafter referred to as "GoI") decided to provide sewerage/sanitation facilities for the urban population in its 12th Five Year Plan (from April 2012 to March 2017). The plan policy emphasizes on the reuse of treated sewage and construction of new sewerage facilities by taking into account the capacities of water supply facilities and the limited water sources available.

The water pollution of Mula-Mutha River has been a major concern of the Pune City in recent years. The river (with a total length of 48 Km) traverses Pune City (Pune Municipal Corporation; herein after referred to as PMC), State of Maharashtra (Present population of the City is about 3.12 million). The pollution is primarily caused by the PMC's sewage being discharged into the river without treatment. The total sewage volume treated at the existing sewage treatment plants in 2014 is estimated at 476 Million Liter per Day (MLD) by its public STPs with 392 MLD (treatment capacity: 477 MLD) and individual private STPs with 84 MLD (treatment capacity: 84 MLD). The generated sewage volume at present, however, is estimated at 728 MLD by Detailed Project Report (hereinafter referred to as "DPR"), which indicates the discharge of 252 MLD untreated sewage directly into the rivers. Presently about 65% of generated sewage in the Project area is treated either by public or private STPs. The pollution can be worsen considering the City's growing population.

It is urgent for the PMC to provide improved sewerage systems to its residents. Sewage generation volume in 2027 is estimated to be 873 MLD in assumption of a high annual population growth ratio of 2.6%. (from 2001 to 2011) Therefore expansion/augmentation of the existing sewage collection systems, intermediate pump stations and sewage treatment plants are an urgent needs for the PMC.

"The Project for Pollution Abatement of River Mula-Mutha in Pune" under National River Conservation Plan (NRCP) (hereinafter referred to as "the Project") was proposed in January, 2014 by the Gov-

ernment of India through the rolling plan for the projects utilizing Japanese Government ODA loan. In this connection, PMC, responsible for implementation of the Project and O&M of the sewerage facilities, prepared a "DPR" to confirm the Project feasibility according to the National River Conservation Plan.

Under the above conditions, in the context of utilization of Japanese ODA loan for the Project, a series of discussions on the scope and implementation arrangements of the Preparatory Survey was made between the Japanese and Indian sides. Then, M/M (Minutes of Meetings) was exchanged on April 15, 2014 between Indian side consisting of National River Conservation Directorate, Ministry of Environment, Forest and Climate Change, Government of India (hereinafter referred to as "NRCD") and PMC, and Japanese side represented by Japan International Cooperation Agency (hereinafter referred to as "JICA") mission to start "the Preparatory Survey on the Project for Pollution Abatement of River Mula-Mutha in Pune" (refer to Supporting Report 1.1). Then, the survey work for the Project commenced on July 29th, 2014 and Final Report for Revised DPR was completed by the end of January, 2015.

1.2 Objectives of the Project and Preparatory Survey

The objective of the Project is to improve the water quality in the Mula, Mutha and Mula-Mutha rivers by augmenting sewage collection systems and sewage treatment facilities in PMC. It also includes other countermeasures required for the pollution abatement and thereby improving the sanitation and living conditions of people who reside in Pune City and in the watershed of the downstream area.

The main objective of the Preparatory Survey is to provide information necessary for feasibility evaluation of the Project, as a Japanese Government ODA loan project. Among others, such information includes the outline of the Project, project cost estimates, economic and financial viability of the Project, the project implementation schedule, manner of procurement and construction, organization of the project implementation, operation and maintenance (O&M) arrangements, and social and environ-mental considerations. The prepared report and additional components suggested in the Preparatory Survey was considered as addendum to the DPR for the Project.

1.3 Survey Area and Design Year

The Preparatory Survey will cover the jurisdiction area of PMC, located in the State of Maharashtra, as shown in the Location Map, as well as the fringe areas of the City (13 villages) and Cantonment area. Seven villages in the fringe areas are located in direct upstream of Mula or Mutha rivers. Table 1.3.1Table 1.3.1summarizes the composition of survey area.

The upstream areas that affect the water pollution of Mula-Mutha River are identified to be Pimpri Chinchward Municipal Corporation (PCMC), upstream of the Mula River.

Table 1.3.1 Composition of Survey Area

Survey Area	Composition of Survey Area (Km^2)
PMC	243.95 Km^2
Fringe Villages (13 villages)	13 villages; Lohagaon, , Mundhava, Manjari Bk., Pisoli, Narhe, Nanded, Kirkatwadi, Khadakvasla, Shivane, Kopare, Kondhave Dhawade, Bavdhan Bk., Sus, Mahalunge; 131.35 Km^2
Cantonment Area	12.47 Km^2
Total	387.77 Km^2

According to the recommendations by the Central Public Health Environmental Engineering Organization (CPHEEO) at "Revised Manual for Sewerage Planning", which is used in the updated Water Supply Plan prepared by PMC in 2014, target years for the Project by design purpose in application of the base year 2017 are as follows:

① Design of sewers: year 2047 (30 years)
② Design of intermediate Pump stations: year 2032 for pump and mechanics (15 years) and year 2047 for civil/architectural (30 years)
③ Design of sewage treatment plant: Phase I- year 2027, Phase II- year 2037 (10-20 years)

1.4 Scope of Work for the Preparatory Survey

The Preparatory Survey covered the following items, through review of the DPR (prepared by PMC) and collection of additional information, if required.

(A) Basic Study

1. Sewerage and pollution status

1.1 Generated and treated sewage volume at present, and the volume difference

1.2 Existing sewerage facilities and their conditions

1.3 Projection of wastewater volume to be generated including that discharged effluent from factories, if any

1.4 Identification and analysis of point and non-point pollution sources along Mula, Mutha and Mula-Mutha rivers in PMC

1.5 Sewage volume generated currently in the upstream area of PMC along the rivers and the existing sewerage facilities, also any improvement plan for the sewerage system

1.6 Impact of the untreated discharged sewage on the rivers and on the general public around the rivers (including river conditions with supporting data such as BOD and negative impacts by the pollution on the population living around the rivers)

2. Existing water supply and future development plan

3. Countermeasures to generated storm water, through reviewing the storm water network master plan prepared by PMC

4. Relevant laws and regulations and their applicability (environmental laws and regulations, effluent discharge standards, etc.)

5. Assessment of working period due to weather conditions in the Project area (assess and clearly quantify the impact of weather in various civil construction activities by estimating available construction period in state of Maharashtra in a given year in order to accurately assess the actual number of man-months/working days for civil work) In addition, data collection and analysis on the risk caused by climate fluctuation shall be conducted.

6. Effect of the project implementation to the business activity in the project area

(B) Detailed Study

1. Scope/ Design of the project

1.1 Sewage Treatment Plants (feasibility of treatment options including power generation as suggested in DPR and implementation of pilot project for Recycle and Re-use need to be carefully examined)

1.2 Pumping stations

1.3 Collection systems and Trunk sewers

1.4 Introduction of available advanced technologies in sewerage facilities including consideration of Japanese technology

1.5 Suggestions for latest IT applications, including GIS, MIS, and SCADA

1.6 Operational data of technologies proposed for the new STPs from India or from other South Asian countries with similar environmental conditions

1.7 Consider additional scope for pollution abatement

2. Physical conditions of the project area (climate, meteorology, topography. hydrology, etc.)

3. Cost estimation for construction cost, capital cost, O&M cost and other supporting cost including that for social development. Construction cost estimation shall take into account year of the contract award for construction activities in and around 2016/2017, accordingly indices for labor/ cement and steel costs have to be considered

4. Necessary clearance for project implementation

4.1 EIA, land acquisition, necessary permission, revised sewerage tariff, other related laws and regulations (Permissions include effluent discharge, road cutting, National Highway, oil pipeline, power

cable, railway, cantonment, etc.).

5. Environmental and social considerations

5.1 Analysis of the Project in accordance with the requirements of the JICA's Guidelines

5.2 Prepare Resettlement Action Plan (RAP) if required, in accordance with the requirements of the JICA's Guidelines

5.3 Initial Environmental Examination, including evaluation of adverse impact, development of mitigation measures and environmental monitoring plan.

5.4 Assess the mitigation of CO_2 emission by biogas power plant

6. Implementation schedule

To make the schedule realistic, it shall be comprehensive and consider the following:

- Weather conditions
- Assessment of availability of contractors and their capability
- Assessment of the capacity of PMC to implement the Project (especially availability of funds/budgetary allocation for a period of 5-7 years to run the PIU and cover administrative expenses, taxes & duties, etc.)

7. Procurement plan

7.1 Procurement practice of similar projects in Pune

7.2 Employment of consultants

7.2.1 Selection method

7.2.2 Prepare RFP (including TOR and man-months / working days)

7.3 Procurement of contractors

7.3.1 Contract packages and methods (The packages shall be determined before the ex-change of L/A.)

8. Implementation structure

8.1 Role and function of each division, organizational structure, personnel organization of NRCD and PMC – staffing for dedicated PIU needs to be finalized within PMC

8.2 Technical capacity of NRCD and PMC (experience of similar projects, experience of each employee, training and manpower planning)

8.3 Decision-making and approval process during project implementation

8.4 Suggest measures and options to streamline the above decision-making and approval process. This will ensure an efficient project implementation Jurisdiction of PIU and the Maharashtra State department needs to be clearly stated and identified at this stage itself to avoid unnecessary delays at a later stage. Effective and smooth disbursement of loan shall also be achieved considering clear allocation of responsibilities between NRCD and PMC.

9. Operation and maintenance structure

9.1 Role and function of each division, organizational structure, personnel organization and personnel system

9.2 Technical capacity (past record, experience of each employee, training and man power planning)

10. Financial management

10.1 Financial capacity of Pune MC (with breakup of revenue and expenditure including water supply department)

10.2 Sewerage charge system

10.2.1 Appropriate sewerage charge level

10.2.2 House connection and fare collection mechanism

10.2.3 Public awareness

10.2.4 Service to slum dwellers (sewerage charge level and subsidy)

11. Project effectiveness

11.1 Quantitative assessment

11.1.1 Setting of key operation and effect indicator

11.1.2 Calculation of FIRR and EIRR

11.2 Qualitative assessment

12. Institutional Improvement

12.1 Prepare action plan for human resource development, financial management, customer oriented service

12.2 Prepare Consultants' TOR to support action plan

12.3 Review the necessity of Technical Corporation

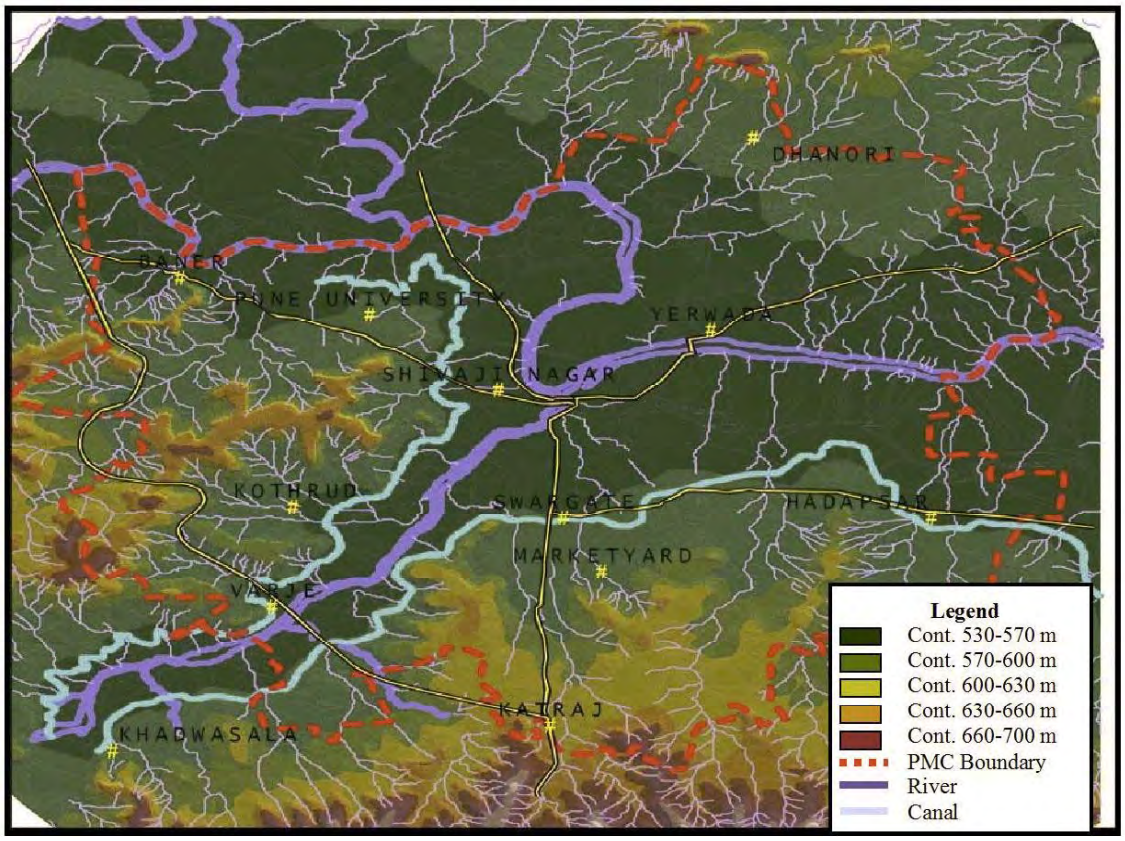
CHAPTER 2 General Description of the Project Area

2.1 Natural Conditions

2.1.1 Topographic Conditions

PMC lies on the eastern foothill of the Sahyadri, which is a mountain range along the western side of India, and is located in western margin of the Deccan Plateau at the confluence of the Mula and Mutha rivers at 18°32'north latitude and 73°50'east longitude. The maximum and minimum levels are 674.77m at southern edge (Katraj), and 530.10m at north bank of Mula-Mutha River (Kharadi Gaothan).

PMC is surrounded by hills, and has steep slopes near the boundaries on southern and eastern parts. The general slope progressively becomes moderate as drains approach river plains. There are number of natural drains flowing in the city which ultimately discharge in Mula and Mutha rivers. Therefore, general topography is undulating. The topographic map of PMC is shown in Figure 2.1.1.



Source: DPR

Figure 2.1.1 Topographic Map of PMC

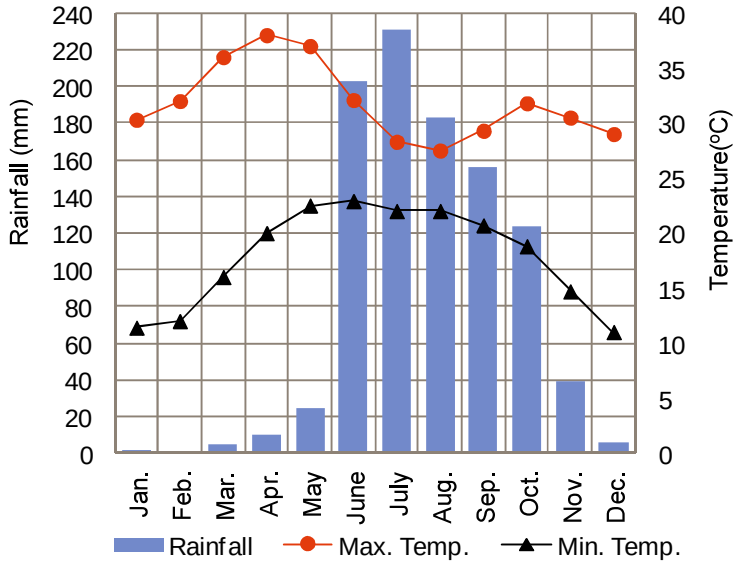
2.1.2 Meteorological Conditions

(1) Temperature and Rainfall

PMC is located in a subtropical zone that experiences three seasons, i.e., summer season from March to May, monsoon season from June to October and winter season from November to February.

The temperature during summer ranges from 16 to 38 ºC, and the warmest month is April. Also, the temperature ranges from 18 to 30 ºC in monsoon season, and from 8 to 30 ºC in winter season. The temperature in PMC are significantly cooler comparing with those in most other parts of this region owing to the high altitude.

The mean annual rainfall is around 982 mm. About 90% of the annual rainfall is recorded during the monsoon season due to the strong effects of monsoons, while 10% of annual rainfall is observed during the summer and winter seasons. In monsoon season, spells of continuous rain fall may stretch many days or even a few weeks. The mean monthly total rainfall is about 230 mm in July and 2 mm in January. The mean monthly maximum and minimum temperatures and mean total rainfall at each month are shown in Figure 2.1.2. The temperature record (1989-2008) and rain fall record (1989 - 2011) are shown in Data Report 2.1.



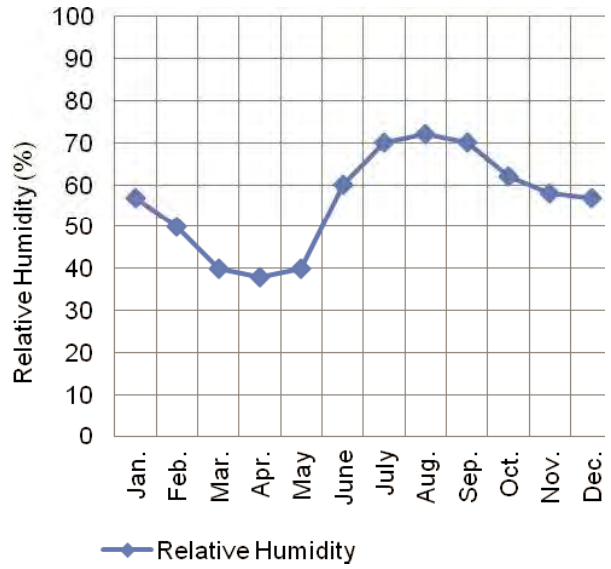
Source: Ministry of Earth Sciences, Government of India

Figure 2.1.2 Mean Maximum and Minimum Temperatures and Mean Total Rainfall at each Month

(2) Humidity and Wind Speed

The relative humidity is highest in the monsoon season with the mean humidity of 72%, while the rest of the year, the air is generally dry and the summer season is the driest season with the mean humidity

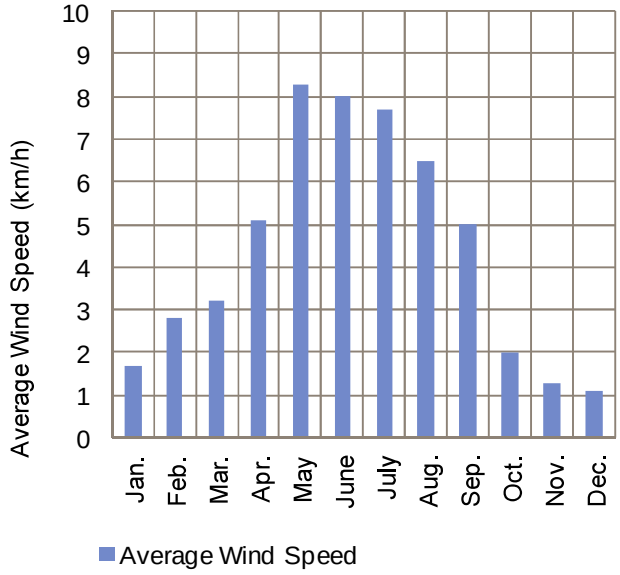
of 38%. The mean monthly relative humidity is shown in Figure 2.1.3.



Source: Ministry of Earth Sciences, Government of India

Figure 2.1.3 Mean Monthly Relative Humidity

The annual average of wind speed is 4.4 km per hour. Even in the monsoon season, winds are normally light to moderate with wind speed of 5.8 km per hour. The mean monthly average wind speeds recorded at each month are shown in the Figure 2.1.4. The wind record (1989-2011) is shown in Data Report 2.1.



Source: Ministry of Earth Sciences, Government of India

Figure 2.1.4 Mean Monthly Average Wind Speed at each Month

(3) Effect of Climate Change

Assessment of climate change vulnerability in Maharashtra is conducted by TERI (The Energy and Resource Institute). The general condition is shown below.

Long coastal line of over 840 km makes the state vulnerable to the impacts of climate change including changes in temperature and precipitation pattern. It will increase in the frequency and intensity of extreme events including droughts, floods, cyclones, storm surges, heat wave occurrence, etc. Each of these predicted changes has adverse implications for Maharashtra's agriculture, water resources, forestry and disaster management strategies. For the Maharashtra region, the projections executed by TERI suggest a warmer and wetter monsoon season from year to year and these changes are characterized by more frequent days of extremely high temperatures and intense rainfall events, with the duration of these extreme days lasting longer into the month of August.

The forecasting model projected an increase in the percentage of days with temperatures above 35 ^{o}C over the entire Maharashtra region, with large reduction in the percentage of days recording less than 25 ^{o}C. The distribution of extremely warm days is apparent and consistent with a temperature increase of approximately 1.5 - 3 ^{o}C. Also, number of days with “high” or “very high” rainfall (greater than 25 mm per day) is projected to increase over the Maharashtra region across projection, while the number of days with “low” to “moderate” rainfall is expected to reduce. In PMC, the mean minimum and maximum temperature have not significantly changed over the past 20 years. However, the torrential rain have caused frequently in recent years, and total monthly rainfall exceeded 400 mm in Augsut, 2006, 2009, 2010, and 2011. The detailed meteorological data is shown in Data Report Chapter 2.

Recently, the river flood and land slide accident have frequently occurred during monsoon season in Maharashtra. Therefore, the adverse effect on the construction progress and flood countermeasure shall be considered in project implementation plan. While the flood control of Mula and Mutha river is managed functionally with the dam gate switching operation by Irrigation Department, the adverse effect on the construction progress along the primary drain shall be considered in project implementation plan in the Monsoon season.

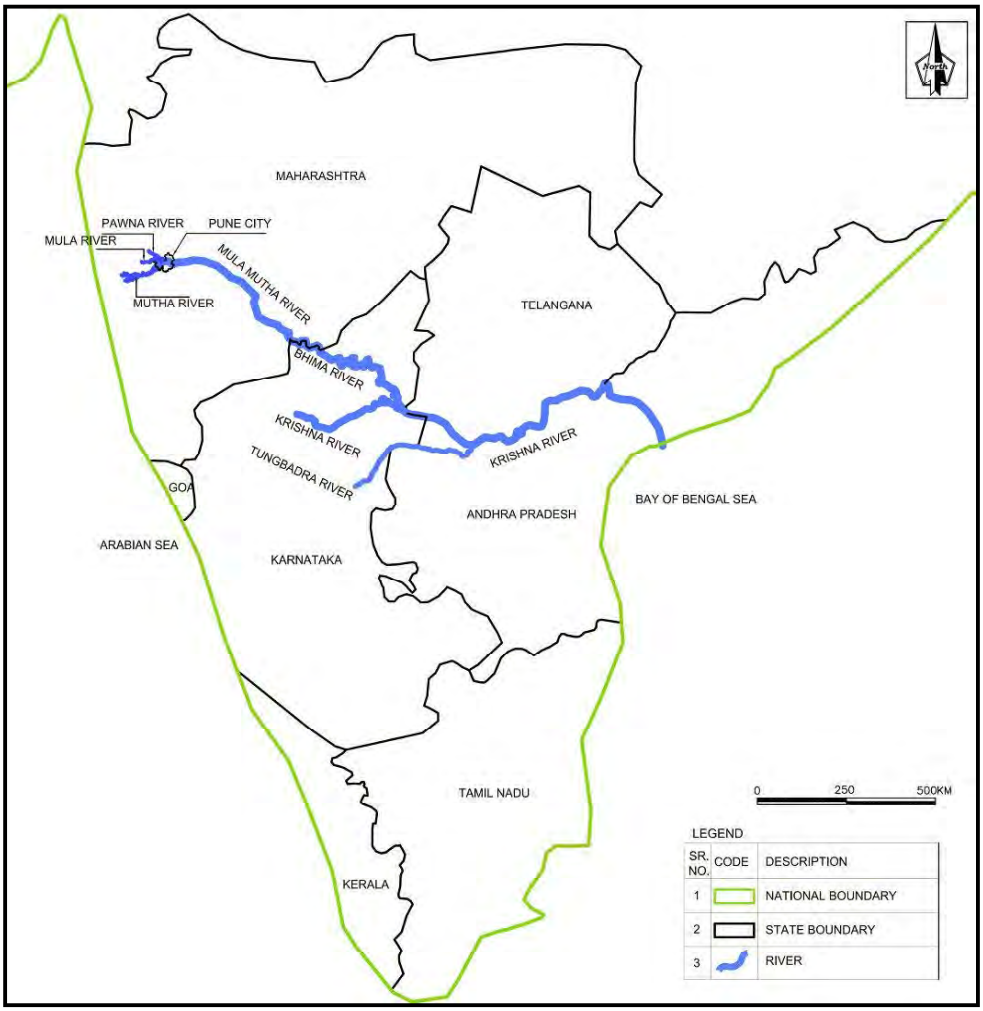
2.1.3 Hydrological Conditions

(1) Mula and Mutha River

There are two major rivers in PMC. The Mula River is originated from North West of PMC. It passes through the neighboring PCMC area before entering PMC. The Mutha River is originated from the Western Ghats, south west of the PMC, and flows eastward until it merges with the Mula River in

PMC. After the confluence, the rivers flow on as the Mula-Mutha River to join the Bhima River which is a major river in southern India.

Bhima River flows southeast for approximately 860 km through Maharashtra, Karnataka, and Telangana states. It is merged by the Krishna river at the boundary of Karnataka and Telangana states. Then, the river flows through the Telangana state and emptys into the Bay of Bengal. The downstream basin of Mula-Mutha river is shown in Figure 2.1.5. The river basin covers an area in excess of 250,000 km^2 (nearly 8% of India) in three large state with a combined basin population of 70 million. Water extractions for agriculture, industrial, and domestic uses continue to grow to support one of the fastest developing regions of peninsular India. Agricultural irrigation represents 95 percent of demand, while industry (2 percent) and domestic use (3 percent) account for the rest.

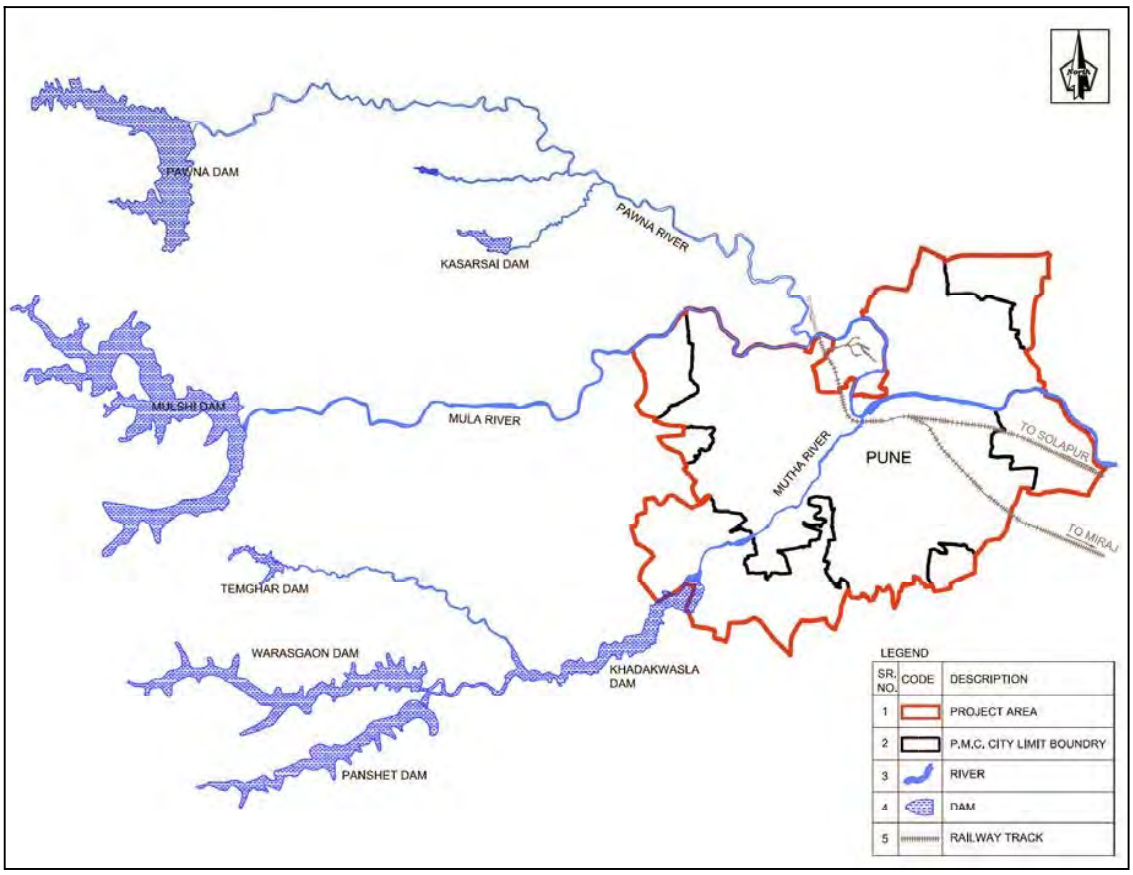


Source: JICA Survey Team

Figure 2.1.5 Downstream Basin of Mula-Mutha River

River water is contaminated with sewage flow discharged from residential areas.. Therefore, water quality examination was conducted through MPCB, DPR, and JICA survey. The sampling points and water quality examination results are included in Supporting Report 2.1 and discussions on the findings are made in Chapter 6 Water pollution Status in Public Water bodies.

In the upstream of the Mula River, there are three dams at Pawna, Kasarsai, and Mulsi. Mulshi reservoir is used for hydro-electric power generation. Likewise, in the upstream of the Mutha River, there are four dams at Temghar, Warasgaon, Pahshet, and Khadakwasla. The water from Khadakwasla is used as a source of drinking water and irrigation in PMC. The location of Mula and Mutha rivers and dams in the upstream of the rivers are shown in Figure 2.1.6.

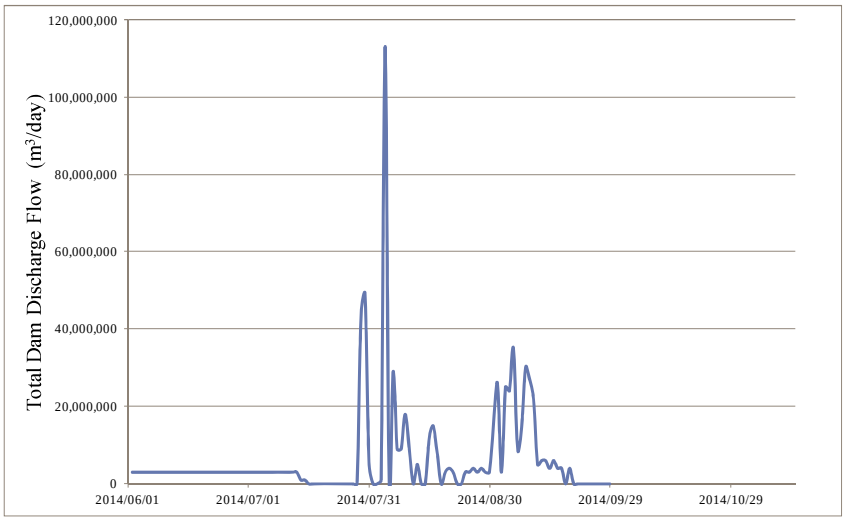


Source: JICA Survey Team

Figure 2.1.6 Location Map of Mula and Mutha Rivers and Dam

The control of river flow at the dams minimizes the flow in the downstream. River flow is only controlled during monsoon season through gate operation by irrigation department, Government of Maharashtra. The records of discharging flow at each dam from Water Resource Department, Government

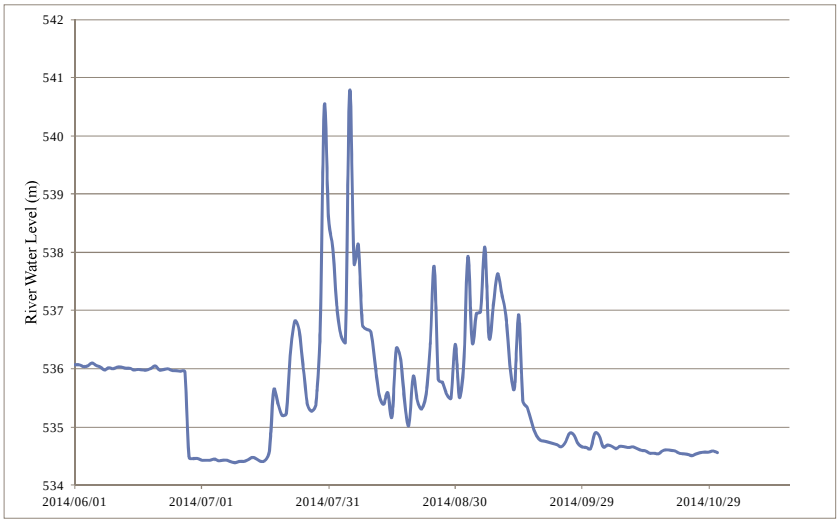
of Maharashtra is included in Supporting Report 2.1. During winter season and summer season from November to May, the dam gate is closed. The total dam discharge flow from Pawna, Kasarsai, Mulshi, and Khadakwasla dams is shown in Figure 2.1.7.



Source: Water Resource Department, Government of Maharashtra

Figure 2.1.7 Total Dam Discharge Flow during Monsoon Season

The river water level has been checked by Irrigation Department since June 1st, 2014. The river water level indicator is placed on the Kalyani Nagar bridge at 5 km downstream from confluence of Mula and Mutha rivers and records the time-dependent river level with water level sensor. The river level monitoring point and river cross section drawing are included in Supporting Report 2.1. The river water level have a strong correlation with dam discharge flow. Especially from end of July to middle of August, the water level became high according to the dam discharge flow. The water river level at Kalyani Nagar bridge is shown in Figure 2.1.8 and Supporting Report 2.1.



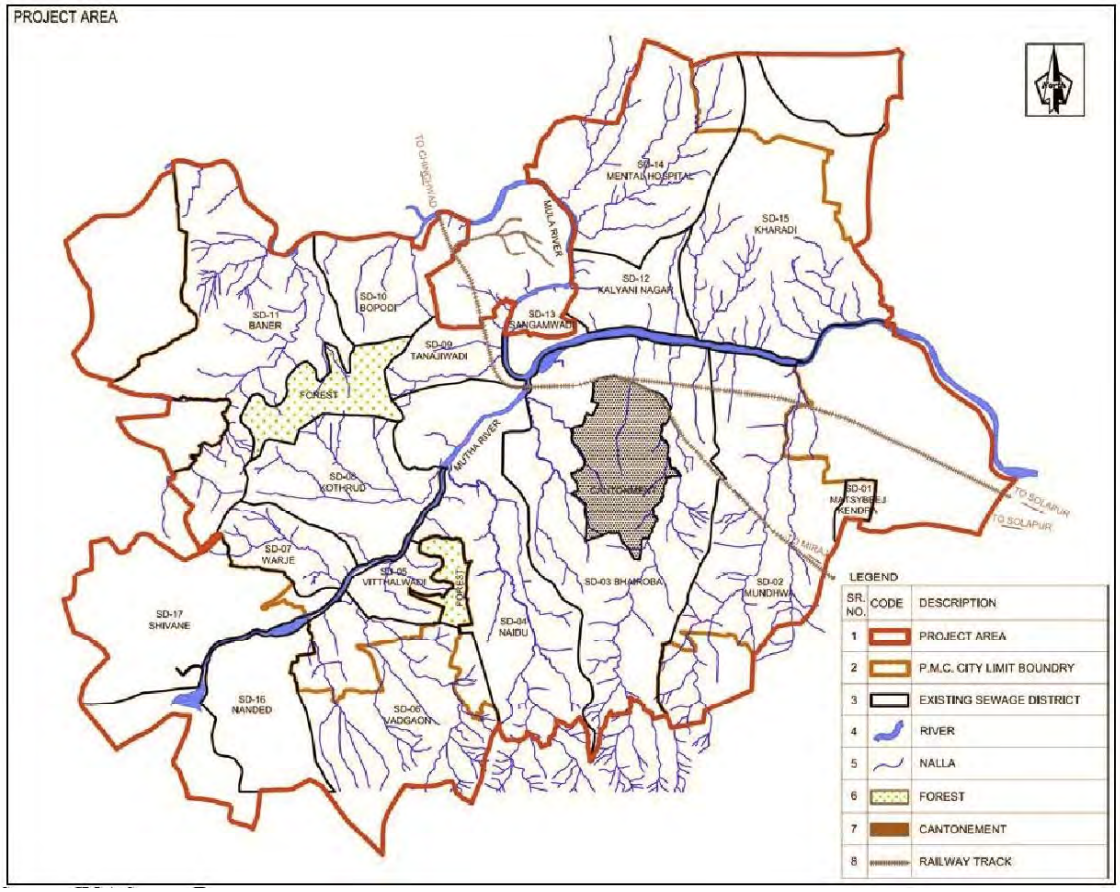
Source: Irrigation Department, Government of Maharashtra

Figure 2.1.8 River Level at Kalyani Nagar Bridge, Mula-Mutha River

(2) Natural Drainage Channels

The detailed reconnaissance survey of the entire project area was conducted in DPR to identify the drainage channels. Total 55 natural drainage channels are identified in the project area, out of which 47 are in the PMC area and 8 are in the fringe area at total catchment area of 37,326 ha.

These channels are considered for the study, because they carry sewage from rapidly urbanizing fringe areas of PMC and join the Mula, Mutha and Mula-Mutha Rivers. Out of the 55 drains, 20 drains discharge in Mula River 19 discharge in Mutha and 16 numbers in Mula-Mutha River. The alignment of natural drainage channels and details of drainage channels are shown in Figure 2.1.9 and Supporting Report 2.1.



Source: JICA Survey Team

Figure 2.1.9 Location of Mula and Mutha Rivers and Natural Drainage Channels

(3) Ground water

The study conducted by Groundwater Surveys and Development Agency (GSDA), Government of Maharashtra shows that PMC is located in the predominantly hard rock areas and ground water occurs under confined conditions in fractured aquifers. The water table is generally shallow in which depth to ground water level ranges from 0.2 to 15.6 m.

The ground water qualification test was carried out by Institute of Environment Education and Research near Katraj lake at the south edge of PMC boundary. The sampling result and drinking water standard of the Bureau of Indian Standards (BIS-10500:2012) are shown in Table 2.1.1. This standard was established by Bureau of Indian Standard, Ministry of Consumer Affairs, Food and Public Distribution. It is applicable for drinking water from any source.

Table 2.1.1 Ground Water Quality

	Sample Average Value	Drinking Water Standard (IS-10500)	
		Acceptable Limit	Permissible Limit
pH	7	6.5-8.5	-
Hardness (mg/l)	246	300	600
Calcium (mg/l)	58	75	200
Magnecium (mg/l)	24	30	100
Alkalinity (mg/l)	287	200	600
Chloride as Cl (mg/l)	107	250	1000
Total Dissolved Solids (mg/l)	187	500	2000
Nitrate as NO_3 (mg/l)	22	45	-
Sulphate as SO_4 (mg/l)	36	200	400

Source: Institute of Environment Education and Research

Average values of pH, Hardness, Calcium, Magnesium, Alkalinity, Chloride, Total Dissolved Solids, Nitrate, and Sulphate, are within the permissible limit. Examination results show that the ground water quality in the sampling area is suitable for drinking as per the standard.

2.1.4 Geological Conditions

(1) General Condition

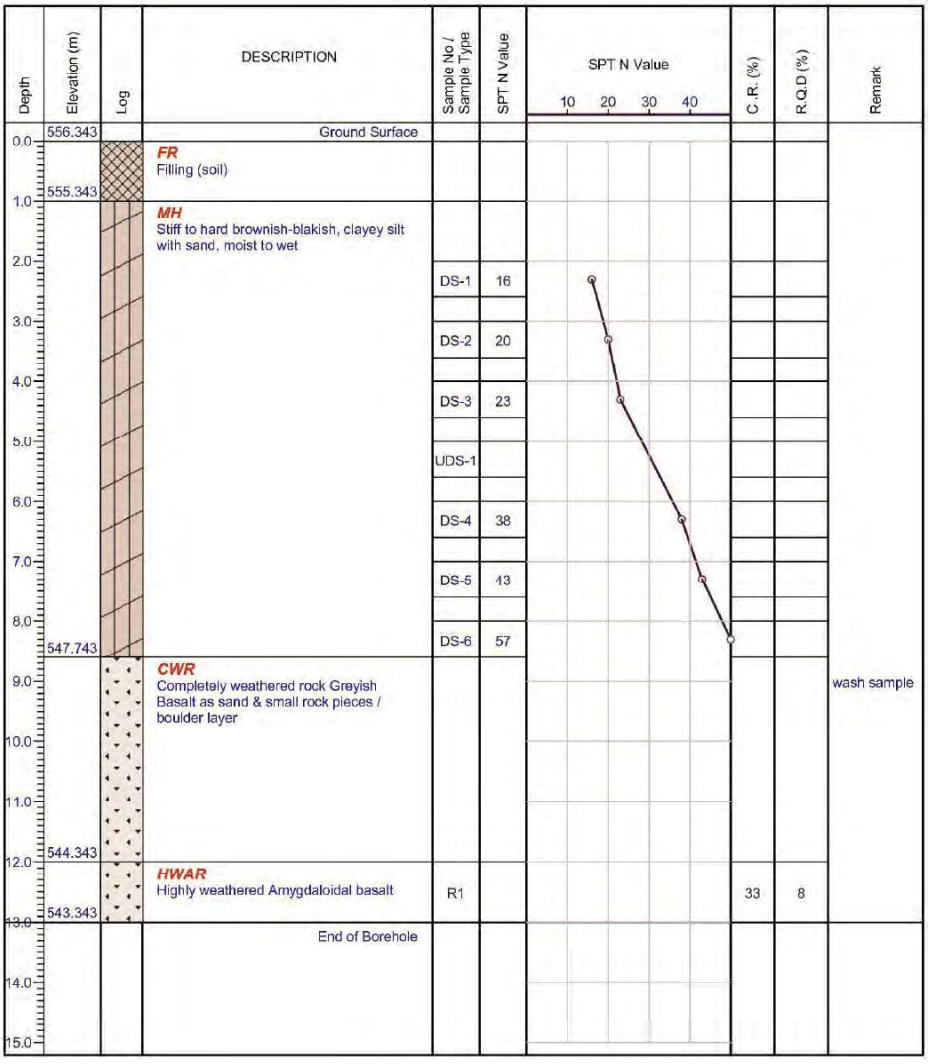
The geology of the area is divided into two; litho types, and basalt and alluvium. Almost entire area is underlain by basalt layer formed at ancient era. Other rock types found in the area are charnockites, granite gneiss, khondalites, liptinites, metamorphic gneisses with detached occurrences of crystalline limestone and iron ore. These layers are normally horizontally disposed over a wide stretch. Alluvium is granular material like sand and gravel which is highly porous and permeable formation, which occurs as thin layer in small areas along banks and flood plains of major rivers like Mula, Mutha and their tributaries.

PMC lies in the seismically active zone of Koyna Region, which is located about 100 km south of PMC. The city has recently been upgraded to lie in zone IV, which is the second most dangerous seismic zone in India as shown in seismic zoning map of India Meteorological Department.

(2) Geotechnical Survey Result

Standard penetration and soil sampling tests were conducted during Preparatory Survey by JICA at the planned STP construction sites. While the survey was planned to conduct at all 11 planned STP construction sites, the permission of the site survey permission was not obtained from state government and private land owner at 5 sites. Therefore, the survey was conducted at the remaining 6 sites. The detailed condition of land acquisition is shown in Chapter 11.

As the typical data of the survey, the boring test result at Baner site is shown in Figure 2.1.10. In general, stratum is mainly composed of two layers such as silty clay and weathered rock. At the proposed Baner STP site, the surface layer from G.L. 0 m to GL -8 m is composed of brownish silty clay where the N-value is less than 50 and the second layer under GL -8 m is composed of highly weathered basalt where the N-value is over 50. From the test results, it was found that the proposed STP site is generally located on the stiff ground where the rock layer with N-value over 50 spreads under G.L. -8 m and is suitable for the construction of the STP. Also, piling foundation is considered at all proposed STP site to assure the safety with bearing stratum. The results of all geotechnical survey are shown in Data Report 2.1.



Source: JICA Survey Team

Figure 2.1.10 Boring Test Result at Proposed Mundhwa STP Site

2.2 Legislative Conditions

This section takes an account of all the relevant policies, laws and legislation and the administrative

framework with regards to sewerage and lake management projects at national, state and local levels. Different bodies that are currently responsible for sewerage and management of the lakes are described along with their roles and jurisdictions.

2.2.1 National Water Policy

The Water (Prevention and Control of Pollution) Act and the Environment Protection Act promulgated in 1974 and 1986, respectively deal with the prevention and control of water pollution. The latter is considered as an umbrella act covering all aspects of the environment, under which the central government can take appropriate measures for;

- Protecting and improving the quality of the environment, and
- Preventing, controlling and abating environmental pollution.

The Pollution Control Board (PCB) was established under this act both at the Central Government called as Central Pollution Control Board (CPCB) and also at the State Government level for each state, known by the name of the State like MPCB(Maharashtra Pollution Control Board).

2.2.2 Legal Framework

The conservation of the Mula-Mutha River in PMCC will need a holistic approach. The Ministry of Environment, Forests and Climate Change has drafted various rules and regulations to control the pollution. The rules applicable in the context of the Project are summarized in Table 2.2.1.

Table 2.2.1 Summary of the Relevant Indian Rules

Environment Legislation	Salient Features
Forest (Conservation) Act, 1980 - as amended in 1988	The Central Government enacted The Forest (Conservation) Act in 1980 to stop large-scale diversion of forestland for non-forest use. As amended in 1988, the Act requires the approval of the Central Government before a State "de-reserves" a reserved forest, uses forestland for non-forest purposes, assigns forestland to a private person or corporation, or clears forests land for the purpose of reforestation. Such diversion is generally allowed on the advice of an Advisory Committee constituted under the Act. In case of such diversion of forest land, compensatory forestation has been made mandatory
Wildlife Protection Act	An act to provide for the protection of wild animals, birds and plants and for matters connected therewith. The provisions under this act are: Section 9 of the Act says that no person shall hunt any wild animal specified in Schedule I The act prohibits picking, uprooting, damaging, destroying, acquiring any specified

	plant from any forest land It bans the use of injurious substances, chemicals, explosives that may cause injury or endanger any wildlife in a sanctuary No alteration of the boundaries of a National Park shall be made except on a resolution passed by the Legislature of State Destruction or damaging of any wildlife property in national Park is prohibited.
Water (Prevention and Control of Pollution) Act, 1974 - as amended in 1978 &1988	The Act vests regulatory authority on the State Pollution Control Boards and empowers them to establish and enforce effluent standards for industries and local authorities discharging effluents. Following are the important provisions under this Act which are to be compiled with: Provide the State Pollution Control Board (SPCB) any information which is sought for preventing or controlling pollution of water regarding the construction, installations, operation or the treatment and disposal system of an industrial establishment Not to discharge, knowingly of any effluent into the stream, sewers or on land of quality which is not conforming to the standards prescribed by SPCB Furnish information to SPCB and other designated agencies of any accident or unforeseen event, in which effluents not conforming to the prescribed standards are being discharged or likely to be discharged in to a stream or sewer or on land Comply with the directions issued in writing by SPCB, within the specified time. Comply with the condition as prescribed in the "Consent to Establish" or "Consent to Operate" for discharge of effluent in to stream or sewers or on land. Responsibilities Obtain "Consent to Establish", prior to taking any steps to establish any industry or any treatment and disposal system which is likely to discharge effluents. Obtain "Consent to Operate", prior to commencing operation of any industry or any treatment and disposal system which is likely to discharge effluents. Apply for renewal of the "Consent to Operate: before the expiry of validity period along with the prescribed fee.
Water (Prevention and Control of Pollution) Cess Act, 1977 including Rules	An act to provide for the levy and collection of a cess on water consumed by persons carrying on certain industries and by local authorities to augment resources for PCB. As per the provision of Section 3, all specified industries under the Water (Prevention and Control of Pollution) Cess Act, 1977 are liable to pay cess in the prescribed rate made under the statute. It is provided under Section 5 that every specified industry or local authority is liable to furnish cess to respective authorities. Also all specified industries and local authorities for the purpose of measuring the quantity of water consumption shall install suitable meters. To encourage capital investment in pollution control, the Act gives a polluter a 70 per cent rebate of the applicable cess upon installing an effluent treatment plant
Air (Prevention and Control of Pollution) Act, 1981 - as amended in 1987	An act providing for prevention, control and abatement of air pollution. Section 21 of the Air Act specifies that no person shall without the consent of the State Board establish or operate any industrial plant in any air pollution control area. It is also provided in the statute that industrial units cannot discharge any pollutants into the air in excess of the standards of the standards prescribed by SPCB. The States are required to prescribe such "Emission Standards" for industry and automo-

	biles after consulting the Central Board and noting its Ambient Air Quality Standards. Furnish information to the SPCB and other designated agencies of any accident or unforeseen event, in which emissions of air pollutants occurred in excess of the prescribed standards or are likely to occur. Comply with the directions issued in writing by the SPCB , within the specified time. Comply with the condition as prescribed in the "Consent to Establish" or "Consent to Operate" for emissions Responsibilities Obtain "Consent to Establish", prior to establishing any industrial plant in an air pollution control area, which is likely to emit air pollutants. Obtain "Consent to Operate", prior to commencing operation of any industrial plant which is likely to emit air pollutants in an air pollution control area,. Apply for renewal of the "Consent to Operate: before the expiry of validity period along with the prescribed fee.
The Environment (Protection) Act, 1986, 2004 (amended)	The Environment (Protection) Act was conceived as an "umbrella legislation" seeking to supplement the existing laws on the control of pollution (the water Act and the Air Act) by enacting a general legislation for environment protection and to fill the gaps in regulation of major environmental hazards. Section 3 (1) of the Act empowers the Centre to " take all such measures as it deems necessary or expedient for the purpose of protecting and improving the quality of the environment and preventing, controlling and abating environmental pollution". It also authorizes the government to make rules on any aspect related to environment protection. No industries can discharge any solid, liquid or gaseous substances beyond the permissible limit as laid down by the Central Government on its behalf. Comply with the directions issued in writing by the Central Government within a specified time as mentioned in the order. Furnish information to the prescribed agencies of any accident or unforeseen event, in which environmental pollutants occurred in excess of the prescribed standards are being discharged, of are likely to be discharged in the environment. Responsibilities Obtain prior "Environmental Clearance" from MoEF in case of a new project or for modernization/expansion of the existing project and in respect of projects falling under EIA notification
The Hazardous Wastes (Management and Handling) Rules, 1989	These rules aim at providing control for the generation, collection, treatment, transport, import, storage and disposal of hazardous wastes. These Rules provide for effective inventorisation and controlled handling and disposal of hazardous waste. Occupiers responsibility to ensure proper handling and disposal of hazardous waste either by themselves or through the operator of hazardous waste management facility Restriction on handling of hazardous wastes without prior authorization Packaging, labelling and transportation of hazardous waste to be done in the specified manner Occupier generating hazardous wastes, or operator handling facility to submit annual

	returns in the prescribed format. Occupier or operator handling facilities to report to SPCB in prescribed forms, in case of accident at the hazardous waste handing site or during transportation.
The Municipal Solid Wastes (Management and Handling) Rules, 2000	Every municipal authority will be responsible for the implementation of the provisions under these rules. The municipal authority shall make an application in Form-I for grant of authorization for setting up waste processing and disposal facility from SPCB The municipal authority shall comply with the implementation schedule under Schedule I The municipal authority shall furnish its annual report in Form II on or before 30th June every year Any municipal solid waste shall be managed in accordance to the procedure laid down in Schedule II The waste processing and disposal facilities to be set up by Municipal authority shall meet the specifications and standards specified in Schedule II and IV
Bio-Medical Waste (Management and Handling) Rules, 1998	The occupier of an institution generating bio-medical waste shall take all steps to ensure that such waste is handled without any adverse effect to human health and environment Bio-medical waste shall be treated and disposed of in accordance with Schedule 1 and in compliance with the standards prescribed in Schedule V. The occupier should set up requisite bio-medical waste treatment facilities in accordance with the time frame in Schedule VI Bio-medical waste shall be segregated into containers/bags at the point of generation as per Schedule II prior to its storage, transportation, treatment and disposal. If a container is transported from the premises of the generation point to any waste treatment facility, it will also carry information as in Schedule IV apart from that prescribed in Schedule III Bio-medical waste shall be transported in vehicles as authorized for the purpose by the competent authority No untreated bio-medical waste shall be kept stored beyond 48 hours Occupier/operator shall submit an annual report to the prescribed authority (SPCB) in Form II by 31st Jan every year for the preceding year.
The Land Acquisition Act, 1894	The Act seeks to set out the circumstances and the purposes for which private land can be acquired by the Central/ State Government. The procedure under the Act is briefly listed below. Stage I Publication of a preliminary notification by the Government that land in a particular locality is needed or may be needed for a public purpose or for a company Entry of authorised officers on such land for the purpose of survey and ascertaining whether it is suitable for the purpose in view Filing of objections to the acquisition by persons interested and enquiry by Collector Stage II Declaration of intended acquisition by Government Publication of declaration as required by the Act

	Collector to take order from the Government for acquisition and land to be marked out, measured and planned Stage III Public notice and individual notices to persons interested to file their claims for compensation Enquiry into claims by Collector Award of Collector Reference to court Stage IV Taking of possession of the land by the Collector Payment of compensation

2.2.3 Classification of Inland Water Bodies

As of now only criteria available for classification of water bodies are as per the "Designated Best Use" (DBU) prescribed by Bureau of Indian Standards and Central Pollution Control Board (CPCB) prepared way back in 1981 (refer to Table 2.2.2). According to this concept, out of various purposes for which the water body is used, the one, which requires highest quality of water, is taken as the benchmark and classified as "Designated Best Use". According to these criteria water bodies are divided into five categories as follows:

Class A: Drinking water source without conventional treatment, but with chlorination
Class B: Outdoor bathing
Class C: Drinking water source with conventional treatment
Class D: Propagation of wildlife and fisheries
Class E: Irrigation, industrial cooling and controlled waste disposal

These criteria lay down reference values for pH, Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), coliform, etc.

Table 2.2.2 Classification of Surface Waters based on Designated Best Use prescribed by Central Pollution Control Board

Designated Best Use	Quality Class	Primary Water Quality Criteria	Values
Drinking water source without conventional treatment, but after disinfection	A	PH	6.5 to 8.5
		Dissolved oxygen, mg/L	6 or more
		BOD5 (20°C), mg/L	2 or less
		Total coliform (MPN/100 ml)	50 not > 5% 200 not > 20% 50

Designated Best Use	Quality Class	Primary Water Quality Criteria	Values
		Free ammonia, mg/L	NIL
		Electrical conductivity, μmho/cm	NIL
		Sodium adsorption ratio	NIL
		Boron	NIL
Outdoor bathing (organized)	B	PH	6.5 to 8.5
		Dissolved oxygen, mg/L	5 or more
		BOD5 (20ºC), mg/L	3 or less
		Total coliform (MPN/100 ml)	500 not > 5% 2,000 not > 20% 500
		Free ammonia, mg/L	NA
		Electrical conductivity, μmho/cm	NA
		Sodium adsorption ratio	NA
		Boron	NA
Drinking water source after conventional treatment and disinfection	C	PH	6.5 to 8.5
		Dissolved oxygen, mg/L	4 or more
		BOD5 (20ºC), mg/L	3 or less
		total coliform (MPN/100 ml)	5,000 not > 5% 20,000 not > 20% 5,000
		free ammonia, mg/L	NA
		electrical conductivity, μmho/cm	NA
		sodium adsorption ratio	NA
		Boron	NA
Propagation of wildlife and fisheries	D	PH	6.5 to 8.5
		Dissolved oxygen, mg/L	4 or more
		BOD5 (20ºC), mg/L	NA
		total coliform (MPN/100 ml)	NA
		free ammonia, mg/L	1.2
		electrical conductivity, μmho/cm	NA
		sodium adsorption ratio	NA
		Boron	NA
Irrigation, industrial cooling, and controlled waste disposal	E	PH	6.5 to 8.5
		Dissolved oxygen, mg/L	NA
		BOD (20ºC), mg/L	NA
		total coliform (MPN/100 ml)	NA
		free ammonia, mg/L	NA
		electrical conductivity, μmho/cm	2250
		sodium adsorption ratio	26
		Boron	2

Recently, CPCB has revised the primary quality for class B regarding coliform number as; fecal coliform: <500MPN/100ml (Desirable), <2,500MPN/100ml (Maximum permissible).

As of now these criteria are followed by various agencies responsible for management and control of water quality in the country including the two ongoing programs viz. National River Conservation Plan and National Lake Conservation Plan.

In year 2002, CPCB has proposed new criteria for classification of water bodies (refer to Table 2.2.3). The new approach is based on the premise of maintaining and restoring "wholesomeness" of water for the health of ecosystem and environment in general; and protecting the designated organized uses of water by human beings and involving community for water quality management.

The new classification system proposes three categories or tiers of indicators of water quality depending on the ease or complexity involved in their determination with regard to knowledge, skills, and equipment. Secondly, it classifies water bodies into three broad categories viz.:

Class A: Excellent (long term goal)
Class B: Desirable level of wholesomeness (medium term goal)
Class C: Minimum acceptable level (Short term goal)

Table 2.2.3 Key Indicators of Inland Surface Water Quality under Revised Criteria proposed by CPC

Indicator	Unit	A-Excellent	B-Desirable	C-Acceptable
DO	(% saturation)	90-110	80-120	60-140
BOD	(mg/L)	<2	<5	<8
Faecal Coliform	MPN/100ml	<20	<200	<2000

2.2.4 Treated Wastewater Discharge Standards

Effluent discharge standards are specified with reference to the type of industry, process or operations and in relation to the receiving environment or water body such as inland surface water, sewers, land or sea (refer to Table 2.2.4).

Table 2.2.4 Effluent Standards for Different Receiving Water Bodies

Indicator	Inland surface water	Public sewers	Land for irrigation	Marine outfall
Suspended solids (mg/L)	100	600	200	100
Oil and grease (mg/L)	10	20	10	20

BOD (mg/L)	30	350	100	100

Note: All values are in mg/L and are the maximum permissible levels.
Source: Pollution control acts, rules and notifications issued hereunder, CPCB, September 2001.

The general BOD limit specified for discharge of wastewater from typical industrial sources or domestic sewage is same at 100mg/L. However, the rules specify that the discharge limits can be made stringent if the concerned State Pollution Control authority finds it appropriate depending on the condition of the receiving environment and severity of the discharges from various sources.

2.2.5 Ambient Air Quality Standards

CPCB has notified the National Ambient Air Quality Standards (NAAQS) in Schedule VII of these Rules, which are reproduced in Table 2.2.5.

Table 2.2.5 National Ambient Air Quality Standards

Pollutant	Time weighted	Concentration in ambient air ($\mu g/m^3$)			Method of Measurement
	Average	Industrial	Residential	Sensitive	
SO_2	Annual*	80	60	15	1. Improved West & Gaeke method
	24 hrs**	120	80	30	2. Ultra violet fluorescence
NO_x	Annual	80	60	15	1. Jacob & Hochheiser modified (Na-Arsenite) method
	24 hrs	120	80	30	2. Gas phase chemi-luminescence
SPM	Annual	360	140	70	Average flow rate not less than
	24 hrs	500	200	100	1.1 m^3/minute
RPM	Annual	120	60	50	
	24 hrs	150	100	75	
Pb	Annual	1.00	0.75	0.50	AAS method after sampling using
	24 hrs	1.50	1.00	0.75	EPM 2000 or equivalent paper
CO$	8 hrs	5	2	1	Non dispersive infrared spectroscopy
	1 hour	10	4	2	

Note: * Annual arithmetic mean of minimum 104 measurements in a year taken twice a week 24 hourly at uniform intervals.
** 24 hourly /8 hourly values to be met 98% of the time in a year. However, 2% of the time, it may exceed but not on two consecutive days.
$ Values in mg/m^3

2.2.6 Ambient Noise Standards

The standards for ambient air quality in respect of noise are given in Schedule III under the rules and are reproduced in Table 2.2.6.

Table 2.2.6 Ambient Air Quality in respect of Noise

Area code	Category of area	Limits in dB (A)	
		Day time	Night time
A	Industrial	75	70
B	Commercial	65	55
C	Residential	55	45
D	Silence zone	50	40

Note 1: Daytime is reckoned in between 6 am to 10 p.m.
Note 2: Night time is reckoned in between 10 p.m. to 6 a.m.
Note 3: Silence zone is defined as areas up to 100 meters around such premises as hospitals, educational institutions and courts. The silence zones are to be declared by the Competent Authority. Use of vehicular horns, loudspeakers and bursting of crackers shall be banned in these zones.
Note 4: Mixed categories of areas should be declared as one of the four above-mentioned categories by the Competent Authority and the corresponding standards shall apply.

2.2.7 Relevant Organizations to the Sectors

Relevant organizations to the project at Central Government level, State Level and Local are identified under this section. These organizations are connected with the project directly or indirectly depending on their mandate.

2.2.7.1 Ministry of Environment, Forests and Climate Change (MoEF&CC), Government of India

MoEF&CC is the nodal agency, in the administrative structure of central government, for planning, promotion, co-ordination and overseeing the various environmental protection and forest conservation programs. The Ministry is responsible for effective implementation of environmental legislation through its various divisions at Central Government level and also through CPCB, State Departments of Environment and Forests, SPCBs and Pollution Control Committees in the Union Territories, which serve as implementing agencies of the Ministry. Besides several legislative measures taken by the ministry to protect the wholesomeness of the environment, a National Conservation Strategy and a policy statement on Environment and Development, 1992, National Forest Policy, 1988 and statement on abatement of pollution, 1992 have also been evolved to tackle the environmental protection issues effectively.

The principal activities undertaken by MoEF consist of conservation & survey of flora, fauna, forests and wildlife, prevention and control of pollution, afforestation & regeneration of degraded areas and protection of environment, in the framework of legislations.

The main tools employed for achieving the above objectives include surveys, impact assessment, control of pollution, regeneration programs, support to organizations, research and development, collec-

tion and dissemination of environmental information and creation of environmental awareness among target groups and stake holders at all levels of the country's population. Realizing the need for authoritative statistical data on environment, the work relating to collection, collation and analysis of environmental data and its depiction has been constantly taken-up through various projects.
The main functions of the Ministry are:

- Environmental policy planning
- Effective implementation of legislation
- Monitoring and control of pollution
- Eco-development
- Environmental clearances for industrial and development projects
- Environmental research
- Promotion of environmental education, training and awareness
- Coordination with concerned agencies at the national and international levels
- Forest conservation development and wildlife protection
- Biosphere reserve programs

2.2.7.2 National River/ Lake Conservation Directorate (NRCD)

NRCD is an auxiliary body of MoEF. It was established in 1985 under the chairmanship of the Prime Minister as "The Central Ganga Authority", and laid down the policies for works to be taken up under the Ganga Action Plan. With the approval of the National River Conservation Plan (NRCP) in July 1995, the Central Ganga Authority was designated as the National River Conservation Directorate (NRCD). It has been entrusted with the charge of implementing the river action plans. NRCD coordinates the implementation of the schemes under the river action plans. The main objective is to improve the water quality of major rivers that are major fresh water sources in the country, through implementation of pollution abatement schemes.

Activities under NRCP include the following:

- Interception and diversion works to capture the raw sewage flowing into the river through open drains and divert them for treatment.
- Sewage treatment plants for treating the diverted sewage.
- Low cost sanitation works to prevent open defecation on riverbanks.
- Electric crematoria and improved wood crematoria to conserve the use of wood and help in ensuring proper cremation of bodies brought to the burning ghats (steps).

- River front development works such as improvement of bathing ghats (steps), etc.
- Public awareness and public participation
- Human resources development, capacity building, training and research in the areas of river conservation
- Other minor miscellaneous works.

2.2.7.3 Central Pollution Control Board (CPCB)

The Central Pollution Control Board (CPCB), a statutory organization, was constituted in September, 1974 under the Water (Prevention and Control of Pollution) Act, 1974. Further, CPCB was entrusted with the powers and functions under the Air (Prevention and Control of Pollution) Act, 1981.

It provides technical services to MoEF under the provisions of the Environment (Protection) Act, 1986. The principal functions of CPCB are as given below:

- Advise the central government on any matter concerning prevention and control of water and air pollution and improvement of the quality of air and water.
- Plan and cause to be executed a nation-wide program for the prevention, control or abatement of water and air pollution;
- Co-ordinate the activities of the State Pollution Control Boards (SPCB) and resolve disputes among them;
- Provide technical assistance and guidance to the SPCB, carry out and sponsor investigation and research relating to problems of water and air pollution, and for their prevention, control or abatement;
- Plan and organize training of persons engaged in program on the prevention, control or abatement of water and air pollution;
- Organize through mass media, a comprehensive mass awareness program on the prevention, control or abatement of water and air pollution;
- Collect, compile and publish technical and statistical data relating to water and air pollution and the measures devised for their effective prevention, control or abatement;
- Prepare manuals, codes and guidelines relating to treatment and disposal of sewage and trade effluents as well as for stack gas cleaning devices, stacks and ducts;
- Disseminate information in respect of matters relating to water and air pollution and their prevention and control;
- Lay down, modify or annul, in consultation with the state governments concerned, the standards for stream or well, and lay down standards for the quality of air; and

- Perform such other function as may be prescribed by the government of India.

2.2.7.4 Maharashtra Pollution Control Board (MPCB)

Maharashtra Pollution Control Board (MPCB) is implementing various environmental legislations in the state of Maharashtra, mainly including Water (Prevention and Control of Pollution) Act, 1974, Air (Prevention and Control of Pollution) Act, 1981, Water (Cess) Act, 1977 and some of the provisions under Environmental (Protection) Act, 1986 and the rules framed there under like, Biomedical Waste (M&H) Rules, 1998, Hazardous Waste (M&H) Rules, 2000, Municipal Solid Waste Rules, 2000 etc. MPCB is functioning under the administrative control of Environment Department of Government of Maharashtra.

Some of the important functions of MPCB are:

- To plan comprehensive program for the prevention, control or abatement of pollution and secure executions thereof,
- To collect and disseminate information relating to pollution and the prevention, control or abatement thereof,
- To inspect sewage or trade effluent treatment and disposal facilities, and air pollution control systems and to review plans, specification or any other data relating to the treatment plants, disposal systems and air pollution control systems in connection with the consent granted,
- Supporting and encouraging the developments in the fields of pollution control, waste recycle reuse, eco-friendly practices etc.
- To educate and guide the entrepreneurs in improving environment by suggesting appropriate pollution control technologies and techniques
- Creation of public awareness about the clean and healthy environment and attending the public complaints regarding pollution.

2.2.7.5 PMC Municipal Corporation

The PMC Municipal Corporation (PMC) was established on 15 February 1950.[1] The PMC controls the whole administration of PMC. The executive power of the corporation is vested in the Municipal Commissioner, an Indian Administrative Service (IAS) officer appointed by the Maharashtra state government. The corporation consists of directly elected cooperators headed by a Mayor. The mayor has few executive powers.

The PMC is in charge of the civic needs and infrastructure of the metropolis including water supply,

sewerage, roads, gardens etc.

PMC is divided into 76 Prabhags, each represented by 2 members. The cooperators of the administration are elected by the people through a popular vote and almost all the state political parties participate in the election.

PMC is well known as PMC Mahanagar Palika (Municipality) and is serving citizens since 1950. To Serve Citizens better PMC has taken initiative for e-Governance. Presently a few big corporations like Persistent Systems are lending help for developing the E-governance system, as a part of their social service initiative. A public-private partnership is perceived to bring tremendous changes in the future.

2.2.8 Sewage discharge standards in India

2.2.8.1 National Standards

The first environment protection act was introduced in 1986. This act comprises of discharge standards for waste water/ sewage. These standards are given as shown in Table 2.2.7.

General standards for discharge of Environmental Pollutants, Part A: Effluents as per Schedule VI of the Environmental (Protection) Rules 1986 and National River Conservation Directorate Guidelines for Fecal Coliform, (Values in mg/L unless stated)

Table 2.2.7 Parameters and Standards of National Standards

Sr. No	parameters	Standards			
		Inland surface water	Public Sewers (A)	Land for irrigation	Marine coastal areas
1	2	3			
		(a)	(b)	(c)	(d)
1	Colour and Odour	(B)	--	(B)	(B)
2	Suspended solids	100	600	200	(C), (D)
3	Particulate size of suspended solids	(E)	--	--	(F), (G)
4	pH	5.5 to 9.0			
5	Temperature	(H)	--	--	(H)
6	Oil and grease	10	20	10	20
7	Total residual Chlorine	1	--	--	1
8	Ammonical nitrogen (as N), mg/L Max.	50	50	--	50
9	Total Kjeldahl Nitrogen (TKN) (as N)	100	--	--	100

Sr. No	parameters	Standards			
		Inland surface water	Public Sewers (A)	Land for irri-gation	Marine coastal areas
1	2	3			
		(a)	(b)	(c)	(d)
10	Free Ammonia (as NH_3)	5	--	--	5
11	Biochemical Oxygen demand [3][3 days at 27 degrees C]	30	350	100	100
12	Chemical Oxygen Demand	250	--	--	250
13	Arsenic (as As)	0.2			
14	Mercury (as Hg)	0.01	0.01	--	0.01
15	Lead (as Pb)	0.1	1	--	2
16	Cadmium (as Cd)	2	1	--	2
17	Hexavalent Chromium (as Cr +6)	0.1	2	--	1
18	Total Chromium (as Cr.)	2	2	--	2
19	Copper (as Cu)	3	3	--	3
20	Zinc (as Zn)	5	15	--	15
21	Selenium (as Se.)	0.05	0.05	--	0.05
22	Nickel (as Ni)	3	3	--	5
23	Cyanide (as CN)	0.2	2	0.2	0.2
24	Fluoride (as F)	2	15	--	15
25	Dissolved Phosphates (as P)	5	--	--	--
26	Sulphide (as S)	2	--	--	5
27	Phenoile compounds (as C_5H_5OH)	1	5	--	5
28	Radioactive materials:				
	(a) Alpha emitter micro curie/ml	10^{-7}	10^{-7}	10^{-8}	10^{-7}
	(b) Beta emitter micro curie/ml	10^{-6}	10^{-6}	10^{-7}	10^{-6}
29	Bio-assay test	(I)			
30	Manganese (as Mn)	2mg/L	2mg/L	--	2mg/L
31	Iron (as Fe)	3mg/L	3mg/L	--	3mg/L
32	Vanadium (as V)	0.2mg/L	0.2mg/L	--	0.2mg/L
33	Nitrate Nitrogen	10mg/L	--	--	20mg/L
34	Faecal Coliform, MPN/100ml for discharge	onto land		into water	
		(J)	(K)	(J)	(K)
		1,000	10,000	1,000	10,000

Notes:

A. These standards shall be applicable only if such sewer leads to a secondary treatment including biological treatment system; otherwise the discharge into sewers shall be treated as discharge into inland surface waters.

B. All efforts should be made to remove colour and unpleasant odour as far as practicable.

C. For process wastewater 100mg/L

D. For cooling water effluent 10% above total suspended matter of influent.

E. Shall pass 850micron IS Sieve

F. Floatable solids max. 3mm
G. Settleable solids max. 850microns
H. Shall not exceed 50C above the receiving water temperature.
I. 90% survival of fish after 96hours in 100% effluent
J. Desirable
K. Maximum permissible

This act is not amended till now for any of standards. However, CPHEEO manual (2013) suggested some modifications for treated sewage, discharging to water bodies to be used as drinking water resource as presented in Table 2.2.8.

Table 2.2.8 Parameters and Maximum Permissible Limits Standards

Sr. No	parameters	Maximum permissible limits Standards	
		As per Act 1986	Recommendation by CPHEEO
1	Biochemical Oxygen demand [3][3 days at 27 degrees C], mg/L	30	Less than 10
2	Suspended solids, mg/L	100	Less than 10
3	Total Kjeldahl Nitrogen (TKN) (as N), mg/L	100	Less than 10
4	Dissolved Phosphates (as P), mg/L	5	Less than 2
	Fecal Coliform, MPN/100ml for discharge	Not specified	Less than 230

2.2.8.2 NRCD Standards

The objective of the national standards given above is to ensure that these standards cannot be relaxed by the implementing agencies. However they can be made more stringent depending upon other factors including the assimilating capacity of the receiving water bodies.

NRCD prescribes to more stringent standards as stated in Table 2.2.9.

Table 2.2.9 Effluent standards prescribed by NRCD, Ministry of Environment, Government of India

Parameters	Units	Effluent standard for discharge in water bodies		Effluent standards for discharge on land
		Existing Standard	Standards revised on 3.2.10	
pH		5.5-9.0		
BOD	mg/L	30	20*	100
TSS	mg/L	50	30*	200
Fecal coliforms	mg/L	Desirable – 1000 Acceptable – 10,000		Desirable – 1000 Acceptable – 10,000

*or lower depending upon the assimilative capacity of the effluent receiving water body.

2.3 Socio-Economic Profile

Looking into the history, Pune was originally a small temple village situated on a raised plateau slightly away from the Mutha River. This oldest part of Pune or the original nucleus of the city corresponds to the original houses of all the oldest families in Pune which lie in the neighborhood of the two Ganapati and Kedareshwar temples. Figure 2.3.1 shows how the city geographically grew since then.

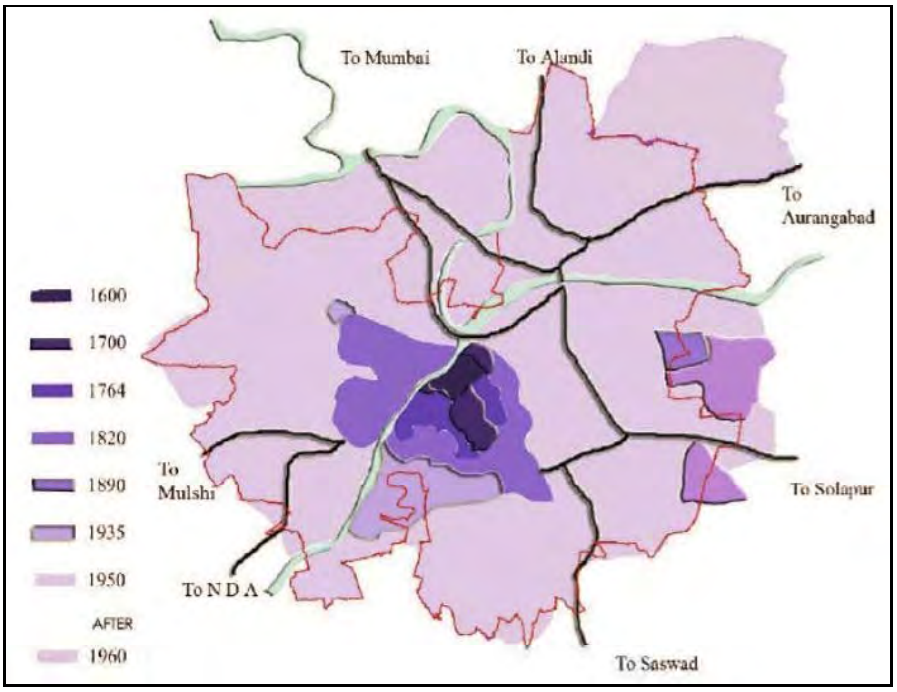


Figure 2.3.1 Growth of Pune since 16th Century

2.3.1 Population, Income, and Housing

2.3.1.1 Population

The City Development Plan, Volume II, states that with population of over 3,000,000, Pune is consistently growing fast by 3.5% per year while the national average is 2.1%. Migration counts for half of the population growth. Since the migrants are mostly at young age the City population is very young with 70% under 35 years. Giving the city area the population density is relatively low though the central part of the city has a high density. Table 2.3.1 shows the city population in 2011 and the estimated growth by 2047 (Chapter 7 provides more details on the City population).

Table 2.3.1 Population in 2011 and the Projections

City	2011	2017	2022	2032	2042	2047
PMC	3,115,431	3,660,631	4,205,832	5,467,581	6,834,477	7,381,235
Decadal growth rate (%)	29.4	35	35	30	25	20

The density of population according to the Census 2001 was 10,412 per sq.km which is higher in the central part of the City (Figure 2.3.2). The city appears to be growing in the southeast and southwest directions. By 2027 it is estimated that its population to be just over 5,000,000 with a high density of 25,000 per square kilometer.

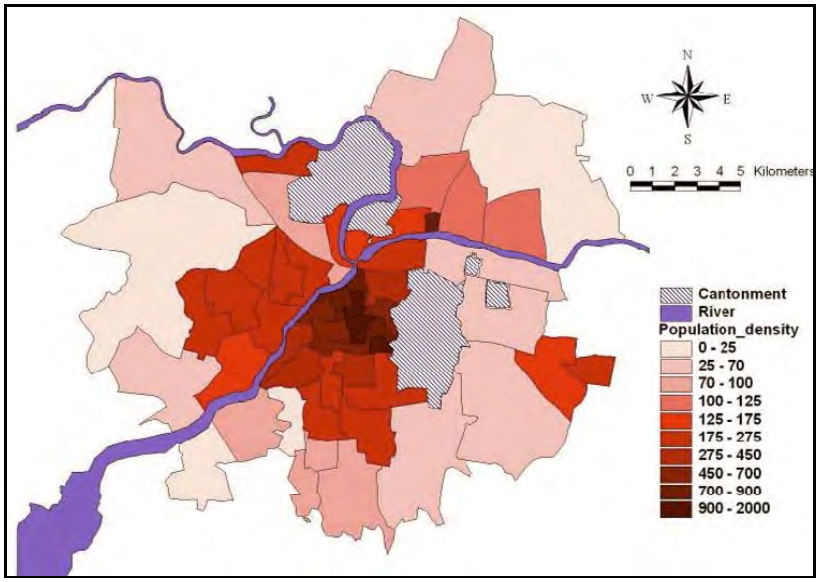


Figure 2.3.2 Population Density of Pune in 2001

The median age in Pune is close to the national level (24 years). However, 62 percent of the total population is under the age of 30 years. In Pune, the 25-34 age group forms a larger proportion of the total population compared to that prevailing at the national level. It is estimated that about 50 percent of the population increase is on account of in-migration. This probably explains Pune's relatively larger share of population in the 25-34 age groups.

In the year 1951, about 82 percent families had an average family size of 5 members. Around 13 percent families had an average family size of 7-9 members and only 5 percent families had 10 members and above. This number has gone down to 4.5 members according to the 2001 Census.

2.3.1.2 Occupation and Income

As full time jobs provide better salary and wider experience, majority of people are engaged in full time jobs (87.1%) with 55.2% engaged in permanent source of employment. The per capita income of Pune has increased from Rs 36,500 in year 2004-05 to Rs 60,000 in year 2008-09 (DPR, p. 50).

The PMC's socio-economic survey in 2008-2009 shows total working population is 36.96% engaging in primary (like farming, mining, fisher, forestry), secondary (processing raw materials from primary sector), and tertiary (like banking, insurance, medical, education, hospitality, and commerce) works (refer to Table 2.3.2).

Table 2.3.2 Occupation Status

Classification of Workers	Frequency	Percentage
Primary (P)	223	2.50
Secondary (S)	4,032	45.30
Tertiary (T)	4,646	52.20
Total working population (P+S+T)	8,901	36.96
Non-working population	15,181	63.04

2.3.1.3 Housing

As seen in Table 2.3.3, according to the Draft Development Plan for Pune City, 2007-2027 report, there were 763,133 buildings in Pune City, about 82% (625,336) which were occupied and the rest vacant. Out of the occupied buildings 82% (509,819) were under residential use and total 65,951 are shops and offices with about 11% share from total.

Table 2.3.3 Type of Building Usage in Pune in 2001

Distribution of Buildings		Distribution of Buildings	
1. Census houses	763,133	6. Schools	1,615
2. Occupied houses	625,336	7.Hotels/lodges/guest houses	3,318
3. Residential houses	509,819	8. Hospitals	3,603
4. Residential commercials	8,810	9. Factories, workshops	10,265
5. Shops/Offices	65,951	10. Place of worship	2,935
11. Other non-residential			19,650

The Pune Housing Report in 2009 states that37% of the City houses are slums and the same percentage of 37% are apartment units followed by Bungalows and Wada. Wadas were Pune's traditional housing that accommodated huge joint families that resided together, typically a large building of two or more stories with groups of rooms arranged around open courtyards. Some of the wads are still in

use and mostly are occupied by the owner or long term tenants. Nowadays percentage of Bungalows and Wada is decreasing as these units are getting redeveloped into apartment units. Figure 2.3.3 shows housing system in PMC.

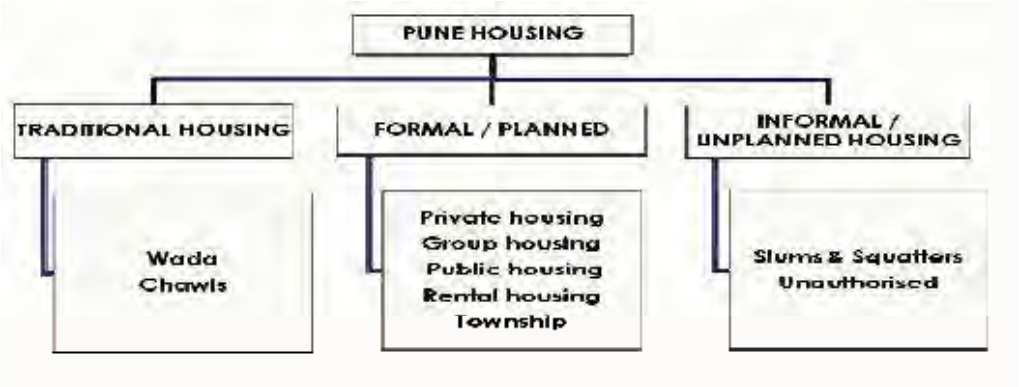


Figure 2.3.3 Housing System in Pune

The report also states that though on one hand an acute residential housing stock shortage observed throughout the city, on the other hand there is high vacancy rate of 18% which is much higher than state average of 12%. This could be attributed to the property tax assessment system for rental properties which discourage the owners from letting their properties for rental purpose. It could be because the rent and/or any improvements to the property for a higher rent can add to the annual value of the property and thus increase the property tax. The high vacancy rate could be also attributed to the Rent Control Act in 1999. The Act governs the law related to rent within the scope of the State of Maharashtra and basically includes restrictive landlord and tenant rights like standard rent, fair rental property return condition, mandatory registration of tenancy agreement, tenancy right, and punishments. But due to property tax revisions in recent years more of the housing stock can be expected to release in the rental market which in turn may narrow the present housing stock. In addition, Pune also needs affordable housing stock, increased flow of funds, and employment generation to help create a healthy housing market.

Figure 2.3.4 Private houses (1), apartments (2), township center (3), slums along the roads (4), and (5,6) Wada houses in PMC

2.3.2 Education

According to the PMC's socio-economic survey in 2008-2009, 83.63% of the population of Pune city is literate (can read and write) while 16.36% are illiterate which shows improve in literacy level since 2001.

2.3.3 Culture and Religion

Hinduism with 92.20% is the most commonly practiced religion in Pune although many other religious buildings are found in the City including mosques, churches, and temples. Unlike past, in present time the people belonging to different religions and castes are scattered all over the city.

Pune city is known as cultural capital of Maharashtra state. The city has large number of cultural organizations to include literature Art and History. The city hosts number festivals and events of regional and national importance. The Ganesh Festival known as "Sarvajanik Ganeshotsav" started in Pune in early 20th century and is 100 years old. The city is famous for hosting annual festival of classical music, known as "Sawai Gandharva Music Festival", which is 57 years old.

There are many religious places which have been declared as heritage buildings. These include Kasba Ganpati, Belbaug Mandir, Sarasbaug Ganesh Temple. One of the most important religious event in the Maharashtra State is "Pandharichi Wari" a process of devotees from Alandi (20 kms form Pune) up to Pandharpur a distance of 180 kms. Thousands of devotees walk this distance. The Wari passes through Pune City.

Pune is known for vibrant movement of experimental and professional drama. The city has four major drama theaters. The National Film and Television institute was established in Pune. This is the only institute of its kind, and has recently completed 50 years. The small towns of Alandi and Dehu are very near to Pune, which are pilgrimage respectively.

2.3.4 Slums

At the time of independence, slum population of Pune was only 8% which has increased to 40% (both declared and undeclared) to that of city's population in 2001. This growth in the composition of slum population could be attributed to non-availability of housing stock at affordable costs, leading to the emergence of a large number of slums.

There are a total of 564 slums in which 353 declared and 211 undeclared (Table 2.3.4). If a slum has been declared (& therefore receives basic services), its existence is considered to be officially recognized by the local government. Undeclared slums, regardless of their conditions, are not considered eligible for basic service provision.

According to the Shelter Associates -an NGO working in Maharashtra, India- the term "slum" is commonly used in India to denote informal settlements. The definition of "slum" is further complicat-

ed by the process of “declaration”, which applies to settlements on privately owned land. When a settlement is recognized by the local municipality as being one where living conditions are below a specified standard, it is “declared”. Once declared, a slum is eligible for basic improvements including water supplies, common toilets, paving, electricity and drainage. In practice, many slums with poor living conditions have not been declared. Slums located on land owned by the public sector can be provided with basic amenities without being declared, although in practice this seldom happens: many lack basic infrastructure and are similar to the undeclared slums. Whilst a declared slum is eligible for basic improvements, this only applies to the area of the slum which lies within the declared boundary. Table 2.3.4 also shows ward-wise distribution of the slums in Pune in 2011.

Table 2.3.4 Declared and Undeclared Slum Population in PMC

Administrative Ward No.	No. of Slums	Population (2011)	No of households
1. Yerawada	9	31,699	6340
2. Tilak road	49	72,855	14571
3. Sangamwadi	21	93,621	18724
4. Karve road	43	53,100	10620
5. Sahakarnagar	24	41,505	8301
6. Aundh	28	39,665	7933
7. Bibwewadi	20	51,600	10320
8. Ghole road	29	39,150	7830
9. Hadapsar	35	61,000	12200
10. Bhavani Peth	29	45,845	9169
11. Dhole Patil road	25	50,000	10000
12. Vishrambagwada	3	9,450	1890
13. Kasba Peth	35	90,530	18100
14. Warje Karvenagar	3	40,200	8040
Total pop. in declared slums	353	7,20,220	144044
Total pop. in undeclared slums	211	3,04,780	60956
Total population in slums	564	10,25,000	205000

The population density in the slum areas is very high. While the declared slums give home to 27% of the City’s total residents, it only occupies 4% of the City area. In fact the density in slum is 6.3 times of the city area. Most of the slums are located in low lying areas along the river and hilltops, also on private lands with large service gaps and lack of basic amenities and sanitation. Figure 2.3.5 shows some characteristics of the slum areas like household size, income, number of families, land ownership, and housing status.

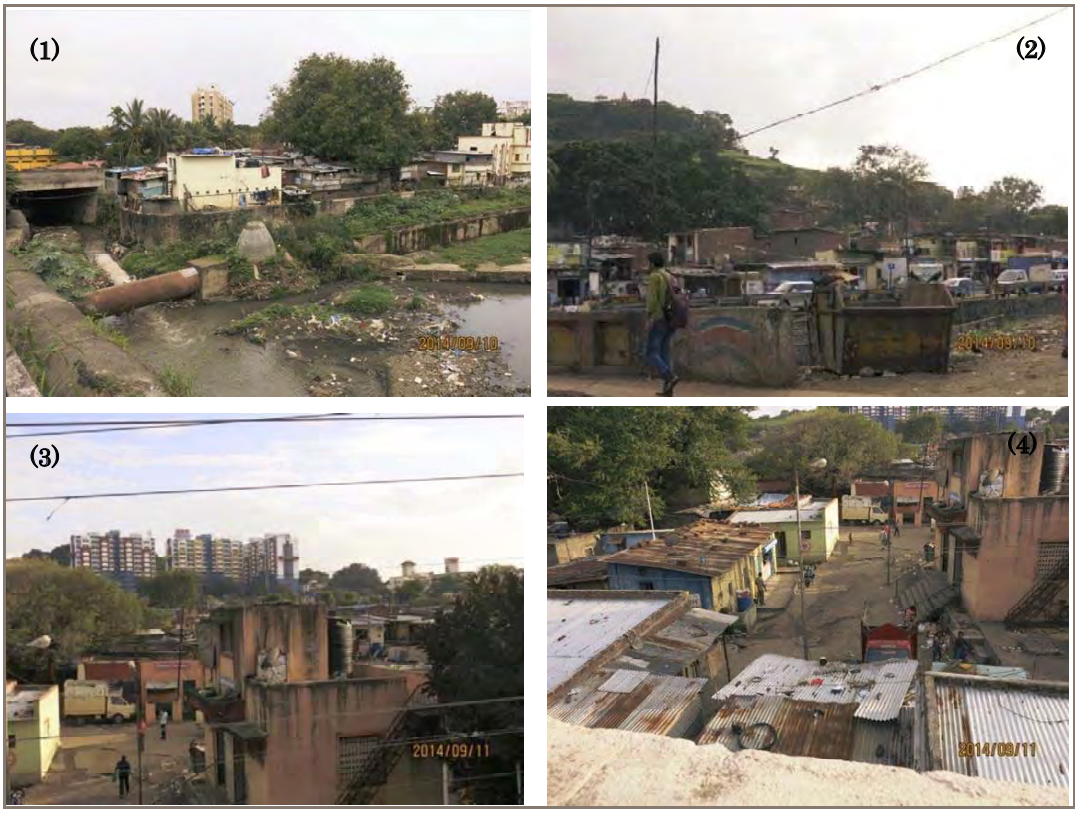


Figure 2.3.5 Slums in low lands (1) hilltops (2), throughout the City (3), and inside a slum with more stable housing materials.

As seen in Figure 2.3.6, household size is much bigger in slum of Pune as compared to the Census 2001 information. Maximum household size observed is between 6-8 members in about 56% households of the slum followed by 3-5 members which is 26%. Average household size observed in slums is 5.4 which is larger than the 2001 Census household size of 4.57. As seen in the same figure, maximum percentage of household monthly income of slums ranges from INR 1,500 to 5,000 and is around INR 4,275 with average annual income below INR 100,000 (below poverty level). Maximum numbers of families stay in single room in most of the slums with very unhealthy living conditions. Majority settlements are having only ground floor structures with very high density development. Most of the slum households either have direct access to services or access them through community or common facilities. 58% households are having individual water supply and rest 42% are having access to common water supply facilities. Mostly settlements are having common toilet blocks. Out of declared 564 slums, 66 slum are on state owned land contributing 11.70% of slum land ownership to total slum followed by also various departments ownerships like PMC, railways land etc.

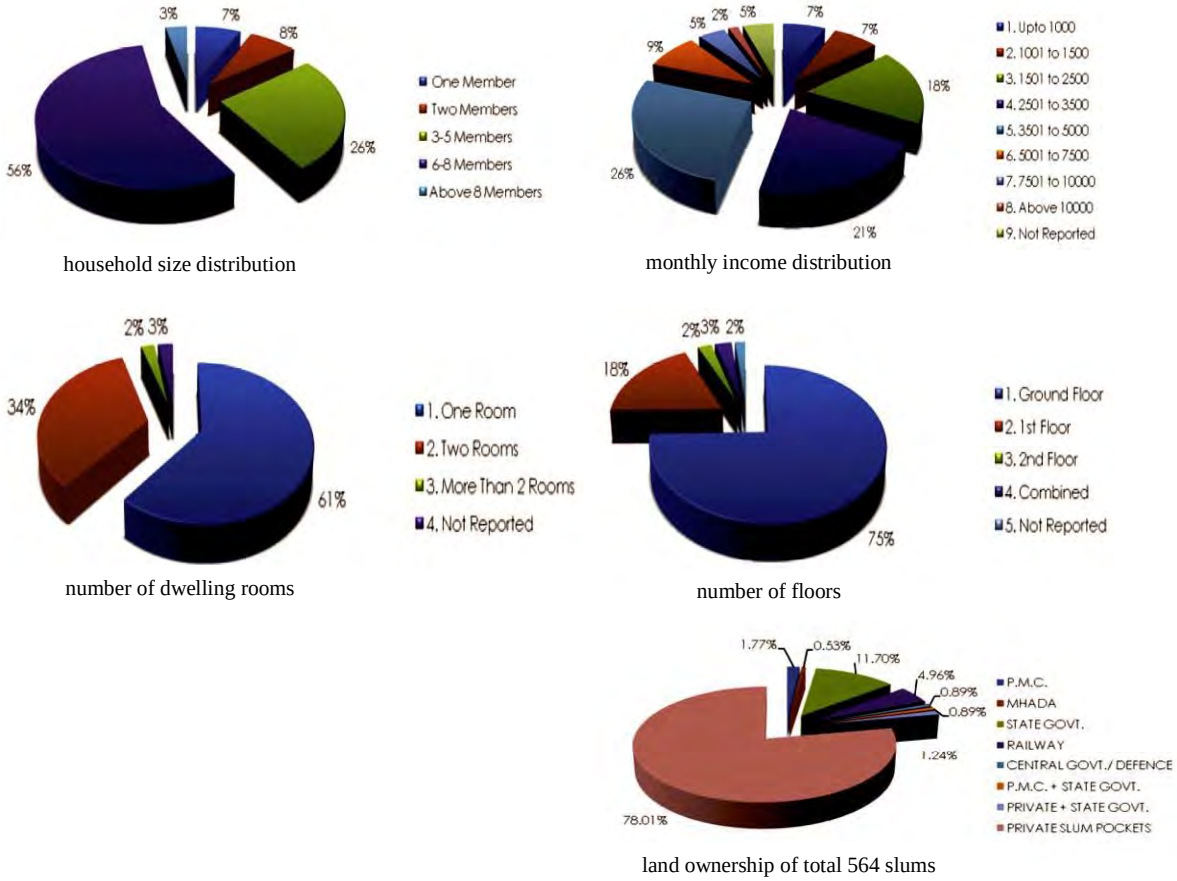


Figure 2.3.6 Slum Characteristics of Pune

2.3.5 Economy

Pune is highly commercialized city being prime center of trade and commerce. The city serves as regional wholesale market for food grains, such as wheat, rice, pulses, oilseeds etc. The city also functions as main distribution center for agricultural produce, fertilizers, drugs & medicine, iron and steel cement and minerals.

The city has a healthy balance of manufacturing and services. Economy of Pune thrives on the industrial belt in the city. In addition to automobile, engineering, energy and environment, and software industries there are other small and medium enterprises, food and processing units (refer to Table 2.3.5).

Pune is one of the largest centers of engineering industries and houses large number of automobile industries such as Tata Motors, Mercedes Benz, Bajaj Auto etc. The PMC area includes nine organized industrial estates, which house 234 industries. The list of the industrial estates and number of units in each estate is given in DPR, p. 47.

Pune is highly commercialized city being prime center of trade and commerce. The city serves as regional wholesale market for food grains, such as wheat, rice, pulses, oilseeds etc. The City also functions as main distribution center for agricultural produce, fertilizers, drugs & medicine, iron and steel cement and minerals. Table 2.3.5 shows commercial establishments in Pune by number of establishment and employee as presented in DPR, p. 46.

Table 2.3.5 Commercial Establishments in Pune

Description	No. of Establishment	No. of Employees
Shops	11,718	28,866
Commercial	22,925	193,557
Hotels	3,967	9,237
Theatres	30	313
Total	38,640	231,973

The educational sector also has helped the City's economic growth. Pune city is also one of the most important educational centers in the country. The city has highest number of foreign students in the country. There are many educational industries which are more than 100 years old. The city is the seat of 6 universities, which includes prestigious "University of Pune". There are more than 600 institutes of higher educational and research. These include Deccan College, College of Engineering Pune (150 years old), college of Agriculture, Armed Forces Medical College (AFMC), and College of Military Engineering. Due to rich history of education and research the city is known as "Oxford of the East".

The City is a major attraction and cultural capital of Maharashtra. Being a city with rich history, heritage and tourist spots, tourism is a major contributing to its economy growth as well. This has translated to increased tax collection, service tax and income tax for the city. However, with the growing population the city needs enough infrastructures to support the inflowing residents such as water supply, sewerage cover, roads, etc.

2.3.6 Social Services

2.3.6.1 Water Supply

According to the City Development Plan 2006-2012, Volume II, the water supply distribution is 100% in entire of the PMC area, however not all households are connected to the network. The water storage capacity is 27%, and the water supply in newly added areas is limited. Out of the City's 14 wards, none have a 24 hours access to water with just 8 hours being the average. Adequate water pressure is

also available to only about 40% of the households while others experience low pressure during the day. The customers are not fairly charged for their water consumption. Currently they are charged with water tax as a component of Property Tax but not based on a volumetric system. Chapter 3 and Chapter 13 provide more information on the current water charge method.

2.3.6.2 Sewerage

Pune's sewerage system is also lacking adequate function. According to the DPR, the present sewerage networks cover 95% of the population, yet the sewage treatment capacity is lower than it should be. The estimated sewage flows work out is to be 496MLD. The present treatment capacity is 477MLD which means that the treatment capacity is not adequate even for present flows and additional capacity is required for the growing population. Also, the sewage collection facilities are not equally available throughout the City. The slums receive the least collection facilities though newly added areas also are in need of the facility expansion. Shortage of community toilets is also another public hygiene issue. Open defecation especially in slum areas is a reality because of the absence of household toilets or proper working public toilets.

2.3.6.3 Solid Waste

The estimated waste generated per day is 1,000 tons with 40% generated by household. About 150 tons of waste is recycled by rag pickers and 600 tons are composed. The central incineration facility also disposes 550kg of biomedical waste. However, not all waste is collected. In fact door-to-door collection is only available to 57% of the households and not available at all of the City wards.

2.3.6.4 Roads, Traffic, and Transportation

According to the City Development Plan 2006-2012- Volume II, during the last four decades, population increased by four times, vehicles by 87 times and road length by five times. Public transport accounts for only 15% of total vehicle in which 50% of them are more than 10 years. This has resulted in an increasing number of private vehicles and thus a heavy traffic in a city that only 25% of its roads have a width of over 24 meters.

2.3.7 PMC Administrative Divisions

PMC is in charge of the civic needs and infrastructure of the metropolis; it is entrusted with the task of providing essential services to the citizens of Pune. PMC has to function and be ―guided by the 'Twelfth Schedule of the 74th Constitutional Act'. The main functions of PMC as defined under the Bombay Provincial Municipal Corporation Act (1948) include:

- Provision of urban amenities and other infrastructural development,

- Provision of sanitation facilities,
- Supply of water,
- Construction of roads, drains, etc.,
- Administering central and state government urban poverty alleviation (UPA) schemes, etc.

The Twelfth Schedule of the 74th Constitutional Act (Article 243W) has listed the following functions for Urban Local Bodies:

1. Urban Planning including town planning.
2. Regulation of land-use and construction of buildings.
3. Planning for economic and social development.
4. Roads and bridges.
5. Water supply for domestic, industrial and commercial purposes.
6. Public health, sanitation, conservancy and solid waste management.
7. Fire services.
8. Urban forestry, protection of the environment and promotion of ecological aspects.
9. Safeguarding the interests of weaker sections of society, including the handicapped and mentally retarded.
10. Slum improvement and up-gradation.
11. Urban poverty alleviation.
12. Provision of Urban amenities and facilities such as parks, gardens, playgrounds.
13. Promotion of cultural, educational and aesthetic aspects.
14. Burials and burial grounds; cremations, cremation grounds and electric crematoriums.
15. Cattle pounds; prevention of cruelty to animals.
16. Vital statistics including registration of births and deaths.
17. Public amenities including street lighting, parking lots, bus stops and public conveniences.
18. Regulation of slaughter houses and tanneries

At present (2014), Pune MC houses an elected body with 152 Ward Councilors (144 in 2013), who are headed by a Mayor. The Mayor and the Ward Councilors are supported by Municipal Commissioner, an Indian Administrative Service (IAS) officer appointed by the Maharashtra state government, who heads the executive arm. The Municipal Commissioner is assisted by an Additional Commissioner (General) and City Engineer, the technical head in the organization, who manages different portfolios which include Sewerage and Water supply.

At present, Pune MC has a total of 18,000 staff, including 500 engineers (450 civil and 50 electrical/ mechanical engineers) carrying out variety of functions related with buildings, roads, street electrification, water supply, sewerage, etc.

There are seven departments in the Pune Municipal Corporation: (1)Development and Planning, (2) Building permission, (3) Water Supply and sewerage, (4) Slum improvement, (5) Tax and collection, (6) Finance and Audit, (7) Land records.

The city is divided into four zones that are Ghole Road, Tilak Road, Dhankawadi, and Dhole Patil Road for administrative control. Each zone is headed by Deputy Commissioner. Each zone has number of regional offices, which are headed by regional officer, who is responsible for all municipal activities

in the area of the region. There are in all 14 regional offices (also known as ward office). DPR provides a list of the regional offices in each zone.

The PMC's Water Supply and Sewerage Department is responsible for planning, execution, operational and maintenance of all works related to waste water collection treatment and disposal. This department is headed by additional city engineer. The municipal area is divided in to 3 zones for the water supply and sewerage works; Swargats, Cantonment, SNDT Each of the zones is headed by a superintending engineer. The organizational structure of this department is provided in DPR.

2.4 Existing and Future Land Use

2.4.1 Existing Land Use

As per the Development Plan 2007-2027 report, a survey of Pune City has identified the existing use of the land as residential, mixed use, commercial, public/semi-public, public utilities (water supply, sewerage, burial ground, cremation ground, garbage disposal etc.), defense, industrial, transport, recreation, agricultural, water bodies, hill top- hill slope, forest, vacant, slum, roads, etc. The overall status of the existing land use seen in the city after the survey (in 2001) is shown in Table 2.4.1, Figure 2.4.1 and Figure 2.4.2.

Table 2.4.1 Existing Land Use in Pune in 2001

Land use category	%	Land use category	%
Agriculture	5.52	Residential	20.48
Commercial	2.54	Residential Space	3.89
Defense	8.41	Slum	3.01
Hill slope	8.38	Transport and Communication	0.92
Industrial	1.82	Under Construction	0.49
Mix Land use	5.26	Vacant	6.70
Public-semi, Public	9.19	Water Bodies	6.37
Public Utilities	1.04	Roads	15.99

As seen in table above, the residential user is 20.48 %. This shows the compact growth of the city. After roads, the next sizable PSP user is 9.19 %, excluding defense. These users consist mainly of educational institutions like university, school, colleges, court offices & institutions etc. Defense user is accounted as 8.41 %. This is due to the reasons that Pune City is the HQ of the Southern Command and the existence of the defense airports and organizations. Hill top and hill slope user is 8.38% occupying. This user is considered important from the environment point of view and hence to be protected from any urban development. Recreation user is 3.89% occupying which is quite low. They include open

spaces, garden, parks, playground, etc. Vacant lands are accounted as 6.70 %. These will be the required land for future development and 0.49% land under construction. There are of 3.01% slum area in the city. Water bodies are accounted as 6.37 % Land. Water courses need to be protected for free flow of rain water and storm water to avoid flooding and should not be allowed to be reclaimed. The Agricultural land is 5.52%. This land may not remain in the agricultural use because of the tendency to convert such lands into non-agricultural activities. The area under public utilities is 1.04%. These areas consist of water treatment plant, sewage treatment plant, pumping stations MSEB etc. Transport & communication area is 0.92% which consist of bus depot, bus terminus parking, railway stations, etc.

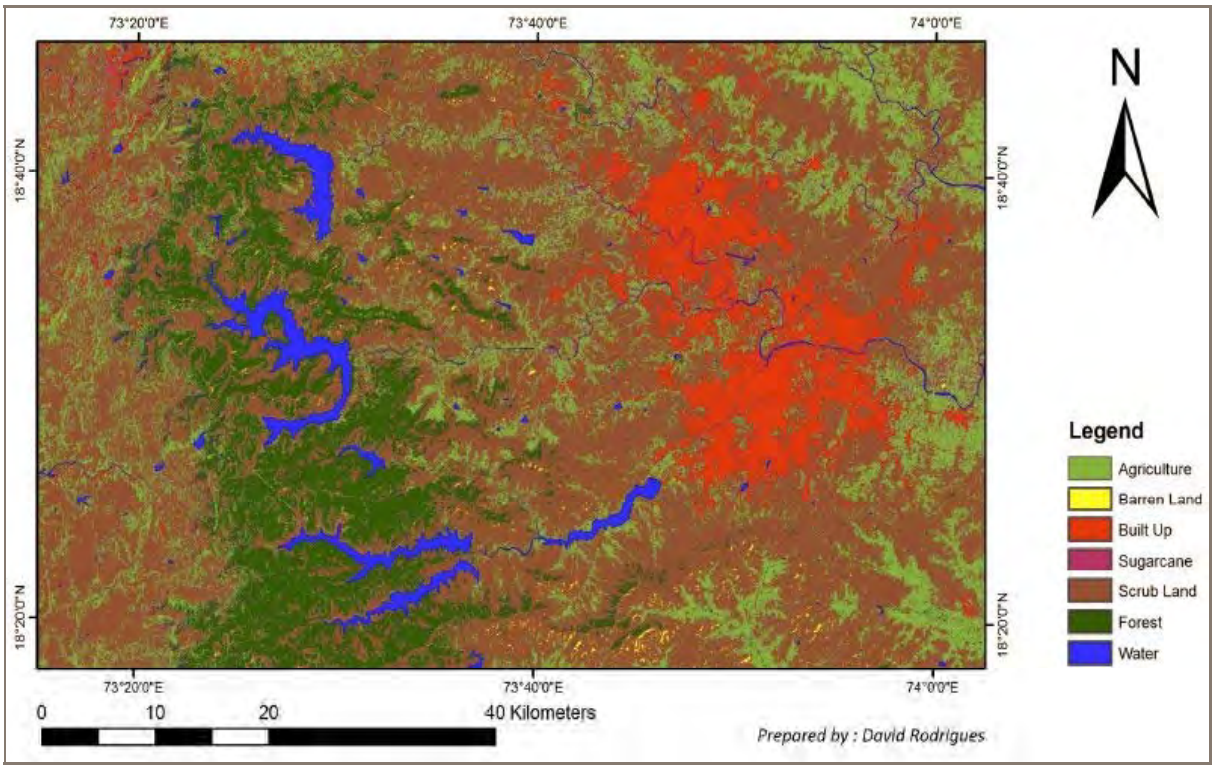


Figure 2.4.1 Pune Land Cover in 2001

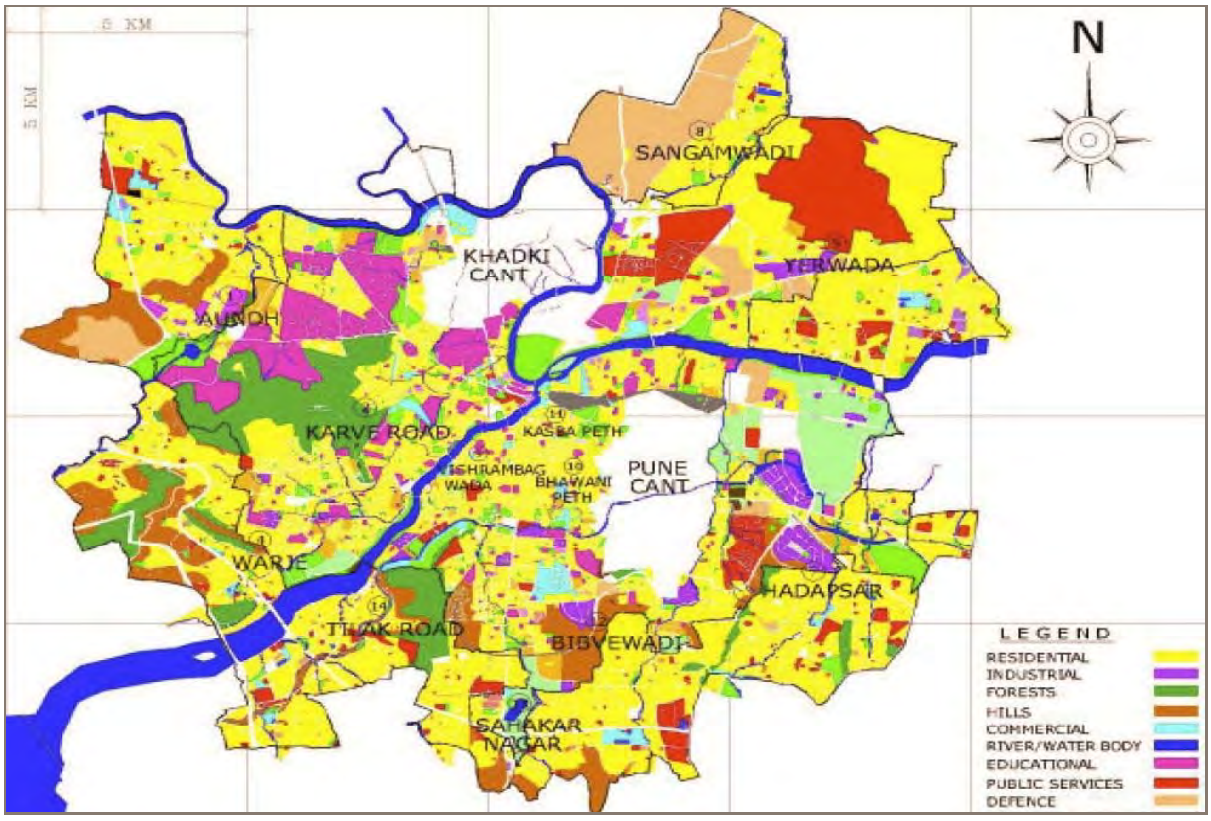


Figure 2.4.2 Pune Land Use in 2001

The Development Plan 2007-2027 report also proposes the future land use of the City for 2027 in order to determine the extent and physical form of future urbanisable area on the basis of the population projection, trend of development and suitability of land for non-agriculture processes. Like the existing land use study, the total area within the City's old limits was divided into six sectors and future land use was proposed for each.

2.4.2 Future Land Use

PMC has been developed as a major center for higher education and research, commerce and industry (particularly automobile and IT services). The city has also a large number of defense establishments.

PMC was set up on 15-2-1950. The first Development Plan was sanctioned by the state government (Urban Department and Public Health Department) and came in force on 15-08-1966. Since then the plan has been updated periodically and the updated Development Plan of Pune City is shown in Table 2.4.2. The classification of the proposed land use is shown in Figure 2.4.3.

Table 2.4.2 Proposed Land Use Classification of PMC

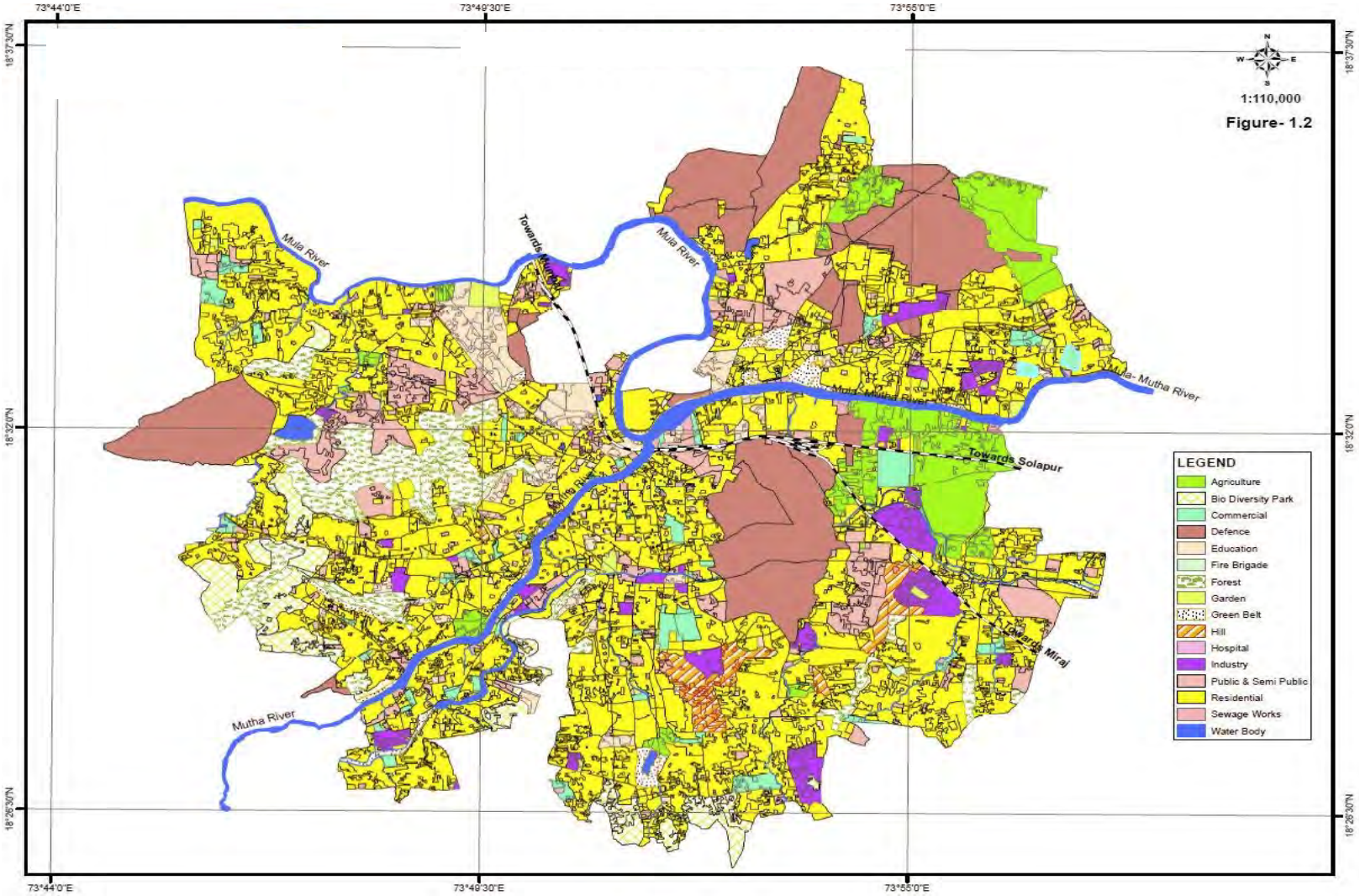
No	Land use category	Area (km^2)
1	Residential	104.57
2	Commercial	4.05
3	Industrial	8.54
4	Public and Semi Public	17.22
5	Public Utilities	4.05
6	Transport	30.02
7	Reserved Forest and Agriculture	30.05
8	Water bodies	13.11
9	Hills	12.50
10	Recreational	19.84
	Total	243.95

Source: Water DPR, PMC, 2014

The PMC has established Metro and Wada policy for the city development, which will increase the population growth rate in the wards affected by this policy.

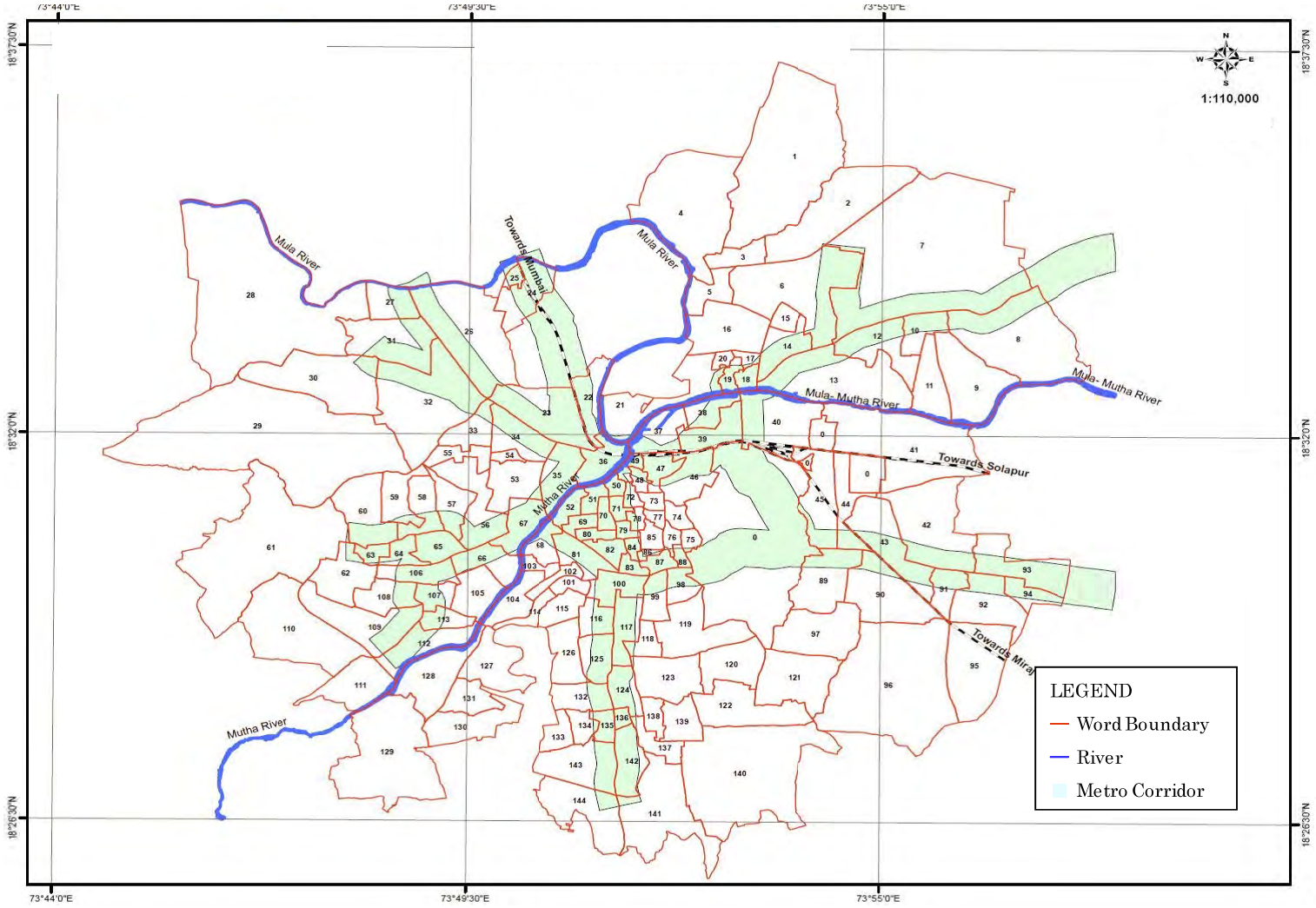
PMC has taken a decision to implement Metro Rail Project for a distance of 72km in the city, and area within 500m on both sides of the proposed route of the Metro is designated as Metro Corridor. Within the Metro Corridor, PMC has decided to allocate a higher Floor Space Index (FSI) of 4, out of which FSI of 2 will be for residential projects and FSI of 2 will be for commercial projects. The higher FSI is proposed to promote higher population density near the Metro Rail.

The Wada policy is applicable for Peth Areas in the old city. Pune has put in a concept of cluster development for more orderly development of the old city. For the Wadas (old housing complexes) that come together to form land area exceeding the minimum plot (cluster) size, FSI of 3 will be granted (2 for residential and 1 for commercial). For those not willing to consolidate into minimum plot size, current FSI of 1 will be applicable. Figure 2.4.4 shows planned corridors with water color expanded from the center of the city toward the boundary of the city.



Source: Water DPR, PMC, 2014

Figure 2.4.3 Development Plan of PMC



Source: Water DPR, PMC, 2014

Figure 2.4.4 Locations of a Metro and Wada Corrido

CHAPTER 3 Existing Water Supply and On-going/Planned Water Supply Project

PMC prepared the "Water Supply System for Pune City; Detailed Project Report (DPR)" in February, 2014. The report utilized the City Development Plan and updated information including the 2011 population census results up to ward population. This report summarizes the existing facilities and future facilities plan as shown below.

3.1 Existing Water Supply

3.1.1 General Conditions on Water Supply in Pune City

3.1.1.1 Storage Dams

According to the Central Pollution Control Board standards for surface water quality, BOD_3 (3 days at 27 degrees C) in the inland water bodies should be less than 3mg/I for the use of the water for drinking purposes. The PMC's Environment Status Report (ESR) for 2013-2014 states the minimum BOD of 15mg/l in the Mula to the maximum BOD of 80mg/l in Mutha Rivers. This shows that the water quality (BOD) of the rivers is far beyond the standards for drinking water. Under the above conditions, water supply to Pune city is provided by four dams with a total storage capacity of 815.36 million m^3, which belong to the Irrigation Department of the State Government.

Table 3.1.1 Sources of Water Supply to Pune City

Sr No.	Name of Dams	Storage capacity (thousand million cubic feet)	Storage capacity Million m^3
1	Panshet	10.64	297.92
2	Varasgaon	12.81	358.68
3	Temghar	3.71	103.88
4	Khadakwasla	1.96	54.88
Total		29.12	815.36

Source: Water DPR, PMC, 2014

3.1.1.2 Raw Water Transmission

The present arrangement of transmission of raw water from Khadakwasla dam, to various water treatment plants is shown in Table 3.1.2.

Table 3.1.2 Arrangement of Raw Water Transmission to Various WTPs

WTP/Water Works	Transmission System	Facilities
Parvati water treatment plants	Mutha Right Bank canal	Two pipes of 1200mm & 1600mm diam. for drawing water to Stage 1 WTP of 220 MLD
	3030mm diam. MS gravity main,	Gravity supply to Parvati stage 2 WTP of 315 MLD

	up to receiving chamber of WTP	
Pune Cantonment water works	3030mm diam. MS gravity main, up to receiving chamber of WTP	Raw water pumping to MBR (in the premises of Parvati water works), and further gravity supply to Pune Cantonment water works for stage 1 WTP of 240 MLD
	Mutha Right Bank canal	Supply to stage 2 WTP of 100 MLD capacity
Warje water works	Jack well at Khadakwasla dam, 1524mm diameter pumping main	- Supply to Warje stage 1 (9 MLD) WTP by 406mm branch; - 1524mm pumping main for supply to Warje stage 2 WTP of 180 MLD
Holkar water works	Jack well at Khadakwasla dam, 1524mm diameter pumping main	1000 mm branch pumping main for 45 MLDWTP
Vadgaon stage 1	3030mm diam. MS gravity main, from Khadakwasla	- 1524 mm branch gravity main - Raw water PS - 1524mm diam. pumping main to stage 1 WTP of 125 MLD.
Chikhali WTP	Jack well at Ravet on Pavana river	711mm diam. pumping main to Chikhali WTP

Source: Water DPR, PMC, 2014

3.1.1.3 Existing Water Treatment Plants

There are nine water treatment plants (WTPs) with a combined capacity of 1,263 MLD. At Warje, a WTP with a planned capacity of 200 MLD is under construction. The summary of existing water treatment capacity is presented in Table 3.1.3. The water treatment plants in Parvati and one of the Pune Cantonment WTPs are very old, and are facing many problems, such as leakages in civil structures and no good condition of old equipment. The PMC has decided to stop the use of these plants, upon the planned additional WTPs are commissioned.

Table 3.1.3 Existing Water Treatment Plant

Sr No.	Name-Location	Capacity in MLD		
		Existing	Under Construction	Total
1	Chikhali-(Pavana River)	29		29
2	Holkar	45		45
3	Cantonment-Old/New	240		240
	Cantonment New	100		100
	Sub Total Cantonment	340		340
4	Parvati Old (line 1)	220		220
	Parvati New (line 2)	315		315
	Sub Total Parvati	535		535
5	Vadgaon stage 1	125		125
6	Warje Old	9		9
	Warje New	180		180
	Warje stage 3		200	200
	Sub Total Warje	189	200	389
Total		1,263	200	1,463

Source: Water DPR, PMC, 2014

3.1.1.4 Distribution Systems

There are 85 distribution reservoirs with a combined capacity of 290 thousand m^3. There are 67 water supply zones in the city with pipeline network of about 2,700 km.

The average water supply in the city level seems to be adequate, but spatial distribution is uneven and in some areas below average. The network in some areas of the city is very old and high leakages are prevalent. The water meters are fixed for bulk consumers and commercial and industrial establishments. There are very few residential premises with metering system in place. Overall percentage of the metered supply is less than 30 percent.

3.1.2 Population Coverage and Access to Water Services

According to the DPR for Water Supply System for Pune City" in February, 2014, the service coverage within the PMC area is 94.19% for households and average per capita water supply amount is estimated at 194 lpcd.

3.1.3 Tariff for Water Supply and Cost Recovery Method

3.1.3.1 Tariff for Water Supply

The main sources of revenue for PMC are water tax, water charges, and water benefit tax. For non-metered connections water tax is levied as a component of property tax. Water charges are recovered based on the meter readings. Water benefit tax is levied on all properties since 1991-92. Presently it is 3% of Annual Rentable Value (ARV). The present water tariffs are as mentioned in Table 3.1.4.

Table 3.1.4 Water Tax for Non-metered Water Connections

Sr No.	Particulars	Water Tax (INR)
1	Residential Properties having Rentable Value	
	1 to 1,000	900
	1,001 to 3,000	1,000
	3,001 to 5,000	1,100
	5.001 and above	25% of Rentable value of INR 2,500 whichever is less
2	Non-Residential Properties having Rentable Value	
	1 to 10,000	750
	10,001 and above	2,000
	Note: These charges are applicable to the Non-Residential Properties having no water connections	
3	Rentable Value of Religious Places	
	1 to 500	No tax
	500 to 1,000	900
	1,001 to 3,000	1,000
	3,001 to 5,000	25% of Rentable value of INR2,500 whichever is less
	Note: These rates are applicable to religious places having no metered connections. The properties having me-	

Sr No.	Particulars	Water Tax (INR)
	tered connections will be charged on the basis of meter reading.	
4	Residential Areas of Flood Affected	300 lump sum
5	Rehabilitated areas of Dhankavadi, Bibvewadi and Properties under Slum Improvement Scheme	300 lump sum
6	Extended area of PMC	
	Villages receiving filtered water supply	
	a) Residential Private Water Connections	1,000 per annum
	b) Residential - Stand post Supply	750 per annum
	c) Non-Residential Properties having independent water connections	1,500 per annum
	d) Small tea shops (Amrittulya) in city and villages in the extended area	600 per month
	e) If Village Panchayat is providing water	INR 375 per annum or old rate whichever is higher
		Properties in the villages receiving water by tanker INR 575 per annum

Source: Water DPR, PMC, 2014

Water charges for supply through metered connections are shown in Table 3.1.5.

Table 3.1.5 Water Charges for Metered Water Connections

Type of Connection	Water Supply	Water Charges INR/1000L
Water Supply in Pune City / Cantonment Area / Khadki Cantonment		
Domestic Supply	0 to 22.5 m^3/mo. (150 lpcd)	INR 3.00
	22.5 to 30 m^3/mo. (150 to 200 lpcd)	INR 5.00
	30 to 37.5 m^3/mo. (200 to 250 lpcd)	INR 10.00
	Above 37.5 m^3/mo. (above 250 lpcd)	INR 15.00
Non-Domestic Supply		INR 33.00

Source: Water DPR, PMC, 2014

3.1.3.2 Cost Recovery Method

Up to March 2000, a metered system was in existence in some areas of Pune city. Water charges were recovered on the basis of quantum of water consumed by the consumers. However, both PMC and consumers were facing many problems with metered water supply. The important issues were:

- Frequent failures of water meters due to bad manufacturing quality
- Billing based on average consumption or quota system
- Non-receipt of water supply bills in time
- Delays in attending complaints of meter repairing by PMC

Considering these problems, PMC decided to discontinue metered water supply to domestic consumers and started charging water tax as a component of Property Tax.
PMC recovers water tax/charges from the consumers in the City, Pune Cantonment and Khadki Cantonment by following three methods:

- In case of domestic consumers the water charges are recovered based on differential rates linked with the ARV. Over and above, Water Benefit tax is charged on the basis of ARV for residential, non-residential, and religious places. As mentioned earlier, at present it is 3% of ARVs as shown in Table 3.1.4.
- All institutional consumers like schools, colleges, religious places, old age homes individual tenants, consumers having additional connections etc. receive their water supply through metered connections and this supply is charged on the basis of domestic tariff rates. The commercial establishments like businesses, hotels also have metered connection and their supply is charged on the basis of non-domestic rates.
- The consumers in slums, flood affected colonies, resettlement colonies etc. are charged one time annual charges. The charge for slums is a lump sum of 300 INR. The same charge is also for flood affected areas. Residential private water connections pay an annual charge of 1,000 INR.

3.2 Water Supply Plan

3.2.1 Population

Population projection was made based on the past census results up to year 2011. Table 3.2.1 shows population adopted for design year of water supply facilities.

Table 3.2.1 Population Adopted for Design Year of Water Supply Facilities

Year	2012	2017	2027	2032	2042	2047
Pune Population	3,115,433	3,918,763	4,430,320	5,771,754	6,939,529	7,375,348
Pune Cantonment	79,965	79,965	79,965	79,965	79,965	79,965
Khadiki Cantonment	78,046	78,046	78,046	78,046	78,046	78,046
Total	3,273,444	4,076,774	4,588,331	5,929,765	7,097,540	7,533,359

Source: Water DPR, PMC, 2014

The city population was then distributed into wards considering the densities observed in 2011 census and evaluating the possible increase of density referring to the Pune Development Plan (effects of the Metro and WADA policies).

3.2.2 Non Domestic Water Demand

Pune is a metropolitan city and provides water supply to a large number of non-domestic consumers. These primarily include the following:

- Government and Non-Government establishments
- Educational institutions
- Commercial and industrial units
- Healthcare institutes, such as Hospitals, clinics and Laboratories
- Cultural centres, Theatres, concert halls
- Transportation terminals for Road, rail and Air traffic

3.2.3 Total Water Demand

The water demand for domestic use and other non-domestic use was then projected taking into account of the consumption levels recommended by CPHEEO. For estimating the water demand for domestic use, the daily average consumption rate of 150 lpcd was adopted. Water losses were calculated assuming that the leakage will be gradually reduced from the present assumed level of 35% in the year 2017 up to the value of 15% in the year 2027, to remain being constant up to the year 2047. The following table shows projected water demand by design year.

Table 3.2.2 Water Demand Projection Unit: thousand m^3/d

Year	2012	2017	2027	2032	2042	2047
Domestic	718.95	839.73	830.69	1,018.54	1,224.62	1,301.53
Non-Domestic	154.48	179.58	329.00	431.56	460.35	576.85
Cantonment	36.46	33.86	29.63	27.88	27.88	27.88
Total	909.89	1,053.17	1,189.31	1,477.99	1,712.86	1,906.26

Source: Water DPR, PMC, 2014

In addition to existing nine WTPs, one WTP with a capacity of 200 thousand m^3/d is presently under construction at Warje to be completed in year 2014, beside the existing 180 thousand m^3/d WTP. Upon completion of the WTO, total treatment capacity of the City will reach to 1,463 thousand m^3/d.

3.2.4 Pune CDP and Proposed Infrastructure Projects

The City Development Plan (CDP) was prepared in 2012 for the year 2041, which includes projects related to infrastructure improvement and the following water supply improvement projects in the City with a total cost of 488.5 INR Crores.

- Water source development/ intake augmentation

- New pipelines
- Distribution Reservoirs
- Water Treatment Plants
- System refurbishment

It should be noted here that, initially, it was planned that the project would be funded by Jawaharlal Nehru National Urban Renewal Mission (JNURM). That scheme was discontinued by the Central Government. A new scheme is being floated by GoI from which PMC will seek funding for the project.

The projected water demand is distributed in the supply areas of the six water treatment plants, as given below.

Table 3.2.3 WTP-wise Projected Water Demand

Description	Installed Capacity in MLD		Water Allocation in MLD		Remarks	
	2032	2047	2032	2047	2032	2047
Parvati	500	500	456.25	390.73	Parvati zone-212.46 Cantonment zone-229.04 Pune Cantonment-14.75	Parvati zone-280.36 Warje zone-110.37
Pune Cantonment	100	100+300	70.87	357.47	BA zone-54.46 Cantonment zone-16.41	Cantonment zone-357.47
Warje	389	389	428.49	461.96	Holkar zone-17.01 Khadki Cantonment-14.18	Holkar zone-18.83 Khadki Cantonment-14.18
Vadgaon	387	387	277.45	356.71		
Holkar	45	45	31.19	33.01		
Bhama Ashked	200	285	214.68	306.54		
Chikhali	22	22				
Total	1,643	2,028	1,478.93	1,906.42		

Source: Water DPR, PMC, 2014

3.2.5 Other Proposed Projects for Improvement of Pune Water Supply

The works which are under construction are summarized below:

- Augmentation of intake works at Khadakwasla dam, jack well, pump station and 2,500 mm dia pumping main up to Parvati water works
- Augmentation of intake works at Khadakwasta dam, jack well, pump station and 1,626 mm dia pumping main up to Warje water works

- 200 thousand m^3/d water treatment plant at Warje water works

3.2.6 Proposed Consumer Meters

The analysis of the various types of water consumption meters was presented in full details in the Metering DPR submitted on August 2012 (prepared by SGI, the same consultancy firm which prepared the water supply DPR. It was prepared for PMC). According to the PMC's Water Supply Department, the metering is currently halted and no further work is ongoing in this regard. However, for completeness of the information provided in this report, the summary of the Consultant recommendations regarding the types of water consumer meters to be adopted are as follows:

- Consumer meters for connections of 15 to 40 mm: Class B, multi-jet mechanical meters or Ultrasonic meters with AMR (automatic metering recording) capacity, with magnetic driving, complying with specifications of ISO 4064(2005)/OIML R49-1, IP 68 waterproof enclosure, and equipped with internal strainer. The meters shall be equipped with RF based AMR technology for communication and remote reading.
- Consumer meters of 50 mm up to 300 mm: these meters will be of the Voltmann type, built-in AMR type, with cast iron body, Class IP68 waterproof housing, complying with specifications ISO 4064(2005), equipped with strainer to prevent clogging.

The main technical reasons that have led to the proposition of the meter with AMR capability are the following:

- Eliminates the risk of incorrect meter reading or tampering of consumer readings,
- Reduces the requirement of personnel for consumer readings,
- Facilitates the computerized filing and storing of data for consumer consumption,
- Enables to compute the actual consumption in any DMA within a very limited period, which is essential for punctual and timely control of water losses and for the active leakage control.

In a limited number of cases, in critical areas that may be affected by low pressure and air entrance, it would be also advisable to adopt ultrasonic meters which offer several advantages such as minimal head pressure drop, are more accurate, not affected by solid transport and do not measure air flow. These factors should therefore provide lower maintenance problems, and more reliable readings which could offset the higher initial investment.

3.2.7 Supervisory Control and Data Acquisition-SCADA

The objective of the proposed SCADA project is to establish continuously pressurized water supply system with universal metering. It automatically follows that an "Active Leakage Control System" is put in place, to continuously monitor the water balance and reduce the NRW to an acceptable level.

Therefore a highly interactive SCADA system is absolutely essential. This has essentially two parts, one is to monitor and improve the performance of the water supply system components and the other is to have a real time access to all the critical parameters at the PMC headquarters.

The entire area considered for water distribution in Pune city is divided into six control areas as below. Each area shall have a control room from where the entire operations shall be taken care of. Thus each control room shall control the WTPs, pump stations, Booster stations, Transmission mains, Service reservoirs and the distribution system in that area.

① Parvati
② Cantonment
③ Vadgaon
④ Warje
⑤ Holkar
⑥ Bhama Askhed

The list of main instruments in various system components as recommended in the SCADA are summarized below.

Table 3.2.4 List of Instruments for Various System Components in SCADA

Instrument	Description of water supply system component				
	Rehabilitation of WTPs	Pump station	Transmission and Distribution systems	Service Reservoirs	Distribution System
Electro magnetic flow meter		✔	✔		✔
Ultrasonic level transmitters		✔		✔	
Residual chlorine transmitters	✔				
pH transmitters	✔				
Turbidity transmitters	✔				
Differential pressure transmitters	✔				
Controllers	✔	✔	✔	✔	✔
Pressure transmitters		✔	✔		✔
Vibration system		✔			

Source: Water DPR, PMC, 2014

CHAPTER 4 Existing Storm water Drainage System

4.1 General Drainage Condition

The general topography of ridges and valleys has resulted in formation of independent watersheds, each of which is draining in one of the two Mula and Mutha rivers. These rivers are principal carriers of storm water The Project area is divided into 23 watersheds or basins, each of which has one or more primary natural drains (Nallas) to convey the storm water into the rivers. The slopes of these networks are generally good enough to carry reasonable storm water volumes. The reinforced cement concrete (RCC) pipes are used for roadside drains, with storm inlet chambers at regular interval.

Recent years, the frequency of overflow of Nalla and over flood of road has increased in PMC. The development plan prepared by PMC in 20012 indicated that a total of 50% of city is used as residential area. Development of the land area could increase the paved areas substantially and result in increased runoff and floods with widespread losses in terms of traffic interruptions, damage to roads and loss of property. Accordingly, PMC invested large amount to repair the damaged road surface after monsoon season. There are many inundation areas in PMC where people have to be relocated to safer areas.

4.2 Primary Drainage Channels

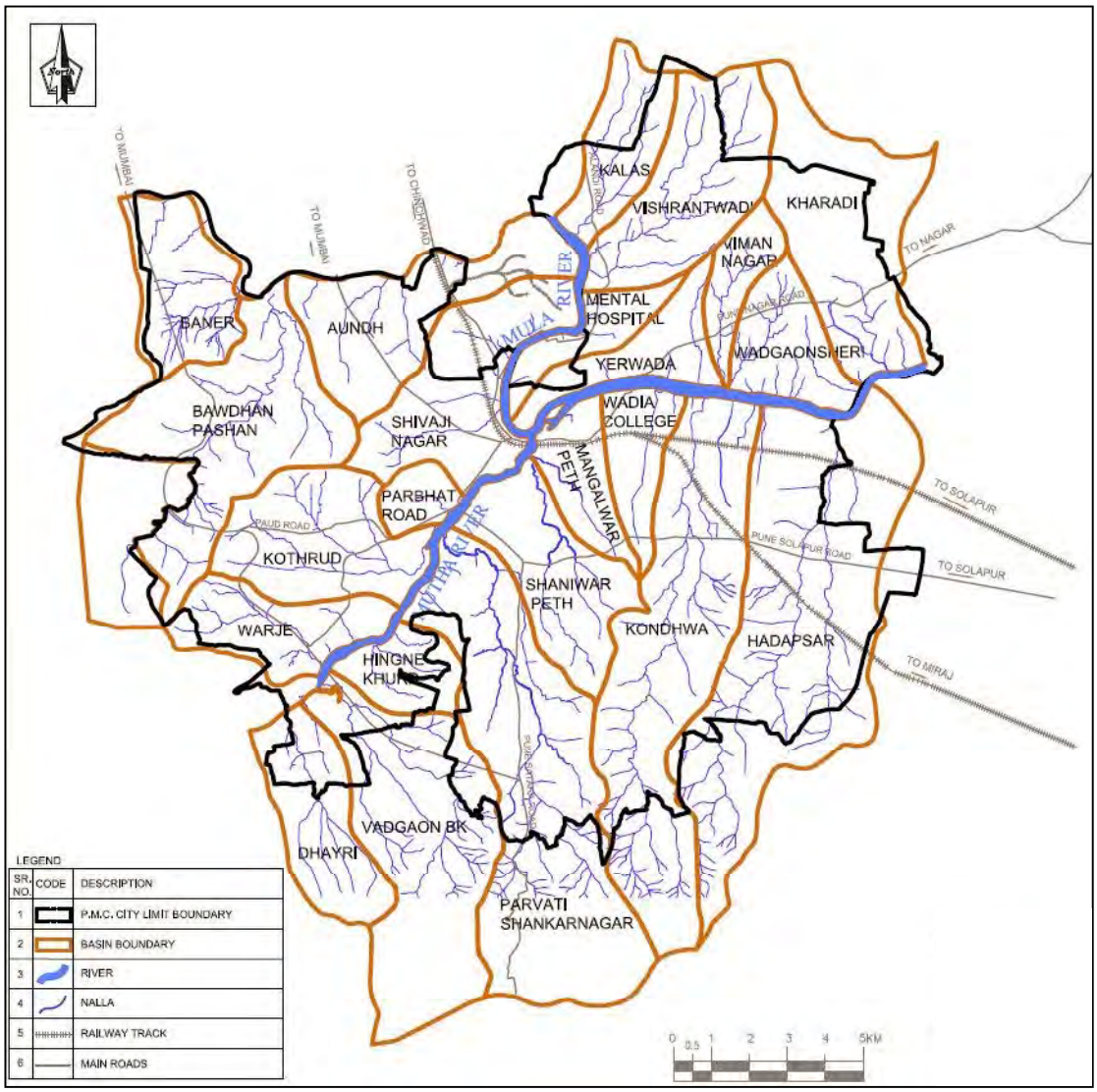
Mula and Mutha are the two rivers which flow within the city area. These two rivers meet within the city area forming Mula-Mutha River. The length of Mutha and Mula River in the PMC areas is 15 Km and 22 Km, respectively. The length Mula-Mutha river from confluence to PMC boundary is 11Km.
In addition, there are three large lakes in the project area, as shown in Table 4.2.1.

Table 4.2.1 Water Bodies in Project Area

Name of lake	Basin	Nallas	Area in Hectares
Pashan Lake	Bawdhan	Ram River	62.6
Katraj Lake	Parvati	Ambil Odha	7.2
Snake park lake	Parvati	Ambil Odha	18.6

Source: Pune Strom Water Management Master Plan

The primary drainage channels are essentially natural Nallas and their tributaries. The total length of Nalla in PMC is about 362 km. The slopes of the Nallas network are generally good enough to carry reasonable storm water volumes. The constructed Nallas generally have masonry walls with bed concrete in the central portion. There are 23 major basins in the PMC, and each basin has one or more primary drainage directly discharging in to either Mutha or Mula rivers. Basin boundaries and natural drainage networks are shown in Figure 4.2.1.



Source: Pune Strom Water Management Master Plan

Figure 4.2.1 Basin Boundaries and Natural Drainage Networks

The rapid urbanization has significantly changed the nature of drainage areas in all basins. The open grounds have nearly vanished, and the paved area is substantially increased. This has brought about increased storm water volume under the same rainfall event. Especially in fringe areas which have been recently merged in PMC, uncontrolled development has generally happened along the Nallas, and resulted in higher silt load, reduction of carrying capacity of Nallas and difficulties in maintenance. This has induced the emergence of areas, which are prone to flooding, even with moderate rainfall intensities.

4.3 Road Side Drains and Cross Drainage Works

Though the roadside drains are available for the PMC roads, there are a few issues that need to be noted. One is that roadside drains are not provided to all, but only to the major arterial roads and in part of the old city area. While the total length of the city roads is about 1,800km, the total length of roadside drains is estimated at about 155km. This indicates very low coverage of roadside drains yet, though road side drains expansion is in progress at many places. On the other hand, blockage of road drains by water pipes crossing the Nallas and the sewerage chambers within the water way are seen in many locations which cause problems.

The cross drainage works are provided at road crossings. The total number of culverts in PMC is 584. These are generally pipes, but RCC box culverts are also prevalent. According to Master Plan for Storm Water Drainage system for Pune City 2007, the afflux generated at the cross drainage work shall be limited as recommended by the Guidelines of Public Work Department, Govt. of Maharashtra. Though the existing cross drainage works are designed to carry the estimated runoff without creating overland flooding their capacities, their capacities are reduced due to solid waste and construction debris dumped near cross drainage works.

4.4 Drainage Maintenance System

Presently, the maintenance of all drainage systems is not managed by a single department of the PMC. The maintenance of Nallas and cross drainage works lies with respective ward offices, however the maintenance of roadside drains are undertaken by the PMC's Road Department.

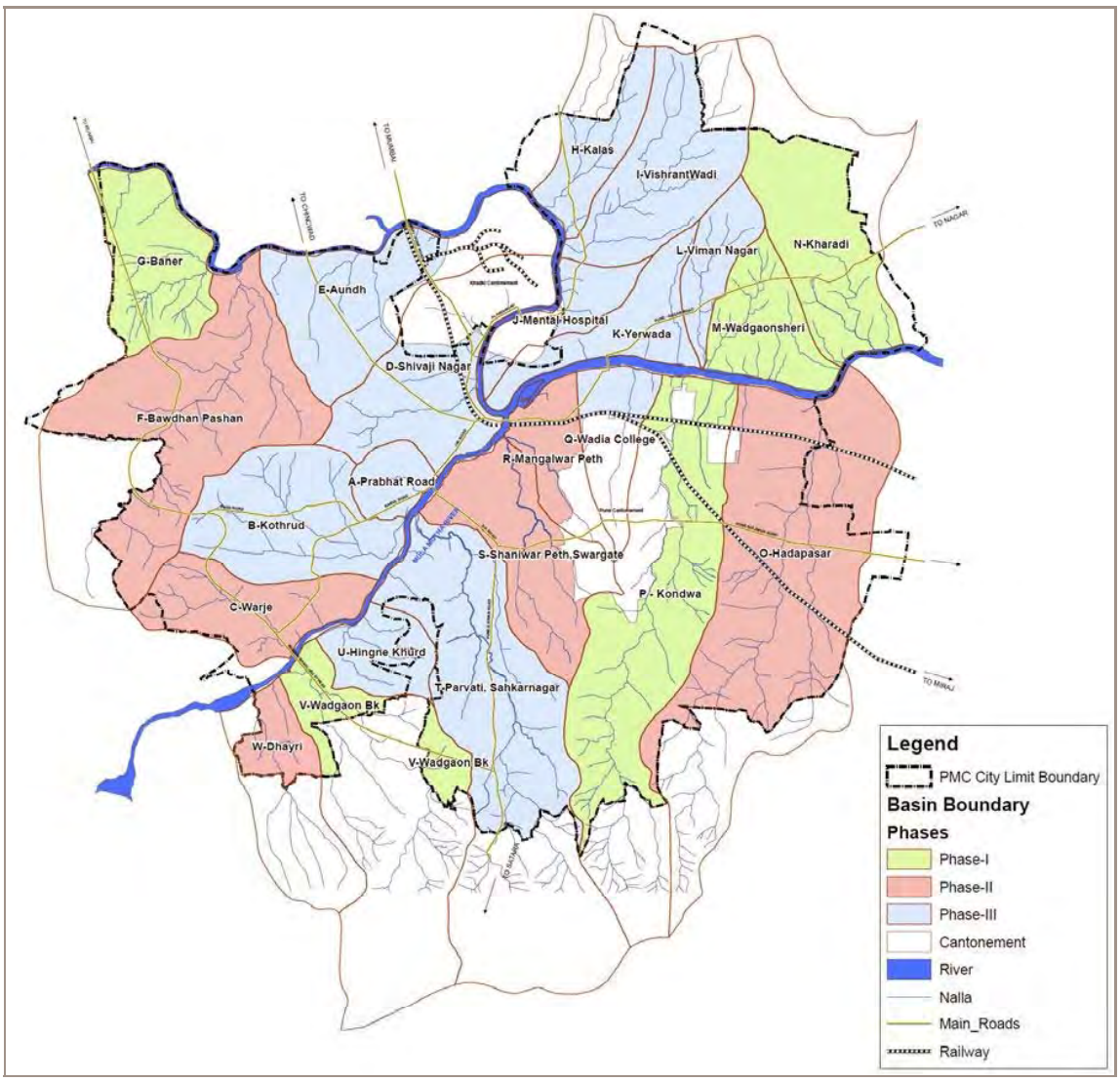
The present operation and maintenance is reactive in nature. Whenever drain blockage or flooding occurs, the available manpower is collected and the problem is fixed by using temporary measures. The systematic planning and implementation of preventive measures are not practiced. Also, the maintenance records for attending to a blockage and/ or flood event is not maintained in a standard format. The deficiencies in the existing maintenance system are caused by inadequate funds and staff, non-availability of drain cleaning equipment, inadequate number of engineer and lack of training.

4.5 Proposed Drainage System in Master Plan

In Master Plan for Storm Water Drainage system for Pune City 2007, 23 drainage basins in the Project area are classified and prioritized based on the degree of flooding and damages. Total 6 basins are identified as Phase-I for the proposed works to be funded under JNNURM. The scope of work includes improvement of Nallas and roadside drains, and modification of cross drainage. The proposed drainage system was designed to meet the standard of CPHEEO. Phase-I work was planned to com-

menced in September, 2008 and completed in September 2010 in Drainage master plan. However, the progress of the construction work is approximately 80% as of November 2014.

Total 3 basins are covered in Phase-II, and Phase-II work was expected to start in April, 2009 and completed in April 2011 in the master plan. However, there is no progress as of November 2014.
The remaining 14 basins are covered in Phase-III, and Phase-III work was expected to be completed by the end of March, 2012 in the master plan. However, there is no progress as of November 2014.
Plan of the improvement with phased demarcation is shown in Figure 4.5.1.



Source: Pune Strom Water Management Master Plan

Figure 4.5.1 Phased Demarcation for Drainage Improvement

4.5.1 Proposed Nallas System

Considering the site conditions, it is proposed to make concrete lining and rubble paving in Nallas bed in order to improve the drain's carrying capacity. In such case when the available Nallas width is more than 10 meters, the central channel bed is proposed to be extended up to 2 meters on either side. If widening of a Nallas is not possible, diversion of upstream flow is pro-posed to reduce the quantity of flood discharge at such Nallas.

It is also proposed to construct recharge pits along the alignment of the Nallas based on the de-tailed study conducted by Groundwater Survey and Development Agency, Government of Maharashtra. . The recharge pit is an underground structure covered by porous-walled chamber that allows rain water to slowly soak into the ground.

This would improve the groundwater table which is been reduced due to over use by urban areas. The recharge pits are proposed on main Nallas, generally at interval of 500 meters and the typical depth of re-charge pit is 15 m.

4.5.2 Proposed Road Side Drains and Cross Drainage Works

The absence of proper roadside drainage is one of the major causes of damage to roads in PMC. Therefore, it is absolutely necessary to provide the adequate roadside drains to ensure that water does not form puddles damaging the carpeting and also does not enter the sub base of the road pavements.

For the road side drains, the stone masonry is proposed because stone is readily available near the Project area and is economical for depth up to 2 meters. The drain deeper than 2 meters are proposed in RCC pipe construction. Manhole chambers are also proposed at an interval not exceeding 20m for maintenance. These chambers shall also act as storm inlets. The chamber is proposed in masonry with concrete bed and provided with gratings, fabricated out of steel flats and angle sections.

In addition, the cross drainage works are extremely critical for safe passage of flood. These are not only required with an adequate size, but have to be maintained properly. The lengths of cross drainage works is not readily accessible and generally difficult to clean. These can be easily clogged by solid waste, plastic material and silt load. Therefore, the catch pits are proposed upstream of all cross drainage works, to minimize the silt entering the cross drainage openings.

4.5.3 Proposed Maintenance System

Regular and routine maintenance of the drainage system is necessary to sustain the designed capacity of the drains. According to the Master Plan's survey result, lack of maintenance of drains and disposal

of solid waste in the drains causes localized flooding and thus affects public health. Therefore, proposed maintenance plan highlights routine maintenance, pre-monsoon and post-monsoon maintenance.

During the monsoon period, a vigilant watch must be utilized in major Nallas and rivers. In addition, the water level in the Mutha River rises after release from the Khadakwasala dam. Thus, a close coordination with the Irrigation Department is necessary for monitoring the river levels.

Maintenance of sewer pipes for the road side drains shall use equipment like jetting machine. The machine shall be readily available over wide range of varieties suitable for different sizes. For Nallas cleaning, it is traditionally conducted by manual labor. This practice is not acceptable due to safety and hygiene issues of the workers. It is therefore recommended that cleaning of Nallas and constructed road side drains to be conducted by drain cleaning machines.

CHAPTER 5 Existing Sewerage Facilities and on-going Sewerage Projects

5.1 Sewage Collection System

Sewage collection system consists of the following major facilities. However, pumping stations are discussed in Sub-section 5.2 IPS.

- House connections
- Branch sewers
- Sub-main/Main sewers
- Intermediate Pumping Station

5.1.1 Findings on Sewer Networks

5.1.1.1 Branch sewers

Sewer installation coverage in PMC is reported at 92% at present. Even in the slum areas all house connections are connected to public branch sewers, however, functioning sewers are reported to be limited at present. There are cases where sewage is discharged into nearby channels without treatment. No records on "as-built plan of sewers" are maintained by PMC.

5.1.1.2 Main/sub-main sewers

Majority of sewage collected through branch sewers is conveyed to intermediate pumping stations (IPSs) or sewage treatment plants (STPs) directly. However, some sewage collected in the service areas is not properly conveyed by main/sub-main sewers being discharged into nearby Nallas/channels without treatment, which finally ends into Mula and Mutha rivers.

5.1.2 Existing Main/Sub-main Sewer System

The total length of sewers is 2,200 Km with pipe diameters ranging from 150 mm to 1,800 mm. The sewer materials are RCC of NP2 /NP3 class. Presently 92% of the roads are covered by existing sewers (total length of roads is 2,400 Km). Main/Sub-main sewer systems with a total length of about 89 Km are summarized in Table 5.1.1.

Table 5.1.1 Existing Main/Sub-main Sewer Systems

Sr. No.	Description	Diameter mm	Length m
1	Conveyance Mundhwa Gaothan to MundhawaSTP	900	500
2	Main Sewer from Mundhawa Nalla	1,200	1,276
3	Main Sewer from Bhairoba Nalla	1,200	12,533
4	Main Sewer from Mangalwar Peth to Bhairoba STP	1,400	5,544
5	Main Sewer from PCB to Bhairoba STP	1,000	1,864

Sr. No.	Description	Diameter mm	Length m
6	Conveyance main Nagzari Nalla to New NaiduSTP	1,800	3,423
7	Main Sewer in Nagzari Nalla	1,800	3,770
8	Conveyance main from Out fall of Ambil Odha to Old kasba	1,200	2,600
9	Conveyance mains from out fall of Ambil Odha to Pune Hospital	1,600	465
10	Conveyance main from Pune Hospital to New Kasba	1,800	2,577
11	Main Sewer in Ambil Odha – Avinash Mitra mandal to out fall of Ambil Odha	1,600	1,620
12	Main Sewer from Vitthalwadi Nalla	450	1,668
13	Conveyance main Vadgoan Nalla out fall to Vitthalwadi STP	1,200	3,000
14	Main Sewer in Vadgoan Nalla	900	1,387
		700	1,250
		600	1,736
15	Main Sewer in Dhayari Nalla	450	1,480
16	Main Sewer in Warje Nalla	1,000	418
		900	491
17	Conveyance main from Warje Nalla to Erandwane STP	1,200	4,842
18	Conveyance main from Erandwane STP to Topkhana	1,200	3,023
19	Conveyance main in Kothrud Nalla	1,200	1,235
		1,000	1,747
20	Main Sewer in Prabhat road	900	107
		600	858
21	Main Sewer from Shivaji Nagar Nalla	1,200	355
		900	3,483
22	Main Sewer from Agricultural Collage	600	618
		450	872
23	Main Sewer in Nalla from Aundh	450	2,792
24	Conveyance main from up Botanical Garden	900	1,082
25	Main Sewer in Ram river	900	6,263
26	Conveyance main to Baner STP	1,200	1,423
		900	643
27	Main Sewer in Nalla from Baner	600	1,390
		450	1,490
28	Main Sewer in Vishrantwadi Nalla	900	981
		800	1,636
29	Conveyance main in Kalyani nagar	1,400	1,731
		1,200	1,056
30	Conveyance main upto Kharadi STP	1,000	3,727
31	Main Sewer in Nallas in Kharadi	600	5,732
		450	
Total			88,887
Say			89 km

Source: DPR, PMC, 2014

5.1.3 On-going Sewerage Projects

Presently, there is no on-going STP/IPS projects. However, there are an on-going sewer construction projects in the PMC as follows:

Project contents	Fund Source	Present Status (as of November, 2014)	Expected Completion Time of Construction
Main sewer for 2,500 m with dia. of 1,800mm from Bund Garden to New Bhairroba STP	PMC	90 %	June 2015 Problem with Garden Dep. of PMC

5.2 Intermediate Pump Station (IPSs)

Based on field investigations on IPSs, present conditions on the facilities were summarized with confirmation on the details in the DPR.

5.2.1 Capacities of existing IPSs

At present there exist six intermediate pump stations. Capacities and pump specifications on these IPSs are shown in Table 5.2.1 and Table 5.2.2, respectively.

Table 5.2.1 Capacities of Existing Intermediate Pump Stations

Name of IPS		Sewerage District	Year of Commissioning	Design Capacity (m^3/d)	Remarks
1	Old Kasba (Old)	SD4	1930	86.40	
	Old Kasba(New)	SD4	1995	60.48	
2	New Kasba	SD4	2008	135.36	
3	Topkhana	SD4	2010	94.46	
4	Kalyani Nagar	SD12,14	2002	60.00	
5	Mental Hospital	SD14	2007	40.08	
6	Botanical Garden	SD10	2004	10.56	

Table 5.2.2 Pump Specifications of Existing Intermediate Pump Stations

Name of IPS		Pump Type	Discharge (m^3/hr)	Head (m)	Pump Number			Remarks
					W	SB	Total	
1	Old Kasba (Old)	Horizontal	1,800	9.5	2	0	2	3units:out of order
	Old Kasba(New)	Horizontal	1,260	7.0	2	0	2	
		Horizontal	1,980	7.0	0	2	2	
2	New Kasba	Submersible	1,410	30	4	2	6	
3	Topkhana	Submersible	984	27	4	2	6	
4	Kalyani Nagar	Submersible	1,250	20.5	2	1	3	

5	Mental Hospital	Submersible	835	20	2	1	3	
6	Botanical Garden	Submersible	220	20.5	2	1	3	

5.2.2 Present situation of existing IPSs

Table 5.2.3presents present operation status (as of September, 2014) with issues and problems.

Table 5.2.3 Operation status of Existing IPS with Issues and Problems, and Countermeasures

IPS	Operation Status with issues & Problems	Countermeasures
1-1.Old Kasba (Old)	・Operation of IPS started in 1930, thus facilities and equipment are deteriorated. ・Mechanical type screen which is located in the riverbed opposite side of Pump house: No functioning ・Sewage Pump : Horizontal type centrifugal pump – 3 units of the total of 5 units are not functioning	・Re-newel of mechanical type screen is required to protect pump units. ・Re-newel of sewage pump units are required.
1-2.Old Kasba (New)	・Sewage pump units: Horizontal type centrifugal pump units (2 units are under operation and 2 units for stand-by) are installed in the circular type pump pit. Pump units seem to be deteriorated.	・Re-newel of pump units is required.
2.New Kasba	・Screen: Two units of mechanical type screen are installed at underground channel and operated. ・Sewage pump: Six units of submersible pump are installed (4 units are under operation and 2 units are stand-by). ・Screen channel: There is sufficient area for the expansion in the future. The operation of ISP for the replacement of pump units need to stop operation, since pump chamber is common to all pump units.	
3.Topkhana	・Screen: Screen is installed at the underground channel and operated ・Sewage pump: Submergible pump unit is under operation.	
4.Kalyani Nagar	・Screen: Two units of mechanical type screen (Coarse Screen 2units and Fine Screen 2units) are not functioning. Accumulated debris affect pump operation at present. ・Sewage pump: Three units of submersible pump are installed and operated. There is suf-	・Need of re-newel for al units of mechanical type screen ・Re-newel of pump crane is necessary.

IPS	Operation Status with issues & Problems	Countermeasures
	ficient area for the expansion in the future. The operation of ISP for the replacement of pump units need to stop operation, since pump chamber is common to all pump units. ・Crane for pump carrying: not functioning	
5.Mental Hospital	・Screen: Mechanical type screen is installed, but not functioning. Debris and scam are accumulated in the pump pit. ・Sewage pump: Three units of submersible pump are under operation.	・Need of re-newel of mechanical type screen
6.Botanical Garden	・Screen: Two units of mechanical type screen are under operation. ・Sewage pump: Three units of submersible pump are under operation.	
7.Mangalwar Peth	・The pump station was constructed in 1932.One unit of the pump facilities is operated for a short time period during rainy season as storm water discharge pump. But pump house is deteriorated.	・In case of re-newel of pump units, pump house should also re-constructed.

5.3 Sewage Treatment Plants (STPs)

5.3.1 Capacities of existing STPs

There are ten sewage treatment plants in PMC at present, but Naidu (Old) STP is not operated. Capacities of these treatment plants are shown in Table 5.3.1.

Table 5.3.1 Capacities of Existing Sewage Treatment Plants

Name of STP		Sewer District	Year of Commissioning	Design Capacity (MLD)	Treatment Process	Present Inflow (MLD)	Remarks
1	Mundhawa	SD2	2010	45.0	SBR	42.0	
2	Bhairoba	SD3	2003	130.0	ASP + Dig.	80.0	
3	Naidu Old	SD4	1988	(90.0)	ASP	-	no operation
4	Naidu	SD4	2010	115.0	ASP	94.0	
5	Vithalwadi	SD5	2010	32.0	ASP	25.0	
6	Eradwane	SD8	2004	50.0	ASP	50.0	
7	Tanajiwadi	SD9	2004	17.0	Bio-Tow + EA	13.0	
8	Bopodi	SD10	2003	18.0	EA	15.0	
9	Baner	SD11	2010	30.0	SBR	31.0	
10	Kharadi	SD15	2012	40.0	SBR	42.0	
Total				477.0		392.0	

5.3.2 Treatment Efficiencies by different treatment process at STPs out of PMC in India

According to "Performance Evaluation of STPs in India Funded by NRCD" (August 2013, CPCB), sewage treatment technologies adopted under NRCD funded schemes can be classified into three groups.

- Natural system
- Conventional technology
- Advanced Technology

State-wise summary of treatment technologies is presented in Table 5.3.2. It is observed from the Table 5.3.2 that the most used technologies are UASB (37), Activated sludge process (19), oxidation pond (34) and waste stabilization pond (31).

Table 5.3.2 Treatment Technologies installed in India

Treatment Technologies / State	Natural Treatment Systems			Conventional Technology						Advanced Technologies			Others
	OP	WSP	AL	ASP	EA	TF	Cyclic ASP	UASB	K.T	SBR	FAB	Bio- far	
Andhra Pradesh	-	5	-	-	-	-	-	4	-	-	-	-	1
Bihar	1	1	1	2	-	-	-	-	-	-	-	-	-
Delhi	-	-	-	-	-	-	-	-	-	-	-	2	-
Goa	-	-	-	-	-	-	-	-	-	1	-	-	-
Gujrat	-	-	-	-	-	-	-	2	-	-	-	-	-
Haryana	3	4	-	-	-	-	-	9	-	-	-	-	-
Karnataka	-	8	-	-	-	-	-	-	-	-	-	-	1
Maharashtra	1	1	-	2	-	-	-	1	-	-	1	-	-
Madhya Pradesh	2	1	-	-	-	-	-	2	4	-	-	-	-
Punjab	2	-	-	-	-	-	-	6	-	1	-	-	2
Uttrakhand	1			1	-			2				-	-
Uttar Pradesh	9	-	-	2	1	1	-	10	-	-	1		-
Tamil Nadu	-	7	-	6	1		2	1	-	1	-	-	-
West Bengal	15	4	2	6	-	6	-	-	-	-	-	-	1
Kerala	-	-	-	-	-	-	-	-	-	-	-	-	1
Total	34	31	3	19	2	7	2	37	4	3	2	2	6

Source: Performance Evaluation of Sewage Treatment Plants in India Funded Under NRCD"(August 2013, CPCB)

This document also shows treatment performance for each STP. Table 5.3.3 summarizes the performance for ASP and its similar processes (mechanical aeration process) excluding Oxidation Pond(OP), Waste Stabilization Pond(WSP), Aerated Lagoon(AL), Trickling Filter(TF), Upflow Anaerobic Sludge Blanket(UASB) (rather natural treatment processes). The overall average of effluent BOD concentration is 17.3 mg/l, however, some data show unusual level. After screening data of some STPs, influent of which exceeds 300 mg/l or less than 100 mg/l and/or effluent exceeds 50 mg/l; an average effluent quality arrived at 8.1 mg/l. Under this condition, activated sludge process would achieve less than 10 mg/l of BOD.

Table 5.3.3 Performance of NRCP funded STP

No.	Name of STP	Process	Design Capacity (MLD)	Actual Treatment (MLD)	Inlet BOD (mg/l)	Effluent BOD (mg/l)	Selected
2	Jajmau	ASP	130	100	314	69	
12	Salori	FAB	29	22.7	44	23	
14	Naini	ASP	60	27.57	69	17	
16	Bhagwanpur	EA	9.8	11.26	21.2	9.6	
26	Jagjeetpur	ASP	18			14	
29	Delhi	Bio-far	10	10	106	4	4
30	Sen	Bio-Far	10	10	306	3	3
40	Fulariwala	SBR	25	22	154	13.5	13.5
68	Tonca,panaji	SBR	12.5	12	270-350	<30	
81	Karur	EA	15	4	37	33	
82	Kodungaiyur	ASP	110	90	138	6	6
83	Koyambedu	ASP	60	60	129	9	9
85	Kumbakonam	ASP	17	7.8	433	2	
87	Madurai	ASP	125	17	180	3	3
88	Nesapakkam	ASP	40	43	138	5	5
90	Perungudi	ASP	54	65	135	25	25
91	Sakkimanglam	ASP	45.7	10	230	4	4
92	Thanjure	ASP	28	9	100	17	17
94	Avaniapuram	SBR	125	17	180	3	3
98	Beur	ASP	35	24	72	38	
99	Saidpur	ASP	45	33	130	5	5
111	Titagarh	ASP	4.5		110	58	
119	Garden	ASP	48	Trial	13	8	
125	Cossipore	ASP	45	Trial	7	7	
126	Naihati	ASP	12		55	8	
129	Jagaddal	ASP	10	10	126	66	
142	Tapovan	ASP,UASB	78+53	103	64+25	11	
149	Bhopal	Oxidation	8	8	102	64	
Average						17.5	8.1

Source: Performance Evaluation of Sewage Treatment Plants in India Funded by NRC

5.3.3 Treatment Efficiencies at the STPs in PMC

Most of the existing STPs except Naidu Old STP were constructed between the years 2003 and 2012 and operated properly. The operation status with issues and problems on the STPs (as of September, 2014) is summarized below.

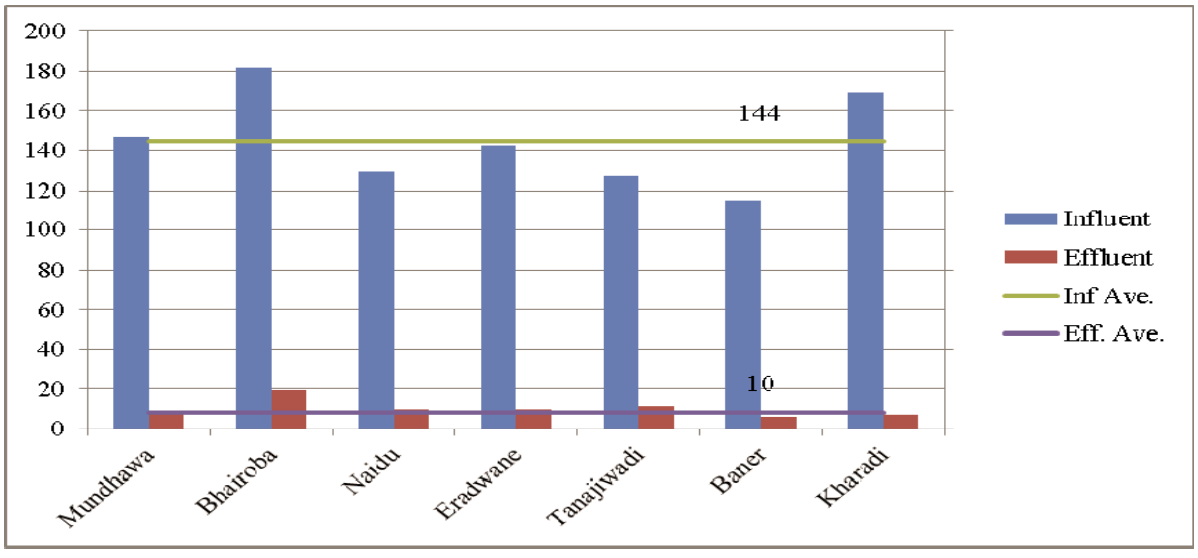
(1) Sewage Quality

The influent and effluent sewage quality for BOD_3 and TSS together with removal ratio are summarized in Table 5.3.4. The figures show an average from September 2013 to August 2014, which are recorded by PMC. The influent quality of BOD_3 ranges from 115mg/l to 182mg/l, while TSS ranges from 100mg/l to 253mg/l. Both BOD_3 and TSS of Bhairoba and Kharadi are high. On the other hand, effluent quality is good meeting the discharge water standards. Among them, BOD_3 of Bhairoba is high and nearly general standard limitation level. Figure 5.3.1 and Figure 5.3.2 presents BOD and TSS.

Table 5.3.4 Influent and Effluent Sewage Quality

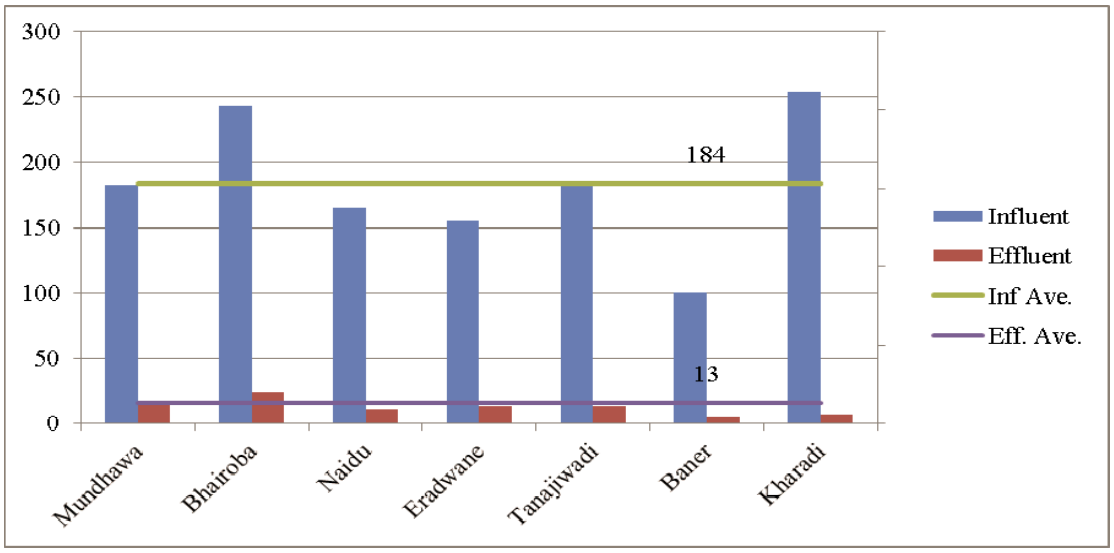
Name of STP	Influent (mg/l)		Effluent (mg/l)		Removal Ratio	
	BOD_3	SS	BOD_3	SS	BOD_3	SS
Standard Limitation			<20	<30		
Mundhawa	147	183	8	16	95%	91%
Bhairoba	182	243	19	24	89%	90%
Naidu	129	166	10	12	92%	93%
Eradwane	142	155	10	13	93%	92%
Tanajiwadi	127	185	11	13	91%	93%
Baner	115	100	6	5	95%	95%
Kharadi	169	253	7	7	96%	97%
Average	*144*	*184*	*10*	*13*	*93%*	*93%*
Max	*182*	*253*	*19*	*24*	-	-

Source: PMC



Source: PMC

Figure 5.3.1 Influent and Effluent in BOD_3



Source: PMC

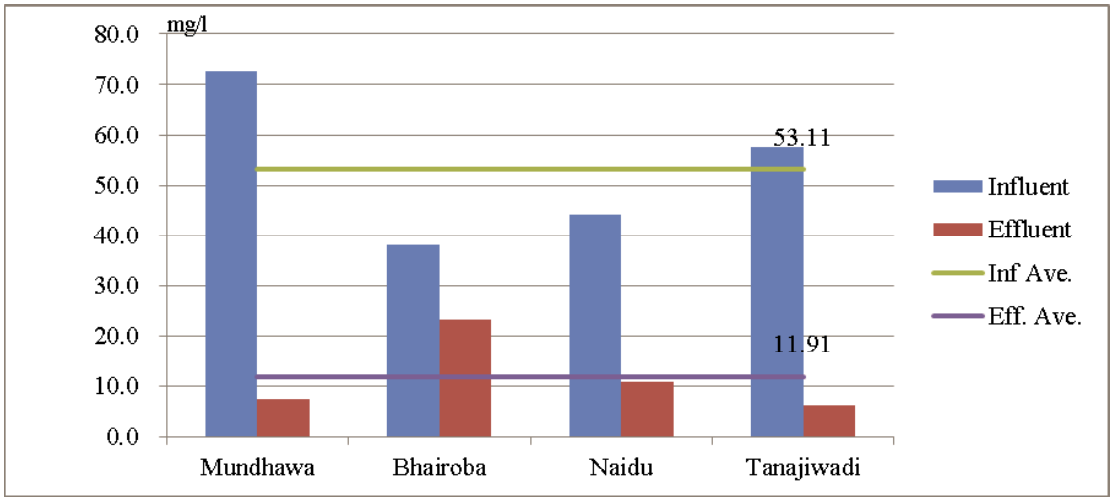
Figure 5.3.2 Influent and Effluent in TSS

Water quality examination was conducted through Preparatory Survey in November 2014.The results are shown in Table 5.3.5. T-N and T-P are shown in Figure 5.3.3 and Figure 5.3.4, respectively. Current T-P of effluent do not exceed 2 mg/l. Current T-N of effluent for Mundhwa (SBR) and Tanajiwadi (EA) is less than 10 mg/l and T-P of all four (4) STPs is less than 2 mg/l. However, it is difficult to assess the treatment performance or design condition for only one data, continuous monitoring of T-N and T-P is recommended.

Table 5.3.5 Influent and Effluent Sewage Quality

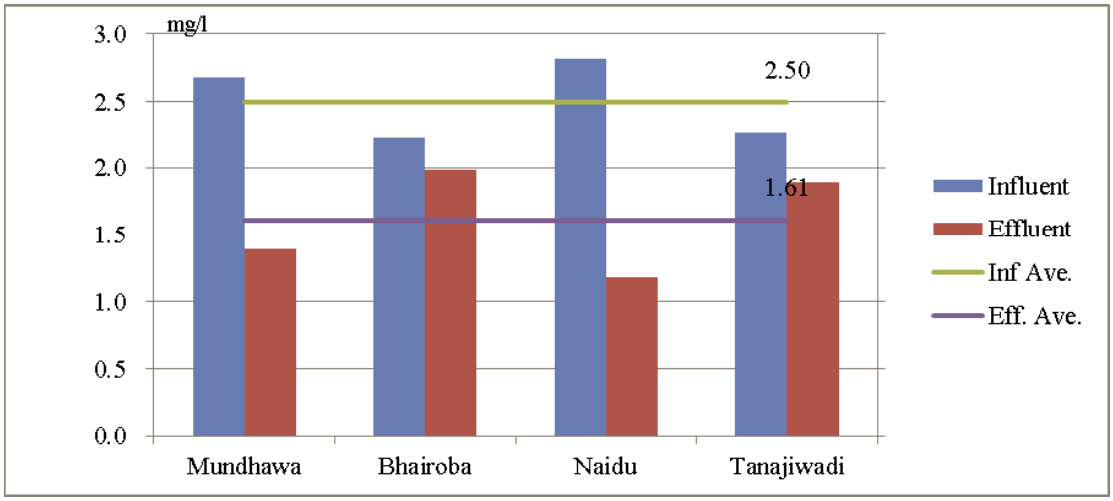
No.	Items	Unit	Mundhwa		Bhairoba		Naidu		Tanajiwadi	
			Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet
1	Water Temperature	ºC	27	27	27	26	27	27	28	28
2	pH value (H^+)	-	7.0	7.2	6.9	7.3	7	7.2	7.3	7.4
3	Dissolved Oxygen (DO)	mg/l	0.8	7.1	0	3.6	1.4	4.8	0.2	4.1
4	Biochemical Oxygen Demand (BOD_3)	mg/l	108	6.3	67.5	13	186	10	126	6
5	Chemical Oxygen Demand (COD)	mg/l	251	35.14	180.72	60.24	431.72	30.12	210.84	35.14
6	Total Suspended Solids (TSS)	mg/l	95	<5	105	10.7	197	<5	107	9.3
7	Ammonia (NH_4^+)	mg/l	42.98	1.56	23.57	18.3	27.73	2.52	37.15	2.44
8	Total Nitrogen (T-N)	mg/l	72.7	7.419	38.05	23.21	44.19	10.89	57.48	6.135
9	Total Phosphorus (T-P)	mg/l	2.68	1.39	2.22	1.99	2.82	1.18	2.26	1.89
10	Coliforms	CFU/ 100ml	>1600	140	>1600	530	>1600	860	>1600	430
11	Air Temperature	ºC	28	28	27	27	27	27	27	27

Source: JICA Survey Team



Source: JICA Survey Team

Figure 5.3.3 Influent and Effluent of T-N



Source: JICA Survey Team

Figure 5.3.4 Influent and Effluent of T-P

(2) Quality of Generated Sludge

The generated sludge at the existing STPs is currently delivered to farm lands for the use as fertilizer. Chemical analysis on the generated sludge at the existing STPs was carried out by the JICA survey, the results of which are shown in Table 5.3.6. The concentrations of the heavy metals of Cadmium, Arsenic, Nickel, Lead and Mercury were below the Japanese standards for the regulated limit of hazardous substances for the use of fertilizer or the EU council directive (86/278/EEC) for the regulated limit for the concentrations of heavy metals of treated sludge for agricultural use.

Table 5.3.6 Concentrations of Heavy Metals in Generated Sludge at Existing STPs

Unit in mg/kg

Parameter	STP				Japanese Standard[1)]	EU Council Directive[2)]
	Naidu	Bhairoba	Mundhwa	Tanajiwadi		
Cadmium	1.4	2.7	1.4	2.5	5	20 - 40
Arsenic	< 0.1	< 0.1	< 0.1	< 0.1	50	-
Nickel	26.3	94.2	58.4	67.9	300	300 - 400
Lead	17.8	61.9	41.0	17.2	100	750 - 1,200
Mercury	< 0.05	< 0.05	< 0.05	< 0.05	2	16 - 25
Chromium	28.7	42.0	22.8	18.3	500	-

Notes:
1) Japanese standards for the regulated limit of hazardous substances for the use of furtilizer, 1986
2) EU council directive (86/278/EEC) for the regulated limit for the concentration of heavy metals of treated sludge for agricultural use

(3) Issues and Problems on the operation of the STP

Basically operation the STPs seems to be adequate and the effluent quality meets general standards at present. The following are findings through site investigations during Preparatory Survey by JICA.

1) Mundha STP

There are no particular issues and problems having provided adequate O&M of facilities with an acceptable effluent quality level. It was found that several workers undertake the removal of scam at SBR tank. The dewatered sludge is used in the STP site and farmers in the vicinity of the STP.

2) Bhairoba STP

The treated effluent quality was the worst due to some problems;

・Screening facilities are not properly operated and debris are not removed timely.

・Operation of a reactor tank has been stopped for a long period and effluent quality seems to be lower than other STPs.

・Sludge digestion tank is not properly operated due to the problem of agitation equipment of the digestion tank and no installation of warming equipment (resulted in playing a role as sludge storage tank). Accordingly, gas-engine facilities have not been operated for a long time.

・Centrifugal type sludge dewatering machine is out of order.

・Caused by the above mentioned sludge treatment problems (anaerobic sludge is accumulated in the sewage treatment process), sewage treatment facilities are affected with lower effluent quality.

・Re-newel of sludge treatment facilities is urgent to improve effluent quality.

・There exist a pump station beside the STP for transmission of treated sewage for re-use purpose. In this regard, improvement of effluent quality is important.

3) Naidu STP

In general O&M of facilities is properly practiced and effluent quality is favorable with adequate

sludge treatment facilities. However, there is no provision of heating equipment for digestion tank and bio-gas generation facilities.

4) Vithalwadi STP

The operation of the STP was stopped since July, 2014 due to the trouble of electricity receiving facilities. The operation of the STP is yet to be resumed. However, a new O&M Contractor has been appointed (M/s. Degremont), and PMC is in the process of obtaining sanction for rectification of the STP so that it can be handed over to the new O&M Contractor. Due to the land limitation, deep aeration and tube-settlers are adopted in this STP.

5) Erandwane STP

There are no specific problems in O&M of facilities.

Effluent quality seems to be favorable through Primary and Secondary Clarifier using Tube Settler type. Facilities are arranged within quite limited land area available (0.7 ha), the depth of aeration tank is 8m.

6) Tanajiwadi STP

Water treatment is properly conducted. But there are some problems;

・Clogging of media at Bio-Tower seems to be frequently. In this regard, improvement of screen for proper removal of debris is recommended.

・The concentration of MLSS seems to be lower than design requirement, due to less inflow of organic substances into the Reactor. The provision of by-pass operation against Bio-Tower may be adopted in this case.

7) Bopodi STP

O&M of sewage treatment facilities is adequately conducted and dewatered sludge is dried at the STP site and disposed of properly out of the STP site. However chlorine injection equipment has been out of order since the year 2008.

8) Baner STP

There is no specific problem in O&M of facilities with favorable quality of the effluent. Dried sludge is used by farmers in the vicinity of the STP site.

9) Kharadi STP

This STP is the newest among existing STPs achieving favorable effluent quality.

CHAPTER 6 Water Pollution Status in Public Water Bodies

6.1 Drainage Basins in PMC

PMC is located near the Ghat range of Sahaydri Mountains and has generally steep to moderate slopes. The maximum and minimum levels are EL 674.77 m and EL 530.10 m, respectively. PMC is part of Bhima Sub basin which is included in the Krishna River basin.

There are 55 storm water drainage basins in PMC. The Mula, Mutha and Mula-Mutha River (after their confluence) are major water bodies. The main drainage channels are in the form of nallas running from hills up to two rivers. The network of natural drains is spread all over the project area. The total length of natural drainage in the city is about 362km.

6.2 Flow measurement

6.2.1 Flow measurement in Mula-Mutha River

Mula and Mutha are the two major rivers of the Bhima basin and have their confluence in the heart of the PMC at Sangamwadi. The river is termed as Mula-Mutha River after confluence and finally drains into the Bhima River. Water pollution of the rivers in the PMC area has been a major concern, which is mainly caused by discharge of sewage from the PMC. There is no flow measurement data available with PMC or the irrigation department for these two rivers.

6.2.2 Sewage flow measurement in Nallas

Sewage flow measurements were conducted in 6 major nallas during the preparation of the Sewerage DPR. The measurements were carried out in April and May when the flow does not include any natural stream flow (wet weather flow) and are summarized in Table 6.2.1. The locations of measurement points are shown in Figure 6.2.1.

Table 6.2.1 Measured Flow during Sewerage DPR Preparation stage

Sr. No	Description of Nalla	SD	Starting point	Outfall Point	Length in km	Measured Flow in MLD
1	Ambil Odha, Avinash Mitra Mandal	SD4	Katraj Gaon	Mutha River	11.00	59.87
2	Ambil Odha Near Outfall	SD4	Katraj Gaon	Mutha River	11.00	81.36
3	Kothrud Nalla	SD8	Kothrud	Mutha River	4.50	44.10
4	Bhairoba Nalla	SD3	Kondhwa	Mutha River	12.60	115.51
5	Warje Nalla	SD7	Warje	Mutha River	2.92	18.75
6	Manik Nalla	SD3	Cant. Area	Mutha River	6.70	23.29
7	Hadapsar Nalla	SD2	Hadapsar	Mutha River	13.70	12.46
	Measured Total Flow					355.34

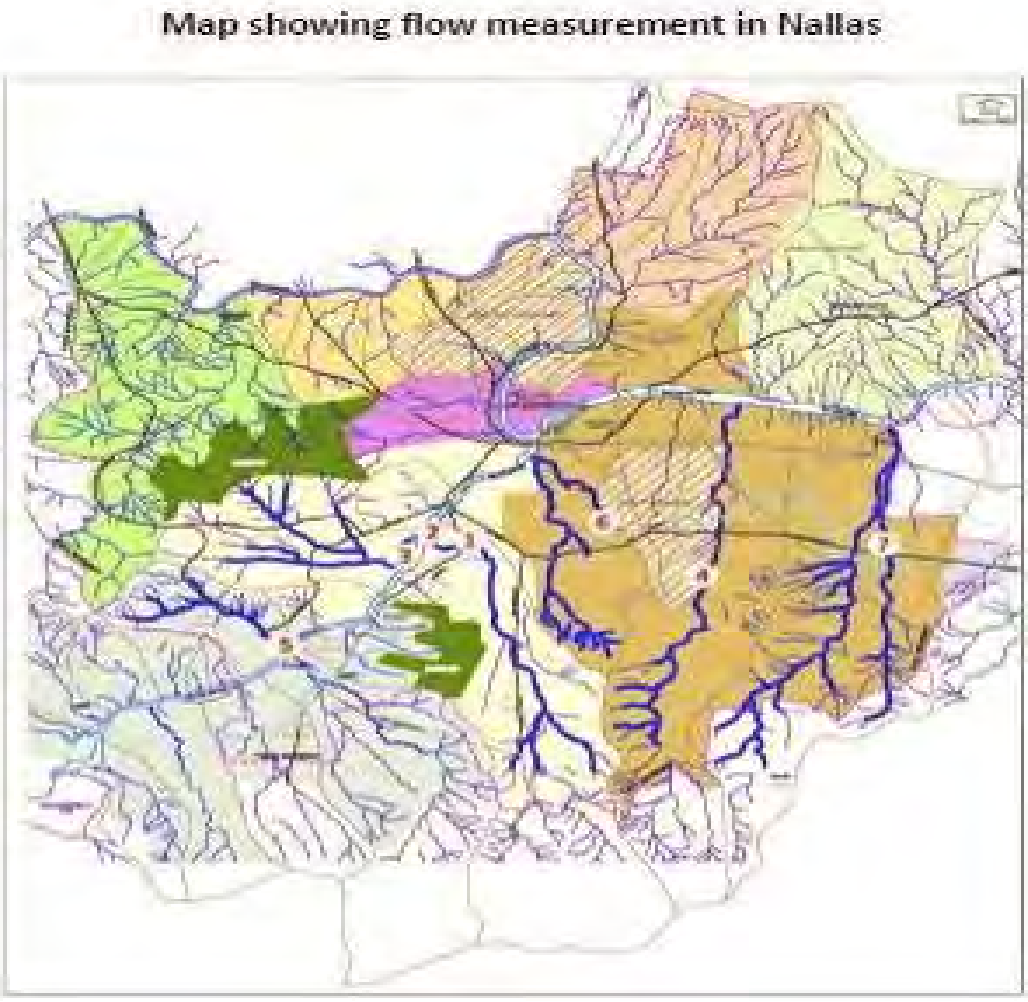


Figure 6.2.1 Locations of flow measurement points in Nallas (from Sewerage DPR)

According to the sewerage DPR, generated sewage volume at present and volume treated at existing STPs are about 673,000m^3/d and 447,000 m^3/d (sewage volume treated at present is estimated at 392,000 m^3/d as a result of Preparatory Survey, while 447,000 m^3/d is treatment capacity), respectively excluding Private STPs. Thus, the treatment service coverage is about 65 % and estimated sewage flow without treatment is estimated at 226,000 m^3/d (Preparatory Survey arrived at 252,000 m^3/d). The total sewage flow in the 7 nallas was measured at about 355,000 $m^{3/}$d, which includes groundwater infiltration. In consideration of measurement and estimation errors, raw sewage flow into the river may be 200,000 to 300,000m^3/day.

6.2.3 Water quality measurement in Mula-Mutha River

Water quality sampling at 15 locations along the Mula, Mutha and Mula-Mutha Rivers, and various nallas in PMC was conducted through JICA Preparatory Survey. The locations of the water quality

sampling points by the Survey are shown in Table 6.2.2 and Figure 6.2.2**.** Figure 6.2.3 presents sampling points as published by PMC in their Environmental Status Report (ESR). The ESR is annually prepared by PMC using water quality examination results prepared by Maharashtra State Government.

Table 6.2.2 Locations of Sampling Points through JICA Preparatory Survey

No	Location	No	Location	No	Location
1	Near Vadgaon	6	Near Dhanori STP	11	Bhairoba Nalla
2	Near Warje	7	Near Bhairoba	12	Tanajiwadi
3	Near Botanical Gardens	8	Near Mundhwa	13	Naidu STP
4	Near Tanajiwadi	9	Warje Nalla	14	Bhairoba STP
5	Near Naidu	10	Baner Nalla	15	Mundhwa STP

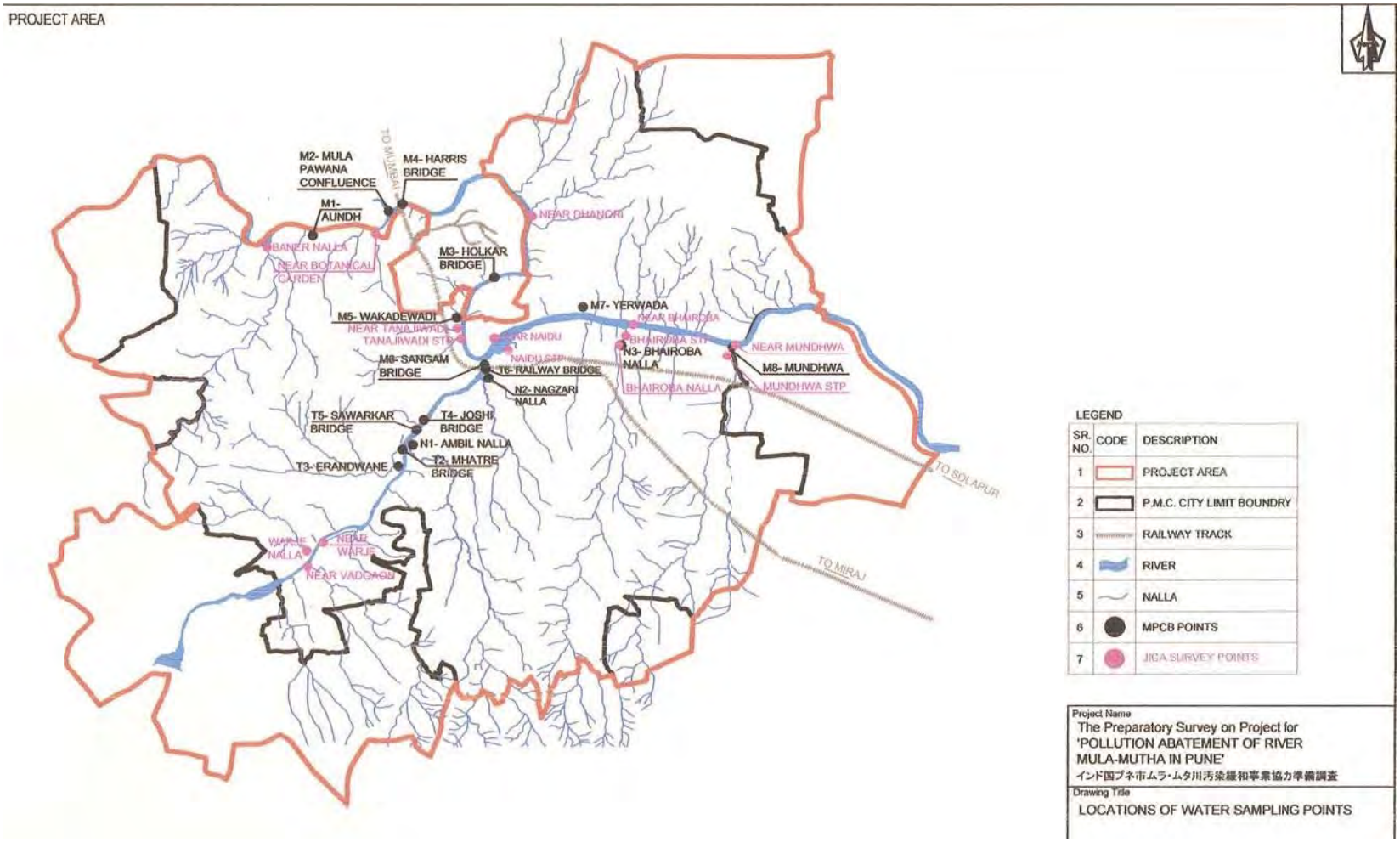


Figure 6.2.2 Locations of Sampling Points by JICA Preparatory Survey

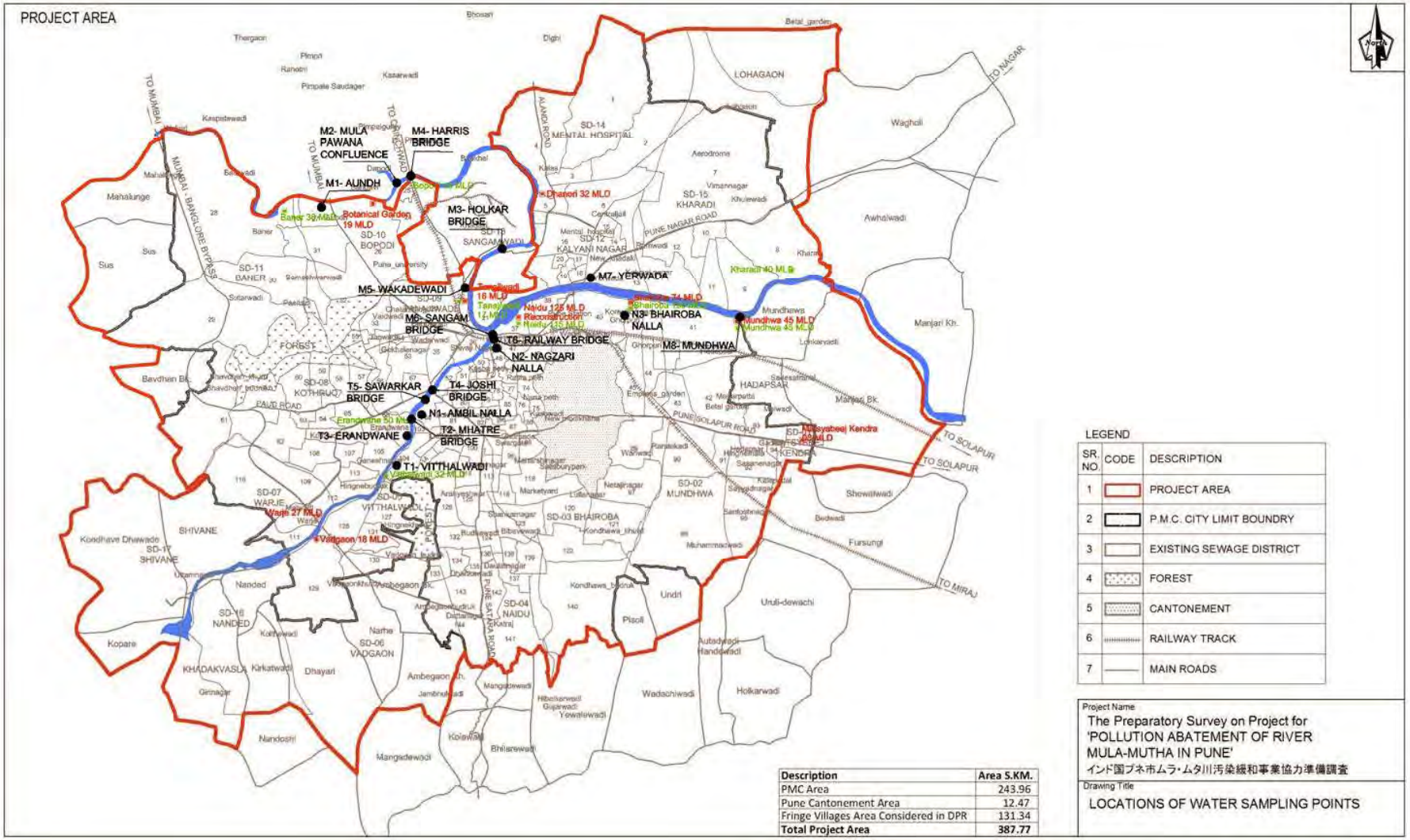


Figure 6.2.3 Location of Sampling Points along Rivers reported by PMC

6.2.4 Characteristics of Sewage Flow and water quality in Mula-Mutha River

Some raw sewage generated in the upstream area of PMC including Pimpri Chinchwad Municipal Corporation (PCMC) is presently discharged into Mula River. Then, Mula River enters into PMC area seemingly increasing the inflow of sewage from PMC (refer to Table 6.2.3: PMC's Environmental Status Report (ESR) for 2013-14). On the other hand, Mutha River winds its way through PMC area after collecting water discharged from Khadakvasla Dam. From the Table 6.2.4 and Table 6.2.5, it can be seen that the Mutha River is subjected to heavy pollution loads discharged through many nallas including Kothrud, Ambil Odha and Nagzari Nallas. Generally speaking, BOD and COD values in the Mutha River are higher than the Mula River. This is partially related to dilution water volume to inflow sewage. Namely, the river flow in the Mula River is larger than Mutha River.

The PMC's ESR for 2013-14 (see Table 6.2.3) states the minimum BOD of 15mg/l at Mula to the maximum BOD of 80mg/l at Erandwane in Mutha River (Table 6.2.4). Thus, the water quality (BOD) of the rivers is deteriorated, far beyond the standards for drinking purpose, which is less than 3 mg/l of BOD.

Dissolved oxygen (DO) is also a useful index to evaluate the water pollution status. Central Pollution Control Board states that DO should be higher than 5mg/l for drinking purpose. As per PMC's ESR for 2013-14, DO fluctuated from 0.1mg/l to 3.6mg/l in the last 5 years. From Table 6.2.3 and Table 6.2.5 regarding the water quality of Nallas, it is seen that the high DO concentrations are observed at Aundh where Mula River enters into the PMC and the low DO concentrations were recorded in Ambil Odha, Nagzari and Bhairoba Nallas where the Nallas pass through densely populated central part of the PMC.

With regard to Chemical Oxygen Demand (COD), PMC's ESR for 2013-14 reveals that COD fluctuated from the minimum of 30mg/l at Mhatre Bridge (refer Table 6.2.4) to 275mg/l (refer Table 6.2.5) at most of Nallas,

Table 6.2.3 MPCB observed values for pollution indices in Mula River

Water Body	Number	Location	Parameter	2009	2010	2011	2012	2013	2014
Mula	M1	Aundh	BOD	22	22	18	18	22	N.A
Mula			COD	35	60	45	60	60	N.A
Mula			DO	2.9	2	3.6	3.5	2.5	N.A

Wa-ter Body	Nu mbe r	Location	Parame-ter	2009	2010	2011	2012	2013	2014
Mula	M2	Holkar Bridge – PMC - MPCB Annual Average	BOD	30	25	22	20	25	N.A
Mula			COD	35	55	60	65	60	N.A
Mula			DO	2.75	1.6	2.75	2.9	2.4	N.A
Mula	M3	Harris Bridge PMC - MPCB Annual Average	BOD	45	28	20	15	28	N.A
Mula			COD	75	85	55	50	55	N.A
Mula			DO	0.5	1	3.25	2.75	2.1	N.A
Mula	M4	Wakdewadi PMC - MPCB Annual Average + JICA STudy	BOD	28	18	25	15	30	11.1
Mula			COD	30	50	60	50	50	58
Mula			DO	2.5	1.9	2.5	2.5	2.7	8.2
Mula	M5	Sangam Bridge PMC - MPCB Annual Average + JICA Study	BOD	40	22	20	18	25	76.5
Mula			COD	35	80	50	60	60	263.12
Mula			DO	2	1.1	3.1	3.2	2.5	0
Mula	M6	Yerwada PMC - MPCB Annual Average + JICA Study	BOD	45	20	28	18	30	10.95
Mula			COD	35	65	65	60	60	35.7
Mula			DO	0.5	0.6	1.5	2	2.4	3.3
Mula	M7	Mundhwa PMC - MPCB Annual Average + JICA Study	BOD	35	30	30	30	45	16.5
Mula			COD	100	70	80	90	95	81.6
Mula			DO	0.4	0.6	1.25	2.3	2.8	0.8
Mula	J1	Near Botanical Garden JICA Survey	BOD	N.A	N.A	N.A	N.A	N.A	11.7
Mula			COD	N.A	N.A	N.A	N.A	N.A	75
Mula			DO	N.A	N.A	N.A	N.A	N.A	8.6
Mula	J2	Near Botanical Garden JICA Survey	BOD	N.A	N.A	N.A	N.A	N.A	18
Mula			COD	N.A	N.A	N.A	N.A	N.A	96.14
Mula			DO	N.A	N.A	N.A	N.A	N.a	7.8

Note: N.A - Not Available

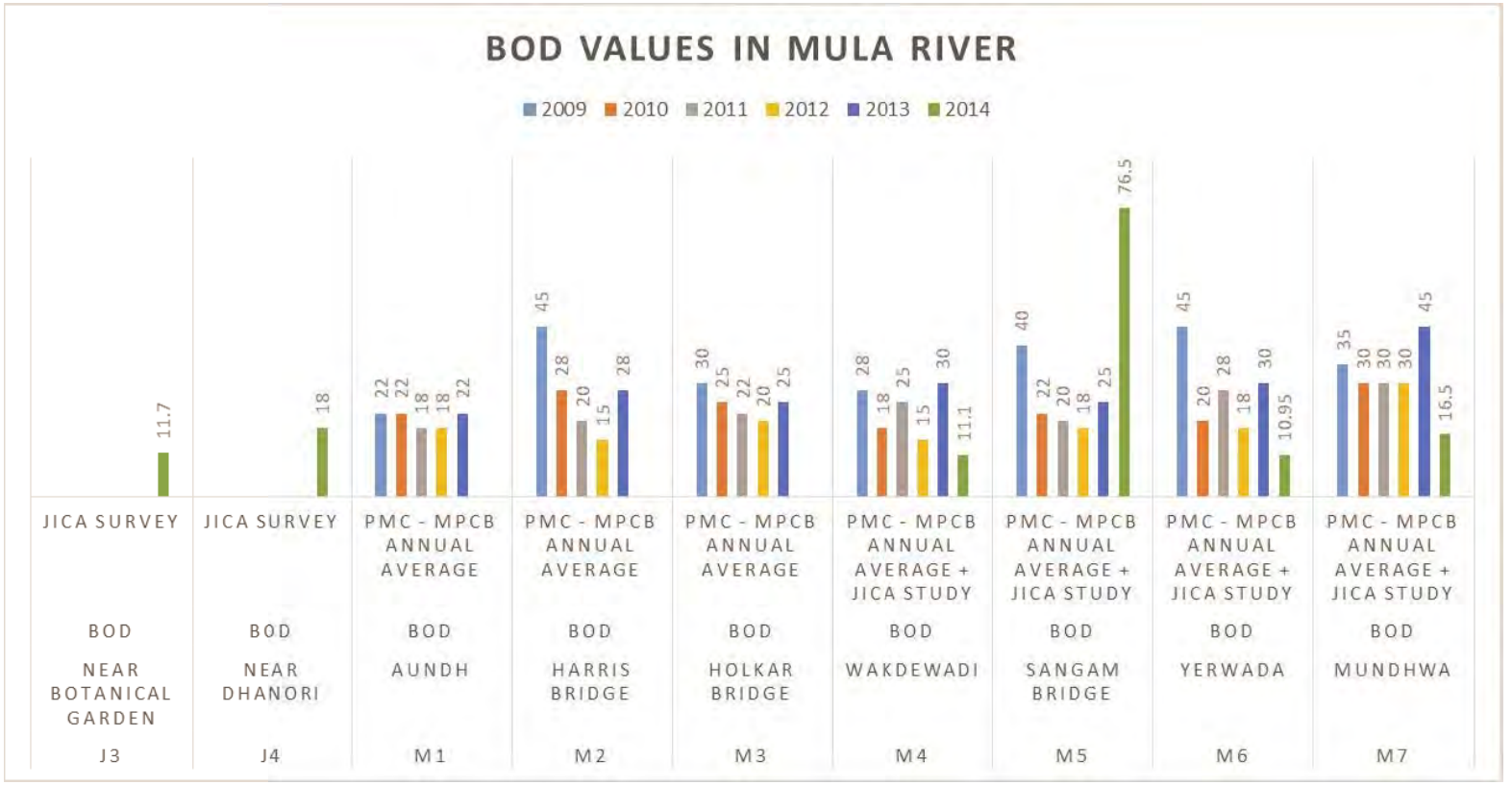


Figure 6.2.4 BOD Concentrations along the course of Mula River

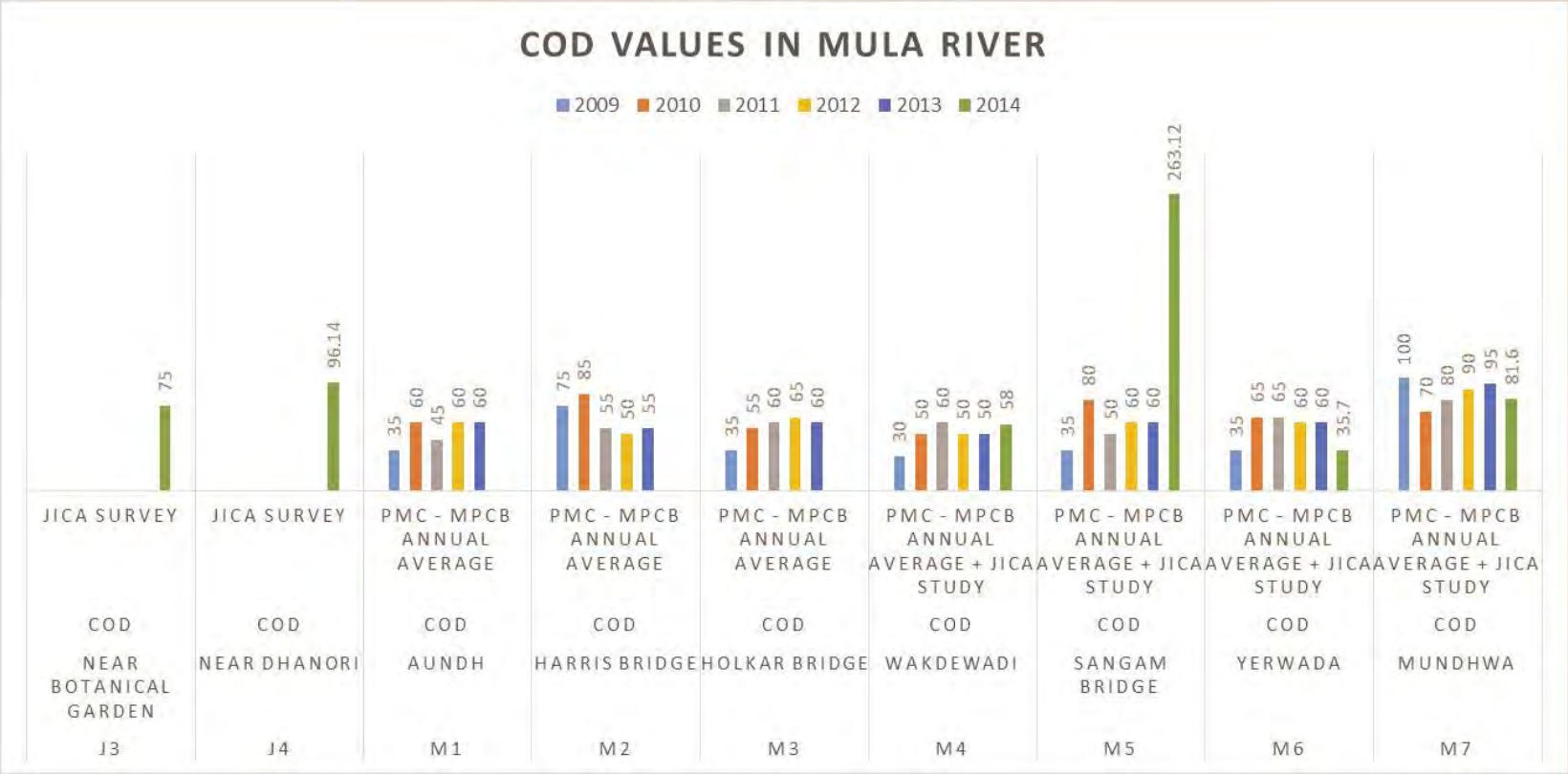


Figure 6.2.5 COD Concentrations along the course of Mula River

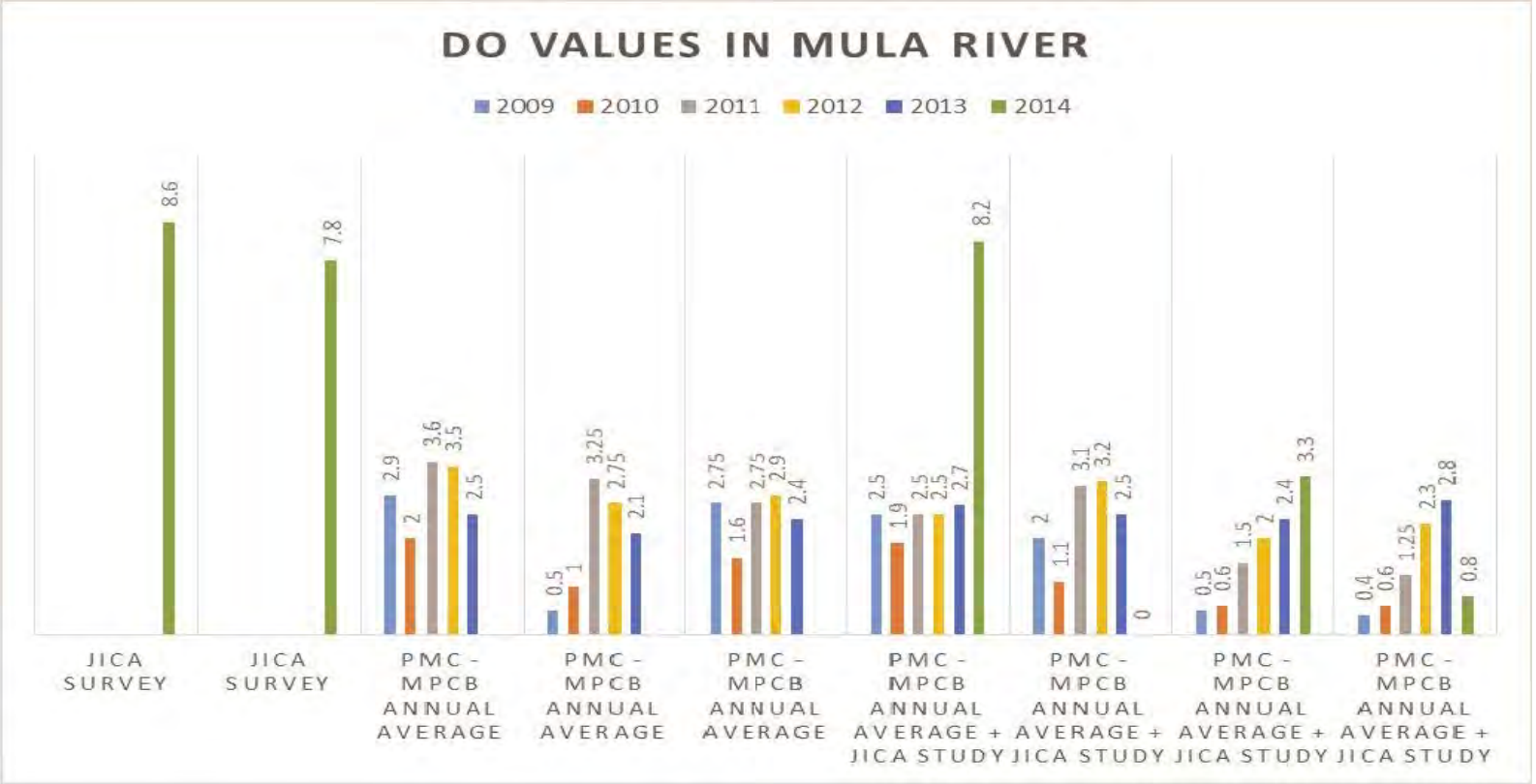


Figure 6.2.6 DO Concentrations along the course of Mula River

Table 6.2.4 MPCB Observed values for pollution indices in Mutha River

Water Body	Num-ber	Location	Index	2009	2010	2011	2012	2013	2014
Mutha	J3	Vadgaon- JICA Survey	BOD	N.A	N.A	N.A	N.A	N.A	9.4
Mutha			COD	N.A	N.A	N.A	N.A	N.A	35
Mutha			DO	N.A	N.A	N.A	N.A	N.A	5.13
Mutha	J4	Warje - JICA Survey	BOD	N.A	N.A	N.A	N.A	N.A	60
Mutha			COD	N.A	N.A	N.A	N.A	N.A	175
Mutha			DO	N.A	N.A	N.A	N.A	N.A	1.75
Mutha	T1	Vithalwadi	BOD	35	30	25	20	25	
Mutha			COD	60	75	55	65	65	
Mutha			DO	1	NA	2.4	2.5	2.7	
Mutha	T2	Mhatre Bridge	BOD	30	15	25	20	30	
Mutha			COD	30	45	60	65	105	
Mutha			DO	0.75	0.75	2.3	1.6	2.5	
Mutha	T3	Erandwane	BOD	80	35	30	20	40	
Mutha			COD	70	150	90	70	120	
Mutha			DO	NA	NA	0.8	1.2	2.1	
Mutha	T4	Joshi Bridge	BOD	40	35	35	22	18	
Mutha			COD	80	110	100	70	55	
Mutha			DO	0.1	0.1	0.6	0.9	1.8	
Mutha	T5	Sawarkar Bridge	BOD	40	40	40	22	25	
Mutha			COD	50	150	100	75	80	
Mutha			DO	0.1	0.1	0.6	1	2	
Mutha	T6	Railway Bridge	BOD	65	35	35	18	40	
Mutha			COD	40	105	100	60	140	
Mutha			DO	NA	NA	0.8	1.3	2.5	

Note: N.A- Not Available

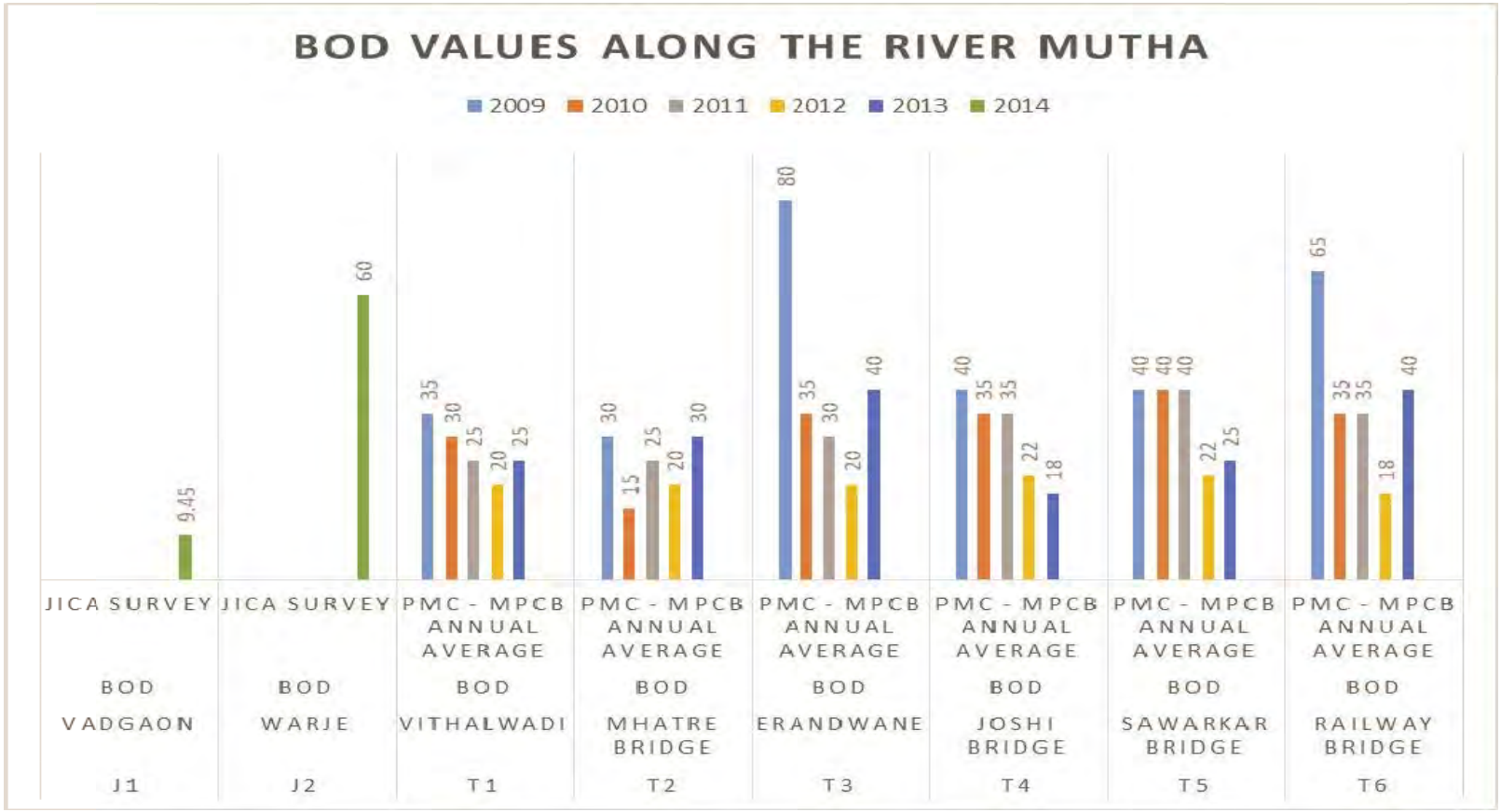


Figure 6.2.7 BOD Concentrations along the course of Mutha River

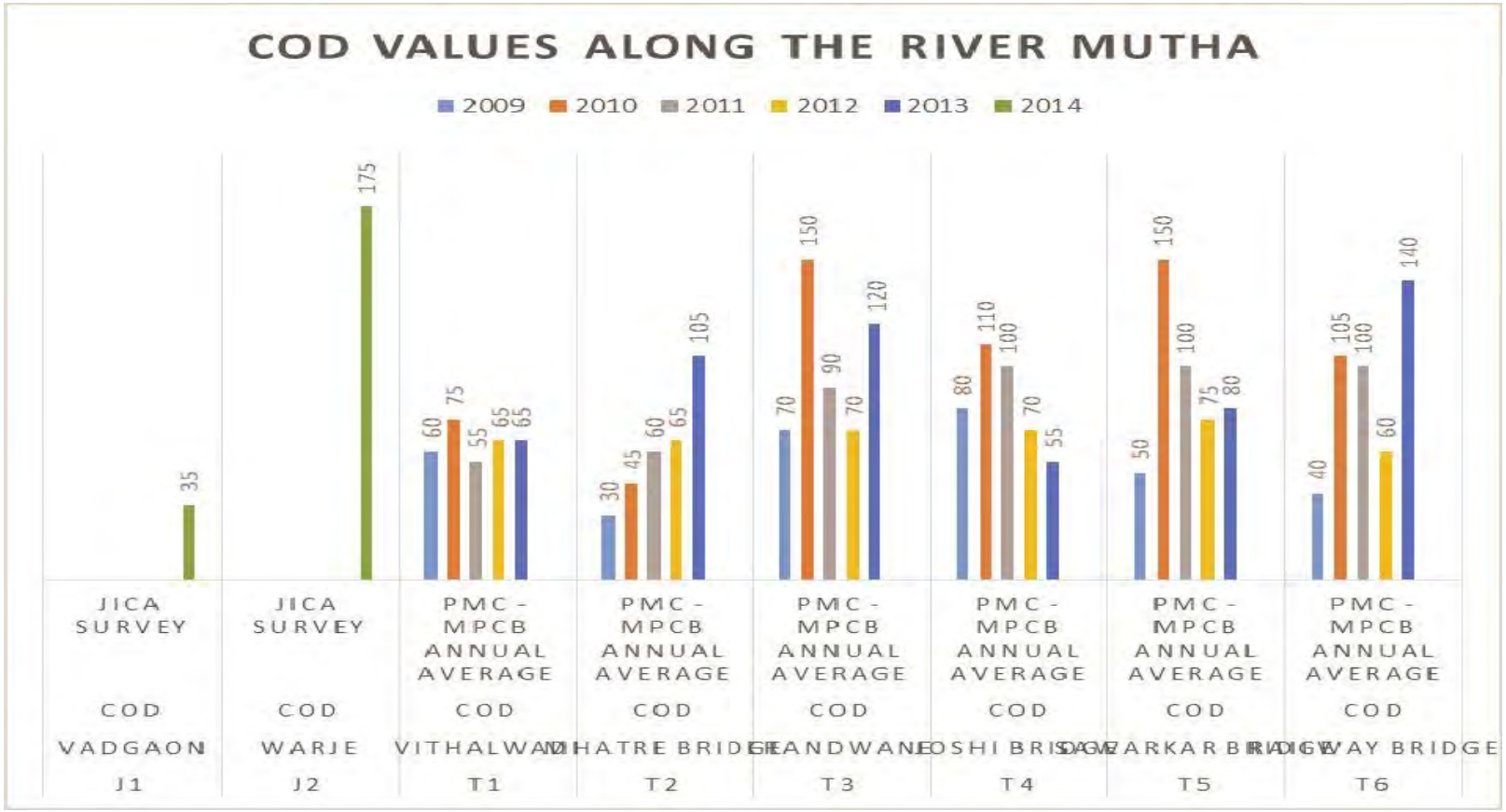


Figure 6.2.8 COD Concentrations along the course of Mutha River

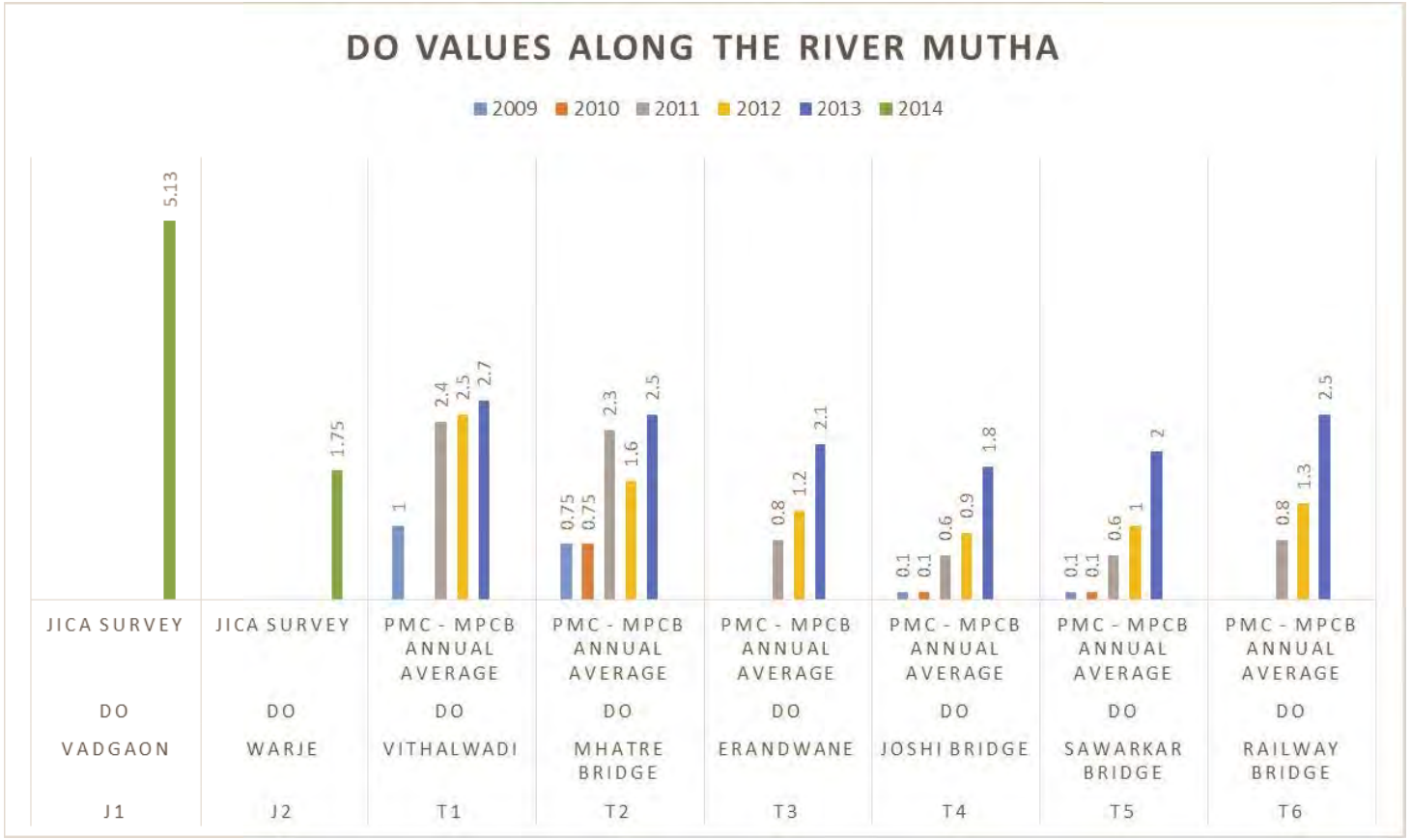


Figure 6.2.9 DO Concentrations along the course of Mutha River

6.2.5 Characteristics of Sewage Flow and water quality in Nallas

Table 6.2.5 shows BOD and COD in Nallas from 2009 to 2013 in the PMC, and these are quite high comparing with those observed in the rivers. BOD concentrations in nallas were observed from 100 to 115mg/l until 2011 and then dipped to 70 to 80mg/l after 2011. This was due to commissioning of some STPs around 2009 to 2012 that discharge treated sewage into the Nallas, and also due to expansion of the sewer networks. However, after 2011, the water quality has started to deteriorate again due to continued population increase in the catchment area and discharge of untreated sewage into the Nallas.

Table 6.2.5 Observed values for pollution indices in PMC in Nallas

Year	N1- Ambil Nalla			N2- Nagzari Nalla			N3- Bhairoba Nalla		
	DO	BOD	COD	DO	BOD	COD	DO	BOD	COD
2009	0.1	105	175	0.1	90	180	0.1	105	240
2010	N.A	105	210	N.A	100	250	N.A	105	250
2011	N.A	115	205	N.A	115	275	N.A	115	275
2012	0.1	70	225	0.1	70	240	0.1	70	225
2013	0.15	75	200	0.15	70	175	0.15	80	240

N.A – Not Available

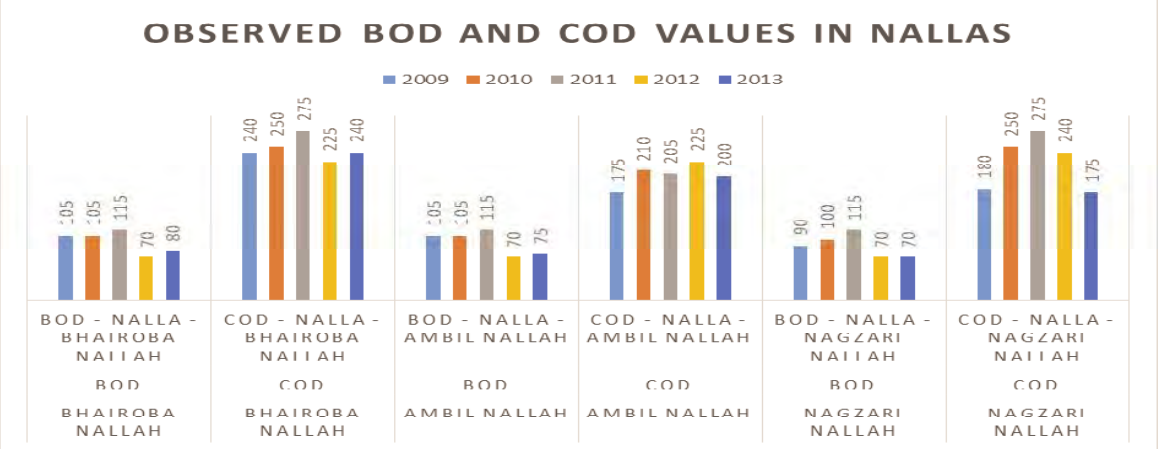


Figure 6.2.10 Water Quality examined in Nallas from 2009 to 2013

6.3 Annual and Seasonal Fluctuation of water Quality

6.3.1 Annual Fluctuation of Water Quality

Figures in section 6.2.4 show that the pollution indices in Mutha and Mula Rivers have reduced considerably after 2011. This is because five STPs (see Table 6.3.1) with a total treatment capacity of 262 MLD were commissioned between 2009 and 2012 and have been discharging effluent to meet the design effluent quality.

Table 6.3.1 List of existing STPs with capacities and year of commissioning

Sr. No	Name of STP	Capacity in MLD	Process	Year of Commis-sioning	BOD re-moved in Kgs
1	Bhairoba Nalla	130	ASP	2003	16900
2	Erandwane	50	ASP	2004	6500
3	Tanajiwadi	17	Bio-Tower	2004	2210
4	Bopodi	18	EA	2003	2340
5	Naidu Hospital (Old) – Not considered	90	ASP	1988	0
	Sub-Total (1988-2004)	215 (305)			27,950
6	Mundhwa	45	SBR	2009	5850
7	Vithalwadi	32	ASP	2009	4160
8	Naidu Hospital New	115	ASP	2010	14950
9	Baner	30	SBR	2010	3900
10	Kharadi	40	SBR	2012	5200
	Sub-Total (2009-2012)	262			34,060
	Total (excluding Old Naidu)	477 (567)			62010

Note: Reduction of BOD is calculated assuming inflow and effluent BOD of 150mg/l and 20 mg/l, respectively.

As can be seen from Table 6.3.1 most of the STPs in PMC were constructed in the last 12 years and demonstrated the effectiveness of water pollution control by the STPs. They can be grouped into 2; Group 1 STPs (Bhairoba, Erandwane, Tanaji Wadi and Bopodi) were commissioned between 2003 and 2005. The total design capacity of these 4 STPs is 215 MLD, and with an average raw sewage BOD of 150mg/l and treated effluent BOD of 20mg/l, these 4 STPs resulted in an average BOD load reduction of 27,950kg/day. The group 2 STPs have been constructed between 2009 and 2012 (Mundhwa, Vithalwadi, Baner, New Naidu and Kharadi). The total installed capacity of these 5 STPs is 262 MLD with average BOD reduction of 34,060kg/day.

With the commissioning of group 2 STPs, the water quality in Mula and Mutha has improved. For example, the COD and DO concentrations measured at Yerawada on Mula River (Figure 6.2.5 and Figure 6.2.6) show improvement after commissioning of New Naidu STP. Similarly BOD and DO

concentrations show improvement after commissioning of Vithalwadi STP (Figure 6.2.7and Figure 6.2.8). However, the quality of water in the river needs to be further improved as the BOD of the river flowing in the PMC area is reported at 45 mg/l (Figure 6.2.4).

6.3.2 Seasonal Fluctuation of water quality

Seasonal variation was observed in Mula and Mutha Rivers, and Nallas. In PMC, the monsoon season (rainy season) is normally from June to September (sometimes up to October). A typical monthly pattern of rainfall and number of rainy days (average data from 1989 to 2012) is shown in Table 6.3.2.

Table 6.3.2 Monthly Rainfall pattern in PMC

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly
Precipitation mm	0	0.5	5.3	16.6	40.6	116.1	187.2	122.3	120.1	77.9	30.2	4.8	721.7
Avg. precipitation days	0.0	0.1	0.6	1.1	2.8	7.5	12.8	10.6	7.4	4.6	2.0	0.4	49.9

Monthly variations of BOD in Mula River, Mutha River and Nalla are shown in Figure 6.3.1, Figure 6.3.2 and Figure 6.3.3, respectively. Higher concentrations of BOD are observed in the months of Jan, Feb and Dec, which are non-rainy (dry) months, and hence this phenomena leads to the obvious conclusion that storm water run-off dilutes pollutants. Higher values were observed near Sangam Bridge, which is the proximity of the outfall of Nagzari Nalla. While, in Mutha River, high values were observed at Railway Bridge.

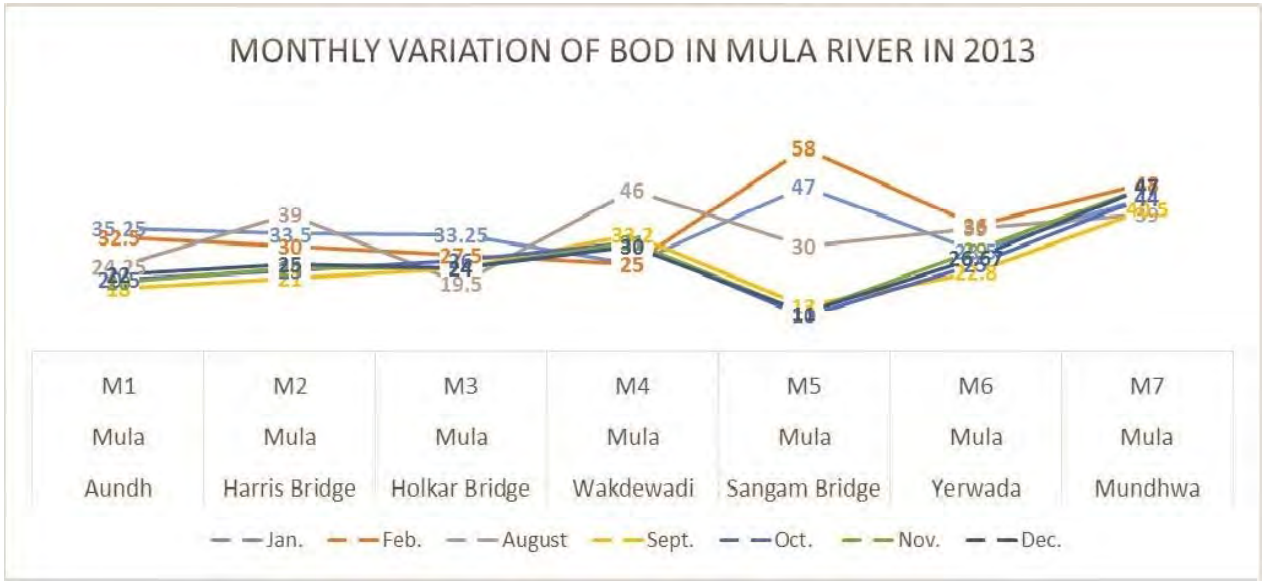


Figure 6.3.1 Monthly variation of BOD values in Mula River

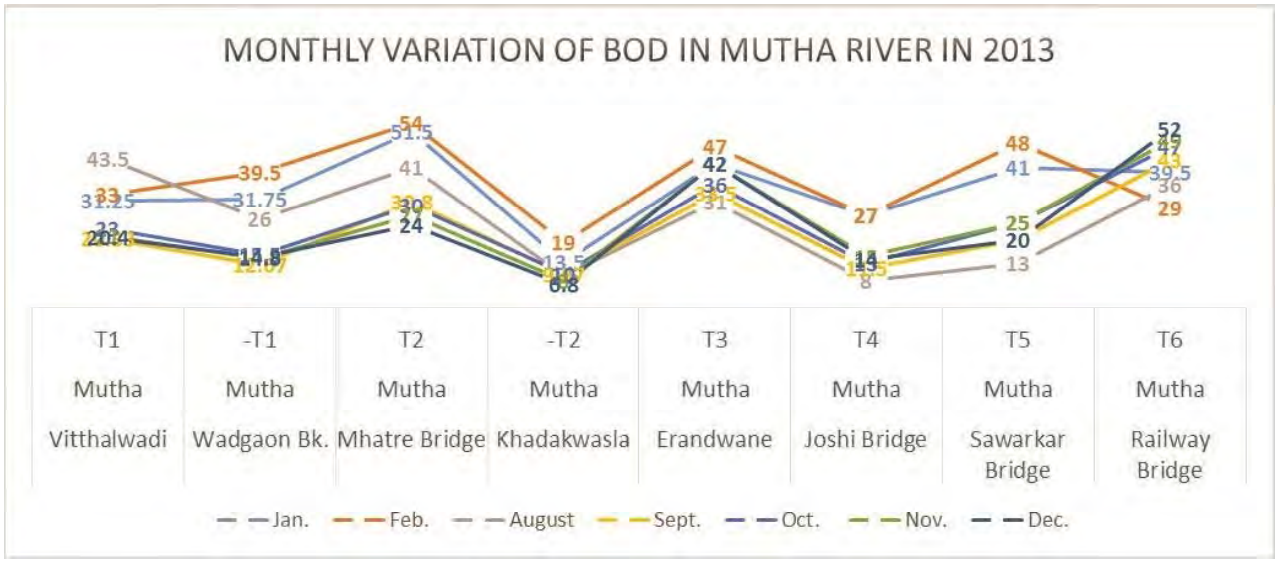


Figure 6.3.2 Monthly variation of BOD values in Mutha River

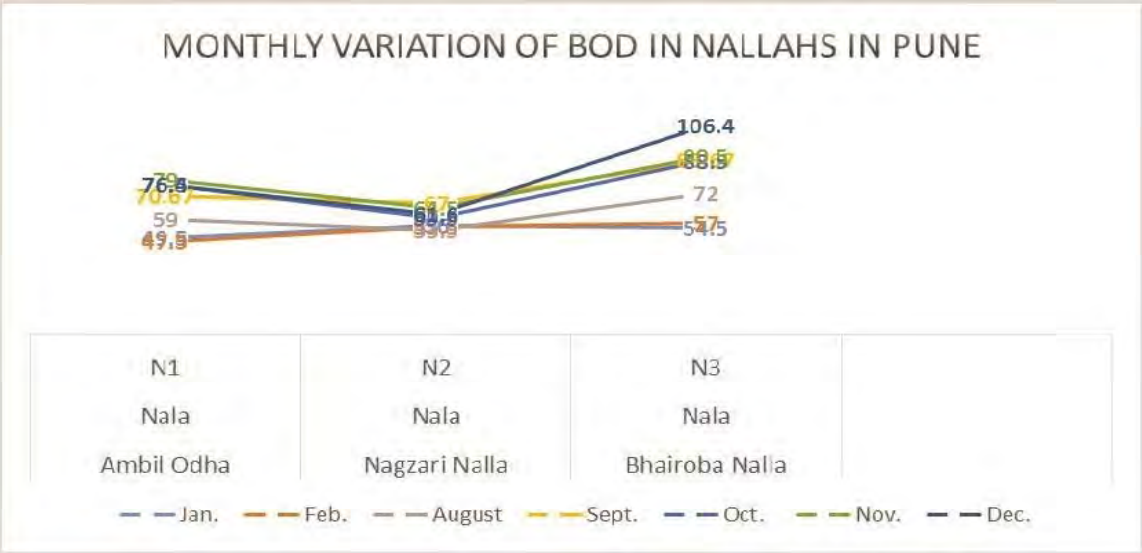


Figure 6.3.3 Monthly variation of BOD values in Nallas

6.3.3 Analysis of Sewage Treatment

All sewage treatment plants under PMC's jurisdiction measure inflow and effluent quality indices. Such measurements ensure that the quality of effluent discharged from the STPs is within the MPCB standards. The water quality indices are measured on a daily basis at a laboratory installed at each STP.

By the year 2009, the sewage treatment plants had been operational at Old Naidu, Bhairoba, Erandwane, Tanajiwadi, and Bopodi with a combined treatment capacity of 305,000m^3/day. These plants reduced the organic load (BOD) by about 39,000kg/d in a total.

STPs were then constructed at Vithalwadi, New Naidu and Baner since 2008.The total treatment capacity is 177,000m^3/day reducing the BOD load by about 23,000kg/d. This BOD load reduction is the main cause of improvement in water quality in Mutha and Mula Rivers.

However, the water quality has been observed to deteriorate again in 2013 as per the ESR. This is attributed to additional polluted flows entering the rivers from Nallas.

6.4 Existing Sewerage system and Future improvement plan upstream of Mula-Mutha River (PCMC area)

The topography of PMC necessitates the drainage of fringe areas of the city located upstream of main rivers, Mula/Mutha rivers through the city. Pimpri Chinchwad Muncipal Corporation (PCMC) is the only major area which discharges mostly treated sewage, directly into the rivers.

PCMC is a modern twin city, situated in the North-West quadrant of PMC. The PCMC is located in the

Deccan Plateau and is surrounded by hills. It is situated 530 m above the mean sea level. Pavana River, a tributary of Mula River, traverses the city, while the Indrayani River flows through the north-western outskirts. Mula River forms a boundary of PMC and PCMC (refer to figure 6.4.29. The area of Mula River basin falling under PCMC jurisdiction has an approximate population of 1,686,000 (2,000,000 x 285/338).

6.4.1 Existing Sewerage systems

Total sewage generated in PCMC at present is estimated by PCMC at 291 MLD, of which 225 MLD is collected by existing sewer systems and transferred to respective pumping stations. Then, the sewage is treated at respective STPs in application of various kinds of treatment processes such as Sequential Batch Reactor (SBR), Activated Sludge Process (ASP), Bio-towers, Aerobic Bioreactor (FAB) etc.
Table 6.4.1 presents outline of sewerage systems in PCMC. Table 6.4.2 summarizes existing Sewage Treatment Plants and their locations along with pump stations. Operation & maintenance of the STPs is undertaken by private contractors.

Table 6.4.1 Outline of Sewerage Systems in PCMC

Item	Present Figure (2013-14)
Total population (2011) of PCMC	1.729 Million
Estimated population (2013)	2.0 Million (Population in Mula River basin; 84.3%= 285/338)
Total sewage generation in 2013	291 MLD
Total length of sewer line in 2013	1287 km
Area covered by sewerage systems	70-80% (225/291=77%)
No. of STPs	13
Total capacity of existing STPs	338 MLD
Sewage Treated by STPs	225 MLD[1]
Types of Treatment	Treatment method: Improved S.B.R., ASP, S.B. R, FAB, Bio Tower

Source: Environment Engineering Department, PCMC

1. The volume of sewage treated is less than the STP capacity as the sewerage network is incomplete. Main/sub-main sewers are to be laid to bring the collected sewage to the STPs.

There are 10 STPs in Mula River basin of PCMC. The Mula River basin includes two nallas; Kaspatevasti Nalla & Sant Sawata Mali Garden Nalla. Kaspatevasti Nalla is polluted receiving sewage from the basin, while Sant Sawata Mali Garden Nalla is comparatively clean (Refer to Figure 6.4.1 on the location of nallas).

Some effluent from STPs in PCMC is discharged into Mula River. While, in the areas where there is no access to the sewers, they (including residents and commercial establishments) have septic tanks

and the effluent runs to the nallas and eventually to the rivers.

Table 6.4.2 Existing Sewage Treatment Plants in PCMC (April 2013- June 2013)

Sr. No	STP	Basin	Capacity (MLD)	Average Sewage Pumped (MLD)	Method
1	Chikhali 1	Indrayani	16	--	ASP, Under Modification
2	Chikhali 2	Indrayani	16	12.90	ASP
3	Akurdi	Mula (Pawana)	30	25.60	ISBR
4	Ravet	Mula (Pawana)	20	6.00	SBR
5	Chinchwad Phase I (Bhatnagar)	Mula (Pawana)	30	12.40	ASP
6	Chinchwad Phase II	Mula (Pawana)	30	26.60	SBR
7	Kasarwadi Phase I	Mula (Pawana)	40	--	ASP, Under Modification
8	Kasarwadi Phase II	Mula (Pawana)	40	35.00	ASP
9	Kasarwadi Phase III	Mula (Pawana)	40	30.10	SBR
10	Charholi	Indrayani	21	7.80	SBR
11	Sangvi Phase I	Mula	15	6.10	FAB
12	Sangvi Phase II (Dapodi)	Mula	20	9.40	SBR
13	Pimple Nilakh	Mula	20	15.90	Bio Tower
	Total		338		Mula; 285, Indrayani; 53 MLD

Source: Environment Engineering Department, PCMC

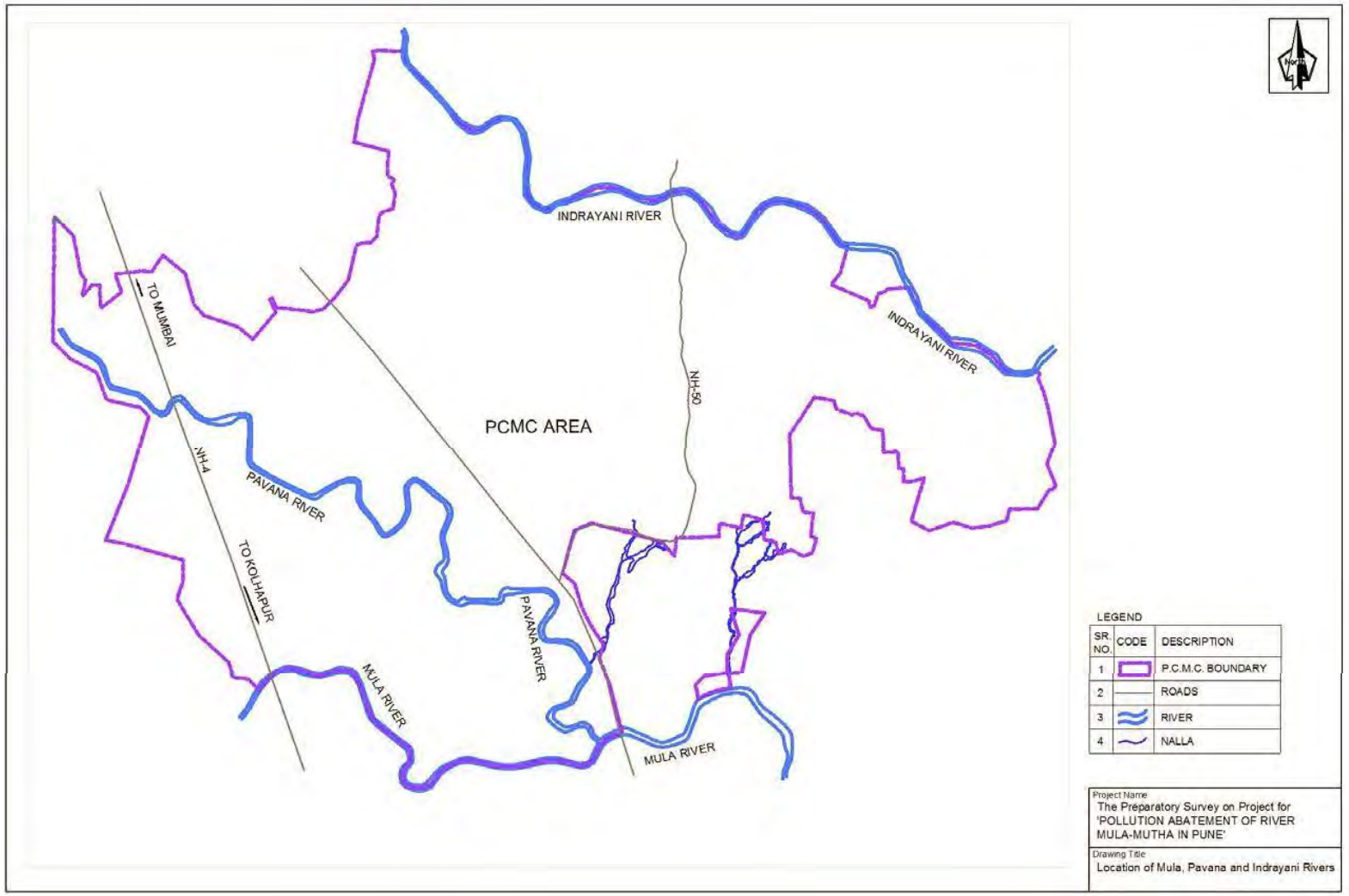


Figure 6.4.1 Map showing Nallas joining Mula River with parameters

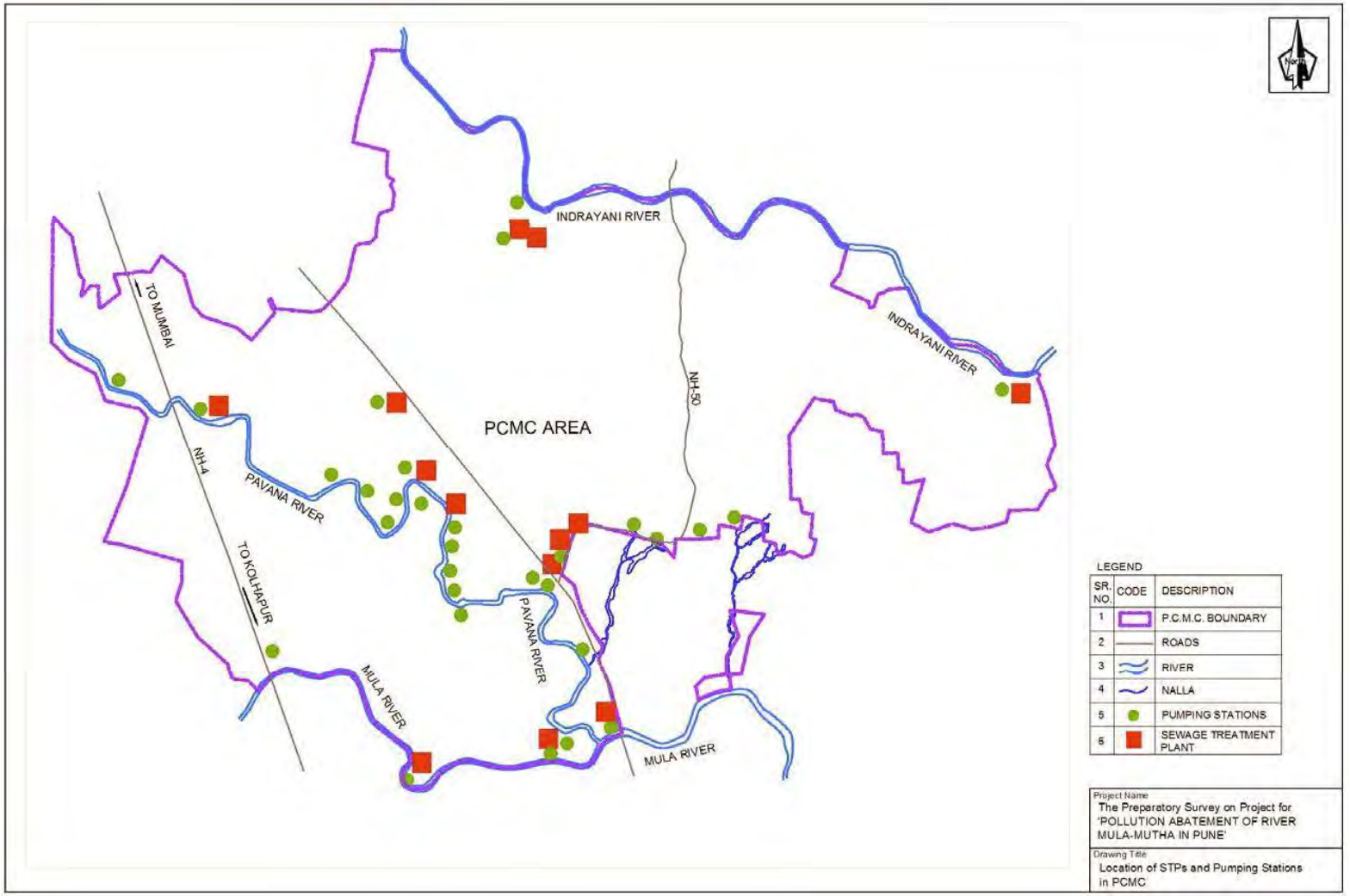


Figure 6.4.2 Location of STPs and Pumping Stations (Source PCMC ESR 2013-14)

The inflow and effluent sewage quality at the STPs located in the Mula river basin is shown below.

Table 6.4.3 The inflow and effluent sewage quality at the STPs located in the Mula river basin

STP Name	Flow	Type of treat-ment	Inflow sewage quality			Effluent quality		
	MLD		BOD	COD	TSS	BOD	COD	TSS
						≤ 30	≤ 250	≤ 100
Ravet	6.0	SBR	64.2	98.9	117.1	8.7	23.6	28.7
Chinchwad 1 Bhatnagar	12.4	ASP	114.5	241.8	179.1	6.8	22.2	6.8
Chinchwad 2	26.6	SBR	114.9	240.7	128.4	13.7	52.9	22
Kasarwadi 1		ASP	Under Modification					
Kasarwadi 2	35.0	ASP	108.6	309.8	128.7	6.5	25.1	7.5
Kasarwadi 3	30.1	SBR	136.4	389.6	155.2	5.5	28.2	7.4
Sanghvi Phase 1	6.1	FAB*	142.4	380.1	284.3	5.1	27.3	18.5
Sanghvi Phase 2 (Dapodi)	9.4	SBR	142.4	380.1	284.3	5.1	27.3	18.5
Pimple Nilakh	15.9	Bio Tower	189	582.3	199.1	9.6	30.5	11.8
Akurdi	25.6	ISBR	84.2	173.7	181.4	7.2	24.9	7.7
	167.1		121.8			7.6		

Source: Environment Engineering Department, PCMC
Note: Data for Sanghvi Phase II is only available. Same has been assumed for Sanghvi Phase I.

In assumption that 77% (average service % of 70 to 80% reported by PCMC) of residents in Mula River basin are served by existing sewerage systems and overall average BOD is 120.5mg/l, generated BOD in the subject basin arrives at 26,150 kg/day (167,100m^3/d x 120.5 g/m^3)/0.77). The total sewage volume in the basin is estimated at about 209,000m^3/d- 238,000m^3/d (service coverage of 70 to 80%).

About 23% of generated BOD in the basin is discharged to the river through Septic Tanks (assuming a total run-off ratio of 50%). BOD load arriving to the Mula River is estimated at BOD 3007 Kg/day (26,150 Kg/d x 0.23 x 0.5). While from the STPs, BOD load of 1270 kg/d (167,100 m^3/d x average effluent BOD 7.6 mg/l) is discharged into the River. As a result, a total BOD load of 4,277 kg/day reaches the Mula River.

6.4.2 Plan of Sewerage in PCMC

PCMC has proposed three new sewage treatment plants at different locations, as given in Table 6.4.4. The projects will start in 2015 to complete in 2020.

Table 6.4.4 Proposed Sewage Treatment Plants

Sr.No.	Name and Location STP	Basin	Designed Capacity (MLD)	Method Of Treatment
1	Charholi Phase II	Out of Mula basin	20	Combi Treat (ISBR)
2	Bopkhel	Mula	5	SBR
3	Pimple Nilakh Phase II	Mula	20	SBR

Source: Environment Engineering Department, PCMC

***SBR**: Sequential Batch Reactor; **ISBR**: Improved Sequential Batch Reactor; **ASP**: Activated Sludge Process, **FAB**: Fluidized Aerobic Bioreactor, **UC**: Under Construction.*

6.4.3 Analysis of Sewage Treatment

All existing sewage treatment plants in the PCMC area have records on inflow and effluent sewage quality. Such measurements ensure that the quality of treated sewage discharged from the treatment plants is within the MPCB limits. The sewage parameters are measured at each water quality laboratory on a daily basis.

Upon construction of Pimple Nilakh Phase II and Bophel STPs, in Mula River basin, sewage treatment capacity will be 310 MLD as a total in Mula River basin. Sewage volume at present in Mula River basin is estimated at 245 MLD (1,686,000 x 145 lpcd). On commissioning of the planned conveyance and treatment facilities within PCMC, current BOD inflow into the River (4,277 kg/d BOD) will be reduced to 1862 kg/d BOD (245,000 m^3/d x 7.6 mg/l BOD). About 56 % of present BOD load into the Mula River will be reduced and BOD in river water may be maintained at less than 10 mg/l (without dilution by river water itself).

6.5 River water Use in the downstream area of PMC

Figure 6.5.1 shows locations and population of villages in the downstream area of PMC using the water of Mula-Mutha River (Source: The Indian Census, 2011).

	Name of Village	Pollution	Households
①	Loni kalbhor	22,518	4,720
②	Kolwadi	651	137
③	Theur	9,674	2,018
④	Koregav mul	4,818	1,094
⑤	Naigav	16,719	3,323
⑥	Ashtapur	3,225	616
⑦	Bhavarapur	823	181
⑧	Khmagav tek	1,045	193
⑨	Nandur	934	219
⑩	Dalitaue	3,373	737
⑪	Undavari	2,181	441
⑫	Pilanwadi	36,910	807
⑬	Rahu	10,220	2,034
⑭	Walaki	1,157	241
⑮	Delawadhi	600	120
⑯	Pargav	13,130	2,753
	total	127,978	19,514

Figure 6.5.1 Small Villages located along Mula-Mutha River

There are more than 100,000 people in the direct downstream area of PMC (about 80 Km from the boundary of PMC up to No 16 villages). No static data on the river water use for drinking purpose is available, but it was confirmed through the Survey that some villages use the surface water as drinking water source. The following are findings through the field confirmation.

1) Visited villages: Theur, Dahitane, Walaki and Dalawadi
2) Water supply: Four villages use either sole river water or combination of river water and ground-water. A simple filtration of river water is practiced with disinfection (bleaching powder). Judging from the color change (thinner color without odor) of river water in the downstream of Mula-Mutha River, self-purification in the river is expected.
3) Sanitation conditions in the villages: in order to obtain a general view about the sanitation status in the villages, an interview was conducted with a primary health care clinic in Delwadi. The nurse (only staff) at the clinic mentioned that diarrhea is 25 to 30 cases during summer (4 months) and drops to 1 to 2 in winters (4 months). She mentioned that fever is common for 30 to 40 cases in a year but is not clear if it's because of waterborne/water disease of other diseases. The team also interviewed a doctor at his clinic in Theur where he explained that waterborne/water diseases are not much concern issues except Gastos. The doctor has 2 to 5 patients per month for diarrhea, but others (Cholera, typhoid fever, and typhoid fever) never happen. Dengue is increasing and he has 1 to 2 patients per month, which has been increasing in recent years. It seems that the case of water-borne/water related diseases has been considerably reduced after year 2009 though no recorded data was available at these villages. The reason of the reduced cases could be because that some STPs in PMC commenced their operations.

6.6 Necessity and Priority of the Project

6.6.1 Present Problems on Health Environment and Hygiene caused by lack of Sewerage System

1) Unsanitary conditions

The PMC's sewerage system is not playing its roll properly at present. Though PMC has several STPs, but some are not operating with full capacities. On the other hand, the sewage collection facilities are not equally available throughout PMC. The slum areas receive the least sewage collection services and newly developed areas are also in need of new facilities. As a result, 23% of the PMC's generated sewage is disposed of into the Rivers Mula-Mutha without treatment. This situation has caused health, environmental, and hygienic problems throughout the PMC area. The following photos show unsanitary conditions.





Sewage flowing in Slum area Broken sewers

Photos showing broken sewer network and sewage spills (September 2014)

2) Open defecation due to low access to private and public toilets

According to the findings through the JICA's Social Survey in October, 2014 (refer to Chapter 11 for detailed findings), though 287 of the 300 surveyed residents (95.6%) are connected to the sewer network, 1/3rd of them (100 out of the 300) -especially slum residents and business establishments (small shops, hotels, and factories)- do not have any toilets in their premises. The reason is that the premises are too small to contain space for toilets (see the survey full report in Data Report for details on the survey method and sample selection). PMC's limited number of public toilets and poor maintenance give no option other than open defecation and urination by those without access to private or public toilets. According to the DPR, around 6 million slum residents are provided with community toilets which are connected to sewerage system. The remaining slum population is provided with community toilets with septic tanks. DPR also states that there are 811 public toilets and most settlements have common toilet blocks. An observation of some the public toilets especially in the slum areas, however, showed that they are few and scarce, some not or poorly maintained, and mostly out of order. They also cost about 40-50Rs per month for the use which is high for the poor. Some toilets were observed in good conditions. They were those with someone sitting at the front to charge the users. The fee then is used for the maintenance. In some cases, however, no one was observed for charging the users and they were in none or poor maintenance conditions.


Photos showing open defecation spots on a major road sidewalk and along the River

3) Existence of many pit latrine and septic tanks

According to the Social Survey results, there are a total of 279 toilets for the 300 respondents, some with more than one toilet. A review of the type of the toilets showed that 40% of them are with septic tank/pit latrine as seen in Table 6.6.1. This indicates that many toilets are not connected to the public sewer networks and can pollute the ground and surface water and harm the public health.

Table 6.6.1 Toilet Types based on the Social Survey Results

Particulars	Non Slum	Slum	Businesses
Flush Toilets	92	3	17
Pit Toilets	6	0	0
Toilets W/septic	83	22	32
Directly connected	6	7	4
Other*	0	0	7

4. Direct use of the River for bathing and washing

Though there is no data on the severity of such practice, but as seen in the photos below use of the river water for bathing and washing goods is practiced by many especially those living along the rivers.


Photos showing use of the River for bathing and washing

4) Use of the river water by the downstream residents and the hygiene status

It was confirmed through field work by JICA Survey Team, as referred to in sub-section 6.5, that more than 100,000 people reside along Mula-Mutha River up to about 80 Km downstream from the boundary of PMC. They use river water partially as drinking water. They said that after year 2009, the cases of water borne/ related diseases have completed reduced, which coincide with the increase of the operation of STPs in PMC.

5) Occurrence of waterborne/related disease especially in slum areas

The PMC's Department of Health provided the JICA study team with some data showing a rapid drop in waterborne/related diseases in the PMC area. The department also mentioned that the rapid decreased was due to the implementation of sanitation programs including mass campaign and awareness programs on good hygiene practice (like preparing awareness leaflets), construction of public toilet and initiative to include sewerage to achieve Millennium Development Goals in their national poverty reduction strategy during 2010s.

Table 6.6.2 and Figure 6.6.1 show this improvement with cases of waterborne/water related diseases for IDH: Infectious Diseases Hospitals in Pune City. In 2011, the disease rate was 0.51% but sharply dropped to 0.23% in 2013, more than 50% reduction. Operation of new STPs in PMC seemed to have given influences on the improvement as well.

Table 6.6.2 Cases of Waterborne/water related Diseases in IHD of Pune

IDH of PMC							
CASE	2007	2008	2009	2010	2011	2012	2013
Disease							
Gastro	17,000	13,380	17,235	13,115	3,857	1,429	629
Cholera	730	455	155	255	7	22	7
Hepatitis A (Jaundice)	2,205	1,260	1,200	1,500	387	113	131
Typhoid	3,395	1,965	1,490	1,430	259	100	50
Diarrhea	3,945	5,280	4,605	4,920	8,216	6,375	5,826
Dysentery	3,855	2,075	4,835	5,640	1,006	437	642
Leptospirosis	330	75	50	20	0	3	6
Dengue	460	340	200	100	80	87	401
total	31,920	24,830	29,770	26,980	13,812	8,566	7,692

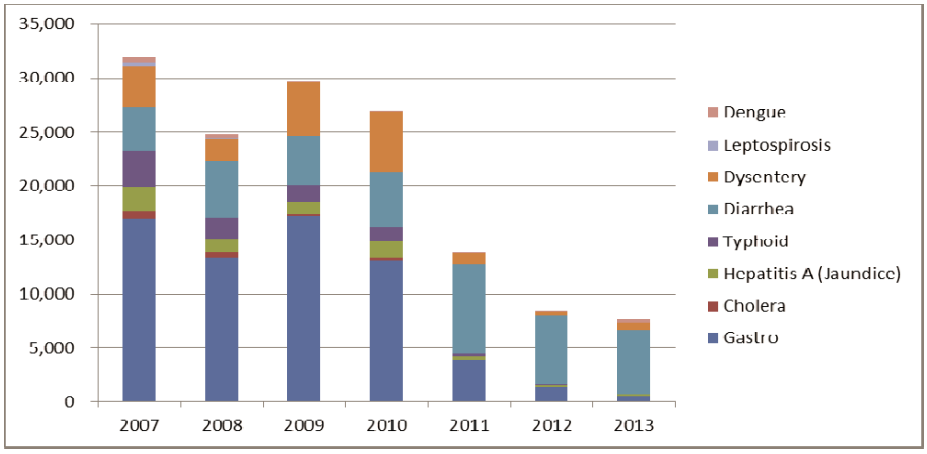


Figure 6.6.1 Cases of Waterborne/water Related Diseases in IHD of Pune

After this success, PMC shifted the budget allocation to diseases such as Malaria and Dengue. Recently, they have shifted the focus away from waterborne/water related diseases to airborne diseases, though still they continue to hold programs on good hygiene practice and sanitation.

The social survey conducted by the JICA team, however, finds that many slum residents are yet suffering from waterborne/water related diseases, because of the low sanitation environment. Out of 200 surveyed households, 28 were affected which stands for 14%. The infection, however, mostly occurred among the slum residents with 11% versus only 3% non-slum residents. Out of 80 slums residents, 22 (27.5%) responded with such infections against only 6 out of the 120 non-slum residents as shown in Figure 6.6.2.

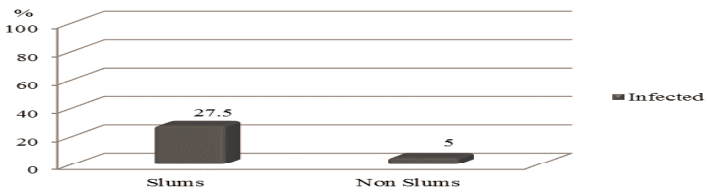


Figure 6.6.2 Respondents Affected by Waterborne/water Relate Diseases in Past Three Years

6) River odor

Though neither data on the river odor has been collected by the Department of Environment nor any complains have been documented by PMC, a strong odor is noticed from the River and Nallas. Undoubtedly, the source of the odor is the large amount of untreated sewage discharge.

6.6.2 Water Pollution and Need of Sewerage Expansion in PMC

Water quality in the Mula and Mutha Rivers based on PMC Environmental Status Report, data published in Sewerage DPR and examination results by JICA Preparatory Survey, shows general tendency of deterioration year by year, though some improvement was observed when some STPs in PMC started their operation during 2009 to 2012. A quick comparison of the observed water quality with that specified by CPCB as standards is shown in Table 6.6.3.

Table 6.6.3 Water Quality Comparison

Parameters	Water Quality Standards	Observed Water Quality in the River
BOD	Maximum 3mg/l	Ranging from 15 to 80mg/l
DO	Minimum 5mg/l	Ranging from 0.1 to 3.6 mg/l

Further, following observations are obtained from the river water quality data:

1) The BOD and COD values where the rivers enter PMC are lower than the quality at the exit of the rivers from PMC. This means that major pollution sources are domestic and non-domestic sewage discharged through the Nallas into the rivers.
2) As the water in the Nallas is not diluted due to absence of natural flow during dry weather, higher BOD, COD values have been observed in the Nallas
3) Reduction in the BOD/COD values in the rivers is observed after 2011, which coincides with commissioning of several STPs between 2009 and 2011.

The above discussions show the effectiveness of sewerage facilities including a comprehensive sewage collection and treatment to reduce the BOD and COD values in the water bodies up to acceptable level for water use in the downstream area of PMC (They use river water for drinking purpose). As discussed in section 6.4.3 all the sewage generated in the Mula River basin in the PCMC will be treated by the year 2020 with expected effluent BOD of 10mg/l. Therefore, expansion of sewerage system in the PMC and its fringe area is a priority requirement to improve the water quality of the Mula-Mutha River.

BOD load for the design year 2027 is estimated in cases without and with planned sewerage Project. Table 6.6.4 presents BOD loads including present conditions. The sewage treatment capacity increases

from 561,000 m^3/d in 2011 to 873,000 m^3/d in 2027. The BOD load discharged into Mula-Mutha River would be reduced by about 23 ton/d.

Table 6.6.4 BOD entering the river

Item	unit	2011	2027 without Project	2027 with Project
Generated Sewage flow	m3/d	728,000	873,000	873,000
BOD of raw sewage	mg/l	150[a]	237[b]	237
BOD load in sewage	kg/d	109,200	206,901	206,901
STP capacity	m^3/d	561,000	561,000	873,000
BOD in STP effluent	mg/l	20	20	15[c]
BOD load discharged from STP into rivers	kg/d	11,220	11,220	13,095
BOD load discharged directly into rivers	Kg/d	25,050	73,944	0
Total BOD load discharged to the rivers	Kg/d	36,270	85,164	13,095

Note:

a. The average BOD of 150mg/l in raw sewage at present as per the data collected from existing STPs

b. The predicted BOD of 237mg/l in raw sewage as per the projection based on CPHEEO recommended BOD contribution of 27g/person and water consumption of 150 lpcd. The 2011 BOD is lower than 2027 BOD, due to higher water consumption..

c. The value is average of existing STP effluent quality of 20mg/l and proposed effluent quality of 10mg/l.

All planned STPs are designed to meet effluent BOD of 10mg/l. After realization of the Project in 2027, a considerable amount of BOD load to be discharged into Mula-Mutha River will be reduced resulted in the BOD with less than 10mg/l. After realization of the Project, BOD load to be discharged would be about 40% of that of 2011 and about 15% of that without the Project in 2027.

CHAPTER 7 Sewage Volume Generated and Treated, and Projection of Sewage Volume by Design Year

7.1 Administrative Composition of PMC

PMC is divided into four zones: namely Ghole Road, Tilak Road, Dhankawadi and Dhole Patil Road. Each zone is headed by a Deputy Commissioner. Each zone has a number of regional offices that are headed by Regional Officers. There are totally 14 regional offices in PMC. Table 7.1.1 presents the composition of regions by zone.

Table 7.1.1 Composition of regions by zone

Zone	Regional Offices
Ghole Road	Karve Road, Aundh, Warje, Ghole Road
Tilak Road	Tilak Road, Kasba Bishram bag, Bhavani Peth
Dhankawadi	Dhankawadi, Bibwewadi, Sahakar nagar
Dhole Patil Road	Dhole Patil Road, Vadgoan Sheri, Sangamwadi, Hadapsar

Administratively PMC was divided in 162 municipal wards in 2001. These were later re-organized into 144 wards as of 2013 (Figure 7.1.1 shows locations of wards as of year 2013 in PMC; The areas with water color show corridors for the development by Metro & Wada Policy of PMC). The Census 2011 population as well as the population projections provided in PMC's Water Supply DPR (February 2014) are for the 144 wards. As of September 1, 2014, the number of wards is reported to be 152; however, for sewage study purpose the word composition in 2013 may be used with reference to sewerage districts (same manner as Water Supply DPR).

PMC is also the headquarters of the Indian Army's Southern Command. Three cantonment areas administered by the Pune Cantonment Board are located in the PMC jurisdiction.

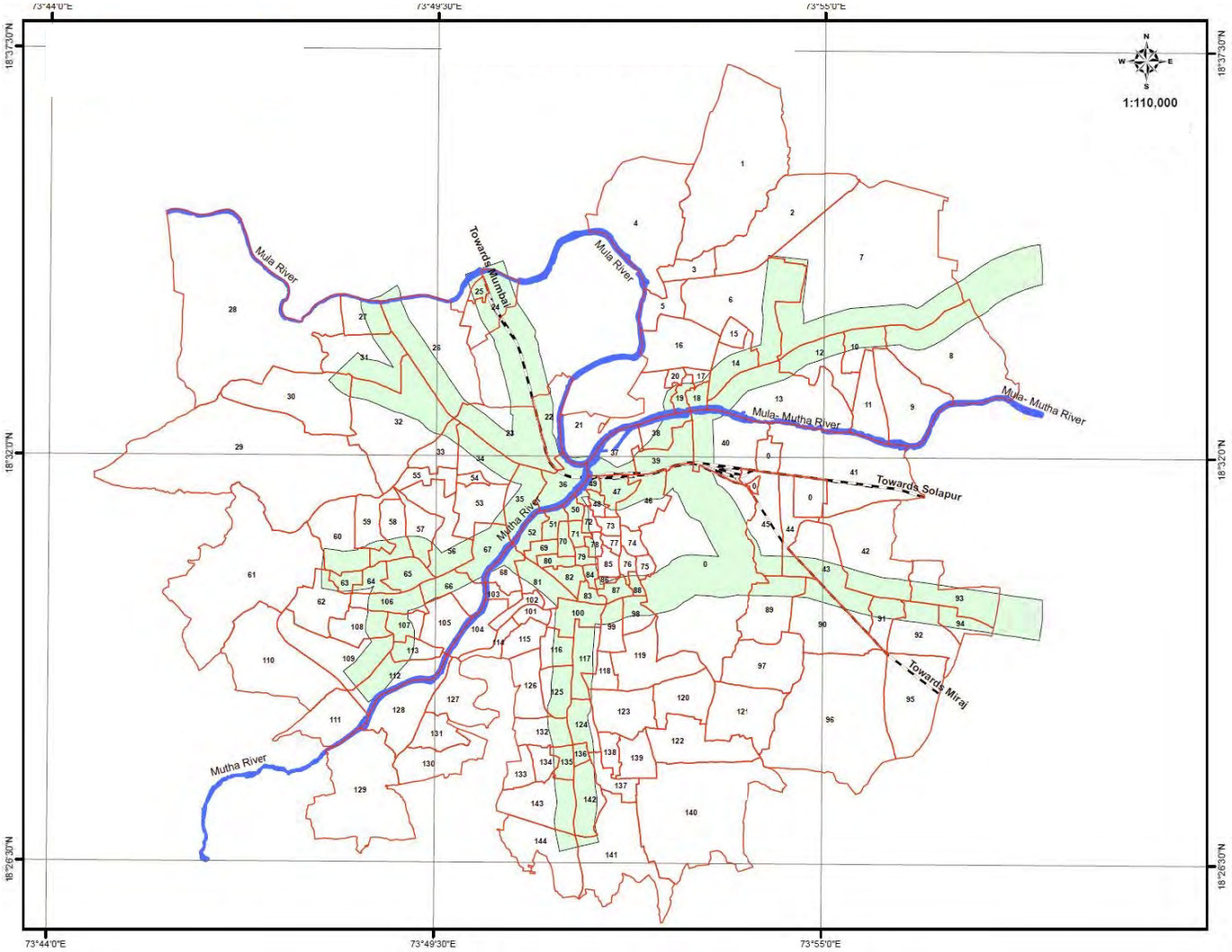
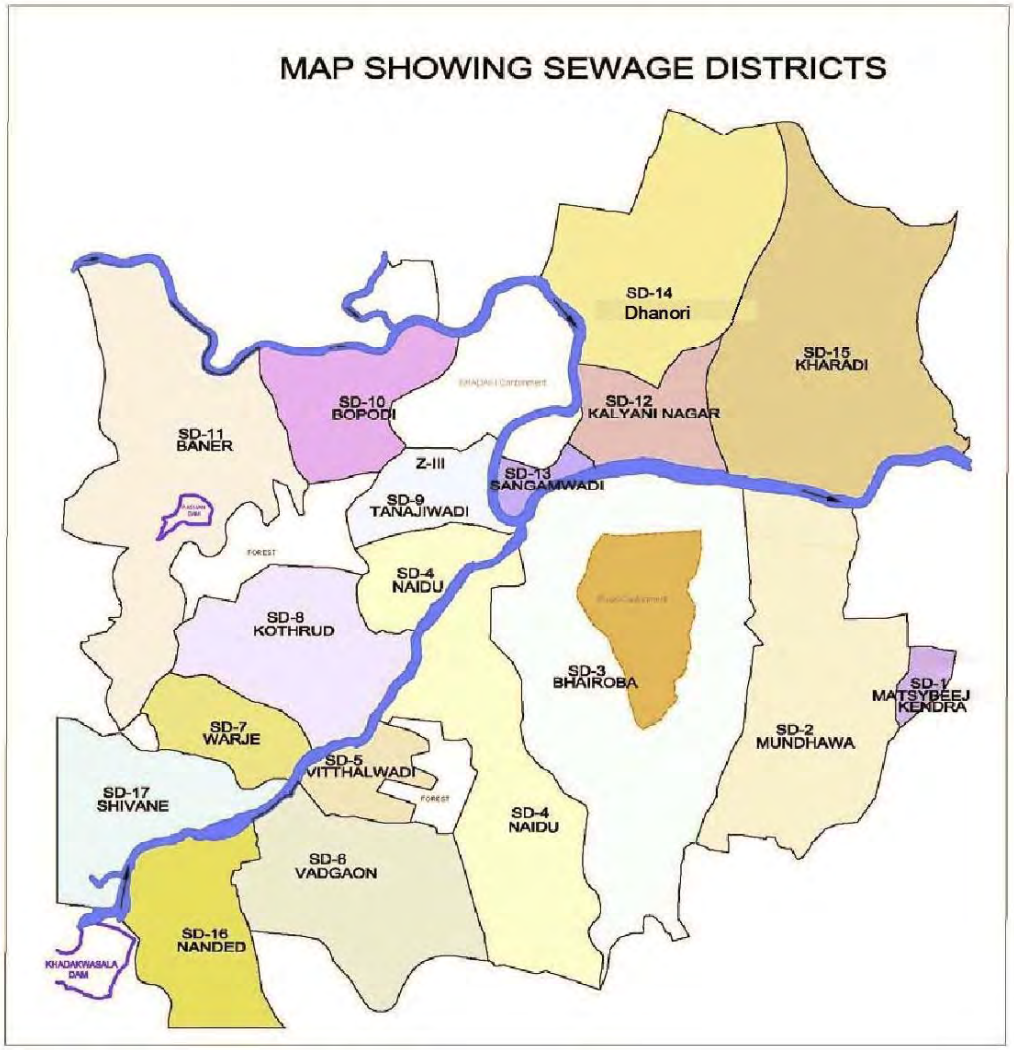


Figure 7.1.1 Locations of Wards based on 2013 ward composition

7.2 Sewerage Districts in PMC

The Project area for the sewerage improvement includes the entire area of the PMC, rapidly urbanizing 13 fringe villages and the Pune Cantonment Board area. The entire Project Area is divided into 17 sewerage districts (SDs) based on the conditions including topography, existing man sewers and locations of sewage treatment plants in the PMC. The names of the 17 SDs are summarized in Table 7.2.1 and the compositions of words and fringe villages by SD are presented in Table 7.2.2. The locations of the SDs in the Project Area are shown in Figure 7.2.1



Source: DPR for Pollution Abatement of River Mula-Mutha in Pune

Figure 7.2.1 Location of Sewerage Districts

Table 7.2.1 Sewerage Districts

No of Sewerage District (SD)	Name of SD	No of Sewerage District (SD)	Name of SD
SD 1	Matysa Beej Kendra	SD 10	Bopodi
SD 2	Mundhawa	SD 11	Baner
SD 3	Bhairoba	SD 12	Kalyani Nagar
SD 4	Nidu Hospital	SD 13	Sangamwadi
SD 5	Vitthalwadi	SD 14	Mental Hospital
SD 6	Vadgoan	SD 15	Kharadi
SD 7	Warje	SD 16	Nanded
SD 8	Kothrud	SD 17	Shivane
SD 9	Tanajiwadi		

Table 7.2.2 Composition of Wards and Fringe Villages by Sewerage District

Sewerage District	Wards	
	Wards fully covered	Wards partially covered
SD 1 (Matsya Bij Kendra)	None	92, 93, 94
SD 2 (Mundhawa)	42, 91 and 96 Villages: Manjri (Bk), Hadapsar Gaon, Undri and Pisoli	41, 43, 44, 90, 92, 93, 94, 96, 97, 121 and 140 and PCB
SD 3 (Bhairoba)	47, 99, 98, 79, 83, 85, 77, 86, 78, 84, 87, 76, 75, 88, 46, 73, 48, 74, 40, 39, 37, 38, 120, 119, 45, 89, 121, 122	100, 117, 123, 118, 139, 81, 70, 80, 82, 83, 71, 49, 72, 44, 97, 90, 41, 43, 141, 140, 96, PCB
SD 4 (Naidu)	53, 116, 115, 101, 114, 125, 126, 132, 134, 135, 136, 124, 138, 104, 102, 68, 103, 69, 52, 51, 50, 142, 137	23, 36, 35, 67, 34, 54, 56, 57, 55, 66, 127, 128, 100, 117, 133, 143, 144, 123, 118, 139, 81, 70, 80, 82, 83, 71, 49, 72, 141, 140, 122
SD 5 (Viththalwadi)	131	129, 130, 127, 128
SD 6 (Vadgaon)	Villages: Ambegaon (Bk), Ambegaon (K) and Dhyari	128, 129, 130, 133, 143, 144
SD 7(Warje)	Villages: Shivane	61, 62, 109, 110, 111, 112
SD 8 (Kothrud)	60, 58, 59, 108, 64, 65, 63, 105, 107, 113, 62, 106,	56, 57, 61, 66, 67, 68, 109, 110, 112, 128,
SD 9 (Tanajiwadi)	22, 23,33	26, 32, 34, 35, 36,54, 55, 56
SD 10 (Bopodi)	24,25,27	23, 26, 28, 31, 32
SD 11 (Baner)	29, 30 Villages: Sus, Mahalunge, Baner,Balewadi	28, 31,32, 61, 110
SD 12 (Kalyani Nagar)	14, 17, 18, 19, 20	5, 6, 7, 13, 15, 16, 21
SD 13 (Sangamwadi)	None	21
SD 14 (Dhanori)	1, 3, 4	2, 5, 6, 7, 15, 16, Villages: Lohagaon
SD 15 (Kharadi)	12, 8, 9, 11, 10,	7, 2 , 13, 6, Villages: Lohgaon

Sewerage District	Wards	
	Wards fully covered	Wards partially covered
SD 16 (Nanded)	Villages: Nanded, Kirkitwadi, Khadakvasla	None
SD 17 (Shivane)	None	111, 110, 129

7.3 City Development Plan (Land Use Plan)

Updated land use plan of PMC is presented in Section 2.4 of this report. Figure 2.4.4 Locations of a Metro ad Wada Corrido shows development corridors according to Metro and Wada Policy of PMC. This development plan is also considered Pune Water Supply Plan prepared in 2014. Likewise, sewerage plan shall use the future land use by the PMC.

7.4 Population Projection in the Project Area

The population in the project area (PMC and its fringe areas, and Cantonment areas) was projected in the DPR for "Pollution Abatement of Mula Mutha River of Pune". However, the projection was based on Census results up to the year 2001. Now 2011 Census results are available. In addition, PMC has established new policy for land development including "Wada and Metro Corridor policy" in its jurisdiction. Under these conditions, population projection needs to be revised using the updated information.

PMC recently prepared a DPR for Water Supply in February 2014, which used the 2011 Census population and also accounted for the "Wada and Metro Corridor policy" for population projection. Therefore, the population and water supply projection results in the Water Supply DPR shall be fully utilized. Thus, the plans for water supply and sewerage systems are on the same assumption bases.

7.4.1 Population Projection for PMC

For the projection, population census data of the City are available from 1961 to 2011 as shown in Table 7.4.1. City's population in the last 5 decades (50 years) shows consistently higher growth rates. However, the rate in the last decade shows rather moderate increase.

Table 7.4.1 Census Population and decadal growth rate

Census (Year)	Population (person)	Decadal Growth rate (%)	PMC area (Km^2)
1961	606,777		
1971	856,105	41.10	
1981	1,203,363	40.60	
1991	1,691,430	40.60	
2001	2,407,654	42.34	
2011	3,115,431	29.40	

For the Water Supply DPR, PMC projected the population with the base year of 2017 for design years of 2022, 2032, 2042 and 2047 (30 years from base year). The following is the summary of comparative study on the projection in the DPR for PMC Water Supply System.

7.4.1.1 Projection by conventional methods

Population projection is made by applying the following three conventional methods.

- Arithmetical Increase method
- Incremental Increase method
- Geometrical Increase method

Averages of combination of the three methods are summarized in Table 7.4.2.

Table 7.4.2 Summary of conventional methods

Year	A	B	C	(A+B)/2	(B+C)/2
	Arithmetical Increase	Geometrical Increase	Incremental Increase		
2017	3,416,470	3,788,427	3,474,660	3,602,449	3,631,544
2022	3,667,335	4,459,055	3,807,356	4,063,195	4,133,206
2032	4,169,066	6,177,472	4,563,670	5,173,269	5,370,571
2042	4,670,797	8,558,126	5,441,214	6,614,462	6,999,670
2047	4,921,663	10,073,088	5,925,447	7,497,376	7,999,268

7.4.1.2 Projection by other Agencies

The decadal growth rate was more than 40% in earlier decades, but in the last decade from 2001 to 2011 it decreased to 29.4%. This phenomenon may be caused by the outflow of population into nearby villages or the contiguous town of Pimpri Chinchward (PCMC).

The earlier population study was conducted in 1999 by Kirloskar Consultants for water supply Master plan. Population in 2025 was projected at 6,440,000, whereas Gokhale Institute of Politics and Economics projected the population to be 5,597,346 in 2026.

7.4.1.3 Projection by Decadal Growth Rates

City Population was projected for the years 2017, 2022, 2042 and 2047 by assuming the following decadal growth rates (refer to Table 7.4.3).

Table 7.4.3 Population Projection in application of decadal growth rates

YEAR	Assumed Decadal Growth Rates (%)	PROJECTED POPULATION
2001 Census		2,407,654
2011 Census	29.4 actual	3,115,431
2017 (Project commissioning year)	35	3,660,631
2022	35	4,205,832
2032(Intermediate stage)	30	5,467,581
2042	25	6,834,477
2047 (Ultimate stage)	20	7,381,235

Projected population in 2047 (7,381,235) is similar to the average figure of the Arithmetical Increase and Geometrical Increase (7,497,376) in Table 7.4.2.

7.4.1.4 Projection using Metro (railway) and Wada (old housing area) policy

PMC planned Metro Railway Project and old city development through Wada Policy. Metro railway Project covers a total of 72 km to be implemented in three phases. The PMC will provide the higher Floor Space Index (FSI) for residential areas within 500 m width in both sides of railway route, designated as Metro corridor. PMC has proposed FSI of two for residential area and additional two FSI for commercial development.

The Wada policy will be applicable for the "Peth areas" i.e. the old city. The policy is established for orderly development of the old city.

Population distribution in each ward was planned based on Metro and Wada policy. The following are basic considerations for projection of ward population.

- Non Metro area -Not fully developed
- Non Metro area –Developed
- Areas in first phase of Metro corridor-(2012-2017)
- Areas in second phase of Metro corridor-(2017-2022)
- Areas in third phase of Metro corridor-(2022-2027)

The population projection was made by PMC for the water supply plan considering the above studies, and the results are summarized in Table 7.4.4. Population in the intermediate years, 2027 and 2037, are calculated as arithmetic averages of population on either side.

Table 7.4.4 Summary of Projected Population with Metro & Wada policy

YEAR	POPULATION WITH METRO and WADA POLICY	REMARKS
2011	3,115,433	Latest Census result
2017	3,918763	Planning base year for this report
2022	4,430,320	Target year for Water Supply
2027	5,101,037*	Target year for Sewerage Plan for STP
2032	5,771,754	Target year for Sewerage Plan for Pump Stations
2037	6,355,642*	Target year for Sewerage Plan for STP
2042	6,939,529	Target year for Water Supply
2047	7,375,348	Target year for Sewerage Plan for Sewer lines

Source: Water Supply System for Pune City DPR
Note: "*" is calculated number

Projected population in 2047 (7,375,348) is similar to the Population Projection in application of Decadal Growth rate (7,381,235) in Table 7.4.3.

7.4.2 Population Projection for Wards

As of year 2011, there are 144 wards in PMC. The ward population for design years projected in Water Supply DPR are applied for this sewerage project as shown in Table 7.4.5.

Table 7.4.5 Projected Ward Population by Design Year

Ward_No.	Ward Name	Area(ha)	2011	2017	2022	2027	2032	2037	2042	2047
1	Dhanori	837.78	44,048	55,839	62,913	82,841	102,768	112,201	121,633	139,319
2	Vidyanagar-Lohgaon	389.20	25,440	30,246	32,907	42,530	52,153	57,806	63,459	69,658
3	Tigarenagar Pumping Station	70.58	22,326	23,631	23,888	25,688	27,488	27,488	27,488	27,488
4	Kalas-Visharantwadi	537.40	24,204	29,535	29,535	29,535	29,535	29,535	29,535	29,535
5	Nanasaheb Parulekar Vidyalaya	88.61	19,018	21,097	21,776	24,169	26,562	27,725	28,887	30,024
6	Yerwada Prizon Press	440.46	23,665	69,167	85,725	92,326	98,927	100,873	102,818	102,818
7	Lohgaon Airport	1,321.21	33,796	68,413	88,192	104,718	121,244	130,989	140,733	153,967
8	Kharadi Gaon	502.69	38,134	71,094	101,442	123,871	146,299	157,795	169,290	179,494
9	Kahradi Infotech Park	263.27	24,182	26,809	28,385	36,038	43,690	45,792	47,893	51,834
10	Sundarabai Marathe Vidyalaya	83.69	23,914	23,914	39,040	45,736	52,431	54,322	56,213	56,213
11	Vadgaon Sheri	133.96	32,878	39,072	39,072	39,072	39,072	39,072	39,072	39,072
12	Ramvadi	164.77	25,769	54,347	61,203	64,079	66,955	67,779	68,602	68,602
13	Aagakhan Palace	400.50	24,647	43,822	54,590	67,617	80,643	88,283	95,922	102,950
14	Don Bosco High school	105.21	18,466	32,999	50,360	57,896	65,432	68,121	70,810	71,176
15	Nagpur Chawl	36.64	16,647	17,186	17,186	17,186	17,186	17,186	17,186	17,186
16	Phulenagar Yerwada	212.36	17,670	25,925	25,925	25,925	25,925	25,925	25,925	25,925
17	Netaji Subhashchandra Bose Vidyalaya	18.60	16,090	16,425	16,425	16,425	16,425	16,425	16,425	16,425
18	Yerwada Gaon	30.92	14,960	17,728	19,728	20,478	21,227	21,477	21,727	21,727
19	Parnkuti	30.92	17,804	17,804	17,804	17,804	17,804	17,804	17,804	17,804
20	Yerwada Hot Mix Plant	18.09	18,330	18,330	18,330	18,330	18,330	18,330	18,330	18,330
21	Deccan College	243.43	17,752	58,654	58,654	58,654	58,654	59,007	59,359	59,359
22	Kamalnayan Bajaj Udyan	113.81	18,064	19,423	21,105	33,070	45,034	45,109	45,184	45,184
23	Agriculture College	234.53	15,740	16,367	20,062	42,146	64,230	64,603	64,976	65,927
24	Sanjay Gandhi Hospital	141.99	17,518	20,321	31,653	38,618	45,582	45,582	45,582	45,582
25	Bopodi	20.26	15,774	16,174	16,238	16,238	16,238	17,656	19,074	19,074
26	Pune University	430.05	16,765	17,929	18,331	23,493	28,655	32,405	36,154	37,568
27	Aundh Gaon	98.03	17,999	19,956	20,367	25,355	30,343	36,003	41,663	43,595
28	Baner-Balewadi	1,222.84	31,714	61,262	78,992	126,392	173,792	207,834	241,876	327,308
29	Sutarwadi	1,243.09	20,022	71,140	71,140	71,140	71,140	71,140	71,140	71,140
30	Pashan	343.72	27,877	34,268	37,871	52,559	67,246	75,167	83,088	92,206

Ward_No.	Ward Name	Area(ha)	2011	2017	2022	2027	2032	2037	2042	2047
31	Aundh ITI	225.44	15,197	18,028	19,671	35,397	51,123	76,390	101,656	118,542
32	Rajbhavan	469.67	17,399	20,966	22,903	36,574	50,244	65,333	80,421	91,501
33	Chaturshrugi Temple	96.21	19,997	20,569	20,702	22,883	25,063	27,081	29,099	29,754
34	Model Colony	130.16	14,892	15,662	15,951	22,770	29,588	44,309	59,030	65,387
35	Modern college	123.50	14,700	18,876	44,568	54,406	64,243	67,657	71,071	71,071
36	Pune Municipal Corporation Bhavan	100.67	16,529	19,281	26,836	29,669	32,502	33,446	34,390	34,390
37	Dr. Naidu Hospital	117.58	15,373	15,622	15,764	15,858	15,952	15,969	15,985	15,985
38	Bundgarden	75.37	14,085	15,738	28,723	34,045	39,367	41,219	43,071	44,223
39	Wadia College	107.63	14,420	15,737	38,690	47,377	56,063	58,972	61,881	61,985
40	Koregaon Park	254.85	14,688	19,896	38,966	51,610	64,254	69,386	74,518	85,735
41	Mundhwa Gaon	526.32	19,151	36,060	46,097	67,623	89,149	105,318	121,486	157,048
42	Magarpatta Hadpsar	349.75	38,338	41,631	43,417	71,173	98,928	118,752	138,575	159,353
43	Hadapsar Industrial colony	216.55	29,634	35,137	36,753	44,117	51,481	56,763	62,045	63,815
44	Saint Patric Town	104.46	27,349	31,262	32,239	35,812	39,384	45,528	51,671	54,328
45	Vikasnagar-Gohrpadi	189.51	29,976	36,428	38,764	51,606	64,447	69,662	74,877	78,376
46	Dr. Babasaheb Aambedkar Garden	126.25	14,737	23,596	39,568	46,281	52,994	55,714	58,434	58,434
47	Sason hospital	60.73	14,191	16,652	17,109	17,337	17,565	22,022	26,478	26,478
48	Kamala Nehru Hosptial	21.81	16,414	17,400	19,371	20,357	21,343	22,914	24,485	24,485
49	Juna Bazar	26.26	18,686	20,349	20,773	20,985	21,197	21,696	22,195	22,195
50	Kasaba Ganpati	22.90	15,945	16,062	16,062	16,062	16,062	17,070	18,077	18,077
51	Shanivarwada	35.68	13,810	13,810	13,810	13,810	13,810	17,976	22,141	22,141
52	New English School(RamanBag)	46.63	12,275	12,275	12,275	12,275	12,275	19,884	27,492	27,492
53	Ferguson College	139.08	12,555	16,976	26,805	31,397	35,989	38,124	40,258	40,258
54	Dr. Homi Bahba Hospital	18.50	16,699	16,699	16,716	17,146	17,575	17,789	18,002	18,872
55	Gokhalenagar	60.49	14,450	16,259	16,259	16,259	16,259	16,259	16,259	16,259
56	Law College	185.82	15,222	23,524	37,197	45,167	53,136	56,272	59,407	61,244
57	Shankarrao More Vidyalaya	97.33	18,056	20,620	23,639	24,801	25,962	26,356	26,750	26,935
58	Rambaug Colony	101.49	20,228	25,958	35,467	39,561	43,655	44,784	45,913	45,913
59	Kishkindha Nagar	99.94	29,089	32,168	33,883	35,197	36,511	36,932	37,353	37,353
60	Ramkrishna Paramhans Nagar	189.03	19,306	23,309	34,959	39,331	43,702	45,158	46,614	46,614
61	Vedbahvan	830.24	37,454	45,520	51,025	67,977	84,929	94,837	104,744	116,842

Ward_No.	Ward Name	Area(ha)	2011	2017	2022	2027	2032	2037	2042	2047
62	Mahatama Society Kothrud	155.02	32,999	36,354	39,273	42,627	45,980	47,218	48,456	50,263
63	Vanaz Company	33.87	18,797	19,530	19,530	19,530	19,530	22,801	26,071	26,071
64	Yashwantrao Chavan Natygruha	51.48	20,020	20,020	20,020	20,020	20,020	30,283	40,546	40,546
65	Ideal Colony	75.75	13,097	15,611	38,474	47,048	55,622	58,480	61,337	61,337
66	Dinanath Mangeshkar Hospital	106.56	16,999	19,198	31,538	37,112	42,686	44,183	45,680	45,680
67	Deccan Gymkhana	109.26	12,908	18,437	41,264	49,967	58,669	61,664	64,658	64,658
68	Rajendranagar	70.57	12,636	19,707	28,547	32,473	36,399	38,115	39,830	39,830
69	Vishrambaugwada	30.41	12,401	12,401	12,401	12,401	12,401	18,495	24,588	24,588
70	Mahatama Phule Market	28.12	10,734	10,734	10,734	10,734	10,734	16,231	21,728	21,728
71	City Post	24.41	12,746	12,771	12,821	12,847	12,872	17,054	21,236	21,236
72	Ganeshpeth Gurudwara	21.04	14,865	15,806	17,592	18,485	19,378	20,845	22,311	22,311
73	Tilak Auyrved Mahavidylaya	24.78	15,959	17,817	21,533	23,392	25,250	26,179	27,108	27,108
74	Rajewadi	35.26	15,484	17,474	21,454	23,444	25,434	26,429	27,424	27,424
75	Harkanagar	23.65	15,170	16,615	19,505	20,950	22,395	23,349	24,303	24,369
76	General Arunkumar Vaidya Stadium	23.84	16,773	18,631	21,586	23,064	24,542	25,378	26,213	26,240
77	Doke talim	18.32	16,662	18,323	21,645	23,306	24,967	25,798	26,628	26,628
78	Swami Samarth Mandir - Ganesh Peth	21.17	15,501	16,309	17,925	18,733	19,541	20,597	21,653	21,653
79	Dr.Kotnis Hospital	19.61	13,675	13,740	13,870	13,936	14,001	15,783	17,565	17,565
80	Renuka Swarup Prashala	26.78	13,649	13,649	13,649	13,649	13,649	16,678	19,707	19,707
81	S.P. College	90.42	13,250	15,780	16,974	28,841	40,708	41,005	41,302	41,302
82	Subahsnagar	43.24	14,013	14,013	14,013	14,013	14,013	23,341	32,668	32,668
83	Gohrpade Udyan	25.59	12,489	12,845	13,814	13,814	13,814	18,599	23,383	23,383
84	Panch Haud Mission	17.33	18,334	18,427	18,614	18,708	18,802	18,849	18,895	18,895
85	Mahatama Phule Samrak(Samata Bhumi)	34.16	15,890	17,007	19,241	20,358	21,475	22,034	22,592	22,592
86	Lohiyanagar	11.28	18,371	18,563	18,946	19,138	19,330	19,750	20,169	20,169
87	Ekbote Colony	32.57	14,593	14,640	14,722	15,109	15,496	20,957	26,417	28,070
88	GuruNanak Nagar	17.24	18,481	18,481	18,481	18,481	18,481	19,438	20,395	20,668
89	Wanvadi Gaon	193.33	23,659	26,780	26,982	27,746	28,510	31,563	34,615	35,524
90	Ram Tekadi	249.92	23,086	23,086	23,402	23,703	24,003	24,571	25,138	25,928
91	Hadapsar Gaon	74.18	22,359	29,538	29,538	33,790	38,042	42,075	46,107	47,259
92	Gliding Centre	185.67	17,681	21,489	22,341	26,164	29,986	34,739	39,492	41,150

Ward_No.	Ward Name	Area(ha)	2011	2017	2022	2027	2032	2037	2042	2047
93	Sadhana Vidyalaya	186.25	28,637	30,732	31,989	47,941	63,892	83,298	102,703	110,650
94	Satavwadi	61.72	24,668	25,292	25,292	25,940	26,588	33,000	39,412	41,244
95	Kale-Borate Nagar	307.94	44,805	73,993	73,993	73,993	73,993	73,993	73,993	73,993
96	Mahamad wadi	796.73	44,351	66,668	80,059	107,969	135,878	153,732	171,586	205,062
97	Mahadaji Shinde Chattri	228.86	28,475	37,113	37,113	37,113	37,113	37,113	37,113	37,113
98	Salisaburry Park	57.57	18,460	20,468	23,746	26,285	28,823	32,982	37,140	38,271
99	Tilak Maharashtra Vidyapeeth	70.32	18,712	20,625	23,792	25,922	28,051	29,986	31,920	32,312
100	Parvati Darshan	89.57	18,988	20,143	21,106	23,478	25,850	33,448	41,045	43,483
101	Paravati Gaon	34.45	16,338	19,198	20,686	21,430	22,174	22,547	22,919	22,919
102	Paravti Jalkendra	35.92	14,729	15,521	17,106	17,899	18,691	19,088	19,484	19,484
103	Dandekar Pul Dattawadi	27.58	16,741	19,691	22,594	24,046	25,497	26,223	26,949	26,949
104	P.L. Deshpande Garden	103.46	23,331	31,601	38,600	42,099	45,598	47,348	49,098	49,098
105	Major Tathwade Udyan	117.99	17,219	19,903	20,611	25,271	29,931	31,451	32,971	32,971
106	Kothrud Gaon	87.08	19,957	21,614	21,614	21,614	21,614	33,046	44,478	44,478
107	Happy Colony	57.21	18,684	20,091	20,523	24,303	28,082	32,131	36,180	37,646
108	Dahanukar Colony	105.17	12,836	13,467	13,607	15,390	17,172	23,362	29,552	31,716
109	Warje Water purification Project	223.54	35,398	49,301	49,301	52,098	54,895	63,918	72,940	75,518
110	Popularnagar Waraje	410.78	39,003	42,219	44,148	47,194	50,239	52,812	55,384	60,208
111	Waraje Malwadi	165.23	26,185	28,599	29,595	32,195	34,795	36,046	37,296	40,416
112	Maharshi Karvenagar	142.20	24,455	32,039	32,412	37,640	42,867	53,912	64,957	68,902
113	Hingane Women Education Sanstha	53.52	21,990	22,849	22,919	23,346	23,773	27,048	30,323	31,406
114	Janata Vasahat	38.77	17,942	17,942	17,942	17,942	17,942	17,942	17,942	17,942
115	Shahu College	69.72	16,314	18,141	18,141	18,141	18,141	18,141	18,141	18,141
116	Parvati Industrial Estate	66.03	14,720	15,290	15,396	16,914	18,431	23,519	28,607	30,245
117	Mahrashinagar	98.85	15,634	20,008	21,726	28,299	34,872	50,506	66,139	71,462
118	Chattrapati Shivaji Marketyard	52.27	19,219	19,219	19,219	19,219	19,219	20,278	21,337	21,640
119	D A D colony	210.06	21,713	23,643	24,801	31,611	38,421	40,523	42,624	45,520
120	Kondhwa Khurd	154.07	25,149	31,544	31,544	31,544	31,544	31,544	31,544	31,544
121	NIBM	241.37	34,923	37,326	38,768	48,112	57,456	60,946	64,435	68,039
122	Mithanagar	217.02	49,327	69,936	69,936	69,936	69,936	69,936	69,936	69,936
123	Bibewadi Gaon	170.35	24,796	25,801	25,801	25,801	25,801	26,151	26,501	26,602

Ward_No.	Ward Name	Area(ha)	2011	2017	2022	2027	2032	2037	2042	2047
124	Shankar Maharaj Math	78.82	20,892	22,653	22,653	24,482	26,311	34,026	41,740	43,944
125	Padmavati Aranyeshwar	86.83	19,808	20,448	20,590	25,214	29,837	41,216	52,595	56,580
126	Taljai Mandir	118.71	18,861	21,168	22,553	26,519	30,485	33,276	36,066	39,565
127	AanadNagar Hingne Khurd	159.38	25,251	36,259	36,259	36,259	36,259	36,259	36,259	36,259
128	Vittalwadi	199.97	36,101	66,335	66,335	66,335	66,335	66,335	66,335	66,335
129	Wadgaon Dhayari	507.46	44,014	54,792	61,259	74,517	87,775	96,398	105,020	121,187
130	Wadgaon Budruk	159.64	25,601	32,732	32,732	32,732	32,732	32,732	32,732	32,732
131	ManikBaug	90.21	20,692	31,886	31,886	31,886	31,886	31,886	31,886	31,886
132	ChavanNagar	96.03	26,684	39,614	39,614	40,966	42,318	48,872	55,425	57,298
133	Dhankwadi Ambegaon Pathar	57.51	23,890	30,637	30,637	30,637	30,637	30,637	30,637	30,637
134	Dhankwadi Gaon	45.91	25,141	25,411	25,411	25,411	25,411	25,965	26,518	26,676
135	Chaitanyanagar-Dhankawadi	37.16	15,029	15,029	15,029	15,029	15,029	22,270	29,510	31,578
136	Balajinagar	17.98	19,914	19,914	19,914	19,914	19,914	19,914	19,914	19,914
137	Sukhsagar nagar	61.64	31,383	32,555	32,718	32,961	33,204	33,650	34,095	34,566
138	VIT(Bibewadi)	45.92	16,451	16,451	16,451	16,451	16,451	16,451	16,451	16,451
139	Upper Indira Nagar-Bibewadi	91.04	35,497	36,028	36,028	36,028	36,028	36,028	36,028	36,028
140	Kondhwa Budruk	718.46	45,223	56,799	63,745	86,960	110,175	125,834	141,493	160,178
141	Katraj Gaon	340.18	41,199	45,250	47,241	56,543	65,845	68,408	70,971	75,505
142	Rajiv Gandhi Prani Sangrhalay	109.94	16,666	16,805	16,888	17,893	18,897	27,731	36,564	39,129
143	Bharati Vidyapeeth	192.69	40,878	54,534	54,534	60,105	65,676	74,510	83,344	85,868
144	Aagam Mandir Katraj	228.23	27,220	28,763	29,533	35,156	40,778	45,817	50,856	53,997
Sum of PMC		24,928.60	3,115,433	3,918,763	4,430,320	5,101,058	5,771,754	6,355,672	6,939,529	7,375,348

7.4.3 Population Projection for Related Fringe Villages and Cantonment

The population by design year for the fringe villages was calculated in use of the projection method adopted in the DPR for Pollution Abatement for the River Mula-Mutha in Pune (sewerage DPR). However, the PMC's sewerage DPR was based on 2001 census population, whereas Census 2011 population is available now for the fringe villages concerned. Therefore, the populations for the fringe villages for design years were calculated using 2011 census population as initial population.

The population distribution for concerned villages was planned in consideration of accessibility from PMC area, past growth trends and planned land use in the Development Plan. Growth rates are initially planned to be higher figures, but after reaching saturation densities, declining figures were anticipated. Table 7.4.6 shows adopted growth rates to concerned villages. Two fringe villages of 'Sus, Mahalunge, Baner and Balewadi', and Shivane are in the midst of spectacular growth, but tapers as saturation density would be achieved.

Table 7.4.6 Decadal growth rates applied for the projection of fringe villages population

Village Name	2022	2032	2042
Manjri Bk.	54%	43%	29%
Hadapsar Gaon	38%	31%	20%
Undri	48%	37%	25%
Pissoli	54%	43%	29%
Ambegaon (Budruk)	48%	37%	25%
Ambegaon (Khurd)	54%	43%	29%
Dhyari	54%	43%	29%
Shivane	167%	43%	29%
Sus, Mahalunge, Baner and Balewadi	358%	115%	23%
Lohagaon (part)	54%	43%	29%
Nanded	54%	43%	29%
Kirkatwadi	54%	43%	29%
Khadakwasala	54%	43%	29%

Pune Cantonment Board is unlikely to have any change in land use and hence flat growth rate of 10% is used in sewerage DPR. The projected population for related fringe villages and Cantonment are shown in Table 7.4.7.

Table 7.4.7 Projected Population of Related Fringe Village and Cantonment by Design Year

Village No.	Column1	Area(ha)	2011	2017	2022	2027	2032	2037	2042	2047
V1	Manjri Bk.		36,816	47,203	56,877	69,503	81,166	93,178	104,644	116,513
V2	Hadapsar Gaon		14,833	17,681	20,495	23,514	26,774	29,491	32,208	34,698
V3	Undri		7,970	9,728	11,766	13,911	16,154	18,156	20,182	22,083
V4	Pissoli		5,417	6,945	8,369	10,226	11,942	13,710	15,397	17,143
V5	Ambegaon (Budruk)		21,562	26,316	31,832	37,634	43,702	49,119	54,599	59,742
V6	Ambegaon (Khurd)		11,088	14,216	17,130	20,933	24,445	28,063	31,516	35,091
V7	Dhyari		21,861	28,029	33,773	41,271	48,196	55,329	62,137	69,185
V8	Shivane		26,253	58,101	70,008	85,549	99,904	114,690	128,803	143,412
V9	Sus Mahalunge		14,549	7,461	66,673	125,886	143,224	160,563	176,799	193,035
V10	Lohagaon (part)		32,857	42,127	50,760	62,029	72,437	83,158	93,391	103,984
V11	Nanded		9,767	12,523	15,089	18,439	21,533	24,720	27,762	30,910
V12	Kirkatwadi		7,250	9,295	11,200	13,686	15,983	18,348	20,606	22,943
V13	Khadakwasala		11,803	15,133	18,234	22,282	26,021	29,872	33,548	37,353
Sum of Villages			222,026	294,758	412,206	544,863	631,481	718,397	801,592	886,092
PCB (Pune Contonment Board)			87,962	90,600	96,758	99,660	106,433	109,626	117,077	120,589
Total sum (Project area = PMC + Villages + PCB)			3,425,421	4,304,121	4,939,284	5,745,581	6,509,668	7,183,695	7,858,198	8,382,029

7.4.4 Population Projection in the Project Area

Population of the Project area is summarized by design year as shown in Table 7.4.8 based on the studies from item 7.4.1 to 7.4.3.

Table 7.4.8 Projected Population of the Project area by design year

Area	2011	2017	2022	2027	2032	2037	2042	2047
PMC	3,115,433	3,918,763	4,430,320	5,101,058	5,771,754	6,355,672	6,939,529	7,375,348
Related Villages	222,026	294,758	412,206	544,863	631,481	718,397	801,592	886,092
Cantonment	87,962	90,600	96,758	99,660	106,433	109,626	117,077	120,589
Total	3,425,421	4,304,121	4,939,284	5,745,581	6,509,668	7,183,695	7,858,198	8,382,029

Table 7.4.9 shows the comparison of population by design year between sewerage DPR and this study results (preparatory survey). Projected Population by Preparatory Survey in 2017 and 2047 are about 90% and 80%, respectively against those in the sewerage DPR.

Table 7.4.9 Population comparison between Sewerage DPR and Preparatory Survey

Year	Preparatory survey				DPR		
	PMC	Related Villages	Cantonment	Total	PMC	PCB	Total
2017	3,918,763	294,758	90,600	4,304,121	4,776,668	91,506	4,868,174
2027	5,101,037	544,863	99,660	5,745,560	6,533,212	100,657	6,633,869
2037	6,355,642	718,396	109,627	7,183,665	8,267,599	110,722	8,378,321
2047	7,375,348	886,091	120,589	8,382,028	9,902,531	121,685	10,024,216

Source: DPR and JICA Survey Team

7.4.5 Projected Population for Sewerage Districts by Design Year

Table 7.2.2 summarizes the composition of wards, fringe villages and the Pune Cantonment Board by Sewerage District (SD). The population projection in Table 7.4.5 and Table 7.4.7 were used to calculate the population for the 17 SDs. For the wards or villages that are partially covered in specific SDs, the population were shared by concerned SDs in proportion to the area percentage in the ward (Calculation details are included in Supporting Report 7.4.1). The projected population for design years are presented in Table 7.4.10.

Table 7.4.10 Projected Populations for Sewerage Districts by Design Year

Sewerage District	2011	2017	2022	2027	2032	2037	2042	2047
SD1	28,663	30,161	30,733	37,994	45,254	57,676	70,097	74,661
SD2	3,26,010	4,28,896	4,72,321	5,90,333	7,07,966	8,05,551	9,02,957	10,16,083
SD3	8,18,913	9,28,068	10,52,061	11,66,781	12,84,979	13,93,981	15,06,800	15,64,376
SD4	6,96,877	7,92,713	8,98,791	9,94,065	10,89,335	12,15,124	13,40,898	13,77,963
SD5	89,020	1,41,576	1,41,819	1,42,318	1,42,817	1,43,141	1,43,466	1,44,074
SD6	1,52,557	1,92,005	2,12,731	2,46,755	2,80,184	3,09,585	3,38,559	3,72,022
SD7	1,10,855	1,59,972	1,74,329	1,98,013	2,20,512	2,48,987	2,76,792	3,00,821
SD8	3,14,762	3,57,681	4,26,169	4,75,305	5,24,436	5,86,324	6,48,213	6,62,222
SD9	92,429	98,566	1,07,964	1,51,994	1,96,017	2,12,005	2,27,993	2,35,724
SD10	91,698	1,03,030	1,18,064	1,56,916	1,95,770	2,35,962	2,76,154	3,00,750
SD11	1,28,735	2,15,613	3,00,689	4,41,163	5,39,760	6,16,744	6,92,626	8,18,396
SD12	1,44,433	2,03,083	2,31,015	2,46,981	2,62,944	2,70,033	2,77,121	2,80,815
SD13	11,887	39,275	39,275	39,275	39,275	39,511	39,747	39,747
SD14	1,54,743	2,10,401	2,33,697	2,73,711	3,13,468	3,33,517	3,53,417	3,81,067
SD15	2,21,534	3,51,405	4,39,853	5,12,978	5,85,500	6,24,030	6,62,216	7,01,260
SD16	28,819	36,951	44,523	54,407	63,536	72,940	81,915	91,206
SD17	13,485	14,726	15,250	16,570	17,914	18,552	19,225	20,840
Total	34,25,420	43,04,122	49,39,284	57,45,560	65,09,668	71,83,664	78,58,197	83,82,028

7.4.6 Assumption of per capita sewage generation rate and non-domestic sewage generation

7.4.6.1 Interception Factor

As per guidelines of NRCP, as well as CPHEEO manual, interception factor (80% of water supply) is used for computing per capita sewage generation.

7.4.6.2 Per capita sewage generation rate and non-domestic (business water) sewage generation

PMC has taken up an ambitious project to bring down the unaccounted for water (UFW) and to bring the rate of domestic water supply within acceptable norm of 150 lpcd. In addition to domestic demand, Water Supply DPR considered non-domestic demand. The Non-Domestic demand consists of the following

- Government and Non-Government Organization
- Educational Institutes
- Commercial Units

- Industrial Units
- Health care institutes like hospitals, laboratories and clinics
- Cultural Centres, Theatres and Concert Halls
- Transport terminals for Road, Air and Rail
- Gardens and Green Belt

Generated sewage derived from non-domestic water supply shall be considered for sewerage plan. Water consumption for all wards by design year is projected in the Water Supply DPR. The water consumption shall be used as base figures for projection of sewage volume. However, the water consumption for Gardens and Green Belt and factories was not considered as sewage to be collected and treated by public sewerage system.

In consideration of above mentioned conditions, the following shall be applied for the calculation of sewage generation volume and the corresponding treatment capacity to be provided up to the design year 2047.

1) Per capita water consumption rate of 150lpcd is considered as recommended for domestic water supply in the CPHEEO manual.
2) Per capita sewage generation rate from design years from 2017 to 2047 is assumed to be 80% of per capita water consumption rate, i.e. 120lpcd.
3) Ground water infiltration - The eastern and higher reaches of Pune city are predominantly hard rock areas and ground water is generally low in these areas. However, a study conducted by Ground water Survey and Development agency, Maharashtra (GSDA) shows rising water table and shallow water table in many areas of the city. Based on the data provide in this report by GSDA, infiltration has been considered at 6 lpcd (or 5% of per capita sewage generation rate) in the areas where ground water is rising. Thus, for such SDs the sewage generation rate is considered at 126 lpcd (120 + 6). Ground water infiltration is assumed for all the SD's in PMC except for the following SDs.

   - SD12: Kalyani Nagar
   - SD13: Sangamwadi
   - SD14: Mental Hospital
   - SD15: Kharadi

4) To calculate sewage generation from non-domestic water (business water), the water demands for gardens and green belt is not considered as this activity does not generate sewage.
5) Factories with their own treatment facilities to meet effluent standards are not considered for the treatment at public sewage treatment plants.

For the projection of non-domestic sewage volume, the following shall be considered.

1) Water consumption by ward is the Water Supply DPR
2) Inception factor is same as that for domestic sewage, 80% of water consumption
3) Ground water infiltration – same as that for domestic sewage

7.4.6.3 No consideration of generated sewage treated at individual (private) sewage treatment plants

According to MOEF guidelines, PMC stipulated that housing developments with more than 20,000 m^2 and/or apartments with more than 150 tenements shall have individual STPs for the treatment of sewage to meet inland discharge standards. The effluent from these individual (private) STPs is discharged to nearby channels/rivers. Existing individual (private) STPs are obliged to continue their operation through the future under current laws and regulations. Therefore, generated sewage from abovementioned development areas is not considered, in principle, for the plan of public sewerage systems.

PMC should monitor such STPs and ensure that they adhere to stipulated discharge standards. The details of concerned SDs with individual STPs are summarized in Table 7.4.11. Total water consumption is about 105 MLD, while sewage generation volume 84 MLD.

Table 7.4.11 Sewage volume generated in the area served by Individual STPs by SD

Unit: MLD

SD No	SD Name	Non-domestic sewage volume	Domestic Sewage volume	Total Sewage volume
SD1	Matyabeej Kendra	-	-	-
SD2	**Mundhwa**	6.2	19.6	25.8
SD3	Bairoba	0.4	2.0	2.4
SD4	Naidu	2.6	3.0	5.6
SD5	Vithalwadi	0.0	0.6	0.6
SD6	Vadgaon	0.0	4.2	4.2
SD7	Warje	0.8	2.1	2.9
SD8	Kothrud	0.4	4.4	4.7
SD9	Tanajiwadi	-	-	-
SD10	Bopodi	2.7	1.7	4.4
SD11	**Baner**	3.4	6.6	10.0
SD12	Kalyani Nagar	1.8	0.4	2.3
SD13	Sangamwadi	3.1	0.2	3.2
SD14	Mental Hospital	0.0	4.4	4.4
SD15	**Kharadi**	3.1	10.5	13.6
SD16	Nanded	-	-	-

SD No	SD Name	Non-domestic sewage volume	Domestic Sewage volume	Total Sewage volume
SD17	Shivane	-	-	-
Total		24.6	59.7	84.3

Source: PMC

Most of large developments are located at the outskirts of the city; 3 SDs namely Mundhwa, Baner and Kharadi.

PMC may consider treatment of some sewage from individual STPs in consideration of transition period for the merging of individual STPs upon construction of public sewerage systems in the area where individual STPs exist and especially for the maintenance period of such STPs to avoid water pollution in the rivers. In this connection, 10% of generated sewage in the individual treatment areas are taken into account for this sewerage plan in the SDs where individual STPs belong to.

In view of water pollution control, PMC shall improve immediately institutional capacity for monitoring the individual STPs. Furthermore, monitoring program shall be prepared and implemented for the references to come up with appropriate arrangements for the sewage treatment in the second phase 2037, aside from the provision of immediate countermeasures.

7.5 Projected Sewage Volume generated by Design Year and Comparison with DPR

Sewage volume by SD for design years is projected in combination of domestic and non-domestic sewage volume and considering reduction of sewage in the concerned SDs where individual STPs exist (however, 10% of individual STP capacity is considered in the concerned SD; in other words 90% of generated sewage is reduced from total sewage volume in concerned SD), as shown in Table 7.5.1 (Detailed calculations are included in 7.5.1, Supporting Report).

Table 7.5.1 Sewage volume by sewerage district (domestic + non-domestic – 90% of individual STPs)

Unit: MLD

SD	Sewage Source	2011	2027	2037	2047
SD1	Domestic	4	5	7	9
	Non-domestic	0	2	4	4
	90% of individual STPs	0	0	0	0
	Total for design	4	7	11	14
SD2	Domestic	41	74	101	128
	Non-domestic	5	14	20	26

SD	Sewage Source	2011	2027	2037	2047
	90% of individual STPs	12	23	23	23
	Total for design	34	65	98	131
SD3	Domestic	103	147	176	197
	Non-domestic	28	49	58	96
	90% of individual STPs	1	2	2	2
	Total for design	130	194	232	291
SD4	Domestic	119	156	153	174
	Non-domestic	14	36	48	69
	90% of individual STPs	3	5	5	5
	Total for design	131	188	196	237
SD5	Domestic	11	18	18	18
	Non-domestic	1	2	3	4
	90% of individual STPs	0	1	1	1
	Total for design	12	19	20	21
SD6	Domestic	19	31	39	47
	Non-domestic	2	4	6	9
	90% of individual STPs	2	4	4	4
	Total for design	19	32	42	52
SD7	Domestic	14	25	31	38
	Non-domestic	0	4	5	7
	90% of individual STPs	1	3	3	3
	Total for design	13	26	34	42
SD8	Domestic	40	60	74	83
	Non-domestic	4	23	26	34
	90% of individual STPs	2	4	4	4
	Total for design	42	78	96	113
SD9	Domestic	12	19	27	30
	Non-domestic	4	13	16	20
	90% of individual STPs	0	0	0	0
	Total for design	16	32	43	49
SD10	Domestic	12	20	30	38
	Non-domestic	3	12	16	21
	90% of individual STPs	2	4	4	4
	Total for design	13	28	42	55
SD11	Domestic	16	56	78	103
	Non-domestic	4	8	11	16
	90% of individual STPs	5	9	9	9
	Total for design	16	55	80	110
SD12	Domestic	17	30	32	34
	Non-domestic	3	8	9	10

SD	Sewage Source	2011	2027	2037	2047
	90% of individual STPs	1	2	2	2
	Total for design	19	35	39	41
SD13	Domestic	1	5	5	5
	Non-domestic	0	1	1	1
	90% of individual STPs	1	3	3	3
	Total for design	0	2	3	3
SD14	Domestic	19	33	40	46
	Non-domestic	2	5	5	6
	90% of individual STPs	2	4	4	4
	Total for design	18	33	41	48
SD15	Domestic	27	62	75	84
	Non-domestic	6	21	22	23
	90% of individual STPs	6	12	12	12
	Total for design	26	70	85	95
SD16	Domestic	4	7	9	11
	Non-domestic	0	0	0	0
	90% of individual STPs	0	0	0	0
	Total for design	4	7	9	11
SD17	Domestic	2	2	2	3
	Non-domestic	0	0	0	0
	90% of individual STPs	0	0	0	0
	Total for design	2	2	3	3
Total project area	Domestic	459	749	898	1,048
	Non-domestic	77	201	252	345
	90% of individual STPs	38	76	76	76
	Total for design	498	873	1,074	1,317

Note: Sewage flow in 2011; flow from individual STPs is assumed to be 50% of existing STP capacity.

In the Sewerage DPR, design sewage volume by SD was established after comparison of (1) projected sewage volume using unit sewage generation rate and projected population, and (2) measured flow at some nallas (conducted during year 2011 to 2012). This approach was taken to confirm required STP capacity to accommodate at least present inflow sewage volume. Due to un-equitable water supply in the PMC, the measured sewage flow in the Nalla covered by Naidu STP was larger than the projected flow for the year 2027. Therefore, for the design of Naidu STP (SD 4) measured flow was adopted in the sewerage DPR. Required sewage volume in 2027 for SD4 is estimated at 188 MLD, which is larger than 153 LMD in sewerage DPR. Thus, no adjustment of design sewage volume is made in this study.

The sewage volume calculated for the 17 SDs are compared with that in the Sewerage DPR as shown in Table 7.5.2.

Table 7.5.2 Comparison of design sewage volume by SD between Preparatory Survey and Sewerage DPR

Unit: MLD

Sewerage District	Preparatory Survey			Sewerage DPR		
	2027	2037	2047	2026	2036	2046
SD1 (Matsya Bij Kendra)	7	11	14	8	10	13
SD2 (Mundhawa)	65	98	131	74	99	122
SD3 (Bhairoba)	194	232	291	194	240	283
SD4 (Naidu)	188[a]	196	237	153	189	223
SD5 (Vithhalwadi)	19	20	21	20	26	32
SD6 (Vadgaon)	32	42	52	23	30	37
SD7 (Warje)	26	34	42	15	20	24
SD8 (Kothrud)	78	96	113	80	100	118
SD9 (Tanajiwadi)	32	43	49	33	42	50
SD10 (Bopodi)	28	42	55	37	47	58
SD11 (Baner)	55	80	110	38	49	61
SD12 (Kalyani Nagar)	35	39	41	40	49	58
SD13 (Sangamwadi)	2	3	3	3	4	5
SD14 (Mental Hospital)	33	41	48	32	41	50
SD15 (Kharadi)	70	85	95	44	59	73
SD16 (Nanded)	7	9	11	7	9	11
SD17 (Shivane)	2	3	3	8	11	14
Total	**873**	**1,074**	**1,317**	809	1025	1232

The sewage volume comparison in Table 7.5.2 shows that the sewage volume in this study increased by 7% to 8% against Sewerage DPR, though target year between the two cases is different by only one year, and though the population estimated in this study for 2017 and 2047 are lower by 10% and 20% respectively than those in the PMC's Sewerage DPR. The higher sewage volume estimated in this study is due to consideration for sewage generation from water supply to non-domestic consumers, which is 125 MLD in 2017 and 490 MLD in 2047 as per the Water Supply DPR.

7.6 Sewage Treatment Plant Capacity

The locations of planned STPs by SD are determined in the DPR based on the geography in the project area. The same arrangements are adopted for this study. Table 7.6.1 shows Capacity required by STP for design year 2027.

Table 7.6.1 Planned Sewage Treatment Capacity by STP by SD

Sewerage District	Existing STP's location	Capacity of Existing STP	Design sewage volume for 2027	Location of Planned STP	Planed capacity of Proposed STP for 2027	Total Treatment capacity by STP for 2027
SD1 (Matsya Bij Kendra)	No treatment	-	7	New STP at Matsya Beej Kendra	7	7
SD2 (Mundhawa)	Mundhawa STP	45	65	New Mundhawa STP	20	65
SD3 (Bhairoba)	Bhairoba STP	130	194	New Bhairoba STP and 25 MLD at New Naidu STP	75[a]	205
SD12 (Kalyani Nagar)	Bhairoba STP		35	New Bhairoba STP		
SD13 (Sangamwadi)	Bhairoba STP		2	New Bhairoba STP	-	-
SD14 (Mental Hospital)	Bhairoba STP		33	New Dhanori STP	33	33
SD4 (Naidu)	Naidu Hospital STP	115	188[a]	New Naidu STP	127[a]	242
SD5 (Vithhalwadi)	Vithhalwadi STP	32	19	Existing Vithhalwadi STP	-	32
SD6 (Vadgaon)	No treatment	-	32	New Vadgaon STP and Existing Vithhalwadi STP	26	26
SD7 (Warje)	No treatment	-	26	New Warje STP	28	28
SD8 (Kothrud)	Erandawane STP	50	78	New Naidu STP	-	50
SD9 (Tanajiwadi)	Tanajiwadi STP	17	32	New Tanajiwadi STP	15	32
SD10 (Bopodi)	Bopodi STP	18	28	New Botanical Garden STP	10	28
SD11 (Baner)	Baner STP	30	55	New Baner STP	25	55
SD15 (Kharadi)	Kharadi STP	40	70	New Kharadi STP	30	70
SD16 (Nanded)	No treatment	-	7	Vithhalwadi STP	-	-
SD17 (Shivane)	No treatment	-	2	New Warje STP	-	-
Total		477	873		396	873

a. Due to limited land availability at the site proposed for the New Bhairoba STP, 25 MLD of sewage flow to Bhairoba STP will be intercepted at Naidu STP and will be treated at the proposed Naidu Hospital STP.

For the subsequent STP design years of 2037 and 2047, similar analysis was done and STP capacities were calculated (refer to 7.6.1 in Supporting Report). The calculated STP capacities are compared with

those in the sewerage DPR in Table 7.6.1. It is noted that the capacities of three STPs have changed considerably (Mundhawa, Vadgaon and Botanical Garden) and two STPs are additionally required (Baner and Kharadi). Thus changes are caused by the following reasons.

① Updated population distribution to the wards, which is used in the Water Supply DPR is different from that in the sewerage DPR.
② In the sewerage DPR, the sewage derived from non-domestic water consumption was not considered.
③ Although in the Sewerage DPR, transfer of some sewage flow from one STP to another was proposed, such flow transfer is minimized. Such STPs have been grouped together in the Table 7.6.2 for easy reference.

Table 7.6.2 Comparison of STP capacities by SD

SD	STP	Preparatory Survey			Sewerage DPR		
		2027	2037	2047	2026	2036	2046
1	Matsya Beej Kendra	7	4	3	8	5	0
2	Mundhwa	20	48	94	45	49	75
3	Bhairoba	75	0	0	74	0	0
4	Naidu	127	27	57	125	55	0
5	Vitthalwadi	0	0	0	0	5	7
6	Vadagaon	26	13	14	18	16	16
7	Warje	28	8	8	27	0	0
8	Erandawane	-	-	-	0	0	0
9	Tanajiwadii	15	11	6	16	0	0
10	Botanical Garden	10	14	13	19	11	10
11	Baner	25	25	30	0	19	12
12	Kalyani Nagar	-	27	-	0	27	0
13	Sangamwadi	-	-	-	0	13	28
14	Dhanori	33	8	7	32	9	9
15	Kharadi	30	15	10	0	15	14
16	Nanded						
17	Shivane						
Total		396	200	243	364	224	171

CHAPTER 8 Scope of Work for Pollution Abatement of Mula-Mutha River in Pune

8.1 Design Sewage Volume for Planned Sewerage Facilities by Sewerage component facility

According to the study in Chapter 7, the planned sewage volume for each facility is shown in Table 8.1.1. The target year is 2047 for sewage collection system, and 2027 for sewage treatment plant.

Table 8.1.1 Planned Sewage Volume by SD and Comparison with Sewerage DPR Sewage Collection System

Unit: MLD

SD No.	Name of SD	Planned Sewage Volume (Target Year 2047)	C.f. Sewerage DPR (Target Year 2047)
1	Matsya Beej Kendra	14	13
2	Mundhwa	131	122
3	Bhairoba	291	283
4	Naidu	237	223
5	Vitthalwadi	21	32
6	Vadagaon	52	37
7	Warje	42	24
8	Erandawane	113	118
9	Tanajiwadii	49	50
10	Botanical Garden	55	58
11	Baner	110	61
12	Kalyani Nagar	41	58
13	Sangamwadi	3	5
14	Dhanori	48	50
15	Kharadi	95	73
16	Nanded	11	11
17	Shivane	3	14
Total		**1,317**	1232

Sewage Treatment Plant Unit: MLD

SD	Name of STP	Planned Sewage Quantity (Target Year 2027)	C.F Sewerage DPR (Target Year 2026)
1	Matsya Beej Kendra	7	8
2	Mundhwa	20	45
3	Bhairoba	75	74
4	Naidu	127	125
5	Vitthalwadi	0	0
6	Vadagaon	26	18
7	Warje	28	27
8	Erandawane	-	0
9	Tanajiwadii	15	16
10	Botanical Garden	10	19
11	Baner	25	0
12	Kalyani Nagar	-	0
13	Sangamwadi	-	0
14	Dhanori	33	32
15	Kharadi	30	0
16	Nanded		
17	Shivane		
Total		396	364

Source: JICA Preparatory Survey

8.2 Plan of Sewers

8.2.1 Scope of Work (SW) considered in the DPR for the Improvement of sewage collection systems

8.2.1.1 House connections and branch sewers

Construction of branch sewers in Baner area, Sewerage District (SD) is planned in the DPR without consideration of house connections. Design of sewers was prepared in the DPR including route map of planned sewers with hydraulic calculations for a total sewer length of 43 km.

8.2.1.2 Main/sub-main sewers

The scope of work for construction of main/sub-main sewers (including rehabilitation, augmentation and newly construction) was determined by the request of O&M staff of PMC based on their experience. There are 23 sewer lines with a total length of 70 km.

8.2.2 Evaluation of the sewer construction plan in the DPR and recommended SW

8.2.2.1 Branch sewers

Construction of sewer network is planned for Baner area where land development has been implemented including many large-size condominium, but presently sewage is treated at septic tanks and small-scale private sewage treatment facilities.

The DPR includes plan of sewer lines and hydraulic calculations of the sewers (without sewer profile drawings).

With regard to the branch sewer requirements for design year 2047 in other areas in comparison with existing capacities of branch sewers, no study has been made in the DPR. The design flow capacity of branch sewer (design condition: 80% of full flow of the sewer) with diameters from 150mm to 200mm is 560MLD to 1,240MLD in assumption of sewer slop of 3. In assumption of hourly maximum per capita sewage generation of 378 lpcd (3 times of daily average sewage generation including groundwater infiltration; 126lpcd), sewage discharged by 1,500 to 3,280 persons/ha can be managed by 150 to 200 mm dia. sewers. Thus, it seems to be no problems on the existing branch sewers to accommodate sewage in the common population density areas. However, additional sewers may be necessary for the areas where buildings are planned to be constructed.

8.2.2.2 Main/sub-main sewers

Although there is no master plan for the construction/improvement of sewer network covering entire Pune City through the future, recommended plan for the construction of main/sub-main sewers in the DPR seems to be very high priority as they are proposed based on present experiences by the people who have been undertaking O&M of sewer networks.

The main/sub-main sewers are planned in the DPR to be installed along river/Nalla without procedural requirements for obtaining right of way. However, the following issues and problems were identified requiring future countermeasures.

- Although excavation for construction of the main/sub-main sewers is planned to apply open cut method, pipe jacking method and others may be required for crossing of the railway, rivers/channels and bridges. Therefore, it is necessary for PMC to review the construction methods before commencement of bidding procedure of concerned packages.
- Hydraulic calculation for the design of some planned main/sub-main sewers was made in the DPR, but there is no study for confirmation of the required diameters and slopes for the sewers

downstream of the planned sewers to accommodate additional sewage. There is no detailed data to confirm if the connection between existing sewer and planed sewer is appropriate in terms of sewer alignment and invert level without profile of sewer lines.

It is ideal to solve the above issues and problems immediately to ensure the design of sewers, especially with reference to existing sewers to be connected to planned sewers. However, it seems to be difficult and not realistic to study the above mentioned requirements now due to non-availability of data/ information on related existing sewers and limited time for the study. Therefore, detailed study for the connection arrangements between existing and planned sewers and confirmation on the accommodation of additional sewage shall be made in the next stage, upon start of Detailed Design work.

For the preliminary cost estimates, the findings with requirements in this field work, as mentioned above, will be considered for much more accurate sewer construction arrangements.

Table 8.2.1 presents findings in the field with comments on the planned main/sub-main sewers. Figure 8.2.1 shows locations of the planned main/sub-main sewer routes.

Table 8.2.1 Field Findings on planned Main/Sub-Main Sewers

Line Nos.	Description	Length	Diameter	Material	Purpose / Outline	Discharge (Connection) Point	Alignment in	Design Status			
		m	mm					L-Section	Capacity Design	Hydraulic Model Required	Comments by Survey Team
1	Trunk sewer in Darga Nalla extend full length (one side only)	3,000	600-900	NP3	Provide conveyance to area sewers	STP	Along Stream	Y	Y	Y	
2	Kharadi S. no. 63 to Eeon Mall to Darga Nalla	1,662	450-600	NP3	To intercept sewer main discharging into River Mula-Mutha and divert it to line no 1(TM in darga nalla)to convey to	Sewer	Along the stream and then along the	N	Y	Y	Pipe jacking may be done for about 100m to cut across ridge portion
3	Trunk sewer along Ambil odha from Katraj to sarasbaug	8,825	450-600	NP3	Provide conveyance to area sewers	Sewer	Along Stream	Y	Y	Y	Pipe jacking would be required to cross the canal near Mitra Mandal Chowk
4	Conveyance main from Khadakwasla Dam to Vadgaon Bk STP	6,250	450-1200	NP3	Provide conveyance to upstream fringe area upto Proposed Vadgaon STP	Proposed STP	Along Mutha river	Y	Y	N	
5	Conveyance main from Kondhave Dhavde to Warje STP	6,459	450-1,200	NP3	Provide conveyance to upstream fringe area upto Proposed Warje STP	Proposed STP	Along Mutha river	Y	Y	N	
6	Conveyance Main from Vadgaon Sheri to airport	1,500	900	NP3	Provide conveyance to area sewers Ramwadi area	Sewer	Along Stream	Y	Ongoing	Y	
7	Trunk main along Hadapsar nalla	7,597	450-900	NP3	Provide conveyance to area sewers from Hadapsar Area	Existing STP	Along Stream	Y	Y	Y	Crossing done by PMC
8	Rehab of lines in Manik Nalla from PCB boundary to Kasba Power house			NP3							
8a.	600mm line	750	600	NP3	To convey the flow from Manik nalla to existing 1800mm trunk sewer in nagzari nallla for Bhairoba STP	Sewer	Along Stream	N	N	Y	Accessibility for moving equipment to be ascertained
8b.	900mm Line	750	900	NP3	To convey the flow from Manik nalla to existing 1800mm trunk sewer in nagzari nallla for Bhairoba STP	Sewer	Along Stream	N	N	Y	Accessibility for moving equipment to be ascertained
9	Trunk sewer from Kasba Power house to Nagzari nalla's line of 1800mm	700	900	NP3	To convey the flow from Manik nalla to existing 1800mm trunk sewer in nagzari nallla for Bhairoba STP	Sewer	Along Road	N	Ongoing	Y	Might require pipe jacking. Feasbility of crossing under the Old outfall sewer (Ovoid) and 1400mm to be ascertained.
10	Connecting line to divert Old Kasba flow to New Kasba	250	1,800	NP3	Optimization of SPS	SPS	Along Mutha river	N	Ongoing	Y	Additional pumps would be required at New Kasba SPS
12	Lining of 1400mm RM from old Kasba to Naidu	2,100	1,400	MS	To increase efficiency of rising main	Rising Main	Along Road	N	N	Y	Flows in Old Kasba to be checked. Access to undertake lining to be ascertained
13	Erandawana STP to Tophkhana - .			NP3		SPS					
13a	New sewer line	2,500	1,200	NP3	Along River Bed to cater to overflow from Erandwane STP	SPS	Along Mutha river	N	Ongoing	Y	To check IL's and capacities of existing sewers lines along the river bed
13b	Rehabilitation of existing line	2,500	1,200	NP3	Maintenance	SPS	Along Mutha river	N	N	Y	To appropriate survey conducted prior to Rehab
14	Conveyance main from Bhide pool to New Kasba on right bank of Mutha river			NP3							
14a	Rehab of Conveyance main 1	1,200	1,200	NP3	Maintenance	SPS	Along Mutha river	N	N	Y	
14b	Rehab of Conveyance main 2	1,200	1,200	NP3	Maintenance	SPS	Along Mutha river	N	N	Y	
15	Conveyance main from Bund Garden to Bhairoba	1,200	1,800	NP3	Missing link	Existing STP	Along Mutha river	N	Ongoing	Y	
16	Trunk sewer line along Bhairoba nalla from PS to U/S 2km	500	1,800	NP3	Missing link	Sewer	Along Stream	N	Ongoing	Y	Check whether PMC will complete works from its own budget?
17	Trunk sewer along Nalla to Dhanori STP	4,000	600&900	NP3	Provide conveyance to area sewers from Dhanori Area	Proposed STP	Along Stream	N	Ongoing	Y	
18	Trunk sewer from Agricultural College to Railway Line leading to Tanajiwadi stp	2,000	1,000	NP3	Provide conveyance to area sewers from Janvadi & Gokhale nagar Area	Sewer	Along Stream	N	Ongoing	Y	
19	Trunk sewer LamanTanda To Bhairavi Hotel	1,500	900	NP3	Provide conveyance to area sewers from Lamantanda & Defence Area	Sewer	Along Stream	N	Ongoing	Y	Needs to be extend up to existing trunk sewer in Ram River
20	Trunk sewer along Paunjai nalla from Ambegaon to Vadgaon STP	3,000	900	NP3	Collect flows from Ambegaon and Vadgaon Bk and covey to Proposed Wadgaon STP	Proposed STP		N	Ongoing	Y	Might require existing 600-900 mm dia pipe to be demolished and reconstructed for portion between Highway and STP
21	Trunk sewer from Mira Society to Golden Bakery	2,000	900	NP3	To collect flows from the area sewers	Sewer	Along Stream and road	N	Ongoing	Y	
22	Trunk sewer from Katraj Byepass to Kondwa Smashan Bhoomi	3,450	900	NP3	To collect flows from the area sewers	Sewer	Along Stream	N	Ongoing	Y	
23	Conveyance main from Balewadi to Baner STP (from boundary after 2km upto baner	4,100	1,200	NP3	Missing Link	Existing STP	Along Mula River	N	Ongoing	Y	

Note) In river/steram side, pipe encasing may have to be undertaken depending depth and soil conditions.

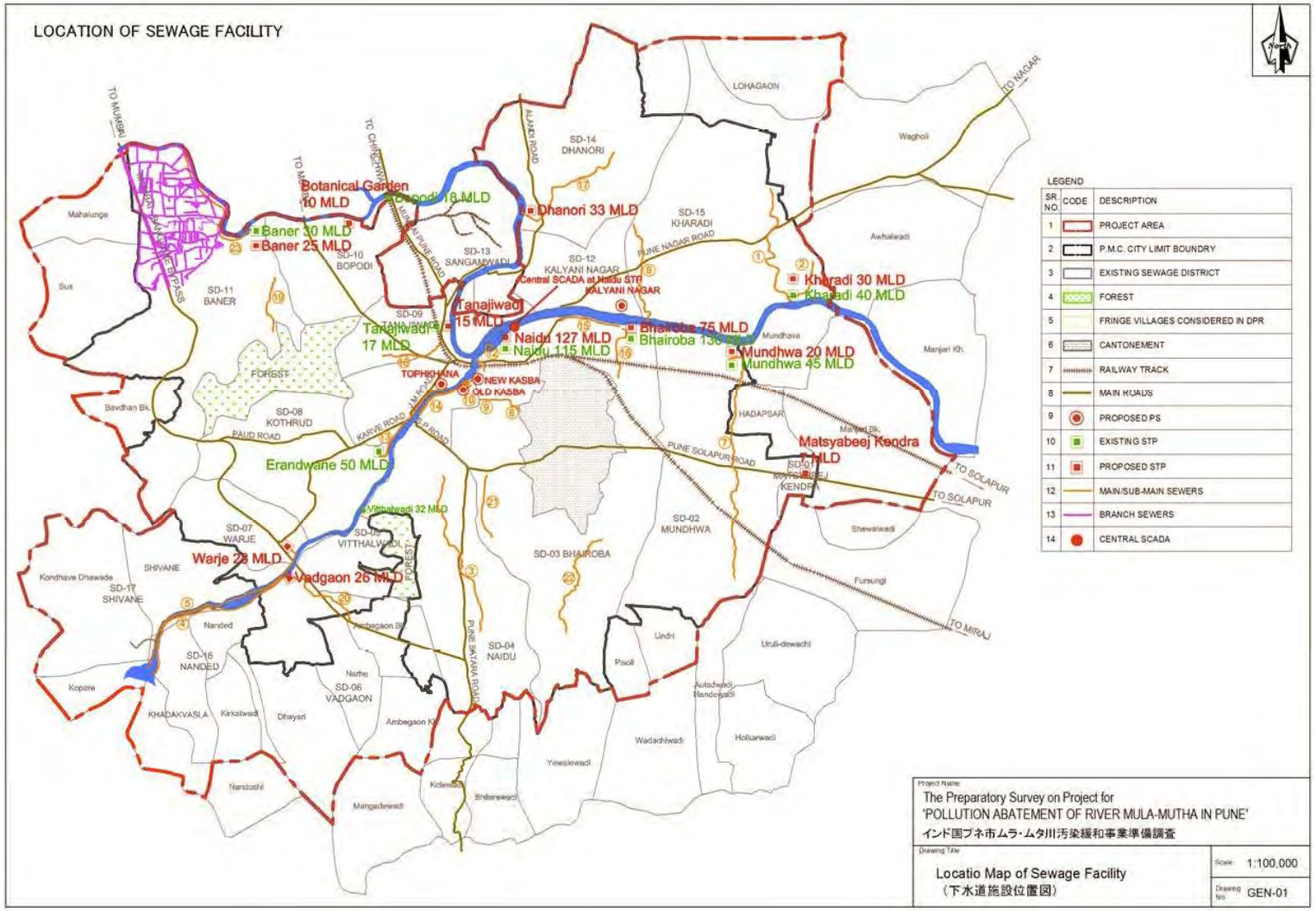


Figure 8.2.1 Location of Planned Main/Sub-Main Sewers

8.3 Intermediate Pump Stations

8.3.1 Scope of Work (SW) considered in the DPR

Scope of work for Intermediate Pumping Station (IPS) considered in the DPR is summarized following table. It includes replace/expansion and rehabilitation of 4 existing IPSs.

Table 8.3.1 Scope of Work for IPS considered in the DPR

Name of IPS	Design Peak Flow (MLD)	Outline of Pumps		Remarks
		Existing Pumps	Proposed Pumps	
Old Kasba	87.6	6	6(4 replace)	Replace 4 pumps and capacity increase Incl. Rising Main Pipe(Dia1400mm,L=50m) and Rehabilitation of Civil structure
New Kasba	304.4	6	12(6 add)	Add 6 pumps and capacity Increase Incl. Rising Main Pipe(Dia1400mm, L=150m)
Kalyani-nagar	87.6	3	3(3 replace)	Replace 3 pumps and capacity Increase
Mangalwar Peth	28.4 (Based on the existing Wet well capacity)	Not function	6(6 added)	Expansion of Pumps Incl. Rehabilitation of Civil structure

Note) W: Working pump, S: Stand-by pump
Source: DPR, Note

Source: JICA Survey Team

- ✓ Old kasba: Four (4) pumps out of six (6) existing pumps will be replaced/expansion and capacity will be increased in total.
- ✓ New Kasba: Existing six(6) pumps are continuously in use and six(6) new pumps will be installed additionally, capacity will be increased in total
- ✓ Kalyaninagar: Three (3) larger pumps will be installed additionally, capacity will be increased and the planned capacity can be satisfied by these three (3) pumps. Existing three (3) pumps will not be removed.

8.3.2 Recommended Scope of Work

Among four (4) pump stations, capacity of three (3) pump stations of Old Kasba, New Kasba and Kalyaninagar are in connection with the destination STP, replace/expansion of them is necessary for this project. And the capacity of two destination STPs (Naidu, Bhairoba) are almost the same as DPR, the scope of these three pump stations can be adopted in this project. Additionally, Topkhana pumping station needs to augment its capacity.

Regarding Kalyaninagar pump station, replacement of screen equipment is additionally proposed because the serious damage was found at the site survey. On the other hand, Mangalwar Peth pump sta-

tion is deleted from the project scope after the discussion with PMC. The reason is described as follows;

- ✓ Currently the pump station is not in use. (it became unnecessary according to sewerage expansion)
- ✓ The purpose of pump station is to prevent inundation for low elevation areas near the pump station discharging increased sewage during monsoon season.
- ✓ The proposed pump capacity is determined by the limitation of pump pit structure, the necessity and appropriateness are not confirmed.

Table 8.3.2 Scope of Work for IPS

Name of IPS	Design Peak Flow (MLD)	Scope of Work	Remarks
Old Kasba	90	4 (replace)	Replace of 4 pumps Incl. Rising Main Pipe(Dia1400mm,L=50m) and Rehabilitation of Civil structure
New Kasba	270	6 (add)	Add 6 pumps Incl. Rising Main Pipe(Dia1400mm, L=150m)
Topkhana	187	6 (add)	Add 6 pumps
Kalyani-nagar	79	3 (replace)	Plan is replace but add 3 pumps and existing 3 pumps are not removed

Source: JICA Survey Team

8.4 Sewage Treatment Plants

8.4.1 Sewage Treatment Methods for Planned Sewage Treatment Plants

8.4.1.1 Effluent quality to be achieved

Target quality of the effluent to be discharged from planned STPs is assumed according to recommended standards by CPHEEO as shown in Table 8.4.1.

Table 8.4.1 Target Effluent Quality (Recommended by CPHEEO)

Item	BOD	SS	T-N	T-DP
Target standard	10 mg/l	10 mg/l	10 mg/l	2 mg/l

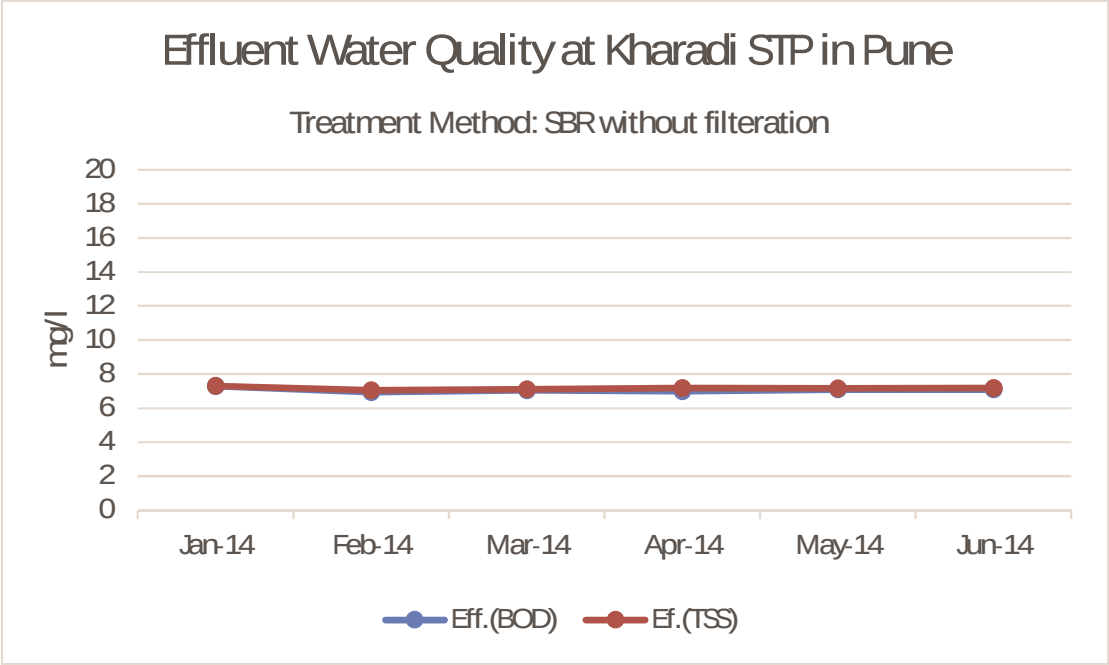
Source: JICA Survey Team

Utility is free to adopt stringent standards than that s prescribed by MOEF/CPCB. The effluent standards adopted for this Project are much more stringent than those adopted for common waterbody in India due to planned water use for drinking purpose in the downstream area of Mula-Mutha River. In this regard, there seems to have some difficulties to achieve the requirements in application of only secondary treatment methods. Additional treatment methods, such as tertiary treatment and chemical coagulation and sedimentation process, may be employed in case there are sufficient land area for the STPs and financially manageable. In the fact of the difficulty at present to ensure land area for STPs in

PMC and economical view points, secondary treatment methods shall be applied for this project with considerations of careful design conditions and provision of proper O&M of the sewage treatment facilities. Furthermore, treatment experiences on the secondary treatment in India and Japan to will be fully refereed to.

8.4.1.2 Experiences on the control of effluent quality at existing STP

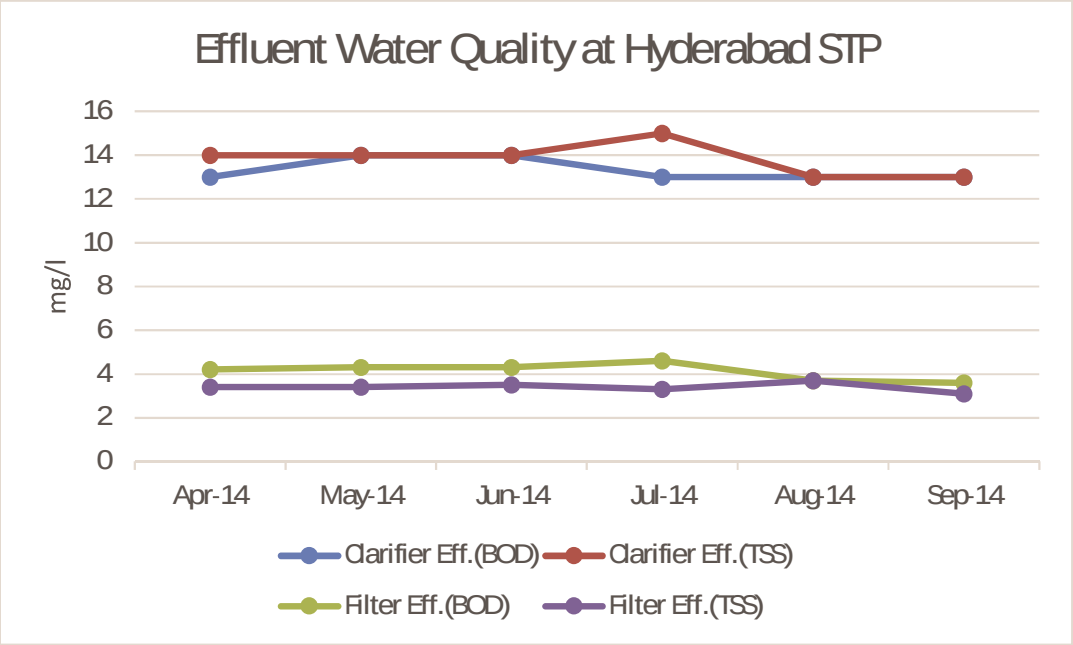
According to the treatment experiences at existing STPs in PMC, there are many STPs having achieved the stringent standards (BOD 10mg/l and SS 10mg/l) using only secondary treatment methods without provision of tertiary treatment processes (such as sand filtration), as shown in Figure 8.4.1, records of effluent quality at Kharadi STP. However, it is noted that there was a condition of inflow sewage load which is lower than design load (in case of Kharadi STP, as a representative STP, inflow sewage volume is about 70% of design volume) to have achieved the standards.



Source: JICA Survey Team

Figure 8.4.1 Records of Effluent Quality at Kharadi STP in PMC

Figure 8.4.2 presents a sample case of effluent quality obtained from existing STP located out of PMC, Hyderabad. The effluent quality after secondary treatment is reported (BOD 13-15 mg/l) beyond standards requiring tertiary treatment to meet the required standards.



Source: JICA Survey Team

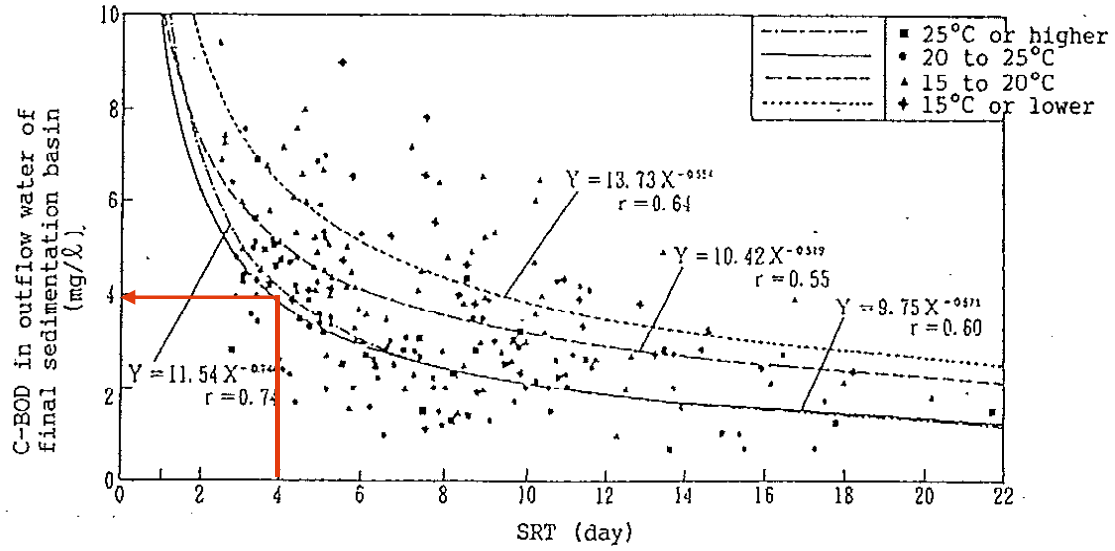
Figure 8.4.2 Records of Effluent Quality after Secondary and Tertiary treatment at Picket Nalla STP in Hyderabad

From the experience of sewage treatment using secondary treatment method, the stringent effluent standards of the effluent may be achieved in provision of adequate O&M of sewerage facilities aside from ensuring proper design and construction work. However, the provision of tertiary treatment is ideal. But, there are some hindrances to implement the requirements, including land availability for the STP, financial limitation, and difficulty for proper O&M. Realistic countermeasure shall be applied in the selection of sewage treatment methods.

8.4.1.3 Projected Effluent Quality based on assumed Secondary Treatment Method for Design of STP

Design of sewage treatment facilities shall be made considering required volume for the aeration tank to remove nitrogen meeting target TN 10mg/l. Under this arrangement, the volume of aeration tank in this design (A-SRT; retention time of aerobic solid) is larger than common aeration tank used for standard secondary treatment process (design effluent quality, BOD 20 mg/l).

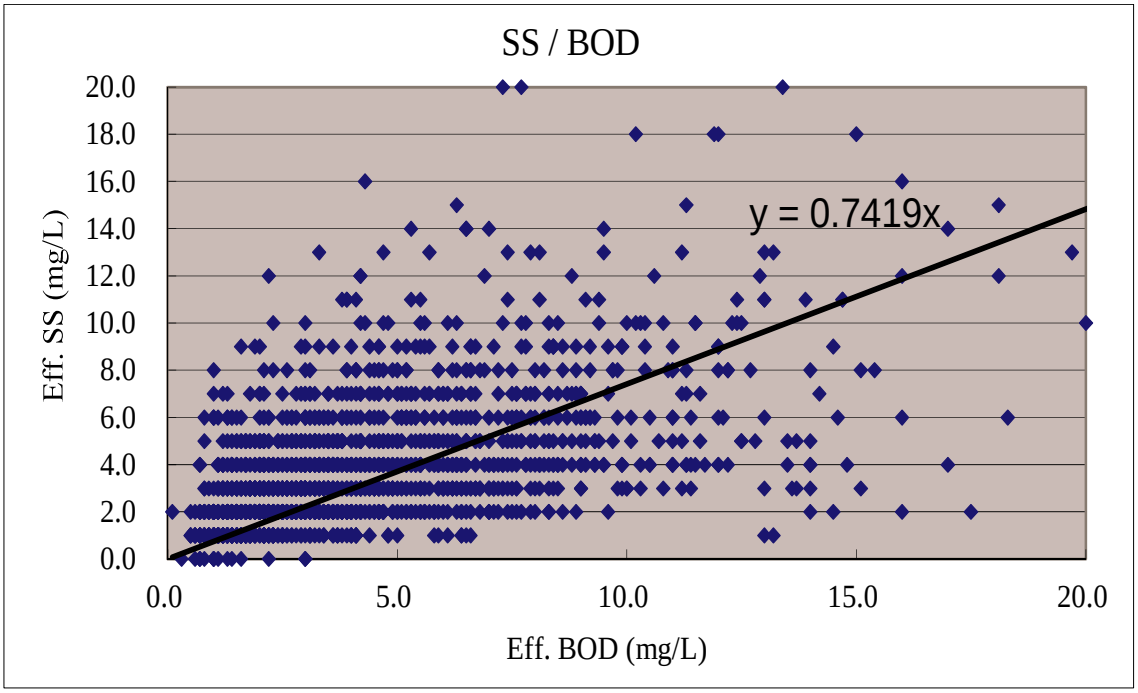
Projected BOD is illustrated in Figure 8.4.3 based on calculation results of aeration tank (A-SRT: 4-5 days).



Source: Japan Sewage Works Association

Figure 8.4.3 Relationship between Effluent BOD and SRT

As shown in Figure 8.4.3, BOD is projected at 4 mg/l in application of A-SRT 4 days. The BOD may be less than 8 mg/l in consideration of 2 times of BOD as annual average quality, which is lower than stringent standard. Figure 8.4.4 shows relationship between BOD and SS.



Source: JICA Survey Team

Figure 8.4.4 Relationship between BOD and SS

Based on the experience in Japan, interrelation between BOD and SS is reported at about 0.74 (SS/BOD) as shown in Figure 8.4.4. In use of the Figure and assuming 8 mg/l of BOD, SS arrives at 6 mg/l (8 mg/l x 0.74), resulted in projected effluent quality both for BOD and SS is less than target quality.

8.4.1.4 Recommended sewage treatment level for this Project

With regard to the present experience on effluent quality in India, it seems to be difficult to satisfy the stringent standards recommended by NRCD (BOD 10mg/l and SS 10mg/l), though currently some secondary sewage treatment plants in PMC meet the requirements.

In this Project application of modified aeration tank to remove nitrogen under secondary treatment process is recommended (a larger aeration tank is provided), which plays a role as tertiary treatment process (A-SRY: 4-5 days) to a certain extent. This arrangement will also allow for the required removal of SS to meet required standard.

In order to satisfy required standards, the need of proper O&M of STP is indispensable. Under adequate O&M of the STP, effluent quality could satisfy the stringent standards as practiced in Japan. Table 8.4.2 presents the experience of secondary treatment plants in Japan with higher level treatment efficiencies (less than 10mg/l BOD and SS).

For this Project application of “secondary treatment process” is recommended in consideration of a larger aeration tank for removal of Nitrogen for utilization of effluent for drinking purpose in the downstream area. The importance of adequate O&M of the STP shall be fully considered through project implementation.

Table 8.4.2 Secondary Sewage Treatment Experience in Japan

Experience in Japan

Treatment Process : Conventional Activated Sludge System

Source : Sewage Works Statistics in Japan

No.	Name of STP	Inflow (m3/day)	BOD (mg/L)				SS (mg/L)			
			Inlet		Outlet		Inlet		Outlet	
			Design	Actual	Design	Actual	Design	Actual	Design	Actual
1	Chubu Ryuiki, Ginowan	87,190	240	210	17	3.4	230	171	17	3.0
2	Chubu Ryuiki, Naha	127,320	260	290	18	3.4	200	207	15	2.0
3	Kagoshima City, Nanbu	119,797	210	283	15	2.4	190	304	17	2.0
4	Kagoshima City, Kinko	22,630	210	265	15	5.6	190	196	29	4.0
5	Nobeoka City, Myoda	27,440	180	150	19	2.3	140	130	16	3.0
6	Miyazaki City, Oyodo	34,486	200	160	20	3.0	200	190	20	3.0
7	Miyazaki City, Miyazaki	68,971	200	130	20	3.3	160	130	16	4.0
8	Beppu City, Chuo	43,813	160	125	16	1.7	160	143	24	2.0
9	Oita City, Benten	31,163	250	160	20	1.6	250	120	20	2.0
10	Oita City, Miyazaki	22,098	250	190	20	2.4	250	200	20	2.0
11	Oita City, Harayama	26,258	250	180	20	4.8	250	160	20	3.0
12	Kumamoto Hokubu Ryuiki	45,709	180	160	15	10.0	180	183	18	4.0
13	Yamaga City, Yamaga	18,074	140	174	20	2.1	120	183	20	3.0
14	Kumamoto City, Nanbu	30,200	200	267	15	9.0	140	124	14	8.0
15	Kumamoto City, Tobu	56,098	200	219	15	5.9	180	207	14	4.0
16	Kumamoto City, Chubu	30,258	180	180	15	2.0	140	159	14	3.0
17	Sasebo City, Chubu	36,739	270	202	15	1.4	170	180	15	3.0
18	Nagasaki City, Seibu	43,915	200	230	15	3.3	190	223	15	2.0
19	Nagasaki City, Chubu	44,230	200	223	20	3.4	190	153	40	4.0
20	Matsuyama City, Chuou	92,202	180	135	18	4.8	125	155	13	2.0
21	Imabari City, Imabari	40,381	190	122	19	4.1	150	119	20	2.0
22	Kamobegawa Ryuiki	118,923	174	143	20	2.0	135	181	30	3.0
23	Takamatsu City, Tobu	69,652	200	268	20	8.3	200	234	20	5.0

8.4.2 Sewage treatment methods for planned sewage treatment plants

8.4.2.1 Basic conditions for the study of sewage treatment methods

(1) Required conditions and references for the design of STPs

1) Effluent standards to discharge treated sewage into rivers

As mentioned before, CPHEEO value as “B” in Table 8.4.3 is adopted for treated effluent quality.

Table 8.4.3 Target Treatment Water Quality

Item	Unit	A MOEF/NPCB	B(Recommended) CPHEEO	C DPR	Remarks
BOD	mg/L	20	10	5	
TSS	mg/L	30	10	10	
TN	mg/L	NA	10	7	
TDP	mg/L	NA	2	2	
Faecal Coliforms	MNP/100ml	Maximum: 10,000 Desirable: 1,000	230		

TKN: Total Kjeldahl Nitrogen

TDP: Total Dissolved Phosphorous

Source: JICA Survey Team

2) Reuse of effluent after sewage treatment

“Guidance Document for Municipal Wastewater Reuse in India” prepared by JICA India shall be referred to for effluent re-use.

3) Sludge Disposal

Currently, there are no relevant regulations for disposal of sewage sludge in India. Under this condition, generated sludge at STPs is dewatered and stored at STPs. The sludge is sometimes used as fertilizer in farm lands.

4) Biogas Power Generation

India is well known as one of the largest contributors to reduce carbon emissions in the world. The country has been taking more aggressive measures to lower its carbon emissions by National Action Plan on Climates Change, June 2008. PMC follows the policy of reducing greenhouse gas emission.

5) Staged Construction

The plan in the DPR includes staged construction every ten years. However, it seems to be a new construction of treatment facilities, not expanding existing facilities based on expansion plan for designed systems through the future.

8.4.2.2 Inflow sewage quality

Current sewage quality is shown in Table 5.3.2 in sub-section 5.3. Currently the influent quality is lower than CPHEEO value because the water consumption is larger than standard. Considering water consumption decrease in the future, inflow sewage quality is calculated as shown in Table 8.4.4.
The followings are the process of estimation.

① CPHEEO recommends per capita pollution load and sewage quality.
② Calculated quality means (per capita pollution load)/ (per capita sewage flow)
③ Sewage flow decreases in the future and the estimated quality is 214 mg/l if BOD.
④ Current inflow quality is 182 mg/l BOD at Bhairoba STP.
⑤ Assuming sewage flow decrease, BOD will increase to 235 mg/l in 2027.
⑥ CPHEEO recommends also sewage quality of 250 mg/l in BOD.
⑦ Recommended raw water quality is 250 mg/l BOD and 350 mg/l TSS.

Table 8.4.4 Estimation of Raw Sewage Quality

	Pollution Load in CPHEEO	Water consumption		Sewage flow*		Calculated Quality		Observed Quality	Assumed	Water Quality in CPHEEO	Recommend
		Current	2027	Current	2027	Current	2027		2027		
	A			B1	B2	A/B*1000		C	C*B1/B2		
	g/cap/day	lpcd	lpcd	lpcd	lpcd	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
BOD	27	194	150	162.96	126	166	214	182	235	250	250
TSS	40.5	194	150	162.96	126	249	321	253	327	375	350

*80% of water consumption and 5% groundwater infiltration

Source: JICA Survey Team

Quality of Nitrogen and Phosphorous are set based on CPHEEO, T-N for 45mg/l and T-DP 5mg/l and

shown in Table 8.4.8.

8.4.2.3 Selection of Sewage Treatment Method

(1) Basic Conditions for Sewage Treatment Required

The following shall be considered for selection of the sewage treatment methods by planned STP (Biological nutrient removal process shall be considered).

- Denitrification is considered.
- Experiences in India are necessary.
- Biogas generation system shall be considered for larger STPs.
- Primary sedimentation tank shall be omitted in case of smaller STPs to reduce O&M requirements.
- Alternative sewage treatment processes shall be limited to simplify O&M of STP in the city.
  (In some cases, STPs' treatment capacity is determined to meet land availability for the STP. Sewage exceeding the capacity of STP in the particular sewerage district is planned in the DPR to convey to other STP.)

(2) Proposed Sewage Treatment Method in the DPR and Alternative methods

The treatment processes with proposed capacity and land area required in the DPR are shown in Table 8.4.5. All proposed STPs are categorized into two groups and the study results are summarized in the same table.

Table 8.4.5 Treatment Processes in the DPR and Recommended by Preparatory Survey

No.		1	2	3	4	5	6	7	8	9	10	11
SD		SD4	SD3	SD2	SD6	SD7	SD10	SD9	SD14	SD1	SD11	SD15
Name of STP		Naidu	Bhairoba	Mundhawa	Vadgaon	Warje	Botanical Garden	Tanaji-wadi	Dhanori	Matsya Bij ken-dra	Baner	Khradi
Process by DPR		SBR + Power	SBR + Power	SBR	ASP	EA	SBR	MBBR	MASP	MBR	SBR	SBR
Influent Flow MLD	DPR	125	74	45	18	27	19	16	32	8	0	0
	This Study	127	75	20	26	28	10	15	33	7	25	30
Group		A	A	B2	B1	B1	B1	B1	B1	B3	B2	B2
Recommended Process by this Study		A2O + Power	A2O + Power	SBR	EA	EA	EA	EA	EA	SBR	SBR	SBR

Source: JICA Survey Team

(3) Sewage Treatment Method Selection

1) Comparison of Treatment Methods

Alternative treatment methods are; a) Conventional Activated Sludge Process, b) Moving Bed Biofilm Reactors(MBBR), c) anaerobic anoxic-oxic process (A2O), d) Step-feed Biological Nitrogen Removal Process, e) Sequencing Batch Reactors (SBR), f) Membrane Bioreactor(MBR), g) Oxidation Ditch Process (OD), h) stabilization pond and i) RO membrane.

For these 10 methods, the following items were compared and evaluated in Table 8.4.6: 1) treated water quality, 2) nitrogen removal, 3) phosphorus removal, 4) ease of O&M, 5) construction costs, 6) O&M costs and 7) experience in PMC. In the selection of treatment methods, Nitrogen removal and experience in PMC was considered most and A2O was selected for larger STP and SBR/EA was selected for small STP.

Table 8.4.6 Comparison of Treatment Methods

Item / Method	BOD/ SS	Nitrogen	Phosp-horus	O&M	Construction Cost	O&M Cost	Experience In PMC	Judge
a) Conventional Activated Sludge	○	△	○	○	○	○	◎	○
b) MBBR	○	△	○	○	○	○	○	○
c) A2O	○	◎	◎	△	○	○	○	◎
d) Step-feed Biological Nitrogen Removal Process	○	◎	○	○	○	○	△	△
e) SBR	○	◎	○	○	○	○	◎	◎
f) MBR	◎	◎	○	○	△	△	△	○
g) OD	○	◎	○	◎	○	○	△	○
h) EA	○	◎	○	◎	○	○	◎	◎
i) Stabilization Pond	△	×	×	◎	◎	◎	△	×
j) RO	◎◎	◎	◎	○	×	×	△	for future

Legends ◎: Grade A ○ : Grade B △ : Grade C × : Grade D or has operating problems

Source: JICA Survey Team

1) Group A

Two large-size STPs; Naidu and Bhairoba, the capacities of which are more than 50 MLD, are considered to include biogas generators.

a) Appropriateness of applying biogas generator

The biogas generator installed at existing Bhairoba STP is not operated at present because of limited gas generation. The cause is not only the weakness of inflow sewage concentration but also improper facility in sludge treatment. Centrifugal type sludge dewatering machine is out of order and no installation of warming equipment. Accordingly, gas-engine facilities have not been operated for a long time.

Cost comparison between construction cost of the relevant facilities and cost reduction by generation is made in the DPR and sub-section 8.1.5, the cost for construction of the facilities will be recovered by generated power selling for operation of around six years. Considering power supply condition and green-house gas reduction, applying biogas generator is advantageous.

Considered above, biogas generation is proposed in this project.

b) Treatment method

Sludge digestion and biogas generator system are usually applied for large-size STPs, because of stable biogas generation and many O&M items required. In many cases ASP is applied for larger size STPs, as used at existing Naidu and Bhairoba STPs. However, in DPR, Sequential Batch Reactor (SBR) with primary sedimentation tank is selected because of the limitation of land availability for the STP. Usually primary sedimentation tank is not provided for SBR as practiced at the existing three STPs in PMC. ASP was recommended for the easy maintenance if nitrogen and phosphorous removal are not necessary.

In consideration of both nitrogen and phosphorous removal, A2O process is recommended instead of ASP. To accommodate required facilities in the available land area, deep aeration (8-10m) reactor with rectangular type sedimentation tanks are adopted.

2) Group B

Smaller size STPs with less than 50 MLD are categorized in this group (9 STPs are included in the DPR). For this group SBR, EA, ASP, MASP are adopted in the DPR. The STPs planned to adopt ASP and MASP require primary sedimentation tanks and sludge digestion tanks. In application of these processes, O&M of digester is difficult for the staff of smaller STPs aside from additional cost required. Thus, SBR or EA, which does not include primary sedimentation tank, are recommended to reduce construction cost and O&M work. Both two methods are currently operated in PMC and also able to denitrification by intermittent aeration or anaerobic and aerobic zoning. For phosphorous removal, 2 mg/l in total dissolved phosphorous is achieved according to Japanese experience for EA. A coagulant dosing facility is necessary for further phosphorous removal.

Both biological reaction and solid separation are done in the same tank in SBR system, it can reduce footprint of the treatment facility. However, solid separation is depended on mechanical equipment named decanter, if a trouble happen in decanter, solid separation may be damaged. On the other hand, EA is equipped with fixed sedimentation tanks, stable treatment is expected but lager area is required than SBR. Tough, to adopt deeper reactor tanks and tube-settlers, footprint can be reduced and almost

same as SBR. The comparison is shown in Table 8.4.7. In this study, EA process is recommended for smaller STPs because easier and steadier operation/treatment is expected by separated sedimentation tanks. However, to construct adjacent to the existing plant and operated by the same staffs, same treatment method is recommended.

Table 8.4.7 Footprint Comparison between SBR and EA

Item	Unit	SBR	EA	EA（Deep Aeration and Tube-settler）
Capacity	MLD	10	10	10
HRT	Hr	17	17	17
Reactor Tank				
Volume	m^3	7,083	7,083	7,083
Depth	m	5.5	6	8
Foot print	m^2	1,288	1,181	885
Clarifier				
Surface load	m^3/m^2		15	30
Foot print	m^2		667	333
Total footprint	m^2	1,288	1,847	1,219

Note: footprint of wall is not considered

Source: JICA Survey Team

a) Group B1

The STPs for new construction belong in this group and EA is recommended. If site area is insufficient, deeper aeration tanks and tube-settler are considered.

b) Group B2

Three STPs of Mundhawa, Baner and Khradito are in this group. They are adjacent to the existing SBR plant and operated by same organization. In this Survey same SBR is recommended.

c) Group B3

Only one STP; Matsya Beij kendra STP is in this group. The plant site available is too small to place all the building on the ground. It means that some buildings are to be constructed on the reactor tank. In this reason, the simple tank is desirable and SBR is selected.

(3) Selection of sludge treatment method

If there are primary sedimentation tanks at existing STPs, thickening, digestion and centrifugal dewatering process are used for sludge treatment. However, without primary sedimentation tans, excess sludge is treated through direct dewatering process.

1) For Group A

In application of the same arrangements as adopted at existing STPs, thickening, digestion and centrifuge dewatering are recommended for A2O process. For sludge thickening, mechanical thickener is recommended considering present practices at Naidu STP which is the latest plant and well operated.

2) For Group B (B1 and B2)

Without primary sedimentation tanks, excess sludge shall be dewatered by direct dewatering using centrifugal type machine.

8.4.3 Recommended SW

Plan on sewage treatment plant is summarized in Table 8.4.8.

Table 8.4.8 Summary of Sewage Treatment Plant Plan

No.			1	2	3	4	5	6	7	8	9	10	11
SD			SD4	SD3	SD2	SD6	SD7	SD10	SD9	SD14	SD1	SD11	SD15
Name of STP			Naidu	Bhairoba	Mundhawa	Vadgaon	Warje	Botanical Garden	Tanajiwadi	Dhanori	Matsya Beij kendra	Baner	Khradi
Influent Flow		MLD	127	75	20	26	28	10	15	33	7	25	30
Influent Quality	BOD	mg/l	250	250	250	250	250	250	250	250	250	250	250
	TSS	mg/l	350	350	350	350	350	350	350	350	350	350	350
	T-N	mg/l	45	45	45	45	45	45	45	45	45	45	45
	T-DP	mg/l	5	5	5	5	5	5	5	5	5	5	5
Effluent Quality	BOD	mg/l	10	10	10	10	10	10	10	10	10	10	10
	TSS	mg/l	10	10	10	10	10	10	10	10	10	10	10
	T-N	mg/l	10	10	10	10	10	10	10	10	10	10	10
	T-DP	mg/l	2	2	2	2	2	2	2	2	2	2	2
Treatment Process	Sewage		A2O	A2O	SBR	EA	EA	EA	EA	EA	SBR	SBR	SBR
	Sludge		Mechanical Thickener + Anaerobic Digester + Centrifuge		Centrifuge								
	Biogas		Generator	Generator	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

Source: JICA Survey Team

8.5 Re-Use of Effluent from STPs

8.5.1 General information for utilization of effluent from STPs

The erratic and unfavorable monsoon conditions over the past couple of years and excessive and uncontrolled pumping of groundwater resources within the urban regions have exacerbated the situation of water availability, making fresh water availability difficult. Less than normal precipitation has resulted in less accumulation of fresh water that could be withdrawn. The low levels of inflow coupled with increased withdrawal rates have resulted in depleting the water levels within the reservoirs and

the rivers. The impact of increased urbanization is clearly visible on the water quality of many rivers that are water resources to many growing cities. Mula and Mutha rivers are not far away from this situation, which exhibit polluted stretches affected by heavy pollution loads as a result of rapid urbanization of PMC City, where partially treated or untreated sewage flows into the rivers. In India treated sewage is sometimes used for a variety of applications such as (a) farm forestry, (b) horticulture, (c) toilet flushing, (d) industrial use for cooling towers, (e) fish culture and (f) indirect & incidental uses.

PMC is already executing a project for supply of treated sewage to downstream areas through irrigation canals. The project includes construction of a weir, on the river Mula-Mutha, construction of Jackwell and pumping station and 3.5 km long rising main with diameter of 2,700 mm. The project cost is 110 crore and it will recycle 515 m^3/d of water back into the system. However, in this approach PMC needs to consider the cost recovery to operate and manage its pumping station as well as Jackwell for supplying water to irrigation. In addition to this the City is thinking of using high quality recycled water through membranes for Matsya Beej Kendra, for a capacity of 8 m^3/d. The objective is to treat the sewage to tertiary level using membranes and supply to the fish culture ponds.

Like other metro cities in India, it is suggested that PMC should consider implementing various small to medium size tertiary treatment plants of 5 to 10 m^3/d and use the water for variety of non-potable and industrial applications and make compulsory for construction industry. The recycle quantity shall be developed considering the requirement of downstream riparian rights of cites and farmers. It is suggested that, as part of the implementation project for pollution abatement of Mula-Mutha rivers, PMC should focus more into recycle and reuse of sewage to augment its water availability while considering the elements of framework as outlined below:

Elements of the Framework: The framework for management of recycled water quality shall incorporate 12 elements, which can be organized within four general areas as listed below and illustrated in the Figure 8.5.1.

① Commitment to responsible use and management of recycled water

This requires the development of a commitment to responsible use of recycled water and to application of a preventive risk management approach to support this use. The commitment requires active participation of senior managers, and a supportive organizational philosophy within beneficiaries responsible for operating and managing recycled water schemes.

② System analysis and management

This requires an understanding of the entire recycled water system, the hazards and events that can compromise recycled water quality, and the preventive measures and operational control necessary for assuring safe and reliable use of recycled water.

③ Supporting requirements

These include basic elements of good practice, such as employee training, community involvement, research and development, validation of process efficacy, and systems for documentation and reporting.

④ Review

This includes evaluation and audit processes to ensure that the management system is functioning satisfactorily. It also provides a basis for review and continuous improvement.

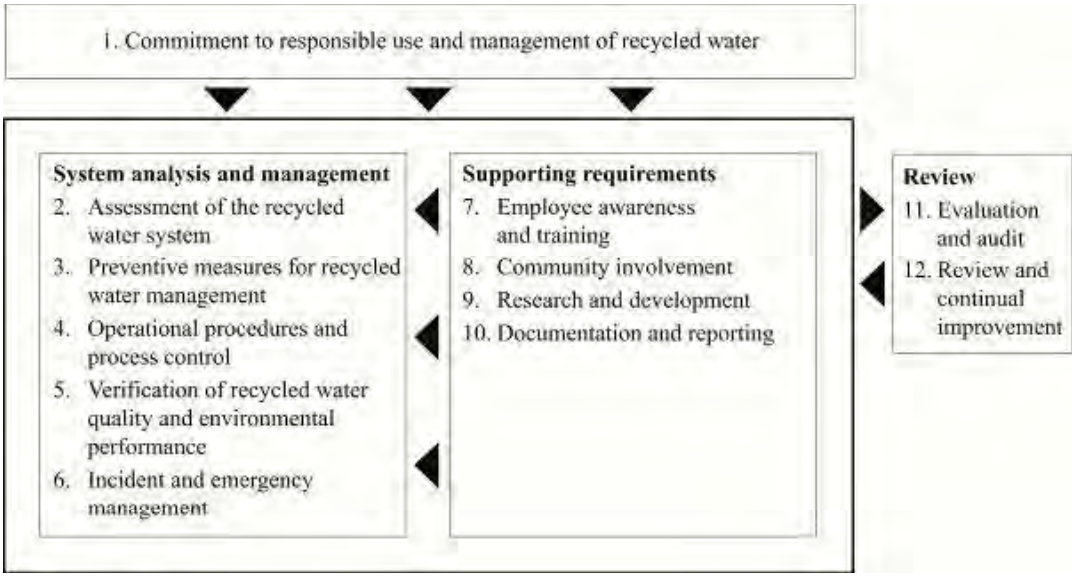


Figure 8.5.1 Elements of the Framework for Management of Recycled Water Quality and Use

This framework approach would certainly help PMC for developing water conservation and lead the way to resource management. Recently under the banner of Delivering Change Foundation (NGO), organized by Sakal Group has prepared a road map for making Maharashtra drought free and to increase water availability. Their ambition is to increase the recycle and reuse potential in Maharashtra up to 30% based on available sewage using tertiary treatment. PMC could take definitive steps by adopting increase interest in recycle and reuse of high quality treated sewage for non-potable applications. The survey conducted on recycle water demand with willingness to pay and use would consider

viability of using additional recycle and reuse options for PMC and any beneficiary entity either government or non-government or private to optimize available water resources. In this regard it is important for PMC to get public acceptance for reuse of water as well as determining economics of return on investment in providing recycle and reuse facility.

8.5.2 Present Re-use of Treated Sewage in PMC and Future Plan

The current quantity of treated sewage (effluent: There are no current National or State Level quality standards for reuse.) available for reuse is about 450MLD (95% of 477MLD existing treatment capacity). About 370MLD (95% of proposed 390MLD) additional treated sewage would be available after the completion of this sewerage project for the design year 2027. Hence the total quantity of treated sewage available would be about 820MLD for the design year 2027. The potential re-use of the effluent are "General use" and "Specific purpose use".

8.5.2.1 General re-use potential in the Mula-Mutha and Bhima rivers

Generally treated sewage /effluent can be used for the following areas.

- Irrigation
- Gardening, lawns etc.
- Washing /Non Process water in Industry
- Construction Water

8.5.2.2 Specific Reuse of treated sewage/ effluent

(1) Existing Re-use of 40MLD from Bhairoba STP

In the Revised City Development Plan prepared by PMC in 2013, about 40MLD of effluent from Bhairoba STP is being recycled and used for irrigation and other secondary purposes. According to the City Sanitation Plan only 5.38% of water is recycled against Service Level Benchmark of 20%[1] (guideline by Government of India).

(2) Large developments Recycle waste internally

According to MOEF[2] notifications[3], one of the conditions for obtaining an environmental clearances for large developments area with more than 20,000 m^2, is installation of a Sewage Treatment Plant, to encourage public participation in reuse of sewage and reduce the load on municipal sewage treatment

[1] Handbook on Service Level Benchmarks, published by Administrative Staff College of India for Government of India.
[2] MOEF guidelines on EIA Notification 2006
[3] Report of the committee constituted under the Chairmanship of J. M. Mauskar, Additional Secretary, to examine the comments / suggestions on the draft amendments to EIA Notification 2006.

plants as well as promoting the concept of decentralized sewage treatment. PMC has made this condition more stringent by specifying that STPs would need to be installed in all development with more than 150 tenements. The treated sewage could be used for toilet flushing and gardening purposes. Hence it is estimated that from the 120lpcd sewage generated, about 45lpcd could be reused whereas remaining would be discharged into the storm water drainage after treatment to meet inland water discharge standards.

The individual private STPs, mainly located in SDs of Kharadi, Mundhwa and Baner, generate about 75MLD of treated sewage based on the record on current permissions granted by PMC to large developments. About 30 to 40% of this treated sewage would be reused (for toilet flushing and gardening/landscaping) and excess effluent is discharged into nearby drainage. This is significant reuse potential in the city, especially in frenetic pace development for larger schemes in the outskirts of the city. Some of these private STPs are already built and functional. The PMC and MPCB need to ensure that these private STPs are properly maintained and discharge effluent meeting appropriate effluent standards. This would promote people's participation in developing the Reuse potential.

(3) Planned 500MLD irrigation demand from Mula-Mutha River at Kharadi:

PMC is under construction of a 500MLD pumping station to take water from the Mula-Mutha River and discharge into the Khadakvasla canal to supply water for irrigation in the areas beyond Hadapsar. The treated sewage would have to be made available to the Irrigation Department. The pump shall be operated depending on the cropping pattern in the irrigated fields. It is expected that the Irrigation Department will utilize the treated sewage about 4 times a week in the non-monsoon period. During the monsoon period the treated sewage can be discharged into the river. The river ultimately drains into the Ujani Dam and hence used for irrigation in the command area of the dam and its irrigation canals.

(4) Other potential uses in the future

There are marginal other uses of the effluent, which include Railway and Construction industry.

1) Reuse by Railways

PMC Railway Station is a fairly large station with a bogie/carriage washing facility and maintenance yard in the Central Railway Network. There is potential for washing Railway wagons in PMC using treated sewage. According to the reuse potential assessment of Secunderabad Railway Station (South Central Railway) conducted for the JICA funded Musi River Pollution Abatement project, the demand for washing purposes was about 2MLD. PMC station is of similar size as Secunderabad and hence demand can be considered in the range of 2MLD.

According to PMC, a dialogue has been initiated with the Central Railway to explore this potential.

2) Reuse by Construction Industry

PMC also explored the possibility of use of treated sewage for construction purposes. To this effect, PMC also floated a public enquiry to gauge potential for utilization of treated sewage from Kharadi STP (especially considering the large construction activities under way in that area). The enquiry did not draw any response from construction companies. According to the PMC, this could be due to:

a) Indian Standards "IS456" permit use of water from any source, while making concrete, provided it meets the quality standards laid down. The treated sewage may require additional treatment to adhere to the water quality standards.
b) Construction activity is distributed across PMC and transport cost would determine usage of effluent, even if the water price is very low.
c) Most construction companies use ground water which is easier as the ground water table in the city is comparatively high.

According to the trial calculation, 3 to 5MLD of treated water at Kharadi STP may be used for the construction work.

3) Reuse in Municipal Gardens

One of the most widely accepted uses of treated sewage is for gardening and similar purposes like watering lawns etc. In the water supply DPR, the total quantity of water required for Municipal Gardening purposes in PMC area is projected at about 60MLD. Currently water supply for most gardens is either by public water supply or by the wells. These gardens are spread all over the PMC area and hence either transmission lines for the treated sewage would be planned or supply could be undertaken by tankers. Both of these methods of water transportation may not be techno-economically feasible at present. However an attempt should be made to identify gardens etc. which are close to treatment plants for reducing distance of transportation either by pipelines or by tankers.

4) Reuse in Industry

The total industrial demand as stated in the Water Supply DPR is 32MLD. Most of these industries are widely distributed across PMC Region. Distribution of treated sewage to these industries may not be techno-economically feasible.

However attempts should be made to identify industrial units which are close to treatment plants for reducing distance of transportation.

5) Reuse potential in the River of Mula-Mutha-Bhima beyond PMC jurisdiction

a) Irrigation

The Mula Mutha River empties into the Bhima River. Ujani Dam exists on Bhima River about 150km downstream from PMC. Ujani Dam has a very large potential for various kind of water uses. The canals installed at left and right banks provide a total of 150m^3/s of water for irrigation and other purposes.

b) Drinking Water for downstream villages and towns (247MLD: information source is Irrigation Department, Government of Maharashtra)

Bhima River / Ujani Dam are used to supply water for drinking purpose to villages/ towns/ cities. Most of these towns are located downstream, 100km or more from PMC city. Some of the major water consumers are the followng: Bhigwan, Daund, Yawat, Sholapur and Pandharpur.

Further a submission[4] made on the allocation of water from Ujani Dam suggests an estimated population of about 3.5million with water demand of 90Million m^3/Year or about 247MLD (say 250MLD) at a modest water supply rate of 70lpcd is dependent on water from Bhima River / Ujani Dam. This area is water scarcity prone and it is understood that in Sholapur, during the peak season in summer months, the frequency of water supply is once in two days or less. Hence should the treated sewage find its way all the way to Ujani Dam, it would be reused suitably.

8.5.2.3 Recommendations

PMC will be in a position to reuse about 65% of the treated sewage when the pumping station to convey treated sewage to Irrigation Canal will be commissioned. Additionally PMC will explore all avenues for reusing water like gardens. Presently specific demand for design of re-use facilities has not been identified. PMC shall identify demand of the re-use of the effluent in consideration of cost recovery.

8.6 Utilization of Bio-gas for Generating Electricity

8.6.1 Feasibility of Bio-gas Generation use

Considerable amount of electricity is consumed for the treatment of sewage to meet effluent standards in application of various kinds of sewage treatment processes such as activated sludge, A2O, EA (Extended Aeration), and SBR. The level of electricity consumption increases when the effluent standards include nutrient removal as well as providing sludge management through mechanized dewatering

[4] Submission by National Alliance for People's Movement dated 22nd Jan 2013 to Expert Appraisal Committee on River Valley and Hydro-electric projects.

processes. In application of specific unit operations such as anaerobic digestion, solids captured and generated during the sewage treatment processes, methane gas is generated. The gas can be utilized for electricity generation and/or as a fuel.

PMC is interested in developing energy through anaerobic digestion at two of the planned STPs. There are planned to install biogas electricity generation sets in the two sewage treatment plants with A2O process at Bhairoba and Naidu. The capacities of the biogas electricity generation sets are estimated in 920 kW (two sets of 460 kW) and 1540 kW (two sets of 770 kW) for the Bhairoba STP and the Naidu STP respectively.

Financial analysis for the biogas electricity generation sets is shown in Table 8.6.1. It would be feasible to introduce the biogas electricity sets at both these two STPs, since the initial investment cost will be recovered in around six (6) for both Bhairoba STP and Naidu STP according to the analysis table. Service factor with 0.7 is applied to generated power (kWh) by the biogas electricity generation sets, it includes fluctuation of sewage quantity, quality, temperature and others.

8.6.2 Information for Future Improvement

PMC is interested in developing energy through anaerobic digestion at two of the planned STPs. This survey work will include the study to determine techno-economic feasibility of using a pre-digestion process consisting of thermal hydrolysis process (THP) to increase the yield of methane generation in anaerobic digestion, to reduce the overall carbon foot print of the project, and to reduce the amount of solid waste that needs to be disposed of in a safe and environmentally friendly manner (refer to Figure 8.6.1). Conditioning of sewage sludge prior to anaerobic digestion (Pre-digestion Process) in large projects via THP, is a process wherein sludge is treated providing increased pressure and temperature, which bring about a significant (35-50%) increase in biogas (methane) generation while reducing the required volume of digesters by at least 50%. Thus, overall volume of sludge to be dewatered is reduced, making the digested/dewatered sludge change to a granular hydrolyzed sludge for easy disposal.

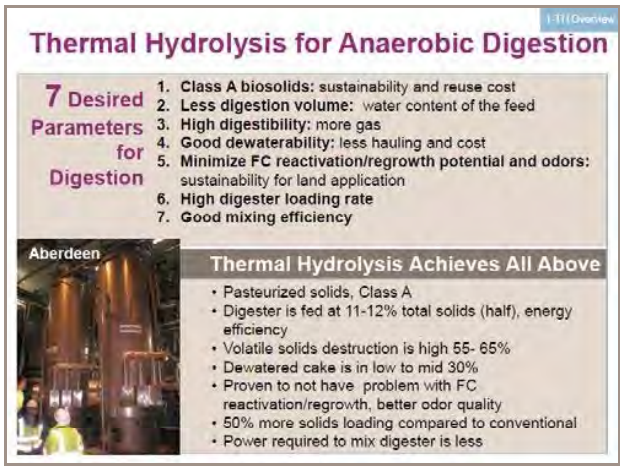


Figure 8.6.1 Thermal Hydrolysis for Anaerobic Digestion

To maximize the benefit of gas and to ensure sizeable level of electricity generation, the study may entail to develop a combined sludge digestion and treatment process in use of thickened sludge generated at other STPs.

8.7 Latest IT Application including GIS, MIS and SCADA systems

With the challenges faced due to rapid growth of PMC, there is an urgent need for creation of reliable baseline data and support for utilities in PMC using IT. The creation of IT infrastructure through this Project will enable utilities to integrate other business processes such as GIS, MIS, and SCADA Systems.

(1) GIS and MIS

1) Proposed scope of work

In order to implement a comprehensive, integrated, GIS based MIS model at PMC, the following scope of work is proposed.

- Detail study on the PMC departments and preparation of AS-IS document.
- Preparation of Functionality Scope for the To-Be processes in consultation with the concerned departments.
- Objective analysis of the existing Information Technology solution at PMC.
- Development of “GIS based household database” for the entire PMC.
- Development of “GIS based Sewerage Asset Database” that includes the existing and the future network within the PMC.
- Design and develop/implement GIS based “Decision Support System" with Asset data, Consumer Database & Call Centre Management Module (Server/Desktop/Mobile Application).
- Design and develop the Integration plan of “GIS based MIS Model” with existing application of PMC.

- Develop & implement the Capacity Building program for managing & updating the GIS Database & "GIS based Decision Support System" to selected officers from PMC.
- Procurement of associated software, database, hardware equipment's that includes the Servers, Storages, firewall etc. for hosting, maintaining , developing & updating with GIS database & Web-GIS base MIS application at PMC.
- Organizational development of the IT center at PMC.
- Support to maintain the System at PMC for two (2) years after the complete "Go Live". "Go-Live" means that the system is ready for actual use by end user (PMC in this case). After the system sets in service under PMC (e.g. in proceeding in sewerage connection), its functions should be maintained properly by debugging and/or updating its defect which will be found in the actual service.

(2) Proposed project components

The following components should be considered when developing the PMC IT:

- GIS database and maintenance:

The database will provide the most update information of sewerage/water network facilities as well as household connections for entire PMC limits. Comprehensive marketing cum service connection survey should be undertaken during the project implementation stage to register all the possible sewerage connections on GIS platform. The survey has been proposed to outsource to the contractor, pipe installation and/or service connection, not consultant, under the supervision of GIS Expert, water sector Consultant. The GIS database should be made available for all the staff through internet/intranet within the organization for strategic needs such as marketing, maintenance and investment planning. The final validation of actual connected consumers should be validated at the time of service connection stage.

- Customer database and maintenance:

The database will provide accurate information of all customers within the PMC including metering and billing information. It is estimated that entire PMC will generate approximately 450,000 customers. Service connections in later stage to the household connection work should follow a sequence of marketing – connection application – actual service connection – metering and billing.

- Sewer/water model building & management:

It is proposed that an integrated GIS and hydraulic modeling platform that provides hydraulic modelers at PMC the necessary tools to efficiently perform all aspects of system assessment. These include some of the following features:

1) Model real-life and theoretical simulations to predict the impacts of rainfall on existing sanitary sewer systems
2) Offer variables for nearly any possible element in a sanitary collection system
3) Identify risk and magnitude of dry and wet weather sewer overflows
4) Optimize capital spending to eliminate combined and sanitary sewer overflows
5) Analyze performance and benefits of system controls

- Management information system:

MIS is to prepare and analyze daily operation status, water consumption, billing records, work progress, etc., however, PMC does not have "GIS / MIS System" now. One of the main outputs of MIS could be utilized for productivity enhancement to compute the attainment of performance targets for each department, division and individuals to be linked with performance incentives.

- Training & capacity building:

With the incorporation of GIS & GIS based MIS systems at PMC it will be imperative for the majority of the staff to acquire GIS/MIS skills. The program can be set up to teach the basics of computer programming operation as well as to teach specific operations of the deployed GIS/MIS System. A certification program may be designed.

(3) Methodology to develop the GIS based database from field

Stage I: Procurement of latest high resolution satellite imagery from NRSA, Hyderabad

Stage II: Georeferencing, edge matching, tiling, & image drape from high resolution satellite imagery.

Stage III: Updating/developing the base map of PMC including administrative boundaries, and base layers & land base data with a strict quality check.

Stage IV: Development of PMC Sewerage Asset Register including, trunk sewers, main sewers, distribution networks, pumps stations, and sewerage treatment plants.

Stage V: Development of consumer database level information from high resolution satellite imagery & extensive field surveys using GPS and automatic updates at Web-Server.

(4) Development of GIS based MIS

The functionality of proposed MIS has to involve users with different roles and different access levels. Application of model-based approach is proposed for designing & development of MIS. It provides many benefits to the various operation and maintenance activities. The benefits of using an integrated data model will be further leveraged by accessing the integrated data model through a GIS interface. It will enhance the ability to explore, navigate, access, and query asset data. Assisted by the GIS functionality, this integration can potentially improve the efficiencies, cost effectiveness, and coordination

of maintenance plans and work processes. Suggestive functional modules under Web-GIS based Decisions Support System for PMC are given below.

- Multi-level security and user access control framework Module
- Property Database Management System
- Sewerage based asset register Module
- Customer service and complaints Module
- On line data updating Module
- Reporting and Analysis Module
- Documentation and Manuals Module

(5) SCADA

SCADA system shall be suitably established for the PMC to operate and maintain the Pumping Stations and the Sewage Treatment Plants in a proper manner. There are eleven STPs including two bio gas generation systems and four pump stations proposed under this project, while there are ten existing STPs and seven PSs within the study area. One STP will be implemented after demolishing one of ten existing STPs at Old Naidu, eleven STPs will be augmented/ newly constructed.

It is desirable that there should be a local SCADA system established at each proposed STP and PS. There exist local SCADA systems established at three existing STPs with SBR process. These three existing STPs with the local SCADA system can be integrated into the newly proposed local SCADA system at the three proposed STPs at Mundhawa, Baner, and Kharadi. Meanwhile, when the existing STPs and PSs without SCADA system are upgraded by adding new local SCADA system. They would be integrated into the newly proposed central/master SCADA system, which has an expandable configuration.

It is essential that the local SCADA system will provide the STP and the PSs with operation in fully automatic (auto mode) arrangements. In the event of failure of the same, the facility shall be provided to operate the plant in manual mode till such time the auto mode is recovered.

The local SCADA system at the STPs comprises PLCs (Programmable Logic Controllers), Operator Station(s), a Connectivity Sever (a front end integration server), an Engineering Station. It also includes Data Servers at the local control rooms and a large Screen at the central control room. The local SCADA system at the PSs consists of a PLC based control system along with a communication device to transmit the field data to the related STP.

The PLCs collect and/or transmit the field data such as the process values, the status of the equipment/plant loads and alarms of the equipment to the front end integration servers. Further, the PLCs will give auto mode operations to the equipment/plant loads through motor control centers in association with instrumentation devices. The front end integration servers play a role of the data collection to backward and command set points for automatic control logics to the PLCs.

The operator stations work as HMI (Human Machine Interface) for assisting the operating staffs to control/monitor the STPs and the PSs properly. There are many set points given to the control logic for the equipment/plant loads as a manipulating value, for ex. levels, flows, etc. The data/SCADA servers play a role of data processing, generating reports such as daily, monthly and yearly, warning alarms. There are some ancillary/incidental devices provided at the central control room to make the local SCADA system complete, like printers, Ethernet managed switches and telecommunication devices. Fiber optic cables may be utilized as data transmission medium within the STP to link among the PLCs and the connectivity server.

The master/central SCADA system will be established at the master station, which will be located at the main office of PMC or one of the eleven proposed STPs. The master/central SCADA system functions as master station to monitor the entire sewerage system efficiently and offering the data to the PMC staffs for their data analysis. There are fiber optic cables, GPRS wireless network, Inter net service provider's web-based fiber optic connection etc., available as data transmission medium to link the local SCADA systems and the central/master SCADA system. The fiber optic cables will be laid along the sewer lines by PMC by their own use purposes, while the GPRS wireless network and the web-based fiber optic cable will be provided by internet service providers for the user of data transmission.

8.8 Possible Components other than sewerage facilities for pollution abatement of the rivers

8.8.1 Social Consideration (Community Participation)

Involving the public as part of the Project process is an important key in achieving the Project purpose. In addition to expansion of PMC city's sewerage infrastructure, it is important that the general public is moved by the Project and willing to take steps in reducing the River pollution. To achieve this, a well-planned public awareness and participation program will play a significant role in strengthening the residents support and engagement in the Project. There are some points that should be considered when preparing the public engagement program.

One is to spark the community attention to the River's severe pollution status. This seems to be challenging in PMC giving its socio-economic characteristics (discussed in Chapter 2) such as income disparity, slums, education level, young and growing population, poor care for public hygiene, and slow or even abandoned city projects which could affect the public trust towards the authorities. To overcome this challenge it is important to reach out members of all groups of the society and communicate with them through as many different ways possible from the pre-planning stages. When reaching out, the focus of conversation should not be how the Public can help save the Rivers but on how reducing the River pollution can secure their children and grandchildren's future. Anybody who's a parent or a grandparent will then sit up and say, "Well, this conversation is about me." Therefore, the purpose should be to make the program about everybody, whether a future parent, a slum dweller, a student, a worker, a professional, or even a CEO of a company that discharges raw sewage to the Rivers.

Noting that knowledge and wisdom deepens people's relationship with the society, the public will be more supportive if empowered by related facts, information, and data on the present state of the Rivers. It could include the positive socio-economic effects of the Rivers on the City's daily life but yet the negative impacts of its users as well. The followings are some example information that could be provided to the community members using different conversation tools:

① Current economic significance of the Rivers:

- Abstraction of raw water for industrial, agriculture, and irrigation purposes
- As a source of potable water after treatment

② Socio-economic impacts on the River degradation:

- Discharge of wastewater without treatment
- Destruction of its aquatic system by dumping solid waste
- Damaging the River fishery, tourism, and recreation

③ Current population affected by unsanitary conditions of the Rivers
④ Projected population, generated wastewater and solid waste
⑤ The individual and public health hazards through the Rivers pollution
⑥ How the Project and the public support can help to restore the River

Finally, the program should consider a variety form of customized conversations and interactions tools in which promote the public engagement and participations more effectively. This will help not only to gain supports but also address concerns during the Project decision making process. Such tools could

include meetings, discussions, published materials, site visits, TV programs, and awareness activities in both slums and general areas. Section 11.3 of this report provides detailed discussions on public participation planning and utilizing such tools.

8.8.2 Public Toilet

There are many people who do not have any toilets in their premises, it is an issue not only for sanitation but also for water pollution.

The coverage of toilets in PMC is 97.57% which is shown in ”Service Level Benchmarking, Sewerage Department, PUNE MUNICIPAL CORPORATION, SHIVAJINAGAR, PUNE – 411 005, September 2010”. According to this document, present toilet is 971,578 while total number of properties without toilet within walkable distance was 24,153. On the other hand current population of slum is 1,025,000 and 205,000 households, which are shown in 2.3.4 in Chapter 2, and approximately 800 public toilets exist.

This project does not cover all the needs for public toilets, however, in connection with the series of public awareness and training activities, 40 of public toilet (it is 5 % of existing community toilet facilities) construction is proposed as a pilot project in consideration of people’s participation for O&M of the facilities.

8.8.3 Environmental Considerations

The project is not a project which may improve hygiene condition of PMC through improvement of water body by development of sewerage systems and thus may not cause significant adverse impact on environment. In addition, a preparation of EA (Environmental Assessment) document is not required for sewerage projects in the Indian EIA regulations.

However, some minor negative impact will be expected at the construction and operation stages as discussed in the Chapter 11 for their details.

The following environmental considerations shall be taken by PMC for above negative impact.

- Appropriate treatment of the trees growing inside the project sites prior to construction works
- Appropriate preparation of design of structure or construction plan of the facilities to avoid ground collapse
- Appropriate PMC’s handling on the land owners for the land acquisition of the project sites which have not been acquired by PMC
- Appropriate process for the construction works at the areas which may disturb other social infrastructure such as railway, road, Nallah and rivers.
- Occupation health and safety at construction and operation stage
- Pollution control measures for air, water, noise and sludge
- Accidents

CHAPTER 9 Preliminary Design of Sewerage Facilities

According to the scope of work established in Chapter 8, preliminary design of the facilities was prepared in this Chapter.

9.1 Sewers and Intermediate Pumping Station (IPS)

9.1.1 Design Fundamentals

Preliminary design of the facilities was prepared according to the following CPHEEO manual. Design fundamentals for sewer system and IPS are shown in Table 9.1.1.

Table 9.1.1 Design Fundamentals for Sewer System and IPS

Items	Adoption	Remarks
(1) Design Criteria	CPHEEO Manual NRCP Guideline	
(2) Design Period	Sewer Network : 30 years IPS (Civil): 30 years IPS (Equipment): 15 years Rising Main Pipe : 30 years	Target Year Sewer Network, IPS (Civil) and Rising Main Pipe : 2047 IPS (Equipment) : 2032
(3) Hydraulic Criteria		
a) Hydraulic Formula	Manning Formula $v = \frac{1}{n} \times R^{\frac{2}{3}} \times I^{\frac{1}{2}}$	Where, V: flow velocity (m/s) n: Roughness Coefficient (-) R: Hydraulic Radius (m) I: Gradient(-)
b) Peak Factor	By Contributory Population Up to 20,000 : 3.00 20,000~50,000 : 2.50 50,000~750,000 : 2.25 Above 750,000 : 2.00	
c) Hydraulic Depth	0.8 times of the nominal diameter	
d) Velocity	Minimum: 0.6 m/s (Present Peak flow) 0.8 m/s (Ultimate Peak flow) Maximum: 3.0 m/s	
(4) Interval of Manhole	90m（Dia. Up to 900mm） 120m（Dia. above 900~1500mm） 150m（Dia. above 1500mm）	
(5) Minimum Diameter	150mm	

Source: CPHEEO Manual

9.1.2 Outlines of the Preliminary Design

Outlines of preliminary design for sewers and IPS are summarized in Table 9.1.2 and Table 9.1.3. Presents location of the planned facilities is shown in Figure 8.2.1. Flow calculation and longitudinal section drawings of the sewers are included in Supporting Report 9.2.1.

(1) Sewer Network for Baner

Total length of 43 km sewer network is proposed for Baner area. Required sewers are summarized in Table 9.1.2 in combination of existing and proposed sewers by diameter.

Table 9.1.2 Summary of Required Sewers for Baner

Diameter	Length of sewers (m)		
	Existing	Proposed	Total
150mm	2,016	35,202	37,218
200mm	444	1,747	2,191
250mm	6,582	3,680	10,262
300mm	4,224	2,032	6,256
450mm	4,074	370	4,444
600mm	1,512	-	1,512
Total	18,852	43,031	61,883

Source: JICA Preparatory Survey

(2) Main/Sub-main Sewers

Total length of 70 km Main/Sub-main sewers is proposed. The summary of the proposed Main/Sub-main sewers by diameter is shown in Table 9.1.3.

Table 9.1.3 Summary of Proposed Main/Sub-main Sewers

Line Nos.	Description	Length m	Diameter mm	Purpose / Outline	Discharge (Connection) Point	Alignment in	Comments by Survey Team
1	Trunk sewer in Darga Nalla extend full length (one side only)	3,047	600-1200	Provide conveyance to area sewers	STP	Along Stream	If Kharadi STP cannot be constructed then a PS might have to be located at Kharadi and a new main laid upto Mundhwa STP
2	Kharadi S. no. 63 to Eeon Mall to Darga Nalla	1,662	450-600	To intercept sewer main discharging into River Mula-Mutha and divert it to line no 1(TM in darga nalla)to convey to STP	Sewer	Along the stream and then along the road	Pipe jacking may be done for about 100m to cut across ridge portion
3	Trunk sewer along Ambil odha from Katraj to sarasbaug	8,825	600-1200	Provide conveyance to area sewers	Sewer	Along Stream	Pipe jacking would be required to cross the water supply canal near Mitra Mandal Chowk
4	Conveyance main from Khadakwasla Dam to Vadgaon Bk STP	6,150	600-900	Provide conveyance to upstream fringe area upto Proposed Vadgaon STP	Proposed STP	Along Mutha river	Proper access needs to be planned for O & M along the river bed
5	Conveyance main from Kondhave Dhavde to Warje STP	6,490	450-1400	Provide conveyance to upstream fringe area upto Proposed Warje STP	Proposed STP	Along Mutha river	Proper access needs to be planned for O & M along the river bed
6	Conveyance Main from Vadgaon Sheri to airport	1,500	450-1200	Provide conveyance to area sewers Ramwadi area	Sewer	Along Stream	
7	Trunk main along Hadapsar nalla	7,547	900-1800	Provide conveyance to area sewers from Hadapsar Area	Sewer	Along Stream	2 nos of Pipe jacking would be required to cross the railway lines
8	Rehab of lines in Manik Nalla from PCB boundary to Kasba Power house						
8a.	600mm line	750	600	To convey the flow from Manik nalla to existing 1800mm trunk sewer in nagzari nallla for Bhairoba STP	Sewer	Along Stream	Accessibility for moving equipment to be ascertained
8b.	900mm Line	750	900	To convey the flow from Manik nalla to existing 1800mm trunk sewer in nagzari nallla for Bhairoba STP	Sewer	Along Stream	Accessibility for moving equipment to be ascertained
9	Trunk sewer from Kasba Power house to Nagzari nalla's line of 1800mm	700	600-900	To convey the flow from Manik nalla to existing 1800mm trunk sewer in nagzari nallla for Bhairoba STP	Sewer	Along Road	Might require pipe jacking. Feasbility of crossing under the Old outfall sewer (Ovoid) and 1400mm to be ascertained.
10	Connecting line to divert Old Kasba flow to New Kasba	250	1200	Optimization of SPS	SPS	Along Mutha river	Partial flow can be diverted to New Kasba PS
12	Lining of 1400mm RM from old Kasba to Naidu	2,100	1400	To increase efficiency of rising main	Rising Main	Along Road	Flows in Old Kasba to be checked. Access to undertake lining to be ascertained
13	Erandawana STP to Tophkhana - .						
13a	New sewer line	2,500	1200	Along River Bed to cater to overflow from Erandwane STP	SPS	Along Mutha river	To check IL's and capacities of existing sewers lines along the river bed
13b	Rehabilitation of existing line	3,110	1200-1800	Maintenance	SPS	Along Mutha river	To appropriate survey conducted prior to Rehab
14	Conveyance main from Bhide pool to New Kasba on right bank of Mutha river						
14a	Rehab of Conveyance main 1	1,200	1200	Maintenance	SPS	Along Mutha river	Appropriate condition assessment survey conducted prior to Rehab
14b	Rehab of Conveyance main 2	1,200	1200	Maintenance	SPS	Along Mutha river	Appropriate condition assessment survey conducted prior to Rehab
15	Conveyance main from Bund Garden to Bhairoba STP	1,828	1200	Missing link	Existing STP	Along Mutha river	IL of existing line to be checked before detailed design
16	Trunk sewer line along Bhairoba nalla from PS to U/S 2km	850	1800	Missing link	Sewer	Along Stream	2 nos of Pipe jacking would be required to cross the railway lines
17	Trunk sewer along Nalla to Dhanori STP	4,130	450-900	Provide conveyance to area sewers from Dhanori Area	Proposed STP	Along Stream	-
18	Trunk sewer from Agricultural College to Railway Line leading to Tanajiwadi stp	1,955	900	Provide conveyance to area sewers from Janvadi & Gokhale nagar Area	Sewer	Along Stream	Might require existing 600-900 mm dia pipe to be demolished
19	Trunk sewer LamanTanda To Bhairavi Hotel	1,540	600-900	Provide conveyance to area sewers from Lamantanda & Defence Area	Sewer	Along Stream	-
20	Trunk sewer along Paunjai nalla from Ambegaon to Vadgaon STP	2,850	900-1200	Collect flows from Ambegaon and Vadgaon Bk and covey to Proposed Wadgaon STP	Proposed STP		Might require existing 600-900 mm dia pipe to be demolished and reconstructed for portion between Highway and STP
21	Trunk sewer from Mira Society to Golden Bakery	2,024	600-900	To collect flows from the area sewers	Sewer	Along Stream and road	-
22	Trunk sewer from Katraj Byepass to Kondwa Smashan Bhoomi	3,450	900-1200	To collect flows from the area sewers	Sewer	Along Stream	IL of existing line to be checked before connection
23	Conveyance main from Balewadi to Baner STP (from boundary after 2km upto baner	4,126	900-1200	Missing Link	Existing STP	Along Mula River	IL of existing line to be checked before connection
	Total Length (m)	70,534					

Note) In river/steram side, pipe encasing may have to be undertaken depending depth and soil conditions.

Source: JICA Preparatory Survey

(3) Intermediate Pump Station (IPS)

Considering pipe line condition, Old Kasba, New Kasba and Topkhana IPSs which are connected to Naidu STP, sewage is recommended to be transferred to the new Naidu STP and then distributed to existing and proposed Naidu STP to reduce friction loss.

1) Old Kasba IPS

Currently this IPS conveys sewage to Existing Naidu STP (115MLD) together with New Kasba IPS. In connection with Naidu STP expansion, transmission capacity of this IPS needs to be increased.

The scope of work for this IPS is to replace 2 units of coarse screen and 4 units of sewage pump, while the civil structure is utilized with some renovation. Figure 9.1.1 shows outline of the IPS.

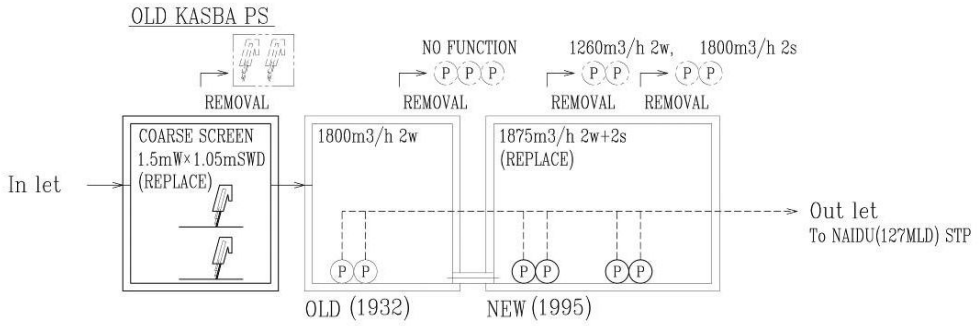
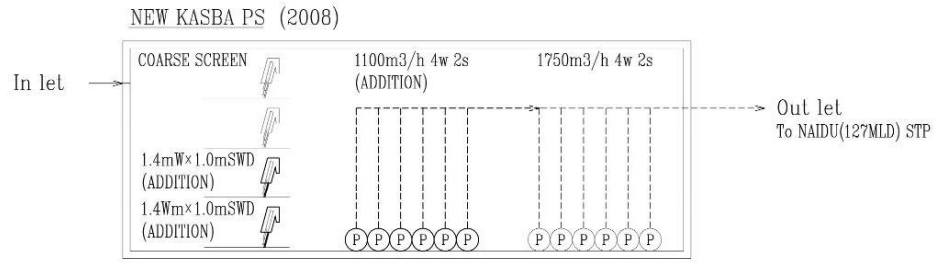


Figure 9.1.1 Schematic of Old Kasba IPS Improvement

2) New Kasba IPS

As mentioned above, currently this IPS conveys sewage to Existing Naidu STP (115MLD) together with old Kasba IPS. In connection with Naidu STP expansion, also transmission capacity of this IPS needs to be increased. The scope of work for this IPS is to add 2 units of coarse screen and 6 units of sewage pump. Figure 9.1.2 shows the plan of rehabilitation.



Source: JICA Survey Team

Figure 9.1.2 Schematic of New Kasba IPS Improvement

3) Topkhana IPS

This IPS conveys sewage to Naidu STP. The scope of work for this IPS is to add 6 units of sewage pump.

Figure 9.1.3 shows outline of the IPS.

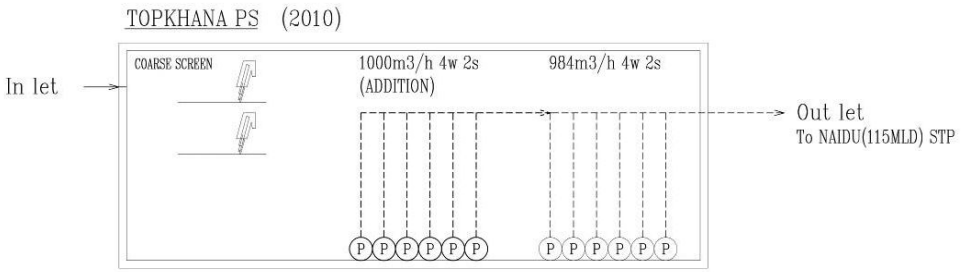
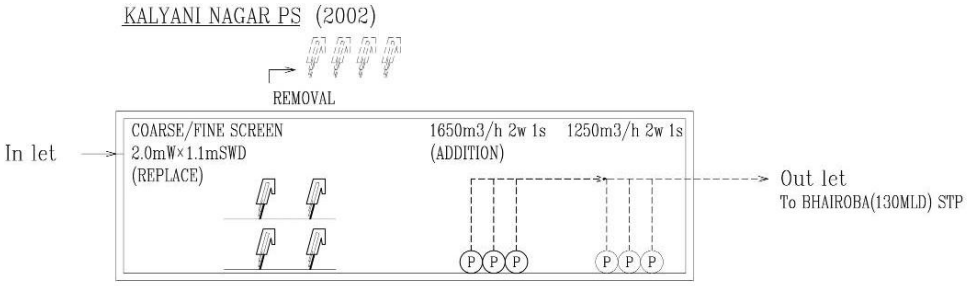


Figure 9.1.3 Schematic of Topkhana IPS Improvement

4) Kalyani Nagar IPS

This IPS conveys sewage to Existing Bairoba STP (130MLD). Existing pump facilities are aged and to be replaced. The scope of work for this IPS is to replace 2 units of coarse screen, 2 units of fine screen and 3 units of sewage pump. For the IPS, 3 larger pump units will be installed additionally and existing pump units are not removed in this project. Figure 9.1.4 shows pump unit installation plan.



Source: JICA Survey Team

Figure 9.1.4 Schematic of Kalyani Nagar IPS Improvement

Table 9.1.4 summarizes improvement plan for the proposed IPSs.

Table 9.1.4 Outline of IPS Improvement

Name of IIPS	Items	Specifications	Remarks
Old Kasba	1) Replace of Coarse Screen	Mechanical Screen 1.5mW×1.05mSWD×2units	Corse screen house renovation included 2 Screens will be removed.
	2) Replace of Sewage Pumps	Horizontal Centrifugal Pump 1,875m^3/h×13mH×132kW×4units Valves and pipes : 1 lot	Existing Pumps will be removed.
	3) Replace of Crane	Single Girder Electric Crane 5ton× 10m×1unit	
	4) Replace of MCC and Pumps Starter panels	MCC for mechanical screen Pumps Starter panels with soft starter	
	5) PLC based automation system	PLC panel including GPRS modem	
New Kasba	1) Addition of Coarse Screen	Mechanical Screen 1.4mW x 1.0mSWD x 2 units MCC for mechanical screen	
	2) Addition of Sewage Pumps	Submersible Sewage Pump 1,100m^3/h×19mH×110kW×6units Valves and Pipes : 1 lot	
	3) Replace of MCC and Pumps Starter panels	MCC for mechanical screen Pumps Starter panels with soft starter	
	4) PLC based automation system	PLC panel including GPRS modem	
Topkhana	1) Addition of Sewage Pumps	Submersible Sewage Pump 1,000m^3/h×35mH×200kW×6units Valves and Pipes : 1 lot	
	2) Replace of MCC and pumps Starter panels	MCC for mechanical screen Pumps Starter panels with soft starter	
	3) PLC based automation system	PLC panel including GPRS modem	
Kalyani Nagar	1) Replace of Coarse Screen	Mechanical Screen 2.0mW x 3.7kW x 2uints	Existing 2 Screens will be removed.
	2) Replace of Fine Screen	Mechanical Screen 2.0mW x 3.7kW x 2units	Existing 2 Screens will be removed.
	3) Replace of Belt Conveyer	0.6mW x 9.0mL x 2units	Existing 2 Conveyers will be removed.
	4) Replace/Expansion of Sewage Pump	Submersible Sewage Pump 1,650m^3/hr x 18mH x160kW x3units Valves and pipes : 1 lot	
	5) Expansion of Crane	Single girder Manually Operated 5ton× 10m×1unit	
	6) Replace of MCC. Expansion of Pumps Starter panel	MCC for Pump Station facilities Pumps Starter panel with soft starter	
	7) Addition of PLC automation system	PLC panel including GPRS modem	

Source: JICA Survey Team

9.1.3 Construction Plan for Sewers

(1) Target Facilities and Construction Method

As most of sewers are planned to install along existing Nallas and public roads, open cut method is basically applied for sewer construction. However, for the crossing railway, highway and bridges, pipe jacking method will be required to minimize influence to existing structures. Target facility of sewer construction by construction method is shown in Table 9.1.5

Table 9.1.5 Target Facility for construction of Sewer

Facility	Contents	Construction Method
(1) Branch Sewer	Dia 150~450 mm (Total Length 43km)	- Open Cut Method
(2) Main/Sub main Sewer	Dia 450~1800 mm (Total Length 70km)	- Open Cut Method - Pipe Jacking Method (for the crossing rail way, highway and bridges)

Note: Pipe Jucking method will be required for sewer line No. 2, 3, 7, 9 and 16.

(2) Construction Schedule

A construction schedule shall be prepared taking into account of scope of the works, execution capacity of contractors, procurement conditions of materials and labors, natural and social conditions in India. The construction period for target sewers will be required for about 3 years for 3major components including sewer networks and main/sub-main sewers. Details will be discussed in *Chapter 12: Implementation Schedule*.

9.2 Sewage Treatment Plants

9.2.1 Design Fundamentals of STPs

(1) Site Condition

The site area, ground level and high water level (H.W.L.) of the river at the discharge point of STP are shown in Table 9.2.1. For some proposed STP sites, land acquisition procedures have not completed yet (refer to Chapter 11 Environmental and Social Conditions). For the site which original ground level is lower than H.W.L., countermeasure is necessary to protect the STP from inundation.

Table 9.2.1 Site Conditions for Proposed STPs

No.	Name of STP	Design Capacity (MLD)	Treatment Method	Site Conditions			
				Area (ha)	Original G.L.(m)	Discharge Point/ H.W.L(m)	Remarks
1	Naidu	127	A2O+Power	4.75	548	Mutha River/ 543.8	
2	Bhairoba	75	A2O+Power	2.70	548	Mutha River/ 541.8	
3	Mundhawa	20	SBR	1.17	544	Mutha River/ 538.5	

4	Vadgaon	26	EA	2.75	555	Mutha River/ 552.9	
5	Warje	28	EA	1.07	554	Mutha River/ 552.5	
6	Botanical Garden	10	EA	1.60	555	Mula River/ 553.5	
7	Tanajiwadi	15	EA	0.58	546	Mula River/ 545.5	
8	Dhanori	33	EA	1.00	547	Mula River/ 550.0	
9	Matsya Beij Kendra	7	SBR	0.30	564	Nalla/ -	
10	Baner	25	SBR	0.95	556	Mula River/ 554.1	
11	Kharadi	30	SBR	1.16	540	Mutha River/ 538.5	

(2) Water Temperature

Raw sewage temperature at Baner STP from 2012 to 2014 is shown in Figure 9.2.1. Temperature ranges from 25 to 30 cent degree. Other STPS' temperature record could not obtained but it seems that the raw sewage temperature is not so different from that at Baner STP. According to this data, the design sewage temperature is assumed to be 25 cent degree.

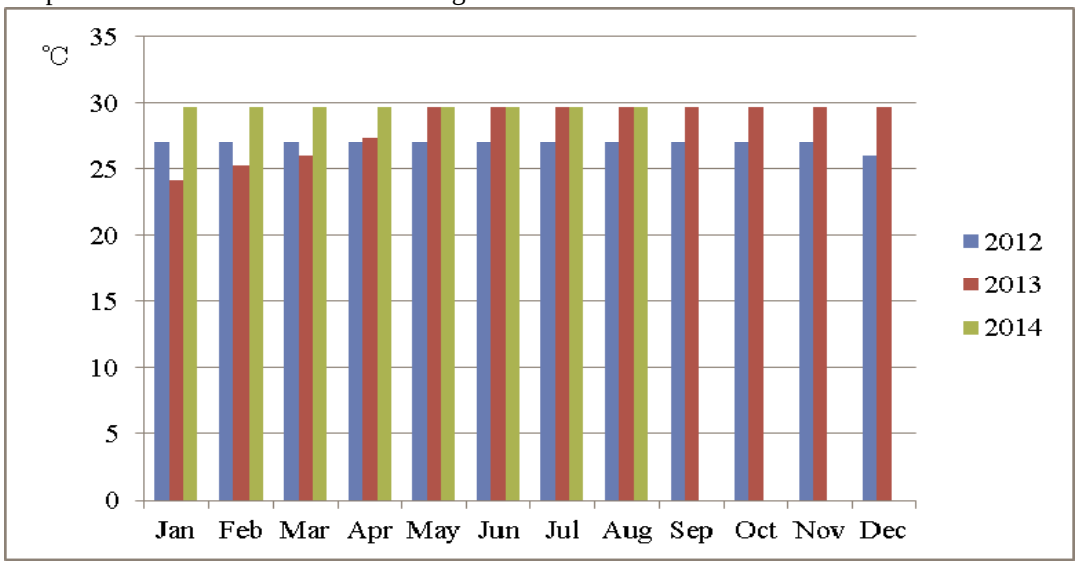


Figure 9.2.1 Raw Sewage Temperature at Baner STP

9.2.2 Basic Design Concept of STPs

Three types of sewage treatment process (A2O, EA and SBR) are applied for planned STPs, and two types of sludge treatment method (thichening + anaerobic digestion + dewatering and direct dewatering) are recommended. On the other hand, the same method is applied for pre-treatment and disinfection for all STPs. The followig are civil and mechanical facility design concept for eath treatment method in

addition to electrical and instrumentation concept.

(1) A2O (Anaerobic-Anoxic-Oxic Activated Sludge Process)

This process is applied for Bhairoba and Naidu STPs. These two STPs are equipped with digesters and biogas generators. The schematic process diagram of A2O is shown in Figure 9.2.2.

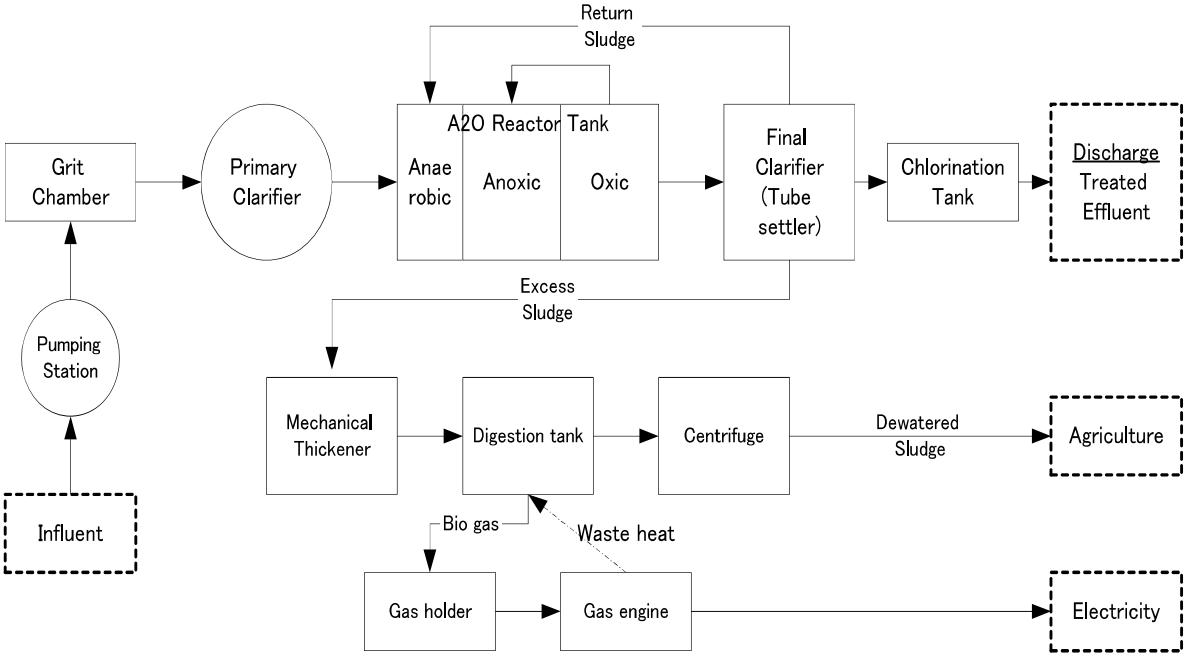


Figure 9.2.2Schematic Process Diagram of A2O

1) PS & Pre-treatment

Pre-treatment means screening and grit removal, these facilities are set after pumping station as existing STPs in PMC. In detail, coarse screen is set before pump and fine screen and grit chamber are set after pumping up. It is cost effective and easy for maintenance because they must be constructed deep under-ground if set before PS. The type of adopted sewage pump is submersible type, which is very popular PMC.

2) Sewage Treatment

A2O process comprises primary clarifier, reactor tank and secondary clarifier. The reactor tank is divided into three 3) parts, anaerobic tank, anoxic tank and oxic (aerobic) tank. A combination of these three parts enables both nitrification and phosphorous removal. A circular type clarifier is adopted for primary sedimentation tank because of the sedimentation efficiency and easy maintenance. On the other hand, secondary clarifier is recommended in application of a deep aeration with rectangular type together with tube-settler reactor tanks. Considering the water temperature of 25 cent degree, HRT of reactor tanks is

assumed to be 9 hours. Ultra-fine membrane diffuser is adopted for energy saving. For the nitrogen removal, recirculation pump units are installed to convey sewage from oxic tank to anoxic tanks. Deep aeration and tube-settler have been adopted at Erandwane and Vitthalwadi STPs in PMC; 10m depth tank is applied for Bhairoba and 8m depth for Naidu. In order to install guide walls, diffusers can be set in the middle level of tank depth as shown in Figure 9.2.3.

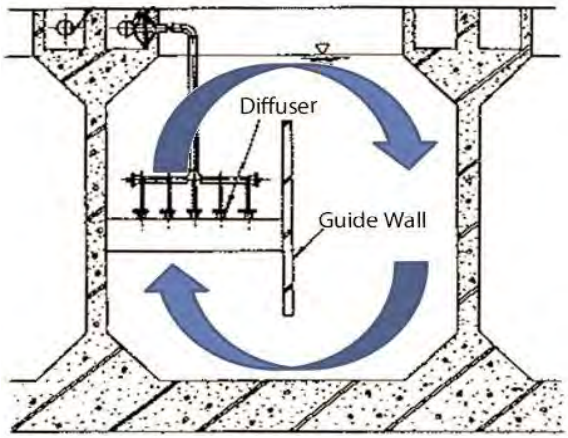


Figure 9.2.3 Deep Aeration

3) Disinfection

Liquid chlorine injection type disinfection is adopted, which is very popular in PMC. The minimum contact duration is set 30 minutes according to CPHEEO.

4) Sludge Treatment

Sludge treatment process for the two STPs (planned for A2O Process) includes thichening, anaerobic digestion and dewatering. The generated biogas is utilised for power generation. Thickener shall concentrate 1% to 4% slugde to make effective digestion. Therefore, mechanical thickener shall be adopted in cosideration of the experience at existing Naidu STP. However, sludge heating process is proposed for these new STPs to get more biogas. To heat and maintain around 35 cent degree in the digestion tank, excess heat emitted from generator shll be utilized as well as preparation of hot water boilar. DigesterThe specifications of the digestion tank are as follows;

a. Digestion method: Mesopholic digestion with heating
b. Mixing type: Outside mixing type
c. Heating type: Using heat exchanger with recovered waste heat of generator and hot water boiler

Centrifugal type mechanical dewatering shall be adopted, which is very popular in in PMC.

(2) EA (Extended Aeration Process)

This process is applied for Vadgaon, Warje, Tanajiwadi, Botanical Garden and Dhanory STPs.

The schematic process diagram of EA is shown in Figure 9.2.4.

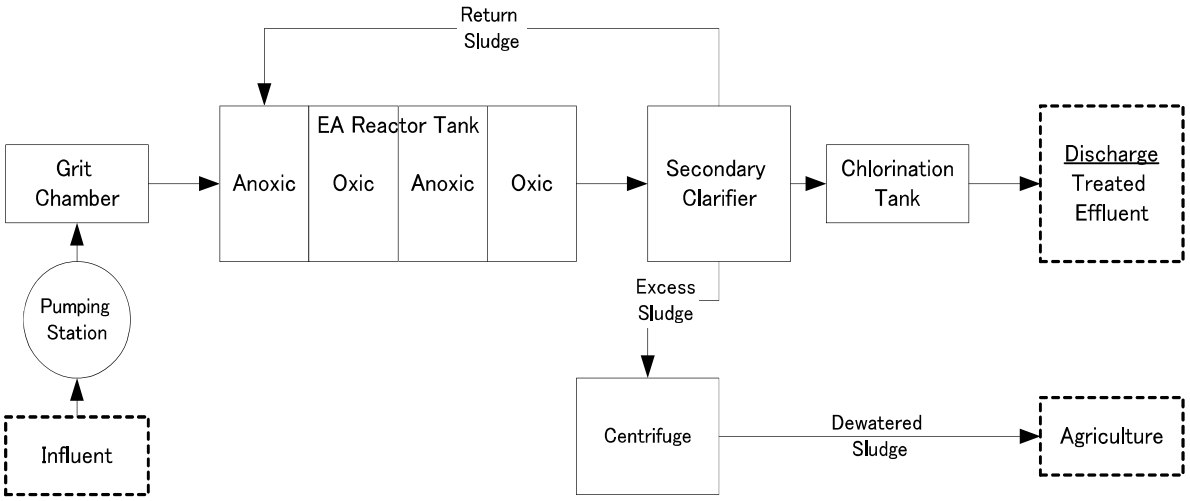


Figure 9.2.4 Schematic Process Diagram of EA

1) PS & Pre-treatment

Same as A2O process.

2) Sewage Treatment

EA process comprises reactor tank and secondary clarifier. This process is adopted for smaller capacity STPs for easy operation and ensuring better effluent quality.

Hydraulic retention time of reactor tank of EA is longer than conventional activated sludge process, about 17 hours is adopted for this project. For the nitrogen removal, a series of anoxic-oxic-anoxic-oxic tanks are designed. Usually water depth is designed at 5.5 m, but a deeper type is adopted in this project because of limited land availability. For the design of secondary clarifier, circular type is desirable, but tube-settler is also adopted for the same reason. Ultra-fine membrane diffuser is adopted for energy saving.

3) Disinfection

Same as A2O process.

4) Sludge Treatment

Centrifugal type mechanical dewatering is adopted, which is very popular in PMC. Low concentration

sludge can be dewatered by this type of machine and excess sludge is dewatered directly without use of thickener.

(3) SBR (Sequencing Batch Reactor Process)

This process is applied for Matsuya Beij Kendra, Mundhawa, Baner and Kharadi STPs.

The schematic process diagram of SBR is shown in Figure 9.2.5.

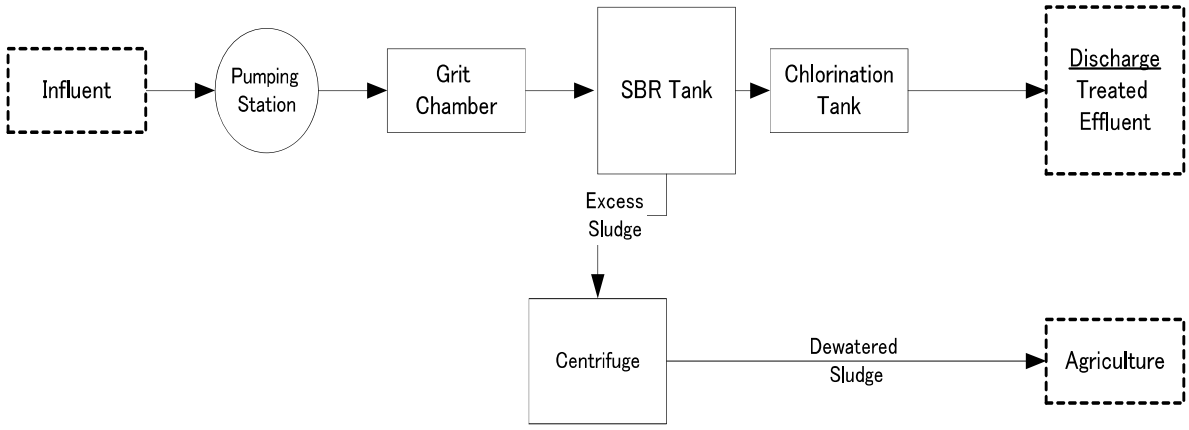


Figure 9.2.5 Schematic Process Diagram of SBR

1) PS & Pre-treatment

Existing civil structure of the pumping station at Mundhawa and Baner STPs can be used for this expansion work. Likewise, existing civil structure and mechanical equipment of grit chamber can be used at Mundhawa STP (Details of the facilities are referred to in Table 9.2.7). Other items are the same as A2O process.

2) Sewage Treatment

SBR process consists of only one reactor tank which acts as a biological reactor and solid–liquid separation in the same tank. It means the function differs as time going, first inlet sewage, second aeration (intermittent aeration for nitrogen removal), third sedimentation and fourth discharge. The timing of each function can be set by programmed timer, better operation can be selected, if the condition changed. On the other hand, there are many control items and mechanical troubles may suffer in the operation.

Hydraulic retention time of reactor tank of SBR is same as EA, about 17 hours is adopted for this project. For the nitrogen removal, intermittent aeration is selectable. Ultra-fine membrane diffuser is adopted for energy saving.

3) Disinfection

Same as A2O process.

4) Sludge Treatment

Same as EA process.

5) Utilizing upper space of SBR tanks at Matsuya Bij Kendra STP

The available land area of Matsuya Bij Kendra STP is very small to accommodate required facilities. To solve this problem, some buildings are planned to construct on the top of SBR tanks. The buildings for administration, substation, sludge-dewatering and blower facilities are integrated under the above arrangement.

(4) Design conditions of recommended 3 types of sewage treatment process

The design values of the STPs are shown in Table 9.2.2.

Table 9.2.2 Design Value for Sewage Treatment Plants

Facility	Unit	A2O	EA	SBR	Remarks
1 Pump Sump					
(1) Duration	min	5 – 10			
2 Grit Chamber					
(1) Surface Load	$m^3/m^2/day$	960			at peak flow
(2) Maximum Velocity	m/sec	Less than 0.3			
3. Primary Clarifier					
(1) Surface Load	$m^3/m^2/day$	50	N.A.	N.A.	
4. Reactor					
(1) BOD-SS Load	kg/kg/day	0.15	0.1	0.1	
(2) MLSS	mg/L	3,000	4,000	4,000	
(3) Return Sludge Rate	%	100 – 200	100 - 200	100 - 200	
(4) Water Depth	m	8.0 –10.0	5.5 - 10.0	5.5 – 6.0	
(5) Temperature	℃	25	25	25	
(6) HRT	Hr	9	17	17	
5. Secondary Clarifier					or Equivalent
(1) Surface Load	$m^3/m^2/day$	20	15	N.A.	Tube settler
6. Chlorination Tank					
(1) Contact time	min	more than 30			
(2) Injection rate	mg/L	5.0			
7. Thickener					
(1) Type		Mechanical Thickener	N.A.	N.A.	

Facility	Unit	A2O	EA	SBR	Remarks
8. Digester					
(1) Type		Mesophilic Anaerobic	N.A.	N.A.	
(2) Duration	Days	20			Bio-gas generator
9. Dewatering					
(1) Type		Centrifuge			
(2) Water Contents	%	80 – 85			

(5) Electrical, Instrumentation and SCADA System

The power required for the planned eleven STPs will be supplied from the existing power distribution panels and newly from MSEDCL (Maharashtra State Electricity Distribution Company Limited) as per site conditions.

The power required will be supplied at 22kV and 11kV at Naidu STP and other STPs, respectively. There is proposed express feeder source at the proposed STPs summarized in Table 9.2.3.

Table 9.2.3 Power Supply Conditions at Proposed Project Sites

STP	Proposed Express Feeder Source	Demand Power (kW)
SD3, Bhairoba, A2O, 75MLD	Extension of existing express feeder at the STP with minor modifications	2510 at 11kV
SD4, Naidu, A2O, 127MLD	Extension of existing express feeder at the STP with minor modifications	3110 at 22kV
SD1, Matsya, EA, 7MLD	Extension from Mundhwa STP	290 at 11kV
SD6, Vadgaon, EA, 26MLD	Extension from Warje STP. No need for separate energy meter, only transformer	590 at 11kV
SD7, Warje, EA, 28MLD	Extension from Warje WTP. No need for separate energy meter, only transformer	840 at 11kV
SD9, Tanajiwadi, EA, 15MLD	Extension from Topkhana pump station	490 at 11kV
SD10, Botanical Garden, EA, 10MLD	Extension from Kharadi substation	390 at 11kV
SD14, Dhanori, EA, 33MLD	Extension from Kharadi substation	900 at 11kV
SD2, Mundhawa, SBR, 20MLD	No express feeder in current STP. Need to draw from Magarpatta substation	570 at 11kV
SD11, Baner, SBR, 25MLD	Extension of existing express feeder with minor modifications	730 at 11kV
SD15, Kharadi, SBR, 30MLD	Extension from Mundhwa STP	880 at 11kV

There are three electrical rooms such as at the electrical substation, the blower house, and the centrifuge house planed at each STP. General arrangements for the three electrical rooms are planned taking into consideration of power requirements. For all STPs, there are power receiving facilities, power transformers, HV switchgears, LV switchgears and MCCs for the pump Station facilities and the grit chamber facilities at the electrical substation. Furthermore, at Bhairoba and Naidu STPs, biogas engine generator sets

are additionally planned to be installed at the electrical substation. The power required for the blower house and centrifuge house will be distributed at high voltage for Bhairoba STP and Naidu STP (11 kV for Bhairoba STP or 22 kV for Naidu STP), while the power will be distributed at low voltage (415V) to the blower house for the other STPs such as Matsya, Vadgaon, Warje, Tanajiwadi, and Dhanori. Accordingly, HV switchgears, LV switchgears, and MCCs for the liquid process are arranged at Bhairoba and Naidu STPs, while only MCCs are arranged at the blower house for the other STPs. For all STPs, MCCs for the solid process are arranged at the centrifuge houses. Further, there will be PLC panel and UPS panel provided at the three electrical rooms for any STPs. There are electrical facilities at the three electrical rooms summarized in Table 9.2.4.

Table 9.2.4 Arrangement of Electrical Equipment at Each Electrical Room

STP	Electrical Sub-station	Blower House	Centrifuge House
SD3, Bhairoba, A2O, 75MLD SD4, Naidu, A2O, 127MLD	HV Switchgears, Two banks of power transformers, Biogas engine generator sets LV switchgears, MCC for pump station and grit chamber, PLC, UIPS	HV Switchgears, Two banks of power transformers, LV switchgears, MCCs for liquid process, PLC, UPS	MCCs for solid process, PLC, UPS
SD1, Matsya, EA, 7MLD SD6, Vadgaon, EA, 26MLD SD7, Warje, EA, 28MLD SD9, Tanajiwadi, EA, 15MLD SD10, Botanical Garden, EA, 10MLD SD14, Dhanori, EA, 33MLD SD2, Mundhawa, SBR, 20MLD SD11, Baner, SBR, 25MLD SD15, Kharadi, SBR, 30MLD	HV Switchgears, Power transformer, LV switchgears, MCCs for pump station and grit chamber facilities, PLC, UPS	LV switchgears, MCCs for liquid process, PLC, UPS	MCCs for solid process, PLC, UPS
SD3, Bhairoba, A2O, 75MLD SD4, Naidu, A2O, 127MLD	HV Switchgears, Two banks of power transformers, Biogas engine generator sets LV switchgears, MCC for pump station and grit chamber, PLC, UIPS	HV Switchgears, Two banks of power transformers, LV switchgears, MCCs for liquid process, PLC, UIPS	MCCs for solid process, PLC, UIPS
SD1, Matsya, EA, 7MLD SD6, Vadgaon, EA, 26MLD SD7, Warje, EA, 28MLD SD9, Tanajiwadi, EA, 15MLD SD10, Botanical Garden, EA, 10MLD SD14, Dhanori, EA, 33MLD SD2, Mundhawa, SBR, 20MLD SD11, Baner, SBR, 25MLD SD15, Kharadi, SBR, 30MLD	HV Switchgears, Power transformer, LV switchgears, MCCs for pump station and grit chamber facilities, PLC, UIPS	LV switchgears, MCCs for liquid process, PLC, UIPS	MCCs for solid process, PLC, UIPS

The biogas engine generator sets at the two STPs (Bhairoba and Naidu) will be operated in parallel with the grid of MSEDCL, so that power consumption supplied by MSEDCL can be saved. It contributes reduction of green-house gas emission as well. The standby diesel generator sets are introduced to all STPs to back up the critical process during power failures taking into account power supply conditions at the proposed STP sites.

It is desirable that power factor should be improved up to 95% at each proposed STP to avoid paying penalties to MSEDCL. There will be static capacities with dry type introduced as normal practice to compensate the power factor at the STPs. Individual static capacitors are installed to the loads with 55 kW or over, while group static capacitors are installed at the common of low voltage side. MCCs will be installed at each electrical room to drive the plant loads in association with instrumentation devices and PLC as shown in the table above.

Motor starting methods for the plant loads have been selected suitably taking into consideration the loads conditions and motor output as follows;

- Less than 15 kW: Direct on-line method,
- 15 kW or over: Start-delta method,
- 55 kW or over: Soft starter method,
- Return activated sludge pumps: VFD (Variable Frequency Drive) method
- Air Blowers: Soft starter method for Naidu and Bhairoba considering numbers of air blowers,
  VFD method for the other STPS,

There will be instrumentation devices arranged suitably to operate the plant loads under an auto mode or monitor the process properly at the STPS as shown in Table 9.2.5.

Table 9.2.5 Instrumental Devices

TP	Level Meters	Flow Meters	Water Quality analyzer and others
SD3, Bhairoba, A2O, 75MLD SD4, Naidu, A2O, 127MLD	• stilling chamber, • pre-, post-screens, • wet well, • SAS feed sump, • Digester • Boiler • Hot and cold water tank • Centrifuge feed sump • Centrate sump • Polyelectrolyte solution tank	• Inlet • MLR • RAS • Effluent • Primary sludge • SAS • Generated gas • Digest sludge circulation • Hot and cold water • Centrate • Polymer dosing	• DO • Residual chlorine • Temperature in digester • Biogas pressure
SD1, Matsya, EA, 7MLD SD6, Vadgaon, EA, 26MLD SD7, Warje, EA, 28MLD SD9, Tanajiwadi, EA, 15MLD SD14, Botanical Garden, EA, 10MLD SD14, Dhanori , EA, 33MLD SD2, Mundhawa, SBR, 33MLD SD2, Baner, SBR, 25MLD SD15, Kharadi, SBR, 30MLD	• stilling chamber, • pre-, post-screens, • wet well, • SAS feed sump, • Centrifuge feed sump • Centrate sump • Polyelectrolyte solution tank	• Inlet • MLR • RAS • Effluent • Primary sludge • SAS • Centrate • Polymer dosing	• DO • Residual chlorine

(6) Bio-gas Generation

Biogas generated in anaerobic sludge digestion process can be utilized for the biogas electricity generator sets as fuel, since it contains methane gas with high calorific value. The capacity of the biogas electricity generator set is calculated in the formula below.

、 P_G (kW) = V_{BG} (Nm^3) * B_C*C*E/860 (kcal/kWh)/24 (hrs)

Here, P_G: Biogas electricity generator set capacity

V_{BG}: Generated bio-gas volumetric flow rate (Nm^3/day)

B_C: Methane calorific value (kcal/ Nm^3)

C: Biogas methane content (%)

E: Bio-gas electricity generation efficiency

The parameters/figures sizing the biogas electricity generator set can be referred to in Table 9.2.6.

Table 9.2.6 Parameters/Figure sizing Biogas electricity Generator Set

Description	Bhairoba STP	Naidu STP
V_{BG} (Nm^3/day)	9,928	16,811
B_C (kcal/ Nm^3)	8,100	8,100
C:	0.6	0.6
E:	0.4	0.4
P_G (kW)	**920 (460 kW x 2sets)**	**1,540 (770 kW x 2sets)**

The biogas electricity generator set will be operated in parallel with the grid of MSEDCL, so that contract power and power consumption at the STPs can be reduced. Further, it contributes to reduction of carbon foot print by saving power consumption supplied from MSEDCL.

(7) Summary of Facilities

The major facilities and equipment by STP are summarized in Table 9.2.7.

Table 9.2.7 Major Facilities/ Equipment of Sewage Treatment Plant

Name of STP	Matsya Beij Kendra	Mundhawa	Bhairoba	Naidu	Vadgaon	Warje	Tanajiwadi	Botanical Garden	Baner	Dhanori	Kharadi
Capacity	7,000 m^3/day	20,000 m^3/day	75,000 m^3/day	127,000 m^3/day	26,000 m^3/day	28,000 m^3/day	15,000 m^3/day	10,000 m^3/day	25,000m^3/day	33,000 m^3/day	30,000 m^3/day
Process	SBR	SBR	A2O	A2O	EA	EA	EA	EA	SBR	EA	SBR
Coarse Screen	Mechanical/ Manual	Mechanical/ Manual	Mechanical/ Manual	Mechanical/ Manual	Mechanical/ Manual	Mechanical/ Manual	Mechanical/ Manual	Mechanical/ Manual	— —	Mechanical/ Manual	Mechanical/ Manual
Sewage Pump	Submersible 350m^3/h×3(1)	Submersible 470m^3/h×6(2)	Submersible 900m^3/h×12(4)	Submersible 1350m^3/h×12(4)	Submersible 600m^3/h×6(2)	Submersible 700m^3/h×6(2)	Submersible 400m^3/h×6(2)	Submersible 450m^3/h×3(1)	Submersible 600m^3/h×6(2)	Submersible 800m^3/h×6(2)	Submersible 700m^3/h×6(2)
Fine Screen	Mechanical/ Manual	Mechanical/ Manual	Mechanical/ Manual	Mechanical/ Manual	Mechanical/ Manual	Mechanical/ Manual	Mechanical/ Manual	Mechanical/ Manual	Mechanical/ Manual	Mechanical/ Manual	Mechanical/ Manual
Grit Chamber	Square 4.5mW×4.5mL×1	----	Square 9.5mW×9.5mL×2	Square 11.5mW×11.5mL×2	Square 8.0mW×8.0mL×1	Square 8.5mW×8.5mL×1	Square 6.0mW×6.0mL×1	Square 5.0mW×5.0mL×1	Square 8.0mW×8.0mL×1	Square 9.0mW×9.0mL×1	Square 9.0mW×9.0mL×1
Primary Clarifier	----	----	Circular 31.0Dia×3.5mH×2	Circular 41.0Dia×3.5mH×2	----	----	----	----	----	----	----
Reactor Tank	20.0mW×21.0mL×6.0mH×2	22.0mW×30.0mL×5.5mH×4	8.0mW×60.0mL×10mH×6	8.0mW×95.0mL×8.0mH×8	10mW×86mL×5.5mH×4	8.0mW×63.0mL×10mH×4	10mW×54.0mL×10mH×2	10mW×66.0mL×5.5mH×2	27.5mW×30mL×5.5mH×4	10mW×60.0mL×10mH×4	30mW×33.0mL×5.5mH×4
Final Clarifier	----	--	Tube Settler 8.0mW×8.0mL×5Hoppers/basin×6	Tube settler 8.0mW×8.33mL×6Hoppers/basin×8	Circular 33.5mDia×3.5mH×2	Tube settler 8.0mW×7.5mL×4Hoppers/basin×4	Tube settler 8.0mW×8.0mL×4Hoppers/basin×2	Circular 21mDia×3.5mH×2	----	Tube settler 8.5mW×8.5mL×4Hoppers/basin×4	----
Chlorination Tank	6.0mW×10.0mL×3.0mH×1	12.5mW×18.0mL×3.5mH×1	15.6mW×22.9mL×5.5mH×1	18.0mW×43.7mL×4.0mH×1	12.5mW×18mL×3.5mH×1	12.5mW×18.0mL×3.0mH×1	7.3mW×18.0mL×3.0mH×1	7.3mW×18.0mL×2.0mH×1	12mW×15.0mL×4.5mH×1	12.0mW×18.0mL×3.5mH×1	12.5mW×15.6mL×3.5mH×1
Blower	Rotary Type 1200m^3/h×3(1)	Rotary Type 1900m^3/h×6(2)	Rotary Type 2250m^3/h×8(3)	Rotary Type 2650m^3/h×12(4)	Rotary Type 2400m^3/h×6(2)	Rotary Type 2800m^3/h×6(2)	Rotary Type 1500m^3/h×6(2)	Rotary Type 1900m^3/h×3(1)	Rotary Type 2300m^3/h×6(2)	Rotary Type 3300m^3/h×6(2)	Rotary Type 2800m^3/h×6(2)
Thickener	----	----	Mechanical 45m^3/h×3(1)	Mechanical 50m^3/h×4(1)	----	----	----	----	----	----	----
Digestion Tank	----	----	27.0mDia×10mH×2	29mDia×10mH×3	----	----	----	----	----	----	----
Bio-Gas Generator	----	----	Gas Engine 460kW×2	Gas Engine 770kW×2	--	----	----	----	----	----	----
Dewatering	Centrifuge 20m^3/h×2(1)	Centrifuge 25m^3/h×3(1)	Centrifuge 35m^3/h×2(1)	Centrifuge 30m^3/h×3(1)	Centrifuge 30m^3/h×3(1)	Centrifuge 35m^3/h×3(1)	Centrifuge 20m^3/h×3(1)	Centrifuge 25m^3/h×2(1)	Centrifuge 30m^3/h×3(1)	Centrifuge 40m^3/h×3(1)	Centrifuge 35m^3/h×3(1)
Electrical	Power receiving facilities, Local SCADA system, and others										

Source: JICA Survey Team

(8) Construction method

STP construction work includes civil and architectural work, mechanical work, electrical work and installation work. Civil work includes site arrangement and structural construction. Mechanical work and electrical work includes manufacturing and transfer. After completion of architectural work, mechanical work will start and electrical equipment will be installed.

The temperature in the PMC ranges from 10 to 40 cent degree and annual rainfall ranges from 700 to 800 mm, they are not serious problem in excavation and/or concrete works. STP construction is possible through the year, though about 4 months are considered as non-working months in a year. The soil condition is different site by site, pile foundation should be selected according to the results of soil investigation. Generally pumping station construction needs deep excavation, requiring earth retaining method.

9.3 Basic Design of STPs

The location of planned STPs and main sewers are shown in Figure 9.3.1. Existing STPs and main/sub-main sewers are also illustrated in the same figures.

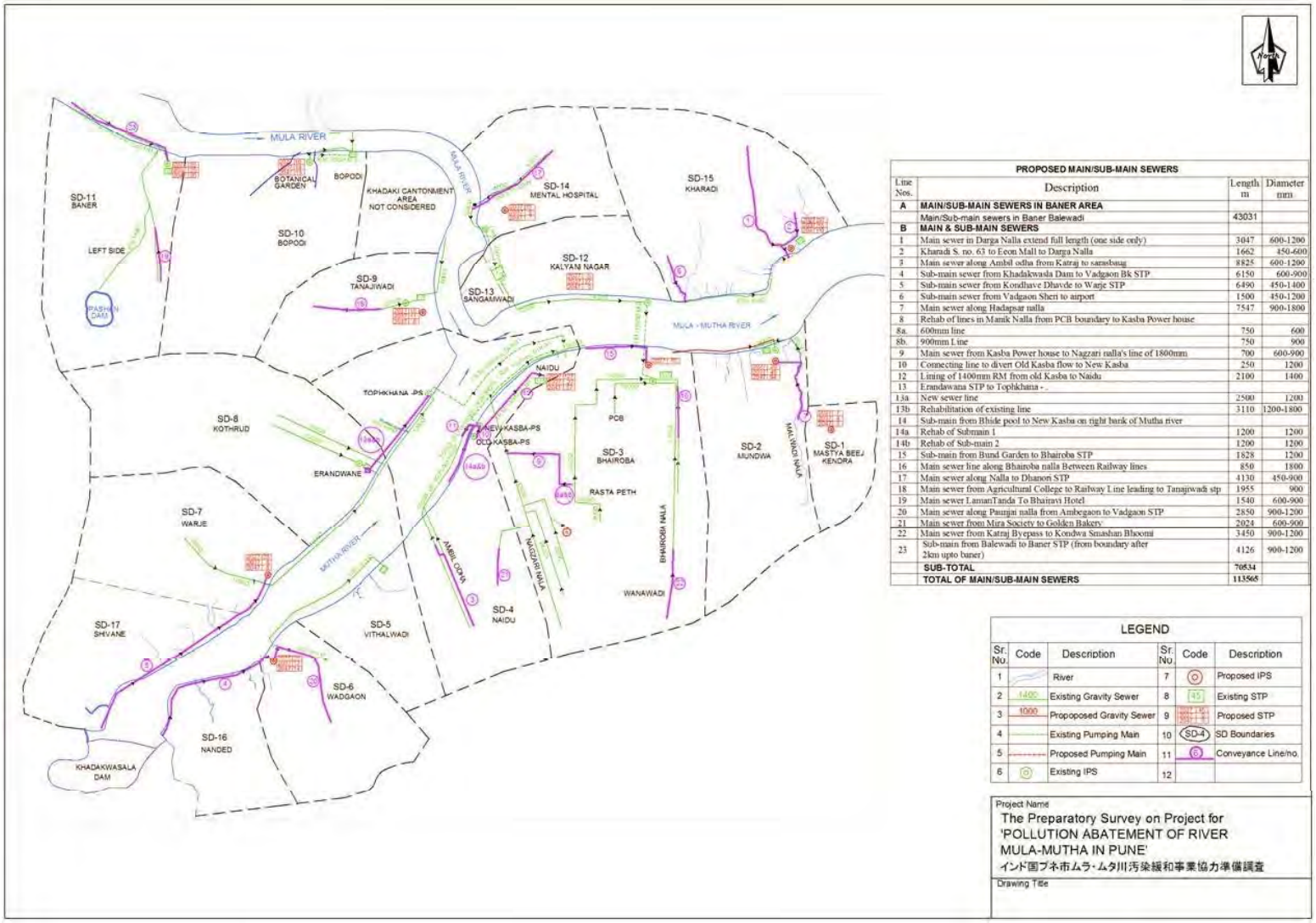
Basic design drawings (layout of facilities and process flow diagram with hydraulic profile) and list of major equipment are presented in this sub-section.

9.3.1 Layout

1) Matsya Beij Kendra
2) Mundhwa
3) Bhairoba
4) Naidu
5) Vadagaon
6) Warje
7) Tanajiwadii
8) Botanical Garden
9) Baner
10) Dhanori
11) Kharadi

9.3.2 Process Flow Diagram with Hydraulic Profile

1) Matsya Beij Kendra
2) Mundhwa
3) Bhairoba
4) Naidu
5) Vadagaon
6) Warje
7) Tanajiwadii
8) Botanical Garden
9) Baner
10) Dhanori
11) Kharadi



PROPOSED MAIN/SUB-MAIN SEWERS

Line Nos.	Description	Length m	Diameter mm
A	**MAIN/SUB-MAIN SEWERS IN BANER AREA**		
	Main/Sub-main sewers in Baner Balewadi	43031	
B	**MAIN & SUB-MAIN SEWERS**		
1	Main sewer in Dariga Nalla extend full length (one side only)	3047	600-1200
2	Kharadi S. no. 63 to Econ Mall to Darga Nalla	1662	450-600
3	Main sewer along Ambil odha from Katraj to sarasbaug	8825	600-1200
4	Sub-main sewer from Khadakwasla Dam to Vadgaon Bk STP	6150	600-900
5	Sub-main sewer from Kondhave Dhavde to Warje STP	6490	450-1400
6	Sub-main sewer from Vadgaon Sheri to airport	1500	450-1200
7	Main sewer along Hadapsar nalla	7547	900-1800
8	Rehab of lines in Manik Nalla from PCB boundary to Kasba Power house		
8a.	600mm line	750	600
8b.	900mm Line	750	900
9	Main sewer from Kasba Power house to Nagzari nalla's line of 1800mm	700	600-900
10	Connecting line to divert Old Kasba flow to New Kasba	250	1200
12	Lining of 1400mm RM from old Kasba to Naidu	2100	1400
13	Erandawana STP to Tophkhana - .		
13a	New sewer line	2500	1200
13b	Rehabilitation of existing line	3110	1200-1800
14	Sub-main from Bhide pool to New Kasba on right bank of Mutha river		
14a	Rehab of Submain 1	1200	1200
14b	Rehab of Sub-main 2	1200	1200
15	Sub-main from Bund Garden to Bhairoba STP	1828	1200
16	Main sewer line along Bhairoba nalla Between Railway lines	850	1800
17	Main sewer along Nalla to Dhanori STP	4130	450-900
18	Main sewer from Agricultural College to Railway Line leading to Tanajiwadi stp	1955	900
19	Main sewer LamanTanda To Bhairavi Hotel	1540	600-900
20	Main sewer along Paunjai nalla from Ambegaon to Vadgaon STP	2850	900-1200
21	Main sewer from Mira Society to Golden Bakery.	2024	600-900
22	Main sewer from Katraj Byepass to Kondwa Smashan Bhoomi	3450	900-1200
23	Sub-main from Balewadi to Baner STP (from boundary after 2km upto baner)	4126	900-1200
	SUB-TOTAL	70534	
	TOTAL OF MAIN/SUB-MAIN SEWERS	113565	

LEGEND

Sr. No.	Code	Description	Sr. No.	Code	Description
1		River	7		Proposed IPS
2	1400	Existing Gravity Sewer	8	45	Existing STP
3	1000	Propoposed Gravity Sewer	9		Proposed STP
4		Existing Pumping Main	10	SD-4	SD Boundaries
5		Proposed Pumping Main	11	6	Conveyance Line/no.
6		Existing IPS	12		

Project Name
The Preparatory Survey on Project for 'POLLUTION ABATEMENT OF RIVER MULA-MUTHA IN PUNE'
インド国プネ市ムラ・ムタ川汚染緩和事業協力準備調査

Drawing Title

Figure 9.3.1 Existing and Planned STPs and Main Sewers

9.3.3 Specification for Major Equipment

1) Matsya Beej Kendra STP

Items	Specification		kW	Pcs/Units
(Mechanical)				
1. Sewage Pumps	Submersible Cast Iron	Dia:200 (mm)×Discharge :350(m^3/h)×Total Head:20.0 (m)	37.0	3
2. Electric Hoist		Rated Load :3.0(Ton)×Lift :15(m)	8.50	1
3. Inlet Gates	Manually Operated Cast Iron	Width 0.4(m)×Height :0.6(m)	-	3
4. Fine Screens (Mechanical)	Step Type SS304	Channel Width :0.70 (m)×SWD :0.40 (m) ×Open Space:6(mm)	2.20	2
5. Fine Screen (Manual)	Bar Screen SS304	Channel Width :0.70 (m)×SWD:0.40 (m) ×Open Space:20(mm)	-	1
6. Belt Conveyor		Belt Width :0.60(m)×Length :8.0 (m)	1.50	1
7. Grit Chamber	Square Horizontal SS304	Width :4.50 (m)×Length :4.5(m)×SWD :0.50 (m)	2.25	1
8. Inlet Gates	Motor Drive Type Cast Iron	Width 0.3(m)×Height :0.3(m)	0.40	2
9. Decanters	Moving Weir Type SS304	SBR Tank Width :22.0 (m)×Length :23(m)×SWD :5.5(m)	2.20	2
10. Diffusers	Fine Bubble Membrane	SOR:195 (kg/h・basin)×setting Depth :5.0(m) ×Efficiency:28 %	-	2
11. Air Blowers	Rotary blower Tri-lobe Type	Dia. :150 (mm)× Air Flow :1400(m^3/h) ×Pressure: 65 (K Pa)	37.0	3
12. Circulation Pumps	Submersible Cast Iron	Dia. :200 (mm)×Discharge:300(m^3/h)×Total Head:5.0 (m)	15.0	4
13. SAS Pumps	Submersible Cast Iron	Dia.:100 (mm)×Discharge :25(m^3/h)×Total Head:15.0 (m)	3.70	4
14. Hand Operation Chain Block	With Geared Trolley	Rated Load :1.0(Ton)×Lift :6(m)	-	2
15. Chlorinators	Gas Chlorination System	Dosing Rate :2.0(kg/h)	1.00	2
16. Chlorine Tonners		Volume:928(kg/Unit)	-	3
17. Electric Hoist for Tonners		Rated Load :3.0(Ton)×Lift :6(m)	8.50	1
18. Air Blowers For Centrifuge Feed Sump	Rotary blower Tri-lobe Type	Dia. :50 (mm)× Air Flow:110(m^3/h) ×Pressure: 40 (K Pa)	3.70	2
19. Centrifuge Feed Pumps	Progressive Cavity Pump, Cast Iron	Dia.:125 (mm)×Discharge :24(m^3/h)×Total Head:20.0 (m)	7.50	2
20. Centrifuges	Centrifuge SS304	Capacity:20(m^3/h)	44.5	2
21. Belt Conveyor		Belt Width :0.60(m)×Length :8.0 (m)	1.50	1
22. Electric Hoist Crane		Rated Load :3.0(Ton)×Lift :15(m)	8.50	1

Items	Specification	kW	Pcs/Units
23. Polyelectrolyte Dosing System	With Agitator SS304 Tank Width: 2.5(m)×Length:2.5(m)×SWD:2.0(m)	3.70	2
24. Polyelectrolyte Dosing Pumps	Progressive Cavity Pump Dia.:40 (mm)×Discharge :1.2(m^3/h)×Total Head:20.0 (m)	0.75	2
25. Centrate Transfer Pumps	Submersible Cast Iron Dia:100 (mm)×Discharge :18(m^3/h)×Total Head:15.0 (m)	2.20	2
(Electrical)			
1. Power receiving facilities at electrical sub-station	HV incoming panel: IP52, 12kV, VCB Power transformers: 11/0.415-0.24 kV,500 kVA		1pc 1pc
2. LV incoming panel, LV switchgears, and MCCs at electrical sub-station	LV incoming panels: IP52, 600V, ACB 800A, 630A, LV feeder panels: IP52, 600V, MCCBs MCC for IPS and G. Chamber		2pcs 2pcs 1pc
3. LV incoming panel, LV switchgears, and MCCs at blower house	MCCs for Liquid process Air blower starter panels with VFD		1pc 3pcs
4. MCCs at centrifuge house	MCCs for Solid process		1pc
5. Instrumentation devices	Flow meters, level meters, water quality analyzers, etc.,		1ls
6. Local SCADA system	Operator stations, engineering station, SCADA/data servers, PLCs, router, etc.,		1ls

2) Mundhawa STP

Items	Specification		kW	Pcs/Units
(Mechanical)				
1. Coarse Screens (Mechanical)	Climber Screen SS304	Channel Width :1.25 (m)×SWD :1.10 (m) ×Open Space:20(mm)	1.50	2
2. Coarse Screens (Manual)	Bar Screen SS304	Channel Width :1.25 (m)×SWD:1.10 (m) ×Open Space:50(mm)	-	2
3. Sewage Pumps	Submersible Cast Iron	Dia:250 (mm)×Discharge :470(m^3/h)×Total Head:20.0 (m)	55.0	6
4. Fine Screen (Mechanical)	Step Type SS304	Channel Width :1.25 (m)×SWD :1.10 (m) ×Open Space:6(mm)	2.20	2
5. Belt Conveyor		Belt Width :0.60(m)×Length :8.0 (m)	1.50	1
6. Inlet Gates	Motor Drive Type Cast Iron	Width 0.4(m)×Height :0.4(m)	0.40	4
7. Decanters	Moving Weir Type SS304	SBR Tank Width :22.0 (m)×Length :30(m)×SWD :5.5(m)	2.20	4
8. Diffusers	Fine Bubble Membrane	SOR:268 (kg/h・basin)×setting Depth :5.0(m) ×Efficiency:28 %	-	4
9. Air Blowers	Rotary blower Tri-lobe Type	Dia. :200 (mm)× Air Flow :1900(m^3/h) ×Pressure: 65 (K Pa)	75.0	6
10. Circulation Pumps	Submersible Cast Iron	Dia. :250 (mm)×Discharge:450(m^3/h)×Total Head:5.0 (m)	18.5	8
11. SAS Pumps	Submersible Cast Iron	Dia.:100 (mm)×Discharge :50(m^3/h)×Total Head:15.0 (m)	7.5	8
12. Hand Operation Chain Block	With Geared Trolley	Rated Load :1.0(Ton)×Lift :6(m)	-	4
13. Chlorinators	Gas Chlorination System	Dosing Rate :5.0(kg/h)	1.00	2
14. Chlorine Tonners		Volume:928(kg/Unit)	-	4
15. Electric Hoist for Tonners		Rated Load :3.0(Ton)×Lift :6(m)	8.50	1
16. Air Blowers For Centrifuge Feed Sump	Rotary blower Tri-lobe Type	Dia. :80 (mm)× Air Flow:240(m^3/h) ×Pressure: 40 (K Pa)	5.50	2
17. Centrifuge Feed Pumps	Progressive Cavity Pump, Cast Iron	Dia.:125 (mm)×Discharge :30(m^3/h)×Total Head:20.0 (m)	7.50	3
18. Centrifuges	Centrifuge SS304	Capacity:25(m^3/h)	44.5	3
19. Belt Conveyor		Belt Width :0.60(m)×Length :8.0 (m)	1.50	1
20. Electric Hoist Crane		Rated Load :3.0(Ton)×Lift :15(m)	8.50	1
21. Polyelectrolyte Dosing System	With Agitator SS304	Tank Width: 3.0(m)×Length:3.0(m)×SWD:2.0(m)	5.50	2
22. Polyelectrolyte Dosing Pumps	Progressive Cavity Pump	Dia.:40 (mm)×Discharge :1.5(m^3/h)×Total Head:20.0 (m)	0.75	3

Items	Specification	kW	Pcs/Units
23. Centrate Transfer Pumps	Submersible Dia:100 (mm)×Discharge :51(m^3/h)×Total Head:15.0 (m) Cast Iron	5.50	2
(Electrical)			
1. Power receiving facilities at electrical substation	HV incoming panel: IP52, 12kV, VCB Power transformers: 11/0.415-0.24 kV,1000 kVA		1pc 1pc
2. LV incoming panel, LV switchgears, and MCCs at electrical substation	LV incoming panels: IP52, 600V, ACB 1600A, LV feeder panels: IP52, 600V, MCCBs MCC for IPS and G. Chamber Sewage Pump starter panels with VFD		2pcs 2pcs 1pc 6pcs
3. LV incoming panel, LV switchgears, and MCCs at blower house	MCCs for Liquid process Air blower starter panels with VFD Circulation pump starter panel with VFD		2pcs 6pcs 6pcs
4. MCCs at centrifuge house	MCCs for Solid process		1pc
5. Instrumentation devices	Flow meters, level meters, water quality analyzers, etc.,		1ls
6. Local SCADA system	Operator stations, engineering station, SCADA/data servers, PLCs, router, etc.,		1ls

3) Bhairoba STP

Items	Specification		kW	Pcs/Units
(Mechanical)				
1. Inlet Gates	Motor Drive Type Cast Iron	Width 1.0(m)×Height :1.5(m)	3.70	3
2. Coarse Screens (Mechanical)	Climber Screen SS304	Channel Width :1.60 (m)×SWD :1.30 (m) ×Open Space:20(mm)	3.70	2
3. Coarse Screens (Manual)	Bar Screen SS304	Channel Width :1.60 (m)×SWD:1.30 (m) ×Open Space:50(mm)	-	1
4. Belt Conveyor		Belt Width :0.60(m)×Length :8.0 (m)	1.50	1
5. Sewage Pumps	Submersible Cast Iron	Dia:350 (mm)×Discharge :900(m^3/h)×Total Head:30.0 (m)	150.0	12
6. Electric Hoist		Rated Load :5.0(Ton)×Lift :6(m)	8.50	1
7. Inlet Gates	Manually Operated Cast Iron	Width 1.00(m)×Height :1.50(m)	-	3
8. Fine Screens (Mechanical)	Step Type SS304	Channel Width :1.60 (m)×SWD :1.30 (m) ×Open Space:6(mm)	2.20	2
9. Fine Screens (Manual)	Bar Screen SS304	Channel Width :1.60 (m)×SWD:1.30 (m) ×Open Space:20(mm)	-	1
10. Belt Conveyor		Belt Width :0.60(m)×Length :8.0 (m)	1.50	1
11. Grit Chambers	Square Horizontal SS304	Width :9.50 (m)×Length :9.5(m)×SWD :0.70 (m)	2.25	2
12. Inlet Weir Gates	Manually Operated Cast Iron	Width 2.00(m)×Height :0.60(m)	-	2
13. Primary Clarifiers	Central turn table Type, MS Epoxy coating	Dia. :31.0 (m)×SWD :3.5(m)	1.50	2
14. Primary Sludge Pumps	Horizontal Centrifugal Type	Dia.:100 (mm)×Discharge :60(m^3/h)×Total Head:10.0 (m)	5.50	3
15. Inlet Weir Gates	Manually Operated Cast Iron	Width 1.00(m)×Height :0.50(m)	-	6
16. Mixers for Anaerobic Tank	Submersible Type SUS	Tank Width 8.00(m)×Length :10.00(m) × SWD :10.00 (m)×1unit/tank	5.00	6
17. Mixers for Anoxic Tank	Submersible Type SUS	Tank Width 8.00(m)×Length :21.00(m) × SWD :10.00 (m)×3unit/tank	4.00	6
18. Diffusers	Fine Bubble Membrane	SOR:169 (kg/h・basin)×setting Depth :6.0(m) ×Efficiency:32 %	-	6
19. Air Blowers	Rotary blower Tri-lobe Type	Dia. :200 (mm)× Air Flow :2250(m^3/h) ×Pressure: 75 (K Pa)	75.0	9
20. RAS Pumps	Submersible Cast Iron	Dia.:350 (mm)×Discharge :600(m^3/h)×Total Head:5.0 (m)	22.00	12
21. SAS Pumps	Submersible Cast Iron	Dia.:100 (mm)×Discharge :80(m^3/h)×Total Head:15.0 (m)	7.50	6
22. Circulation Pumps	Submersible Cast Iron	Dia. :400 (mm)×Discharge:1000(m^3/h)×Total Head:5.0 (m)	30.00	12
23. Hand Operation Chain	With Geared Trolley	Rated Load :1.0(Ton)×Lift :6(m)	-	3

Items		Specification		kW	Pcs/Units
	Block				
24.	Final Clarifiers	Tube settler Type	Width :8.00 (m)×Length:40.00(m)×SWD :3.5(m)	-	6
25.	Chlorinators	Gas Chlorination System	Dosing Rate :20.0(kg/h)	1.00	2
26.	Chlorine Tonners		Volume:928(kg/Unit)	-	9
27.	Electric Hoist for Tonners		Rated Load :3.0(Ton)×Lift :6(m)	8.50	1
28.	Air Blowers For Thickener Feed Sump	Rotary blower Tri-lobe Type	Dia. :80 (mm)× Air Flow:210(m^3/h) ×Pressure: 40 (K Pa)	5.50	2
29.	Thickener Feed Pumps	Progressive Cavity Pump, Cast Iron	Dia.:150 (mm)×Discharge :45(m^3/h)×Total Head:10.0 (m)	15.00	3
30.	Mechanical Thickeners	Rotary drum Type	Capacity :45(m^3/h)	2.60	3
31.	Air Blowers For Digester Feed Sump	Rotary blower Tri-lobe Type	Dia. :80 (mm)× Air Flow:210(m^3/h) ×Pressure: 40 (K Pa)	5.50	2
32.	Digester Feed Pumps	Progressive Cavity Pump, Cast Iron	Dia.:100 (mm)×Discharge :20(m^3/h)×Total Head:20.0 (m)	5.50	3
33.	Mixers for Digester	Screw impeller Type	Dia.:500 (mm)×Circulation Rate :1900(m^3/h)	15.00	2
34.	Digested Sludge circulation Pumps	Horizontal Centrifugal Type	Dia.:150 (mm)×Discharge :120(m^3/h)×Total Head:15.0 (m)	15.00	4
35.	Digested Sludge Transfer Pumps	Progressive Cavity Pump, Cast Iron	Dia.:150 (mm)×Discharge :50(m^3/h)×Total Head:10.0 (m)	15.00	4
36.	Desulfurization Equipment		Capacity :310(m^3/h)	-	2
37.	Biogas Holder	Balloon Type	Capacity:5000(m^3)	-	1
38.	Sludge Heat Exchangers	Double Pipe Type	Heat transfer area:20(m^2)	-	2
39.	Heating Boilers	Hot Water Boiler	Capacity:173(kW)	1.5	2
40.	Biogas Feed Blowers	Rotary blower	Dia. :80 (mm)× Gas Flow:250(m^3/h) ×Pressure: 10 (K Pa)	2.20	4
41.	Biogas Power Generators		Electrical Output :460(kW)	-	2
42.	Surplus Gas Burner Apparatus		Capacity :310(m^3/h)	-	2
43.	Mixers For Centrifuge Feed Sump	Vertical Paddle- Type SUS304	Tank Width: 4.5(m)×Length:4.5(m)×SWD:3.5(m)	7.50	2
44.	Centrifuge Feed Pumps	Progressive Cavity Pump, Cast Iron	Dia.:125 (mm)×Discharge :35(m^3/h)×Total Head:15.0 (m)	11.00	2
45.	Centrifuges	Centrifuge	Capacity:35(m^3/h)	108.5	2

Items	Specification	kW	Pcs/Units
	SS304		
46. Electric Hoist Crane	Rated Load :3.0(Ton)×Lift :15(m)	8.50	1
47. Polyelectrolyte Dosing System	With Agitator Tank Width: 3.0(m)×Length:3.0(m)×SWD:3.0(m) SS304	7.50	2
48. Polyelectrolyte Dosing Pumps for Mechanical Thickeners	Progressive Cavity Pump Dia.:32 (mm)×Discharge :0.9(m^3/h)×Total Head:20.0 (m)	0.75	3
49. Polyelectrolyte Dosing Pumps for Centrifuges	Progressive Cavity Pump Dia.:80 (mm)×Discharge :8.5(m^3/h)×Total Head:20.0 (m)	3.70	2
50. Centrate Transfer Pumps	Submersible Dia:100 (mm)×Discharge :37(m^3/h)×Total Head:15.0 (m) Cast Iron	3.70	2
(Electrical)			
1. Power receiving facilities at electrical substation	HV incoming panel: IP52, 12kV, VCB HV switchgears: IP52,12kV,VCB Power transformers: 11/0.415-0.24 kV,1000 kVA		1pc 6pcs 2pcs
2. LV incoming panel, LV switchgears, and MCCs at electrical substation	LV incoming panels: IP52, 600V, ACB 1600A, LV feeder panels: IP52, 600V, MCCBs MCC for IPS and G. Chamber Sewage Pump Starter panels with VFD		2pcs 2pcs 1pc 12pcs
3. LV incoming panel, LV switchgears, and MCCs at blower house	LV incoming panels IP52,600V,ACB 1600A, LV feeder panels: IP52,600V,MCCBs MCCs for Liquid process Air blower starter panels with soft starter RAS Pump starter panels with VFD		2pcs 2pcs 2pcs 9pcs 12pcs
4. MCCs at centrifuge house	MCCs for Solid process Digested sludge circulation pump starter panels with soft starter		3pcs 4pcs
5. Instrumentation devices	Flow meters, level meters, water quality analyzers, etc.,		1ls
6. Local SCADA system	Operator stations, engineering station, SCADA/data servers, PLCs, router, etc.,		1ls
7. Power receiving facilities at Blower house	HV incoming panel: IP52, 12kV, VCB HV switchgears: IP52,12kV,VCB Power transformers: 11/0.415-0.24 kV,1000 kVA		2pcs 3pcs 2pcs

4) Naidu STP

Items	Specification		kW	Pcs/Units
(Mechanical)				
1. Inlet Gates	Motor Drive Type Cast Iron	Width 1.2(m)×Height :1.8(m)	3.70	3
2. Coarse Screens (Mechanical)	Climber Screen SS304	Channel Width :1.80 (m)×SWD :1.80 (m) ×Open Space:20(mm)	3.70	2
3. Coarse Screens (Manual)	Bar Screen SS304	Channel Width :1.80 (m)×SWD:1.80 (m) ×Open Space:50(mm)	-	1
4. Belt Conveyor		Belt Width :0.60(m)×Length :9.0 (m)	1.50	1
5. Sewage Pumps	Submersible Cast Iron	Dia:400 (mm)×Discharge :1350(m^3/h)×Total Head:20.0 (m)	150.0	12
6. Electric Hoist		Rated Load :5.0(Ton)×Lift :6(m)	8.50	1
7. Inlet Gates	Manually Operated Cast Iron	Width 1.20(m)×Height :1.80(m)	-	3
8. Fine Screens (Mechanical)	Step Type SS304	Channel Width :1.80 (m)×SWD :1.80 (m) ×Open Space:6(mm)	2.20	2
9. Fine Screens (Manual)	Bar Screen SS304	Channel Width :1.80 (m)×SWD:1.80 (m) ×Open Space:20(mm)	-	1
10. Belt Conveyor		Belt Width :0.60(m)×Length :9.0 (m)	1.50	1
11. Grit Chambers	Square Horizontal SS304	Width :11.50 (m)×Length :11.5(m)×SWD :0.70 (m)	2.25	2
12. Inlet Weir Gates	Manually Operated Cast Iron	Width 2.40(m)×Height :0.60(m)	-	2
13. Primary Clarifiers	Central turn table Type, MS Epoxy coating	Dia. :41.0 (m)×SWD :3.5(m)	2.20	2
14. Primary Sludge Pumps	Horizontal Centrifugal Type	Dia.:100 (mm)×Discharge :95(m^3/h)×Total Head:10.0 (m)	7.50	3
15. Inlet Weir Gates	Manually Operated Cast Iron	Width 0.80(m)×Height :0.50(m)	-	8
16. Mixers for Anaerobic Tank	Submersible Type SUS	Tank Width 8.00(m)×Length :16.00(m) × SWD :8.00 (m)×1unit/tank	5.00	8
17. Mixers for Anoxic Tank	Submersible Type SUS	Tank Width 8.00(m)×Length :33.50(m) × SWD :8.00 (m)×3unit/tank	4.00	24
18. Diffusers	Fine Bubble Membrane	SOR:217 (kg/h・basin)×setting Depth :6.0(m) ×Efficiency:32 %	-	8
19. Air Blowers	Rotary blower Tri-lobe Type	Dia. :250 (mm)× Air Flow :2650(m^3/h) ×Pressure: 75 (K Pa)	90.0	12
20. RAS Pumps	Submersible Cast Iron	Dia.:350 (mm)×Discharge :700(m^3/h)×Total Head:5.0 (m)	22.00	16
21. SAS Pumps	Submersible Cast Iron	Dia.:100 (mm)×Discharge :100(m^3/h)×Total Head:15.0 (m)	11.00	8
22. Circulation Pumps	Submersible Cast Iron	Dia. :400 (mm)×Discharge:1250(m^3/h)×Total Head:5.0 (m)	37.00	16
23. Hand Operation Chain	With Geared Trolley	Rated Load :2.0(Ton)×Lift :13(m)	-	8

Items		Specification		kW	Pcs/Units
	Block				
24.	Final Clarifiers	Tube settler Type	Width :8.00 (m)×Length:50.00(m)×SWD :3.5(m)	-	8
25.	Chlorinators	Gas Chlorination System	Dosing Rate :30.0(kg/h)	1.00	2
26.	Chlorine Tonners		Volume:928(kg/Unit)	-	13
27.	Electric Hoist for Tonners		Rated Load :3.0(Ton)×Lift :6(m)	8.50	1
28.	Air Blowers For Thickener Feed Sump	Rotary blower Tri-lobe Type	Dia. :100 (mm)× Air Flow:360(m^3/h) ×Pressure: 40 (K Pa)	7.50	2
29.	Thickener Feed Pumps	Progressive Cavity Pump, Cast Iron	Dia.:150 (mm)×Discharge :50(m^3/h)×Total Head:10.0 (m)	15.00	4
30.	Mechanical Thickeners	Rotary drum Type	Capacity :50(m^3/h)	2.60	4
31.	Air Blowers For Digester Feed Sump	Rotary blower Tri-lobe Type	Dia. :100 (mm)× Air Flow:360(m^3/h) ×Pressure: 40 (K Pa)	7.50	2
32.	Digester Feed Pumps	Progressive Cavity Pump, Cast Iron	Dia.:100 (mm)×Discharge :20(m^3/h)×Total Head:20.0 (m)	5.50	4
33.	Mixers for Digester	Screw impeller Type	Dia.:500 (mm)×Circulation Rate :2200(m^3/h)	15.00	3
34.	Digested Sludge circulation Pumps	Horizontal Centrifugal Type	Dia.:150 (mm)×Discharge :140(m^3/h)×Total Head:15.0 (m)	15.00	6
35.	Digested Sludge Transfer Pumps	Progressive Cavity Pump, Cast Iron	Dia.:150 (mm)×Discharge :55(m^3/h)×Total Head:10.0 (m)	15.00	6
36.	Desulfurization Equipment		Capacity :550(m^3/h)	-	2
37.	Biogas Holder	Balloon Type	Capacity:4200(m^3)	-	2
38.	Sludge Heat Exchangers	Double Pipe Type	Heat transfer area:20(m^2)	-	3
39.	Heating Boilers	Hot Water Boiler	Capacity:195(kW)	1.5	3
40.	Biogas Feed Blowers	Rotary blower	Dia. :100 (mm)× Gas Flow:420(m^3/h) ×Pressure: 10 (K Pa)	3.70	4
41.	Biogas Power Generators		Electrical Output :770(kW)	-	2
42.	Surplus Gas Burner Apparatus		Capacity :550(m^3/h)	-	2
43.	Mixers For Centrifuge Feed Sump	Vertical Paddle- Type SUS304	Tank Width: 6.0(m)×Length:6.0(m)×SWD:3.5(m)	15.00	2
44.	Centrifuge Feed Pumps	Progressive Cavity Pump, Cast Iron	Dia.:100 (mm)×Discharge :30(m^3/h)×Total Head:10.0 (m)	7.50	3
45.	Centrifuges	Centrifuge	Capacity:30(m^3/h)	90.00	3

Items	Specification		kW	Pcs/Units
	SS304			
46. Belt Conveyor		Belt Width :0.60(m)×Length :9.0 (m)	1.50	1
47. Electric Hoist Crane		Rated Load :3.0(Ton)×Lift :6(m)	8.50	1
48. Polyelectrolyte Dosing System	With Agitator SS304	Tank Width: 3.50(m)×Length:3.50(m)×SWD:3.50(m)	11.00	2
49. Polyelectrolyte Dosing Pumps for Mechanical Thickeners	Progressive Cavity Pump	Dia.:32 (mm)×Discharge :1.0(m^3/h)×Total Head:20.0 (m)	0.75	4
50. Polyelectrolyte Dosing Pumps for Centrifuges	Progressive Cavity Pump	Dia.:65 (mm)×Discharge :7.1(m^3/h)×Total Head:20.0 (m)	2.20	3
51. Centrate Transfer Pumps	Submersible Cast Iron	Dia:100 (mm)×Discharge :62(m^3/h)×Total Head:15.0 (m)	7.50	2
(Electrical)				
1. Power receiving facilities at electrical sub-station	HV incoming panel: IP52, 12kV, VCB HV switchgears: IP52,12kV,VCB Power transformers: 11/0.415-0.24 kV,1500 kVA			1pc 6pcs 2pcs
2. LV incoming panel, LV switchgears, and MCCs at electrical sub-station	LV incoming panels: IP52, 600V, ACB 1600A, LV feeder panels: IP52, 600V, MCCBs MCC for IPS and G. Chamber Sewage Pump Starter panels with VFD			2pcs 2pcs 1pc 12pcs
3. LV incoming panel, LV switchgears, and MCCs at blower house	LV incoming panels IP52,600V,ACB 1600A, LV feeder panels: IP52,600V,MCCBs MCCs for Liquid process Air blower starter panels with soft starter RAS Pump starter panels with VFD			2pcs 2pcs 4pcs 12pcs 16pcs
4. MCCs at centrifuge house	MCCs for Solid process Digested sludge circulation pump starter panels with soft starter			3pcs 4pcs
5. Instrumentation devices	Flow meters, level meters, water quality analyzers, etc.,			1ls
6. Local SCADA system	Operator stations, engineering station, SCADA/data servers, PLCs, router, etc.,			1ls
7. Power receiving facilities at Blower house	HV incoming panel: IP52, 12kV, VCB HV switchgears: IP52,12kV,VCB Power transformers: 11/0.415-0.24 kV,1000 kVA			2pcs 3pcs 2pcs

5) Vadgaon STP

Items	Specification		kW	Pcs/Units
(Mechanical)				
1. Inlet Gates	Motor Drive Type Cast Iron	Width 0.6(m)×Height :0.9m)	1.50	3
2. Coarse Screens (Mechanical)	Climber Screen SS304	Channel Width :1.20 (m)×SWD :0.70 (m) ×Open Space:20(mm)	1.50	2
3. Coarse Screens (Manual)	Bar Screen SS304	Channel Width :1.20 (m)×SWD:0.70 (m) ×Open Space:50(mm)	-	1
4. Belt Conveyor		Belt Width :0.60(m)×Length :8.0 (m)	1.50	1
5. Sewage Pumps	Submersible Cast Iron	Dia:300 (mm)×Discharge :600(m^3/h)×Total Head:20.0 (m)	75.0	6
6. Electric Hoist		Rated Load :5.0(Ton)×Lift :6(m)	8.50	1
7. Inlet Gates	Manually Operated Cast Iron	Width 0.60(m)×Height :0.90(m)	-	3
8. Fine Screens (Mechanical)	Step Type SS304	Channel Width :1.20 (m)×SWD :0.70 (m) ×Open Space:6(mm)	2.20	2
9. Fine Screens (Manual)	Bar Screen SS304	Channel Width :1.20 (m)×SWD:0.70 (m) ×Open Space:20(mm)	-	1
10. Belt Conveyor		Belt Width :0.60(m)×Length :8.0 (m)	1.50	1
11. Grit Chambers	Square Horizontal SS304	Width :8.00 (m)×Length :8.00(m)×SWD :0.70 (m)	2.25	1
12. Inlet Weir Gates	Manually Operated Cast Iron	Width 1.00(m)×Height :0.40(m)	-	4
13. Mixers for Anoxic Tank	Submersible Type SUS	Tank Width 10.00(m)×Length :35.00(m) × SWD :5.50 (m)×2unit/tank	5.00	8
14. Diffusers	Fine Bubble Membrane	SOR:173 (kg/h・basin)×setting Depth :5.0(m) ×Efficiency:28 %	-	4
15. Air Blowers	Rotary blower Tri-lobe Type	Dia. :200 (mm)× Air Flow :2400(m^3/h) ×Pressure: 65 (K Pa)	75.0	6
16. RAS Pumps	Submersible Cast Iron	Dia.:200 (mm)×Discharge :300(m^3/h)×Total Head:5.0 (m)	11.00	3
17. SAS Pumps	Submersible Cast Iron	Dia.:100 (mm)×Discharge :45(m^3/h)×Total Head:15.0 (m)	5.50	3
18. Hand Operation Chain Block	With Geared Trolley	Rated Load :1.0(Ton)×Lift :6(m)	-	4
19. Final Clarifiers	Central turn table Type, MS Epoxy coating	Dia. :33.50 (m)×SWD :3.5(m)	2.20	2
20. Chlorinators	Gas Chlorination System	Dosing Rate :6.0(kg/h)	1.00	2
21. Chlorine Tonners		Volume:928(kg/Unit)	-	5
22. Electric Hoist for Tonners		Rated Load :3.0(Ton)×Lift :6(m)	8.50	1
23. Air Blower For Centrifuge	Rotary blower Tri-lobe Type	Dia. :100 (mm)× Air Flow :310(m^3/h) ×Pressure: 40 (K Pa)	7.50	2

Items	Specification		kW	Pcs/Units
Feed Sump				
24. Centrifuge Feed Pumps	Progressive Cavity Pump, Cast Iron	Dia.:125 (mm)×Discharge :36(m^3/h)×Total Head:20.0 (m)	7.50	3
25. Centrifuges	Centrifuge SS304	Capacity:30(m^3/h)	90.00	3
26. Belt Conveyor		Belt Width :0.60(m)×Length :8.0 (m)	1.50	1
27. Electric Hoist Crane		Rated Load :3.0(Ton)×Lift :6(m)	8.50	1
28. Polyelectrolyte Dosing System	With Agitator SS304	Tank Width: 3.50(m)×Length:4.00(m)×SWD:3.00(m)	11.00	2
29. Polyelectrolyte Dosing Pumps for Centrifuges	Progressive Cavity Pump	Dia.:40 (mm)×Discharge :2.1(m^3/h)×Total Head:20.0 (m)	1.50	3
30. Centrate Transfer Pumps	Submersible Cast Iron	Dia:100 (mm)×Discharge :66(m^3/h)×Total Head:15.0 (m)	7.50	2
(Electrical)				
1. Power receiving facilities at electrical sub-station	HV incoming panel: IP52, 12kV, VCB Power transformers: 11/0.415-0.24 kV,1000 kVA			1pc 1pc
2. LV incoming panel, LV switchgears, and MCCs at electrical sub-station	LV incoming panels: IP52, 600V, ACB 1600A, LV feeder panels: IP52, 600V, MCCBs MCC for IPS and G. Chamber Sewage Pump Starter panels with VFD			2pcs 2pcs 1pc 6pcs
3. LV incoming panel, LV switchgears, and MCCs at blower house	MCCs for Liquid process Air blower starter panels with soft starter RAS Pump starter panels with VFD			2pcs 6pcs 3pcs
4. MCCs at centrifuge house	MCCs for Solid process			1pc
5. Instrumentation devices	Flow meters, level meters, water quality analyzers, etc.,			1ls
6. Local SCADA system	Operator stations, engineering station, SCADA/data servers, PLCs, router, etc.,			1ls

6) Warje STP

Items	Specification		kW	Pcs/Units
(Mechanical)				
1. Inlet Gates	Motor Drive Type Cast Iron	Width 0.6(m)×Height :0.9m)	1.50	3
2. Coarse Screens (Mechanical)	Climber Screen SS304	Channel Width :1.20 (m)×SWD :0.70 (m) ×Open Space:20(mm)	1.50	2
3. Coarse Screens (Manual)	Bar Screen SS304	Channel Width :1.20 (m)×SWD:0.70 (m) ×Open Space:50(mm)	-	1
4. Belt Conveyor		Belt Width :0.60(m)×Length :8.0 (m)	1.50	1
5. Sewage Pumps	Submersible Cast Iron	Dia:300 (mm)×Discharge :700(m^3/h)×Total Head:20.0 (m)	75.0	6
6. Electric Hoist		Rated Load :5.0(Ton)×Lift :6(m)	8.50	1
7. Inlet Gates	Manually Operated Cast Iron	Width 0.60(m)×Height :0.90(m)	-	3
8. Fine Screens (Mechanical)	Step Type SS304	Channel Width :1.20 (m)×SWD :0.70 (m) ×Open Space:6(mm)	2.20	2
9. Fine Screens (Manual)	Bar Screen SS304	Channel Width :1.20 (m)×SWD:0.70 (m) ×Open Space:20(mm)	-	1
10. Belt Conveyor		Belt Width :0.60(m)×Length :8.0 (m)	1.50	1
11. Grit Chambers	Square Horizontal SS304	Width :8.50 (m)×Length :8.50(m)×SWD :0.70 (m)	2.25	1
12. Inlet Weir Gates	Manually Operated Cast Iron	Width 0.90(m)×Height :0.40(m)	-	4
13. Mixers for Anoxic Tank	Submersible Type SUS	Tank Width 10.00(m)×Length :20.50(m) × SWD :10.00 (m)×2unit/tank	5.00	8
14. Diffusers	Fine Bubble Membrane	SOR:186 (kg/h・basin)×setting Depth :5.0(m) ×Efficiency:26%	-	4
15. Air Blowers	Rotary blower Tri-lobe Type	Dia. :250 (mm)× Air Flow :2800(m^3/h) ×Pressure: 65 (K Pa)	90.00	6
16. RAS Pumps	Submersible Cast Iron	Dia.:200 (mm)×Discharge :300(m^3/h)×Total Head:5.0 (m)	15.00	6
17. SAS Pumps	Submersible Cast Iron	Dia.:100 (mm)×Discharge :50(m^3/h)×Total Head:15.0 (m)	7.50	6
18. Hand Operation Chain Block	With Geared Trolley	Rated Load :2.0(Ton)×Lift :13(m)	-	4
19. Final Clarifiers	Tube settler Type	Width :8.00 (m)×Length:30.00(m)×SWD :3.5(m)	-	4
20. Chlorinators	Gas Chlorination System	Dosing Rate :6.0(kg/h)	1.00	2
21. Chlorine Tonners		Volume:928(kg/Unit)	-	5
22. Electric Hoist for Tonners		Rated Load :3.0(Ton)×Lift :6(m)	8.50	1
23. Air Blower For Centrifuge	Rotary blower Tri-lobe Type	Dia. :80 (mm)× Air Flow :360(m^3/h) ×Pressure: 40 (K Pa)	5.50	2

Items	Specification		kW	Pcs/Units
Feed Sump				
24. Centrifuge Feed Pumps	Progressive Cavity Pump, Cast Iron	Dia.:125 (mm)×Discharge :42(m^3/h)×Total Head:20.0 (m)	15.00	3
25. Centrifuges	Centrifuge SS304	Capacity:35(m^3/h)	108.5	3
26. Belt Conveyor		Belt Width :0.60(m)×Length :8.0 (m)	1.50	1
27. Electric Hoist Crane		Rated Load :3.0(Ton)×Lift :6(m)	8.50	1
28. Polyelectrolyte Dosing System	With Agitator SS304	Tank Width: 4.00(m)×Length:4.00(m)×SWD:3.00(m)	11.00	2
29. Polyelectrolyte Dosing Pumps for Centrifuges	Progressive Cavity Pump	Dia.:40 (mm)×Discharge :2.3(m^3/h)×Total Head:20.0 (m)	1.50	3
30. Centrate Transfer Pumps	Submersible Cast Iron	Dia:100 (mm)×Discharge :71(m^3/h)×Total Head:15.0 (m)	7.50	2
(Electrical)				
1. Power receiving facilities at electrical sub-station	HV incoming panel: IP52, 12kV, VCB Power transformers: 11/0.415-0.24 kV,1500 kVA			1pc 1pc
2. LV incoming panel, LV switchgears, and MCCs at electrical sub-station	LV incoming panels: IP52, 600V, ACB 1600A, LV feeder panels: IP52, 600V, MCCBs MCC for IPS and G. Chamber Sewage Pump Starter panels with VFD			2pcs 2pcs 1pc 6pcs
3. LV incoming panel, LV switchgears, and MCCs at blower house	MCCs for Liquid process Air blower starter panels with soft starter RAS Pump starter panels with VFD			2pcs 6pcs 6pcs
4. MCCs at centrifuge house	MCCs for Solid process			1pc
5. Instrumentation devices	Flow meters, level meters, water quality analyzers, etc.,			1ls
6. Local SCADA system	Operator stations, engineering station, SCADA/data servers, PLCs, router, etc.,			1ls

7) Tanajiwadi STP

Items	Specification		kW	Pcs/Units
(Mechanical)				
1. Inlet Gates	Motor Drive Type Cast Iron	Width 0.5(m)×Height :0.75m)	1.50	3
2. Coarse Screens (Mechanical)	Climber Screen SS304	Channel Width :1.00 (m)×SWD :0.50 (m) ×Open Space:20(mm)	1.50	2
3. Coarse Screens (Manual)	Bar Screen SS304	Channel Width :1.00 (m)×SWD:0.50 (m) ×Open Space:50(mm)	-	1
4. Belt Conveyor		Belt Width :0.60(m)×Length :8.0 (m)	1.50	1
5. Sewage Pumps	Submersible Cast Iron	Dia:250 (mm)×Discharge :400(m^3/h)×Total Head:20.0 (m)	55.0	6
6. Electric Hoist		Rated Load :5.0(Ton)×Lift :6(m)	8.50	1
7. Inlet Gates	Manually Operated Cast Iron	Width 0.60(m)×Height :0.90(m)	-	3
8. Fine Screens (Mechanical)	Step Type SS304	Channel Width :1.00 (m)×SWD :0.50 (m) ×Open Space:6(mm)	2.20	2
9. Fine Screens (Manual)	Bar Screen SS304	Channel Width :1.00 (m)×SWD:0.50 (m) ×Open Space:20(mm)	-	1
10. Belt Conveyor		Belt Width :0.60(m)×Length :8.0 (m)	1.50	1
11. Grit Chambers	Square Horizontal SS304	Width :6.00 (m)×Length :6.00(m)×SWD :0.70 (m)	2.25	1
12. Inlet Weir Gates	Manually Operated Cast Iron	Width 1.00(m)×Height :0.40(m)	-	2
13. Mixers for Anoxic Tank	Submersible Type SUS	Tank Width 10.00(m)×Length :22.00(m) × SWD :10.00 (m)×2unit/tank	5.00	4
14. Diffusers	Fine Bubble Membrane	SOR:199 (kg/h・basin)×setting Depth :5.0(m) ×Efficiency:28%	-	2
15. Air Blowers	Rotary blower Tri-lobe Type	Dia. :200 (mm)× Air Flow :1500(m^3/h) ×Pressure: 65 (K Pa)	55.00	6
16. RAS Pumps	Submersible Cast Iron	Dia.:200 (mm)×Discharge :350(m^3/h)×Total Head:5.0 (m)	15.00	3
17. SAS Pumps	Submersible Cast Iron	Dia.:100 (mm)×Discharge :50(m^3/h)×Total Head:15.0 (m)	7.50	3
18. Hand Operation Chain Block	With Geared Trolley	Rated Load :1.0(Ton)×Lift :6(m)	-	2
19. Final Clarifiers	Tube settler Type	Width :8.00 (m)×Length:32.00(m)×SWD :3.5(m)	-	2
20. Chlorinators	Gas Chlorination System	Dosing Rate :4.0(kg/h)	1.00	2
21. Chlorine Tonners		Volume:928(kg/Unit)	-	4
22. Electric Hoist for Tonners		Rated Load :3.0(Ton)×Lift :6(m)	8.50	1
23. Air Blower For Centrifuge	Rotary blower Tri-lobe Type	Dia. :80 (mm)× Air Flow :210(m^3/h) ×Pressure: 40 (K Pa)	5.50	2

Items	Specification		kW	Pcs/Units
Feed Sump				
24. Centrifuge Feed Pumps	Progressive Cavity Pump, Cast Iron	Dia.:125 (mm)×Discharge :24(m^3/h)×Total Head:20.0 (m)	7.50	3
25. Centrifuges	Centrifuge SS304	Capacity:20(m^3/h)	44.5	3
26. Belt Conveyor		Belt Width :0.60(m)×Length :8.0 (m)	1.50	1
27. Electric Hoist Crane		Rated Load :3.0(Ton)×Lift :6(m)	8.50	1
28. Polyelectrolyte Dosing System	With Agitator SS304	Tank Width: 3.00(m)×Length:4.00(m)×SWD:2.00(m)	5.50	2
29. Polyelectrolyte Dosing Pumps for Centrifuges	Progressive Cavity Pump	Dia.:40 (mm)×Discharge :1.3(m^3/h)×Total Head:20.0 (m)	0.75	3
30. Centrate Transfer Pumps	Submersible Cast Iron	Dia:100 (mm)×Discharge :38(m^3/h)×Total Head:15.0 (m)	3.70	2
(Electrical)				
7. Power receiving facilities at electrical sub-station	HV incoming panel: IP52, 12kV, VCB Power transformers: 11/0.415-0.24 kV,1000 kVA			1pc 1pc
8. LV incoming panel, LV switchgears, and MCCs at electrical sub-station	LV incoming panels: IP52, 600V, ACB 1600A, LV feeder panels: IP52, 600V, MCCBs MCC for IPS and G. Chamber			2pcs 2pcs 1pc
9. LV incoming panel, LV switchgears, and MCCs at blower house	MCCs for Liquid process Air blower starter panels with soft starter RAS Pump starter panels with VFD			2pcs 6pcs 3pcs
10. MCCs at centrifuge house	MCCs for Solid process			1pc
11. Instrumentation devices	Flow meters, level meters, water quality analyzers, etc.,			1ls
12. Local SCADA system	Operator stations, engineering station, SCADA/data servers, PLCs, router, etc.,			1ls

8) Botanical Garden STP

Items	Specification		kW	Pcs/Units
(Mechanical)				
1. Inlet Gates	Motor Drive Type Cast Iron	Width 0.4(m)×Height :0.6m)	1.50	3
2. Coarse Screens (Mechanical)	Climber Screen SS304	Channel Width :0.70 (m)×SWD :0.50 (m) ×Open Space:20(mm)	1.50	2
3. Coarse Screens (Manual)	Bar Screen SS304	Channel Width :0.70 (m)×SWD:0.50 (m) ×Open Space:50(mm)	-	1
4. Belt Conveyor		Belt Width :0.60(m)×Length :8.0 (m)	1.50	1
5. Sewage Pumps	Submersible Cast Iron	Dia:250 (mm)×Discharge :450(m^3/h)×Total Head:20.0 (m)	55.0	3
6. Electric Hoist		Rated Load :5.0(Ton)×Lift :6(m)	8.50	1
7. Inlet Gates	Manually Operated Cast Iron	Width 0.40(m)×Height :0.60(m)	-	3
8. Fine Screens (Mechanical)	Step Type SS304	Channel Width :0.70 (m)×SWD :0.50 (m) ×Open Space:6(mm)	2.20	2
9. Fine Screens (Manual)	Bar Screen SS304	Channel Width :0.70 (m)×SWD:0.50 (m) ×Open Space:20(mm)	-	1
10. Belt Conveyor		Belt Width :0.60(m)×Length :8.0 (m)	1.50	1
11. Grit Chambers	Square Horizontal SS304	Width :5.00 (m)×Length :5.00(m)×SWD :0.50 (m)	2.25	1
12. Inlet Weir Gates	Manually Operated Cast Iron	Width 0.60(m)×Height :0.40(m)	-	2
13. Mixers for Anoxic Tank	Submersible Type SUS	Tank Width 10.00(m)×Length :26.00(m) × SWD :5.50 (m)×2unit/tank	5.00	4
14. Diffusers	Fine Bubble Membrane	SOR:133 (kg/h・basin)×setting Depth :5.0(m) ×Efficiency:28 %	-	2
15. Air Blowers	Rotary blower Tri-lobe Type	Dia. :200 (mm)× Air Flow :1900(m^3/h) ×Pressure: 65 (K Pa)	55.0	3
16. RAS Pumps	Submersible Cast Iron	Dia.:150 (mm)×Discharge :210(m^3/h)×Total Head:5.0 (m)	11.00	3
17. SAS Pumps	Submersible Cast Iron	Dia.:100 (mm)×Discharge :35(m^3/h)×Total Head:15.0 (m)	5.50	3
18. Hand Operation Chain Block	With Geared Trolley	Rated Load :1.0(Ton)×Lift :6(m)	-	1
19. Final Clarifiers	Central turn table Type, MS epoxy coating	Dia. :21.00 (m)×SWD :3.5(m)	2.20	2
20. Chlorinators	Gas Chlorination System	Dosing Rate :2.5(kg/h)	1.00	2
21. Chlorine Tonners		Volume:928(kg/Unit)	-	3
22. Electric Hoist for Tonners		Rated Load :3.0(Ton)×Lift :6(m)	8.50	1
23. Air Blower For Centrifuge	Rotary blower Tri-lobe Type	Dia. :65 (mm)× Air Flow :110(m^3/h) ×Pressure: 40 (K Pa)	3.70	2

Items	Specification		kW	Pcs/Units
Feed Sump				
24. Centrifuge Feed Pumps	Progressive Cavity Pump, Cast Iron	Dia.:125 (mm)×Discharge :36(m^3/h)×Total Head:20.0 (m)	7.50	3
25. Centrifuges	Centrifuge SS304	Capacity:25(m^3/h)	44.5	2
26. Electric Hoist Crane		Rated Load :3.0(Ton)×Lift :6(m)	8.50	1
27. Polyelectrolyte Dosing System	With Agitator SS304	Tank Width: 2.50(m)×Length:3.00(m)×SWD:2.00(m)	3.70	2
28. Polyelectrolyte Dosing Pumps for Centrifuges	Progressive Cavity Pump	Dia.:40 (mm)×Discharge :1.6(m^3/h)×Total Head:20.0 (m)	0.75	3
29. Centrate Transfer Pumps	Submersible Cast Iron	Dia:100 (mm)×Discharge :26(m^3/h)×Total Head:15.0 (m)	3.7	2
(Electrical)				
7. Power receiving facilities at electrical substation	HV incoming panel: IP52, 12kV, VCB Power transformers: 11/0.415-0.24 kV,630 kVA			1pc 1pc
8. LV incoming panel, LV switchgears, and MCCs at electrical substation	LV incoming panels: IP52, 600V, ACB 1250A,630A LV feeder panels: IP52, 600V, MCCBs MCC for IPS and G. Chamber Sewage Pump Starter panels with VFD			2pcs 2pcs 1pc 3pcs
9. LV incoming panel, LV switchgears, and MCCs at blower house	MCCs for Liquid process Air blower starter panels with soft starter RAS Pump starter panels with VFD			2pcs 3pcs 3pcs
10. MCCs at centrifuge house	MCCs for Solid process			1pc
11. Instrumentation devices	Flow meters, level meters, water quality analyzers, etc.,			1ls
12. Local SCADA system	Operator stations, engineering station, SCADA/data servers, PLCs, router, etc.,			1ls

9) Baner STP

Items	Specification		kW	Pcs/Units
(Mechanical)				
1. Sewage Pumps	Submersible Cast Iron	Dia:300 (mm)×Discharge :600(m^3/h)×Total Head:20.0 (m)	75.0	6
2. Inlet Gates	Manually Operated Cast Iron	Width 0.6(m)×Height :0.9(m)	-	3
3. Fine Screens (Mechanical)	Step Type SS304	Channel Width :1.20(m)×SWD :0.70 (m) ×Open Space:6(mm)	2.20	2
4. Fine Screen (Manual)	Bar Screen SS304	Channel Width :1.20(m)×SWD :0.70 (m) ×Open Space:20(mm)	-	1
5. Belt Conveyor		Belt Width :0.60(m)×Length :8.0 (m)	1.50	1
6. Inlet Gates	Motor Drive Type Cast Iron	Width 0.4(m)×Height :0.4(m)	0.40	4
7. Decanters	Moving Weir Type SS304	SBR Tank Width :27.50 (m)×Length :30(m)×SWD :5.5(m)	2.20	4
8. Diffusers	Fine Bubble Membrane	SOR:335 (kg/h・basin)×setting Depth :5.0(m) ×Efficiency:28 %	-	4
9. Air Blowers	Rotary blower Tri-lobe Type	Dia. :200 (mm)× Air Flow :2300(m^3/h) ×Pressure: 65 (K Pa)	75.0	6
10. Circulation Pumps	Submersible Cast Iron	Dia. :250 (mm)×Discharge:550(m^3/h)×Total Head:5.0 (m)	22.00	8
11. SAS Pumps	Submersible Cast Iron	Dia.:100 (mm)×Discharge :70(m^3/h)×Total Head:15.0 (m)	11.00	8
12. Hand Operation Chain Block	With Geared Trolley	Rated Load :1.0(Ton)×Lift :6(m)	-	4
13. Chlorinators	Gas Chlorination System	Dosing Rate :6.0(kg/h)	1.00	2
14. Chlorine Tonners		Volume:928(kg/Unit)	-	4
15. Electric Hoist for Tonners		Rated Load :3.0(Ton)×Lift :6(m)	8.50	1
16. Air Blowers For Centrifuge Feed Sump	Rotary blower Tri-lobe Type	Dia. :100 (mm)× Air Flow:310(m^3/h) ×Pressure: 40 (K Pa)	7.50	2
17. Centrifuge Feed Pumps	Progressive Cavity Pump, Cast Iron	Dia.:125 (mm)×Discharge :36(m^3/h)×Total Head:20.0 (m)	11.00	3
18. Centrifuges	Centrifuge SS304	Capacity:30(m^3/h)	90.00	3
19. Belt Conveyor		Belt Width :0.60(m)×Length :8.0 (m)	1.50	1
20. Electric Hoist Crane		Rated Load :3.0(Ton)×Lift :15(m)	8.50	1
21. Polyelectrolyte Dosing System	With Agitator SS304	Tank Width: 3.5(m)×Length:4.0(m)×SWD:3.0(m)	11.00	2
22. Polyelectrolyte Dosing Pumps	Progressive Cavity Pump	Dia.:40 (mm)×Discharge :2.1(m^3/h)×Total Head:20.0 (m)	0.75	3
23. Centrate Transfer Pumps	Submersible Cast Iron	Dia:100 (mm)×Discharge :61(m^3/h)×Total Head:15.0 (m)	7.50	2

Items	Specification	kW	Pcs/Units
(Electrical)			
7. Power receiving facilities at electrical sub-station	HV incoming panel: IP52, 12kV, VCB Power transformers: 11/0.415-0.24 kV,1500 kVA		1pc 1pc
8. LV incoming panel, LV switchgears, and MCCs at electrical sub-station	LV incoming panels: IP52, 600V, ACB 1600A, LV feeder panels: IP52, 600V, MCCBs MCC for IPS and G. Chamber Sewage Pump starter panels with VFD		2pcs 2pcs 1pc 6pcs
9. LV incoming panel, LV switchgears, and MCCs at blower house	MCCs for Liquid process Air blower starter panels with VFD Circulation pump starter panel with VFD		2pcs 6pcs 8pcs
10. MCCs at centrifuge house	MCCs for Solid process		1pc
11. Instrumentation devices	Flow meters, level meters, water quality analyzers, etc.,		1ls
12. Local SCADA system	Operator stations, engineering station, SCADA/data servers, PLCs, router, etc.,		1ls

10) Dhanori STP

Items	Specification		kW	Pcs/Units
(Mechanical)				
1. Inlet Gates	Motor Drive Type Cast Iron	Width 0.6(m)×Height :0.9m)	1.50	3
2. Coarse Screens (Mechanical)	Climber Screen SS304	Channel Width :1.40 (m)×SWD :0.70 (m) ×Open Space:20(mm)	1.50	2
3. Coarse Screens (Manual)	Bar Screen SS304	Channel Width :1.40 (m)×SWD:0.70 (m) ×Open Space:50(mm)	-	1
4. Belt Conveyor		Belt Width :0.60(m)×Length :8.0 (m)	1.50	1
5. Sewage Pumps	Submersible Cast Iron	Dia:300 (mm)×Discharge :800(m^3/h)×Total Head:15.0 (m)	75.0	6
6. Electric Hoist		Rated Load :5.0(Ton)×Lift :6(m)	8.50	1
7. Inlet Gates	Manually Operated Cast Iron	Width 0.60(m)×Height :0.90(m)	-	3
8. Fine Screens (Mechanical)	Step Type SS304	Channel Width :1.40 (m)×SWD :0.70 (m) ×Open Space:6(mm)	2.20	2
9. Fine Screens (Manual)	Bar Screen SS304	Channel Width :1.40 (m)×SWD:0.70 (m) ×Open Space:20(mm)	-	1
10. Belt Conveyor		Belt Width :0.60(m)×Length :8.0 (m)	1.50	1
11. Grit Chambers	Square Horizontal SS304	Width :9.00 (m)×Length :9.00(m)×SWD :0.70 (m)	2.25	1
12. Inlet Weir Gates	Manually Operated Cast Iron	Width 1.00(m)×Height :0.40(m)	-	4
13. Mixers for Anoxic Tank	Submersible Type SUS	Tank Width 10.00(m)×Length :23.50(m) × SWD :10.00 (m)×3unit/tank	5.00	12
14. Diffusers	Fine Bubble Membrane	SOR:220(kg/h・basin)×setting Depth :5.0(m) ×Efficiency:26%	-	4
15. Air Blowers	Rotary blower Tri-lobe Type	Dia. :250 (mm)× Air Flow :3300(m^3/h) ×Pressure: 65 (K Pa)	90.00	6
16. RAS Pumps	Submersible Cast Iron	Dia.:200 (mm)×Discharge :350(m^3/h)×Total Head:5.0 (m)	15.00	6
17. SAS Pumps	Submersible Cast Iron	Dia.:100 (mm)×Discharge :60(m^3/h)×Total Head:15.0 (m)	7.50	6
18. Hand Operation Chain Block	With Geared Trolley	Rated Load :1.0(Ton)×Lift :6(m)	-	4
19. Final Clarifiers	Tube settler Type	Width :8.50 (m)×Length:34.00(m)×SWD :3.5(m)	-	4
20. Chlorinators	Gas Chlorination System	Dosing Rate :7.0(kg/h)	1.00	2
21. Chlorine Tonners		Volume:928(kg/Unit)	-	5
22. Electric Hoist for Tonners		Rated Load :3.0(Ton)×Lift :6(m)	8.50	1
23. Air Blower For Centrifuge	Rotary blower Tri-lobe Type	Dia. :100 (mm)× Air Flow :420(m^3/h) ×Pressure: 40 (K Pa)	5.50	2

Items	Specification		kW	Pcs/Units
Feed Sump				
24. Centrifuge Feed Pumps	Progressive Cavity Pump, Cast Iron	Dia.:125 (mm)×Discharge :48(m^3/h)×Total Head:20.0 (m)	15.00	3
25. Centrifuges	Centrifuge SS304	Capacity:40(m^3/h)	108.5	3
26. Belt Conveyor		Belt Width :0.60(m)×Length :8.0 (m)	1.50	1
27. Electric Hoist Crane		Rated Load :3.0(Ton)×Lift :6(m)	8.50	1
28. Polyelectrolyte Dosing System	With Agitator SS304	Tank Width: 4.00(m)×Length:4.50(m)×SWD:3.00(m)	11.00	2
29. Polyelectrolyte Dosing Pumps for Centrifuges	Progressive Cavity Pump	Dia.:40 (mm)×Discharge :2.7(m^3/h)×Total Head:20.0 (m)	0.75	3
30. Centrate Transfer Pumps	Submersible Cast Iron	Dia:100 (mm)×Discharge :84(m^3/h)×Total Head:15.0 (m)	11.0	2
(Electrical)				
1. Power receiving facilities at electrical sub-station	HV incoming panel: IP52, 12kV, VCB Power transformers: 11/0.415-0.24 kV,1500 kVA			1pc 1pc
2. LV incoming panel, LV switchgears, and MCCs at electrical sub-station	LV incoming panels: IP52, 600V, ACB 1600A, LV feeder panels: IP52, 600V, MCCBs MCC for IPS and G. Chamber Sewage Pump Starter panels with VFD			2pcs 2pcs 1pc 6pcs
3. LV incoming panel, LV switchgears, and MCCs at blower house	MCCs for Liquid process Air blower starter panels with soft starter RAS Pump starter panels with VFD			2pcs 6pcs 6pcs
4. MCCs at centrifuge house	MCCs for Solid process			1pc
5. Instrumentation devices	Flow meters, level meters, water quality analyzers, etc.,			1ls
6. Local SCADA system	Operator stations, engineering station, SCADA/data servers, PLCs, router, etc.,			1ls

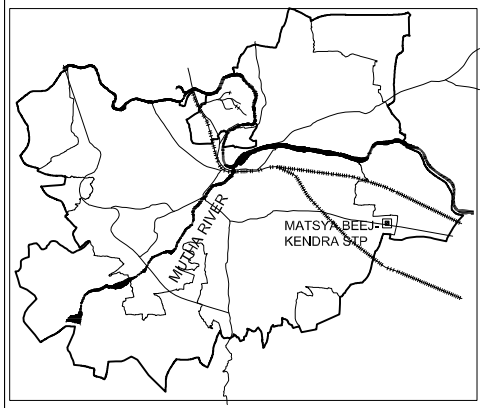
11) Kharadi STP

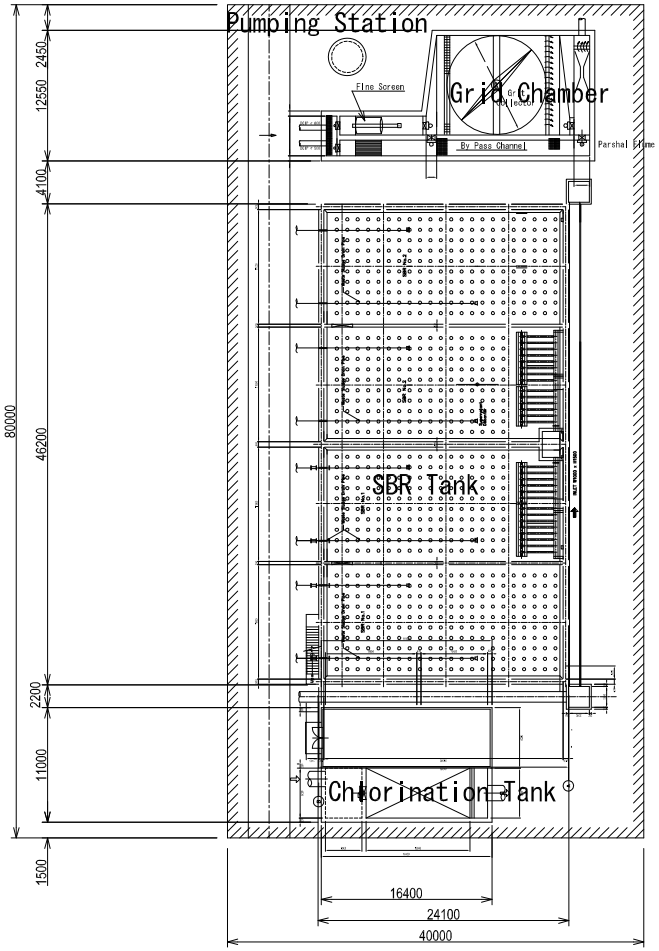
Items	Specification		kW	Pcs/Units
(Mechanical)				
1. Inlet Gates	Motor Drive Type Cast Iron	Width 0.6(m)×Height :0.9(m)	1.5	3
2. Coarse Screens (Mechanical)	Climber Screen SS304	Channel Width :1.40(m)×SWD :0.70 (m) ×Open Space:20(mm)	2.20	2
3. Coarse Screen (Manual)	Bar Screen SS304	Channel Width :1.40(m)×SWD :0.70 (m) ×Open Space:50(mm)	-	1
4. Belt Conveyor		Belt Width :0.60(m)×Length :8.0 (m)	1.50	1
5. Sewage Pumps	Submersible Cast Iron	Dia:300 (mm)×Discharge :700(m^3/h)×Total Head:20.0 (m)	75.0	6
6. Electric Hoist		Rated Load :3.0(Ton)×Lift :15(m)	8.50	1
7. Inlet Gates	Manually Operated Cast Iron	Width 0.6(m)×Height :0.9(m)	-	3
8. Fine Screens (Mechanical)	Step Type SS304	Channel Width :1.40(m)×SWD :0.70 (m) ×Open Space:6(mm)	2.20	2
9. Fine Screen (Manual)	Bar Screen SS304	Channel Width :1.40(m)×SWD :0.70 (m) ×Open Space:20(mm)	-	1
10. Belt Conveyor		Belt Width :0.60(m)×Length :8.0 (m)	1.50	1
11. Inlet Gates	Motor Drive Type Cast Iron	Width 0.5(m)×Height :0.5(m)	0.40	4
12. Decanters	Moving Weir Type SS304	SBR Tank Width :30.00 (m) × Length :33.00(m) × SWD :5.5(m)	2.20	4
13. Diffusers	Fine Bubble Membrane	SOR:402 (kg/h・basin)×setting Depth :5.0(m) ×Efficiency:28 %	-	4
14. Air Blowers	Rotary blower Tri-lobe Type	Dia. :200 (mm)× Air Flow :2800(m^3/h) ×Pressure: 65 (K Pa)	90.0	6
15. Circulation Pumps	Submersible Cast Iron	Dia. :300 (mm)×Discharge:650(m^3/h)×Total Head:5.0 (m)	30.00	8
16. SAS Pumps	Submersible Cast Iron	Dia.:100 (mm)×Discharge :75(m^3/h)×Total Head:15.0 (m)	11.00	8
17. Hand Operation Chain Block	With Geared Trolley	Rated Load :1.0(Ton)×Lift :6(m)	-	4
18. Chlorinators	Gas Chlorination System	Dosing Rate :7.0(kg/h)	1.00	2
19. Chlorine Tonners		Volume:928(kg/Unit)	-	5
20. Electric Hoist for Tonners		Rated Load :3.0(Ton)×Lift :6(m)	8.50	1
21. Air Blowers For Centrifuge Feed Sump	Rotary blower Tri-lobe Type	Dia. :100 (mm)× Air Flow:360(m^3/h) ×Pressure: 40 (K Pa)	7.50	2
22. Centrifuge Feed Pumps	Progressive Cavity Pump, Cast Iron	Dia.:125 (mm)×Discharge :42(m^3/h)×Total Head:20.0 (m)	15.00	3
23. Centrifuges	Centrifuge SS304	Capacity:35(m^3/h)	108.5	3

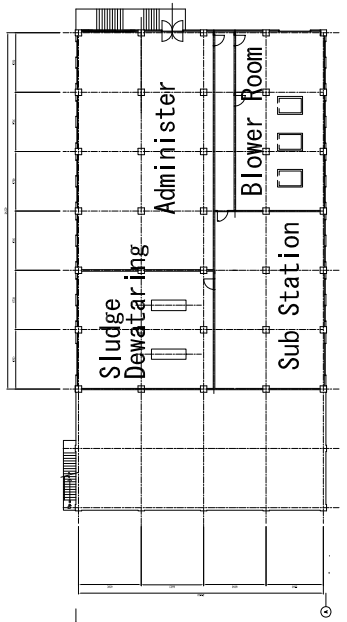
Items	Specification	kW	Pcs/Units
24. Belt Conveyor	Belt Width :0.60(m)×Length :8.0 (m)	1.50	1
25. Electric Hoist Crane	Rated Load :3.0(Ton)×Lift :15(m)	8.50	1
26. Polyelectrolyte Dosing System	With Agitator SS304 Tank Width:4.0(m)×Length:4.5(m)×SWD:3.0(m)	11.00	2
27. Polyelectrolyte Dosing Pumps	Progressive Cavity Pump Dia.:40 (mm)×Discharge :2.4(m^3/h)×Total Head:20.0 (m)	1.50	3
28. Centrate Transfer Pumps	Submersible Cast Iron Dia:100 (mm)×Discharge :76(m^3/h)×Total Head:15.0 (m)	7.50	2
(Electrical)			
13. Power receiving facilities at electrical sub-station	HV incoming panel: IP52, 12kV, VCB Power transformers: 11/0.415-0.24 kV,1500 kVA		1pc 1pc
14. LV incoming panel, LV switchgears, and MCCs at electrical sub-station	LV incoming panels: IP52, 600V, ACB 3200A,1600A LV feeder panels: IP52, 600V, MCCBs MCC for IPS and G. Chamber Sewage Pump starter panels with VFD		2pcs 2pcs 1pc 6pcs
15. LV incoming panel, LV switchgears, and MCCs at blower house	MCCs for Liquid process Air blower starter panels with VFD Circulation pump starter panel with VFD		2pcs 6pcs 8pcs
16. MCCs at centrifuge house	MCCs for Solid process		1pc
17. Instrumentation devices	Flow meters, level meters, water quality analyzers, etc.,		1ls
18. Local SCADA system	Operator stations, engineering station, SCADA/data servers, PLCs, router, etc.,		1ls

GENERAL LAYOUT PLAN OF MATSYA BEEJ KENDRA

LOCATION MAP







Aeration Tank Upper Floor

OUTLINE OF STP	
NAME OF STP	MATSYA BEEJ KENDRA STP
DESIGN CAPACITY	7 MLD
TREATMENT METHOD	SBR PROCESS
TARGET TREATMENT WATER QUALITY	BOD < 10 mg/l TSS < 10 mg/l TN < 10 mg/l TP < 2 mg/l

LEGEND	
	LAND BOUNDARY

0 50 100m

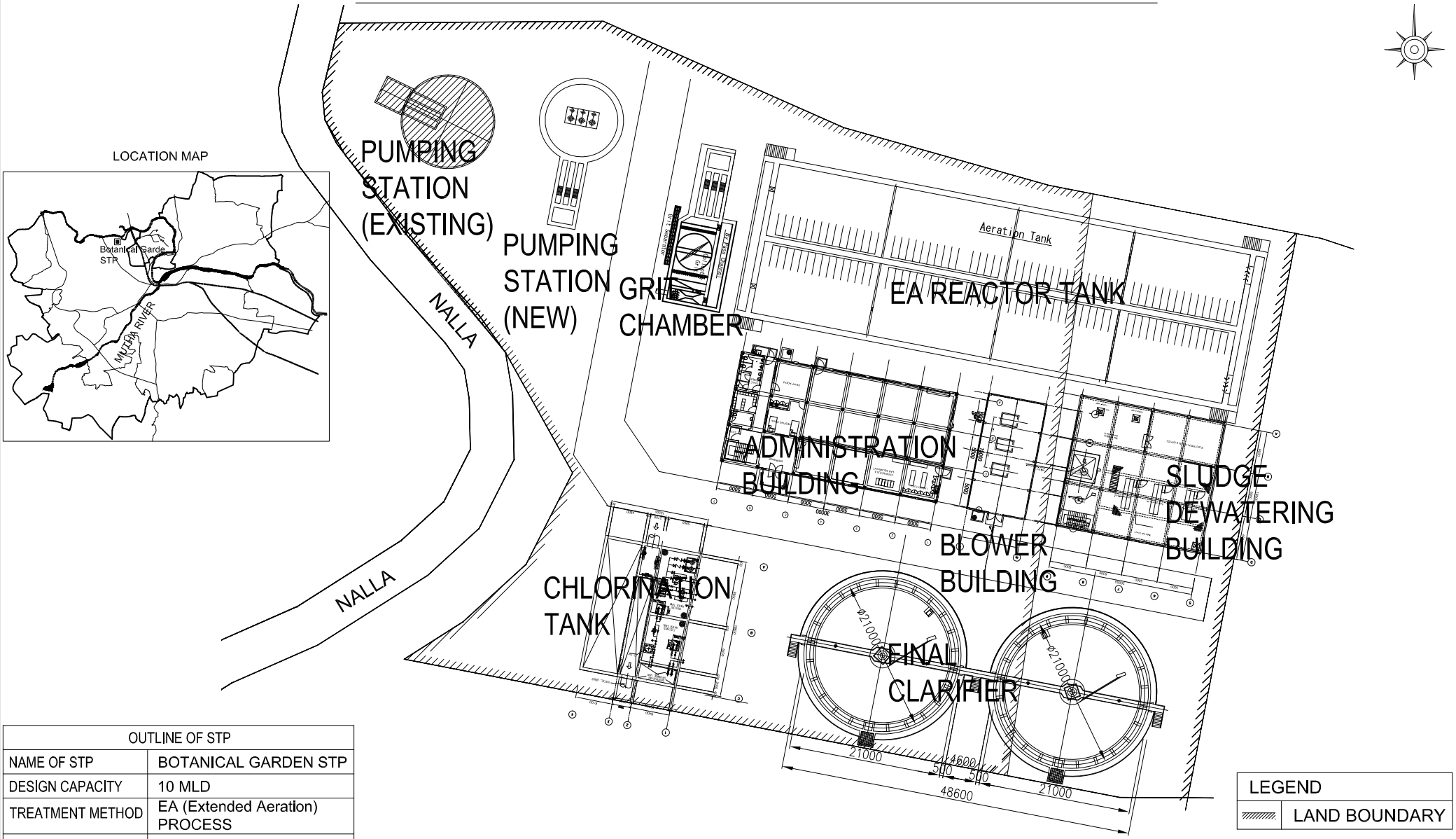
Project Name
The Preparatory Survey on Project for
'POLLUTION ABATEMENT OF RIVER MULA-MUTHA IN PUNE'
インド国プネ市ムラ・ムタ川汚染緩和事業準備調査

Drawing Title
MATSYA BEEJ KENDRA STP
GENERAL LAYOUT PLAN

Scale: 1:500

Drawing No. STP-xx

GENERAL LAYOUT PLAN OF BOTANICAL GARDEN STP



OUTLINE OF STP	
NAME OF STP	BOTANICAL GARDEN STP
DESIGN CAPACITY	10 MLD
TREATMENT METHOD	EA (Extended Aeration) PROCESS
TARGET TREATMENT WATER QUALITY	BOD < 10 mg/l TSS < 10 mg/l TN < 10 mg/l TP < 2 mg/l

LEGEND	
	LAND BOUNDARY

Project Name
The Preparatory Survey on Project for
'POLLUTION ABATEMENT OF RIVER MULA-MUTHA IN PUNE'
インド国プネ市ムラ・ムタ川汚染緩和事業準備調査

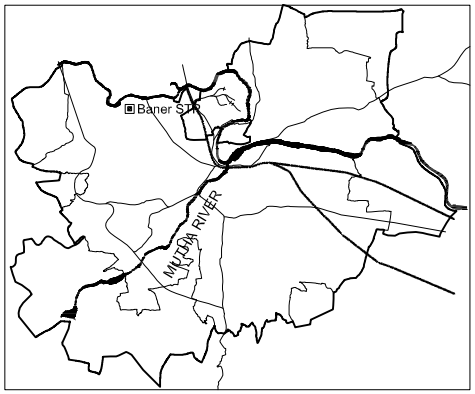
Drawing Title
BOTANICAL GARDEN STP

Scale: 1:500

Drawing No. STP-xx

GENERAL LAYOUT PLAN OF BANER STP

LOCATION MAP



OUTLINE OF STP	
NAME OF STP	BANER STP
DESIGN CAPACITY	25 MLD
TREATMENT METHOD	SBR PROCESS
TARGET TREATMENT WATER QUALITY	BOD < 10 mg/l TSS < 10 mg/l TN < 10 mg/l TP < 2 mg/l

LEGEND	
	LAND BOUNDARY

Project Name

The Preparatory Survey on Project for
'POLLUTION ABATEMENT OF RIVER MULA-MUTHA IN PUNE'
インド国プネ市ムラ・ムタ川汚染緩和事業準備調査

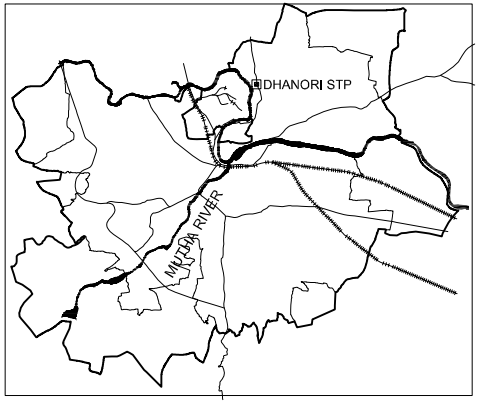
Drawing Title

BANER STP GENERAL LAYOUT PLAN

Scale: 1:1,000

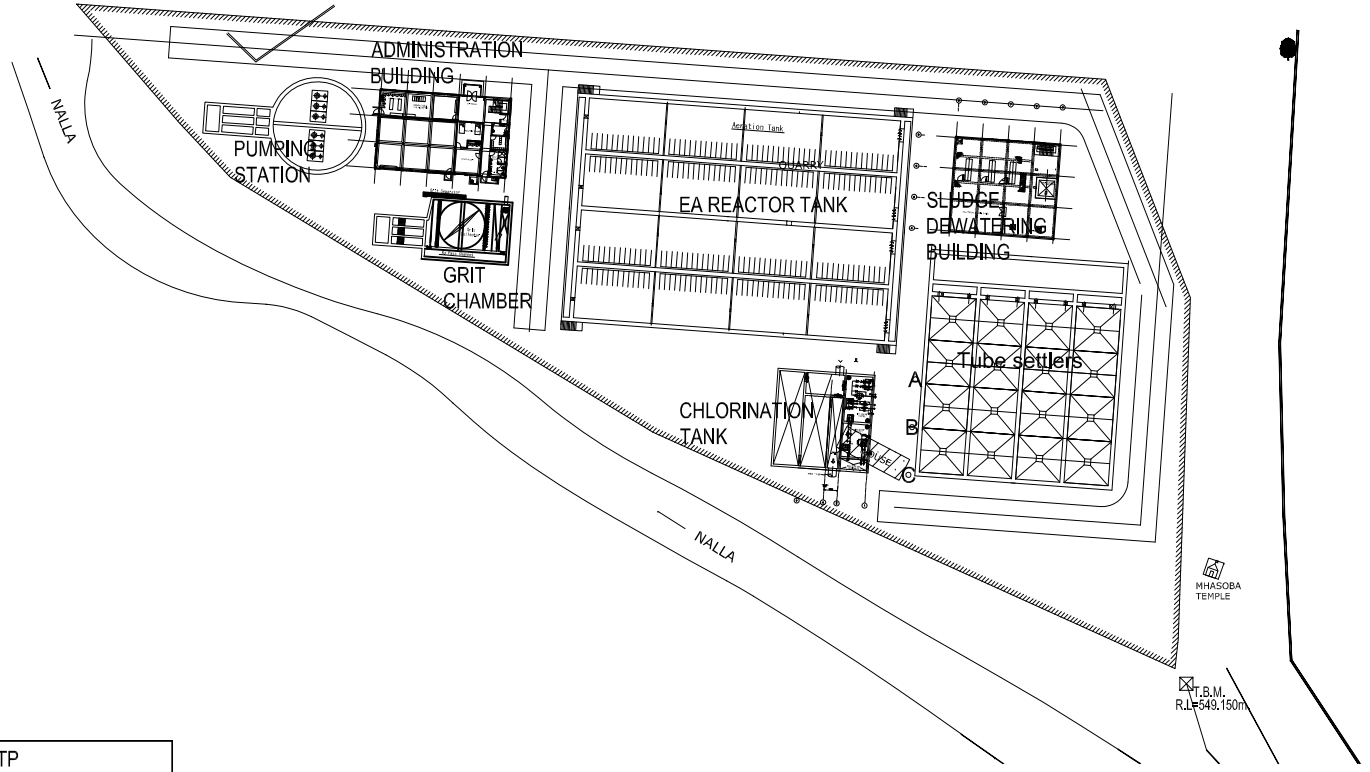
Drawing No. STP-xx

LOCATION MAP



GENERAL LAYOUT PLAN OF DHANORI STP

N



OUTLINE OF STP	
NAME OF STP	DHANORI STP
DESIGN CAPACITY	33 MLD
TREATMENT METHOD	EA (Extended Aeration) PROCESS
TARGET TREATMENT WATER QUALITY	BOD < 10 mg/l TSS < 10 mg/l TN < 10 mg/l TP < 2 mg/l

0 50 100m

LEGEND	
	LAND BOUNDARY

Project Name

The Preparatory Survey on Project for
'POLLUTION ABATEMENT OF RIVER MULA-MUTHA IN PUNE'
インド国プネ市ムラ・ムタ川汚染緩和事業準備調査

Drawing Title

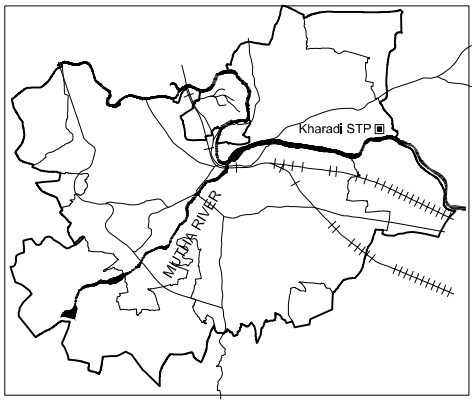
DHANORI STP GENERAL LAYOUT PLAN

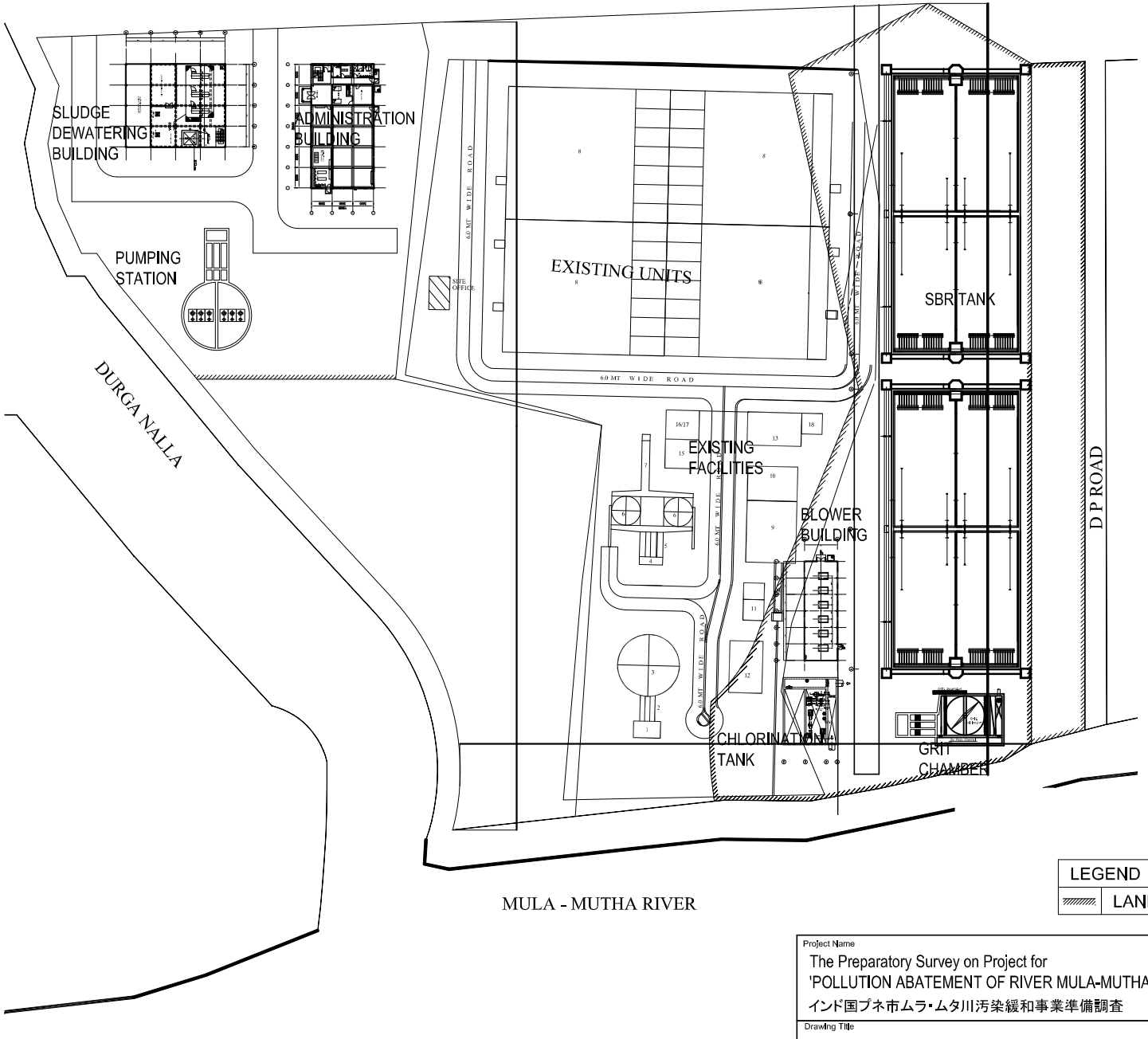
Scale: 1:1,000

Drawing No. STP-xx

GENERAL LAYOUT PLAN OF KHARADI STP

LOCATION MAP





N

LEGEND	
	LAND BOUNDARY

OUTLINE OF STP	
NAME OF STP	KHARADI STP
DESIGN CAPACITY	30 MLD
TREATMENT METHOD	SBR PROCESS
TARGET TREATMENT WATER QUALITY	BOD < 10 mg/l TSS < 10 mg/l TN < 10 mg/l TP < 2 mg/l

Project Name
The Preparatory Survey on Project for
'POLLUTION ABATEMENT OF RIVER MULA-MUTHA IN PUNE'
インド国プネ市ムラ・ムタ川汚染緩和事業準備調査

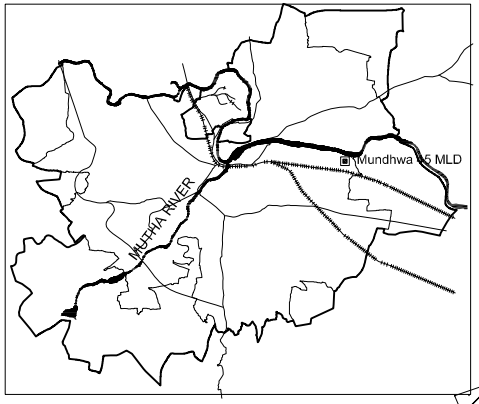
Drawing Title
KHARADI STP GENERAL LAYOUT PLAN

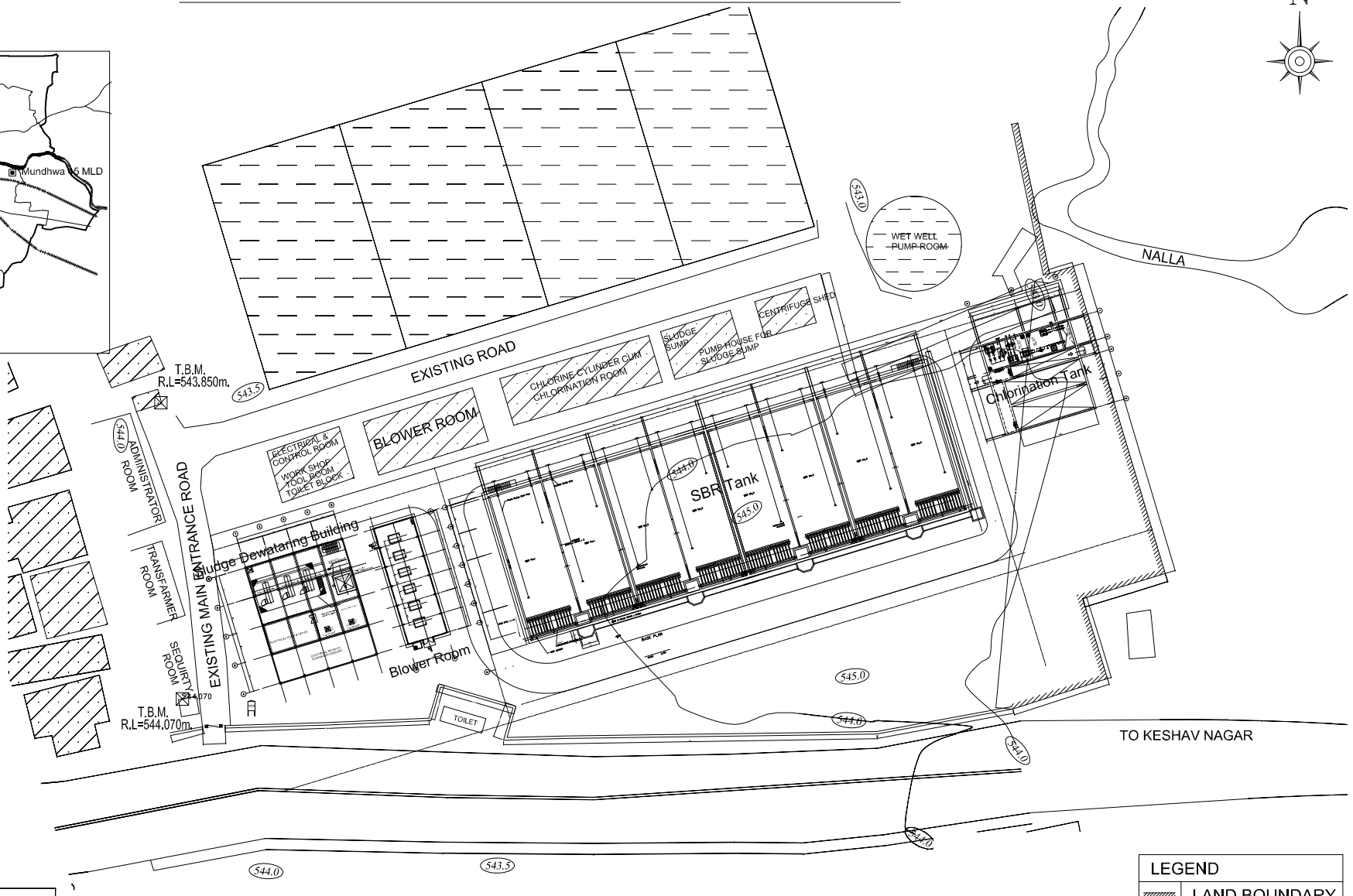
Scale: 1:1,000

Drawing No. STP-xx

GENERAL LAYOUT PLAN OF MUNDHWA STP

LOCATION MAP





LEGEND	
	LAND BOUNDARY

OUTLINE OF STP	
NAME OF STP	MUNDHWA STP
DESIGN CAPACITY	20 MLD
TREATMENT METHOD	SBR PROCESS
TARGET TREATMENT WATER QUALITY	BOD < 10 mg/l TSS < 10 mg/l TN < 10 mg/l TP < 2 mg/l

Project Name

The Preparatory Survey on Project for
'POLLUTION ABATEMENT OF RIVER MULA-MUTHA IN PUNE'
インド国プネ市ムラ・ムタ川汚染緩和事業準備調査

Drawing Title

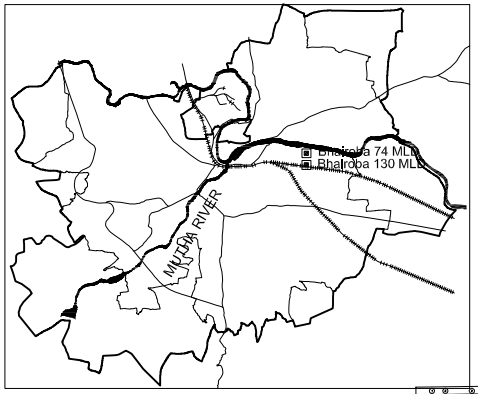
MUNDHWA STP GENERAL LAYOUT PLAN

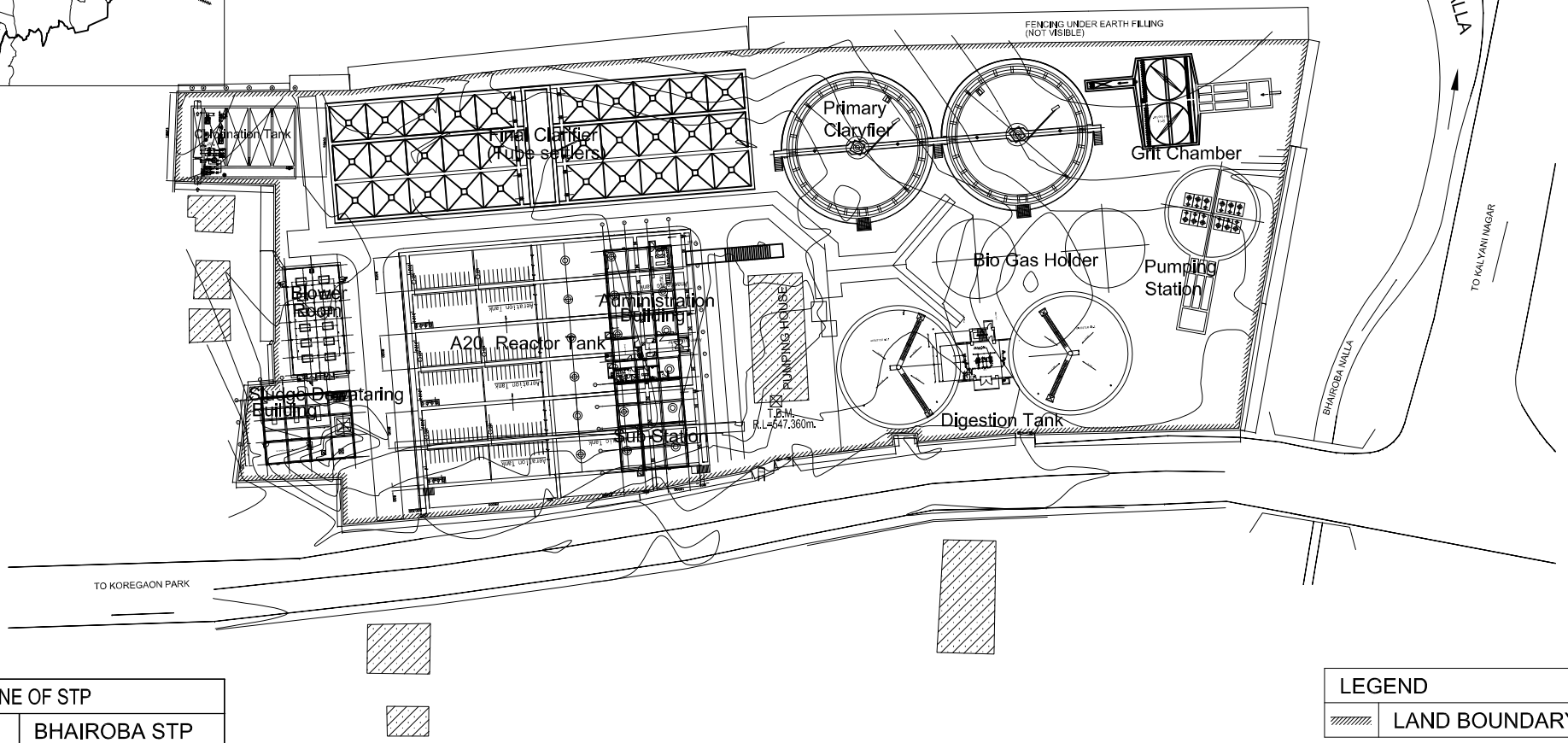
Scale: 1:800

Drawing No. STP-xx

GENERAL LAYOUT PLAN OF BHAIROBA STP

LOCATION MAP





OUTLINE OF STP	
NAME OF STP	BHAIROBA STP
DESIGN CAPACITY	75 MLD
TREATMENT METHOD	A20 PROCESS
TARGET TREATMENT WATER QUALITY	BOD < 10 mg/l TSS < 10 mg/l TN < 10 mg/l TP < 2 mg/l

0 50 100m

LEGEND	
	LAND BOUNDARY

Project Name
The Preparatory Survey on Project for
'POLLUTION ABATEMENT OF RIVER MULA-MUTHA IN PUNE'
インド国プネ市ムラ・ムタ川汚染緩和事業準備調査

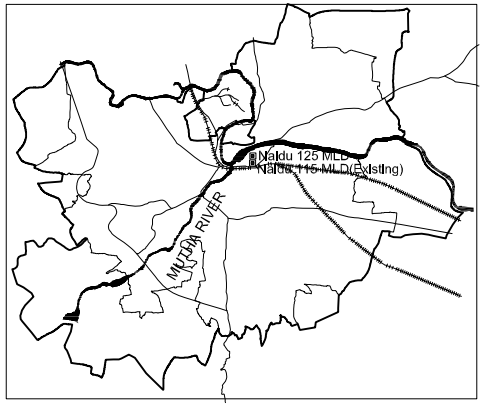
Drawing Title
BHAIROBA STP GENERAL LAYOUT PLAN

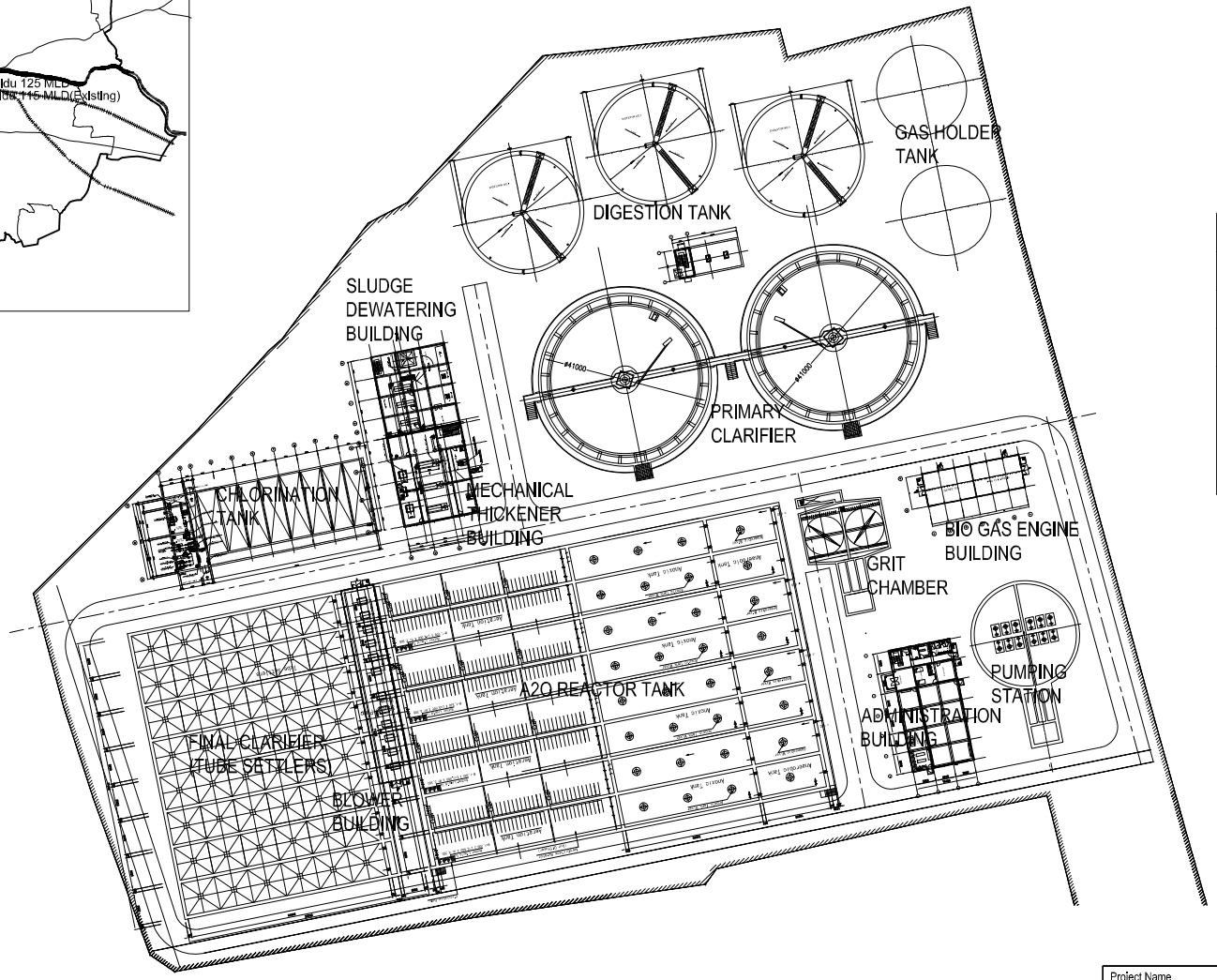
Scale: 1:200

Drawing No. STP-xx

GENERAL LAYOUT PLAN OF NAIDU STP

LOCATION MAP





OUTLINE OF STP	
NAME OF STP	NAIDU STP
DESIGN CAPACITY	127 MLD
TREATMENT METHOD	A2O PROCESS
TARGET TREATMENT WATER QUALITY	BOD < 10 mg/l TSS < 10 mg/l TN < 10 mg/l TP < 2 mg/l

LEGEND	
	LAND BOUNDARY

0 50 100m

Project Name
The Preparatory Survey on Project for
'POLLUTION ABATEMENT OF RIVER MULA-MUTHA IN PUNE'
インド国プネ市ムラ・ムタ川汚染緩和事業準備調査

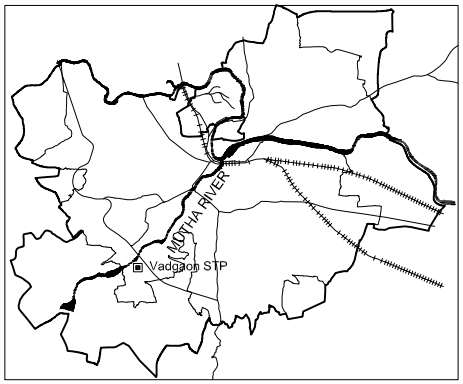
Drawing Title
NAIDU STP GENERAL LAYOUT PLAN

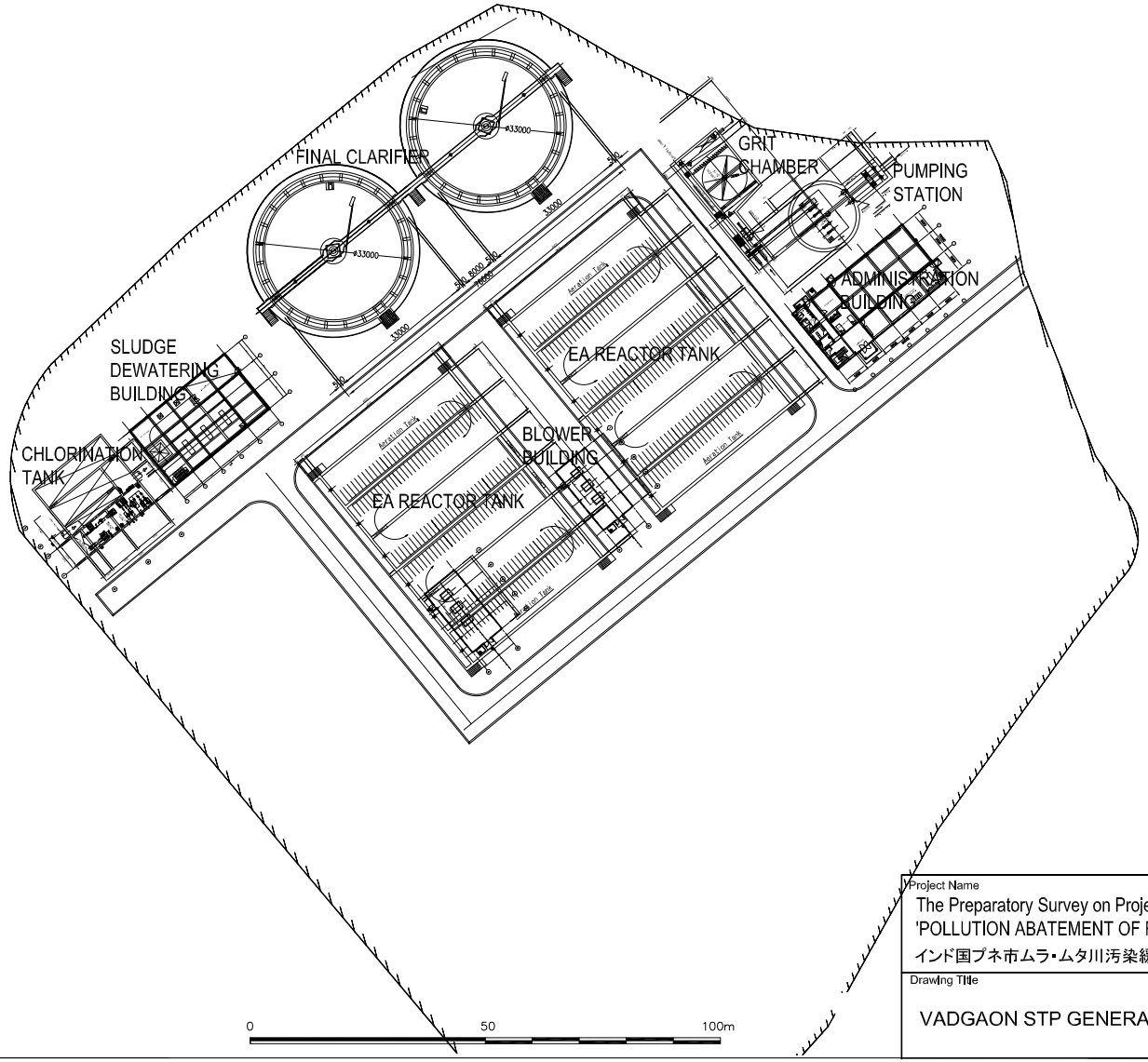
Scale: 1:1,200

Drawing No. STP-xx

GENERAL LAYOUT PLAN OF VADGAON STP

LOCATION MAP





OUTLINE OF STP	
NAME OF STP	VADGAON STP
DESIGN CAPACITY	26 MLD
TREATMENT METHOD	EA (Extended Aeration) PROCESS
TARGET TREATMENT WATER QUALITY	BOD < 10 mg/l TSS < 10 mg/l TN < 10 mg/l TP < 2 mg/l

LEGEND	
	LAND BOUNDARY

Project Name
The Preparatory Survey on Project for
'POLLUTION ABATEMENT OF RIVER MULA-MUTHA IN PUNE'
インド国プネ市ムラ・ムタ川汚染緩和事業準備調査

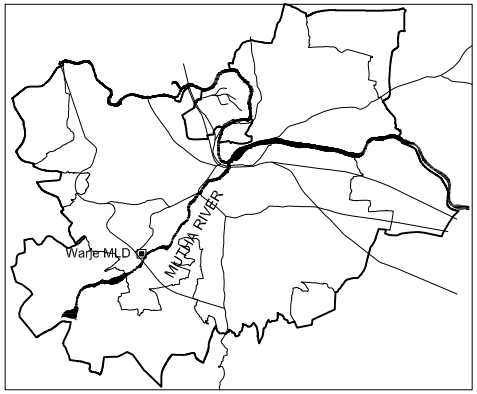
Drawing Title
VADGAON STP GENERAL LAYOUT PLAN

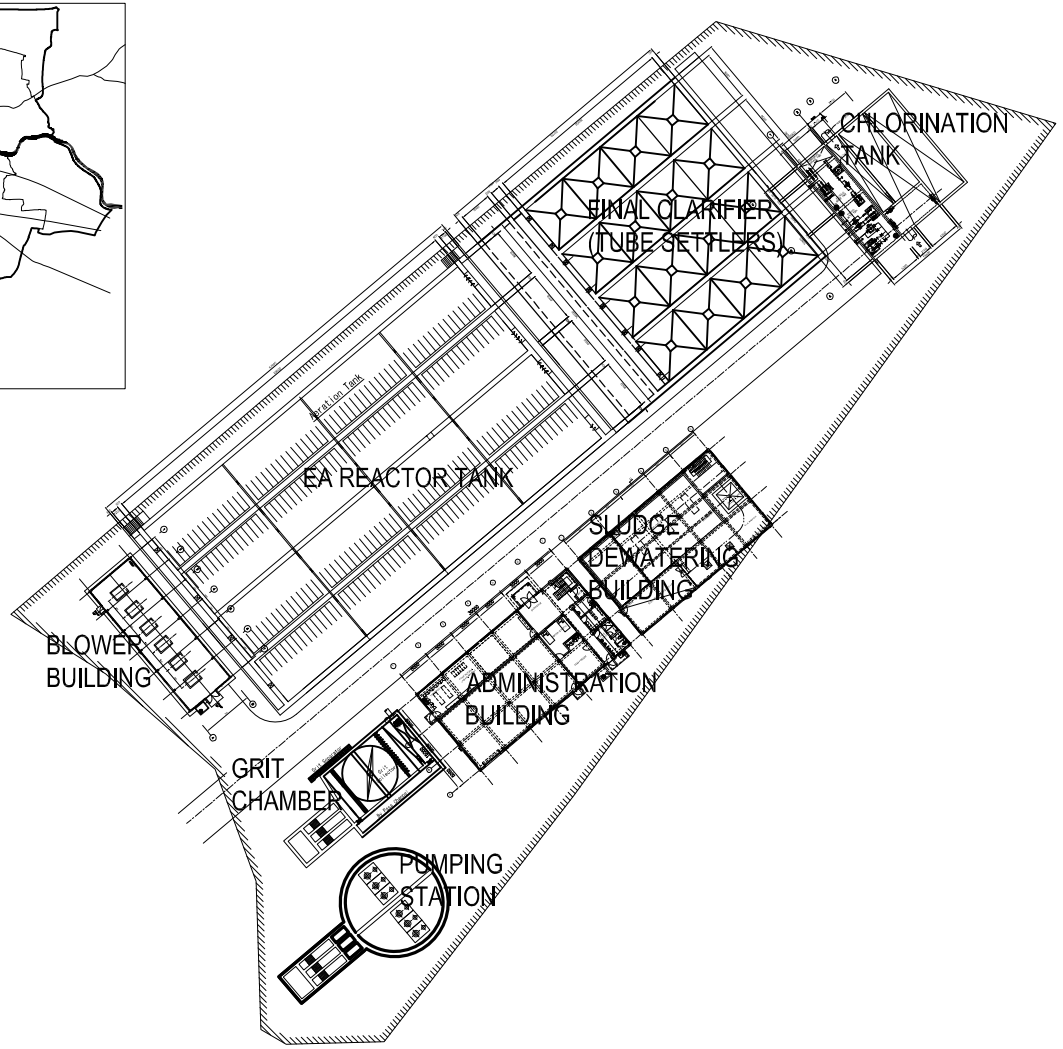
Scale: 1:200

Drawing No. STP-xx

GENERAL LAYOUT PLAN OF WARJE STP

LOCATION MAP





OUTLINE OF STP	
NAME OF STP	WARJE STP
DESIGN CAPACITY	28 MLD
TREATMENT METHOD	EA (Extended Aeration) PROCESS
TARGET TREATMENT WATER QUALITY	BOD < 10 mg/l TSS < 10 mg/l TN < 10 mg/l TP < 2 mg/l

LEGEND	
//////////	LAND BOUNDARY

0 50 100m

Project Name
The Preparatory Survey on Project for
'POLLUTION ABATEMENT OF RIVER MULA-MUTHA IN PUNE'
インド国プネ市ムラ・ムタ川汚染緩和事業準備調査

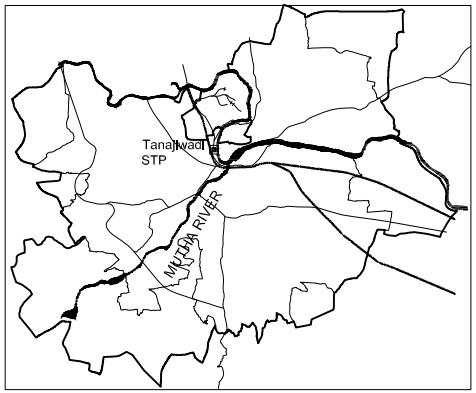
Drawing Title
WARJE STP GENERAL LAYOUT PLAN

Scale: 1:800

Drawing No. STP-xx

GENERAL LAYOUT PLAN OF TANAJIWADI STP

LOCATION MAP



OUTLINE OF STP	
NAME OF STP	TANAJIWADI STP
DESIGN CAPACITY	15 MLD
TREATMENT METHOD	EA (Extended Aeration) PROCESS
TARGET TREATMENT WATER QUALITY	BOD < 10 mg/l TSS < 10 mg/l TN < 10 mg/l TP < 2 mg/l

LEGEND	
	LAND BOUNDARY

Project Name

The Preparatory Survey on Project for
'POLLUTION ABATEMENT OF RIVER MULA-MUTHA IN PUNE'
インド国プネ市ムラ・ムタ川汚染緩和事業準備調査

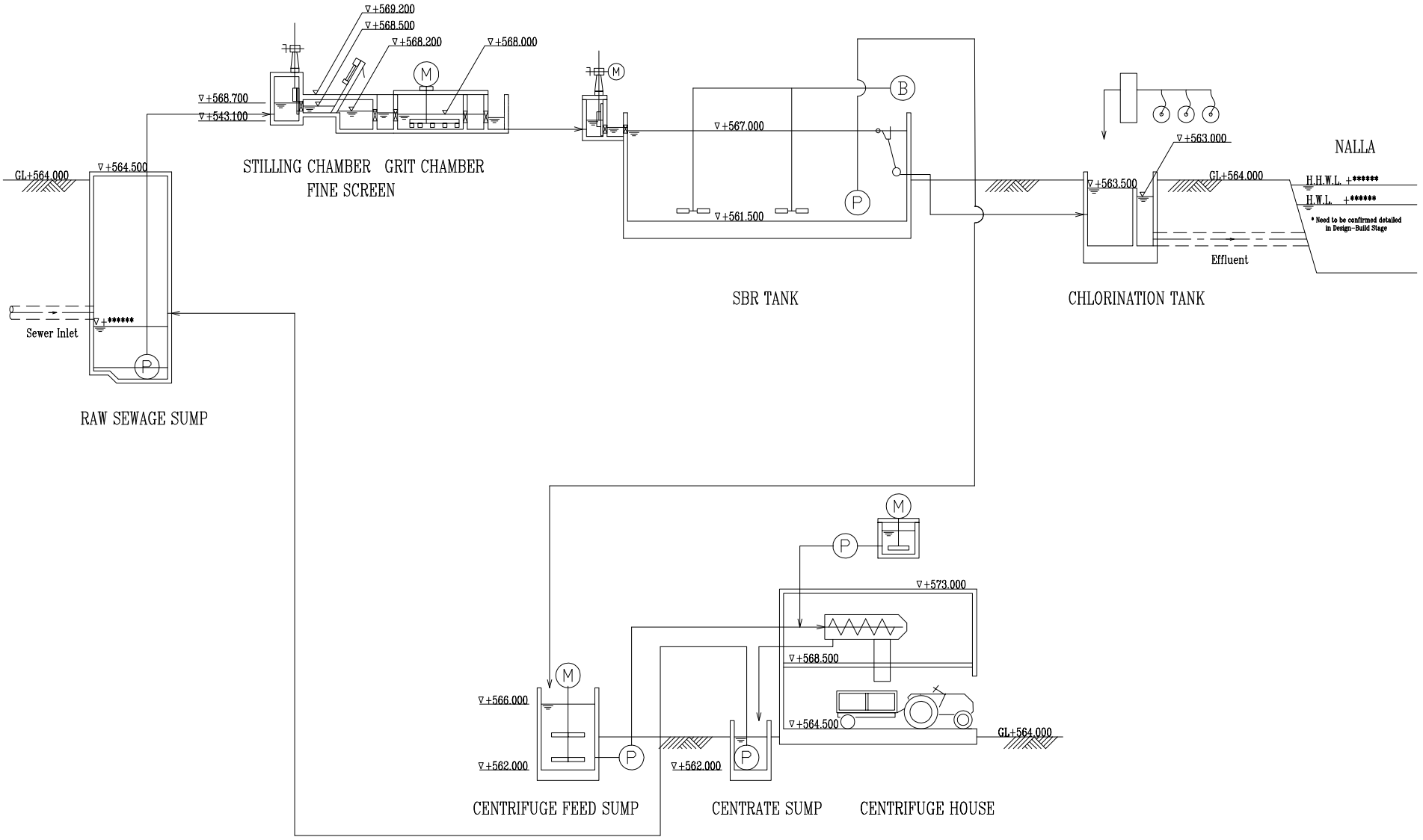
Drawing Title

TANAJIWADI STP GENERAL LAYOUT PLAN

Scale: 1:500

Drawing No. STP-xx

MATSYA BEEJ KENDRA STP 7MLD SBR



Project Name

The Preparatory Survey on Project for
'POLLUTION ABATEMENT OF RIVER MULA-MUTHA IN PUNE'
インド国プネ市ムラ・ムタ川汚染緩和事業協力準備調査

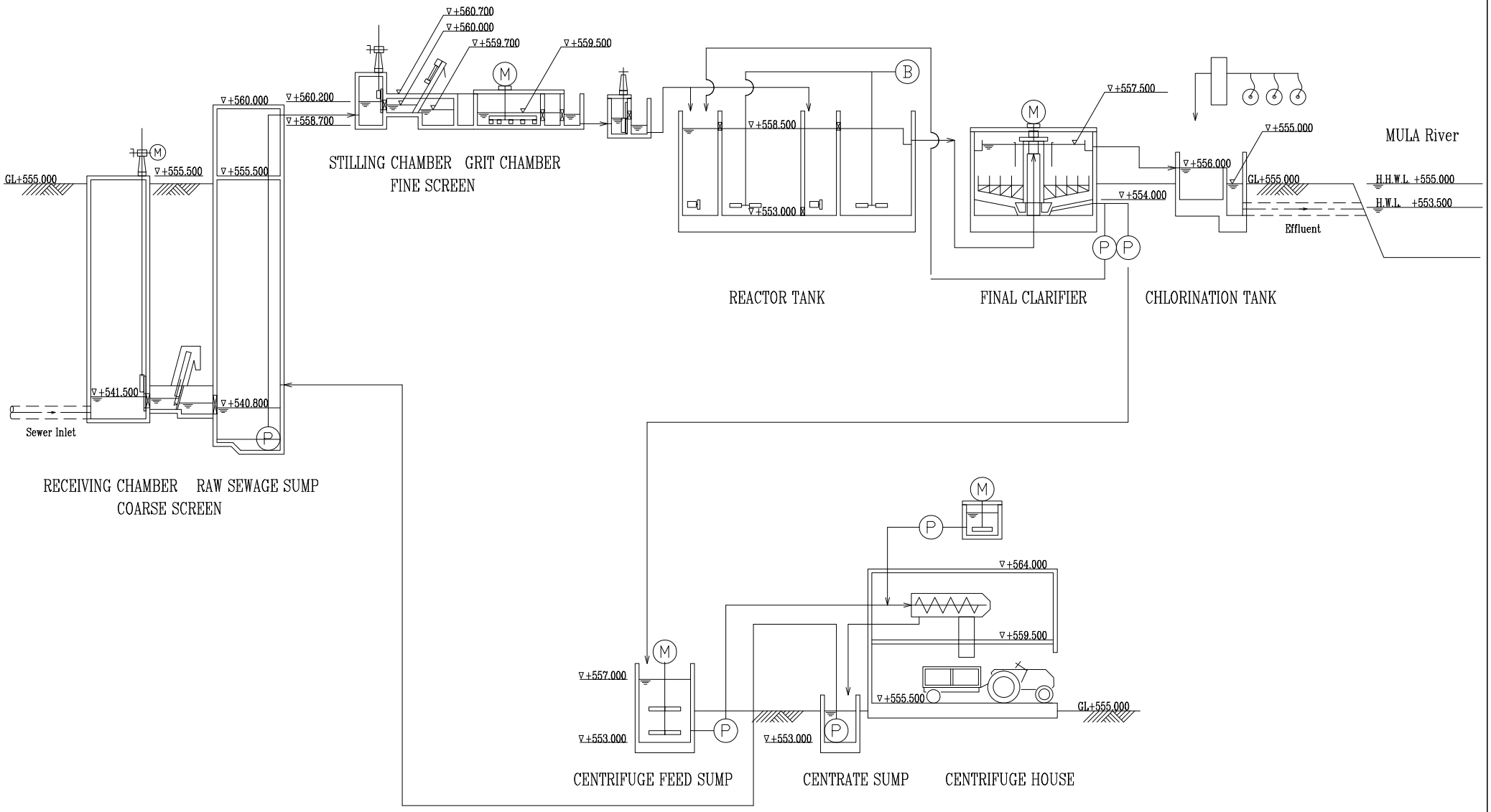
Drawing Title

MATSYA BEEJ KENDRA STP
HYDRAULIC & PROCESS FLOW DIAGRAM

Scale: NON

Drawing No. STP-xx

BOTANICAL GARDEN 10MLD EA



Project Name

The Preparatory Survey on Project for
'POLLUTION ABATEMENT OF RIVER MULA-MUTHA IN PUNE'
インド国プネ市ムラ・ムタ川汚染緩和事業協力準備調査

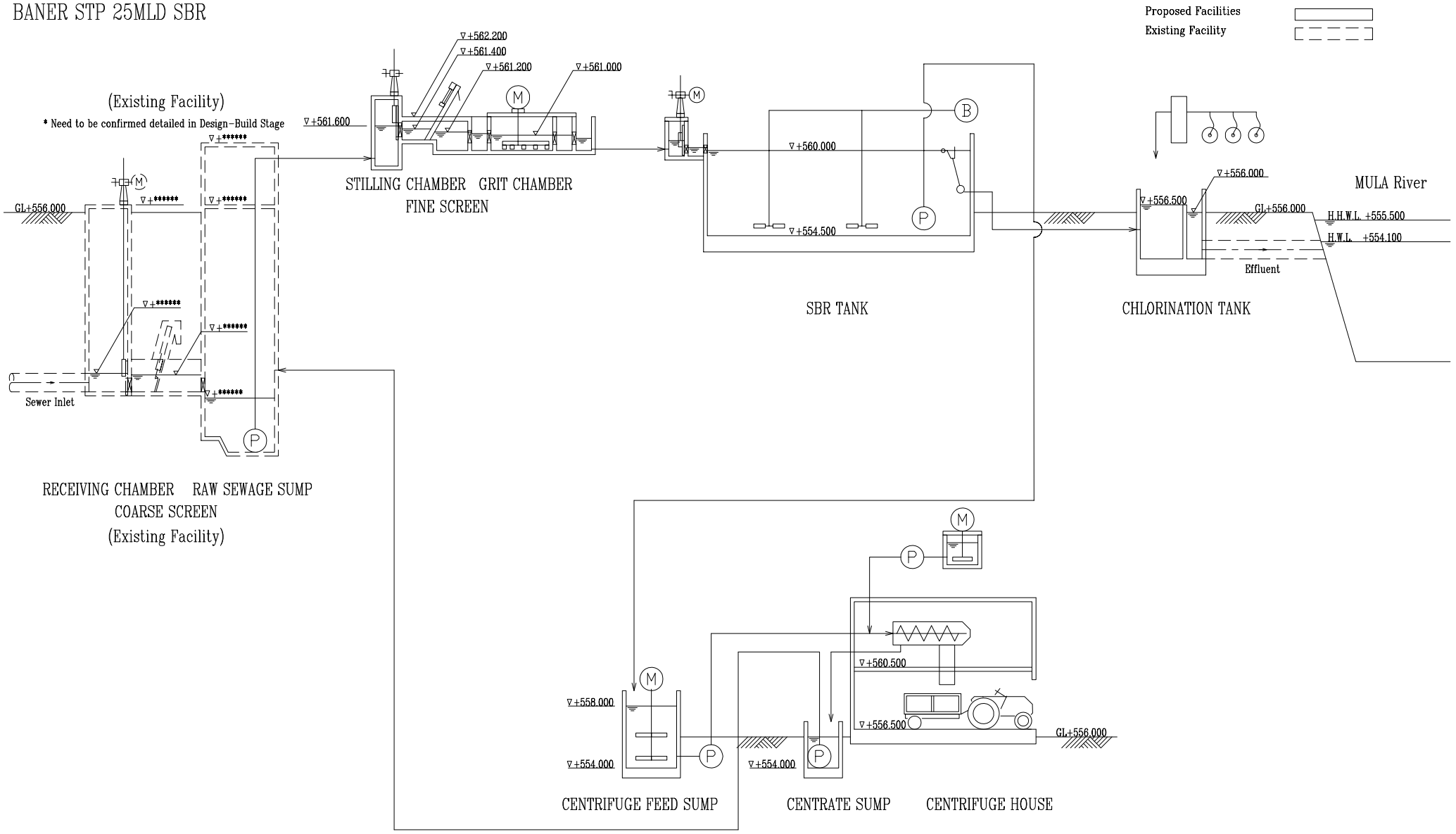
Drawing Title

BOTANICAL GARDEN STP
HYDRAULIC & PROCESS FLOW DIAGRAM

Scale: NON

Drawing No. STP-xx

BANER STP 25MLD SBR



Project Name

The Preparatory Survey on Project for
'POLLUTION ABATEMENT OF RIVER MULA-MUTHA IN PUNE'
インド国プネ市ムラ・ムタ川汚染緩和事業協力準備調査

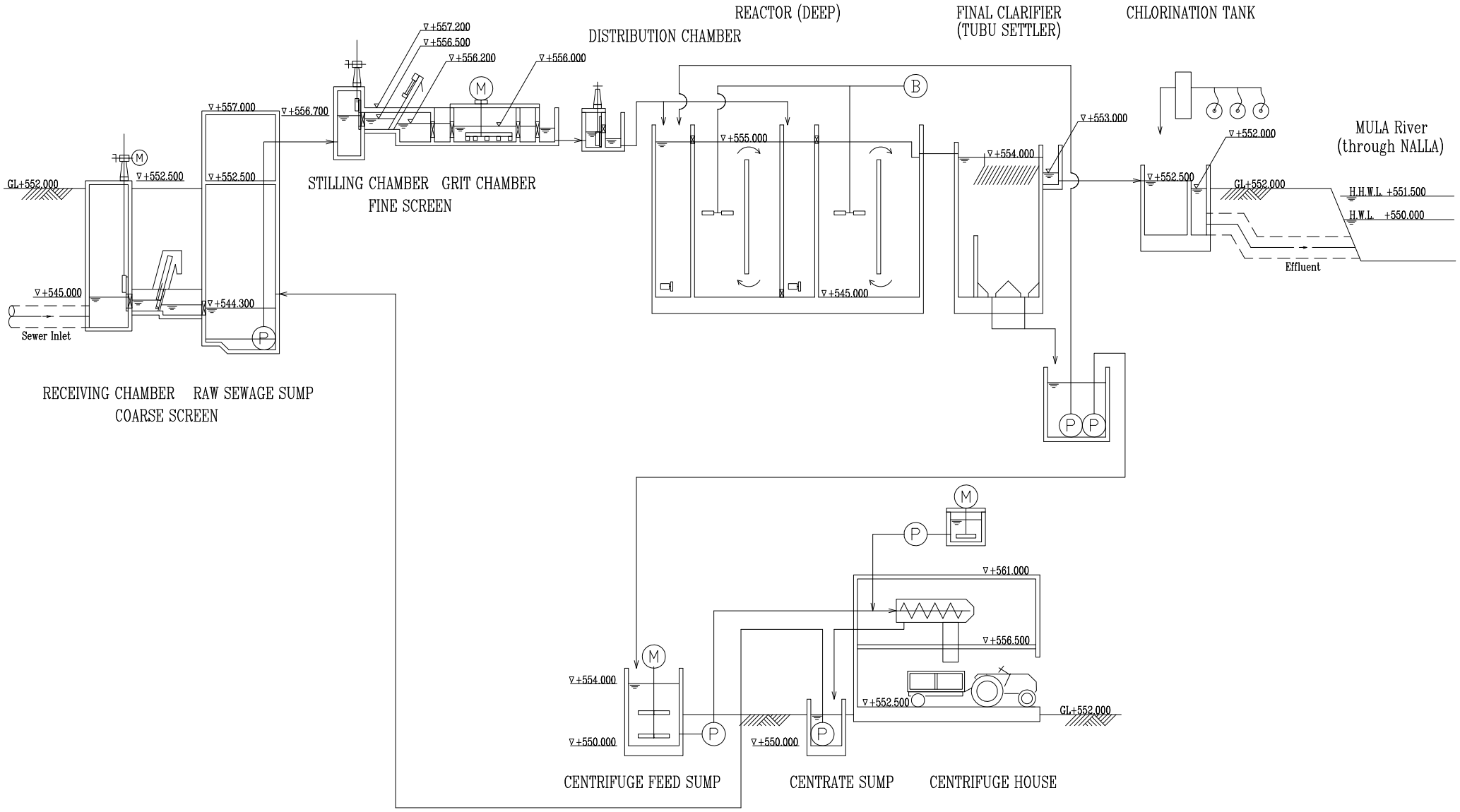
Drawing Title

BANER STP
HYDRAULIC & PROCESS FLOW DIAGRAM

Scale: NON

Drawing No. STP-xx

DHANORI 33MLD EA



Project Name

The Preparatory Survey on Project for
'POLLUTION ABATEMENT OF RIVER MULA-MUTHA IN PUNE'
インド国プネ市ムラ・ムタ川汚染緩和事業協力準備調査

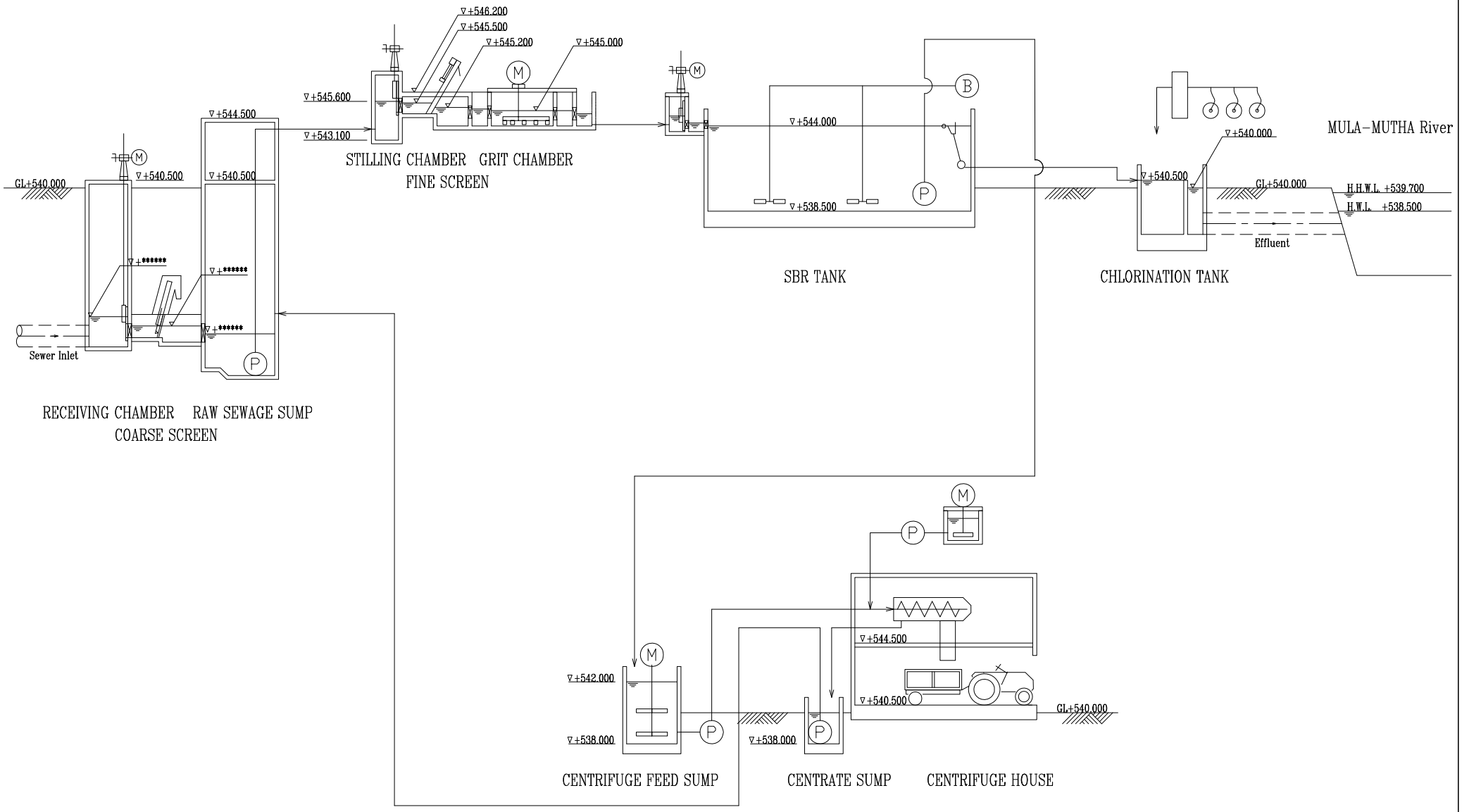
Drawing Title

DHANORI STP
HYDRAULIC & PROCESS FLOW DIAGRAM

Scale: NON

Drawing No. STP-xx

KHARADI STP 30MLD SBR



Project Name

The Preparatory Survey on Project for
'POLLUTION ABATEMENT OF RIVER MULA-MUTHA IN PUNE'
インド国プネ市ムラ・ムタ川汚染緩和事業協力準備調査

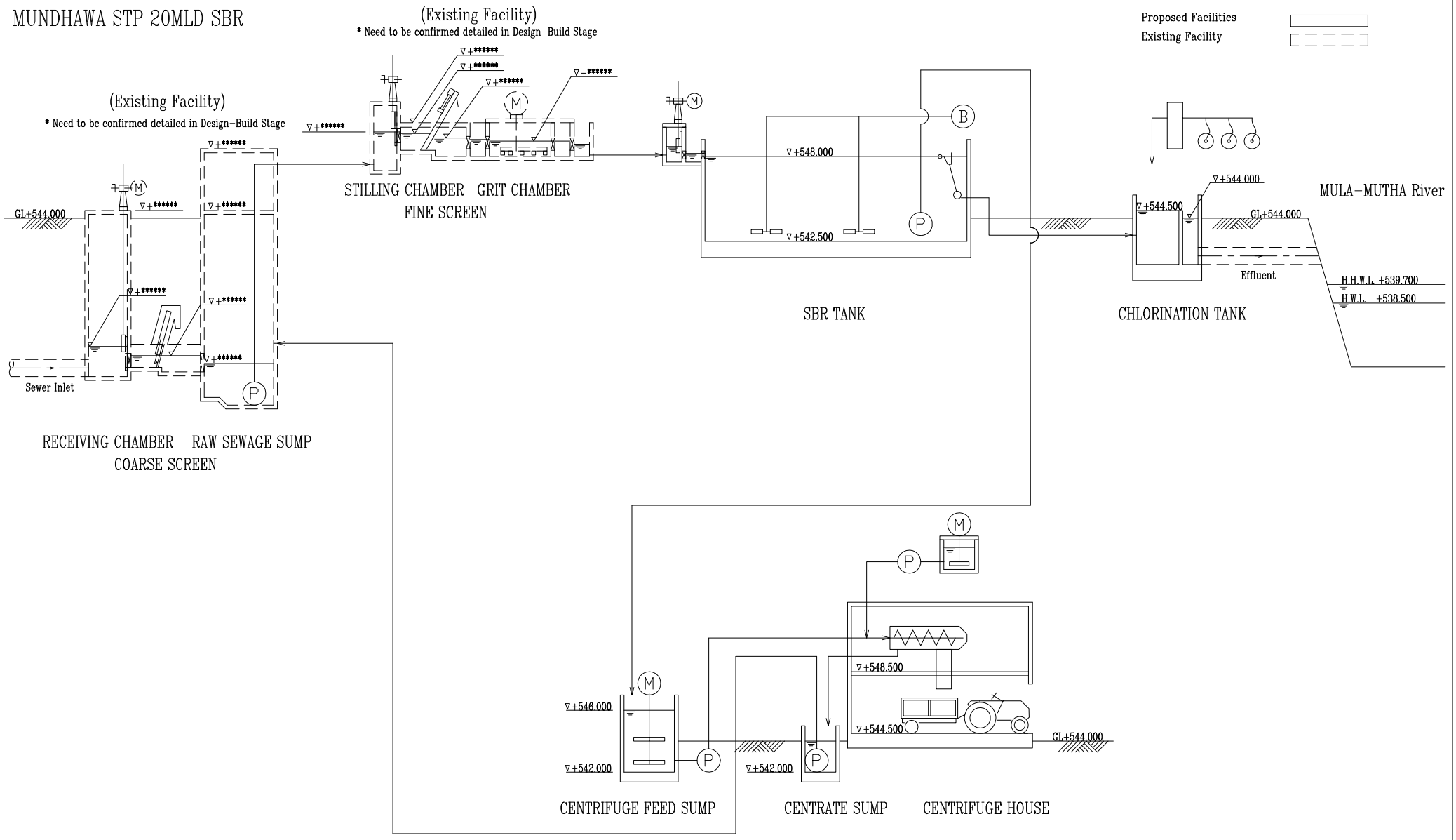
Drawing Title

KHARADI STP
HYDRAULIC & PROCESS FLOW DIAGRAM

Scale: NON

Drawing No. STP-xx

MUNDHAWA STP 20MLD SBR



Project Name

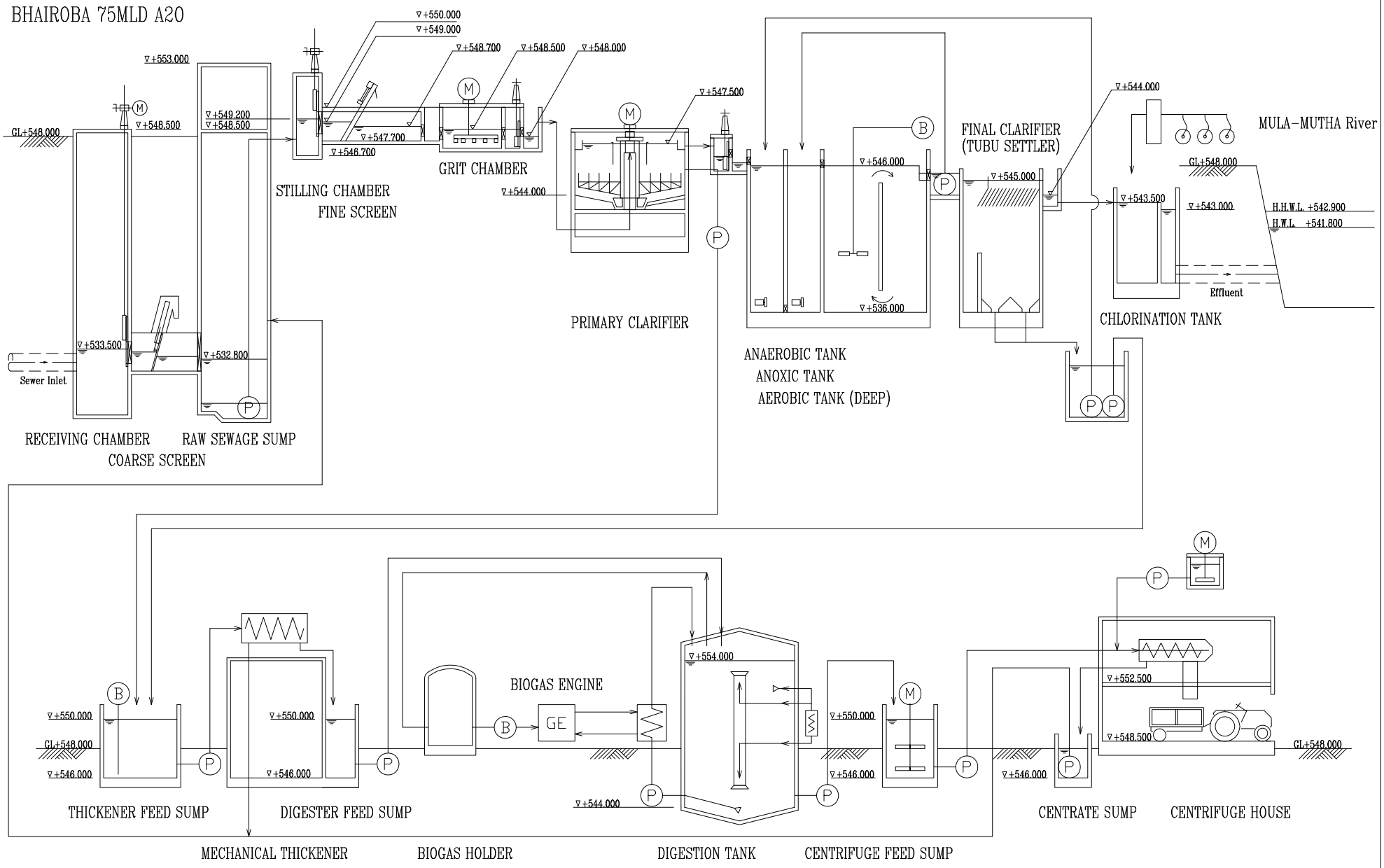
The Preparatory Survey on Project for
'POLLUTION ABATEMENT OF RIVER MULA-MUTHA IN PUNE'
インド国プネ市ムラ・ムタ川汚染緩和事業協力準備調査

Drawing Title

MUNDHAWA STP
HYDRAULIC & PROCESS FLOW DIAGRAM

Scale: NON

Drawing No. STP-xx



Project Name

The Preparatory Survey on Project for
'POLLUTION ABATEMENT OF RIVER MULA-MUTHA IN PUNE'
インド国プネ市ムラ・ムタ川汚染緩和事業協力準備調査

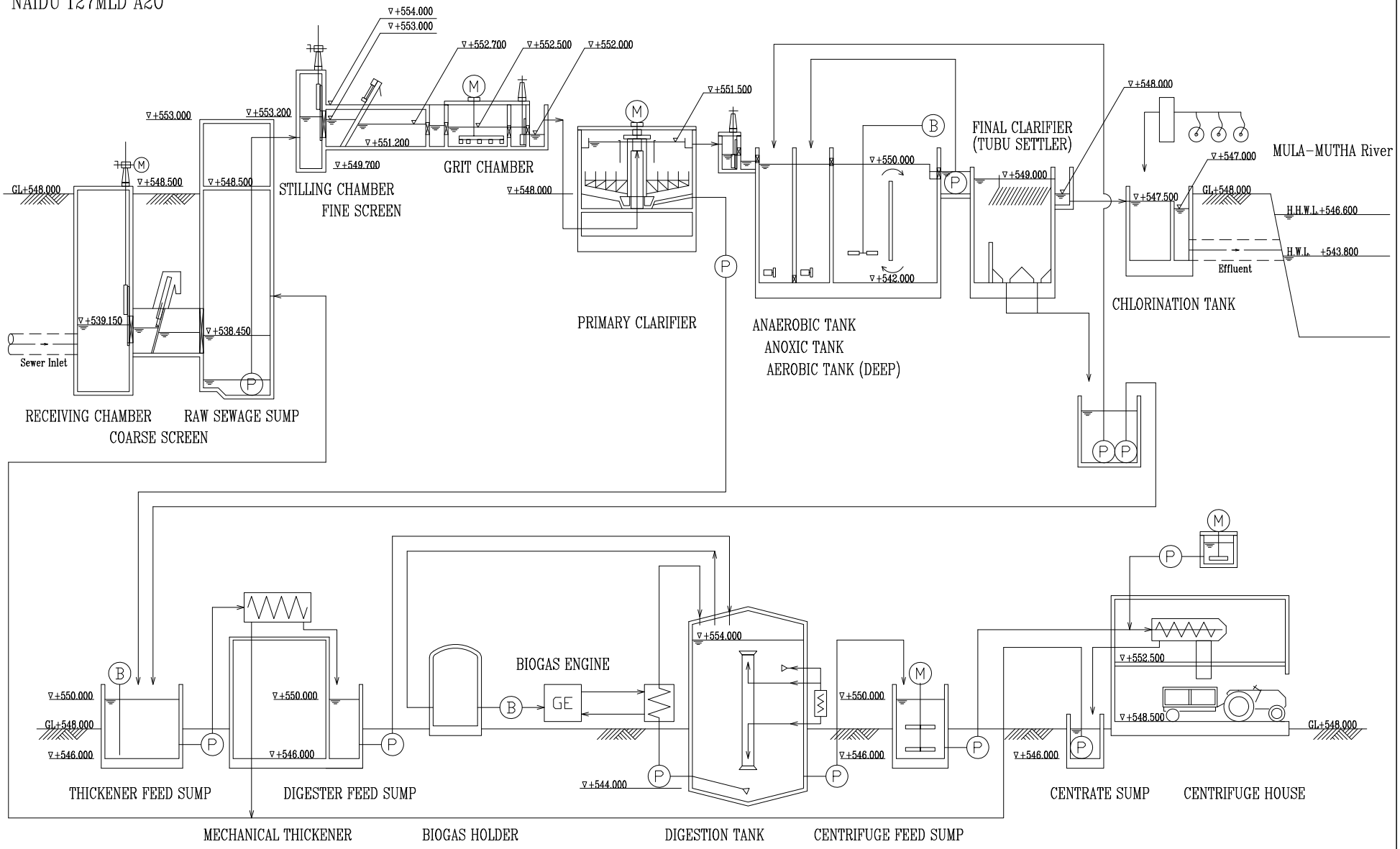
Drawing Title

BHAIROBA STP
HYDRAULIC & PROCESS FLOW DIAGRAM

Scale: NON

Drawing No. STP-xx

NAIDU 127MLD A20



Project Name

The Preparatory Survey on Project for
'POLLUTION ABATEMENT OF RIVER MULA-MUTHA IN PUNE'
インド国プネ市ムラ・ムタ川汚染緩和事業協力準備調査

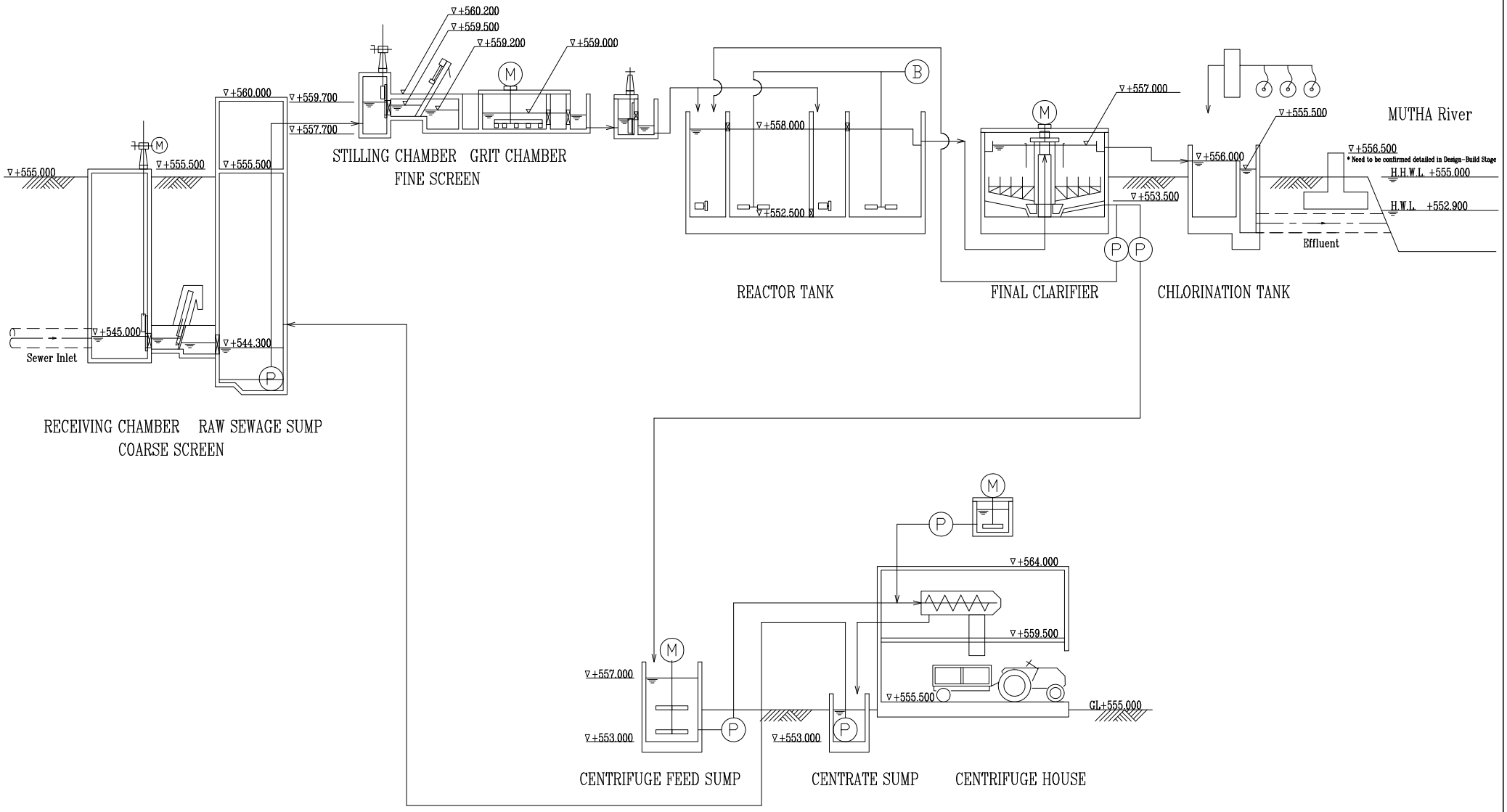
Drawing Title

NAIDU STP
HYDRAULIC & PROCESS FLOW DIAGRAM

Scale: NON

Drawing No.: STP-xx

VADGAON 26MLD EA



Project Name

The Preparatory Survey on Project for
'POLLUTION ABATEMENT OF RIVER MULA-MUTHA IN PUNE'
インド国プネ市ムラ・ムタ川汚染緩和事業協力準備調査

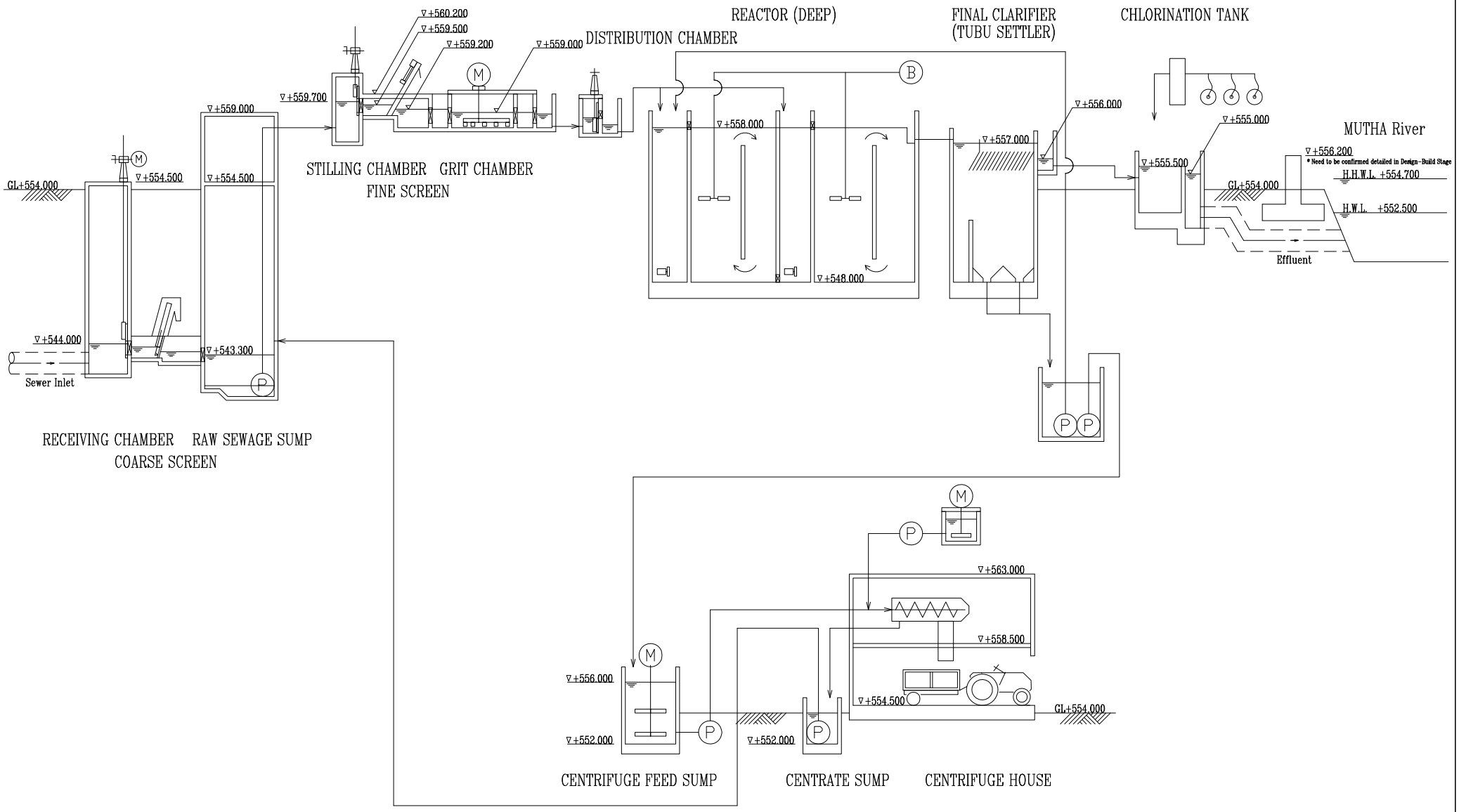
Drawing Title

VADGAON STP
HYDRAULIC & PROCESS FLOW DIAGRAM

Scale: NON

Drawing No. STP-xx

WARJE 28MLD EA



Project Name

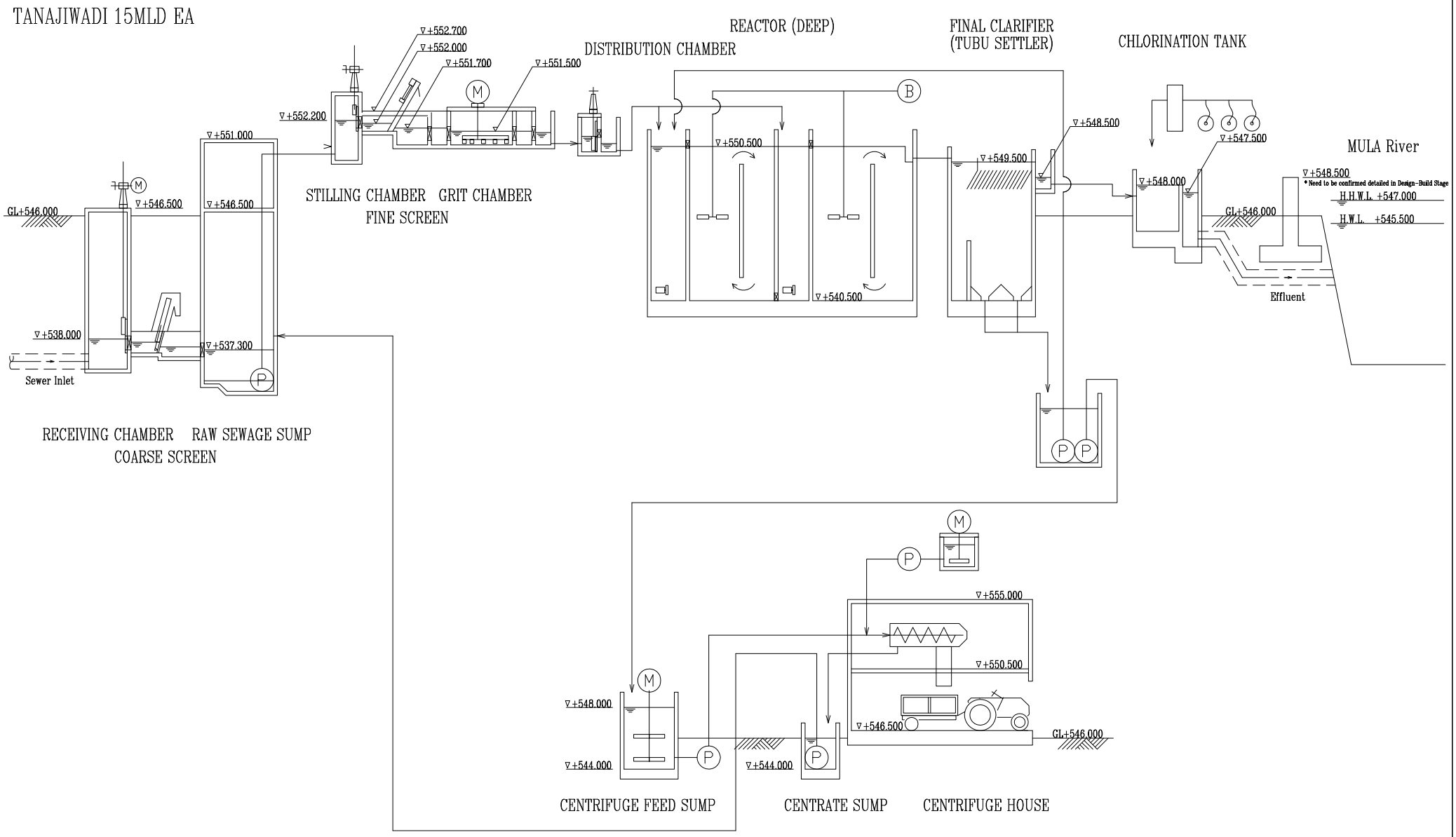
The Preparatory Survey on Project for
'POLLUTION ABATEMENT OF RIVER MULA-MUTHA IN PUNE'
インド国プネ市ムラ・ムタ川汚染緩和事業協力準備調査

Drawing Title

WARJE STP
HYDRAULIC & PROCESS FLOW DIAGRAM

Scale: NON

Drawing No. STP-xx



Project Name

The Preparatory Survey on Project for
'POLLUTION ABATEMENT OF RIVER MULA-MUTHA IN PUNE'
インド国プネ市ムラ・ムタ川汚染緩和事業協力準備調査

Drawing Title

TANAJIWADI STP
HYDRAULIC & PROCESS FLOW DIAGRAM

Scale: NON

Drawing No. STP-xx