2030 Water Resources Group

KARNATAKA

Wastewater Reuse Potential: Rapid Assessment of Urban Wastewater Reuse Opportunities in Three Cities of Karnataka

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About 2030 Water Resources Group

The 2030 Water Resources Group is a unique public–private–civil society partnership that helps governments to accelerate reforms that will ensure sustainable water resource management for the long term development and economic growth of their country. It does so by helping to change the "political economy" for water reform in the country through convening a wide range of actors and providing water resource analysis in ways that are digestible for politicians and business leaders. The 2030 WRG was launched in 2008 at the World Economic Forum and has been hosted by the International Finance Corporation (IFC) since 2012.

This report has been developed by the 2030 Water Resources Group (2030 WRG), in conjunction with knowledge partner, Powertec Engineering Pvt Ltd.

Foreword

Water, the linchpin of urban, rural, and industrial development, is a fast-depleting resource facing competing yet ever-increasing demand. Sustaining the economic growth pathway necessitates innovative solutions to maximize the potential use of each drop of water. In this context, wastewater reuse emerges as an effective option for ensuring water availability for economic, social and environmental growth.

Undertaken at the request of the Secretary, Urban Development Department, Government of Karnataka, this publication represents a high-level assessment of the potential for wastewater reuse in three towns of Karnataka, namely Tumkur, Hubli-Dharwad, and Bellary. The document focuses on the potential for maximizing wastewater reuse in the short, medium and long term; the financial viability of developing projects in the three cities; as well as implementation options and PPP solutions. In view of the nature of the analysis—structured as a *rapid assessment*—this publication is not intended to provide an in-depth analysis of solutions in this sector.

The results of the assessment have been used to inform the establishment of a broader work stream on wastewater reuse across urban centers in Karnataka, supplementing earlier analyses on the urban and industrial sectors undertaken by 2030 WRG.

2030 WRG, hosted by the International Finance Corporation, is a unique public-private-civil society collaboration. We facilitate open, trust-based dialogue processes to drive action on water resources reform in water stressed countries in developing economies. The ultimate aim of such reforms and actions is to close the gap between water demand and supply by the year 2030.

2030 WRG wishes to acknowledge the inputs of various stakeholders who have contributed to this document, including, among others, the Urban Development Department, Department of Industries and Commerce, private sector players, and local community organizations.

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2030 Water Resources Group/International Finance Corporation

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Abbreviations & Acronyms

ACT	Analyze-Convene-Transform
ADB	Asian Development Bank
BCC	Bellary City Corporation
BMC	Brihan Mumbai Corporation
BOT	Build-Operate-Transfer
CETP	Common Effluent Treatment Plant
CPHEEO	Central Public Health and Environmental Engineering Organization
DBFOT	Design-Build-Finance-Operate-Transfer
DBO	Design-Build-Operate
DEWATS	Decentralized Wastewater Treatment Systems
DPR	Detailed Project Report
DWMS	Decentralized Wastewater Management Systems
ETP	Effluent Treatment Plant
GoI	Government of India
HDMC	Hubli-Dharwad Municipal Corporation
HLC	High Level Canal
JNNURM	Jawaharlal Nehru National Urban Renewal Mission
KIADB	Karnataka Industrial Areas Development Board
KL	Kilo Litres
KSPCB	Karnataka State Pollution Control Board
KSSIDC	Karnataka State Small Industries Development Corporation
KUAS	Karnataka University of Agricultural Sciences
KUIDFC	Karnataka Urban Infrastructure and Finance Corporation Limited
KUWS&DB	Karnataka Urban Water Supply and Drainage Board
LLC	Low Level Canal
LPCD	Litres per Capita per Day
MBR	Master Balancing Reservoir
MoUD	Ministry of Urban Development
MLD	Million Litre per Day
NIMZ	National Investment and Manufacturing Zones
NPV	Net Present Value
O&M	Operations and Maintenance
OSWTS	On-site Wastewater Treatment system
PPP	Public-Private-Partnership
SLB	Service Level Benchmark
SBR	Sequencing Batch Reactor
SPCB	State Pollution Control Board
STP	Sewage Treatment Plant
TCC	Tumkur City Corporation
TMC	Thousand Million Cubic Feet
UGD	Underground Drainage
VIMS	Vijayanagar Institute of Medical Sciences
2030 WRG	Water Resources Group
WTP	Water Treatment Plant

Executive Summary

Introduction

Water availability has become an important driver for facilitating economic growth in the state of Karnataka. The state currently has an existing supply level of 35 TMC vis-à-vis demand of 46 TMC in urban areas. According to a recent study,[1] the total demand for domestic consumption in urban areas would increase from 46 TMC in 2011 to about 84 TMC in 2030, while demand from the industrial sector could increase from about 26 TMC in 2011 to 85 TMC in 2030. As only 20% of water supplied is consumed and the balance 80% is wastewater, treatment and reuse of this wastewater will reduce the pressure to augment water supply from freshwater sources. The Government of Karnataka and respective city governments need to frame suitable policies and facilitate cost effective solutions for reuse of wastewater as part of their effort to meet this demand. However, there are challenges in tapping the full potential of wastewater in the form of social taboos, technology availability and cost effectiveness. In this context, the following report has carried out a rapid assessment of the wastewater reuse potential in three cities viz. Tumkur, Hubli-Dharwad and Bellary. The study attempts to assess: urban water demand; on-going and planned wastewater treatment and reuse initiatives; potential for maximizing reuse in the short, medium and long term; as well as the potential for income generation to improve the financial viability of such projects in these three cities and create the possibility of implementation on a PPP basis. Finally the report comes up with recommendations for an enabling policy framework in the state of Karnataka to facilitate reuse of wastewater and encourage PPPs in the sector.

Inferences and Recommendations on Wastewater Reuse

The key messages from the rapid assessments of the three towns of Tumkur, Hubli-Dharwad and Bellary in terms of potential for re-use of treated municipal water are briefly presented below.

Tumkur

- **Water Supply Scenario:** Existing freshwater supply sources *adequate till the mid 2030s* with proposed rehabilitation of old WTP and planned reduction in losses in the transmission and distribution system to 15% from current 40%. However, significant water supply augmentation needed after that.
- **Sewage System Scenario:** Planned sewerage network adequate over the forecast horizon but *STP capacity would need augmentation by 2030.*
- STPs are essential to treat wastewater in order to reduce pollution load on surface and ground water bodies in the vicinity and to enhance environmental flows by recharging ground water aquifers and improving water flows in surface water bodies.
- It would prudent for the Tumkur City Corporation (TCC) to start planning for the possibility that there would be water scarcity in the very long run (a time horizon of 20 years or more in the future) i.e., by the late 2030s.
- **Reuse Potential:** In order to augment/conserve freshwater supplies to meet impending water supplies scarcities, TCC can actively consider recycling treated wastewater as a substitute for freshwater in the following uses: industrial process water; non-potable domestic, commercial and public use and peri-urban agriculture.
  - *Reuse potential of industry* in short term as well as the medium to long term is significant as there is both existing demand and significant potential demand due to Tumkur and its environ being a part of the Chennai–Chitradurga Industrial Corridor.
  - *Reuse* of treated wastewater *potential in agriculture* negligible as they get freshwater which is preferred for the crops cultivated in the region.
  - *Reuse for non-potable purposes* in domestic, commercial and public uses only possible in the very long run, i.e., late 2030s and beyond as there is adequate freshwater supply till then.
- **Constraints on Reuse:** However, constraints to maximising reuse potential exist in municipal households, institutions, commercial establishments, parks, etc. in the form of:
  i. Social taboos; and
  ii. High cost of laying the infrastructure for supplying treated municipal wastewater to consumer.
- **PPP Opportunities:** There are a couple of income generating reuse projects, which could be implemented on a PPP basis. These are :
  i. *Vasantha Naraspur Industrial Estate:* 30 mld of treated sewage water required. DPR on conveyance infrastructure is ready and with KIADB, Tumkur office. Estimated cost is Rs. 35 crore for a 21 km pipeline and associated infrastructure. Discussions with KIADB required.
  ii. *Dabas Pete Industrial Estate,* may be an income generating and PPP opportunity but needs to be discussed with KIADB, Bangalore.

Actions required by Tumkur City Corporation

Water Management Plan

1. As a first step TCC should develop an integrated water and wastewater management plan at the city level by merging its current water supply as well as sewerage network and STP expansion plans. The plan should view treated wastewater as a critical component in the overall strategy to augment/conserve freshwater supplies to the city. An example of such a plan is the recent Water Policy for Delhi. The plan also should acknowledge the need to maintain minimum environmental flows to nourish rivers and aquifers to maintain the flora (including agriculture) and fauna of the region.

1 Deloitte's study on "Creating a Sustainable Water Future for Karnataka-Urban and Industrial Sectors" for 2030 Water Resources Group

Municipal Regulation

1. Regulations mandating major wastewater generators such as commercial establishments like hotels, malls, etc. to go in for in-house decentralized wastewater management systems/on-site wastewater treatment and, where possible, reuse. This could be implemented through the enactment of a municipal by-law.
2. Reuse of treated municipal wastewater should be incorporated in the planning of new residential and commercial developments. This would involve setting aside land for STPs; and designing building codes, making it compulsory for developers to install dual pipelines in households; one for treated drinking water and the other for treated recycled wastewater for toilet flushing, etc.

Promoting Industrial Reuse

1. TCC should facilitate reuse by industries located in its vicinity by supplying treated sewage water at price which would cover its operating cost of supply such as for industries located at Vasantha Narasapur and Dabas Pete industrial estates.

Tariff Reform

1. Treated municipal freshwater supplies should be priced higher than the cost of treated municipal wastewater supplies to discourage excessive freshwater use and encourage reuse of treated wastewater, particularly for bulk consumers. Further, both treated freshwater price and treated municipal wastewater price should initially cover operating costs of each source and in the long run cover both operating and capital costs.
2. The Sewage tax/charge currently levied should be enhanced to at least cover operating cost. The sewerage revenues generated by TCC should be earmarked for providing sewerage collection, treatment and reuse services by ring fencing them from the rest of the municipal fund.

Tackling Taboos

1. Sensitizing citizens through focused awareness campaigns on television, radio, social media and live events. The campaigns should aim at educating the citizens of a city of advantages of saving freshwater and breaking social taboos on reusing wastewater for non-potable purposes.

Capacity Building

1. Build capacity within TCC to operate wastewater recycling and reuse systems and to engage with the private sector in the discharge of such activities. This would involve:
    a. Rationalizing the number of posts required as has been given in the CPHEEO manual and fill vacant posts, wherever necessary;
    b. Have proper career planning and incentive mechanisms to improve morale;
    c. Impart regular training to engineers and technicians in operations and maintenance practices. For instance, attendance at CPHEEO training programmes could be made mandatory; and
    d. Taking the municipal corporation councillors and officials to visit sewage treatment and reuse facilities in Bangalore such as those for the golf course and the international airport and adopt similar technologies and institutional structures to recycle and reuse the city sewage for non-potable uses.

Hubli-Dharwad

- **Water Supply Scenario:** Hubli-Dharwad Municipal Corporation (HDMC) has ample freshwater supplies till 2041, if allocation request for additional 222 mld comes through either fully or substantially (Scenario 1). If Scenario 2 (the allocation request is not granted or very partially granted) materialises then HDMC will face freshwater shortages in the medium term itself (i.e., the next 6–10 years). At this stage, chances of Scenario 1 materialising are high.
- **Sewage System Scenario:** Planned sewage treatment capacity would need to be augmented by the early 2030s in case Scenario 1 prevails from the medium term. In case Scenario 2 materialises over the medium term then planned capacity sufficient for the very long run (i.e., a time horizon of > 20 years).
- **Reuse Potential:** The treated wastewater reuse potential in HDMC is as follows:
    - *Industrial reuse potential* is limited as the industries in the region are not water intensive and there is sufficient surface water available to meet their needs. Only reuse possibilities are:
        - Railway Workshop: 15 mld future demand and about 5 kms from the 40 mld Madihal (near Gabbur) STP in Hubli.
        - Circa 1.5 mld for Rayapur and Lakamanhalli industrial areas in Dharwad about 12 kms from KUAS STP in Dharwad.
    - There is *significant reuse potential in peri-urban agriculture* as farmers in the vicinity currently use untreated sewage as fertilizer and to irrigate their crops. Treated wastewater will reduce health hazards for both the farmers and the final consumers of their products.
        - STPs have to be designed with discharge infrastructure like small canals or pipelines to ensure equitable geographical distribution of wastewater amongst farmers in the vicinity of the STPs.
        - Finally, fee charged for reuse in agriculture should be minimal in order to maximize reuse in peri-urban agriculture.
    - *In case Scenario 2 materialises*, then reuse possibility in HDMC for household toilet flushing and watering gardens, non-potable in commercial establishments and institutions and for use in public parks and toilets, etc. open up from the medium term itself.
    - *Small scale, decentralised collection, treatment and reuse opportunities* are available in *educational institutions*, particularly private ones. However, such opportunities may or may not be financially viable on a stand-alone basis without external support from the Government of Karnataka and/or HDMC.
- **Constraints on Reuse:** Significant constraints to maximising reuse potential exist:
    - In municipal households, institutions, commercial establishments, parks, etc. in the form of social taboos and

high cost of laying the infrastructure for supplying treated municipal wastewater to consumer.

- In case Scenario 2 materialises, another constraint to maximizing reuse in non-potable municipal uses would be competition for limited supply of treated sewage from farmers using it for peri-urban agriculture, which could turn ugly and take a political twist.

- **PPP Opportunities:** There is only one income generating reuse project, which could be implemented on a PPP basis:
  - *Railway Workshop:* The South-Western Railways have a workshop in Hubli which currently consumes 3 mld of water but according to KUWS&DB officials is likely to increase to 15 mld in the in the future depending on the expansion plans of the workshop. Madihal STP could supply treated wastewater for wagon cleaning and non-potable domestic use to it.

Actions required by Hubli-Dharwad Municipal Corporation. In case of Scenario 2, the actions would have to be implemented in the next 5 to 6 years, while in case of Scenario 1 the actions could be undertaken over the next 15 years

Water Management Plan

1. As a first step HDMC should develop an integrated water and wastewater management plan at the city level by merging its current water supply as well as sewerage network and STP expansion plans. The plan should view treated wastewater as a critical component in the overall strategy to augment/conserve freshwater supplies to the city. An example of such a plan is the recent Water Policy for Delhi. The plan also should acknowledge the need to maintain minimum environmental flows to nourish rivers and aquifers to maintain the flora (including agriculture) and fauna of the region.

Municipal Regulation

1. Currently HDMC regulations mandate medical colleges, private nursing homes and hospitals to collect and treat wastewater in-house before discharging into nearby drains and sewers. These regulations should be extended to other major wastewater generators such as commercial establishments like hotels, malls, etc. to go in for in-house decentralized wastewater management systems/on-site wastewater treatment and reuse in non-potable uses. This could be implemented through the enactment of a separate municipal by-law.
2. Reuse of treated municipal wastewater should be incorporated in the planning of new residential and commercial developments. This would involve setting aside land for STPs; and designing building codes, making it compulsory for developers to install dual pipelines in households: one for treated drinking water and the other for treated recycled wastewater for toilet flushing, etc.

Promoting Industrial Reuse

1. HDMC should facilitate reuse by supplying treated sewage water to the South-Western Railways' workshop in Hubli at price which would cover its operating cost of supply.

Tariff Reform

1. Treated freshwater supplies should be priced higher than the cost of treated municipal wastewater supplies to discourage excessive freshwater use and encourage reuse of treated wastewater, particularly for bulk consumers. Further, both treated freshwater tariffs and treated municipal wastewater tariffs should initially cover operating costs of each source and in the long run cover both operating and capital costs.
2. At present HDMC levies a property tax which does not have a separate sewerage tax sub-component. HDMC could consider creating a separate sewerage tax sub-component in its property tax structure. Further, it could also consider levying a sewage user charge in addition to a sewerage tax component in property tax to generate revenues for covering at least the operations and maintenance cost of the sewer network and STPs. The sewerage charge could be 50% of the water tariff revenues as recommended by the Ministry of Urban Development. The revenues so generated should be earmarked for providing sewerage collection, treatment and reuse services by ring fencing them from the rest of the municipal fund.

Tackling Taboos

1. Sensitizing citizens through focused awareness campaigns on television, radio, social media and live events. The campaigns should aim at educating the citizens of a city of advantages of saving freshwater and breaking social taboos on reusing wastewater for non-potable purposes.

Capacity Building

1. Build capacity within HDMC to operate wastewater recycling and reuse systems and to engage with the private sector in the discharge of such activities. This would involve:
   a. Rationalizing the number of posts required as has been given in the CPHEEO manual and fill vacant posts, wherever necessary;
   b. Have proper career planning and incentive mechanisms to improve morale;
   c. Impart regular training to engineers and technicians in operations and maintenance practices. For instance, attendance at CPHEEO training programmes could be made mandatory; and
   d. Taking the municipal corporation councillors and officials to visit sewage treatment and reuse facilities in Bangalore such as those for the golf course and the international airport and adopt similar technologies and institutional structures to recycle and reuse the city sewage for non-potable uses.

Bellary

- **Water Supply Scenario:** Existing freshwater sources are adequate for Bellary City requirements only untill the mid-2020s (i.e., 2025), despite reduction in UFW to 15% and augmentation of treatment capacity by 35 mld.
- **Sewage System Scenario:** Planned sewage treatment capacity is sufficient for the forecast supply of 93 mld of bulk raw water (i.e., 79 mld of treated water supply at the consumer end) but not if water supplies increase significantly beyond 93 mld, say due to reuse within Bellary.
- **Reuse Potential:** Therefore, it may be prudent for Bellary City Corporation (BCC) to start looking at a city wide water management plan, which amongst other initiatives, considers enhancing supply from unconventional sources such as harvested rainwater and recycled, treated municipal wastewater as a contingency measure.
  - *Industrial Reuse:* Sponge Iron and Steel units around the city, particularly to the South-East and South-West are the main potential customers for reuse of treated wastewater. Acute shortage of freshwater from surface and groundwater sources will drive them to consider reuse as an option in the medium term (next eight to ten years) provided the industry performs well in the interim.
  - *Municipal Reuse*: Great potential for reuse of recycled wastewater for non-potable purposes in households, institutions, commercial establishments and parks in the next eleven to fifteen years.
  - *Peri-Urban Agriculture Reuse:* Demand for sewage water from farmers in the peri-urban areas is high. This will result in competition and conflict with industry and the BCC as and when wastewater reuse by industry picks up.
- **Constraints to Reuse:** The constraints to achieving maximum reuse potential are:
  - The potential conflict with industry and municipal reuse has been diffused by the Government of Karnataka through an order mandating that at least 30% of the treated urban wastewater has to be let out into natural water courses (nallahs), tanks and open fields for use by farmers and for natural recharge of surface waters and the groundwater table (minimum environmental flow).
  - Biggest constraints to reuse for non-potable purposes in households, institutions, commercial establishments, parks etc. stem from:
    - Social taboos regarding reutilising sewage
    - High cost of laying pipelines and other associated infrastructure for conveying treated wastewater to the end-users.
    - Lack of awareness amongst city officials about reuse options and technologies.
- **PPP Opportunities:** In the medium term, i.e., over the next 10 years, supply of treated sewage to the sponge iron and steel industry could be a lucrative opportunity for both the BCC and the private sector. Immediately there is only one PPP opportunity:
  - Janki Corporation Ltd. in Sidiginamola village in Bellary taluk, is being supplied 15 mld of treated wastewater by BCC from its Ananthpur STP 22 kms away. The conveyance infrastructure to the unit has been laid and was commissioned in December, 2014.
  - Private sector operators in wastewater management could engage with Janki Corporation to undertake operations and maintenance of the conveyance infrastructure and any additional on-site treatment facilities.

Actions Required by Bellary City Corporation

Water Management Plan

1. As a first step BCC should develop an integrated water and wastewater management plan at the city level by merging its current water supply as well as sewerage network and STP expansion plans. The plan should view treated wastewater as a critical component in the overall strategy to augment/conserve freshwater supplies to the city. An example of such a plan is the recent Water Policy for Delhi. The plan also should acknowledge the need to maintain minimum environmental flows to nourish rivers and aquifers to maintain the flora (including agriculture) and fauna of the region.

Municipal Regulation

1. Regulations mandating major wastewater generators such as commercial establishments like hotels, malls, etc. to go in for in-house decentralized wastewater management systems/on-site wastewater treatment and where possible reuse. This could be implemented through the enactment of a municipal bye law.
2. Reuse of treated municipal wastewater should be incorporated in the planning of new residential and commercial developments. This would involve setting aside land for STPs; and designing building codes, making it compulsory for developers to install dual pipelines in households; one for treated drinking water and the other for treated recycled wastewater for toilet flushing, etc.

Promoting Industrial Reuse

1. BCC should continue facilitating reuse by the sponge iron and steel units and other industries located in its vicinity by regularly allocating treated sewage water at price which would at least cover its operating cost of supply.

Tariff Reform

1. Treated freshwater supplies should be priced higher than the cost of treated municipal wastewater supplies to discourage excessive freshwater use and encourage reuse of treated wastewater, particularly for bulk consumers. Further, both treated freshwater price and treated municipal wastewater price should initially cover operating costs of each source and in the long run cover both operating and capital costs.
2. The sewage tax/charge currently levied should be enhanced to at least cover operating costs. Sewage revenues so generated should be earmarked for providing sewerage collection, treatment and reuse services by ring fencing them from the rest of the municipal fund.

Tackling Taboos

1. Sensitizing citizens through focused awareness campaigns on television, radio, social media and live events. The campaigns should aim at educating the citizens of a city of advantages of saving freshwater and breaking social taboos on reusing wastewater for non-potable purposes.

Capacity Building

1. Build capacity within BCC to operate wastewater recycling and reuse systems and to engage with the private sector in the discharge of such activities. This would involve:
    a. Rationalizing the number of posts required as has been given in the CPHEEO manual and fill vacant posts, wherever necessary;
    b. Have proper career planning and incentive mechanisms to improve morale;
    c. Impart regular training to engineers and technicians in operations and maintenance practices. For instance, attendance at CPHEEO training programmes could be made mandatory; and
    d. Creating awareness amongst municipal corporation councillors and officials through visits to sewage treatment and reuse facilities in Bangalore such as those for the golf course and the international airport and adopt similar technologies and institutional structures to recycle and reuse the city sewage for non-potable uses.

Rapid Assessment Process for Identification of Wastewater Reuse Opportunities

Based on the analysis of many water reuse projects in the country and elsewhere, the following checklist can be used by any stakeholder to quickly evaluate whether there are significant wastewater reuse opportunities in a city/town.

Step 1: Assess existing water supply demand balance in the city and project it over the next 20 to 30 years to get a reasonable picture of availability of water and ability of the city management to meet water demand from conventional surface and ground water sources

Step 2: Assess the existing and future sewage generation capability of the town as well as its wastewater collection and treatment capacity. This involves gathering information on plans to construct sewer networks and wastewater treatment plants over the forecast horizon and then calculating the amount of sewage collected and treated. At this stage it is also useful to gather information on the quality of raw and treated sewage being generated by the urban local body, as it can shed light on the extent of treatment required prior to reuse.

Step 3: Similarly, since industries located in the vicinity of the city are bulk water users and potential large reusers of treated wastewater, the existing and future water demand supply balance emanating from industries requires to be estimated over the same forecast horizon.

Step 4: Once the water demand supply balance for consumers within the city as well as the industry have been reckoned, the water deficits or unmet water demand from conventional sources arising from assessments in Step 1 and Step 3 are tabulated and taken as the maximum reuse potential which needs to be met from recycling of treated wastewater.

However the extent to which this potential can be met will be a function of the total volume of treated sewage generated, the minimum environmental flows required for maintenance of surface flows and ground water levels in the vicinity and the constraints on reuse in households, commercial establishments, institutions and industry.

Since estimation of minimum environmental flows is a data intensive and time consuming activity, in a rapid assessment maximum reuse potential is taken to be equivalent to the projected volume of the treated sewerage available over the forecast time horizon.

The reuse potential of forecast sewage generated is further constrained by social and technical factors such as social sensitivity towards reuse, lack of conveyance infrastructure and the possibility of contamination. Thus in a rapid assessment the various constraints to reuse are noted and used to quickly arrive at the areas in which reuse is possible. Quantification of these limited reuse possibilities is usually not attempted till the subsequent stage of project formulation for capitalizing on reuse opportunities. For this purpose a detailed project report needs to be prepared.

Step 5: The rapid assessment report also needs to quickly assess reuse opportunities which can generate income for the urban local body and private wastewater system operators. Since income generation requires ability and willingness to pay on the part of the potential reuse customer the rapid assessment should collect data on the cost of sourcing water from different sources as well as estimate the total cost of supplying treated sewage or at the very least the operating cost of supply of treated sewage.

Step 6: Finally, since in Indian cities the industrial customers are not only bulk consumers but also have the capacity to pay, the rapid assessment should identify a few income generating opportunities which can then be converted in to PPP projects fairly quickly.

Recommendations for 2030 Water Resources Group Program

In order to promote reuse of municipal wastewater in Karnataka and particularly in Tumkur, Hubli-Dharwad and Bellary, the 2030 WRG could engage with the Government of Karnataka, ULBs, KSSIDC, KIADB, Commissioner for Industrial Development and Directorate of Industries and Commerce, district administration and KUWS&DB to, inter alia:

- Detailed Studies
    i. Validate the findings of the rapid assessment through field visits to Tumkur, Hubli-Dharwad and Bellary.
    ii. Conduct techno-commercial feasibility studies at Tumkur to conceptualize and develop a PPP project involving reuse of municipal wastewater by industries such as the 30 mld wastewater supply project to Vasantha Narasapur Industrial Estate; the 15 mld wastewater supply to Janki Corporation; and the 7.5 mld wastewater supply from Cowl Bazaar STP.
    iii. Detailed market survey to ascertain demand from sponge iron and steel industry in Bellary.
    iv. Evaluate, in detail, opportunities such as the requirement by South-Western Railways workshop in Hubli;
    v. Evaluate in conjunction with the management of hospitals and nursing homes the opportunity for providing DEWATS/ DWMS systems with private participation in all three towns.
- Policy and Planning
    i. Assist the various departments of Government of Karnataka such as the Urban Development Department, the Industries and Commerce Department, Water Resources Department, Ground Water Board and Karnataka State Pollution Control Board as well as the agencies/parastatals (KUIDFC, KUWS&DB) under their purview in formulating policy at the state level for promoting recycling and reuse of wastewater which does not conflict with the need of farmers in the vicinity;
    ii. Assist ULBs and its councillors in developing policy and plans for reuse in non-potable activities in households, institutions, commercial establishment, etc.
    iii. Organise visits by state government officials and municipal corporation councillors and officials to visit plants in India treating wastewater for reuse, like the one in Bangalore, where treated wastewater is used in the golf course and the international airport so that they can adopt similar technologies and institutional structures to recycle and reuse the city sewage for non-potable uses.
- User Sensitisation
    i. Assist ULBs and its councillors in running awareness campaigns for promoting reuse amongst its citizens and institutions;
- Capacity Building
    i. Build capacity within ULBs, KUIDFC and KUWS&DB to design, build and operate wastewater recycling and reuse systems and to engage with the private sector in the discharge of such activities.

The 2030 WRG could consider undertaking the steps delineated above as part of its detailed assessment of the wastewater reuse opportunities in Karnataka.

Introduction

Genesis

The 2030 Water Resources Group (2030 WRG), in its on-going dialogue with the Government of Karnataka to reform the water sector for ensuring the management of its water resources for the long-term development and economic growth of the state, recently completed two analytical studies focusing on agricultural, industrial and urban water demand-supply balance and possible solutions for addressing future water scarcity in Karnataka including wastewater reuse options. As part of this exercise, 2030 WRG has identified two work streams for engagement as part of the convening phase in Karnataka, viz., "Agricultural Water Use Efficiency in Canal Command Areas" and "Wastewater Reuse" for further investigation as part of the Convene phase of its 'ACT' (Analyze-Convene-Transform) approach. The goal of the wastewater reuse work stream is to facilitate relevant technology, finance, capacity building and off take solutions for wastewater reuse including private sector participation or PPP models for the same.

In its dialogue with 2030 WRG regarding the "Wastewater Reuse" component, the Government of Karnataka identified the cities of Bellary, Tumkur and Hubli-Dharwad as candidates for pilot initiatives in the wastewater reuse segment and wanted 2030 WRG's support in carrying out a rapid assessment of urban wastewater opportunities in these three towns. In this regard, 2030 WRG has engaged the services of Powertec Engineering Pvt. Ltd for undertaking a rapid assessment of urban wastewater opportunities in the cities of Tumkur, Hubli-Dharwad and Bellary.

Assignment Objectives

The objective of the rapid assessment is to identify the potential for urban wastewater reuse in the cities of Tumkur, Hubli-Dharwad and Bellary, derive certain takeaways and policy measures which the Government of Karnataka could follow in promoting wastewater recycling and reuse, particularly in, small and medium cities in Karnataka and delineate the next steps for 2030 WRG as part of its Convene and Transform phases. As a result, the study has focussed on the following:

- Assessment of on-going urban wastewater treatment/ (re)-use initiatives and planned activities in each city.
- Assessment of short and medium-term potential for maximizing reuse in each city.
- Potential introduction of alternative technologies including decentralized solutions.
- Income generating and/or cost reducing wastewater opportunities (through reuse, energy recovery, agri-compost, horticulture use) in the city.
- Policy inputs for improving the enabling environment in the state, with special focus on PPPs where appropriate.
- Knowledge for replication of good practices across the state.
- Assessment of the role of 2030 WRG in supporting current and/ or potential reuse opportunities.

Approach and Methodology Used

This study has focussed on carrying out a detailed situational analysis of the wastewater sector in the identified cities through a rapid field survey which included interaction with officials from KUIDFC, KUWS&DB, Municipal Corporations, KIADB, the District Industries Centre, senior project personal and associates/ consultants. The situational analysis which was carried out in the towns of Tumkur, Hubli-Dharwad and Bellary covered an assessment of the city level water demand-supply scenario; industrial water demand-supply scenario; availability of treated sewage and potential for urban wastewater recycling and reuse, particularly by industries. A brief assessment of the sewerage assets in the city as well as institutional capacities to manage the sewerage assets within the local government agencies was carried out. Opportunities for generating income from wastewater were identified in these three towns and potential project opportunities for wastewater reuse were flagged for further investigation by 2030 WRG and the Government of Karnataka. A brief compendium of relevant international and national case studies has been prepared in order to derive good practises in this sector which may be replicated across Karnataka. The study recognises the need for huge investments in this sector and desire of governments to bring in private sector players to bridge the investment technology and capacity gap through PPPs. However based on experience elsewhere in the country and in China, the study identifies cases and situations where PPPs may work as well as the appropriate PPP model for a given set of operating constraints. In order to realise the full potential of wastewater reuse opportunities and PPPs in the urban wastewater sector, the study recommends policy intervention by the Government of Karnataka and how 2030 WRG may support the Government of Karnataka in implementing some of these interventions in the form of policy support, programs and projects.

Tumkur Rapid Assessment

Key Inferences

- **Water Supply Scenario:** Existing freshwater supply sources *adequate till the mid 2030s* with proposed rehabilitation of old WTP and planned and reduction in losses in the transmission and distribution system to 15% from current 40%. However, significant water supply augmentation needed after that.
- **Sewage System Scenario:** Planned sewerage network adequate over the forecast horizon but *STP capacity would need augmentation by 2030.*
- STPs are essential to treat wastewater in order to reduce pollution load on surface and ground water bodies in the vicinity and to enhance environmental flows by recharging ground water aquifers and improving water flows in surface water bodies.
- It would prudent for the Tumkur City Corporation (TCC) to start planning for the possibility that there would be water scarcity in the very long run (a time horizon of 20 years or more in the future) i.e. by the late 2030s.
- **Reuse Potential:** In order to augment / conserve freshwater supplies to meet impending water supplies scarcities, TCC can actively consider recycling treated wastewater as a substitute for freshwater in the following uses: industrial process water; non-potable domestic, commercial and public use and peri-urban agriculture.
  - *Reuse potential of industry* in short term as well as the medium to long term is significant as there is both existing demand and significant potential demand due to Tumkur and its environ being a part of the Chennai–Chitradurga Industrial Corridor.
  - *Reuse* of treated wastewater *potential in agriculture* negligible as they get freshwater which is preferred for the crops cultivated in the region.
  - *Reuse for non-potable purposes* in domestic, commercial and public uses only possible in the very long run i.e. late 2030s and beyond as there is adequate freshwater supply till then.
  - *Constraints on Reuse:* However, constraints to maximising reuse potential exist in municipal households, institutions, commercial establishments, parks, etc. in the form of:
    i. Social taboos; and
    ii. High cost of laying the infrastructure for supplying treated municipal wastewater to consumer.
- **PPP Opportunities:** There are a couple of income generating reuse projects, which could be implemented on a PPP basis. These are:
    iii. *Vasundhara Industrial Estate:* 30 mld of treated sewage water required. DPR on conveyance infrastructure is ready and with KIADB, Tumkur office. Estimated cost is Rs. 35 crore for a 21 km pipeline and associated infrastructure. Discussions with KIADB required.
    iv. *Dabas Pete Industrial Estate,* may be an income generating and PPP opportunity but needs to be discussed with KIADB, Bangalore.

Existing and Future City Water Demand-Supply Scenario

Existing water consumption as well as forecast water demand and supply in Tumkur are given in Table 2.1 below:

Table 2.1 Water Demand-Supply Balance 2011 to 2046 (in mld)

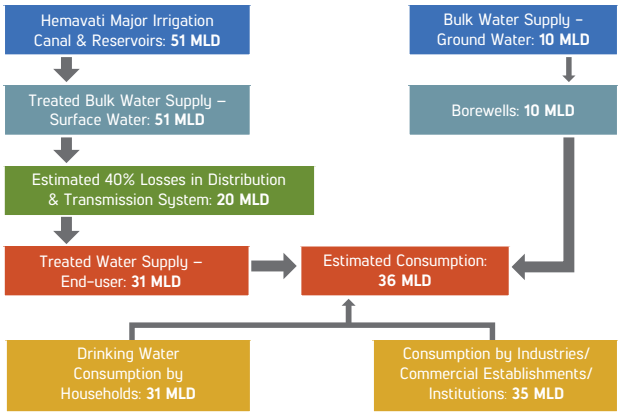
	2011	2031	2046
Forecasted Population (in Lacs)	3.05	4.63	5.91
Household Demand	31*	62♦	80♦
Institutions/Commercial/Industrial etc. Demand	5	6	8
Total Treated Water Demand at Retail Level	36	68	88
System Losses Estimated Only for WTP Supply	20 Θ	11 Φ	14 Φ
Total Treated Bulk Water Demand at WTP/Bore Wells	56	79	102
Treated Water Supply at Retail Level – New WTP 2011 (51 mld capacity)	31 Θ	43 Φ	43 Φ
Water Supply at Retail Level – Bore Wells Δ	5	10	10
Total Treated Water Supply at Retail Level	36	53	53
Treated Water Demand-Supply Surplus/(Deficit) at Retail Level	Nil	(15)	(35)
Treated Bulk Water Supply Ex-New WTP	51	51	51
Bulk Water Supply Ex-Bore Wells	5	10	10
Total Bulk Water Supply at Source	56	61	61
Bulk Water Demand-Supply (Deficit) at WTP/Bore Wells	Nil	(18)	(41)
Measures to Augment Bulk Water Supply to Meet Treated Bulk & Retail Water Demand			
Old WTP Pressed into Full Service – Treatment Capacity (in mld)		30	30
Old WTP Treated Water Supply at Retail Level Φ		26	26
Treated Water Demand-Supply Surplus/(Deficit) at Retail Level		11	(9)
Bulk Water Demand-Supply Surplus/(Deficit) at WTP/Bore Wells		12	(11)

Source: Tumkur City Corporation and KUWS&DB

* at 100 lpcd; ♦ at 135 lpcd; Θ at 40% system loss
Φ at 15% system loss; Δ Assuming no system loss

Existing Water Demand–Supply Balance

Existing Water Scenario



Source: Tumkur City Corporation, KUWS&DB and KIADB

At present, the 31 mld of treated drinking water consumption emanating from households, institutions, commercial establishments and industry within the city boundaries is being met by supply from a single 51 mld treatment plant drawing water from the Hemavati irrigation canal and two storage reservoirs at Bugudanally and Hebakka about 6 kms from the city. In addition, the Tumkur City Corporation (TCC) supplies about 5 mld from 542 bore wells to industries, commercial establishments and institutions. It is assumed that there is negligible loss of water supplied from bore wells. Thus TCC is able to meet its drinking water needs of 36 mld despite a 20 mld loss in transmission and distribution from the WTP.

Table 2.2 below gives the current rates at which water is supplied by TCC to its customers and by the KIADB to industrial units in the industrial estates managed by it.

Table 2.2 Existing Water Tariff for Different Sources of Water Supply

Users	Piped Municipal Supply (Flat Rate) (in Rs) ♦	Municipal Tankers (in Rs)	Private Tankers (in Rs)	KIADB (in Rs) Δ Φ
Domestic	120 per month	Free	64 / KL	–
Non–Domestic	240 per month	Free	64 / KL	–
Commercial + Industrial	360 per month	Free	64 / KL	30 / KL

♦ TCC levies one time installation charge of Rs. 1500 per connection

Δ KIADB levies a onetime development charge of Rs 2.5 lacs per acre for provision of water at the time of allotment of plot on a 99 year lease.

Φ KIADB provides both treated piped water from the Hemavati canal and bore wells to the industrial estate at Rs 30/KL.
But the bore well water is not treated.

Source: Tumkur City Corporation, KUWS&DB and KIADB

Future Water Demand–Supply Balance

In the future, if we presume that 40% system losses will continue, the expected demand[2] for treated bulk water from the city is likely to touch 109[3] mld in 2031 and 141 mld in 2046. Further if we assume that bulk water supplies from the new WTP commissioned in 2011 and from the bore wells would continue at the present levels of 51 mld and 5 mld respectively, *a bulk water demand–supply gap of approximately 53 and 85 mld would result in 2031 and 2046 respectively.* To bridge this gap, the city is planning to:

- Undertake a project for remodelling the water supply distribution system in order to reduce unaccounted for water from 40% at present to 15% in the future.
- Press the old water treatment plant (WTP) of 30 mld capacity into full service.
- Enhance supplies from bore wells.

Distribution System Renovation: A detailed project report (DPR) on remodelling the water distribution system has been prepared by Karnataka Urban Water Supply and Drainage Board (KUWS&DB), which has pegged the cost of the project at Rs 198 crore. Thus, it is expected that this would enable the 51 mld treatment plant installed in 2011 *to supply 43 mld of treated water to end–users i.e. an additional 12 mld over the present supply of 31 mld.*

Bore Wells: Based on current bore well capacity, the TCC has estimated that it can double supply of bore well water to end–users to 10 mld from 5 mld at present.

Old Water Treatment Plant (WTP): Even though the old WTP has been decommissioned, it has been kept in working condition by operating it for 2–3 days in a week to supply water to nearby villages. Thus, according to KUWS&DB officials, it can be easily pressed into service in the future with minor refurbishment to provide *an additional 26 mld of water* (assuming 15% loss in the transmission & distribution system as per CPHEEO guidelines) throughout the year. The current allocation of 1.2 TMC is sufficient to accommodate this additional raw water drawl of 30 mld.

Water Deficits: The distribution system renovation and bore well supply enhancements would be able to increase treated water supplies in Tumkur to 53 mld by 2031 from the current 36 mld leaving the city short of expected demand by 15 mld in 2031. The old water treatment plant, if pressed into full service by TCC, would be able to augment treated water supply by 26 mld to meet the water demand deficit till the mid 2030s. *However, the city would need to find new sources of freshwater by the mid 2030s in order to meet its growing water requirements from the late 2030s onwards.*

2 Projections based on interviews with KUWS&DB officials in Tumkur.

3 This has been calculated as follows: 62 mld of household water demand in 2031 when grossed up for 40% system losses is 103 mld; to this if we add another 6 mld emanating from institutions, commercial establishments and industrial units the result is 109 mld of bulk water demand.

Current and Future Sewage Generation and Treated Sewage Capacity

Current Status of Sewer System

Sewer Network: *The present underground drainage (UGD) or sewer network in the city has a length of 186 kms with 6300 manholes and is restricted to the core areas of the city.*[4] *It covers 60–70% of the population of the city.* The remaining 30–40% of the population not connected to UGD uses septic tanks with or without soak pits.

Sewage Treatment Facilities: Currently, *there is one sewage treatment plant (STP) of 25 mld capacity near Bhimasandra tank using facultative aerated lagoon with polishing pond. Out of approximately 30 MLD of sewage generated, from the sewer network areas by households, institutions and commercial establishments, the STP receives just 16–18 MLD of sewage at the plant site,* the remaining effluent is directly disposed off in to storm water drains by the population not connected to the UGD network. The treated effluent from the plant is let out into nearby fields as well as Bhimasandra tank. Due to erratic power supply and a mostly dysfunctional back-up generator, the STP is not in operation for two to three hours in a day quite frequently.

Table 2.3 gives the sewerage tax/charges levied by BCC annually for collecting revenues to finance the cost of operating and maintaining the sewer network and sewage treatment plant

Table 2.3 Existing Sewerage Tax/Charges

Users	House Holds	Non-domestic	Industry & Commercial	Hotels	Lodges
Charges (Rs. Per Annum)	254	600	1200	3000	1080
One time installation charge of Rs. 1500 per connection					

**Source:* TCC and KUWS & DB, Tumkur

Planned Expansion

It is proposed that by 2017, 100% of the households will be connected to the UGD network; hence the expected sewage generation is likely to touch 66 mld in 2031. In order to meet this demand, the city is planning *to commission an additional 25 mld capacity STP by 2017,* increasing the total sewage collection and treatment capacity to 50 mld. This would, however, leave the city 7 mld short of projected requirement in 2031. According to KUWS&DB officials in Tumkur, the estimated capital cost of the expansion network and the proposed STP to be commissioned by 2017 by KUWS&DB[5] is Rs 172 crore.

Forecast Sewage Generation and Treatment Capacity 2011–2046

Table 2.4 below gives the existing and future sewage generation, collection and treatment capacity scenario.

Table 2.4 Sewage Generation and Treatment Capacity 2011 to 2046 (in mld)

	2011	2031	2046
Sewage Generation[6]	30	57*	66*
Wastewater Collection[7]	16–18	57	66
Wastewater Treatment Capacity	25	50	50
Sewage Treatment Capacity Shortfall	Nil	7	16

Source: KUWS&DB
*Powertec Estimates

The forecast assumes that treated water supply at the retail level in 2046 will remain unchanged at 79 mld for the city. In case the shortfall in treated water supply of 9 mld in 2046 is met through additional water supply schemes using both additional freshwater from surface and groundwater sources, harvested rain water as well as reuse of treated sewage water then the sewage generated would be 74 mld.[8]

4 It was commissioned in December, 2003 and along with the STP was designed for a 2021 population of 3.5 lacs in the core areas of the city according to KUWS&DB officials in Tumkur.

5 KUWS&DB designs and constructs the UGD assets in Tumkur, while the TCC operates and maintains the sewer network and the STP.

6 Sewage generation is a function of treated water consumed, which is the lower of unconstrained treated water demand by consumers or treated water supply at consumer doorstep. Treated water supplies are expected to be 79 mld in 2031 and remain constant thereafter as against treated water demand of 68 mld and 88 mld in 2031 and 2046 respectively. Thus sewage generated in 2031 and 2041 would be 80% of 68 mld of demand plus 5% extra for infiltration i.e. approximately 57 mld and in 2046 it would 80% of 79 mld of supply plus 5% extra for infiltration or 66 mld. The calculations take the entire population into account not just those connected to the network.

7 Sewage generation calculation takes the entire population of Tumkur into account, while wastewater collection is based on population actually connected to the sewer network, which was just 60–70% in 2011 and is expected to be 100% in 2031 and 2041.

8 88 mld X 80%X1.05 = approx. 74 mld.

Existing and Future Industrial Water Demand–Supply Scenario

Present situation

Industrial water demand arises from rice mills, fabrication shops, small-scale workshops and the like in and around the city. *Most of the demand emanates from rice mills which are concentrated in the northern part of the city and require about 3 mld of water which is met from the municipal water supply system and their own bore wells.*

There is however significant demand for water emanating from industries located in industrial areas outside the city. The prime being:

- **Vasantha Narasapura and National Investment and Manufacturing Zones (NIMZ) extension** (totalling 13000 acres) in the North-West on the Chennai–Chitradurga Industrial Corridor;
- **Dabas Pete Industrial Estate** to the South-East of the city on NH-4 again on the Chennai-Chitradurga Industrial Corridor; and
- The **dairy plant** on the Bangalore-Honavar road west of the city.

The *type of industries* located in these parks is mixed i.e. *a blend of engineering, packaging, food processing etc.* For example, the Food Park near Vasantha Narasapura, recently inaugurated by the Prime Minister Narendra Modi, exemplifies the type of industry that would come up in the area.

Present Water Consumption in Industrial Estates

At present, the consumption of water by industries located in the estates mentioned above is approximately 16 mld which includes 0.1 mld or 100 KL per day from the dairy plant. Since these estates are developed and maintained by Karnataka Industrial Areas Development Board (KIADB) the responsibility for supplying water vests with KIADB. Hence, *KIADB is responsible for constructing and operating water supply systems for supplying water to industries in these estates.*

Existing Water Supply Situation

Current consumption is being met by supplies from both treated piped water from Hemavati canal (15.68 mld) and untreated bore well water from bore wells in the industrial estates.[9] All the bore wells are under the control of KIADB, which has metered them. KIADB charges Rs 30/KL from the industries for both sources of supply. Further, KIADB collects Rs 2.5 lacs per acre upfront from industrial units at the time of applying for a plot, as a development charge for providing water supply infrastructure.

Projected Water Demand in Industrial Estates[10]

Based on applications received by KIADB for plots in the 3800 acres being developed in three phases over the next 5 years at Vasantha Narasapur, *it is projected by KIADB that the total water demand from all three phases will be 30 mld in 5 years time.* Further, KIADB estimates that the *ultimate demand from all industrial estates over the next 15–20 years would be 98 mld.* Annexure 2 gives a list of industries that have applied for plots at Vasantha Narasapur over the next 5 years.

Proposed Augmentation of Water Supplies to Industrial Estates[11]

As there is an apprehension that the current sources of water may not be available for industries in the future, *KIADB has designed a scheme to supply 30 mld from the treated*[12] *wastewater discharged into Bhimsandra Tank to meet the expected demand at Vasantha Narasapur in 2019.* The tank is located on the western boundaries of the city next to the STP. The components of the scheme include a collection well, a 21 km rising main, pumping machinery and reservoir. The scheme would abstract 32 mld from Bhimasandra tank in order to supply 30 mld at the industrial estate. The DPR prepared by EI Technologies Pvt Ltd, Bangalore for KIADB estimates the capital cost to be Rs 35 crore at 2013-14 prices. KIADB will fund the entire capital cost of the venture.

There is also a proposal with KIADB for supplying an unspecified amount of treated sewage water from Bhimasandra tank to the industrial estate at Dabas Pete over a distance of 22 kms from Bhimasandra Tank. The Dabas Pete industrial estate is located to the south-east of Bhimasandra Tank on NH-4 in the direction of Bangalore. The Table 2.5 below gives the demand-supply balance for industries:

9 Average depth of groundwater is 700–800 ft.

10 *Source*: Discussions with KIADB, Tumkur and TCC officials.

11 *Source*: Discussions with KIADB, Tumkur officials.

12 Wastewater is treated to secondary level of treatment.

Table 2.5 Industrial Demand-Supply Balance 2014 to 2031						
Demand						
	Existing Requirement 2014 (mld)	Location	Future Requirement 2019 (mld)	Location	Future Requirement 2031 (mld)	Location
	16	Vasantha Narasapur & NIMZ Extension, Dabas Pete, Dairy Farm etc	46	Vasantha Narasapur & NIMZ Extension, Food Park, Dabas Pete, Dairy Farm etc	98	Vasantha Narasapur & NIMZ Extension, Food Park, Dabas Pete, Dairy Farm etc
Total	16		46		98	
Supply						
	Current Supply (mld)	Supply Source	Future Supply 2019 (mld)	Source	Future Supply 2031 (mld)	Source
	16	KIADB – Hemavati Canal & Groundwater	16	KIADB – Hemavati Canal & Groundwater	16	KIADB – Hemavati Canal & Groundwater
			30*	KIADB – Bhimasandra Tank – Treated Sewage Water	30*	KIADB – Bhimasandra Tank – Treated Sewage Water
Total	16		46		46	
Gap	0		0		52	

Source: Discussions with KIADB, Tumkur and TCC officials

*Supplies from Dabas Pete project have not been included as no details were available with the KIADB office in Tumkur.

Assessment of Potential and Constraints for Maximising Reuse

The potential for reuse in industry as well as Tumkur City is given in the Table 2.6 below

Table 2.6 Reuse Potential		(in mld)
	2019	2031
Unmet Water Demand Tumkur City	0	0
Unmet Water Demand from Conventional Surface and Underground Sources – Industries	30	82
Forecast Volume of Treated Sewage	50	50

Source: KUWS&DB, KIADB, TCC and Powertec Research

Existing Water Supply Sources Adequate for TCC till the Mid-2030s

As is clear from Table 2.5 above and the previous sections, the existing surface and groundwater sources would be adequate to meet the treated water requirements of Tumkur City till 2031, particularly after the Old WTP is recommissioned after renovation. However, by the late 2030s treated water demand would outstrip supply from existing as well as presently envisaged water supply sources and the treated water supply deficit is projected to touch 9 mld by 2046.

TCC Water Demand-Supply Balance Post-2031 Scenarios

Scenario 1: *One scenario that may emerge after 2031, is that the TCC manages to secure additional raw water allocation from the Hemawati Major Irrigation Canal over and above the existing 1.2 TMC.* **This would enable it to meet the deficits in treated water supply post**-2031 by constructing additional reservoir capacity, installing more jack wells for greater water abstraction capability and establishing additional water treatment plants.

Scenario 2: *The second scenario would emerge from the likelihood that the TCC may either not be granted any additional raw water allocation over and above the current 1.2 TMC or may be granted an insignificant increase because of overall scarcity of raw water in the region and the Gorur-Hemavati dam on the Hemavati river feeding the Hemavati Major Irrigation Canal.* In either case, the TCC would find it difficult to augment treated water supplies using surface and groundwater sources of raw water alone and would have to resort to the use of alternative sources such as rainwater harvesting and reuse of treated sewage water to augment supplies.

At this juncture, based on the forecast water scarcity situation in the region, it seems that the likelihood of Scenario 2 prevailing from the late 2030s is high. Therefore, it would behove the TCC to start planning for the possibility that the second scenario may characterize the water supply situation in the very long run (very long run is defined as more than 20 years in the future). This would imply that by the mid 2030s, the TCC would have the infrastructure in place or be actively implementing infrastructure works for utilizing a mix of sources viz., surface water, groundwater, harvested rainwater and recycled municipal wastewater to provide water to the residents, institutions and commercial establishments of Tumkur City.

Areas of Reuse of Treated Municipal Wastewater

Municipal sewage or wastewater can be recycled for reuse after tertiary treatment and disinfection in:

- **Industrial units** including power plants but excluding food processing units for process use, cooling water and wash water purposes.

Municipal sewage or wastewater can be recycled for reuse after secondary treatment and disinfection in:

- **Households** for non-potable purposes such as flushing toilets, watering gardens and washing cars.
- **Public and Private Institutions** like schools, colleges, hospitals, bus and railway stations etc. for non-potable purposes such as for flushing toilets, watering gardens and centralised air conditioning.
- **Commercial establishments** including offices, small industrial units and workshops for non-potable as well as non-process purposes such as for flushing toilets, watering gardens, centralised air conditioning etc.
- **Public purpose** by municipalities such as street washing, flushing of sewers, watering parks etc.

Further, urban wastewater can be reused after secondary treatment and disinfection in:

- **Peri-Urban Agriculture** as water for irrigation and as fertiliser for vegetables and other crops grown in the vicinity of the city.

Finally, it can be used after secondary treatment and disinfection for:

- **Surface Water Discharge:** this is to augment surface waters in rivers, streams and lakes in the vicinity to ensure that the flows in them meet the minimum environmental flow standards, which is essential to keep them from going dry and to maintain the flora and fauna including agriculture of the region.
- **Groundwater Recharge** by discharging treated sewage on to nearby fields, nallahs (natural water courses) and tanks. Indirectly, this leads to wastewater reuse for both potable and non-potable activities as groundwater is regularly abstracted to augment surface water supplies in most places.

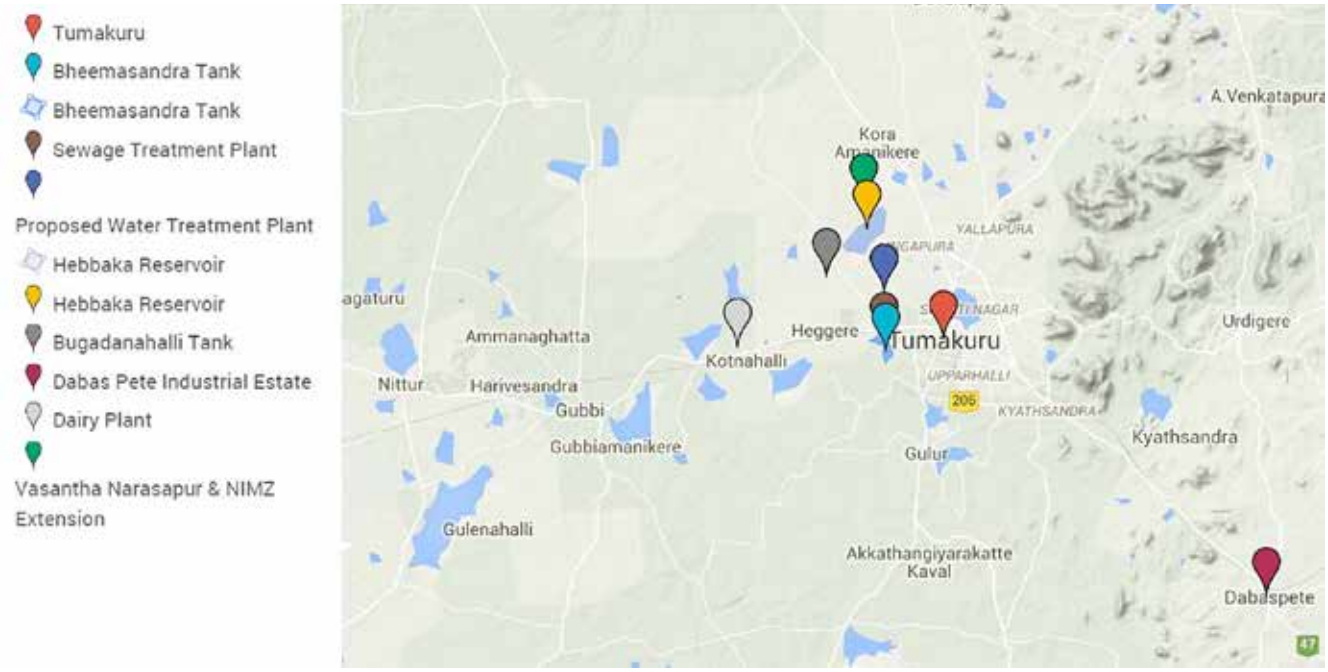
Reuse Potential of Treated Municipal Wastewater in Tumkur City

- **Non-Potable Use in Households:** As conventional surface and groundwater sources are expected to be adequate in the short (up to next 5 years) to long term (from 11 to 20 years in the future) term there is *very little scope to reuse recycled municipal wastewater for non-potable purposes in households in Tumkur over the next fifteen years.* In the long term (from 11 to 20 years in the future) and the very long term (> 20 years), if Scenario 2 manifests itself as is likely, supply shortages would create a conducive environment for potential reuse in non-potable activities.
- **Non-Potable Use in Institutions:** Similarly, the water demand emanating from institutions in Tumkur City can be met from conventional sources for the next ten to fifteen years. Hence there is *little scope for reuse of treated municipal wastewater in the short to medium term.* However, one could look at a few institutions such as the Sree Siddhaganga Matt, a religious institution, on the outskirts of the city, which is currently getting free water from the TCC. However, the potential needs of such institutions as well as the costs of such systems would need to be closely evaluated, particularly since there is no municipal bye-law directing such institutions to recycle and reuse wastewater.
- **Commercial Establishments:**[13] Again as water scarcity is only likely to manifest itself in the early 2030s the potential for reuse of municipal wastewater *is limited in the short to medium term.*
- **Public Parks and Other Public Purposes:** As increasing water scarcity will be the main determinant of reuse; t*he potential will only materialize in the long term or very long term i.e. over the next twenty years or more.*
- **Industry:**[14] As Tumkur and its environs fall on the Chennai-Chitradurga Industrial Corridor which is expected to develop very rapidly over the next decade or two, KIADB has estimated that at least 46 mld of water would be required by industries located in the Vasantha Narasapur and NIMZ Extension and Dabas Pete in the next 5 years. Ultimately, demand from all the industrial estates in the vicinity is expected to go up to 98 mld in the next 15-20 years. In the medium term, there is significant potential for reuse of treated municipal sewage given that surface and groundwater supplies are likely to be inadequate due to rising water scarcity in the region combined with competing demands from agriculture and households. Thus, the *potential for recycled municipal wastewater is expected to be 30 mld in the medium term (6-10 years) and 82 mld in the very long term (> 20 years), on the assumption that the 16 mld currently being supplied by water sourced from the Hemavati Canal and bore wells on the industrial estates is unlikely to be enhanced.*
- **Peri-Urban Agriculture:** There is *unlikely to be much demand from farmers in the vicinity for treated sewage water* as the main crops being grown in the neighborhood of Tumkur are coconut and areca nut. For both crops freshwater is better than treated municipal wastewater.[15] Thus ever since farmers in the region have started getting free water from the Hemavati canal for irrigation, demand for wastewater from them has completely disappeared. This situation is likely to continue in the foreseeable future as well.

13 Treated sewage water is not recommended for use in rice mills for process use as there is the possibility of contamination of food products in case of any operational problems experienced by the treatment plants.

14 Treated sewage water is also not recommended for use in the dairy farm for process use as there is the possibility of contamination of dairy products in case of any operational problems experienced by the treatment plants.

15 As mentioned by officials of KIADB and KUWS & DB in discussions with them.



Constraints to Maximizing Reuse Potential in Tumkur

- **Constraints to Non-Potable Reuse in Households:** The biggest obstacles over the next fifteen years to reuse of treated municipal wastewater in households for non-potable purposes are:
  - the cost of laying the pipelines for conveying the treated wastewater to residences for use in toilets and gardens; and
  - The sensitivity of society towards use of wastewater for any purpose. The sensitivity of society to reuse of treated wastewater is understandable given that historically wastewater has not been treated in India and wherever it has the functioning of STPs leaves much to be desired.[16]
- **Constraints to Non-Potable Reuse in Institutions:** The biggest impediment is the cost of laying pipelines and other associated infrastructure for conveying wastewater to institutions from large, centralised STPs. This impediment could be overcome by encouraging adoption of decentralized wastewater collection and treatment systems by institutions either individually or in a group located in the same area. It is also likely to disappear in the long to very long run in case scenario 2 materializes.
- **Constraints to Non-Potable Reuse in Commercial Establishments:** Similarly, the cost of laying pipelines and other associated infrastructure for conveying wastewater is the biggest impediment to reuse. In the long to very long run this constraint may naturally disappear as water scarcity levels rise, if scenario 2 manifests itself. Also, treated sewage water is not recommended for use in rice mills (which account for about 60% of commercial demand for water in the city) for process use as there is the possibility of contamination of food products in case of any operational problems experienced by the treatment plants. This restricts reuse by the agro-processing industry.
- **Constraints to Reuse in Public Parks and Other Public Purposes:** Again, the main obstacle to reuse in urban horticulture is the cost of laying pipelines and other associated infrastructure for conveying wastewater. Similarly, under scenario 2 this constraint may no longer be a big hindrance. Also, since the parks belong to the City Corporation, it is likely that the treated wastewater will be supplied free or at a very nominal rate, hence TCC will not be able to earn enough revenue to substantially offset the costs of reuse. Hence, it will not generate much financial benefits for the city but would save freshwater.
- **Constraints to Reuse in Industry:** Usually, there are two key constraints to reuse by industry; the first is economic i.e. the cost of reuse supply relative to other sources of supply; and second, social/political due the conflict with farmers on the periphery, who utilize the same sewage for irrigation and fertilizing their fields. In Tumkur's case, the second constraint does not exist as the main crops in the region require freshwater.[17]
- **Constraints to Reuse in Peri-Urban Agriculture:** As mentioned above, there is negligible demand for treated sewage water by farmers; hence the question of constraints to maximizing reuse potential in agriculture does not arise.

16 The Tumkur STP at Bhimsandra Tank is not operational for 2-3 hours most days due to erratic power supply and a generally dysfunctional back-up generator because TCC budgetary constraints result in a shortage of spares and fuel.

17 The main crops in the vicinity of Tumkur are coconut and areca nut. For both crops freshwater is better than treated municipal waste water. Thus ever since farmers in the region have started getting free water from the Hemavati canal for irrigation, there is no demand for wastewater from them.

Income Generating Wastewater Opportunities

Revenue generating opportunities are given below:

- **Vasantha Naraspur and NIMZ Extension Project:** The KIADB has a proposal to abstract 32 mld of secondary treated wastewater from Bhimasandra tank for supply of 30 mld of secondary treated sewage water to Vasantha Narasapur and NIMZ Extension 21 kms away at an estimated capital cost of Rs. 35 crore in FY 2013–14 prices.
- **Dabas Pete Industrial Estate:** There is a proposal with KIADB to supply an unspecified amount of *treated wastewater let into the Bhimasandra tank* to Dabas Pete industrial estate over a distance of 22 kms.

Project Implementation Structures

There are several ways that the abovementioned projects could be implemented. The main modes are given below:

1) *TCC owns, develops, finances and operates the projects itself* and recovers the capital costs and operating costs of not only the additional infrastructure involved in conveying the treated sewage from Bhimsandra tank but also the capital and operating costs of Tumkur's sewerage network and STPs from the industrial units located in the industrial estates.
2) *The private sector is allowed to develop the projects to supply treated municipal wastewater to industry on a Public–Private–Partnership (PPP) basis.* Thus the projects get housed in an SPV either fully privately owned or in a joint venture between the private party, the TCC and GoK. The SPV would have the responsibility to finance, build, own and operate the project and would recover its capital and operating costs of treatment of wastewater from Bhimsandra tank and conveyance to the industrial estates from the industrial units.
3. *The private sector is allowed to develop on a PPP basis not only the aforementioned projects but also the municipal STP/STPs located near the tank,* so that issues related to STP operations and sewage quality are taken care off as well.
4) *Private sector involvement could be in the form of management contracts* where its specialised knowledge and management skills could impart better operating efficiency than public sector alternatives. Thus the ownership of the projects would vest with TCC and GoK and they would be operated by the private sector.

Caveat: However, it would be advisable to closely evaluate the financial viability of a full-fledged Build-Operate-Transfer (BOT) or a Design-Build-Finance-Operate-&-Transfer (DBFOT) scheme based on a close assessment of demand, future reliability of alternate water supply sources, cost of constructing and operating a recycled municipal wastewater system (cost of treated sewage, pipeline, tertiary treatment including disinfection by chlorination etc.), industry's willingness to pay and the cost of supply from alternate sources such as ground and surface water.

Wastewater Collection and Treatment System Cost Recovery Measures for TCC

In both the PPP structures outlined above, the TCC could look at supplying treated sewage to the SPV from its STPs at Bhimasandra tank, at a price which at least covers its O&M cost of collecting and treating municipal wastewater to secondary levels. Quick estimates of the existing sewerage network and the STP indicate that the unit O&M cost of the system is Rs 3.18/ KL.

Please refer to the tables below for estimates of the unit O&M costs of Tumkur City's existing sewerage network and STP.

Table 2.7 Cost of Operating and Maintaining Existing Sewer System at 2013–14 prices

Annual O&M Cost Excluding Electricity Charges for Pumps (Rs Lacs)	40.5
Annual Electricity Charges for Pumps (Rs Lacs)	55
Total Annual O&M Cost Including Electricity Cost (Rs Lacs)	**95.5**
Estimated Annual Sewage Flow (in Lacs KL in FY 2013–14)	62.05
Estimated Electricity Cost (Rs/KL)	**0.89**
Estimated Total O&M Cost Including Electricity Cost in Rs/KL	**1.54**

Table 2.8 Cost of Operating and Maintaining STP at 2013–14 prices

Annual O&M Cost Excluding Electricity Charges (Rs Lacs)	61
Annual Electricity Charges (Rs Lacs)	41
Total Annual O&M Cost Including Electricity Cost (Rs Lacs)	**102**
Estimated Annual Sewage Flow (in Lac KL)	**62.05**
Estimated Electricity (Rs/KL)	0.66
Estimated Total O&M Cost Including Electricity Cost in Rs/KL	1.64
Total O&M Cost of Sewerage System including STP	**3.18**

Source: Tumkur City Corporation and Powertec Estimates

TCC Cost Recovery Enhancement or PPP Revenue Enhancement Measures

TCC will not be able to use revenues from the sale of sludge as a regular source of income since sludge is removed only once in every 5–10 years as sludge production is low in aerated lagoons. Further, the use of bio-culture, as is being done presently, reduces the sludge produced to negligible quantities. It is advisable that the evaluation methodology of the various technology options and revenue enhancement measures be based on the NPV of their capital expenditures, O&M costs and the revenues/savings generated over their lifecycle.

Hubli – Dharwad Rapid Assessment

Key Inferences

- **Water Supply Scenario:** Hubli-Dharwad Municipal Corporation (HDMC) has ample freshwater supplies till 2041, if allocation request for additional 222 mld comes through either fully or substantially (Scenario 1). If Scenario 2 (the allocation request is not granted or very partially granted) materialises, then HDMC will face freshwater shortages in the medium term itself (next 6–10 years). At this stage, chances of Scenario 1 materialising are high.
- **Sewage System Scenario:** Planned sewage treatment capacity would need to be augmented by the early 2030s in case Scenario 1 prevails from the medium term. In case Scenario 2 materialises over the medium term, then planned capacity sufficient for the very long run (i.e., a time horizon of > 20 years).
- **Reuse Potential:** The treated wastewater reuse potential in HDMC is as follows:
  - *Industrial reuse potential* is limited as the industries in the region are not water intensive and there is sufficient surface water available to meet their needs. Only reuse possibilities are:
    i. Railway Workshop: 15 mld future demand and about 5 kms from the 40 mld Madihal (near Gabbur) STP in Hubli.
    ii. Circa 1.5 mld for Rayapur and Lakamanhalli industrial areas in Dharwad about 12 kms from KUAS STP in Dharwad.
  - There is *significant reuse potential in peri-urban agriculture* as farmers in the vicinity currently use untreated sewage as fertilizer and to irrigate their crops. Treated wastewater will reduce health hazards for both the farmers and the final consumers of their products.
    i. STPs have to be designed with discharge infrastructure like small canals or pipelines to ensure equitable geographical distribution of wastewater amongst farmers in the vicinity of the STPs.
    ii. Finally, fee charged for reuse in agriculture should be minimal in order to maximize reuse in peri-urban agriculture.
  - *In case Scenario 2 materialises,* then reuse possibility in HDMC for household toilet flushing and watering gardens, non-potable in commercial establishments and institutions and for use in public parks and toilets, etc. open up from the medium term itself.
  - *Small scale, decentralised collection, treatment and reuse opportunities* are available in *educational institutions,* particularly private ones. However, such opportunities may or may not be financially viable on a stand-alone basis without external support from the Government of Karnataka and/or HDMC.
- **Constraints on Reuse:** Significant constraints to maximising reuse potential exist:
  - In municipal households, institutions, commercial establishments, parks, etc. in the form of social taboos and high cost of laying the infrastructure for supplying treated municipal wastewater to consumer.
  - In case Scenario 2 materialises, another constraint to maximizing reuse in non-potable municipal uses would be competition for limited supply of treated sewage from farmers using it for peri-urban agriculture, which could turn ugly and take a political twist.
- **PPP Opportunities:** There is only one income generating reuse project, which could be implemented on a PPP basis:
  - *Railway Workshop:* The South-Western Railways have a workshop in Hubli which currently consumes 3 mld of water but according to KUWS&DB officials is likely to increase to 15 mld in the in the future depending on the expansion plans of the workshop. Madihal STP could supply treated wastewater for wagon cleaning and non-potable domestic use to it.

Existing and Future City Water Demand-Supply Scenario

The existing as well as forecast water consumption and supply are given in Table 3.1 below:

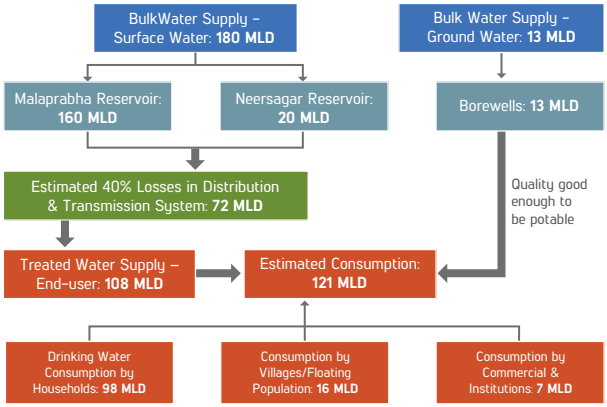
Table 3.1 Water Demand and Supply Balance 2014 to 2041 (in mld)

	2014	2021	2031	2041
Treated Water Demand	121♦	208	275	362
System Losses @ 15%	72*	31	41	54
Bulk Raw Water Demand	193	239	316	416
Raw Water Supply – Malaprabha Reservoir**	160	160	160	160
Raw Water Supply – Neersagar Reservoir	20	20	20	20
Bore Wells	13	13	13	13
Total Raw Water Supply	193	193	193	193
Surplus/(Deficit) of Bulk Raw Water	Nil	(46)	(123)	(223)
Measures to Augment Water Supply				
Enhanced Allocation from Malaprabha Reservoir has been Requested (2.842 TMC)		222	222	222
Surplus/(Deficit) of Bulk Raw Water		176	99	(1)

Source: KUWS&DB Projections
* System Losses @ 40%
♦ Includes industry consumption by the South-Western Railway Workshop
** 2.02 TMC

Existing Water Demand–Supply Balance

Existing Water Scenario



At present, the estimated demand of 121 mld of treated drinking water emanating from households, institutions, commercial establishments and industry within the city boundaries is being met by raw water supply from two storage reservoirs, the Malaprabha Reservoir and the Neersagar Reservoir of 160 mld and 20 mld respectively. In addition, the Hubli-Dharwad Municipal Corporation (HDMC) supplies about 13 mld of potable treated water from 1133 bore wells. Thus, despite 40% of the supply from the two treatment plants or approximately 72 mld being lost in the transmission and distribution system due to leakages, pilferage and illegal connections, the city is able to meet its water consumption requirements.

Table 3.2 below gives the current rates at which water is supplied by HDMC to its customers and by the KIADB/KSIDC to industrial units in the industrial estates managed by it.

Table 3.2 Tariffs for Different Categories of Users

Users	Municipal Supply (Flat Rate)	Municipal Supply (Metered Rate)	Municipal Supply (24x7 Rate)	KIADB/KSIDC
Domestic	Rs. 90 per month	0–15 KL – Rs. 90 per month; > 15 KL – Rs 5.80/KL	Min Rate = Rs. 48 per month; 0–8 KL = Rs. 6/KL; 8–25KL = Rs. 8/KL; 25–40 = Rs. 12/KL; > 40 KL = Rs. 40/KL	
Non–Domestic	Rs. 180 per month	0–15 KL – Rs. 90 per month; > 15 KL – Rs 11.60/KL	Min Rate = Rs. 96 per month; 0–8 KL = Rs. 12/KL; 8–25KL = Rs. 16/KL; 25–40 = Rs. 24/KL; > 40 KL = Rs. 80/KL	
Commercial + Industrial	Rs. 360 per month	0–15 KL – Rs. 90 per month; > 15 KL – Rs 23.20/KL	Min Rate = Rs. 192 per month; 0–8 KL = Rs. 24/KL; 8–25KL = Rs. 32/KL; 25–40 = Rs. 48/KL; > 40 KL = Rs. 160/KL	Rs. 32/KL (KIADB); Rs. 242p.m.+ Rs. 25/KL (KSIDC); Single Flr: Rs. 82–645/month; > = 2 Flr: Double 1 Flr Rate

Source: HMDC, KUWS&DB , KUIDFC and KIADB.

Future Water Demand–Supply Balance

In the future, the treated water demand of the city is expected to touch 275 mld in 2031 and 396 mld in 2044.[18] ***The South–Western Railway Workshop*** situated in Hubli is also a part of the demand emanating from commercial and industrial establishments within the city. Currently, according to KUWS&DB, it *receives 3 mld of water for wagon cleaning and domestic use*. This demand is *expected to go up to 15 mld in the long run subject to the expansion plans of the workshop*.

In order to meet this demand the city is:

- Planning to undertake remodelling of the water supply distribution system to reduce unaccounted for water from 40% at present to 15% in the future.
- Augment the surface-source raw water available for use by HDMC by 222 mld.

Allocation Enhancement: HDMC and KUWS&DB have applied to the Water Resources Department through the Karanataka Neeravari Nigam Ltd. for enhancing the allocation from Malaprabha Reservoir to 4.86 TMC[19] i.e., by an additional 2.84 TMC over the current draw of 2.02 TMC.[20] *This would increase the bulk raw water available from surface sources by 222 mld.*

Water Deficit: However, the city would still be 1 mld short of expected demand for bulk raw water in 2041 assuming no increase in bulk water supply.

18 KUWS&DB projections based on 135 lpcd for domestic population, 70 lpcd for floating population and 45 lpcd for schools and colleges.

19 1 TMC = 78 mld supplied for 365 days in a year.

20 The actual allocation is 0.216 TMC but as per Government of India rules one can draw 10 times the actual allocation for drinking water purposes.

Current and Future Sewage Generation and Sewage Treatment Capacity

Current Status of Sewer System

Sewer Network:[21] *At present, the twin cities have a sewer network with a length of 440 kms connecting 60% of the area in Hubli and 40% in Dharwad respectively. Approximately 45% of the households in Hubli and 35% of the households in Dharwad are connected to the underground drainage (UGD) network. This is equivalent to 41% of the households of the twin cities combined.* The households not connected to the UGD network in the twin cities use septic tanks with or without soak pits, however, quite a few households which do not have soak pits dispose of the effluents by directly connecting septic tanks to storm water drains. Presently, the sewers are cleaned by HDMC using eight jetting machines and suction pumps owned by them.

Sewage Treatment Facilities:[22] Currently, the UGD network does not have any treatment plants. The sewage from the existing outfall sewer collects in the Gabbur nallah in Hubli and Madihal nallah in Dharwad and is then disposed into the open or on to agricultural fields south of Hubli and Dharwad.

Planned Expansion[23]

Sewer Network: Over the last few years, HDMC through KUIDFC has been undertaking extensive rehabilitation and extension of the underground drainage network. *It is expected that by 2021, the UGD network will expand to 578 kms covering 90% of area in Hubli and 80% in Dharwad. This proposed expansion plan seeks to connect 75% of the population in Hubli and 65% of the population in Dharwad respectively, i.e., 68% of the combined population of the twin cities*. Further, Hubli Dharwad Urban Development Authority has made it mandatory for developers to lay underground sewers for all new developments. *By 2029, it is expected that the underground drainage network would cover 100% of the city area and connect all households in the city.*

Sewage Treatment Facilities: *In order to meet the growing demand for sewage treatment, HDMC through KUIDFC is undertaking the design and construction of four STPs based on SBR tertiary treatment technology with disinfection through chlorination.* Two STPs, each of 40 mld treatment capacity in Hubli; and two STPs, each of 20 mld treatment capacity in Dharwad, are proposed to be commissioned. Further, another STP of 25 mld capacity is planned for Dharwad, taking the total tertiary treatment capacity of the twin cities to 145 mld by 2029.

21 *Source*: Discussions with HDMC and KUIDFC officials.

22 *Source*: Concept Report Underground Sewerage Scheme in Hubli Dharwad City Corporation, Wilbur Smith Associates.

23 *Source*: Discussions with KUIDFC officials and CDM Wilbur Smith Consultants; Concept Report Underground Sewerage Scheme in Hubli Dharwad City Corporation, Wilbur Smith Associates; NKUSIP Package I: Dharwad Sewage Treatment Plant, February 2011, Wilbur Smith Associates.

Table 3.3 Influent & Effluent Sewage Quality			
40 mld STP at Madihal – Technology: SBR + Chlorination (Design Parameter Values)			
Parameter	KSPCB Standards	Raw Sewage	Treated Sewage
pH Value	6.00 – 8.50	7.0 – 8.0	7.0 – 8.0
Biochemical Oxygen Demand (mg/l)	20	270	<=10
Chemical Oxygen Demand (mg/l)	250	500	<=100
Total Suspended Solids (mg/l)	30	300	<=10

Source: KUIDFC

Capital Cost: The estimated capital cost of the expansion network and one 40 mld STP in Hubli and one 20 mld STP in Dharwad is Rs 164 crore.[24] Table 3.4 below gives the component-wise bundling of capital cost:

Table 3.4 Component-Wise Bundling of Capital Cost		
Hubli Sewerage Network: Package 1		
Sewerage Network Length (Km)	SCOD	Capex (Rs. crore)
35.53	February 2015	36
Hubli Sewerage Network: Package 2		
Sewerage Network Length (Km)	SCOD	Capex (Rs. crore)
57.5	February 2015	48
Dharwad Sewerage Network: Package 3		
Sewerage Network Length (Km)	SCOD	Capex (Rs. crore)
42.52	March 2016	29.53
Hubli STP : SBR + Chlorination (Tertiary Treatment)		
Capacity (mld)	SCOD	Capex (Rs. crore)
40	February 2015	29.40
Dharwad STP: SBR + Chlorination (Tertiary Treatment)		
Capacity (mld)	SCOD	Capex (Rs. crore)
20	March 2016	20.87

* *Source:* KUIDFC & CDM Wilbur Smith, KUWS&DB

24 The capital cost of the 40 mld STP at Madihal (near Gabbur) in Hubli is Rs. 29.4 crore which is approximately Rs. 74 lacs per mld. This is in line with the capital cost of STPs built with SBR technology in India untill 2011. The current capital cost of such plants is Rs. 100–125 lacs per mld.

Forecast Sewage Generation and Treatment Capacity 2011–2046

Scenario 1

Definition: In case the additional raw water allocation of 2.84 TMC or 222 mld materialises then Table 3.5 below gives the existing and future sewage generation, collection and treatment capacity scenario.

Table 3.5 Scenario 1: Sewage Generation and Treatment Capacity 2014 to 2041 with 222 mld Additional Allocation from Malaprabha Reservoir				(in mld)
	2014	2021	2031	2041
Sewage Generation[25]	82	132	156	183
Wastewater Collection[26]	34*	90	156	183
Wastewater Treatment Plants – Total Capacity		**120**	**145**	**145**
Madihal, Hubli STP (SCoD: Jan/Feb, 2015) (SBR+Chlorination)		40	40	40
KUAS, Dharwad STP (SCoD: Mar, 2015) (SBR+Chlorination)		20	20	20
Hubli STP (SCoD: Jan/Feb, 2021) (SBR+Chlorination)		40	40	40
PB Road, Dharwad STP		20	20	20
Dharwad, STP			25	25
Sewage Treatment Capacity Shortfall	**34**	**Nil**	**11**	**38**

Source: KUIDFC & CDM Wilbur Smith, KUWS&DB

* Powertec Estimate based on 41% coverage of the population by the network as per discussions with HDMC and KUIDFC officials and data provided by them.

KUIDFC Projections:[27] KUIDFC has projected much lower quantities for sewage generation than what KUWS&DB treated water demand figures in Table 3.1 indicate because: (i) the sewage generation forecasts have taken into consideration only the demand emanating from households and exclude demand from institutions, commercial establishments as well as floating population; and (ii) its forecasts for population figures for 2031 and 2041 are much lower than KUWS&DB's.[28]

Sewage Generation and Collection Forecasts: The sewage generation of the twin cities is expected to touch 141 mld by 2021, of which approximately 100 mld will be collected by the sewerage

25 The estimates are based on household water consumption of 98 mld in 2014 as per the discussion with KUWS&DB officials and Powertec estimates and KUIDFC projections of household treated water demand of 157 mld, 186 mld and 218 mld for the years 2021, 2031 and 2041 respectively. The calculation also takes into account 100% of the population.

26 Sewage generation calculation takes the entire population of Hubi-Dharwad into account, while wastewater collection is based on population actually connected to the sewer network, which was just 41% in 2014 and is expected to be 68% in 2021 and 100% in 2031 and 2041.

27 *Source:* Concept Report Underground Sewerage Scheme in Hubli Dharwad City Corporation, Wilbur Smith Associates; NKUSIP Package I: Dharwad Sewage Treatment Plant, February 2011, Wilbur Smith Associates.

28 KUIDFC has followed the Graphical Method Based on a Single City as given in the CPHEEO Manual using decadal population data from 1901 to 2001 to derive a line of best fit. KUWS&DB on the other hand has used the Geometrical Increase Method as mentioned in the CPHEEO Manual and included 2011 census figures as well before making forecasts.

network as only 68% of the population would be connected to the network. In the long run, i.e., by 2031 it is forecast to touch 156 mld with collection also slated to be 156 mld as by 2029 all the households in HDMC would be connected to the sewer network. In the very long run (i.e., 2041), sewage generation and collection is likely to touch 145 mld.

Sewage Treatment Capacity Deficits: By the early 2030s the 145 mld of tertiary treatment capacity envisaged today would not be enough to meet the growing demands of the twin cities, hence HDMC would require to design and construct additional STPs of circa 11 mld and 38 mld capacity to meet the estimated sewage collection requirements for the years 2031 and 2041 respectively.

Scenario 2

Definition: In case the additional allocation of 2.84 TMC does not materialise, then Hubli–Dharwad will not only experience severe water scarcity but will also generate less sewage compared to forecasts by KUIDFC.

Table 3.6 below attempts to estimate the future generation of sewage and the sewage flows collected by the UGD network.

Table 3.6 Scenario 2: Sewage Generation and Treatment Capacity 2014 to 2041 without 222 mld Additional Allocation from Malaprabha Reservoir (in mld)

	2014	2021	2031	2041
Sewage Generation[29]	82	113	113	113
Wastewater Collection[30]	**34**	**77**	**113**	**113**
Wastewater Treatment Plants – Total Capacity		120	145	145
Madihal, Hubli STP (SCoD: Jan/Feb, 2015) (SBR+Chlorination)		40	40	40
KUAS, Dharwad STP (SCoD: Mar, 2015) (SBR+Chlorination)		20	20	20
Hubli STP (SCoD: Jan/Feb, 2021) (SBR+Chlorination)		40	40	40
PB Road, Dharwad STP		20	20	20
Dharwad, STP			25	25
Sewage Treatment Capacity Shortfall	**34**	**Nil**	**Nil**	**Nil**

Source: Powertec estimates based on KUIDFC & KUWS&DB data

29 For the forecasts from years 2021 to 2041, it has been assumed that raw bulk water supplies will remain unchanged at 193 mld as at present and T&D losses will be 15%. Given the supply constrained scenario treated water consumption will be the same as available treated water supplies. To calculate available treated water supplies to households, the ratio of bulk water supplies going to meet treated water demand in 2021 to total bulk water supplies (as per KUWS&DB projections) of 82% has been taken. Assuming that all end-users cut back their consumption proportionately in a water scarcity scenario, the bulk raw water available to meet household demand would be 82%X193 mld=158 mld. 158 mld of bulk water would support final treated water consumption of 158x85%=134 mld. This is expected to be the final water consumption of households from 2021 to 2041. Based on this, treated water consumption of 134 mld, the sewage generation by the population of HDMC will be 134 mld X 0.8X1.05=112.56 or 113 mld for the years 2021 to 2041.

30 Wastewater collection is based on population actually connected to the sewer network, which was just 41% in 2014 and is expected to be 68% in 2021 and 100% in 2031 and 2041.

Sewage Generation & Collection Forecasts: From Table 3.5 it may be seen that the sewage generation in the twin cities will remain the same from 2021 to 2041 in case the 222 mld of additional raw water allocation from the Malaprabha Reservoir does not materialise.

Sewage Treatment Capacity Deficits: Due to the shortage of water, sewage generation will stagnate from 2021 and collection from 2031 hence the sewage treatment capacities of 120 mld in 2021 and 145 mld in 2031 shall suffice.

Existing and Future Industrial Water Demand-Supply Scenario

Present Water Consumption and Supply Situation

Industrial Water Consumption within HDMC: There are not many large-scale industries in Hubli-Dharwad except *The South-Western Railway Workshop* situated in Hubli. Currently, according to KUWS&DB, it receives 3 mld of water from the city's water system for wagon cleaning and domestic uses.

Demand from Industrial Estates: Most of the industries in the industrial areas of Belur Growth Center, Rayapur Industrial Area and Lakamanahalli in Dharwad and Tarihal and Gokul Industrial Estate in Hubli are a mix of engineering units, food processing etc. which do not require significant amounts of water for their processes. At present, their consumption is 13 mld.

Water Supply to Industrial Estates: Their consumption of 13 mld is being met through supplies from a mix of surface (Malaprabha Reservoir – 11.35 mld) and ground water sources (bore wells – 1.65 mld) provided by KIADB and KSSIDC.

Projected Water Demand and Supply

Water Demand Railway Workshop: According to KUWS&DB officials the present consumption of 3 mld is *expected to go up to 15 mld in the long run subject to the expansion plans of the workshop.*

Water Demand Industrial Estates: With the expected growth of the existing industrial estates as well as the proposed industries coming up in Mummigatti Industrial Area in Dharwad and Gamangatti Industrial Area in Hubli,[31] consumption will increase in the long term to 33 mld according to District Industries Centre officials in Dharwad.

Water Supply to Industrial Estates: According to the District Industries Centre officials, KIADB and KSSIC will supply 29 mld

31 Mummigatti Industrial Area is about 20 kms from the proposed Dharwad STP behind Karanataka University of Agricultural Sciences. Gamanagatti Industrial Area is approximately 13 kms from the Madihal(near Gabbur) STP in Hubli.

to the aforementioned industrial estates through surface water sources, namely, the Malaprabha (27 mld) and Neersagar (2 mld) reservoirs. Another 2.5 mld would sourced through bore wells provided by KIADB and KSSIDC.[32] Thus only 1.5 mld of demand would be left to be met from alternative sources.

Treated Sewage Reuse: According to the plans of KIADB and KSSIDC *1.5 mld would be required by industry based in Rayapur and Lakamanhalli Industrial Areas from the proposed Dharwad STP located behind Karnataka University of Agricultural Sciences (KUAS).*

Table 3.7 below presents the demand for water being generated by industrial estates and sources of water supply to them from 2014 to 2041.

Table 3.7 Industrial Water Demand–Supply Balance 2014 to 2041

Demand				
	Existing Requirement (mld)	Location	Future Requirement 2041 (mld)	Location
	13	Belur Growth Center, Rayapur, Lakamanhalli, Tarihal, Gokul	33	Belur Growth Center, Rayapur, Lakamanhalli, Tarihal, Gokul, Mummigatti, Gamangatti
Total	13		33	
Supply				
	Current Supply (mld)	Supply Source	Future Supply 2041 (mld)	Source
	13	Malaprabha Reservoir (11.35 mld); Bore wells (1.65 mld)	27	Malaprabha Reservoir
			1.5	Dharwad STP at KUAS
			2	Neersagar Reservoir
			2.5	Bore wells
Total	13		33	
Gap	0		0	

Source: District Industries Centre, Dharwad

Low Industrial Water Demand: Given the non-water intensive type of industries and their small scale, the demand for water for industrial use is limited and expected to remain so over the foreseeable future. Further, the requirements of industry, both present and future, can easily be met by KSSIDC and KIADB through groundwater and surface water from nearby reservoirs. Thus, the expected demand from industries for treated municipal wastewater is just 1.5 mld. KIADB and KSSIDC have already been taken this into account in their future water supply plans communicated to the District Industries Centre in Dharwad. Therefore, given the limited demand projected for the industries, most of the treated wastewater can be used for domestic, commercial and institutional purposes within the city as well as by farmers in the vicinity for irrigating their crops.

32 Average groundwater level in the area is 250 ft.

Assessment of Potential and Constraints for Maximising Reuse

The potential for reuse in industry as well as in Hubli-Dharwad is given in the Table 3.8 below

Table 3.8 Reuse Potential 2021 to 2041 (in mld)

	2021	2031	2041
Unmet Water Demand Hubli-Dharwad Without Additional Allocation from Malaprabha Reservoir (Scenario 2)	46	123	223
Unmet Water Demand Hubli-Dharwad With Additional Allocation from Malaprabha Reservoir (Scenario 1)	0	0	1
Unmet Water Demand from Conventional Surface and Underground Sources – Industries (Scenario 1 & 2)	0	2	2
Forecast Volume of Treated Sewage Scenario 1	100	145	145
Forecast Volume of Treated Sewage Scenario 2	80	112	112

Source: Powertec estimates based on data given by and discussions with KUWS&DB, KUIDFC, HDMC and District Industries Centre officials

Hubli-Dharwad Municipal Corporation Water Demand-Supply Balance Scenarios

Scenario 1

The first scenario would emerge in case HDMC manages to secure either the entire or a substantial part of the additional raw water allocation of 2.84 TMC from the Malaprabha reservoir requested by it from the Water Resources Department, Government of Karnataka in the next five years. As a consequence, HDMC's bulk raw water supply sources would be augmented by up to 222 mld by 2021. This would enable HDMC to meet the deficits in treated water supply for the next twenty years, i.e., from 2021 to 2040.

Scenario 2

The second scenario would emerge in the event that the request for enhancement of allocation is not granted or only an insignificant increase is granted by the Water Resources Department, Government of Karnataka, in the next five years. As a result HDMC would face a substantial shortfall in water supply by 2021 which would worsen with each passing year. Table 3.1 indicates that the bulk water requirements would be in excess of raw bulk water supply by 46 mld in 2021, 123 mld in 2031 and 223 mld ultimately, in case the additional allocation does not come through.

At this juncture, based on discussions with KUIDFC officials the prospects of the entire additional allocation of 2.86 TMC being granted are brighter than the prospects of it not being granted. Thus the likelihood of Scenario 1 manifesting itself is greater than Scenario 2 materialising over the medium term. Hence the potential for reuse in HDMC is likely to be limited.

However, the possibility of Scenario 2 materialising cannot be ruled out, therefore, it may be in HDMC's best interest to start looking at a city wide water management plan, which amongst other initiatives, considers enhancing supply from unconventional sources such as harvested rainwater and recycled, treated municipal wastewater as a contingency measure. Reuse of recycled wastewater for non-potable purposes in households, institutions, commercial establishments and parks could be a viable proposition given the substantial amount of treated wastewater that would be in available by 2021.

Areas of Reuse of Treated Municipal Wastewater

Municipal sewage or wastewater can be recycled for reuse after tertiary treatment and disinfection in:

- **Industrial Units** including power plants but excluding food processing units for process use, cooling water and wash water purposes.

Municipal sewage or wastewater can be recycled for reuse after secondary treatment and disinfection in:

- **Households** for non-potable purposes such as flushing toilets, watering gardens and washing cars.
- **Public and Private Institutions** like schools, colleges, hospitals, bus and railway stations etc. for non-potable purposes such as for flushing toilets, watering gardens and centralised air conditioning.
- **Commercial Establishments** including offices, small industrial units and workshops for non-potable as well as non-process purposes such as for flushing toilets, watering gardens, centralised air conditioning, etc.
- **Public Purpose** by municipalities such as street washing, flushing of sewers, watering parks, etc.

Further, urban wastewater can be reused after secondary treatment and disinfection in:

- **Peri-Urban Agriculture** as water for irrigation and as fertiliser for vegetables and other crops grown in the vicinity of the city.

Finally, it can be used after secondary treatment and disinfection for:

- **Surface Water Discharge:** this is to augment surface waters in rivers, streams and lakes in the vicinity to ensure that the flows in them meet the minimum environmental flow standards, which is essential to keep them from going dry and to maintain the flora and fauna including agriculture of the region.
- **Groundwater Recharge** by discharging treated sewage on to nearby fields, nallahs (natural water courses) and tanks. Indirectly, this leads to wastewater reuse for both potable and non-potable activities as groundwater is regularly abstracted to augment surface water supplies in most places.

Reuse Potential of Treated Municipal Wastewater in Hubli-Dharwad Twin Cities

Scenario 1

- **Non-Potable Use in Households:** As conventional surface and groundwater sources are expected to be adequate for the long term (from 11 to 20 years in the future) to very long term (> 20 years in the future) term there is *very little scope to reuse recycled municipal wastewater for non-potable purposes in households in Hubli-Dharwad over the next twenty to twenty five years.*
- **Non-Potable Use in Institutions:** *Similarly, the water demand emanating from institutions in Hubli-Dharwad can be met from conventional sources for the next twenty to twenty five years. Hence there is little scope for reuse of treated municipal wastewater.* However, one could look at reuse opportunities in institutions like hospitals, nursing homes and medical colleges given that HDMC has promulgated bye-laws in 2009 making it mandatory for all such institutions to treat wastewater.
- **Commercial Establishments:** *Again as conventional water supply sources are expected to adequate for the next twenty to twenty five years potential for reuse is limited.*
- **Public Parks and Other Public Purpose:** In this scenario, it is unlikely that HDMC will use treated wastewater for watering public parks and gardens or for public toilets for a very long time.
- **Industry:** *As KIADB and KSSIDC have already planned to supply an additional 29 mld from Malaprabha (27 mld) and Neersagar Reservoirs (2 mld), the likelihood of their resorting to greater reuse of treated wastewater than already planned is low for the next twenty to twenty five years.*
  - *Railway Workshop:* The South-Western Railways have a workshop in Hubli which currently consumes 3 mld of water but according to KUWS&DB officials is likely to increase to 15 mld in the long run depending on the expansion plans of the workshop. Further, the workshop is just 5 kms from the 40 mld STP[33] at Madihal in Hubli. Thus there could be an opportunity to supply treated wastewater from the Madihal STP in Hubli to the workshop for wagon cleaning and non-potable domestic use.
- **Peri-Urban Agriculture:** *There is likely to be significant demand from farmers in the vicinity for treated sewage water* as the farmers are currently utilizing untreated sewage for cultivating crops such as vegetables, jawar, pulses and cotton quite often by diverting sewage in the sewers by pumping it out through manholes. This poses a health hazard to both farmers and the ultimate end-users. Thus treated sewage water from the STPs should be supplied to the farmers in the neighborhood of the STPs after treating it to standards required for farming as per the CPHEEO manual. Also, in case arrangements have to be made to dispose the treated sewage for reuse by farmers, then the STP designs should incorporate them upfront as far as possible. For instance, at the Madihal STP a small canal or pipeline may have to be constructed to give treated wastewater to a majority of the farmers in the vicinity which has not been envisaged in the original design.

33 The Railway workshop is at a higher level than the Madihal STP.

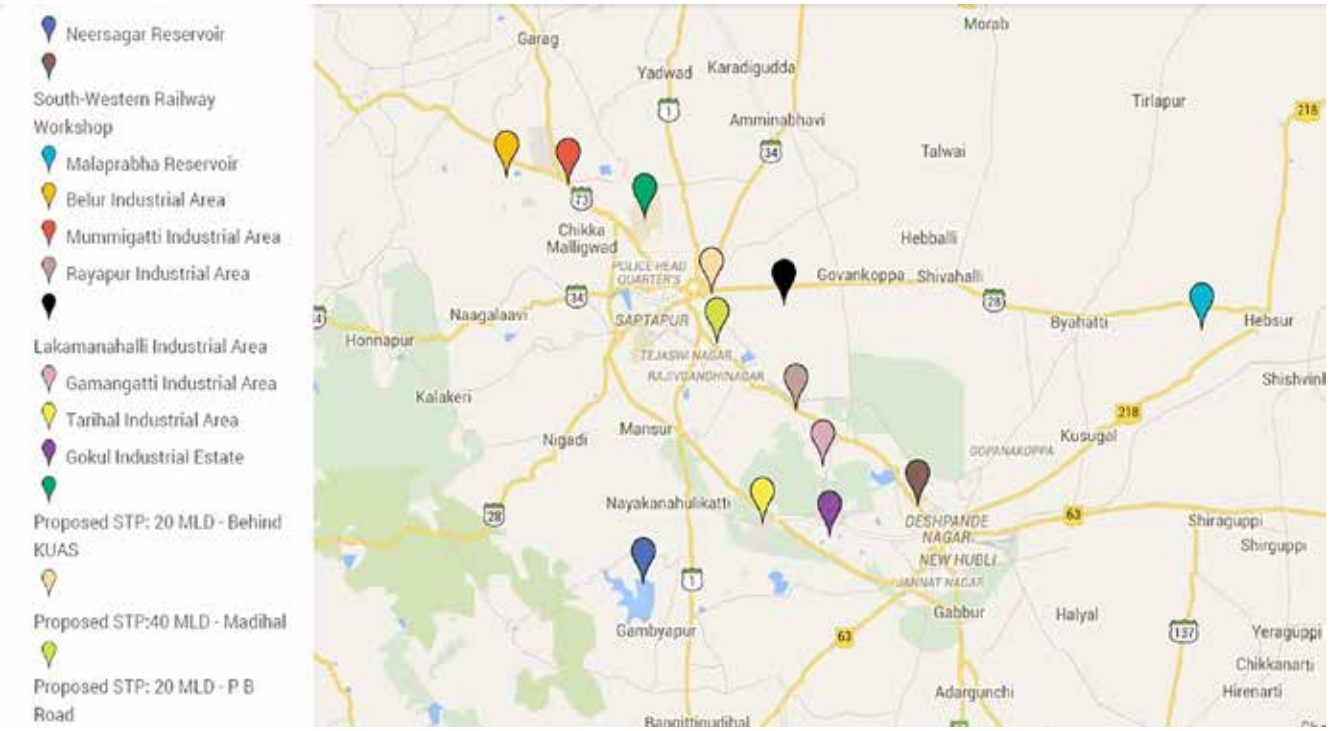
Scenario 2

- **Non-Potable Use in Households:** If Scenario 2 manifests itself, supply shortages in Hubli and Dharwad cities would create an environment *conducive for potential reuse in non-potable activities in the medium term itself.*
- **Non-Potable Use in Institutions:** In case Scenario 2 materializes, then the potential for reuse would be quite significant in the next five or six years.
- **Commercial Establishments:** In the event that Scenario 2 manifests itself, *water scarcity is likely to emerge in the medium term; therefore, HDMC is likely to resort to reuse of treated wastewater to supply to commercial establishments for non-potable purposes in order to augment conventional sources of supply.*
- **Public Parks:** In the event that Scenario 2 materializes, increasing water scarcity will compel HDMC to look at reuse of treated wastewater for watering parks and gardens. However, since the parks belong to the City Corporation, it is likely that the treated wastewater will be supplied free or at a very nominal rate making it a financially unviable exercise.
- **Industry:** Industry is unlikely to be affected much as their requirement is catered to separately by KIADB and KSSIDC and they seem to have already made firm plans regarding water supply sources in the future. Thus it has been assumed that industry demand will be met primarily from surface water sources as in Scenario 1.
  - *Railway Workshop:* Prevalence of water scarcity within HDMC boundaries would most likely spur HDMC to supply treated wastewater from the Madihal STP (near Gabbur) to the workshop for wagon cleaning and non-potable domestic use in the medium term.
- **Peri-Urban Agriculture:** *The demand from farmers in the vicinity for treated sewage water* is likely to remain unaffected by the shortage of drinking water in the city.

Constraints to Maximizing Reuse Potential in Hubli-Dharwad

Scenario 1

- **Constraints to Non-Potable Reuse in Households:** The biggest obstacles under Scenario 1 to reuse of treated municipal wastewater in households for non-potable purposes are:
  - The cost of laying the pipelines for conveying the treated wastewater to residences for use in toilets and gardens; and
  - The sensitivity of society towards use of wastewater for any purpose. The sensitivity of society to reuse of treated wastewater is understandable given that historically wastewater has not been treated in India and wherever it has the functioning of STPs leaves much to be desired.
- *Constraints to Non-Potable Reuse in Institutions:* The biggest impediment is the cost of laying pipelines and other associated infrastructure for conveying wastewater to institutions from large, centralised STPs. This impediment could be overcome by limiting wastewater collection and treatment to an institution or group of institutions in the same area.
- **Constraints to Non-Potable Reuse in Commercial Establishments:** Similarly, the cost of laying pipelines and other associated infrastructure for conveying wastewater is the biggest impediment to reuse.
- **Constraints to Reuse in Public Parks:** Again, the main obstacle to reuse in urban horticulture is the cost of laying pipelines and other associated infrastructure for conveying wastewater.
- **Constraints to Reuse in Industry:** Usually, there are two key constraints to reuse by industry:
  - The first is economic, i.e., the cost of reuse supply relative to other sources of supply; and
  - The second, social/political due the conflict with farmers living on the periphery of the city, who utilize the same sewage for irrigation and fertilizing their fields. In Hubli-Dharwad's case, the second constraint does not exist as industrial demand is low and provision has been made by KIADB and KSSIDC to ensure adequate supply of water to industries.
- **Constraints to Reuse in Peri-Urban Agriculture:** As farmers benefit significantly from use of sewage water in the form of free fertilizer and water for irrigating their crops, the constraints to reuse under Scenario 1 will lie in:
  - Charging a fee for its reuse given that wastewater is available for free at present;
  - The level of nutrients in treated wastewater since farmers use it more for its nutrients than as a source of water for irrigation; and
  - The presence or absence of conveyance infrastructure in the form of small canals or pipelines carrying the treated effluent from the STP to fields, nallahs or tanks in such a manner that there is geographically equitable distribution of treated wastewater amongst the farmers in the vicinity of the STP.



Scenario 2

- **Constraints to Non-Potable Reuse in Households:** The biggest obstacles to reuse of treated municipal wastewater in households for non-potable purposes are:
  - Conflict with farmers in the peri-urban areas as more and more treated wastewater would be diverted for use in city households, resulting in farmer agitations and political interventions;
  - The cost of laying the pipelines for conveying the treated wastewater to residences for use in toilets and gardens; and
  - The sensitivity of society towards use of wastewater for any purpose. The sensitivity of society to reuse of treated wastewater is understandable given that historically wastewater has not been treated in India and wherever it has the functioning of STPs leaves much to be desired.
- **Constraints to Non-Potable Reuse in Institutions:** The biggest impediment is the cost of laying pipelines and other associated infrastructure for conveying wastewater to institutions from large, centralised STPs. This impediment could be overcome by limiting wastewater collection and treatment to an institution or group of institutions in the same area.
- **Constraints to Non-Potable Reuse in Commercial Establishments:** Similarly, the cost of laying pipelines and other associated infrastructure for conveying wastewater is the biggest impediment to reuse.
- **Constraints to Reuse in Public Parks and Other Public Use:** Again, the main obstacle to reuse in urban horticulture is the cost of laying pipelines and other associated infrastructure for conveying wastewater relative to existing freshwater system, bore wells and tankers.
- **Constraints to Reuse in Industry:** Usually, there are two key constraints to reuse by industry:
  - The first is economic, i.e., the cost of reuse supply relative to other sources of supply; and
  - The second, social/political due the conflict with farmers living on the periphery of the city, who utilize the same sewage for irrigation and fertilizing their fields. In Hubli-Dharwad's case, the second constraint does not exist as industrial demand is low and provision has been made by KIADB and KSSIDC to ensure adequate supply of water to industries.
- **Constraints to Reuse in Peri-Urban Agriculture:** As farmers benefit significantly from use of sewage water in the form of free fertilizer and water for irrigating their crops, the key constraint to reuse under Scenario 2 will lie in:
  - Competition for limited supply of treated sewage with non-potable reuse by HDMC in households, institutions, commercial establishments, parks, etc.

Income Generating Wastewater Opportunities

Revenue generating opportunities are given below:

- *South Western Railway Workshop:* The railway workshop currently uses 3 mld, as estimated by KUWS&DB, for wagon cleaning and other uses. According to KUWS&DB, it may go up to 15 mld in the future. Hence, HDMC could consider supplying tertiary treated wastewater from its Madihal STP (5 kms from the workshop) in Hubli to the workshop on payment of a sewage charge. However, the future demand would need to be verified with the South-Western Railways before designing a project to supply treated wastewater to the railway workshop.

Project Implementation Structures

There are several ways that the abovementioned project could be implemented. The main modes are given below:

1) *HDMC owns, develops, finances and operates the projects itself* and recovers the capital costs and operating costs of not only the additional infrastructure involved in conveying the treated sewage from Madihal STP but also the capital and operating costs of Hubli's sewerage network (ideally just that part supplying sewage to the Madihal STP) and any additional treatment required on-site that is provided by it.
2) *The private sector is allowed to develop the projects to supply treated municipal wastewater to industry on a Public-Private-Partnership (PPP) basis.* Thus the project, which comprises the conveyance infrastructure from Madihal STP and any additional on-site treatment at the Railway workshop, gets housed in a SPV either fully privately owned or in a joint venture between the private party, the HDMC and GoK. The SPV would have the responsibility to finance, build, own and operate the project and would recover its capital and operating costs of any additional on-site treatment and conveyance of treated wastewater from Madihal STP to the South Western Railway workshop from user charges levied on the railways.
3) *The private sector is allowed to develop on a PPP basis not only the aforementioned project but also the Madihal STP*, so that issues related to STP operations and sewage qualities are taken care off as well.
4) *Private sector involvement could be in the form of management contracts* where its specialised knowledge and management skills could impart better operating efficiency than public sector alternatives. Thus the ownership of the projects would vest with HDMC and GoK and they would be operated by the private sector.

   Caveat: However, it would be advisable to closely evaluate the financial viability of a full-fledged Build-Operate-Transfer (BOT) or a Design-Build-Finance-Operate-&-Transfer (DBFOT) scheme based on a close assessment of demand, future reliability of alternate water supply sources, cost of constructing and operating a recycled municipal wastewater system (cost of treated sewage, pipeline, tertiary treatment including disinfection by chlorination etc.), Railway's willingness to pay and the cost of supply from alternate sources such as ground and surface water.

Wastewater Collection and Treatment System Cost Recovery Measures for HDMC

In both the PPP structures outlined above, *HDMC could look at supplying treated sewage to the SPV from its STP at Madihal in Hubli, at a price which at least covers its O&M cost of collecting and treating municipal wastewater to secondary levels. Quick estimates of the existing sewerage network and the STP at Madihal indicate that the unit O&M cost of the network and STP is Rs 2.57/KL.* Please refer to the tables below for quick estimates of the costs of operating and maintaining Hubli-Dharwad's existing sewerage network and STP.

Table 3.9 Cost of Operating and Maintaining Existing Sewer System at 2013–14 Prices

Annual O&M Cost Excluding Electricity Charges for Pumps (Rs Lacs)	208
Annual Electricity Charges for Pumps (Rs Lacs)	60
Total Annual O&M Cost Including Electricity Cost (Rs Lacs)	**268**
Estimated Annual Sewage Flow (in Lac KL in FY 2013–14)	146
Estimated Electricity Cost (Rs/KL)	0.41
Estimated Total O&M Cost Including Electricity Cost in Rs/KL	1.84

Table 3.10 Cost of Operating and Maintaining STP at 2013–14 prices Assuming Full Capacity Operations without Chlorination

Annual O&M Cost Excluding Electricity Charges (Rs Lacs)	38
Annual Electricity Charges (Rs Lacs)	69
Total Annual O&M Cost Including Electricity Cost(Rs Lacs)	**107**
Estimated Annual Sewage Flow (in Lac KL)	146
Estimated Electricity Cost (Rs/KL)	0.47
Estimated Total O&M Cost Including Electricity Cost in Rs/KL	0.73
Total O&M Cost of Sewerage System including STP	**2.57**

Source: HDMC and KUIDFC

HDMC Cost Recovery Enhancement or PPP Revenue Enhancement Measures

Additional sources of revenue for HDMC could be sale of dried sludge and electricity generated from methane (sewage) gas as sludge is continuously generated in SBR technology and has to be removed daily. However, the STPs being built in Hubli-Dharwad should have a provision for units such as centrifuges, sludge digesters, gas turbines, scrubbers etc. before these revenue sources can be considered. Generating revenue from sale of dried sludge can be a loss making activity because of the high cost of the equipment and the possibility of low off take of manure. Similarly, the equipment required to generate electricity is expensive and would add another Rs. 50–70 lacs per mld of capacity to the plant's capital cost, as well as increase its O&M cost. However the electricity generated if used by the STP would significantly reduce its external electricity consumption hence power purchase expenditure. Hence, the costs and benefits of the additional sources of revenue need to be evaluated carefully before embarking on a programme to capitalize on them. It is advisable that the evaluation methodology of the various technology options and revenue enhancement measures be based on the NPV of their capital expenditures, O&M costs and the revenues/savings generated over their lifecycle.

Bellary Rapid Assessment

Key Inferences

- **Water Supply Scenario:** Existing freshwater sources adequate for Bellary City requirements only till the mid-2020s (i.e., 2025), despite reduction in UFW to 15% and augmentation of treatment capacity by 35 mld.
- **Sewage System Scenario:** Planned sewage treatment capacity is sufficient for the forecast supply of 93 mld of bulk raw water (i.e., 79 mld of treated water supply at the consumer end) but not if water supplies increase significantly beyond 93 mld, say due to reuse within Bellary.
- **Reuse Potentia:** Therefore, it may be prudent for Bellary City Corporation (BCC) to start looking at a city wide water management plan, which amongst other initiatives, considers enhancing supply from unconventional sources such as harvested rainwater and recycled, treated municipal wastewater as a contingency measure.
  - ***Industrial Reuse:*** Sponge Iron and Steel units around the city, particularly to the South-East and South-West are the main potential customers for reuse of treated wastewater. Acute shortage of freshwater from surface and groundwater sources will drive them to consider reuse as an option in the medium term (next eight to ten years) provided the industry performs well in the interim.
  - ***Municipal Reuse:*** Great potential for reuse of recycled wastewater for non-potable purposes in households, institutions, commercial establishments and parks in the next eleven to fifteen years.
  - ***Peri-Urban Agriculture Reuse:*** Demand for sewage water from farmers in the peri-urban areas is high. This will result in competition and conflict with industry and the BCC as and when wastewater reuse by industry picks up.
- **Constraints to Reuse:** The constraints to achieving maximum reuse potential are:
  - The potential conflict with industry and municipal reuse has been diffused by the Government of Karnataka through an order mandating that at least 30% of the treated urban wastewater has to be let out in to natural water courses (nallahs), tanks and open fields for use by farmers and for natural recharge of surface waters and the groundwater table (minimum environmental flow).
  - Biggest constraints to reuse for non-potable purposes in households, institutions, commercial establishments, parks etc. stem from:
    - Social taboos regarding reutilising sewage
    - High cost of laying pipelines and other associated infrastructure for conveying treated wastewater to the end-users.
    - Lack of awareness amongst city officials about reuse options and technologies.
- **PPP Opportunities:** In the medium term, *i.e.*, over the next 10 years, supply of treated sewage to the sponge iron and steel industry could be a lucrative opportunity for both the BCC and the private sector. Immediately there is only one PPP opportunity:
  - Janki Corporation Ltd. in Sidiginamola village in Bellary taluk, is being supplied 15 mld of treated wastewater by BCC from its Ananthpur STP 22 kms away. The conveyance infrastructure to the unit has been laid and was commissioned in December, 2014.
  - Private sector operators in wastewater management could engage with Janki Corporation to undertake operations and maintenance of the conveyance infrastructure and any additional on-site treatment facilities.

Existing and Future City Water Demand-Supply Scenario

The existing as well as forecast water demand and supply are given in Table 4.1 below:

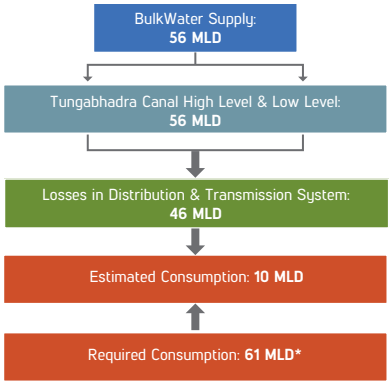
Table 4.1 Water Demand-Supply Balance 2011 to 2041 (in mld)

	2011	2026	2041
Forecasted Population (in Lacs)	3.98	5.65	7.90
Treated Water Demand	10	88	122
System Losses @ 15% *	46**	16	22
Bulk Raw Water Demand	57	104	144
Raw Water Supply – Tungabhadra Canal HLC and LLC	57	57	57
Surplus/(Deficit) of Bulk Raw Water	NIL	(47)	(87)
Measures to Augment Raw Bulk Water Supply			
Enhanced Allocation from Tungabhadra HLC & LLC		36	36
Surplus/(Deficit) of Bulk Raw Water		(11)	(51)

Source: KUWS&DB, Bellary Mahanagar Pallike (BCC) and Powertec Research
*It is assumed that the proposed 24x7 scheme starting early 2015 would be completed by end 2017
**82% system losses

Existing Water Demand–Supply Balance

Existing Water Scenario



* Domestic=3.98 lacs x 135 lpcd, institutions, commercial

The city of Bellary gets its water supply from the Tungha Bhadra Dam through two canals, the High Level Canal (HLC) and the Low-Level Canal (LLC). Everyday 56 mld of treated bulk water is pumped from 2 WTPs, one at Allipore (45 mld) and the other at Shivpur (11 mld). Of this, about 46 mld is pumped through an MBR 4 km away and the remaining 10 mld is pumped through a booster station into the distribution system to meet the water requirements of the city. These WTPs are operated and maintained by KUWS&DB.

Apparent High Loss Level:[34] On any given day only 7–8 wards are supplied water by Bellary City Corporation (BCC). These wards are estimated to consume only 10 mld of water. Thus, the system loses a phenomenal 46 mld or 82% of the treated water pumped by the WTPs. The reason for these incredibly high loss levels is that the BCC supplies water to only one-fifth/one-fourth of the city at a time every day, i.e., just 7–8 wards out of 35 wards in the city, because they are extremely inadequately staffed given the needs of operating an intermittent supply system. Since the BCC has only 50 junior staff at present, (most of whom are temporary), against a desired junior staffing level of 150–200 individuals. Hence, the BCC concentrates its entire workforce on supplying water to 7–8 wards a day. As a result, each area gets water once in four or five days, hence, people have built large in-house storage capacities to store water for the intervening 3–4 days. In addition, these storages are not maintained properly hence a lot of water is lost due to overflow and leakages at the consumer end. Moreover, the problem is compounded by an old and leaking distribution system. *Thus the actual losses in the system would be closer to 40% than 82% as data indicates, since a lot of water supplied during the day gets stored in tanks and other storage facilities.*

Table 4.2 below gives the current rates at which water is supplied by BCC to its customers and by the KIADB/KSIDC to industrial units in the industrial estates managed by it.

Table 4.2 Existing Water Tariff for Different Sources of Water Supply

Users	Municipal Supply (Flat Rate) (in Rs)	Private Tankers (in Rs)	KIADB/ KSIDC (in Rs)	Secondary Treated Sewage (in Rs)
Domestic	175 per month	500 – 600/5KL	NA	–
Non–Domestic	350 per month	500 – 600/5KL	NA	–
Commercial + Industrial	750 per month	400/5 KL* 500 – 600/5KL**	NA	3.15/KL***

Source: BCC, KUWS & DB and District Industries Center , Bellary , Department of Industries
* Frequent Supply of Bulk Quantities
** Infrequent Supply
*** Since these charges were in 2007 prices, BCC may escalate them to current prices

Future Water Demand–Supply Balance[35]

In the future, the demand for treated water in the city is expected to touch 88 mld in 2026 and 122 mld in 2041. In order to meet this demand, the city is planning to:

- Undertake a 24x7 scheme in early 2015 which is expected to be completed by the end of 2017 in order to reduce unaccounted for water (UFW) from 40% at present to 15% in the future.
- Design and construct of two WTPs, one for 20 mld and another for 15 mld.

Distribution System Renovation: A DPR for the 24X7 scheme has been prepared by SNC Lavalin and potential private operators have also been shortlisted. The project will be funded by KUIDFC with ADB assistance. BCC will contribute 10% to the capital costs of the scheme and be responsible for the debt servicing of the KUIDFC/ADB loan.

Augment Bulk Water Supplies: To utilize the enhanced bulk water allocation of 36 mld from Tungabhadra HLC and LLC, the BCC has also undertaken the design and construction of two WTPs, one for 20 mld and another for 15 mld, which are likely to be completed by June, 2015.

Water Deficits: However, these measures would not be enough to meet future demand and would leave the city 11 mld short of the expected bulk water requirements in 2026 and 51 mld short in 2041assuming there is no further augmentation in supply.

34 *Source:* Discussions with KUWS&DB and Bellary City Corporation officials.

35 *Source:* Discussions with KUWS&DB, KUIDFC and Bellary City Corporation officials.

Current and Future Sewage Generation and Treated Sewage Capacity

Current Status of Sewer System[36]

Sewer Network: At present, the sewer network with a length of 450 kms (old network: 175 kms; new network till date: 275 kms) *connects 70% of the area and 55% of the households in Bellary to the underground drainage system.* Households which are not connected to the UGD network in the city use septic tanks with or without soak pits. The households which do not have soak pits connect their septic tanks directly to storm water drains to dispose of the effluents. The network also has seven wet wells (sewage pumping stations).

Sewage Treatment Facilities: The sewage flows from the wet wells to the two STPs located at Ananthpur Road and Cowl Bazaar through gravity as well as by pumping. *The STP at Ananthpur Road has a treatment capacity of 30 mld and uses secondary treatment facultative aerated lagoon technology with Bio-culture usage for treating sewage. The STP at Cowl Bazaar has a treatment capacity of 15 mld and also uses the facultative aerated lagoon technology with Bio-culture usage for treating sewage.* At present, the 30 mld plant at Ananthpur Road receives about 21 mld of sewage and the 15 mld plant at Cowl Bazaar receives around 9 mld of sewage. The table 4.3 below gives the quality of influent and effluent associated with the aforementioned STPs.

Table 4.3 Influent & Effluent Quality in 2014 at Ananthpur Road and Cowl Bazaar STPs

30 mld STP at Ananthpur Road – Technology: Aerated Lagoon + Bioculture			
Parameter	KSPCB Standards	Raw Sewage	Treated Sewage
pH Value	6.00 – 8.50	6.93	8.25
Biochemical Oxygen Demand (mg/l)	20	320	9
Chemical Oxygen Demand (mg/l)	250	785	85
Total Suspended Solids (mg/l)	30	132	16
15 mld STP at Cowl Bazaar – Technology: Aerated Lagoon + Bioculture			
Parameter	KSPCB Standards	Raw Sewage	Treated Sewage
pH Value	6.00 – 8.50	6.90	7.40
Biochemical Oxygen Demand (mg/l)	20	310	7
Chemical Oxygen Demand (mg/l)	250	802	73
Total Suspended Solids (mg/l)	30	116	6

36 *Source:* Discussions with KUWS&DB and BCC officials.

Table 4.4 below presents the existing sewerage treatment capacity and their cost of construction

Table 4.4 Capex for Existing Sewerage Treatment Plants

Second stage UGD Scheme to Bellary City: Facultative Aerated Lagoon		
STP Capacity (mld)	STP Technology	Capex (Rs. crore)
45	Facultative Aerated Lagoon	60.30

Source: KUWS&DB

Sewer System Maintenance: The KUWS&DB maintains the sewer network and operates and maintains the two STPs on behalf of BCC as BCC does not have the trained manpower and technical knowhow to do it on its own. For the purpose of cleaning sewers the BCC has bought and handed over to the KUWS&DB one 10 KL capacity sucking machine, one 6 KL capacity jetting machine and one 6 KL capacity jetting-cum-sucking machine. The BCC pays KUWS&DB every month for cleaning, maintenance and repair of sewers, however, the amount deposited is far less than the amount spent by KUWS&DB on operating and maintaining the system. As a consequence, long payment delays to contractors and suppliers are common.

Sewerage Tax Revenues: To finance the expenditure on sewer maintenance and STP operations, the BCC levies a sewerage tax of Rs. 20 per month on domestic connections and Rs. 100 per month on commercial connections. In FY 2013-14, it collected Rs. 2.5–3 lacs per month on average from approx 20,000 connections against an average demand of Rs. 4.25 lacs per month.

Planned Expansion[37]

It is proposed that in the near future, 100% of the households will be connected to the UGD network; the sewage generation is expected to touch 66 mld[38] by 2026 and remain at that level thereafter unless additional bulk water is supplied to Bellary. In order to meet this demand, BCC and KUWS&DB have *proposed to undertake the expansion of the UGD network by laying an additional 165 kms of pipelines covering new extension areas as well as commissioning an additional 25 mld capacity STP*. The estimated capital cost of the expansion network and the proposed STP to be commissioned is Rs 122.5 crores at FY 2013-14 prices. Table 4.5 below presents the existing and future sewage generation, collection and treatment capacity scenario.

37 *Source:* Discussions with KUWS&DB and BCC officials.

38 Sewage generation is a function of treated water consumed, which is the lower of treated water demand by consumers or treated water supply at consumer doorstep. Given that bulk raw water supplies are expected to be 93 mld in 2026 and 2041 and system losses are expected to be 15%, treated water supplies would be 79 mld (85% X 93 mld) as against treated water demand of 88 mld and 122 mld in 2026 and 2041 respectively. Thus sewage generated in 2026 and 2041 would be 80% of 79 mld plus 5% extra for infiltration i.e. approximately 66 mld.

Table 4.5 Sewage Generation and Treatment Capacity 2014 to 2041 (in mld)			
	2014	2026	2041
Sewage Generation	30	66*	66*
Wastewater Collection	30	66	66
Wastewater Treatment Plants – Total Capacity	45	70	70
Ananthpur Road STP	30	30	30
Cowl Bazaar STP	15	15	15
Proposed STP		25	25
Sewage Treatment Capacity	Nil	Nil	Nil

Source: KUWS&DB and BCC
* Powertec Estimates

Existing and Future Industrial Water Demand-Supply Scenario

Present Situation

Till the 1990's, Bellary was a small town known only for its apparel (jeans) manufacturing and agro-based industries like cotton ginning, oil extraction etc. In the 2000's, it transformed into a boom town thanks to the development of iron-ore mines in the vicinity and the establishment of a large number of sponge iron and steel units. For the last three years the sponge iron and steel industry has been languishing as it has been buffeted by the headwinds from the Supreme Court decision to ban iron-ore mining as well as the prolonged domestic economic downturn which began around the same time. The consequent poor financial performance of the industry in the region has caused them to operate at half capacity and put their expansion plans on hold. This has affected their water consumption and has also reduced their demand for water in the future. As a result, a number of units today are either cancelling or delaying their water off-take plans.

The industrial expansion of the 2000's resulted in *a number of industrial units setting up shop outside the city boundaries along Bangalore Road (NH-4) to the South and West of the Cowl Bazaar STP and along the ring road to the South-East of the Ananthpur Road STP at an average distance of 5-6 kms from the city boundaries.*

Present Industrial Water Consumption

Sponge Iron and Steel Industry: The main consumers of water in the region are the Sponge Iron and Steel units, quite a few of whom also have captive power plants. The District Industries Centre, based on water requirement applications submitted to KSSIDC and KIADB between 2007 and 2011, estimated that the requirement of water by industries in the vicinity of Bellary city in 2011 was 69 mld

Apparel Industry: The other major industry in the area is the apparel industry. Current consumption from the apparel industry comprising 40 units located in the Stage 4 Industrial Area, 8 kms south and east of Ananthpur Road STP is a mere 60 kld.

Existing Water Supply Situation

Freshwater Sources:[39] At present, the sponge iron and steel units are meeting their water requirements primarily through supplies from surface water sources, namely, the Tungabhadra HLC & LLC supplemented by groundwater sourced through bore wells on their premises and private water tankers. The Apparel industry relies primarily on groundwater from bore wells and private water tankers.

Groundwater:[40] The dependence on groundwater by the apparel industry is quite significant. Groundwater is easy to extract as the groundwater table is at an average depth of 200 ft. However, in most cases the water[41] is hard hence, requires softening before it can be used. KSSIDC and KIADB are not able to provide enough water from either their own bore wells or freshwater sources in the region; but both KSSIDC and KIADB have allowed units in their industrial areas to set up bores on their own premises.

Treated Sewage Water Reuse:[42] Based on requirements stated by industries located around Bellary City in their applications given to KSSIDC and KIADB between in 2007, the BCC together with the Commissioner for Industrial Development and Directorate of Industries and Commerce, District Industries Centre and the district administration had allocated *23.5 mld of treated sewage water* out of the 30 mld of treated sewage for reuse from the Ananthpur and Cowl Bazaar STPs in 2007. *18.5 mld of treated sewage was allocated from the Ananthpur STP to 3 units and 5 mld was allocated from Cowl Bazaar STP to 16 units located on Hospet Road.* Out *of the 18.5 mld* allocated from Ananthpur STP, *15 mld had been earmarked for Janki Corporation Ltd* situated in Sidiginamola village in Bellary taluk and remaining 3.5 mld was allotted to another 2 Sponge Iron and Steel units including Hothur Ispat Pvt. Ltd. and Noble Distilleries & Power Pvt Ltd. *BCC intended to charge Rs 3.15/KL in 2007 for the treated sewage provided by them to the industries. Since then, only Janki Corporation has invested Rs 15 crore for building the infrastructure (22 km pipeline) to off take 15 mld of treated sewage, which started operations in December 2014. BCC may escalate treated sewage charges of Rs. 3.15/KL to current prices for supply to Janki Corporation, as these charges are at 2007 prices.* Please refer to Annex 3 for further details regarding allocation of treated wastewater.

39 *Source:* Discussions with District Industries Centre, Bellary officials.
40 *Source:* Discussions with District Industries Centre, Bellary officials.
41 Within the city the groundwater is highly alkaline because of the prevalence of black cotton soil hence, fit only for non-potable use in parks etc. However, the prevalence of black cotton soil diminishes considerably 5-6 kms outside the city.
42 *Source:* Discussions with KUWS&DB officials in Bellary.

Projected Industrial Water Demand[43]

Sponge Iron and Steel Units: It is expected by the District Industries Centre, Bellary that water requirements from the sponge iron and steel industry would increase over the next 12 to 15 years to 174 mld. The forecast of demand from industries in the future should be treated with caution as these are based on requirements stated by industries[44] in their applications given to KSSIDC and KIADB in 2007. In response, the BCC together with the district administration and the District Industries Centre had allocated 23.5 mld of treated sewage water for reuse from the Ananthpur and Cowl Bazaar STPs in 2007; but since then, only one industrial unit Janki Corporation has come forward to draw its share of the allocation. In Janki's case too, the infrastructure to collect and convey the treated municipal wastewater from Ananthpur STP was completed only in November, 2014 and off take of treated sewage from the STP began in December, 2014.

This lack of interest on the part of the iron and steel industry could be due to the ban on illegal mining and the economic downturn which has affected the industry's profitability considerably in the last 3 years. Given that the industry's water requirements are directly related to their financial performance and availability of cheap raw materials, the stated future requirements based on applications given several years ago may be an overstatement of the actual demand that manifests itself in the long run. Please refer to Annex 2 for details.

Apparel Industry: It is expected that in the near future another 43 apparel units are going to be relocated from the city to the Stage 4 Industrial Area. The demand from these 43 units is estimated to be 65 kld. Thus the total future demand is likely to be 125 kld.

Projected Industrial Water Supplies[45]

Freshwater: In the absence of any information about new water supply schemes and initiatives, it is expected that in the future too, 69 mld of water would be supplied from freshwater sources comprising a mix of surface and groundwater sources, viz., the Tungabhadra HLC and LLC, bore wells and private tankers.

Treated Sewage Water: *Also, in the absence any information about fresh allocations or likely allocations about treated sewage water from existing as well as planned STPs, it has been assumed that the existing allocation of 23.5 mld (18.5 mld from Ananthpur STP and 5 mld from Cowl Bazaar STP) would continue to hold* and the remaining 3.5 mld from Ananthpur STP and 5 mld from Cowl Bazaar STP would finally be utilized by the other units allocated these amounts as industry prospects improve. Please refer to Annex 3 for the names of the units.

Industrial Wastewater Recycling: The Apparel industry was directed by KPCB in October, 2014 to recycle its effluents by treating them using zero discharge technology. The units are currently treating their effluents in Effluent Treatment Plants (ETPs) and letting it out into the open. They had decided to set up a CETP of 3 mld capacity about three years ago and formed an SPV for the purpose, but the plan is currently in cold storage. Thus, in the future, a large part of the apparel industries' requirements would be met by water from recycled industrial effluent.

Table 4.6 Industrial Demand–Supply Balance 2014 to 2031

Demand				
	Existing Requirement 2011 (mld)	Location	Future Requirement 2031 (mld)	Location
	69	Outside North–East, South–West, South & South East Boundaries of City. Almost all is requirement from the Sponge Iron & Steel Industry	174	Outside North–East, South–West, South & South East Boundaries of City. Almost all is projected demand from the Sponge Iron & Steel Industry
Total	69		174	
Supply				
	Current Supply 2011 (mld)	Supply Source	Future Supply 2031 (mld)	Source
	69	Tungabhadra Canal HLC & LLC/ Own & Pvt. Bore Wells/Tankers	69	Tungabhadra Canal HLC& LLC/ Own & Pvt. Bore Wells & Tankers
			18.5	Ananthpur Road STP
			5	Cowl Bazaar STP
Total	69		92.5	
Gap	Nil		81.5	

Source: District Industries Centre, Bellary and KUWS&DB

43 *Source:* Discussions with District Industries Centre, Bellary officials.

44 The requirements of JSW Steel and BMM Ispat have not been considered as they already have allocations from the Tungabhadra Dam. Also, BCC and KUWS&DB officials consider them to be too far away from the city to supply treated wastewater economically. Finally, their requirements are considered to be too large relative to the availability of treated municipal wastewater by BCC and KUWS&DB officials.

45 *Source:* Discussions with KUWS&DB and BCC officials.

Assessment of Potential for Maximising Reuse

The potential for reuse in industry as well as Bellary is given in the Table 4.7 below

Table 4.7 Reuse Potential			(in mld)
	2011	2026	2041
Unmet Water Demand Bellary	0	11	51
Unmet Water Demand from Conventional Surface and Underground Sources – Industries	0	105	105
Forecast Volume of Treated Sewage	30	66	66

Source: KUWS&DB, Powertec Research

Existing Water Supply Sources Sufficient Only for the Medium Term

Table 4.7 above as well as the previous sections of this chapter indicate that unless there is substantial enhancement of allocation from the Tungabhadra Dam, Bellary city will start experiencing water shortages by 2026. In 2026 the shortage of raw water is forecast at 11 mld implying a treated water deficit of 9 mld given a transmission and distribution loss of 15%. Moreover, the requirement of water emanating from industries in the long run i.e. over the next 10–20 years is substantial. It is likely that sometime between 2025 and 2031 at least 105 mld of industrial water demand would go unmet from the existing surface and groundwater sources.

At this stage, there is no information which suggests that substantial extra water will be allocated to the city over the next ten years from the Tungabhadra Dam. Therefore, it would be prudent for BCC to start planning for freshwater scarcity in the long run. This would imply that by the mid-2020s the TCC would have the infrastructure in place or be actively implementing infrastructure works for utilizing a mix of sources viz., surface water, groundwater, harvested rainwater and recycled municipal wastewater to provide water to the residents, institutions and commercial establishments of Bellary City.

Areas of Reuse of Treated Municipal Wastewater

Municipal sewage or wastewater can be recycled for reuse after tertiary treatment and disinfection in:

- **Households** for non-potable purposes such as flushing toilets, watering gardens and washing cars.
- **Public and Private Institutions** like schools, colleges, hospitals, bus and railway stations etc. for non-potable purposes such as for flushing toilets, watering gardens and centralised air conditioning.
- **Commercial Establishments** including offices, small industrial units and workshops for non-potable as well as non-process purposes such as for flushing toilets, watering gardens, centralised air conditioning, etc.
- **Public Purpose** by municipalities such as street washing, flushing of sewers, watering parks, etc.
- **Industrial Units** including power plants but excluding food processing units for process use, cooling water and wash water purposes.

Further, urban wastewater can be reused after secondary treatment and disinfection in:

- **Peri-Urban Agriculture** as water for irrigation and as fertiliser for vegetables and other crops grown in the vicinity of the city.

Finally, it can be used after secondary treatment and disinfection for:

- **Surface Water Discharge:** this is to augment surface waters in rivers, streams and lakes in the vicinity to ensure that the flows in them meet the minimum environmental flow standards, which is essential to keep them from going dry and to maintain the flora and fauna including agriculture of the region.
- **Groundwater Recharge** by discharging treated sewage on to nearby fields, nallahs (natural water courses) and tanks. Indirectly, this leads to wastewater reuse for both potable and non-potable activities as groundwater is regularly abstracted to augment surface water supplies in most places.

Reuse Potential of Treated Municipal Wastewater in Bellary City

- **Non-Potable Use in Households:** As conventional surface and groundwater sources are expected to be adequate in the short to medium term there is very little scope to reuse recycled municipal wastewater for non-potable purposes in households in Bellary over the next ten years. In the long term and the very long term water supply shortages *would create an environment conducive for potential reuse in non-potable activities.*
- **Commercial Establishments:** *In the long term and the very long term water supply shortages would create an environment conducive for potential reuse in non-potable activities.*
- **Public Parks and Other Public Purposes:** *As increasing water scarcity will be the main determinant of reuse; the potential will only materialize in the long term i.e. over the next ten to eleven years.*
- **Industry:** The main reuse opportunities in Bellary till 2031 would be generated by the Sponge Iron and Steel industrial units located in the vicinity of the city. It is likely that sometime between 2026 and 2031 at least 105 mld of industrial water demand would go unmet from the existing surface and groundwater sources. *Despite the likelihood of future industrial demand being overstated, the actual demand that may materialise in the future may still be quite large relative to the amount of treated sewage that would be available for reuse over the next 8–10 years. Thus, the potential for reuse of municipal treated wastewater in industry is quite high.*
- **Peri-Urban Agriculture:** *There is likely to be substantial demand from farmers in the vicinity for treated sewage water* as the area is known for cultivation of cotton, jowar, groundnut and sunflower. Also there was significant opposition by farmers to the diversion of for industrial or domestic and non-domestic uses in the city has been mitigated through Karnataka

Government orders mandating that at least 30% of the treated wastewater should be discharged in to natural water courses (nallahs), tanks and open fields for use by farmers and for natural recharge of groundwater.

Constraints to Maximizing Reuse Potential in Bellary

- **Constraints to Non-Potable Reuse in Households:** The biggest obstacles to reuse of treated municipal wastewater in households for non-potable purposes are:
  - The cost of laying the pipelines for conveying the treated wastewater to residences for use in toilets and gardens; and
  - The sensitivity of society towards use of wastewater for any purpose. The sensitivity of society to reuse of treated wastewater is understandable given that historically wastewater has not been treated in India and wherever it has the functioning of STPs leaves much to be desired. Most likely taboos will weaken naturally over the long run as rising freshwater scarcity raises costs and reduces consumption to basic levels.
- **Constraints to Non-Potable Reuse in Institutions:** The biggest impediment is the cost of laying pipelines and other associated infrastructure for conveying wastewater to institutions from large, centralised STPs. This impediment could be overcome by encouraging adoption of decentralized wastewater collection and treatment systems by institutions either individually or in a group located in the same area. It is likely to disappear in the long run as freshwater scarcity rises.
- **Constraints to Non-Potable Reuse in Commercial Establishments:** Similarly, the cost of laying pipelines and other associated infrastructure for conveying wastewater is the biggest impediment to reuse. In the long run this constraint may naturally disappear as water scarcity levels rise and cost of delivering freshwater to the end-user rise substantially.
- **Constraints to Reuse in Public Parks and Other Public Purposes:** There are two constraints to reuse of water for public purposes like watering parks and flushing public toilets:
  - First, *awareness levels in the BCC about reuse possibilities and methods are low;*
  - Second, *the cost of laying pipelines and other associated infrastructure for conveying wastewater to parks compared to the cost of constructing and operating bore wells with submersible pumps is much higher.* Given that the average water table is 200 ft, the BCC spends about ***Rs. 1.5 lacs to drill a well and install a submersible pump***. It spends another ***Rs. 4000 to 5000 per month on electricity to operate the bore well***. Also, since the parks belong to the Bellary City Corporation, it is likely that the treated wastewater will be supplied free or at a very nominal rate, hence, BCC will not be able to earn any revenue from reuse water to offset its costs. Thus, the preference for using bore wells for watering parks is likely to continue in the medium term. In the long run, this constraint may naturally disappear as water scarcity levels rise.
- **Constraints to Reuse in Industry:** In Bellary, there are two key constraints to maximizing reuse both in the medium term and the long run:
  - First, the prospects of the sponge iron and steel industry the only potential customer for urban treated wastewater. Thus, the better its financial performance the greater will be its need for water and therefore, greater the willingness to pay extra for additional supply of water from treated urban sewage rather than do without it.
  - Second, social/political risk emanating from the conflict with farmers on the periphery, who utilize the same sewage for irrigation and fertilizing their fields. This constraint has been mitigated by Karnataka Government orders mandating that at least 30% of the treated wastewater should be discharged in to natural water courses (nallahs), tanks and open fields for use by farmers and for natural recharge of groundwater.
- **Constraints to Reuse in Peri-Urban Agriculture:** These arise from a conflict with competing uses of wastewater by industry and the city for non-potable uses. In the long run i.e. the next ten years as demand for water outstrips supply both in industry and the corporation, the desire to divert greater and greater amounts of treated sewage water away from peri-urban agriculture will grow thus reducing the amount of treated wastewater being given to farmers. Fortunately, the Government of Karnataka has had the foresight to see this emerging conflict and contain it by mandating that at least 30% of treated wastewater will be discharged into the in to natural water courses (nallahs), tanks and open fields for use by farmers and for natural recharge of groundwater.

Income Generating Wastewater Opportunities

Revenue generating opportunities are given below:

- **Janki Corporation Ltd.:** *15 mld of treated wastewater to be supplied to its unit situated in Sidiginamola village in Bellary, 22 kms from Ananthpur STP*. The conveyance infrastructure has been laid at an estimated cost of Rs. 15 crore.[46] The conveyance infrastructure has been commissioned in December 2014 and takes 15 mld of treated sewage from the Ananthpur STP for which it *pays Rs. 3.15/KL*. This is the original rate at which *BCC had agreed to supply treated sewage. Since it is in 2007 prices, the BCC may escalate it in the future to take into account inflation since then*.
- **Sponge Iron and Steel Industry:** Over the next ten years, the entire 66 mld of sewage generated by Bellary City will be collected and treated at three STPs with a combined treatment capacity of 70 mld. Since only 70% of the treated wastewater will be allowed to be reused for non-agricultural and non-environmental flow (groundwater recharge and surface water discharge) purposes, *a maximum of 46 mld of treated sewage would be available for reuse by industry and BCC. Hence, supply of treated sewage to the sponge iron and steel industry could be a lucrative opportunity for both the BCC and the private sector in the medium to long run*.

Project Implementation Structures

Janki Corporation Ltd.: As Janki Corporation will operate the infrastructure for collecting and conveying treated wastewater from the STP on Ananthpur road to its industrial unit in-house, it may be worthwhile for the 2030 WRG to discuss with Janki Corporation the possibility of outsourcing the operations and management of the system to a private operator under a management contract framework.

In the longer run, once Janki Corporation is comfortable with the facilities being operated by a private third party, a full-fledged full-fledged Build-Operate-Transfer (BOT) or a Design-Build-Finance-Operate-&-Transfer (DBFOT) type PPP structure which would involve not just O&M but also investments to replace and upgrade existing infrastructure and recovery through user charges or availability based annuity payments from Janki Corporation could be considered after undertaking a detailed assessment of the financial viability of such a proposal.

Reuse by the Sponge Iron and Steel Industry

There are several ways that the projects for supplying the treated wastewater to the industry could be implemented. The main modes are given below:

1) *BCC owns, develops, finances and operates the projects itself* and recovers the capital costs and operating costs of not only the additional infrastructure involved in conveying the treated sewage from the STPs, but also the capital and operating costs of Bellary's sewerage network and STPs from the industrial units located in the industrial estates.

46 *Source:* KUWS&DB, Bellary officials

2) *The private sector is allowed to develop the projects to supply treated municipal wastewater to industry on a Public–Private–Partnership (PPP) basis*. Thus all the reuse projects, each comprising conveyance infrastructure from the STPs and possibly additional on-site treatment facilities, get housed in an SPV either fully privately owned or in a joint venture between the private party, the TCC and GoK. The SPV would have the responsibility to finance, build, own and operate the projects and would recover its capital and operating costs of treatment and conveyance of wastewater from the STPs to the industrial units from the industrial units.

3) *The private sector is allowed to develop on a PPP basis not only the aforementioned projects but also the municipal STP/STPs*, so that issues related to STP operations and sewage quality are taken care off as well.

4) *Private sector involvement could be in the form of management contracts* where its specialised knowledge and management skills could impart better operating efficiency than public sector alternatives. Thus the ownership of the projects would vest with BCC and GoK and they would be operated by the private sector.

Caveat: However, it would be advisable to closely evaluate the financial viability of a full-fledged Build-Operate-Transfer (BOT) or a Design-Build-Finance-Operate-&-Transfer (DBFOT) scheme based on a close assessment of demand, future reliability of alternate water supply sources, cost of constructing and operating a recycled municipal wastewater system (cost of treated sewage, pipeline, tertiary treatment including disinfection by chlorination etc.), industry's willingness to pay and the cost of supply from alternate sources such as ground and surface water.

Wastewater Collection and Treatment System Cost Recovery Measures for BCC

In both the PPP structures outlined above, *the BCC could look at supplying treated sewage to the SPV from its STPs, at a price which at least covers its O&M cost of collecting and treating municipal wastewater to secondary levels*. Please refer to the tables below for estimates of the O&M costs of Bellary City's existing sewerage network and STP.

Table 4.8 Cost of Operating and Maintaining Existing Sewer System at 2013–14 prices

Annual O&M Cost Excluding Electricity Charges for Pumps (Rs. Lacs)	137.31
Annual Electricity Charges for Pumps (Rs. Lacs)	23.45
Total Annual O&M Cost Including Electricity Cost (Rs. Lacs)	**160.76**
Estimated Annual Sewage Flow (in Lacs KL in FY 2013–14)	109
Estimated Electricity Cost (Rs./KL)	0.22
Estimated Total O&M Cost Including Electricity Cost in Rs./KL	1.47

Table 4.9 Cost of Operating and Maintaining STP at 2013–14 prices

Annual O&M Cost Excluding Electricity Charges (Rs. Lacs)	70.53
Annual Electricity Charges (Rs. Lacs)	57.28
Total Annual O&M Cost Including Electricity Cost (Rs. Lacs)	**127.80**
Estimated Annual Sewage Flow (in Lac KL)	109
Estimated Electricity Cost (Rs / KL)	0.52
Estimated Total O&M Cost Including Electricity Cost in Rs/KL	1.17

*Source: KUWS&DB, Bellary

BCC Cost Recovery Enhancement or PPP Revenue Enhancement Measures

BCC will not be able to use revenues from the sale of sludge from its Ananthpur and the Cowl Bazaar STPs as a regular source of income since sludge is removed only once in every 5–10 years as sludge production is low in aerated lagoons. Further, the use of bio-culture, as is being done presently, reduces the sludge produced to negligible quantities. It is advisable that the evaluation methodology of the various technology options and revenue enhancement measures be based on the NPV of their capital expenditures, O&M costs and the revenues/savings generated over their lifecycle.

Knowledge for Replication, Policy Intervention Needed and Way Forward

This chapter outlines the key learnings from the case studies outlined in Annex 5 of the report and highlights areas for replication in Karnataka as well as policy interventions that may be required to promote municipal wastewater recycling in industry, agriculture, horticulture, institutions, households and commercial establishments. The list of measures is not intended to be exhaustive but rather should be viewed as a basis for informed discussion on key issues that would need to be addressed in the policy. The subsequent section of this chapter delineates the role that 2030 WRG could play in promoting reuse through baseline studies and project formulation as well as in assisting Government of Karnataka and local bodies in policy making, planning, capacity building and user sensitisation.

Knowledge for Replication of Good Practices Across the State

A compendium of reuse cases, technologies and transaction models is appended with this report at Annex 5. An analysis of these examples from Madras Fertilizers, Chennai; Rashtriya Chemicals and Fertilizers, Mumbai; and the wastewater recycling initiative by Pragati Power Corporation ,New Delhi; indicate that it is possible for large industrial consumers to consider reuse of wastewater supplied by the local government agencies. All these examples talk of secondary treated sewage being treated further in tertiary treatment plants and RO systems to levels required by them for their own industrial processes. These cases highlight the fact that a large anchor consumer for treated wastewater is crucial to the success of the initiative to encourage reuse of wastewater. A similar example can be found in Bangalore where the Yelahanka tertiary treatment plant supplies treated effluent to a few anchor customers such as the New International Airport at Devanhalli, ITC Ltd, Wheel and Axle Plant etc. **The development of the Chennai–Chitradurga Industrial Corridor offers an opportunity for the Government of Karnataka to look at the industries located in this corridor as potential customers for treated municipal wastewater from urban clusters located along the industrial corridor.**

China has made considerable progress in use of PPPs in the water and wastewater sectors. A recent study carried out by Asian Development Bank estimated that there are around 400 water and wastewater PPPs in the People's Republic of China (PRC). Companies operating in the water sector include trans-national water companies, privatised local water companies and domestic operators. PRC began to deregulate the water sector in the 1990s, allowing private and foreign investment in the water and wastewater sectors. China has gone in for both complete privatisation as well as PPPs and allowed majority foreign ownership in joint venture companies in this sector. The most common model for wastewater projects is the Build-Operate-Transfer (BOT) model, unlike in India where the BOT model has met with limited success because of the high revenue risk associated with such projects. BOT models work in China because the country went in for tariff reforms ahead of private sector participation in this sector. A successful example of wastewater PPP in China is the Shanghai Zhuyan Youlian No.1 wastewater treatment project providing advanced primary treatment. The Plant serves 23.5 Million residents of Shanghai over an area of 107sq.km. **The service fees charged by the project are relatively low on account of indirect subsidies in the form of land and cost of some investments being borne by the government**. In this case, **the service contract with the local government specified a two tiered service fee with a fixed component of CNY0.22 per cubic meter and a variable component of CNY0.082 per cubic meter, with the variable component being revised every three years**. This experience holds important lessons for India and Karnataka on the need to embark on tariff and regulatory reforms before embarking on PPPs. The two tiered tariff structure used may also be replicated where by operators are compensated for financing and investment costs through a fixed tariff whereas the variable component could be linked to performance.

A rare BOT model which has succeeded in India is the Alandur Sewerage Project in Tamil Nadu. Like the Chinese example quoted above, this project had significant public investment in the sewerage network and the sewerage treatment plant was developed on a BOT basis due to lack of technical and financial capacity at the municipal level. **To address the issue of sewerage charges, a 'willingness to pay' survey was conducted covering over 10% of the cities' population. According to the survey, although the public generally had strong support for the project and accepted that users should pay for sewage service, this willingness had its limits.** The municipality initially proposed monthly sewer charges of Rs. 150 per month per household, to be increased by 6 percent a year until reaching a target level of Rs. 180 per month. To gain public acceptance of these rates, the municipality mounted a vigorous public participation campaign with extensive media coverage to explain the project's benefits, costs, and tariff system. Although, initially a large population of the town was not ready to pay the high deposits of sewerage connection charges and monthly tariff, the active canvassing and awareness raising activities educated people on the benefits of the project and succeeded in persuading residents that the services were worth paying for. To ensure effective participation of the local population it was decided to collect deposits from at least 10,000 residents before calling for tenders. **Thus it is important for governments to consult with the public in an effective manner before attempting tariff increases and projects on a BOT basis**.

Tamil Nadu also has implemented a number of projects in the sewerage sector on a Design-Build-Operate (DBO) model where the land is provided upfront by the government to bidders, choice of technology is left open to the bidders and the revenue risk is borne completely by the government. This model addresses the key concerns of technology providers and private players in the sector in terms of providing flexibility in choosing technology according to availability of land. Many of these projects also selected bidders on the basis of least life-cycle costs, thus enabling selection of optimal technologies.

Checklist for Attempting Wastewater PPPs

Based on the analysis of many water reuse PPPs in the country and elsewhere, the following checklist has been evolved.

1. Assess potential for industrial consumption of wastewater in the vicinity of the proposed sewerage treatment plant. Consult with industry stakeholders to understand their requirements in terms of quality of treated water and whether they are willing to undertake tertiary treatment themselves. Also understand 'willingness to pay' by user industries.
2. Once industrial demand is established, undertake a detailed feasibility report and then get a detailed project report prepared. Appoint a transaction advisor to assist with the bid process management. A BOT model may be explored in this instance. It is important to ensure that data provided in the DPR is reasonably accurate and that sufficient quantity of raw sewerage is available to the STP.
3. In case there is not much industrial demand in the proximity of the sewerage treatment plant, then the municipality should look at secondary treatment of sewage and disinfection only. In this case, the reuse possibilities are either in agriculture or for non-potable purposes. The municipality should get a feasibility study conducted followed by a DPR. In case the municipality wants to go in for a PPP approach, then it should look at a DBO model for the sewerage treatment plant alone. The network should be developed and financed by the municipality itself. It should also carry out 'willingness to pay' surveys amongst citizens for recovery of sewerage charges, and some form of partial recovery of capital costs for the network through one time connection charges to the network.

Policy Imperatives and Directions

At present, there is no state government policy on reusing municipal wastewater. However, the Ministry Of Urban Development, GoI has formulated Service Level Benchmarks (SLB) as a reform measure under the Jawaharlal Nehru National Urban Renewal Mission (JNNURM), according to which the cities are required to treat at least 20% of its municipal wastewater appropriately and recycle and reuse it for non-potable uses This measure will help not only in reducing the pollution load on the receiving water bodies or land, but also reduce the requirement of freshwater to some extent.

This section attempts to give some suggestions on the areas that the policy could encompass and the type of policy intervention that may be involved based on the findings of the rapid assessment as well as learnings from wastewater reuse policies and projects in India. In order to encourage wastewater reuse the state government could look at the following recommendations while formulating policy for it.

- **Base for guidelines**
  - i. To start with, the Government of Karnataka should adopt the Government of India guidelines, particularly with regard to service level benchmarks (SLB) that recommend that at least 20% of wastewater needs to be reused.
- **Promotion of reuse by industry**
  - i. Industries requiring bulk water (including power plants) and located close to urban areas should be mandated to use treated wastewater and limit freshwater use. Municipal water authorities should facilitate this, for example by supplying raw sewage or treated sewage water at cost of supply. Industries located further away from urban areas, should be directed to recycle their own sewage to meet part of their overall water requirement.
  - ii. Plans for development of industrial areas, SEZs and new townships should incorporate provisions for collecting, conveying and treating wastewater as well as its reuse by providing for tertiary treatment systems and allied infrastructure for treated wastewater etc.
  - iii. Polluting industries and industries located in water scarce regions could be directed to go in for in-house/on-site wastewater treatment and reuse. An initiative in this regard has already been taken by the Karnataka SPCB order of October, 2014 directing the textile industries in Bellary to adopt zero discharge wastewater treatment technologies.
  - iv. Power plants producing wastewater should be allowed to use electricity generated by them for the operation of their own STP.
  - v. For STPs, operated by industry or by ULBs/water authorities, the electricity from distribution companies should be provided at a lower cost than industrial rates.
- **Promotion of reuse by non-domestic users**
  - i. Reuse of treated municipal wastewater should be incorporated in the planning of new townships and cities. This would involve setting aside land for STPs; and designing building codes, making it compulsory to install dual pipelines in households; one for treated drinking water and the other for treated recycled wastewater for toilet flushing etc. Adequate precautions should be taken to ensure that there is no intermixing of sewage with freshwater by careful monitoring of system operations, particularly the operations of STPs. Further, it should be made compulsory for developers to lay not only freshwater pipelines and sewers but also pipelines to carry treated wastewater in new developments.
  - ii. Regulations mandating major wastewater generators such as hospitals, commercial establishments etc. to go in for onsite treatment and reuse. The state has already taken similar initiatives such as the HDMC By-law of 2009 mandating all new private nursing homes, medical colleges to treat their wastewater.
  - iii. Sensitizing citizens through focused awareness campaigns on television, radio, social media and live events like Raahgiri in Gurgaon and Delhi. The campaigns should aim at educating the citizens of a city of advantages of saving freshwater and breaking social taboos on reusing wastewater for non-potable purposes.
  - iv. A few examples of recycling and reuse of treated wastewater for non-potable uses already exist in India, like the one in Bangalore, where treated wastewater is used in the golf course and at the international airport. The state government and the municipal corporation councillors

and officials could visit these plants and adopt similar technologies and institutional structures to recycle and reuse the city sewage for non-potable uses.

- **Measures for harmonious use of wastewater**
  - i. Guidelines need to be issued to earmark a portion of wastewater for agricultural use to avoid conflict with farmer interests and political intervention. The exact percentage of municipal wastewater allotted to farmers would vary from region to region and would have to be set in conjunction with local authorities, farmer representatives and industry associations.
  - ii. Further, quality norms would have to be established for ensuring the quality of wastewater to be supplied to farmers as per CPHEEO guidelines for treated sewage in farming and agriculture. This is to ensure that the treated wastewater is free of harmful organisms and chemicals but not completely devoid of nutrients for plants.

- **Tariff policies to promote recycling**
  - i. The scarcity value of water should be brought home to industries located at a distance from urban areas which require piped freshwater supply. This can be done by ensuring that water tariffs reflect the willingness to pay of industries as measured by what it costs them to procure similar quantity and quality of water from the next best alternatives such as tanker supplied drinking water or groundwater from bore wells.
  - ii. Treated freshwater supplies should be priced higher than the treated municipal wastewater supplies to discourage excessive freshwater use and encourage reuse of treated wastewater, particularly for bulk consumers.

- **Measures to restrict groundwater use**
  - i. There should be a provision limiting ground water abstraction. The relevant government departments should allocate the ground water abstraction quantity by industry sector/type and non-domestic consumers. The provisions would also need to be enforced strictly by the concerned government departments and local authorities in order to encourage on-site/in-house treatment and reuse of own wastewater.

- **PPP interventions**
  - i. PPP interventions in this sector should be focused on improving service delivery and meeting environmental and social objectives.
    - a. Given the limited revenue potential and significant capital expenditure involved, full- fledged DBFOT/BOT type PPP models will only work in those cases where the major consumers are industries which are water intensive, performing well and have few inexpensive alternative sources of water.
    - b. However, management contracts and DBO contracts focused on ensuring performance of STPs would be a more appropriate way for involving the private sector, particularly, in managing municipal wastewater systems and recycling systems providing treated wastewater to institutions, commercial establishments and community parks.

- **Measures to improve wastewater system operations**
  - i. One of the parameters that will govern industrial off take of treated municipal wastewater is the quality of treated sewage. Therefore, the operator of the municipal sewage network and STP has to ensure proper operation of the system on a 24x7 basis. A municipal corporation/state government entity may find this a difficult task due to both shortage of trained manpower and paucity of funds. Therefore, the state governments and ULBs involved in municipal wastewater operations should undertake, among others, measures to:
    - a. Rationalize the number of posts required as has been given in the CPHEEO manual and fill vacant posts, wherever necessary, to relieve the burden of the existing staff and bring in efficiency.
    - b. Have proper career planning and incentive mechanisms to improve morale
    - c. Impart regular training to engineers and technicians in operations and maintenance practices. For instance, attendance at CPHEEO training programmes could be made mandatory.

- **Government support**
  - i. The quantum and type of government support needs to be clearly articulated for projects to be managed well either by the private sector or the government. For example Maharashtra has a scheme, Maharashtra Sujal Nirmal Abhiyan (MSNA) Incentive Based Reform, in which the Government of Maharashtra offers fiscal incentives in the form of grants under the MSNA programme linked to achievement of specified milestones. Similar 'output based support' could be considered in order to ensure that municipal wastewater and recycling systems are financially self sustaining.

- **Stakeholder participation**
  - i. Before devising a state level policy, it is recommended that the Government of Karnataka undertake widespread consultation with local industries, citizens and farmers to address the concerns of the aforementioned entities in the policy.

- **Technology choices**
  - i. Technology minimizing land use to be encouraged
  - ii. Tertiary treatment technology to be adopted where likelihood of reuse of treated wastewater by industry is high
  - iii. Technology to reduce lifecycle costs of networks and STPs.
  - iv. Technology to reduce O&M costs on cleaning, pumping of the sewer network
  - v. Decentralized wastewater collection and treatment systems for low density and low per capita supply areas like peri-urban developments and institutions.

Next Steps

In order to promote reuse of municipal wastewater in Karnataka and particularly in Tumkur, Hubli-Dharwad and Bellary, the 2030 WRG could engage with the Government of Karnataka, ULBs, KSSIDC, KIADB, Commissioner for Industrial Development and Directorate of Industries and Commerce, district administration and KUWS&DB to, inter alia:

- **Detailed Studies**
  - i. Validate the findings of the rapid assessment through field visits to Tumkur, Hubli-Dharwad and Bellary.
  - ii. Conduct techno-commercial feasibility studies at Tumkur to conceptualize and develop a PPP project involving reuse of municipal wastewater by industries such as the 30 mld wastewater supply project to Vasantha Narasapur Industrial Estate; the 15 mld wastewater supply to Janki Corporation; and the 7.5 mld wastewater supply from Cowl Bazaar STP.
  - iii. Detailed market survey to ascertain demand from sponge iron and steel industry in Bellary.
  - iv. Evaluate in detail, opportunities such as the requirement by South-Western Railways workshop in Hubli;
  - v. Evaluate in conjunction with the management of hospitals and nursing homes the opportunity for providing DEWATS/ DWMS systems with private participation in all three towns.
- **Policy and Planning**
  - i. Assist the various departments of Government of Karnataka such as the Urban Development Department, the Industries and Commerce Department, Water Resources Department, Ground Water Board and Karnataka State Pollution Control Board as well as the agencies/parastatals (KUIDFC, KUWS&DB) under their purview in formulating policy at the state level for promoting recycling and reuse of wastewater which does not conflict with the need of farmers in the vicinity;
  - ii. Assist ULBs and its councillors in developing policy and plans for reuse in non-potable activities in households, institutions, commercial establishment etc.
  - iii. Organise visits by state government officials and municipal corporation councillors and officials to visit plants in India treating wastewater for reuse, like the one in Bangalore, where treated wastewater is used in the golf course and the international airport so that they can adopt similar technologies and institutional structures to recycle and reuse the city sewage for non-potable uses.
- **User Sensitisation**
  - i. Assist ULBs and its councillors in running awareness campaigns for promoting reuse amongst its citizens and institutions;
- **Capacity Building**
  - i. Build capacity within ULBs, KUIDFC and KUWS&DB to design, build and operate wastewater recycling and reuse systems and to engage with the private sector in the discharge of such activities.

The 2030 WRG could consider undertaking the steps delineated above as part of its detailed assessment of the wastewater reuse opportunities in Karnataka.

ANNEX 1: List of Officials Met

Name of Officer	Designation	Organization	City
Ms. Rochi Khemka	Program Coordinator, Karnataka	2030 Water Resources Group	Bangalore
Mr. C. Dwaraka Nath Acharya	Senior Strategic Finance Advisor Karnataka	2030 Water Resources Group	Bangalore
Mr. B. M. Nagesh	Deputy Chief Engineer	KUWS&DB	Bangalore
Mr. Arifulla Sheriff	Executive Director	KUIDFC	Bangalore
Mr. Aswin	Project Manager	KUIDFC	Bangalore
Mr. C. S. Prathinidhi	Advisor (WS)		
Captain Swamy	Assistant Executive Engineer	KUIDFC	Bangalore
Mr. Nagararaj	Executive Engineer	KUWS&DB	Tumkur
Mr. Muddarajanna	Assistant Executive Engineer	KUWS&DB	Tumkur
Mr. Murthy	Consultant	KIADB	Tumkur
Mr. Ashaad R. Shariff	Municipal Commissioner	Tumkur City. Corporation	Tumkur
Ms. Soumya	Environmental Engineer	Tumkur City. Corporation	Tumkur
Mr. Vasanth	Assistant Executive Engineer	Tumkur City. Corporation	Tumkur
Mr. Prakash Lakshman Garag	Superintending Engineer	Hubli- Dharwad Municipal Corporation	Hubli- Dharwad
Mr. L. R. Naik	Deputy Commissioner	KUIDFC	Hubli- Dharwad
Mr. Wallad	Executive Engineer	KUWS&DB	Hubli- Dharwad
Mr. Shrikeshav	Executive Engineer	KUWS&DB	Hubli- Dharwad
Mr. Hanumanthappa	Executive Engineer	KUWS&DB	Hubli- Dharwad
Mr. Mahadevaiah	Executive Engineer	KUWS&DB	Hubli- Dharwad
Mr. Venkata Rao	Executive Engineer	KUWS&DB	Hubli- Dharwad
Mr. Managond	Assistant Executive Engineer	KUIDFC	Hubli- Dharwad
Mr. B. N. Gadag	Joint Director	District Industries Centre	Hubli- Dharwad
Mr. Shakil Ahmed	Joint Commissioner	Hubli- Dharwad Municipal Corporation	Hubli- Dharwad
Ms. Naina	Environmental Engineer	Hubli- Dharwad Municipal Corporation	Hubli- Dharwad
Mr. Anjaneyalu	Consultant	M/s Wilbur Smith	Hubli- Dharwad
Mr. Sheik Iqbal	Assistant Executive Engineer	KUIDFC	Bellary
Mr. Ramappa	Assistant Executive Engineer	KUIDFC	Bellary
Mr. Mallikarjuna Kushtigi	Executive Engineer	KUWS&DB	Bellary
Mr. Narayana Rao	Assistant Executive Engineer	KUWS&DB	Bellary
Mr. Thimmappa	Municipal Engineer	Bellary Municipal Corporation	Bellary
Mr. Devaraj	Assistant Executive Engineer	KUWS&DB	Bellary
Mr. V. Lokesha	Joint Director	Department of Industries	Bellary
Mr. Somasekar	Deputy Director	Department of Industries	Bellary
Mr. Naik	Deputy Commissioner	KUIDFC	Bellary
Mr. Gangadhara Goud	Assistant Executive Engineer	KUWS&DB	Bellary

ANNEX 2: List of Industries and Their Water Requirement

Tumkur

Vasanthanarasapura 1st Phase, Tumkur					
S. No	INDUSTRY: (Name)	(Address)	Plot No	Nature of the Unit	Extent in Acres
1	M/s. Sri Ranganatha Engineering Works Prop: Sri Nagaraju R	S/o Late Rangappa, Urukere, Kasaba Hobli, Tumkur Taluk, Tumkur District	2–B	Engineering Works	0.25
2	M/s. Hindustan Forgings Prop: Sri E. V. Muralidhara	No. 407, 7th Main, 17th Cross, Rajajinagar 2nd Stage, Bangalore – 560 055	2–B1	Forged Components	0.25
3	M/s. S. M. Onestop Solutions Prop: Sri, S. M. Manjunatha,	# 159, 1st Floor, 6th Main Road, H.V.R. Layout, Magadi Main Road, Bangalore – 560 079. Mobile No: 9886402413	3–A	General Engineering & Fabrication Works	0.50
4	M/s. S.N. Engineers	No. 9/26, 4th Main, 7th Cross, Industrial Town, Rajajinagar, (Near Vikrani Hotel) Bangalore – 560 044	4	Precision Machine Components	1.00
5	M/s. Power Equations India Pvt. Ltd.	No. 1488, MKK Road, Mariyappana Palya, Post – 2132, Bangalore – 560 021	6 (Corner)	Heavy Fabrication on Electrical Towers	1.00
6	M/s. Anand Automats	No. 9/26, 4th Main, 7th Cross, Industrial Town, Rajajinagar, Bangalore – 560 044	9	Precision Auto Turned Components	1.00
7	M/s. Ganesh Graphics	No. 1179/33, 4th Main, 5th Cross, L. N. Colony, Yeshwanthpur, Bangalore – 560 022	10	Machine Printed Lables Tags Stickers Bar Code Etc.	1.00
8	M/s. Anugraha Industries	No. 204, 2nd A main, 1st Stage, 2nd Bock, HBR Layout, Bangalore – 560 043	11	Packing Materials, Electronic and Electrical Goods	1.00
9	M/s. Vinayaka Fabrication	No. 518, 53rd Cross, 3rd Block, Rajajinagar, Bangalore – 560 010	13	Concrete Block and Pavers	1.00
10	M/s. Manu Colour Tech Powder Coats & Precision Punches Industries	No. 68, 3rd Cross, Garudacharpalya, Mahadevapuram, Bangalore	14–A	Sheet Metal Enclosures & Powder Coating Activities	0.50
11	M/s. Sri Byraveshwara Logistics Prop: Sri V P Trishul,	No. 66/B, 2nd Block, 2nd Cross End, Near Somanna Garden, Vidyaranyapura, Bangalore – 560 097	14–B	Logistics	0.50
12	M/s. Sri Ramanjaneya General Engineering Works Propx: Smt. Shanthamma, Sri. Ramanjaneya Nilaya, Anekar Layout	New Extension, Prashantha Nagar, Devarayapattana Post, Tumkur – 572 104	14–C	General Engineering Works, (Steel Furniture & Fabrication) & Ware Housing Service	0.25
13	M/s. Mahesh Industries	No. 332, 9th K Main, Vijayanagar, Bangalore – 40	15	Garments	1.00
14	M/s. Innovative Engineers	No. 11/42, 2nd Main Road, Rajajinagar Industrial Town, Bangalore	16–A	Material Handing Equipemtns	0.50
15	M/s Eswar Industries Prop: Sri Kale Gowda	No. 231/85, Kempe Gowda Layout, Near Freedom Fighter Society Laggere, Banglaore – 560 058	16–B	Electrical & Electronic Items	0.50
16	M/s. Bhrath Electrical Industries Prop: Sudhir Kumar Singhivi	No. 10, 1st Floor, B V K Iyengar Road, Bangalore – 560 053	17	Induction Motors Electrical Parts, A C Motors	1.00
17	M/s. Hanuman Rubber Products	No. 532, 9th Cross, PIA, 3rd Phase, Ganapahty Nagar, Bangalore – 560 058	18	Rubber Products	1.00
18	M/s. K.S. Enterprises Prop: Sri. K. Anand	No. 177/26, 1st Cross, 4th Main, Industrial Town, Rajajinagar, Bangalore – 560 044	19–B	Auto Turning Components	0.50
19	M/s. Nuflux Electromagnetics Pvt Ltd. Director: Sri Prasad Lella	No. 140, 1–A Block, J.P.Nagr, 8th Phase, S.O.S. Post, Bangalore – 560 076	20–A	Coils & Transformers	0.50

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Vasanthanarasapura 1st Phase, Tumkur					
S. No	INDUSTRY: (Name)	(Address)	Plot No	Nature of the Unit	Extent in Acres
20	M/s. Sagar Industries Prop: Sri. Waheed Ahmed	C/o Shahabuddin, Near Chowdeshwari Temple, Behind City Club, Sira Gate, Tumkur	20–B	Re–Processing of Industrial Oil & Grees	0.50
21	M/s. Vijay Spheroidals Private Limited	17th – B, 2nd Phase, Peenya Industrial Area, Bangalore – 560 058	21 (Corner)	Grey and S G Iron Costing	1.00
22	M/s. Shivam Enterprises Prop: Sri. Sanaur Singh	C/o Nagarajaiah S/o Venkataramaiah, Mallasandra Village, Sondekoppa Post, Dasanapura Hobli, Bangalore North Taluk, Bangalore – 562 130	22–A (Corner)	Scrap Battery Melting	0.50
23	M/s. Sree Sharadha Enterprises Prop: Sri. T.N. Naveen Bhushan	S/o T. Narasimhaiah, No. 191, SIT Extension, 1st Main, 3rd Cross, Tumkur	22–B	Granite Cutting & Polishing	0.50
24	M/s. Abhishek Enterprises	1st Main Road, 2nd Cross, New Mandipet, Tumkur	23–A	HDPE Woven Sacks	0.50
25	M/s. Hi–Tech Industries Prop: Veeregowda B. N.	6th Main, 2nd Cross, Sadashivanagar, Kunigal Road, Tumkur – 572 101	24–A	Steel Fabrication	0.50
26	M/s. Aero Treatments Private Limited	Plot No. 467–469, Site No. 1D, 12th Cross, 4th Phase, Peenya Industrial Area, Bangalore – 560 058	25	Mfg. of Spl Process for Metallic & Non–Metallic Parts & Allied Activities	1.00
27	M/s. Maruthi Industries	No. 195/175/6, Opp: Villgepanchayt Office, Billekahalli, Banneraghatta Road Bangalore – 560 076	26	Industrial Fastners like Nuts, Bolts, Riverts, Screws and Washers	1.00
28	M/s. Sandesh Industries	No. 1117, Sanjosh, 2nd Cross Nagarabhavi, 1st Stage Bangalore – 560 072	28	Mfg of Bright Steel Bars	1.00
29	M/s. Nittoor Industries, Devavrinda	No. 1713, C – Block, 4th Main, 11th Cross, Sahakar Nagar, Bangalore – 560 092	29	Control Penels Power Distribution Panels & Accessories & MCB,s	1.00
30	M/s. S.R.S. Enterprises Prop: Sri. Revaiah. R.	S/o Late Revaiah, Hakkinalu, Marikuppe Post, Solur Hobli, Magadi Taluk, Ramanagar District	30	Granite Cutting & Polishing	1.00
31	M/s. Megha Cable Corporation Prop: Sri Sunil Mehta	No. 72, A.M. Lane, M.G.D. Complex, B.V.K. Iyengar Road Cross, Bangalore – 560 053	31	Under Ground Cables, PVC Wires & PVC Pipes	1.00
32	M/s. Ambadi Enterprises Prop: Sri Muneshwara Estate	Near Peenya Police Station, Bangalore – 560 058	32	Welding Machines & Industrial Dies	1.00
33	M/s. Anura Metala India	No. C–345, Industrial Estate, Peenya, Bangalore	33	Press Components Turned Components & Fabrication	1.00
34	M/s. Bhavesh Industries	No. B/1, 13th KM, Kanakapura Road Cross, Bubbala Gate, Doddakalsandra West, Bangalore	34 (Corner)	PVC Pipes & Allied Products	1.00
35	M/s. H.N. Industries, Prop: Sri. Kottappa	Siddapura, Madugiri Taluk Tumkur District	35	Fabrication	0.50
36	M/s. Srinivasa Enterprises Prop: Sri. M. Hareesha	2nd Main Road, 3rd Cross, Janatha Colony, Mariyappana Palya, Bangalore – 560 052	35–P	General Engineering & Fabrication Works	0.50
37	M/s. Veenus Engineering Industries, Prop: K. Raghava	No. 157, 10th Main, 3rd Phase, Peenya Industrial Area, Bangalore – 560 058	35–B	Mfg of Machine Components & General Engg & Industrial Fabrication	1.00
38	M/s. SVG Engineering Works	No. M – 122, Rajajinagar Industrial Area, 6th Block, Rajajinagar, Bangalore – 560 044	35–C & 35–D (Corner)	M S Fabrication, Erection & Allied Services	1.00
39	M/s. Vishaka Industries Limited	No. 27/1, G–Nagenahalli, Kempanadodderi Post, Tumkur Taluk,Tumkur District	37–Part (Adjoining to Visaka Industries Ltd)	Asbestos Cement Sheets	0.50
40	M/s. K.K. Overseas Propx: Smt. Rupshri Baid	No. 4, Samarpana Building, Sector 19, Kharghar, Navi Mumbai – 410 210	37–A	Food Items & Confectioneries	1.50

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Vasanthanarasapura 1st Phase, Tumkur					
S. No	INDUSTRY: (Name)	(Address)	Plot No	Nature of the Unit	Extent in Acres
41	M/s. Bhavishyath Logistics	No. 3496, 14th Main, HAL 2nd Stage, Bangalore – 560 008	37–B	Logistics & Warehousing	1.00
42	M/s. VEE EMM Logistics	No. 2884, 2nd Main, HAL 2nd Stage, Kodihalli, Bangalore – 560 075	37–C	Logistics & Warehousing	1.00
43	M/s. Karnataka Automats Pvt. Ltd.	No. 474/1, 1st Floor, Bhuvaneshwari Road, 8th Block, Koramangala, Bangalore – 95	42	Sub Assembly of Precision Engineering Components	5.00
44	M/s. Jiah Enterprises Prop: Sri. Gautam Rajmalji Bokadia	1st Parsiwada, New Hira Building, 1st Floor, Room No. 18, N.D. Road, Mumbai – 400 004	43–A	General Engineering & Fabrication Works	1.00
45	M/s. Tumkur Bright Bars Partner: Smt. Vanajakshi	No. 154, Madapattana Village, Haragadde V & P, Jigani Hobli, Anekal Taluk, Bangalore – 560 105.	43–B	Bright Bar Steels	0.50
46	M/s. Shivaganga Enterprises	"Venkateshwara Krupa" 12th Cross, S.S.Puram, Tumkur	43–C	Motor and Pumpsets	0.50
47	M/s. Prakash Marketing	No. 11, Sindhi Colony, Behind VISL Building, J. C. Road, Bangalore – 560 002	43–D	Domastic Pumps, Industrial Pumps and its Spare	0.50
48	M/s. Sri Lakshmi Venkateshwara Enterprises Partner: Sri. M. N. Krishnasa	No. 318, Sri Nanjudeshwara Complex, Chickpete Bangalore – 560 053	43–E (Corner)	General Engineering & Steel Fabrication Works	0.25
49	M/s. Bhavana Polymers	No. B/2, 13th KM, Kanakapura Cross, Gubbalal Gate, Doddakallasandra, Bangalore – 560 062	44 (Corner)	HDP/PVC Pipes & Drip Irrigation Systems	1.00
50	M/s. Sri Raghavendra Industries Partner: Sri Praveen Kumar G.R.	"Anjana Krupa" Near Akashaya Hospital, Dhobighat Road, 2nd Cross, Ashokanagar, Tumkur.	45–A	Fabrication & Errection	0.50
51	M/s. Spoorthy Industries	No. 17/1, 1st Cross, Sankranthi Industrial Estate, Ring Road, Pantharapalya, Mysore Road, Bangalore – 560 039	45–B	General Engineering & Steel Fabrication works	0.50
52	M/s. JNY Construction	No. 191/4, 9th Main, 8th Cross, 3rd Stage, BEML Layout, Raja Rajeshwari Nagar, Bangalore – 560 098	46	Hallow Concrete Blocks, Fence & RCC Poles	1.00
53	M/s. Sai Shiva Packaging	No. 298, 7th Main, 2nd Stage, Peenya, Bangalore – 560 058	47	Corrugated Boxes	1.00
54	M/s. Sampoorna Ice Cream	No. 78/1, 8th Cross, Magadi Road, Shankarappa Garden, Bangalore – 560 023	48–A	Ice Cream Food Products	0.50
55	M/s. Annapoorneshwari Food Products Propx: Smt. H.R. Hemalatha	No. 202, 4th Main Road, Parimalanagar, Opp. K.N. Geetha School, Kanteerava Road, Bangalore – 560 096	48–B	Food Products	0.50
56	M/s. Shilps Industries Prop: Sri. Ramesh Bantwal	No. 1331/1, Vinayak Nagar, Kamakshipalya, Bangaloe – 560 079	49	Rubber Products	1.00
57	M/s. Dyna Move Engineers	No. 139, D M Enclave, 2nd Main Road, Sheshadripuram, Bangalore – 560 020	50	Conveyour Systems and General Engineering and Fabrication Products	1.50
58	M/s. Ammonia Marketing Company	No. 125, 3rd Phase, Peenya Industrial Area, Bangalore	51	Liquor Ammonia & Ammonia Refilling Cylinders	2.00
59	M/s. Govinda Printers	No. 446, RMV Extension, 11th Main, 5th Cross, Sadashivanagar, Bangalore – 560 080	52	Printing	2.00
60	M/s. GKH Industries Prop: Sri M Harish	No. 624, 13th Cross, Domlur Layout, Bangalore – 71	53–A	Industrial Control Panels, AC & DC Control Panels.	1.00
61	M/s. Ever Green Irrigation	No. 226/8, (No. 79/2), 7th Cross, Tiles Factory Compound, Magadi Road, Bangalore – 560 023	53–B	Drip Irrigation Systems	1.00
62	M/s. New Medicon Pharma Lab Pvt. Ltd. Director: Sri. E. Harinath	New # 104/2, (Old # 328/6), T.T.K Road, Diwan Sahib Garden, Roypettah, Chennai – 600 014	54	Mfg. Biopharmaceuticals, Aportioning, Hyaluronidase, Gonadotrophin & Menotrophin	2.00
63	M/s. Canara Steel Corporation Prop: Sri Muneshwara Estate	Peenya, Bangalore – 560 058	55	Mild Steel & Bright Bars	2.00

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Vasanthanarasapura 1st Phase, Tumkur					
S. No	INDUSTRY: (Name)	(Address)	Plot No	Nature of the Unit	Extent in Acres
64	M/s. A. A. Industries Managing Parner: Mahamed Aqull	No. 8, R. Sonappa Block, 3rd Cross, Benson Town Post, Bangalore – 560 046	56–A (Corner)	Bulk and Fine Chemicals and Middle East and Japan	0.50
65	M/s. Agrovision Food Technologies Pvt. Ltd. Director: Sri. Pradip Kantilal Shah	Plot No. A–11, Old M.I.D.C. Area, Satara – 415003. Maharashtra	56–B	Wheat Flour Mill Unit	1.50
66	M/s. Arcot Foods Prop: A. J. Janaradhan	No. 104, Pavamana Nagar, Kothnur–Dinne Main Road, J. P. Nagar, 8th Phase, Bangalore– 560 076	56–C	Food Processings	0.80
67	M/s. Global Coils	No. 841, 23rd Main Road, 2nd Phase, J. P. Nagar, Bangalore	57 (Corner)	Coils for Motors & Generators	2.00
68	M/s. Ultra India	No. 45, 1st Main, Link Road, Deepanjali Nagar, Bangalore – 560 026.	58	Candles – All Types	2.00
69	M/s. Woodtech Consultants Pvt. Ltd. Director: Sri. T. Gopi	No. 610, 18th Main, 25th Cross, Rajarajeshwari Nagar, Bangalore – 560 098	59–A	High Quality Furniture and Wood Cutting Machine	1.00
70	M/s. Pavan Electricals Prop: Sri. H. A. Ravindra Reddy	No. 132, 4th Main, 4th Cross, Sree Vinayaka Layout, Boopasandra, Bangalore – 560 094	59–B	Establishment of Logistics & Warehousing facility	1.00
71	M/s Sajeev Engineering Works Prop: Sri Soman Pillai K.S,	No. 49/51, 9th Cross, Kalanagar, Kammagondahalli, Jalahalli West, Bangalore – 560015	60–A	Precision components & Fabrication works	1.00
72	M/s. Haldipura Hydraulics Prop: Keshava Subbarao	No. 90/99, 11th Cross, Doddanna Industrial Estate, Near Peenya 2nd Stage, Bangalore – 560 091	60–B	Exercise Note Book	1.00
73	M/s. Coburg Enginering Services Pvt. Ltd. Director: Madhu Kumar R.	#18, 1st Main Road, Ganganagar Extn.,Bangalore – 560 032	61–A	Structures Fabrication & Air Receiver	1.00
74	M/s. Sree Hanuman Electricals Prop: Sri. H. N. Sudhakar Reddy	No. 132, 4th Main, 4th Cross, Sree Vinayaka Layout, Boopasandra, Bangalore – 560 094	61–B	Establishment of Logistics & Warehousing facility	1.00
75	M/s. Sri Vasavi Traders	No. 14–A, 5th Main, 3rd Phase, Peenya Industrial Area, Opp: Power Gears, Bangalore – 560 058	62	Raw Materials for Agarbattis, Mosquito Coils Pulveriser for Starch Powder, Coconut Shell Powder Tamrind Powder and Ball Mill	2.00
76	M/s. S. V. Engineering Industries	No. 312, 1st Floor, 5th Main, BEML Layout, Basaveshwara Nagar, Bangalore – 560 079	64–A	Steel Fabrication, General Engineering Works and Pressed Components	1.00
77	M/s. Baruni Electronics & Services	1st Floor, R. K. Appartments, T. C. Palya Main, 3rd Main, Hoysala Nagar, Bangalore – 560 016	64–B	Electrical Panel Boards and Indsutrial Fabrication and Allied Works	1.00
78	M/s. Sathe's Enterprises,	No. 16, 7th Main, 2nd Stage, Indiranagar,Bangalore – 560 038	65	Logistics and Warehouring	2.00
79	M/s. Euro Ceramics World	No. 339/1, Ananth Ramaiah Wollen Factory Compound, Bapujinagar, Opp Big Bazar, Mysore Road, Bangalore – 560 026	66	Processing of Glass Industrial Fabrication & Aluminum Fabrication	2.00
80	M/s. Indo Burma Agencies	No. 19, J. C. Road, Opp: SBI Bank, Bangalore – 560 002	67	Wooden & Steel Furnitures Industrial Structural Glazing Fabrication & Aluminum Fabrication	2.00
81	M/s. Agarwal Industries Prop: Sri Mangat Ram Agarwal	# 37/1, 2nd Floor, Singasandra Village, Begur, (next to P.F. Office), Bangalore – 560 068.	68 (Corner)	Warehousing & Logistics	2.00
82	M/s. Siddharth Polymers Pvt. Ltd.	No. 1/1–02, 1st Cross, 1st Floor, Wilson Garden, Bangalore – 560 027	69–A (Corner)	Precision injection moulding plastic components in CNC machines.	3.00
83	M/s. Kailash Roofing Solutions Pvt. Ltd.	M D: Smt. Yashoda, Sy. No. 61, Site No. 8, Andrahally Main Road, Vishwaneedam Post, Bangalore – 560 091	69–B & 69–C	Metal Sheets and G. I. Sheets Fabrication Work	1.75

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Vasanthanarasapura 1st Phase, Tumkur					
S. No	INDUSTRY: (Name)	(Address)	Plot No	Nature of the Unit	Extent in Acres
84	M/s. Engineering Steel Fabrication Works,	No. 161, 10th Main Road, 3rd Phase, Peenya Industrial Area, Banalore – 560 058	73–A	Heavy Engineering Fabrication & Sheet Metal Work	0.50
85	M/s. Lakshmi Ceramics Refractories (India) Pvt Ltd.,	No. C–260A, 5th Cross, 1st Stage, Peenya Industrial Estate, Bangalore – 560 058	73–B	Monolothics & Refractories	1.00
86	M/s. Guru Electricals Prop: Sri. G. Ramakrishna	No. M–14/A, 7th Cross, 1st Phase, Peenya,Bangalore – 560 058	73–D	Electrical Implements AC Motors Generators	1.00
87	M/s. Ganesh Packaging, Prop: Keshava Dhandania	No. C–17, Raheja Residency, 3rd Block, Koramangala, Bangalore – 560 034	73–E	Plastic Bag	1.00
88	M/s. Divya Engineering Industries	No. 9, Muneshwara Estate, 1st Phase, Peenya, Bangalore – 560 006	73–F (Corner)	Fabrication of Steel Structures & Material handling Equipment	1.00
89	M/s. S. J. F. Fab Industries	No. 168, 1st Cross, Vidyanagar, Opp: S K F Factory, Bommasandra Industrial Area, Bangalore – 560 099	73–G	Turbo Ventilators and Other Handling Equipment	1.00
90	M/s. Maruthi Engineering Works Prop: Sri. T.R. Venkatesh Babu	Banashankari Nagar, Kunigal Road, Tumkur	73–H	General Engineering Works	1.00
91	M/s. Sri Vignesh Industries	No. 41, J. C. Industrial Estate, Bikasipura Road, Off: Kanakapura Road, Bangaloree – 560 062	74–A	Providing Powder Coating and allied surfact coating solutions and activities etc.	0.50
92	M/s. Noble Innovations Prop: H. N. Sathishkumar	No. 29, Simhadri, M S J College Post, Kottanur Dinne Main Road, J. P. Nagar, 8th Phase, Bangalore – 560078	74–A1	Fabrication	0.50
93	M/s. Karnataka Commercial Corporation	No. 63/1, J. C. Road, Bangalore – 560 002	74–B	Rexine PVC Sheets & Allied Products	1.00
94	M/s. L. B. S. Automation Systems Prop: Sri. Basavaraj N.K.	# SPL, B–120, 3rd Cross, Peenya Industrial Estate, 1st Stage, Bangaore – 560 058	74–C	Supply of Precision Engineering, Metal Components & S S Fabrication	1.00
95	M/s. Zenith Diecast Pvt. Ltd	23–B, Attibele Industrial Area, 1st Phase, Hosur Road, Anekal Taluk, Bangalore – 107.	74–D	Mfg of Aluminium Alloy Diecastings	1.00
96	M/s. Sakshi Industries Partner: Sri. V. C. Parvathamallappa	Wisspring Midown Appartments, No. C–202, R.M.V. 1st Phase, 2nd Stage, Dollars Colony, Bangalore – 560 094.	75–B	Corrugated Boxes & Packaging Materials	2.00
97	M/s. Josch Systems Pvt. Ltd.	No. 71, N. R. Road, Bangalore – 560 002	76 (Corner)	Electrical Tools (Power Tools) & Eectrical Wiring Accessories	5.00
98	M/s. Yash Karan Enterprises Smt. Reena Jain	C/o M/s. Ideal Textiles # 37/1, Singasandra Village, Begur, (next to P. F. Office), Bangalore – 560 068.	77 (Corner)	Warehousing & Logistics	2.00
99	M/s. G Tech Rebar Technology Pvt. Ltd.	A–39, Hosiery Complex, Phase–2, Extension, Noida, G.B. Nagar – 201305 UP	78	Cut & Bend of Reinforcement Steel for the construction Industry	3.00
100	M/s. Aeromech Technologies Private Limited	No. 362, 10th Cross, 4th Phase, Peenya Industrial Area, Bangalore – 560 058	79	Special Purpose Machines	2.00
101	M/s. Samskruthi Graphics & Printings Prop: K. S. Keshavakumar	No. 163, Bharatha Darshana, Manjunatha Road, 2nd Block, Thyagrajnagar, Bangalore – 560 028	80–A	Offset Printing	1.00
102	M/s Sharath Engineering Prop: Sri K Sasi	No.A–18, 3rd Stage, Peenya Industrial Area Bangalore – 560058	80–B	CNC Machine components and proposed to start heavy fabrication with laser cutting	1.00
103	M/s. Spectrum Industries	No. 199, 2nd Phase, Near MBB Coffee Works, Bommasandra Industrial Area, Bangalore – 560 099	81	Software Development for Chemical Composition	2.00
104	M/s. Soundrya	No. 1000, Chithra, Havanoor Extension, Nagasandra Post, Bangalore – 560 073	82–A (Corner)	Steel Fabrication	1.00

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Vasanthanarasapura 1st Phase, Tumkur					
S. No	INDUSTRY: (Name)	(Address)	Plot No	Nature of the Unit	Extent in Acres
105	M/s Gaganashree Granites	C/o Abhishek Enterprises, Jigani main Road, Anekal Taluk, Bangalore – 5620106	82–B	Stone cutting polishing chemical processing	1.00
106	M/s. New Shiva Shakthi Wood Industries	No. 133/2, Mysore Road, Kengeri Bangalore – 560 060	83–A (Corner)	Readymade Flush Doors & Furnitures	1.00
107	M/s. Balaji Timber Ply	No. 133/2–A, Mysore Road, Kengeri, Bangalore – 560 060	83–B	Flush Doors and Plywood Articles	1.00
108	M/s. Raghavendra Industries Partner: Smt. Gayathri	No. 463, Paranjothidama, 26th B Cross, 19th Main, Judicial Layout, GKVK Post, Bangalore – 560 027	83–C	Structural Engineering & Fabrication	1.00
109	M/s. S. P. R. Enterprises	No. 20/4, 4th Cross, 5th Main, Chamarajpet, Bangalore – 560 018	83–C1	Servicing Reconditiong of Earth Moving & Mining Equipments	1.00
110	M/s. Ranjitha Industries Prop: Sri. N. Sampath Kumar	No. 71, Rauthanahalli Road, Dasanapura Village & Hobli, Bangalore North – 562 123	83–D	Auto Mobile & Fabrication	1.00
111	M/s. Vishwa Shilpi Industries Prop: B. S. Sathya Raju,	No. 326, 5th Cross, 4th Main, Mahaganapathi Nagar, West of Chord Road, Rjajinagar, Banglore – 560 044	84–B	Metal Pressing Components Injection Moulded Components Press Tools and Moulds	2.00
112	M/s. Meditrina Industries Partner: Sri. H.A. Nagabhushana	No. 518, "E" Cross, Ideal Homes, Township, 2nd Phase, Rajajajeshwari Nagar, Bangalore – 560 096	85–A	Pharmaceutical Products & Chemicals	2.00
113	M/s. Shree Shaym Granite Prop: Sri. Jagadish Prasad Saraogi	C–708, Cyprus II, Siddha Pines, Rajarhat Main Road, Kolkata – 700136, West Bengal	85–B	Granite Slab Cutting and Polishing	1.00
114	M/s. Kailash Roofing Solutions Pvt Ltd. Director: Sri. Umed Singh	No. 51, 1st Floor, Dr. Siddaiah Puranik Road, 2nd Main, 4th Stage, 4th Block, Basaveshwaranagar, Bangalore – 560 079	86	Mfg. of profile sheets HR & CR Purlines PED Structure	4.00
115	M/s. Kamala Steel & Metal Corporattion	No. 1/8, Ramakrishna Building, N. R. Road Cross, Bangalore	87–A & 88–P2	Automobile Turned Components Precision Engineering Components	1.50
116	M/s. Intrans Electro Components Pvt Ltd	Industrial Development Arc Erumathala, Aluva, Kerala State – 683 105	87–B	Electrical Transformers & Panel Boards	2.00
117	M/s. Amara E–Waste Recovery Systems	No. 35, 2nd Cross, Adarshanagar, Nagarabhavi 1st Stage, Bangalore – 72	87–C	Electronics Waste Recycling	2.00
118	M/s. Sree Balaji Packaging Industry Prop: Sri. R. Manjunath Reddy	No. 1760, 1st Floor, 21st Main, 2nd Cross, H S R Layout, Bangalore – 560 034	88–P1	Export Quality Corrugated Boxes, Boards and Offset Printing	2.00
119	M/s. Sree Maruthi Enterprises	No. 171, 4th Cross, 4th Main Road, Industrial Town, Rajajinagar, Bangalore – 560 044	90–A (Corner)	Agarbatties & Raw Materials & Packaging & Export Agarbatties	2.00
120	M/s. Vasavi Steel Industries	No. 130/4, 4th Main Road, Industrial Town, Rajajinagar, Bangalore	90–B	M S Bright Bars & Thar Steel	2.00
121	M/s. Lakshmi Steels	No. 25, 9th Cross, 2nd Main Road, S. R. Nagar, Bangalore	90–C	Steel Bars and Bright Bars	2.00
122	M/s. Indo Arya Central Transport Limited Director: Sri. R. P. Arya	No. 41, Abrar Chamber, 1st Floor, Lalbagh Road, Bangalore – 560 027	92–A	Logistics and Warehouring and C F Agents Limited	2.00
123	M/s. Roopkala Holding Pvt. Ltd. Director: Amir Pradhan	Block No. 3, 1st Floor, Opp: Bank of India, No. 51, Hill Road, West Bandra, West Mumbai – 400 050 No. 312, The Embassy Appartments 15, Ali Askar Road, Near Police Commissioner Office, Bangalore – 560 052	93–A (Corner)	Textile Readymade Garmetns and Apparels	1.00

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Vasanthanarasapura 1st Phase, Tumkur					
S. No	INDUSTRY: (Name)	(Address)	Plot No	Nature of the Unit	Extent in Acres
124	M/s. Pradhan Merchantile Pvt. Ltd.	C/o. Industrial Engineering Corporation, G M: Sri. Siddarth Bhuwalka, No. 139, Nagindas Master Road, Fort Mumbai – 400 023 Plot No. 735/3/11–12, Near Oxford College, Off: Housr Main Road, Bommanahalli, Begur Hobli, Bangalore – 560 068	93–B	Readymade Garments (Apparles)	2.00
125	M/s. Magnum Distributor Pvt. Ltd. Director: Sri. Jamal Pradhan	Block No. 3, 1st Floor, Opp: Bank of India, No. 51, Hill Road, Bandra (West), Mumbai – 400 050 No. F2, D – Villa Apartments, No. 4, Edward Road, Off Queens Road, Bangalore – 560 052	93–C	Textiles, Readymade Garments (Apparels)	2.00
126	M/s. Adarsha Chemicals Prop: Sri. Omkarmurthy G. S.	No. F–404, Lunkad Sky, Longue Kalyani Nagar, Pune – 411 006 Shwetha Paradise, No. B–102, Site No. 2152/13/14, Sahakar Nagar, Bangalore – 560 092	94–A (Corner)	Specialty Chemical Products, Adhesives/ Sealants, Lubricants, Dispersions, Fluids, Polimers & Other compounds	2.00
127	M/s. Cauvery Industries Prop: Sri. Jayaramaiah	"Anugraha" No. ELN 393, K.R.S. Anugraha, B.K.A. Road, Kunigal – 572 130, Tumkur District	94–B	Bio Fuels & Cement Products	2.00
128	M/s. Maruthi Enterprises Prop: Sri. G. V. Ramamurthy	Maruthi Krupa, C S I Layout, Tumkur – 572 102	94–C	General Engineering & Steel Fabrication works	1.00
129	M/s. Bharath Oil & Gas Corporation	Limited, No. 703, 704, Krishna Tower, 16/63, Civil Lines, Kanpur – 01, UP	95–P & 96–P	Processing and Bottling of LPG	5.00
130	M/s. Famous Foam & Mattresses Private Limited Prop: Sri Siraj Jaffer Mohiuddin	S/o Jaffer Mohiuddin, 6th Main, 4th Cross, Sadashivanagar, Tumkur	96–P2, 96–P3 & 96–P4	Foam & Mattress	2.00
131	M/s. Prakruthi Biotech Prop: A. R. Ravindra	Sy. No. 228/2, A. K. Kaval Kunigal Road, Naruganahally Post, Tumkur	96–P5 (Corner)	Organics Manufacture, Bio–Fertilizer Plant Health Tonics	0.50
132	M/s. Chowdeshwari Industries Prop: Sri. T. V. Nagendraiah	Higiri, 29th Cross, Mallige Road, SIT Extension, Tumkur – 02	97–A (Corner)	Concrete Products, Cistern Pipes, Electric Poles & Sanitary Slabs Etc	1.00
133	M/s. Spandana Enterprises, Sri Renukamba Tours & Travels	Near State Bank of India, APC circle, Jigani Industrial Area, Jigani Hobli, Bangalore – 560 105.	97–B	General Fabrication	1.00
134	M/s. Vectus Industries Ltd.	No. 7, 2nd Main, MM Road, Betarayanapura New Extension, Mysore Road, Bangalore – 560 026	98–A	Mfg & supply of Plastic Pipes & Tanks	3.00
135	M/s. Vectus Industries Limited	No. 7, 2nd Main Road, Byatarayanapura, New Extension, Mysore Road, Banglaore – 560 026	98 & 99–A	Plastic Tank Pipe and Fittings	3.00
136	M/s. Seven Hills Propx: Smt. Smitha Butt	No. 406, 4th Main, N. S. Palya, BTM Layout, 2nd Stage, Bangalore – 560 076	99–B	Handicrafts and Diamond Cutting	1.00
137	M/s. Sri Sai Engineering Prop: Sri. B. I. Channaveer	No. 1807, 23rd Cross, Govindaraj Nagar, Magadi Main Road, Kamakshipalya, Bangalore – 560 079	100–A	Granite Polishing and Machinery	0.50
138	M/s. R.K. Associates Prop: Sri. H. N. Ramakrishna	No. 8/1, 1st Main Road, Sultanplaya Main Road, R. T. Nagar Post, Bangalore – 560 032	100–B	Transformers, Tubelight Fittings, Control Panels, Motor Rewinding Distribution Board	0.50
139	M/s. Dhruva Infotech Propx: Smt. Smitha K. P Girish Kumar	No. 201, Mahaveer Woods Appartment, 19th Cross, 22nd Main Road, J P Nagar 5th Phase, Bangalore – 560 078	102–A & 174–A	Software Development	1.00
140	M/s. Manupriya Industries Propx: Smt. Priyadarshini H. V.	23/A, Athimeya Geleyara Balaga, 1st Stage, Mahalakshmi Layout, 2nd Phase, Bangalore – 560 086	102–B	P C B Development and Allied Activities	0.50

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Vasanthanarasapura 1st Phase, Tumkur					
S. No	INDUSTRY: (Name)	(Address)	Plot No	Nature of the Unit	Extent in Acres
141	M/s. Energy Resources Partner: Sri. T.N. Madhu	Plot No. E–007, Iskon Temple, Yeshwanthpura Industrial Suburb, Bangalore – 560 022.	103	Bio Fuels	1.00
142	M/s. S. G. F. Fab Industries	No. 23–62, Kenchanayakanahalli, Bommasandra Industrial Area, Bangalore – 560 099	104	Cranes Fabrication Handling Equipements	1.00
143	M/s. Delta Products	2nd Cross, Opp: Ganesh Temple, Gokula Extension, Kyathasandra, Tumkur	105	Leather Pouches & Leather Products & Watch backs	0.50
144	M/s. Sri Rama Engineering Prop: S. R. Sunil Ramu	No. 204, 4th Stage, Industrial Town, 6th Main, West of Chord Road, Rajajinagar, Bangalore – 560 044	106–A	Press Tools and Components	0.50
145	M/s. Divya Shree Tool Tech Prop: Sri. G. Shivkumar	No. 174, 4th Main, 5th Cross, Industrial Town, Rajajinagar, Bangalore – 560 044	106–B	Press Tools Components	0.50
146	M/s G.S.S. Engineering Works Prop: Smt. Latha	No–911, 6th Main, 2nd Stage, WOC Road, Rajajinagar, Bangalroe	107	General Engineering & Fabrications	1.00
147	M/s. Tetra Space Fabricators Prop: Sri. Abhik Kumar Dey	No. 4/22, G.T.Road, Howrah, West Bengal.	108–A	General Engineerings & Fabrications	0.50
148	M/s. A.S.P. Engineers & Fabricators	No. 671/673, V.V. Ramu Indl Estate, Bommasandra, Bangalore – 99	108–B	General Engineerings & Fabrications	0.50
149	M/s. Tirupati Welded Mesh Industries	No. 5, M.R.R. Lane, Godown Street Cross, Opp. Chandra Vihar Lodge, City Market, Bangalore – 560 094	108–C	Mfg. of wire netting, welded mesh chain line fencing	0.50
150	M/s. Nikon Elevators	B–4, Srishti, # 1761, 36th Cross, East End 'A' Main Road, 9th Block, Jayanagar, Bangalore – 560 011	109 & 110	Elevators	2.00
151	M/s. Navbharath Engineers Partner: Nipul Desai	"Desai House", No. 39/2, J. C. Road, Bangalore – 560 002	111 & 112 (Corner)	Switch Gear and Power Systems	2.00
152	M/s. New India Electricals Ltd. CEO: Sri. Hemanshu Desai	"Desai House", No. 39/2, J. C. Road, Bangalore – 560 002	113 (Corner)	Electrical Power Systems	1.00
153	M/s. Yashaswini Enterprises Prop: Sri Narayanaswamy	No. 23, "Arunodhaya", 4th A Cross, Maruthi Nagar, Tumkur – 572 103	114	Granite Cutting & Polishing	1.00
154	M/s. Nanda Contructions	No. 43, 5th Cross, 19th Main, BSK 1st Stage, 2nd Block, Bangalore	115	Material Handling Equipments	1.00
155	M/s. KML Chemicals Private Limited Managing Director: S. Kannan	Mariyamma Temple Street, Vaddarapalya, Hardadde Post, Anekal Taluk, Bangalore	116	Sodium Azide, Hydrazine Hydrate and Other Chemicals	1.00
156	M/s. S. P. Tool Tech Prop: Sri. C. Suresh	No. 22/10, 14th Cross, A D Hally Industrial Town, Bangalore – 560 079	117	Motor Spares	1.00
157	M/s. M.D. Craft Industries Prop: Mohamad Wazeed	Akkrirampura Village, Koratagere Taluk, Tumkur District	118	Paper Processing	1.47
158	M/s. Gayathri Structural & Roofing Pvt.Ltd. Director: Sri. K.n.Shivashankar	No. 20, 3rd Main, Kali Temple Street, Subedarpalya, Yeshwanthpur, Bangalore – 560 022	119	Steel Structures	1.00
159	M/s. United Eletro Technologies	No. 59, 2nd Floor, 4th Main, Ganganagar Extension, Bangalore – 560 032	120	Educational Trainers Equipment, Data Acquisition Cards, Wireless SCADA System & Other Customissed Electronics Products	1.00
160	M/s. V.S.S. Industries Pvt. Ltd.	Shalimer Plaza, 2nd Floor, Palace Guttahally Main Road, Malleshwaram, Bangalore	121	Grinding Wheels	1.00
161	M/s. A. M. Corporation, Prop: Sri. Hans Peter Pinto	No. 46/1–3, 2nd Floor, Bhrudavan Complex, Sampige Raod, Malleshwaram, Bangalore – 560 003	122	Grinding Wheels and Moulded Points	1.00
162	M/s. Brite Stone Abrasives, Prop: Herald Titus Pinto	No. 5, Raghavendra Idnsutrial Estate, Thigalara Palya Main Road, Near Peenya 2nd Stage, Bangalore – 560 058	123	Brite Stone & Brand Honning Stone, Super Finishing Stones, Dimond and CBN Honning Sticks	1.00

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Vasanthanarasapura 1st Phase, Tumkur					
S. No	INDUSTRY: (Name)	(Address)	Plot No	Nature of the Unit	Extent in Acres
163	M/s. Ramisol	Shed No. C–17, Industrial Estate, B. H. Road, Tumkur – 572 103	124	Refractory Bricks	1.00
164	Sri Datta Venkatramana Industries	No. 1088/38, 6th Main, 3rd Cross, New Gokul Extension, Mathikere, Bangalore – 560 054	125–A	General Engineering and Steel Fabrication	0.25
165	M/s Shanoor Industries, Makkal Manzil	9th main, 5th Cross, P.G layojut, P H Colony, Tumkur	125–A1	Steel Fabrication, General Engineering	0.25
166	M/s. S.R. Metal Marts Prop: Sri. Rajendra Patel	C/o Narasegowda S/o Kempaiah, Poojari Street, Tavarekere, Magadi Main Road, Bangalore – 562 130	126–A	Scrap Battery Melting	0.50
167	M/s. Smitha Electricals	No. 271, Sree Sumeru, 5th Main, 6th Cross, Vyalikaval Layout, Vijayanagar, Bangalore – 40	126–B	Electrical Spares & Equipments	0.50
168	M/s. Shiva Industries Prop: Sri. B. Basavaraju	No. 11/1, 14th Cross, Industrial Town, Rajajinagar, Bangalore – 560 044	126–C	Pressing Components, Handling Equipments and Sheet Metal Fabrication	0.50
169	M/s. Sri Sai Sagar Industries Prop: Sri. Shivaraj Karamunje	No. 40, P & T Colony, 14th Cross, Cholarapalya, Bangalore – 560 0023	126–D	Pressed Components	0.50
170	M/s. Perfect Electricals Prop: Sri. P. V. Kumaraswamy	No. 12, 3rd – "B" Main Road, Someshwarbagar, GKVK Post, Bangalore – 560 065	127	Power and Distribution Transformers	1.50
171	M/s. Serendip Associated (P) Ltd.	No. B–111, 3rd Stage, Peenya Industrial Area, Bangalore – 560 058	128	Shelters and Containers	1.00
172	M/s. Adarsha Engieers	No. 13, 20th Cross, Doddanna Estte, Near Peenya 2nd Stage, Bangalore – 560 091	129–A	Hoists Hoy & EOT Cranes, Good Lift, Material Handling Equipemetns, Conveyours Etc.	0.50
173	M/s. G. R. Industries Prop: G. Ramaiah	No. 9/24, 4th Main, 5th Cross, Industrial Town, Rajajinagar, Bangalore – 560 010	129–B	Steet Metal Boxes & Pressed Components	0.50
174	M/s. M. T. C. Industries Smt. Shantha V Shetty D/o. Gopalakrishna Shetty	3rd Cross, 2nd Link Road, S I T Layout, Tumkur	130	Rigid P V C Pipes	1.00
175	M/s. R S Granites Partner: Ramakrishna H.N.	No. 8/1, 1st Main Road, Sultanapalya, R T Nagar Post, Bangalore–32	131	Granites Slabs Processing & Publishing	1.00
176	M/s. Yesdiors Tools & Components	No. 123/124, Rajajinagar Industrial Estate, Rajajinagar, Bangalore – 560 044	132	CNC Turned Components, Spare for Earth Moving Equipments Mining Tools & Machine Shop	1.00
177	M/s. S. S. Enterprises	No. 14/2, 6th Cross, Magadi Road, Right Side, Bangalore – 560 023	133	Deep Drawn Components	1.00
178	M/s. Mano Packers	No. 306/1, 4th Main Road, Kaveripura, Behind Rama Mandira Road, Kamakshipalya, Bangalore – 560 079	134 (Corner)	Corrugated Boxes & Multi Colour Printing	1.00
179	M/s. Ramanjaneya Engineering Works Propx: Smt. C. Uma	C/o Late Rangappa, Kuthinagere, Adarangi Post, Kuduru Hobli, Magadi Taluk, Ramanagara District	135–A (Corner)	General Engineering works & Spares	0.25
180	M/s. Gopala Krishna Swamy Granite Tiles Propx: Smt. Gangamma	W/o Govindaraju, Ward No. 2, Bovipalya, Antharasanahalli, Arakere Post, Tumkur Taluk, Tumkur District	135–B	Granite Tiles	0.25
181	M/s. CBS Enterprises Prop: Sri. N.G. Channabasavaiah	Arudi – 561 204, Doddaballapura Taluk, Bangalore Rural District	135–C	General Engineering & Fabrication Works	0.50
182	M/s. Vinayaka Enterprises	No. 44, Basavanapuram Main Road, Devasandra, K. R. Puram, Bangalore	136 & 137–A	Granite Tiles & Slabs	1.50
183	M/s. Plasmotek	B–47, ITI Axillary Estate, Mahadevapura, Whitefield, Bangalore	137–B & 138	Precision Plastic Components & Moulds	1.50
184	M/s. D. C. Hoist and Instruments	No. 68, West of Chord Road, 2nd Stage, Mahalakshmipura, Opp. Metro Rajajinagar Station (W), Bangalore – 560 086.	139–A	EOT Crane, HOT Crane, Wire Rope, Elecrical Hoist, Frieght Lift, Trollies & All type of Materials	0.50

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Vasanthanarasapura 1st Phase, Tumkur					
S. No	INDUSTRY: (Name)	(Address)	Plot No	Nature of the Unit	Extent in Acres
185	M/s. Chandra Engineering Industry Partner: Sri. Chandra Shekar Y Puthin	No. 5–A, 5th Main Road, 5th Cross, Muneshwara Block, Kanteerava Studio Main Road, Bangalore – 560 098	139–B	Press Tools, Jigs, Furniture, Fabrication Items	0.50
186	M/s. Shri Industries	No. 1, 8th Cross, 3rd Main, Cholurplaya, Magadi Main Road, Bangalore – 560 023	139–C	Press Components	0.50
187	M/s. Sri Vinayaka Engineering's Prop: Sri. A. Keshava Murthy	No. 35, "Sumukha Nilaya", Haragadde V & P, Jigani Hobli, Anekal Taluk, Bangalore – 560 105.	140	General Engineering & Fabrication Works	1.00
188	M/s. Decima Engineering Works Prop: Sri. D.V. Krishan Kumar	No. 2/2A, 13th & 14th Cross, Karivobana Halli, Thigalarapalya Main Road, Raghavendra Industrial Estate, Near Peenya 2nd Stage, Bangalore – 560 058	141–A	General Engineering Works	0.50
189	M/s. Expo Mark	No. 32, Ezara Street, Suit No. 761, 7th Floor, Culcutta (Kolkatha)	142 & 143 (Corner)	Hydrawlic Filters	2.00
190	M/s. G. K. Industries Prop: Sri. C. B. Patil	No. 135, 12th Main, Puttaiah Road, Vrushabhavathi Nagar, Kamakshipalya, Bangalore – 560 079	144 (Corner)	Steel Fabrication	1.00
191	M/s. Balaji Lorry Body Builders Partner: Smt. H. S. Usha Rani	1st Floor, Behind Maruthi Plaza, 4th Cross, M. G. Road, Tumkur – 572 101.	145	Lorry Body Building & Services	1.00
192	M/s. Spur Engineering Industries	No. 33, 2nd Main, Chunchappa Block, R T Nagar Post, Bangalore – 560 032	146	Optical Fibre Glass & Concrete Blocks	1.00
193	M/s. Unity Offset Printers	No. 45/5–A, Gubbanna Industrial Area,6th Block, Rajajinagar, Bangalore	147	Multi Colour Offset Printing & Packaging	1.00
194	M/s. K. R. Auto Spares Pvt. Ltd	No. 51/10, 2nd Floor, A. M. Road, K P N New Extension, Bangalore – 560 002	148	Air Filters and Auto Spare parts	1.00
195	M/s. Balaji Granites Propx: Sri. K. Vijaya	Rajeswari Krupa, 2nd Main, 2nd Cross, Vidhyanagar, Chittradurga.	149	Granite Slab	1.00
196	M/s. Sri Venkateshwara Enterprises	No. 16, 7th Main, 2nd Stage, Indiranagar, Bangalore – 560 038	150	Logistics and Warehouring	1.00
197	M/s. Maruthi Garments Prop: Sri. Anant Kumar H.	S/o Hanumanthaiah. K. Batawadi Circle Bus Stop, Tumkur Town.	151	Readymade Garments	1.00
198	M/s. D J M Power Controls	No. 5, 8th Main Cross, Pipeline Road, Santhosh Nagar, Bangalore – 560 057	152	Panel Boards, Power Distribution Transformers & Welding transformers	1.00
199	M/s. Shanthi Electrical	No. 6, 2nd Floor, 1st Stage, Peenya, Bangalore	153 (Corner)	Penel Boards, Power Distribution Transformers & Welding Transformers	1.00
200	M/s. Chirag Tubes	No. 54, Sherif Building, 4th Cross, K. S. Garden, Lalbagh Road, Bangalore – 560 027	154 (Corner)	Seamless Hydraulic Boiler ERW Square Rectangular Tubes Stainless Steel Pipes Etc.	1.00
201	M/s. Mukesh Clothing Company	No. 10/2, 5th Cross, Right Side, Magadi Road, Behind Minerva Mill, Bangalore – 560 023	155	Readymade Garments	1.00
202	M/s Marudhara Auto Products	79/3, A D Hally,(Opp Veeresh Theater)Magadi Main Road, Bangalore – 560 079	157	Automobile Products (2 Wheeler)	1.00
203	M/s. Lakshmi Venkateshwara Enterprises	No. 17/2, Srinivasa Nilaya, 2nd Cross, Kirloskar Layout, Near Shankaramatt, West of Chord Road, Bangalore – 560 079.	160	Logistics	1.00
204	M/s. Global Industries Prop: Irfan Ahamed	S/o. Abdul Rehaman, No. 1, 1st Main Road, Hidayuth Nagar, K. G. Halli, Arabic College (Post) Bangalore – 560 045	161–B	Exercise Note Book	0.50
205	M/s. M. J. Machines Prop: Abdul Kuddus	No. 5, 2nd Main Road, Chura Lane, Lidkar Colony, Arabic College Post, K. G. Hally, Bangalore – 560 045	161–C	Bamboo and Allied Materials	1.00
206	M/s. Logic Logistics Propx: Smt. Meena	No. 411, 1st Floor,10th Main, M S Ramaiah Enclave, Tumkur Road, Nagasandra Post, Bangalore – 560 073	162–A (Corner)	Logistics & Warehousing	2.00

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Vasanthanarasapura 1st Phase, Tumkur					
S. No	INDUSTRY: (Name)	(Address)	Plot No	Nature of the Unit	Extent in Acres
207	M/s. P. K. Power Systems Prop: Sri. P. Prasanna Kumar, Sri Venkateshwara Nilaya,	1797/A, 7th Main E Block, Rajajinagar 2nd Stage, Bangalore-560 – 010	162-B	Electrical Micro Components	2.00
208	M/s. D.C.S. Industries Prop: Sri. D.C. Shantha Veeranna	Dornal, Tarikere Taluk, Chikkamangaluru District.	163 (Corner)	General Engineering & Fabrication Works	2.00
209	M/s. Kropex India Limited	211/22, 11th Main, 16th Cross, Lakkasandra, Wilson Garden, Bangalore – 560 030	164	Offset Printing & Warehouse	2.00
210	M/s. Coastal Coatings	No. 639, 46th A Cross, 3rd Block, Rajajinagar, Bangalore – 560 010	165	Paints Resins	4.00
211	M/s. Metal Impacts Private Limited	No. 88/A, Koramangala, Industrial Layoout, Bangalore – 560 095	166 (Corner)	Hydraulic Einchers	4.00
212	M/s. OTS Office Tech Systems Pvt. Ltd.	No. 6/8, Commandess Place, Near Richmond Circle, Rajaram Mohan Roy Road, Bangalore	166-A	Office Equipments & Furnitures	1.00
213	M/s. Silwin Winches India Pvt Ltd,	No. 4, 1st Floor, NGFE Industrial Estate, off. Whitefield Road, Mahadevapura Post, Bangalore – 560 048	167-B	Aluminum Aerosol Cans	2.00
214	M/s. HMX Systems Pvt. Ltd.	No. A-422, 1st Cross, 1st Stage, Peenya Industrial Estate, Bangalore – 560 058	168	Eco Friendly & Energy Efficient Products	5.00
215	M/s. Alu Top	(ISO Certified Unit), P-26-C, 10th Main, 3rd Stage, Peenya Industrial Area, Bangalore – 560 058	169-A (Corner)	Bottle Caps & Sheet Metal Printing	2.00
216	M/s. SB-Impex	A-146, 3rd Cross, 1st Stage, Peenya Industrial Estate, Bangalore – 560 058	169-B	Starch and Related Products	1.00
217	M/s. Dinesh Printers	No. 32, Bashyam Circle, 5th Block, Rajajinagar, Bangalore – 560 010	169-C	Printing and Packaging	1.00
218	M/s. Avigiri Urethane & Rubber Industries Private Limited	B-311, Sobha Amber, Sobha Ultima Complex, Jakkur Plantations, Jakkur, Yelahanka, Bangalore – 560 064	169-D	Polyurethane and Rubber Products	2.00
219	M/s. Siporex India Limited	No. 72 – 76, Industrial Estate, Mundhwa – Pune	170 (170 & 89-Part of 171 & 88) (Corner)	Light Weight Blocks & Prefabricated Cement Structure for Buildings	15.00
220	M/s. Kaden Healthcare Pvt. Ltd.	Old No. 200 (New No. 96), 2nd Floor, Sree Diyalakshmi Towers, Sultanpet Main Road, Bangalore – 560 053	171-Part-1 & 172-A	Pharmaceuticals (Tablets Capsuls & Ointments)	4.00
221	M/s. Kisan Mouldings Limited	South Regional Office: 13/14, 2nd Floor, "M" Block, Unity Building, JC Road, Bangalore – 560 002.	172-B & 173-A	U-PVC Pipes & Fittings, C-PVC Pipes & Fittings, Moulded Furnitures.	7.00
222	M/s. Nayana Industries Prop: Sri. M Sathyanarayana	"Nayana Nilaya," opp. S.B.M, Behind Nataraja Circle, Sira Gate, Tumkur.	173-B	Human Safety Products	0.50
223	M/s. Universal Industries Prop: Sri. M. K. Mohan	S/o. Krishnan, "Raghavendra Krupa," 9th 'A' Cross, Ashokanagar, Tumkur – 572 103.	173-C	Rooftruses, Stell Doors, Windows, Grills, Gates, etc.,	0.50
224	M/s. S.D.M. Industries Prop: Sri. T. K. Kumar Manjunath	Supriya, 9th Cross, Sampige Road, Ashok Nagar, Tumkur – 02	173-D	Granite, Slab & Tiles	1.00
225	M/s. Chandana Industries Prop: Sri. Vijay Bahadur Patel	C/o Mudlappa S/o L.T. Kuntathimmaiah, Tavarekere, Varakeri, Magadi Main Road, Bangalore South Taluk, Bangalore – 562 130.	174-B	Scrap Battery Melting	0.50
226	M/s. S. N. A. Engineering Prop: Sri. Shiva Kumar R.	No. 162, 10th Main, Peenya Industrial Area, 3rd Phase, Bangalore – 560 058.	174-C	General Engineering & Conveyors	1.00
227	M/s Shreyas Printers	Ashoka nagar, 8th Cross, Tumkur	174-D1	Printing & Book Binding	0.25
228	M/s. I-Tech Software Development Centre Prop: Smt. Jyothi Rani V Aladakatti	No. 509, 4th Cross, 1st Main, BEML Layout, 5th Stage, 2nd Phase, Rajarajeshwari nagar, Bangalore – 98	174-D2 (Corner)	Software Development	0.50

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Vasanthanarasapura 1st Phase, Tumkur					
S. No	INDUSTRY: (Name)	(Address)	Plot No	Nature of the Unit	Extent in Acres
229	M/s. Pratham Pressings Partner: Sri. Narendra K. Shah	No. 341, 9th Cross, 4th Phase, Peenya Industrial Area, Bangalore – 560 058.	174–D3	Pressed Components & Electro Peleting	0.50
230	M/s. Premier Industries Prop: Sri. D. R. Ramu	No. 1181, 14th Main Road, 3rd Stage, Prakashnagar, Bangalore – 560 021	175–A (Corner)	Precission/Machinery Components	1.00
231	M/s. Areva Paints Private Limited Prop: Sri. T Prasanna Kumar	No. 127, 3rd 'A' Cross, 3rd Main, Prakashnagar, Next to Ayyappa Swamy Temple, Bangalore – 560 021.	175–B	Decorative Paints	1.00
232	M/s. Ganesh Industries Propx: T. S. Leevathi	Manjunatha Nilaya, 4th Cross, Banashankari, Tumkur	175–C	Steel Fabrications and General Engineering Works	1.00
233	M/s. Tensil Steels Smt. Santhosh Devi Agrwal	No. 850, Subha Nivas, H M T Layout, Nagasandra Post, Bangalore – 560 073	176–A (Corner)	Structural Steel Fabrication	2.00
234	M/s. Manjushree Avanish Enterprises Propx: Dr. Asha H. M.	No. 804, Sangama, 3rd Cross, 3rd Main, Vijaya Bank Colony, Behind Indian Institute of Management, Bannerugatta Road, Bangalore – 560 020	176–B	Manufacture of Medical & Surgical Equipments	2.00
235	M/s. Sri. "G" Software	No. 60/60–A, Saraswathipuram, 2nd Main Road, 3rd Cross, Ulsoor, Bangalore	177–A (Corner)	Software Solutions & Software Development Center	2.00
236	M/s. Sha Enterprises Prop: Shaji Chacko	No. 73, 17th Cross, 34th Main, J.P. Nagar, 6th Phase, Bangalore – 560 078.	177–B	Moulded Plastic	2.00
237	M/s Trafo Switch Engineers Prop: Smt Pooja P Raj	No. 7, Shibra Farms, Nagasandra Post, Bangalore–560073	178–A1 (Corner)	all Off Circuit Top Swtiches & other Transformer Spares	1.00
238	M/s. Khushi Entrprises Propx: Smt. Kanthamma	W/o. B. G. Krishnappa, Shanthinivassa, 3rd Cross, Gokul Extension, Tumkur	179–C (Corner)	Readymade Garments	2.00
239	M/s Saklecha Solvent Extractions	Venkateshapura, Madhugiri Road, KGY Agro Industries Complex, Tumkur–106	180–C & 180–D (Corner)	Rice Bran/Cake/Tamrind/Seeds/ Soyabeen etc.	3.00
240	M/s. Chesa Dental Care Services Ltd.	No. 51–52, 2nd Floor, EPIP Zone, KIADB Industrial Area, Whitefield, Bangalore – 560 066	180–E & 180–D2	Dental Care Products	3.00
241	M/s. DSP Logistics Prop: Sri. Dattaraya Joshi	No. 44, HIG, 2nd Stage, KHB Colony, Basaveshwara Nagar, Bangalore – 560 079	181–A1	Logistics & Warehousing	2.00
242	M/s. Shree Om Engineering Partner: Sri. R. Mahadev	Plot No. 17, G/A, II Phase, Peenya Industrial Area, Bangalore – 560 058	181–A2	General Engineering works	2.50
243	M/s. Lakshmi Steel Overseas Private Limited	Plot No. 196, 197, 198, 243, 245, KIADB Industrial Area, Bommasandra, Jigani Link Road, Bangalore – 562 106	182–A (Corner)	Ingots & TMT Angle, Bars, Sections and other related products	5.00
244	M/s. Liveon Biolabs Private Limited Director: Dr. Y.S. Suhas	Plot No. 46 & 47, II Phase, Water Tank Road, KIADB Industrial Area, Kasaba Hobli, Antharasanahalli Village, Tumkur Taluk, Tumkur District– 572 106.	186–A	Testing Analiysis Resarch & Development Labs	2.00
245	M/s. Sian Industries Propx: Smt. B.S. Susheela	Behind Municipality Office, Gandhinagar, Tumkur – 572 102.	186–B (Corner)	Apparels	2.00
246	M/s Arihanth Automats Prop: Sri G S Rajendra Kumar	No 2208–B, Sadhana Road, k R layout, Tumkur	187–C1	Turned Components	1.00
247	M/s. V.S. Enterprises Prop: Sri. Shashidhara	No. 23, "Rajarathna," 2nd Main Road, Girinagar, Tumkur – 572 104.	187–C2	Granite Cutting & Polishing	1.00
248	M/s. Pushkar Export Garments Prop: Sri. Shakunthala N	Vidya Nagar, 1st Cross, Chikkanayakanahalli, Tumkur District– 572214	188–A	Readymade Garments	2.00
249	M/s.Sree Dhamodhar Coach Crafts Pvt. Ltd.	Plot No. 97/98, Bicholim Industrial Estate. Bicholim, Goa – 403 529	188–B	Body Building on Automobile Classis Like Bus Trucks, Vans and Others	2.00
250	M/s. Dhamodhar Motor India Pvt. Ltd.	No. "Vatsalya" 6, Parma Hans Colony, Bandhu Nagar, Murilipura, Jaipura, Rajasthan – 302 012	188–C (Corner)	Bus Body Building and Container Building	2.00

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Vasanthanarasapura 1st Phase, Tumkur					
S. No	INDUSTRY: (Name)	(Address)	Plot No	Nature of the Unit	Extent in Acres
251	M/s. BIR Metal Systems Propx: Smt. Shaily Bir	No. A–276, 6th Main, Peenya Industrial Area, Bangalore – 560 058	189–A	Modular Furniture	2.00
252	M/s Sur Hennig Pvt Ltd Director: Pankaj Bir	No. 1–B Peenya Industrial Area, Bangalore – 560 058	189–B	Machine Tool Protection Equipment	2.00
253	M/s. R. R. Enterprises Prop: Sri. J. George	No. 8, 1st Cross, Modi Garden, J.C. Nagar P.O., Bangalore – 560 058	189–C (Corner)	Agro Chemicals	2.00
254	M/s. Indotech Tooling Pvt. Ltd. Director: Sri Joseph Johnson	No. 549–A, 14th Cross, 4th Phase, Peenya Indl Area, Bangalore – 560 058.	190–A	Tool Room & Press Shop	1.00
255	M/s Universal Polymers	No–4, Nayandahally, G R S layout, Behind Mysore Road, Bangalore–560039	190–B	Plastic Moulding	1.00
256	M/s. Srinidhi Packers Prop: Ambarish	No. 104, S L V Industrial Area, Andrahally Main Road, Vishwaneedam Post, Bangalore – 560 091	190–C	Corrugated Boxes	0.50
257	M/s. Vijay Industries Prop: Sri. Vijay Kumar K. V.	No. 3854, 26th Main, 32nd Cross, Banashankari 2nd Stage, Bangalore – 560 070	190–D	General Engineering Works	0.50
258	M/s. Harshitha Enterprises Prop: Sri. L. S. Shivaprasad Rao	Plot No. 205, 2nd Floor, Shesha Banu Residency, 4th Main, 6th Cross, BTM 2nd Stage, Bangalore–560 076	190–E1	Food Products	0.50
259	M/s. Sharath Engineering Industries Prop: Sri. Shankar. P.	No. 56/26, 40 feet BDA Road, Pattegar Palya, 2nd Main Road, Basaveshwara Nagar, Bangalore – 560 079	190–E2	Precision Electronic Press, Tools Components, Sheet Metal Fabrication	0.29
260	M/s. Samarth Life Sciences Pvt. Ltd	No. 41/P–3, 3rd Main, 1st Phase, Peenya Industrial Area, Bangalore – 560 058	191–A (Corner)	Cardio Vascular Antibacterial, Anti Infectives and Anti Cancer Drugs	5.00
261	M/s. Chira Information Technologies Prop: Sri. Raghu G. S.	No. 505, 3rd Block, 4th Main, 2nd Stage, R M V Extension, Bangalore – 560 094	191–B	Computer Hardware & Software Services	1.00
262	M/s. Genuine Products (ISO 9001 Company)	No. L–8, 65/2, Kademane Chennegowda Estate, Kamakshipalya, Bagnalore – 560 079	192–A (Corner)	Machine Enclosures and Precision Sheet Metal Components	1.00
263	M/s. Ashwini Innovators Prop: Sri. M. V. Nagesh Babu	No. 516, Kalyani 14th Main, 19th Cross, B.S.K Second Stage, Bangalore – 560 070	192–B	Structural Fabrication & Building Material Industry	1.00
264	M/s. Nethravathi Engineering Works	No. 781, 9th Cross, 6th Block, Rajajinagar, Gubbanna Industrial Estate, Bangalore – 560 010	192–D	Turbine Blades Space for Earth Moving Equipments Mining Tools & Reconditioning pf CNC Machines	1.00
265	M/s. Manju Machine Tools	No. 117, 1st Main Road, Opp: A:10 (KHDC), Peenya 2nd Stage, Bangalore – 560 058	192–E	Multi Point Carbide & HSS Cutting tools in CNC tools and cutter Grinding	1.00
266	M/s. Karthik Logistics Prop: Smt. S. Leelavathi	N. 74, Andhrahalli Main Road, Bairaveshwara Indl. Estate Entrance,Peenya II Stage, Bangalore – 560 094	194–E1	Logistics & Warehousing	1.00
267	M/s. Sathish Engineering	No. B–69/A, Peenya 3rd Stage, Peenya Industrial Estate, Bangalore – 560 058	195–A (Corner)	Lathes Drilling Machineries, Boring Machines, Grinding Machines & CNC Machines	2.00
268	M/s. Volt Amps	No. C–30, (Backside 1st Floor) Industrial Estate, Rajajinagar, Bangalore – 560 044	195–B	Current Transformers upto 110 KVA Capacity	1.00
269	M/s. Statweigh India Pvt. Ltd	No. 447, 4th Phase, Peenya Industrial Area, Bangalore – 560 058	195–C	Manufacture of Weighting Equipments/Weigh Bridges	1.00
270	M/s. Ambrutesh Industries	C–13, Industrial Estate, Rajajinagar,Bangalore – 560 044	195–D	Precision Turned Components	1.00
271	M/s. Sri Kumaraswamy Enterprises	No. 3495, 14th Cross, 2nd Stage, HAL Indiranagar, Bangalore – 560 038	196–A	Software Development	1.00
272	M/s. K Technologies	No. 1232, 5th Cross, 17th Main, Muneshwara Block, Srinagar, Bangalore – 560 026	196–B	Software Development & Training	1.00
273	M/s. Sudhir Enterprises Prop: Sri Sudhir	No. 20, 3rd Cross, 1st Main, 1st Stage, K.H.B. Colony, Basaveshwara Nagar, Bangalore – 560 079	196–C	Software Development	1.00

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Vasanthanarasapura 1st Phase, Tumkur					
S. No	INDUSTRY: (Name)	(Address)	Plot No	Nature of the Unit	Extent in Acres
274	M/s. Ajay Sensors and Instruments	No. 45/17, Gubbanna Industrial Estate, 12th – A Cross, 6th Block, Rajajinagar, Bangalore	197–A	Sensors & Instruments	1.00
275	M/s. Nag–Tech Electronics	No. A–421, Peenya Industrial Estate, Peenya 1st Stage, Bangalore – 560 058	197–B	Aerospace Defence Equipments Sensors & Measuring Instrument	1.00
276	M/s. Vivaan Jewellery Manufacturing Company	No. 102, Jala Shambavi Complex, 1st Floor, 1st Main, Gandhinagar, Bangalore – 560 009	197–C	Gold Silver Ornament & Utensils	1.00
277	M/s. Usha Iron Alloy and Forgings Pvt. Ltd.	# 56 & 57, 5th Cross, Bapuji Layout, Vijayanagar, Bangalore – 560 040.	198–A	Alloy Steels	2.50
278	M/s. Kailash Roofing Solutions Pvt Ltd. Director: Sri. Umed Singh	No. 51, 1st Floor, Dr. Siddaiah Puranik Road, 2nd Main, 4th Stage, 4th Block,Basaveshwaranagar, Bangalore – 560 079	198–B	Manufacturing of Roofing Sheets Trapezoidal Profile used in Roofing and Cladding in Pre–Engineering Buildings	2.50
279	M/s. South India Wire Products Pvt. Ltd.	No. 17, J2, Peenya II Phase, Peenya Industrial Area, Bangalore – 560 058	199–C1 & 199–C2	Mfg of Bright Steel Bars	3.00
280	M/s. Silver Sand	No. 21/3, Spencer Road, Frazer Town, Near 7th Day Adventures High School, Bangalore – 560 005	200–A (Com–1) Corner	Super Market and Shopping Complex	2.00
281	M/s. Silver Park	No. 21/3, Spencer Road, Frazer Town, Near 7th Day Adventures High School, Bangalore – 560 005	200–B (Com–1)	Hotel and Lodging Facility	2.00
282	M/s M/s Hotel S.V INN	17, 6th Main 13th Cross, B T M Layout, 2nd Phase, Bangalore – 76	200–C (Com–1)	Hotel	3.60
283	M/s. R & M Associates Prop: Sri. Meanatha Reddy	No. 384, 1st Cross, R. T. Nagar, Bangalore – 560 032	201–A (Com – 2)	Weigh Bridge and Service Station	1.00
284	M/s. Jai Bhavishyath Transport Pvt. Ltd.	No. 2884, 1st Floor, 2nd Main, HAL 2nd Stage, Kodihalli, Bangalore – 560 008	201–B (Com–2)	Office Complex for Banks, Service Appartments and Hotel	1.00
285	M/s. G. K. Logistics	No. 84/5, 8th Main, 1st Cross, 3rd Block, LIC Colony, Jayanagar, Bangalore – 560 011	201–C (Com–2) Corner	Logistics and Ware Housing	2.00
286	M/s. Amrutha Enterprises Prop: Sri. Venkateshan N	No. 12, Railway Colony, R. M. V. 2nd Stage, Lottegollahalli, Bangalore – 560 094	201–D (Com–2)	PVC Pipes & Tubes	1.00
287	M/s. Shrikar Infra Amenities	No. 212, 15th "C" Cross, 2nd Stage, 2nd Phase, West of Chord Road, Mahalakshmipuram, Bagnalore – 560 086	202 (Corner)	Hospitality Services, Financial Services and Business Services	2.00
288	M/s. Byraveshwara Industries Propx: Smt. Pushpalatha V.	No. 775/A, Lakshmi Nilaya, Annayappa Layout, Kanena Agrahara, HAL Post, Bangalore – 560 017	205–A	General Engineering & Fabrications	0.50
289	M/s C S Vin Enterprises Prop: Smt Shalini V,	No. 123/A, 5th Main, Mathikere, Bangalore – 54	205–B	General Engineering & Fabrications	0.50
290	M/s. S. B. V. Engineering Industries Prop: Sri Manjunatha Hegde No. 52	4th Main Road, LIC Colony, I R Thota Yeshwanthpur, Bangalore – 560 022	207 (Corner)	Precission and Press Components	0.50
291	M/s. S. S. Forgings & Engineering	# 2, Mathrushree Nilaya, 10th 'B' Cross, Defence Colony Main Road, Nagasandra, Bangalore – 73.	208–A	Mfg of Components	0.25
292	M/s. Vedha Engineers & Contractors Pvt. Ltd	No. 191, 5th Cross, KHB Colony 2nd Stage, Basaveshwara Nagar, Bangaloure – 560 079.	208–B	General Engineering Components & Sub–Assemblies	0.25
293	M/s. Mysore Apparel Training Center Partner: Sri M.S. Mysorappa	Banashankari Handloom Building, Banashankari Badavane, Chikkanayakanahalli, Tumkur District.	209	Apparels Training Center	1.00
294	M/s. Sri Ranga Granites	No. 73, Mallasandra, opp. BBMP Office, Hesaraghatta Main Road, Bangalore – 560 057	210	Granite Sinks and Slabs, Granite Slab Cutting and Polishing	1.00
295	M/s. Maruthi Industries Prop: D H Nagaraju	S/o. Hanumanthappa, Sri Banashankari Temple Street, Kote Hosadurga, Chitradurga District	211	General Engineering & Steel Fabrication	1.00

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Vasanthanarasapura 1st Phase, Tumkur					
S. No	INDUSTRY: (Name)	(Address)	Plot No	Nature of the Unit	Extent in Acres
296	M/s. N. H. G. R. Ply Board Industries	No. 77, 17th Cross, Behind East West Park Road, Malleshwaram, Bangalore – 560 055	212	Play Boards	1.00
297	M/s. Vijaya Vitala Chemicals Pvt. Ltd.	Sy. # 15/1,2,3, V.V. Industrial Complex, Andhrahalli Main Road, Vishwaneedam Post, Bangalore – 560 091.	213 (Corner)	Thinners & Paints	1.00
298	M/s. Vinn Technologies Partner: Sri. Srinivas H. N.	No.22, MEI Layout, 19th Cross, Bagalkunte, Bangalore.	214–A (Corner)	Granite Cutting & Polishing	0.50
299	M/s. Peenya Heat Treatment Company	No. 76, 5th Cross, Bhyraveshwara Industrial Estate, Andrahally Main Road, Near Peenya 2nd Stage, Bangalore – 560 091	214–B	Heat Treatment of Castings and Fabricated items and allied services	0.50
300	M/s. G. K. Technologies Prop: Sri. Dinesh Ithal	No. 151, 5th Main 4th Phase, Banashankari, Bangalore	215	Machinery Components	1.00
301	M/s. A. B. Company Engineers	No. 138, Bommasandra Industrial Area, Bangalore – 560 099	216	Cranes Fabrications Handling Equipments	1.00
302	M/s. KNR Roofing Pvt Ltd. Prop: Sri. Rajendra R	Rajathadri Nilaya, Kyathasandra, NH–4, Tumkur	217	Roofing Gallering Sheets	1.00
303	M/s Mahalakshmi Industries Sri Nilesh Jain	Plot No–401, Lakshmi Complex, Cottenpet Main Road, Bangalore – 560053	218 (Corner)	Packing of Lubricant	0.25
304	M/s. Jai Matha El–Nicko Prop: Sri. Jagannath Ghale	No.1, 3rd Cross, Shankarappa Garden, Magadi Road, Bangalore – 560 023	219	Pressing Components	0.50
305	M/s. Karibasaveshwara General Engineering Works Prop: Sri Mallikarjuna V.E,	Thyala Post, Holalkere Taluk, Chitradurga District	220	General Engineering & Steel Fabrication	1.00
306	M/s. A. K. Industries Partner: Y. Kiran	No.64, 1st Main, 1st Block, Tyagarajanagar, Bangalore – 560 019.	221	General Engineering & Fabrication Works	1.00
307	M/s. Pushpa Roto Printers Prop: Sri. Babulal S Jain	No. 25, 3rd Cross, Okalipuram, Bangalore – 560 021.	224	Manufacturing of Flexible Packaging Converters	1.00
308	M/s. Tejaswi Logistics & Warehousing Prop: Smt. K.S. Kavitha	W/o M. Rajamohan, 'Tejaswi', 8th Main, Jayanagar East, Tumkur.	225, 226 & 227–A	Logistics & Warehousing	2.00
309	M/s. Venkateshwara Industries Propx: Smt. Jyothi Rao	No. 481, 7th Cross, 7th Block West, Jayanagar, Bangalore – 560 082.	227	General Engineering & Fabrication	0.50
310	M/s. J.S.S. Fabrications Prop: Sri. P. Ravishankar	Jayalakshmi Nivasa, Pampa Mahakavi Road, Shettihalli Gate, Tumkur – 572 102	228	Steel Fabrication	0.50
311	M/s. Balaji Industries Prop: Smt. K. Shobha	No. 30, 1st Main Road, 2nd Cross, Ashirwad Colony, Horamavu Main Road, Basasawadi Post, Bangalore – 560 043	229 (Corner)	Automobile Spare Parts	0.50
312	M/s. N. K. Industrie Partner: Sri. H. Mohamed Haneef	Door No. 18, Masjid Road, Santhepet, Tumkur	232	Agricultural Implements & General Engineering Works	0.80
313	M/s. Karthik Roofings & Structurals Private Limited	No. 76, Andhrahalli Main Road, Byraveshwara Industrial Estate Entrance, Peenya 2nd Stage, Bangalore – 560 094.	233, 234 & 235 (Corner)	All types of roofing sheets structural & Indl. Fabrication	3.00
314	M/s. Manjunatha Enterprises Prop: Sri. N Ramakrishnaiah	Near old Kaveri School, Maralurdinne Road, Shanthinagar, Tumkur.	236	General Engineering Works	1.00
315	M/s. Deepthi Enterprises Propx: Kum. Deepthi R Krishna	NO. 154, Vasantha Nilaya, 2nd Main, 7th Cross, MSR Nagar, Bangalore – 560 0054.	CA3–P1	Service Station, Weigh Bridge and Petrol Bunk	0.50
316	M/s. Naseer Humayun	No. 82, Ferns Residency, Narayanapura, Bangalore – 560 077	CA3–P2	Women & Men Garment Training Institute and Office Complex	2.00
317	M/s. Sri Raghavendra Industries	No. 75, Andhrahalli Main Road, Bairaveshwara Industrial Estate Entrance, Peenya 2nd Stage, Bangalore – 560 091.	CA3–P3 (Corner)	Hotel & Garden Restaurant	1.00

Vasanthanarasapura Industrial Area, 2nd Phase, Tumkur			
S. No.	INDUSTRY: Name	Plot No	Extent In Acres
1	M/s. Parvathi Plastics	141	0.25
2	M/s. Doddammadevi Industries	187 (Corner)	0.50
3	M/s. Bagadia Chaitra Industries Pvt. Ltd.	7 & 8 (Corner)	2.00
4	M/s. Kerry Ingredients India Pvt. Ltd	124 & 104-A	10.00
5	M/s. TMEIC Industrial Systems India (P) Ltd.	316, 317, 318, 319, 320, 321, 322, 327, 328, 329, 330, 331, 332, 333, 344, 345, 346, 347, 348, 349, 350, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 373, 374, 375, 376, 377, 378, 379, 380, 381, 382 & 383	15.00
	TOTAL EXTENT		27.75

Consent Letter Issued List			
S. No.	INDUSTRY: Name	Plot No	Extent in Acres
1	M/s. Remidex Pharma Pvt. Ltd	65	5.00
2	M/s. Sri Lakshmi Steels & Alloys	51	1.00
3	M/s. Ukani Traders	76	1.50
4	M/s. Refcoat Industries	93	0.50
5	M/s. Amoolya Rubber Industries	181	0.50
6	M/s. Lucent Office	182	0.50
7	M/s. S.N. Enterprises	183	0.50
8	M/s. Durga Rubber Industries	184	0.50
9	M/s. Sanjeevini Food Products	197 & 198	1.00
10	M/s. Aquafit Piping Systems (I) Pvt Ltd.,	259 & 260	2.00
11	M/s. Aquafit Piping Systems (I) Pvt Ltd	261 & 262	2.00
12	M/s. Krishna Industries	484	1.00
13	M/s. Parekh Industries	485 & 486	2.00
14	M/s. Dhruv Industries	487	1.00
15	M/s. Gayathri Industries	489	1.00
16	M/s. Shree Ganesh Electric Co	517	1.00
17	M/s. Ram Colour Chem	538	1.00
18	M/s. Komal Plast	539 & 540	2.00
19	M/s. Sakshi Polymers	541	1.00
20	M/s. Aquafit Piping Systems (I) Pvt Ltd.	217 & 218	10.00
21	M/s. Cogito Cranes Pvt. Ltd.	30	1.00
22	M/s. Yadav Engineering	15	1.00
23	M/s. Octania Aero Structure Group Pvt. Ltd.	67	5.00
24	M/s. Vasundhara Enterprises	199	0.50
25	M/s. Sree Sainath Solvent Pvt. Ltd	135	5.00
26	M/s. Super Abrasives	6	1.00
27	M/s. Soni Special Steels and Alloys (India) Pvt. Ltd.	114	0.50
28	M/s. ACE Carbo-Nitriders	10	1.00
29	M/s. M.N. Industries	537	1.00
30	M/s. Sri Ranga Traders	112	0.50
31	M/s. G.R. Enterprises	113	0.50
32	M/s. High Voltage Equipment	2 & 3	2.00
33	M/s. Banashankari Electricals	16	1.25
34	M/s. Annapoorna Trading	186	0.50
35	M/s. Aquafit Piping Systems (I) Pvt Ltd	258	1.00
36	M/s. Ingenious Plastics Private Limited	22 & 23	2.00
37	M/s. Maarc Industries	194	0.50

Continued on next page.

Consent Letter Issued List			
S. No.	INDUSTRY: Name	Plot No	Extent in Acres
38	M/s. Lakshmi Rubber Industries	195	0.50
39	M/s. Nanjundeshwara Industries	4 & 5	2.00
40	M/s. Bharath Metal Industries	102	0.50
41	M/s. CNC Automotive	491	1.00
42	M/s. Kaizen CNC Centre Pvt. Ltd	492	1.00
43	M/s. NEO Foods Pvt. Ltd.	41, 42, 43, 44, 61, 62, 63 & 64	8.00
44	M/s. Magnus Power Private Limited	45	2.00
45	M/s. Ambica Patterns (I) Pvt. Ltd.,	488	1.00
46	M/s. SUV Technology	490	1.00
47	M/s. Sonce Technologies (India) Pvt. Ltd	9	1.00
48	M/s. Geetanjali Graphics	11	2.00
49	M/s. Dinesh Printers	12	1.00
50	M/s. Alloy Steel Enterprises,	13	1.00
51	M/s. Sri Devi Products	143	0.25
52	M/s. Bramashri Milk Products,	144	0.25
53	M/s. S.K.C. Enterprises	173	0.25
54	M/s. S.K.S. Enterprises,	174	0.25
55	M/s. S.R.S. Fabricators	185	0.50
56	M/s. Aaryan Industries	493	1.00
57	M/s. Ruthvik Industries	494	1.00
58	M/s. Ashoka Metal,	509	1.00
59	M/s. Micro Metal	513	1.00
60	M/s. Bhagyalakshmi Industries,	518	1.00
61	M/s. Print Solutions	519	1.00
62	M/s. Maa Padmavathi Metal Corporation	520 & 521	2.00
63	M/s. Mahadev Metal Industries,	522	1.00
64	M/s. Universal Components	542	1.00
65	M/s. Bhagyalakshmi Paper Co.	514, 515 & 516	3.00
66	M/s. Tanjyo and Co	139	0.25
67	M/s. Benaka Electronics	534 & 535	2.00
68	M/s. Perfect Industries	60	1.00
69	M/s. Sai India Ltd.,	71	3.00
70	M/s. Future tech Industries	250	1.00
71	M/s. Akul Electrical	145	0.25
72	M/s. Micro Industrial Chemicals Organisation	511	1.00
73	M/s. Sanjana Infotech	137	0.25
74	M/s. Refcoated Internationals	134	0.50
75	M/s. M/s. Global Hydraulics Pvt. Ltd.,	309	0.50
76	M/s. Shri Manjunath Profiles	295	0.50
77	M/s. Ven pack	189	0.80
78	M/s. Muneshwara Enterprises	301	0.50
79	M/s. S.R.Engineering Works	281 (Corner)	0.50
80	M/s. Divyashree Enterprises	159 (Corner)	0.50
81	M/s. Spectra Weighing Scale	190	0.50
82	M/s. Bhagyalakshmi Enterprises	151	0.25
83	M/s. M.M. Industries	155	0.25
84	M/s. Annie Enterprises	153	0.25
85	M/s. Jayaram Enterprises	156	0.25

Continued on next page.

Consent Letter Issued List			
S. No.	INDUSTRY: Name	Plot No	Extent in Acres
86	M/s. Hansraj & Co.,	532	1.00
87	M/s. Naveen Conceret Product	146	0.25
88	M/s. Skanda Engineering Works & General Fabricators	149	0.25
89	M/s. Sri Mallikarjuna Concreter Products,	157	0.25
90	M/s. Amrith Synthetic Products Pvt. Ltd.,	475	1.00
91	M/s. SVP Industries	473	1.00
92	M/s. Vijaya Innovative Technologies	236	2.00
93	M/s. Stamford Engineering Works	536	1.00
94	M/s.Nutrikraft India Private Ltd.,	265	1.00
95	M/s. Kaviraj Incorporation	477	1.60
96	M/s. Venkateshwara Printers	339	1.00
97	M/s. Thraiking Industial Controls	412	0.50
98	M/s. Hara System Soultion	222	2.00
99	M/s. Hotel Sri Ani	188	0.50
100	Clarion Enigeering Company	390	1.00
101	M/s. AMA Enterprises	482	1.00
102	M/s. Lakshmamma Kariyappa Industries	289	0.25
103	M/s. G.S. Industires,	285	0.25
104	M/s. Bhoosiri Industires	287	0.25
105	M/s. Lift Tech	313	1.00
106	M/s. Nandavara Organics	478	1.00
107	M/s Krishna Fab Tech	335	1.00
108	M/s. Navarathna Steel Industries	561 (corner)	2.53
109	M/s. Hydraulic Technologies Pvt Ltd.,	227 (corner)	4.00
110	M/s. Raja Enterprises	393	2.90
111	M/s. Belmount Absorbents Pvt Ltd.,	310	1.00
112	M/s. Krison Electrical & Electronics	448	1.00
113	M/s. Preetham Industries	341	1.00
114	M/s. Avina Pharamaceuticals	142	0.25
115	M/s. C.S. VIN Enterprises	241	0.50
116	M/s. Marudhar Auto Products	101	1.00
117	M/s. Raghavendra Industries	24	1.00
118	M/s. Navami Agro Tech	203	0.50
			144.58
	GRAND TOTAL		172.33

List of Allotment Made at Vasanthanarasapura Industrial Area 3rd Phase					
	INDUSTRY: (Name)	(Address)	Plot No	Nature of the Unit	Extent in Acres
1	2		4	6	7
1	M/s. Integrated Food Park Pvt. Ltd., RPAD Director & CEO: Mr. Praveen Dwivedi	No. 18/1, Pasadena, 2nd Floor, 10th Main, Ashoka Pillar Road, Jayanagar 1st Block, Bangalore – 560 011	Kempanadodderi Sy. No. 88, 89/1, 89/2, 92/1, 92/2 & Bathsandra Sy. No. 21, 22/1B, 22/2, 23, 24, 16, 25	Mega Food Park	99 Acre 20 Guntas
2	M/s. Power Grid Corporation of India Limited, RPAD	Southern Region, Transmission System – II H.Q., No. 32, Race Course Road, Bangalore – 560 001	Kempanadodderi Sy. No. 82, 83, 84, 85/P, 86/3A, 86/3B, 86/4, 87 Vasanthanarasapura Dy. No. 10/1P & Doddanaplaya Villages Sy. No. 4/2, 5/2P, 5/3P	765/400/220KV Substation	54 Acre 34 Guntas

Hubli – Dharwad

Name of the Industrial Area/Estate	Present Consumption (mgd)	Supply Source	Additional Requirement (mgd)	Source	Distance from STP
Belur Growth Center, Dharwad	2.5	Malaprabha Reservoir	2.5	Malaprabha Reservoir	20 kms from Dharwad STP (KUAS)
Mummigatti Industrial Area, Dharwad	Nil	None	1	Malaprabha Reservoir	20 kms from Dharwad STP (KUAS)
Rayapur Industrial Area, Dharwad	0.12	4 Bore wells: 3000 gallons/hr x 10 hours	0.12	Dharwad STP	12 kms from Dharwad STP (KUAS)
Lakamanhalli, Dharwad	0.12	4 Bore wells: 3000 gallons/hr x 10 hours	0.2	Dharwad STP	12 kms from Dharwad STP (KUAS)
Gamanagatti Industrial Area, Hubli	Nil	Nil	0.2+0.2	Bore wells drilled in the next 3 months and Neersagar Reservoir	13 kms from Gabbur STP (Madihal)
Tarihal Indusrtial Area, Hubli	0.18	6 Bore wells: 3000 gallons/hr x 10 hours	0.2	Neersagar Reservoir	11kms from Gabbur STP (Madihal)
Gokul Industrial Estate, Hubli	0.04	4 Bore wells: 3000 gallons/hr x 10 hours	Nil	Neersagar Reservoir	15kms from Gabbur STP (Madihal)

Bellary

No.	Name of the company	Activity	Water requirement (mgd)	Remarks
1	Noble Distilleries & Powers Ltd., Bellary dist.	Sponge Iron	1.360	production started
2	BMM Ispat ltd. Hospet tq, Bellary dist.	Sponge Iron	33.000	production started
3	Divyajothi steels ltd., Sandur tq, Bellary dist	Sponge Iron	0.020	production started
4	Rangineni Steel pvt. ltd., Bellary	Sponge Iron	0.020	production started
5	Supra Steel pvt., ltd., Bellary	Sponge Iron	0.040	production started
6	Balajiswamy premium steels pvt. ltd., Bellary	Sponge Iron	0.500	production started
7	Rayen steels pvt. ltd., Bellary	Sponge Iron	0.600	production started
8	Gayathri Metals pvt. ltd., Bellary	Sponge Iron	0.040	production started
9	Sajjala Iron & Power ltd., Bellary	Sponge Iron	0.044	production started
10	Hothur Ispat pvt. ltd., Bellary	Sponge Iron, steel, power and iron ore pallet	1.000	production started
11	PGM Ferro Steels pvt. ltd., Bellary	Sponge Iron	1.100	production started
12	Bellary Ispat pvt. ltd., Bellary	Sponge Iron	1.000	production started
13	Agarwal Sponge & Energy pvt. ltd., Bellary	Sponge Iron	0.100	production started
14	Sigma Solid Strips pvt. ltd., Bellary	Sponge Iron	0.030	production started
15	Popuri Steels ltd., Bellary	Sponge Iron, steel, power and pellet plant	0.056	production started
16	Embitee Iron & Steel pvt. ltd., Bellary	Sponge Iron	1.000	production started
17	Benaka sponge iron pvt. ltd., Bellary	Sponge Iron	0.000	production started
18	Padmavathi Ferrous ltd., Bellary	Sponge Iron, Steel, Power and Fero Alloys	0.400	production started
19	Hindusthan Calcined Metals pvt. ltd., Bellary	Sponge Iron	0.200	production started
20	IST Steel & Power ltd., Bellary	Sponge Iron, steel, power and coal washery	5.000	production started
21	KMMI Steel pvt. ltd., Bellary	Sponge Iron and iron ore pellet	4.000	production started
	Total		49.510	

No.	Name of the company	Activity	Water requirement (mgd)	Remarks
1	KMMI Exports, Bellary	Sponge Iron beneficiation	3.000	units yet to commence
2	Basai steels pvt. ltd., Bellary	Sponge Iron, Captive power plant etc.,	1.160	units yet to commence
3	Jai Raj Ispat Ltd., Bellary tq & dist.	Sponge Iron	0.650	units yet to commence
4	Scotts Metals & Mines Pvt. Ltd, Sandur tq, Bellary dist.	Sponge Iron	5.750	units yet to commence
5	Marmagoa Steel ltd., Bellary	Sponge Iron, steel and power	18.800	units yet to commence
6	Aaress Iron & Steel ltd., Hospet	Sponge Iron, Power and pellet plant	57.550	units yet to commence
7	Parwaz sponge iron pvt. ltd., Bellary	Sponge Iron	0.070	units yet to commence
8	Brahamini Industries Ltd	Steel and co-generation plant	34.000	units yet to commence
9	Arcellor Mittal Ltd	Steel and co-generation plant	40.00	units yet to commence
10	Tata Metallics	Steel and co-generation plant	15.00	units yet to commence
11	Kalavathi ISPAT	Steel and co-generation plant	23.00	units yet to commence

ANNEX 3: Allocation of Treated Wastewater from STPS in Bellary

Statement Showing the Details of Total Treated Sewage Generated, Quantity Already Allotted to Sponge Iron Industries from 30 MLD & 15 MLD Sewage Treatment Plants at Bellary			
Sl No	Name of Sponge Iron Plants	Quantity already alloted in MLD during the year 2007	Remarks
1	2	3	5
	I. 30 MLD STP at Ananthapur Road ,Bellary (Present Qty Receiving – 22.00 ML)		
1	Noble Distilleries & Power Pvt.Ltd.	1.50	No infrastructure has been done till today.
2	Hothur Ispat Pvt. Ltd	2.00	No infrastructure has been done till today.
3	Janki Corporation	15.00	The infrastructure to utilise the sewage water has been completed and given requisition to City Corporation, Bellary to draw the treated sewage water from December 2014.
	Total	18.50	
	II. 15 MLD STP at Cowl Bazaar, Bellary (Present Qty Receiving – 08.00 ML)		
1	Balaji Swamy Premium Steel Ltd.	0.40	No infrastructure has been done till today.
2	Rangineni Steel Pvt. Ltd.	0.10	No infrastructure has been done till today.
3	Bellary Ispat Pvt. Ltd	0.10	No infrastructure has been done till today.
4	Supra Steel & Power Pvt. Ltd	0.10	No infrastructure has been done till today.
5	Hothur Steels	0.60	No infrastructure has been done till today.
6	Sigma Solid Strips Pvt. Ltd	0.10	No infrastructure has been done till today.
7	Popuri Steels Pvt. Ltd	0.20	No infrastructure has been done till today.
8	Benaka Sponge Iront Pvt. Ltd	0.50	No infrastructure has been done till today.
9	Gayathri Metals Pvt. Ltd	0.10	No infrastructure has been done till today.
10	Pragathi P.G.M. Ferro Steels Pvt. Ltd	0.40	No infrastructure has been done till today.
11	Sajjala Iron Steels Pvt. Ltd	0.40	No infrastructure has been done till today.
12	Rehan Steels Pvt. Ltd	0.30	No infrastructure has been done till today.
13	A.P.S.M. Pvt. Ltd	0.30	No infrastructure has been done till today.
14	M.B.T. Iron Steels Pvt. Ltd	0.55	No infrastructure has been done till today.
15	M/s.Hothur Ispat Pvt. Ltd	0.55	No infrastructure has been done till today.
16	Venkateshwara Sponge Iron Pvt. Ltd	0.30	No infrastructure has been done till today.
	Sub Total	5.00	

ANNEX 4: Sewage Treatment Capital Costs by Technology in FY 2014–15

Treatment Technology	Capital Cost (Rs Mn./MLD)	Source
Secondary Treatment – Facultative Aerated Lagoons	2 to 3	1. KUWS&DB, Bellary 2. Presentation by Prof. Arunabha Majumder, School of Water Resource Engineering, Jadhavpur University.
Secondary Treatment – Activated Sludge Process (ASP)	7 to 10 w/o co-generation of power 12 to 17 with co-generation of power	1. Discussions with leading firms in the Water & Wastewater Industry. 2. Independent Industry Experts.
Secondary Treatment – Sequencing Batch Reactors (SBR) /Cyclic Activated Sludge Process (CASP)	10 to 12.5	1. Discussions with leading firms in the Water & Wastewater Industry. 2. Independent Industry Experts.
Tertiary Treatment – Membrane Bio Reactor (MBR)	30 to 40	1. Discussions with leading firms in the Water & Wastewater Industry. 2. Independent Industry Experts.

Sample Sewage Treatment Capital Costs by Capacity and Technology

S. No.	Technology	Capacity (MLD)	Capital Costs (Rs. Mn./MLD)	Source
1	Secondary Treatment – Facultative Aerated Lagoon (Bellary, Karnataka)	45	2 (Actual Project Cost)	1. KUWS&DB, Bellary
2	Secondary Treatment – ASP (Dharwad, Karnataka)	22	6.2 (Report Estimate – 2011)	1. Concept Report, Sewerage Scheme, Hubli–Dharwad (NKUSIP –KUIDFC, Package 1 – Dharwad), Wilbur Smith Associates Pvt. Ltd.
3	Secondary Treatment – SBR	20	8.5 (Report Estimate – 2011)	1. Report on Sewage Treatment Plant, (NKUSIP–KUIDFC, Package 1 – Dharwad), Wilbur Smith Associates Pvt. Ltd., Feb. 2011
4	Secondary Treatment – SBR (Hubli, Karnataka)	40	7.4 (Actual Project Cost – 2014)	1. KUIDFC, Hubli–Dharwad
5	Secondary Treatment – SBR (Nerul, Navi Mumbai)	100	6.79 (Actual Project Cost 2008)	1. IDFC Quarterly Research Note No. 12, June 2011

ANNEX 5: Compendium of Reuse Cases, Technologies and Transactional Model

Table of Contents

Case 1: Tertiary Treated Municipal Sewage Reuse, Madras Fertilizers Ltd., Chennai, India

Type of Case Study: Recycling and reuse of municipal sewage for non-potable uses in the fertilizer plant.

Project Background: Chennai city has perennially limited water resources. Two industries i.e. the Madras Refineries Ltd. (MRL) and the Madras Fertilizer Ltd. (MFL) are the biggest users of water for their process requirements. Both industries commissioned tertiary treatment plant (TTP) for municipal sewage reuse in order to become water self-sufficient and to meet increasing process water requirements.

Project Features: In 1992, the Madras Fertilizer Ltd. constructed a 16 MLD tertiary treatment and reverse osmosis (TTRO) producing 16 MLD of recycled water. Based on these TTPs, the Chennai Metro Water and Sewerage Board (CMWSB) supplies12MLD of secondary treated sewage (with BOD 120 mg/L even after secondary treatment) and 3MLD of treated freshwater and the MFL provides the required further treatment depending on its end uses. The TTP infrastructure at Madras Fertilizer Ltd. consists of following:

a. MFL constructed their 16 MLD TTRO plant in 1992 at a cost of Rs. 30 crores.

b. A 1.6 km Pipeline from STP to TTRO plant.

c. 5km pipeline and pumping machinery from TTRO to Fertilizer Plant.

Transaction Mode: MFL are the owners of the pipelines and the associated pumping infrastructure, as well as the TTRO and De-Mineralization (DM) Plant. MFL also undertakes the entire O&M of the facilities mentioned above itself.

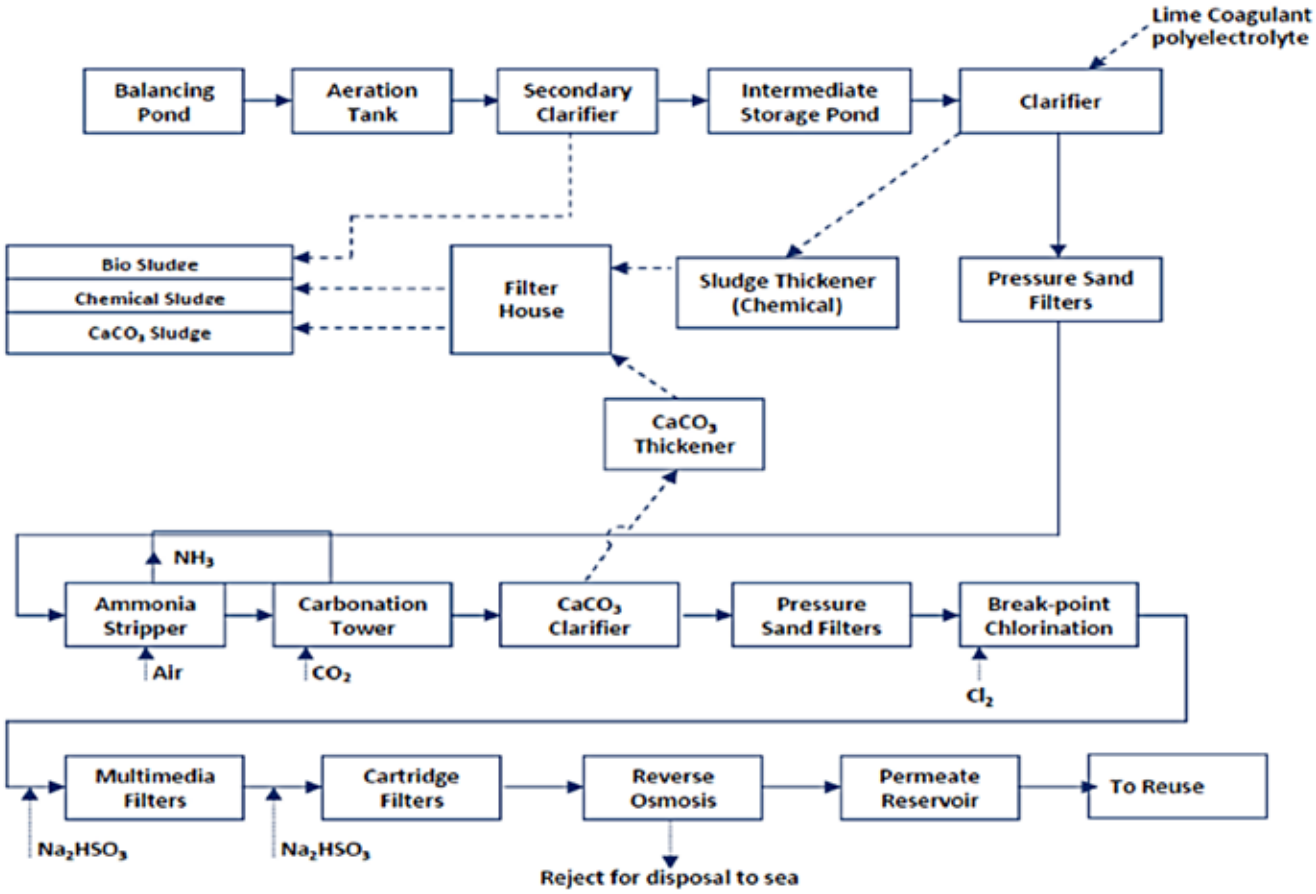
Unit Cost: Unlike most other municipalities in the country, Chennai's water board CMWSB treats all sewage to the required CPCB level. Therefore, MFL agreed to purchase 12 MLD of sewage treated water (STW) from CMWSB at Rs. 10.20/KL, which they would then treat further to their specifications and 3 MLD of freshwater at Rs. 60/KL. MFL utilizes 60 percent of its water at the tertiary treatment level while 40 percent is sent for RO and DM. Stage-wise cost of treatment and weighted average incremental cost of treatment are given in the table below.

Stage-wise cost of treatment: (Rs/KL)		
	MFL	
	Sewage treated water	Freshwater
At Plant gate	10.2	60
At TTP plant	28	Not Req
At RO Plant	70	Not Req
At DM Plant	100	130
Weighted avg treatment cost	47	28

It is evident that it costs more to bring sewage treated water to the DM level than it does freshwater—in MFL's case these costs are Rs. 90 (100-10.2) /KL and Rs. 70 (130-60)/KL respectively. However, cost differences should be weighed against having a reliable supply of water and control over quality which is highly valued by these kinds of industries. Moreover, there is scope to reduce cost differentials. For instance, MFL is able to use tertiary level STW rather than RO water for cooling which is more cost-effective.

Treatment Process: The TTPs which receive secondary treated wastewater from the Chennai city at the Madras Refineries Ltd. and the Madras Fertilizer Ltd. consist of following treatment units:

Additional Secondary Biological treatment → Chemically-aided Settling + Pressure Filtration + Ammonia Stripping, Carbonation, Clarification, Pressure Filtration → Chlorination → Sodium Bisulfate Dosing → Multimedia Filtration → Cartridge Filtration → Reverse Osmosis → Permeate for Reuse.



Source: 'Review of Wastewater Reuse Projects Worldwide', Consortium of IITs. Quarterly research note by IDFC on 'Sewage wastewater recycling for industrial use', No. 12, June 2011

Case 2: Water Reuse Facility, Indian Institute Technology, Madras, Tamil Nadu, India

Type of Case Study: Treatment, storage and reuse of wastewater from hostels, residential apartments and the institution for toilet flushing in the hostels and gardening.

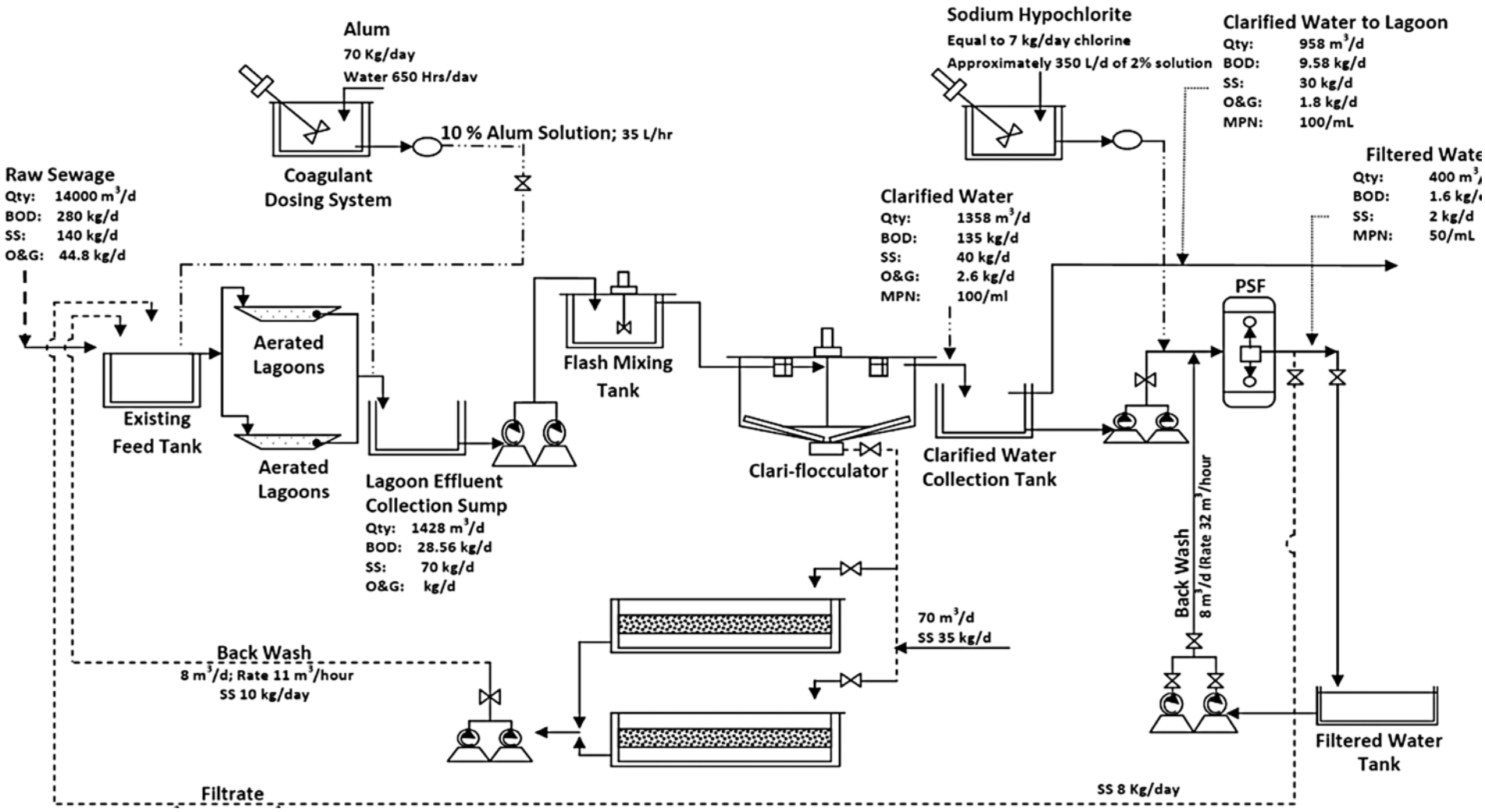
Project Features: The IIT Madras (IITM) campus has thirteen hostels, two guest houses and many residential apartments and bungalows with a total population of nearly 10,000 people. The total water consumption in the IITM campus is around 1.5 MLD and the total quantity of wastewater generated including the institute section varies from 1.0 to 1.2 MLD. Till 2004, the wastewater generated in the campus was treated in two oxidation ponds of capacity 136 m x 136 m x 2.5 m and the characteristics of the treated effluent from the pond was: 200–250 mg/L of BOD5 (total) and 35–40 mg/L of BOD5 (soluble), which is highly unsuitable for discharge into existing water bodies as per the Tamil Nadu Pollution Control Board (TNPCB) norms. In order to reuse the water, to prevent the formation of marshy area and to discharge the treated effluent to existing water bodies (Buckingham canal) there was a need to improve the existing treatment system. Moreover, the marshy area existing in and around the wastewater treatment system used to overflow during rainy season and contaminate the lake water as well as the swimming pool water in the campus. Against the backdrop of these problems and in order to conserve water in a water starved place like Chennai and to reduce the procurement of water from outside, water reuse is viewed as essential in the campus.

A preliminary investigation suggested that a water reuse facility consisting of aerated lagoon followed by tertiary treatment is the best option for the existing condition with a possibility of around 0.2– 0.4 MLD of wastewater reuse for toilet flushing and gardening in the hostel zone.

Treatment Process: The water reuse facility designed and installed to treat 1.4 MLD of wastewater and comprises of aerated lagoon, clariflocculator, chlorination, pressure filter, storage unit and sludge drying bed. There are two units of aerated lagoon with volume of 2600 m^3 each and take care of organic matter in the wastewater. The detention time provided in the aerated lagoon is relatively high compared to conventional ASP and thereby ensuring negligible sludge production. The effluent from the aerated lagoon is subjected to clariflocculation in order to remove colloidal and suspended solids. Alum and poly-electrolytes are being used as coagulant and coagulant aid respectively. The clariflocculator is also designed for a capacity of 1.4 MLD. After the clariflocculator, about two-third of the water (1 MLD) is send to the storage tank which was an oxidation pond earlier. The remaining one-third water (0.4 MLD) is chlorinated and filtered through a pressure filter. The pressure filter improves the quality of the water considerably by further removing the colloidal and suspended solids. Chlorination helps to reduce the pathogenic organisms substantially and keeps the filter relatively free from the microbial growth. The last unit in the reuse facility is the storage tank of water for further distribution. The performance characteristics of various treatment units of the reuse facility are presented in the Table below. The highly treated effluent is reused for toilet flushing and gardening in the hostel zone alone. The sludge generated in the whole system is disposed off in the sludge drying bed. This case study is a good example of sustainable water management and a notable initiative towards the reuse of wastewater in residential as well as in the institutional sectors in India.

Treatment Unit		Parameter			
		Quantity, m^3/d	BOD, mg/L	SS, mg/L	MPN/ml
Aerated Lagoon	Influent	1400	200	100	NA
	Effluent	1428	20	49	NA
Clariflocculator	Influent	1428	20	49	NA
	Effluent	1358	10	29.45	100
Pressure Filter	Influent	400	10	29.45	100
	Effluent	400	4.0	5.0	50

Figure: The Detailed Flow Schematic of the Water Reuse Facility at Indian Institute of Technology, Madras, Tamil Nadu



Source: 'Review of Wastewater Reuse Projects Worldwide', Consortium of IITs

Case 3: Sewage Reclamation Plant, the Rashtriya Chemicals and Fertilizers (RCF) Plant, Chembur, Mumbai, India

Type of Case Study: Reuse of complex wastewater (municipal sewage polluted with various industrial wastes) for industrial uses.

Background: Municipal sewage generated in the vicinity of the Rashtriya Chemicals and Fertilizers (RCF) Plant, Chembur, Mumbai is heavily contaminated with various streams of industrial wastes and results in complex wastewater. In order to become water self-sufficient and to meet increasing process water requirements, the RCF plant realized the importance of recycling and reuse of wastewater for non-potable industrial use and commissioned a sewage reclamation plant for itself.

Project Features: The RCF Plant commissioned a 23 MLD capacity sewage reclamation plant involving reverse osmosis to treat complex wastewater comprising municipal sewage heavily contaminated with various industrial wastes. RCF's STP, which is located in the heart of Mumbai, came on line in 2000. RCF constructed a 5 km pipeline to receive raw sewage from Brihan Mumbai Corporation's (BMC) Ghatkopar pumping station. They also buy 11 MLD of freshwater from BMC.

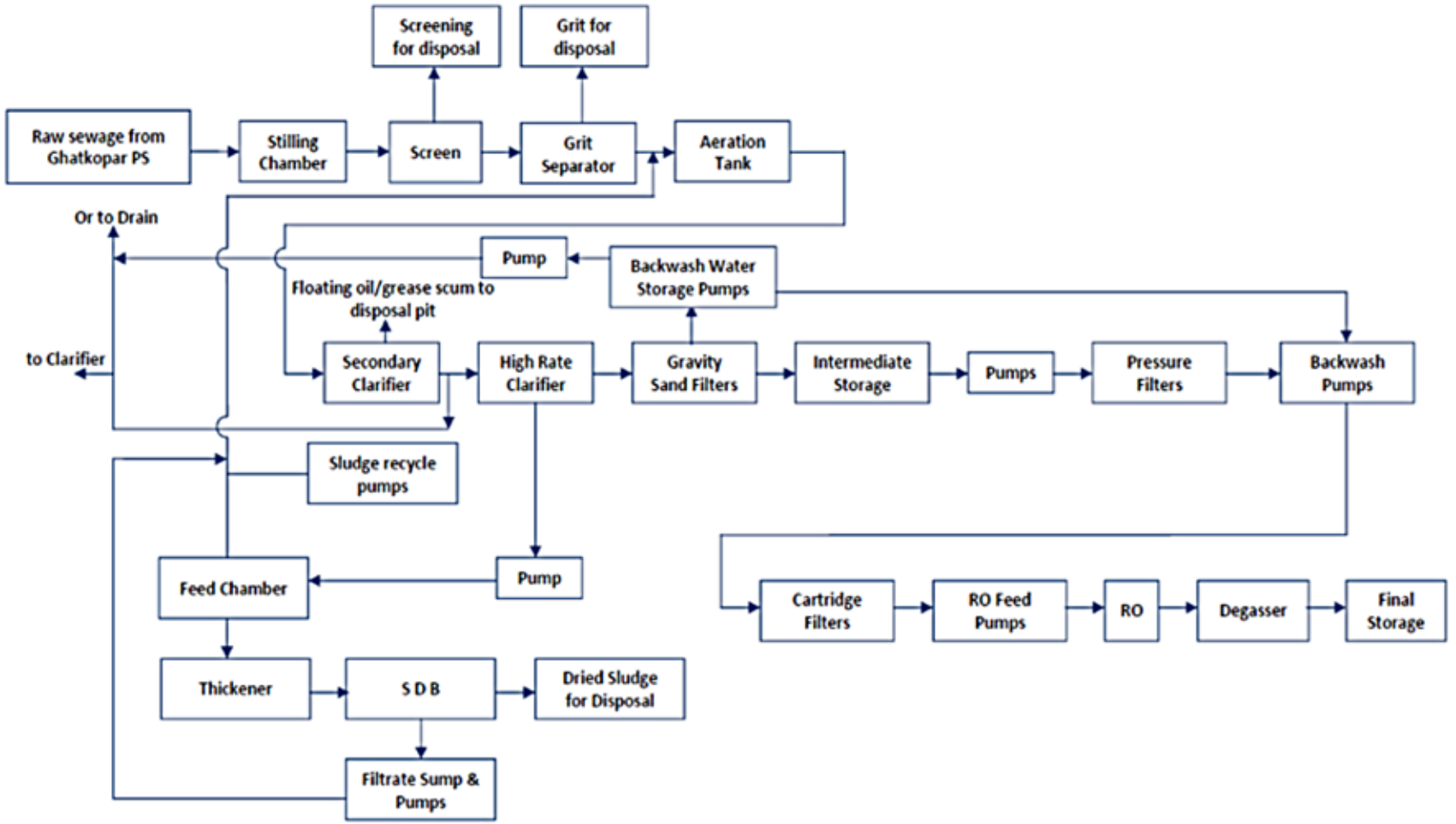
The sewage reclamation plant at the RCF consists of following treatment units: Screening → Grit Removal → Activated Sludge System → Clarifier → Sand Filter → Pressure Filter → Cartridge Filters → Reverse Osmosis → Degasser to remove CO_2 → Reuse in Industry.

Transaction Mode: RCF owns the 23MLD sewage reclamation plant as well as the 5km pipeline conveying the raw sewage from Ghatkopar pumping station to its treatment plant. RCF undertakes the O&M of the sewage treatment plant and the pipeline that they own itself.

Unit Cost: Since RCF requires a high amount of De-Mineralized (DM) water, of the total water they receive from BMC and their STP, RCF uses 73 percent at the RO level and 27 percent at DM stage. The RCF purchases raw sewage from BMC at approximately Rs. 0.60/ KL and treated freshwater from BMC at Rs. 40/KL. The stage-wise cost of treatment and weighted average incremental cost of treatment are given below.

	RCF	
	Raw sewage	Freshwater
At Plant gate	0.60	40
At TTP plant	NA	Not Req
At RO Plant	45	Not Req
At DM Plant	100	100
Weighted avg treatment cost	59	16

The plant cost nearly Rs. 40 crores to build in 1998 and the operating cost as reported in 2005 came to Rs. 39/- per m^3. With the passage of time and the success of reuse schemes, the municipal charge levied also became higher at Rs 6/- per m^3 of raw sewage. Some additional treatment steps like use of Ultrafiltration became necessary in order to improve the quality of the water reaching the RO system (keeping the silt density index, SDI < 3.0) owing to the more polluted nature of the influent wastewater.



Source: 'Review of Wastewater Reuse Projects Worldwide,' Consortium of IITs

Case 4: Wastewater Treatment Recycling Plants, Bangalore Water Supply and Sewerage Board (BWSSB), India

Type of Case Study: Recycling and reuse of wastewater for non-potable and industrial uses in order to meet the water demands of ever growing population of Bangalore city in view of limited water resource and to reduce the high energy cost for pumping of water from Cauvery River.

Background: Bangalore city has limited raw water resources to meet its water demands for ever growing population. City is almost completely depending on the Cauvery River, located more than 100 km away from the city for its requirements. The pumping of water from the river for water supply involves an exorbitantly high energy costs. In view of extremely finite source of raw water and high energy cost for pumping of water, the recycling and reuse of wastewater becomes absolutely imperative in Bangalore city and prompted the Bangalore Water Supply and Sewerage Board (BWSSB) to undertake a major initiative towards the recycling of wastewater. The BWSSB planned and established the two tertiary treatment plants (TTPs) in Bangalore at Yelahanka (capacity: 10 MLD) and another at Vrishabhavathy Valley (capacity: 60 MLD) for water recycling and reuse.

Project Features: The 10 MLD TTP with recycling facilities at Yelahanka with funding support from KUIDFC/HUDCO under Megacity scheme and through the Indo-French protocol has been commissioned in May 2003 for the BWSSB.

Treatment Process: The Yelahanka TTP has three treatment stages, viz., primary treatment, secondary treatment and tertiary treatment. The collected wastewater from Yelahanka is initially subjected to primary stage treatment (screening, grits and grease removal), followed by the secondary stage using primary settling and activated sludge process. Tertiary filtration (using sand and gravel) along with coagulation with aluminium sulphate are provided to the effluent from the secondary stage for removal of suspended solids. The chlorinated recycled water from the TTP is supplied to ITC Ltd., Wheel and Axle Plant and the new International Devanahalli Airport to meet the non-potable water requirements. The characteristics of raw influent wastewater and tertiary treated effluent at the Yelahanka plant are shown in Table.

Characteristics of Raw Wastewater and Tertiary Treated Effluent at Yelahanka TTP

Parameter	Raw Wastewater	Treated wastewater
pH	6.8–7.5	7.0–8.0
Suspended solids (mg/L)	480	<5
Turbidity (NTU)	NA	<2
BOD (mg/L)	380	<5
Faecal Coli form (MPN/100ml)	NA	<25

The BWSSB commissioned another 60 MLD capacity tertiary treatment plant (TTP) with recycling facilities at Vrishabhavathy Valley with funding support from KUIDFC/HUDCO under Megacity scheme and through the Indo-French protocol in May 2003. The V. Valley TTP provides a combination of biological and physiochemical treatment to the secondary effluent from the existing 183 MLD STP based on conventional bio-filter near Kenchenahally.

Treatment Process: The treatment chain in the V. Valley TTP consists of trickling filter, DENSADEG high rate clarifier (combination flash mixer, lamella separators and counter current flow thickener), FLOPAC aerobic biological filtration unit and chlorine based disinfection. The chlorinated recycled water from the V. Valley TTP is supplied to M/s Karnataka Power Corporation Ltd. at Bidadi and M/s Pulikeshi Power Corporation Ltd. at Kumbalgod for their power generation plants.

Source: Review of Wastewater Reuse Projects Worldwide,' Consortium of IITs

Case 5: Pomona Water Reclamation Plant with Integrated Aqua-Culture Wetland Ecosystem, Los Angeles County, California, USA

Type of Case Study: Reuse of municipal wastewater for irrigation purposes. Case study that demonstrates an effluent reuse system with significant health and ecological benefits.

Background: Los Angeles (LA) County, California is a severely water-stressed region, depending on imported water from the neighboring river basins (Colorado River for example). However, the imported supplies are dependent on climate variability, environmental, political and energy consumption issues. Over 90% of LA's wastewater was discharged into the San Gabriel River then to ocean, or directly into the ocean at San Pedro Bay. In this context, there has been an increasing effort to upgrade all of LA's treatment plants to tertiary wastewater facilities and to expand water markets for wastewater reuse inland as an alternative to ocean disposal in order to maintain integrated water resources management.

Project Features: The Pomona Water Reclamation Plant (WRP) is located at 295 Humane Way in the City of Pomona. The plant occupies 14 acres northeast of the intersection of the Pomona and Orange Freeways. The original plant was known as the Tri-City Plant and was owned by the cities of Pomona, Claremont, and La Verne. It was placed into operation in July 1926 with effluent reuse beginning in 1927. The Sanitation Districts took over operations in 1966 and increased the plant capacity to 4 MGD/day (15.16 MLD). In 1970, the plant capacity was expanded to 10 MGD/day (37.9 MLD) with the construction of additional primary, aeration, and final sedimentation tanks. In 1977, the plant capacity increased to 15 MGD/day (56.85 MLD) with the implementation of tertiary level wastewater treatment, including activated-carbon gravity filters, chlorine contact tanks, and a dechlorination system. In the early 1990s, the plant underwent a third expansion with the construction and retrofit of the activated-carbon gravity filters to deep bed anthracite filters and the addition of a third chlorine contact tank for additional disinfection capacity.

Currently, the Pomona WRP provides primary, secondary and tertiary treatment of wastewater at 13 MGD/day (49.27 MLD) (see Figure 1). The plant serves a population of approximately 130,000 people. Approximately 8 MGD/day (30.32 MLD) of the purified water is reused at over 90 different reuse sites. Reuse includes landscape irrigation of parks, schools, golf courses, greenbelts, etc.; irrigation and dust control at the Spadra Landfill; and industrial use by local manufacturers. The remainder of the purified water is put back into the San Jose Creek channel where it makes its way to the unlined portion of the San Gabriel River. Therefore, nearly 100% of the water is reused since most of the river water recharges into the ground water.

Although it is a common perception that tertiary sewage treatment plants (TSTPs) are the preferred method of waste utilization and are 'environmentally friendly', many TSTPs do not remove inorganic nitrogen and phosphorus to levels below which these nutrients stimulate marine aquatic production. Therefore, the existing WRP is further upgraded using an aquaculture–wetland ecosystem (AWE) to simultaneously accomplish aquatic food production and inorganic nitrogen removal from the tertiary-treated wastewater received from the Pomona, TSTP. The AWE consists of a 28-m^3 wastewater supply tank, three 200–240 m2 (1-m deep) aquaculture ponds, and a 0.05 ha artificial wetland (Figure 2).

The wetland is a simple bowl-shaped depression where waters are impounded by a rock dam. The wetland develops a *Typha*–water hyacinth–duckweed (*Lemna* sp.) aquatic plant community on its own, with the emergent plants and duckweed comprising about 50% of the surface area of the wetland, and the water hyacinths occupying the remainder. Reclaimed wastewater is pumped from the Pomona TSTP to the storage tank located on a hill. Ponds are filled initially by gravity with a mixture of 50% potable water: 50% reclaimed water to allow water hyacinths to get established, thereafter they are flushed 20% per week with reclaimed water. A polyculture species stocking is used which defined 'target' and 'janitor' species. The target species are hybrid, all male, sex-reversed tilapia (*Oreochromis mossambicus_O. hornorum*). Janitor fish species stocked are common carp (*Cyprinus carpio*) and mosquitofish (*Gambusia affinis*). Water hyacinths (*Eichhornia crassipes*) are added to all ponds at 10–20% of the pond area and maintained at about 50% of the pond surface area by use of floating booms and manual harvesting every 2 weeks. The AWE accomplishes aquatic food production and almost complete removal of inorganic nitrogen from wastewater, functioning as a 'quaternary' wastewater treatment/food production ecosystem. The case study demonstrates that the concept of using tertiary-treated wastewater for aquatic food production may be attractive in the peri-urban areas of many mega-cities like Los Angeles, both for fish markets and to stem the growing discharges of wastewaters that are causing coastal pollution.

Figure 1: Flow diagram of the Pomona Water Reclamation Plant (WRP)

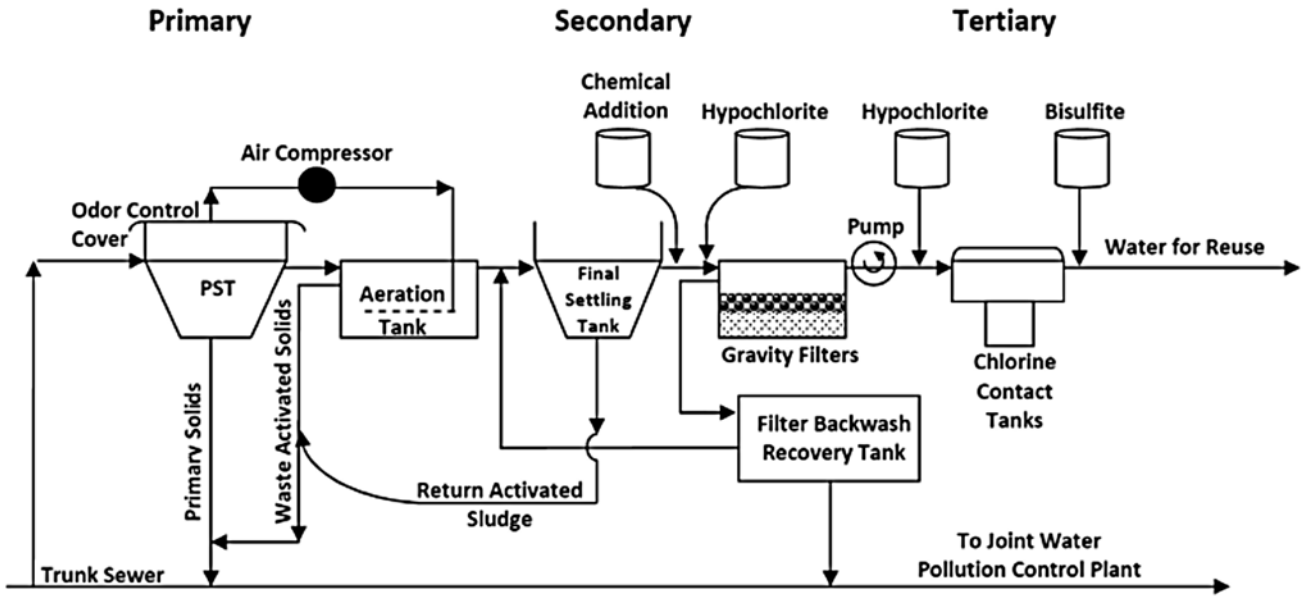
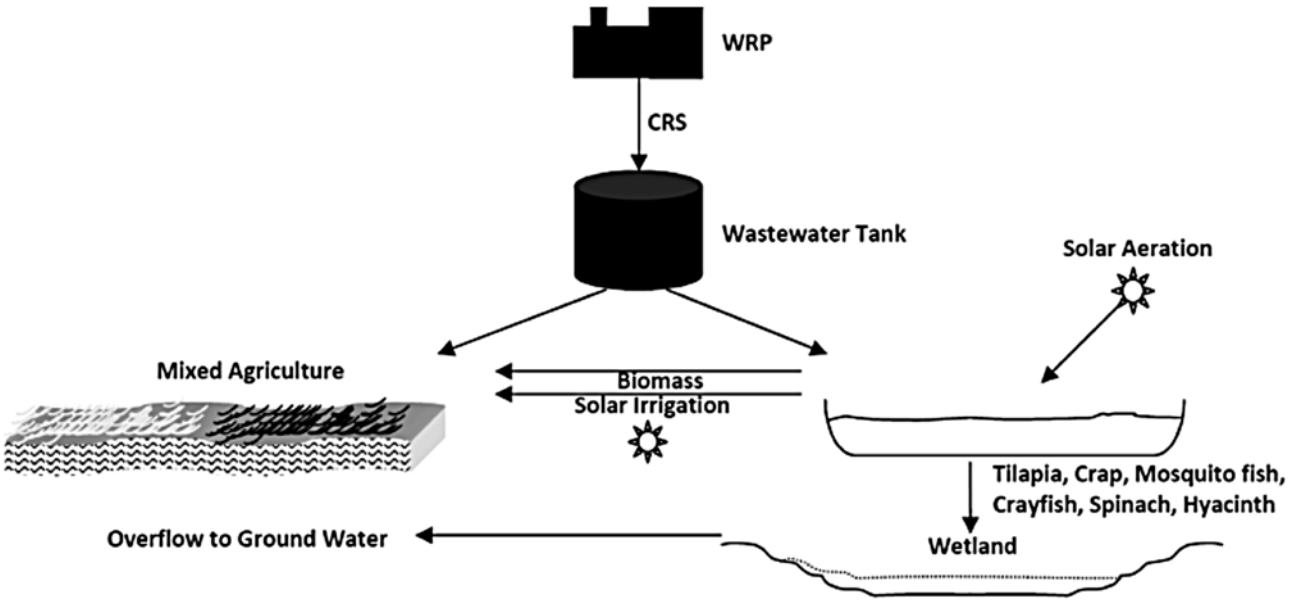


Figure 2: Flow Diagram of the Integrated Aquaculture–Wetland Ecosystem (AWE)



Source: 'Review of Wastewater Reuse Projects Worldwide,' Consortium of IITs

Case 6: Florida Water Reuse Program, Florida, USA

Type of Case Study: Reuse of domestic wastewater for the purposes of land application and residential irrigation, groundwater recharge and indirect potable reuse and industrial use of reclaimed water.

Background: Florida is the fourth most populous state in the USA and population is projected to grow from about 16 million in 2000 to about 21 million in 2020. While Florida receives a large amount of rainfall every year compared to other states, the distribution is not even throughout the year and across the state. As the state continues to grow, demand for freshwater also will increase. In 1995, Florida used about 7.2 billion gallons of water each day (27,288 MLD). By 2020, water use is forecast to grow to 9.1 billion gallons per day (34,489 MLD). Florida is the largest user of irrigation water east of the Mississippi River. In 2020, agriculture is expected to account for about 46 percent of Florida's total demand for freshwater. Public water supply will account for about 34 percent of the total. The remaining 20 percent of water use will be associated with industrial/commercial/electric generation, recreational irrigation, and domestic self supply. In 2001, Florida's domestic wastewater treatment plants had a total capacity of about 2,220 MGD (8414 MLD) and actually treated about 1,486 MGD (5,632 MLD). In 2020, it is estimated that wastewater flows to be treated will reach 1,950 MGD (7,390 MLD). This represents 1,950 MGD (7,390 MLD) of a water resource that can and should be reclaimed and reused for beneficial purposes. Periodic droughts combined with increased demand for fresh, clean surface and groundwater for public consumption have resulted in periodic and prolonged water shortages. Conservation measures such as irrigation and groundwater recharge with reclaimed water are viewed as the plausible ways to reduce the use of existing potable water supplies and tackle the water shortages.

Project Features: The Florida Department of Environment Protection (DEP) began looking at ways to promote reuse of reclaimed water in 1987. Reuse systems serving Tallahassee and St. Petersburg significantly influenced reuse in Florida and paved the way for today's multitude of excellent, innovative reuse projects. Table shows the different types of reuse systems in Florida and a brief description of the treatment and disinfection requirements for each. As per the Florida Water Reuse 2009 inventory, a total of 484 domestic wastewater treatment facilities (WWTF) with permitted capacities of 0.1 MGD (0.379 MLD) or above that make reclaimed water available for reuse are there in the Florida state. These facilities have WWTF capacity totaling 2,287 MGD (8,668 MLD) and treated 1,421 MGD (5,386 MLD) of domestic wastewater in 2009. These treatment facilities serve 433 reuse systems. Approximately 673 MGD (2,551 MLD) of reclaimed water from these facilities is reused for beneficial purposes. The total reuse capacity associated with these systems is 1,559 MGD (5,909 MLD). Irrigation of areas accessible to the public like residential areas, golf courses, athletic fields, parks, etc. represented about 56 percent of the 673 MGD (2,551 MLD) of reclaimed water reused. Reclaimed water from these systems was used to irrigate 276,471 residences, 533 golf courses, 873 parks, and 306 schools. Following public access areas, the next largest uses are industrial uses (14%) such as cooling water in power plants and groundwater recharge (13%). Most of the reclaimed water used for agricultural irrigation is used to grow feed, fiber, or other crops that are not for direct human consumption. Over 12,750 acres of edible crops on 75 farms are reported to be irrigated with reclaimed water. In addition to the Florida Water Reuse Program, the Hazen and Sawyer in partnership with another national firm the Miami–Dade Water and Sewer Department are currently designing 21 MGD (79.6 MLD) South District Water Reclamation Plant (SDWRP), the largest advanced wastewater reclamation plant of its kind in the State of Florida, for replenishment of the Biscayne Aquifer via rapid infiltration, in which the domestic wastewater that has been treated to meet drinking water standards percolates through the soil down to the groundwater level. The SDWRP is planned to upgrade the South District Wastewater Treatment Plant (SDWWTP) and will treat secondary effluent from the SDWWTP which adds High Level Disinfection (HLD) to the existing pure oxygen secondary treatment plant.

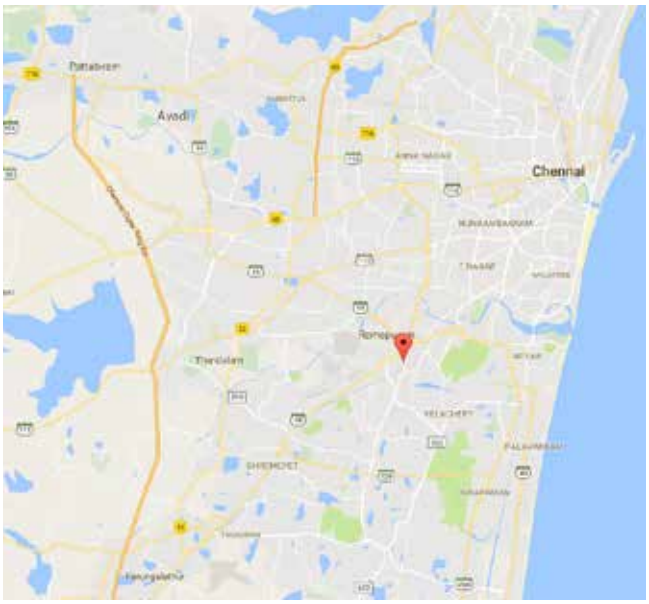
Treatment Process: The first step in the treatment process will be strainers followed by microfiltration (MF) or ultra filtration (UF) to minimize suspended solids from the secondary effluent. The RO treatment process at the SDWRP will remove organic carbon (TOC), total organic halides (TOX), and significantly reduce nitrogen and phosphorus to satisfy potable reuse and environmental application requirements. Micro constituents and emerging pollutants of concern (EPOC) will also be reduced in the final step of the process which includes advanced oxidation processes (AOP) like ultraviolet light (UV) application and hydrogen peroxide (H_2O_2) addition to form hydroxyl radicals (OH^-) which oxidize most organic compounds.

Different Type of Reuse Systems under Florida Water Reuse Program		
Reuse System Type	**Reuse Activities**	**Treatment and Disinfection Requirements**
Slow-rate land application systems; restricted public access	• Irrigation of pastures, trees, feed, fodder, fiber, or seed crops	Secondary treatment and basic disinfection
Slow-rate land application systems; public access areas, residential irrigation, and edible crops	• Residential, golf course, and other landscape irrigation • Toilet flushing • Fire protection • Dust control • Aesthetic features (ponds and fountains) • Irrigation of edible crops (direct contact only with crops that will be peeled, skinned, cooked, or thermally processed)	Secondary treatment, filtration, and high-level disinfection
Rapid-rate land application systems	• Rapid Infiltration Basins (RIBs) • Absorption Fields	Secondary treatment, basic disinfection, < 12 mg/L NO3-N
Groundwater recharge and indirect potable reuse	• Salinity barriers • Augmentation of surface waters	Principal treatment and disinfection or full treatment and disinfection (depending on use)
Industrial uses of reclaimed water	• Cooling water • Wash water • Process water (not to include food processing for human consumption)	Secondary treatment and basic disinfection (additional treatment may be needed to meet needs of a particular application)

Source: 'Review of Wastewater Reuse Projects Worldwide', Consortium of IITs

Case 7: Alandur Sewerage Project

Recognizing the need for a centralized sewerage system in the city but lacking the funds to pay for it, Alandur municipality initiated an innovative public–private financing scheme which encouraged the local population to contribute to construction and operation costs through connection and service provider fees. The approach has been shown to be economically sustainable and the new system has contributed to reduced sanitation related disease within the community and environmental benefits in the local area.



Type of Case Study: Innovative Community involvement in PPP model to implement an Underground Sewerage System.

The Alandur underground sewerage project became a bankable project through a coordinated effort involving the municipalities of Alandur and Chennai, the State of Tamil Nadu, the state asset management and credit facilities, and the donor community working together to implement a comprehensive package of innovative financial and credit enhancement arrangements. The uniqueness of the project lies in the fact that it mobilized private money for developing public infrastructure. The innovative financing mechanism ensured people's involvement right from the conception and design of the project. The initiative was awarded the National Urban Water Award in 2008.

The importance of the issue

Prior to the initiative, Alandur municipality had no underground sewerage system; sewage was primarily collected in septic tanks or holding tanks. Sewage overflows from septic tanks would regularly enter storm water drains creating unsanitary conditions.

To address these problems, Alandur Municipality announced an ambitious proposal to construct an underground sewage system and wastewater treatment facility, to be implemented through a combination of private sector participation and municipal funding. A system was designed for an estimated population of 300,000 in 2027 with the objectives of improving the standard of living of the residents; disposing of sewage through an exclusive drainage network; avoiding recurring expenditure on septic tank cleaning; and preventing groundwater contamination. The proposal was transformational as it involved a service never before made available by the city, with financial and management responsibilities being shared by the municipality, residents, the private sector, and state government bodies.

Alandur in context

Located 14 km south of Chennai, Alandur is part of the Kanchipuram district of Tamil Nadu and forms a part of the Chennai Metropolitan Development Area (CMDA). The town has developed as a residential suburb of Chennai with a population of 160,000 (Census 2004) of which approximately one–fourth lives in slums.

The Alandur Sewerage Project (ASP) was the first project in the municipal water sector to be undertaken through the Public Private Partnership (PPP) route in India. Prior to the project, Alandur had no sewerage system and wastewater from the majority of its residents was collected either in septic tanks or holding tanks. The sewerage was collected periodically in tankers and disposed of in low–lying areas outside the municipal limits. The clearance of septic tanks was irregular due to lack of sufficient vehicles and staff in the public health department. In 1997, the Government of Tamil Nadu decided to provide a sewerage system in 12 selected major urban centers, including Alandur, in the context of a World Bank funded project. The Chairperson of the Municipality took up the task of implementing the project in Alandur.

Public Private Partnership in Underground Sewerage Network – Alandur, India

The Alandur Municipality found that due to a lack of financial and technical resources, it would not be in a position to implement the project on its own through the traditional Engineering Procurement and Construction (EPC) procedure.

To overcome this issue, the municipality worked in partnership with the state asset management company Tamil Nadu Urban Infrastructure Financial Services Limited (TNUIFSL) and partnered with USAID's Financial Institutions Reform and Expansion (FIRE) Project. To address issues of the sewerage charges, a "willingness to pay" survey was conducted covering over 10 percent of the city's population. According to the survey, although the public generally had strong support for the project and accepted that users should pay for sewage service, this willingness had its limits. The municipality initially proposed monthly sewer charges of Rs. 150 per month per household, to be increased by 6 percent a year until reaching a target level of Rs. 180 per month.

Public Awareness: To gain public acceptance of these rates, the municipality mounted a vigorous public participation campaign with extensive media coverage to explain the project's benefits, costs, and tariff system. An election-style campaign was launched where officials and councillors informed people about the project through various means; local cable TV networks were roped in; pamphlets in English and Tamil were distributed; door to door canvassing was done by municipal sanitary workers along with senior municipal officials. All holidays and weekends were used for discussion with the Residents' Welfare Associations. Although, initially a large population of the town was not ready to pay the high deposits of sewerage connection charges and monthly tariff, the active canvassing and awareness raising activities educated people on the benefits of the project and succeeded in persuading residents that the services were worth paying for. To ensure effective participation of the local population it was decided to collect deposits from at least 10,000 residents before calling for tenders.

Collection of Charges: By the end of May 2000, more than 13,000 connection seekers (domestic and non domestic) had deposited the one time connection fee to the municipality. In order to facilitate the collection procedure, collection centres at different locations were opened for the convenience of people and arrangements were made for collection of deposits including through the receipt of phone messages and at designated banks. The names of the depositors were displayed in public places to motivate others to pay.

To further reduce the burden on consumers, the city council decided to split the connection fee into two installments. People who were unable to pay the deposits on their own were given the option of loans from local banks on nominal interest rates. While special provisions were not made for waiving fees for the poor, plans did include the connection of public latrines to the sewer system. The construction of community toilets was taken up on demand from slum dwellers and hence helped extend sanitation services to the poorest segment of the population who could not afford the non-refundable deposit and were therefore not connected to the system. Full transparency was maintained regarding financial aspects with status updates provided every month. Communication with the local community was maintained through a feedback and grievance redressal system which was reviewed daily by the project management team and twice a week by the municipal commissioner. Approximately, 29% of the project cost was garnered from public contribution which far exceeded expectations.

Sewage Treatment Plant

Pumping Station

Branch Sewers

Main Sewer

Results

The Alandur Sewerage Project was the first project in the municipal water sector to be undertaken through the Public Private Partnership (PPP) route in India. To implement this complex and politically challenging project, the Alandur Municipality worked in partnership with the state asset management company, Tamil Nadu Urban Infrastructure Financial Services Limited (TNUIFSL) and with USAID's Financial Institution Reform and Expansion (FIRE) Project. TNUIFSL and the municipality decided to undertake the project as a whole on a BOQ (Bill of Quantities) basis, and construct the sewerage treatment plant (STP) on a BOT (Build, Operate and Transfer) basis due to the absence of financial and technical capacity at the municipal level. The Alandur sewerage project is a unique case of public participation in financing of municipal infrastructure where the use of active campaigning and awareness raising convinced the community that the payment of sewerage charges in exchange for benefiting from the services was a worthy investment. As mentioned above, the public contributed almost a third of project costs allowing a functional underground sewerage system to be created in the city through genuine and effective public participation. About 120 km of branch and main sewers have been laid, and a BOT operated Sewage Treatment Plant has been completed. The replacement of septic tanks has led to a reduction in the contamination of storm water drains and the underground sewerage system has eliminated the breeding grounds for mosquitoes thereby reducing the risk of related health impacts to the citizens. Once the scheme was implemented, the municipality levied an initial fee of Rs. 150 to the consumers per household. This was essential in reducing financial pressure on the municipality to a great extent. The impact of the project financing scheme on sectoral policy for financing projects through PPPs and self-financing as introduced through this project has been significant.

Sustainability of the initiative

The Alandur urban sewage scheme, and the PPP method to finance it, considers a number of sustainability factors that help to ensure that the benefits provided by the scheme are maintained in the long-term. These include the following:

Health and hygiene: In the absence of a proper sewage system, Alandur faced serious unhygienic sanitation related issues. The construction of underground drainage enabled structured and hygienic disposal of sewage leading to a cleaner, healthier and safer environment

Environment and natural resources: In the absence of a wastewater drainage network in Alandur, untreated wastewater from the city used to drain into nearby streams causing pollution in the river Cauvery. This posed a risk to both the environment and public health. The construction of an underground sewer system prevented the pollution of water resources leading to considerable improvements in the well being of natural habitats.

Technology and operation: The Alandur Sewerage Project was the first project in the municipal water sector to be undertaken through the Public Private Partnership route in India. This enabled funding to be raised for construction costs and continues to provide the necessary revenue streams to operate and maintain the system.

Financial and economic issues: The total project cost was estimated to be approximately Rs 340 million and the contribution came from various resources through loans and grants. About 29 percent of the project cost was garnered from public contribution.

Socio-cultural and institutional aspects: An aggressive public outreach campaign and awareness generation was embarked upon to involve people in the initiative. This formed a key part of the project and was essential in convincing members of the community that the sewer charges were worth paying. Simultaneously, involvement of stakeholders throughout implementation ensured timely completion of the project.

Lessons learned

The PPP method to finance the Alandur Sewerage Project (ASP) led to an improved sanitation situation in the city, while at the same time reducing the recurring costs of sewage disposal from septic tanks and holding tanks as well as reducing pollution of ground water due to the discharge of untreated sewage. The then chairman Mr. R S Bharati played an important role in promoting the project by introducing it to his council and generating popular support for it. This high-level commitment was an essential requirement for getting the project up and running.

The most challenging issue faced by the municipality was to convince people about the need for the project. Since there had been no previous examples of private participation in municipal services along with the fact that the success of the project required people to pay for the service, public outreach was critical. Moreover, there were also objections from people residing near to the proposed pumping stations. It took considerable effort and time to convince the community about the importance of a sewerage management system and the need for public involvement during project implementation and maintenance. To gain the confidence of the public, Alandur Municipality made a strong and concerted effort to spread awareness about the benefits of the project. Involvement of stakeholders throughout the project has been a key factor in ensuring its successful completion.

The innovative financing mechanism of bringing together private money to develop public infrastructure was a big factor in meeting the financial requirements of the project. The Alandur experience demonstrates that mobilizing people's participation for infrastructure projects is possible through effective leadership, collective efforts and transparent procedures. Political will, effective communications, transparency and partnerships with community-based organizations represent the key factors for the success of the project. Inter-departmental coordination and active involvement of all stakeholders also ensured successful completion and sustenance of the project.

Source: accessanitation.org

Case 8: Wastewater Recycling Initiative by Pragati Power Corporation Limited (PPCL), New Delhi

Types of Case Study: Recycling of treated municipal wastewater for Gas Power plants.

Project Background: Pragati Power Corporation Limited (PPCL) is a subsidiary of Indraprastha Power Generation Corporation Limited. PPCL commenced operations of its 330 MW gas based power plant in mid-2004. At its planning and development stage, PPCL was denied a freshwater linkage but given the option to operate and use two sewage treatment plants (STPs) of 10 MLD each built atop nearby nallahs 1 and 3 kilometers away.

Project Features: Gas based Power Plants use over 90% of their water for cooling, requiring only slightly higher than secondary or in some cases tertiary and only a fraction of water, 5 percent, is required at the high-end level which requires de-mineralization. The STPs that PPCL was given to operate and use, were two of nine Activated Sludge Process (ASP) plants built along the Yamuna River under JICA funding as a pilot project for the Delhi Jal Board (DJB) in 2002. The STPs used by PPCL treat only 5–10 percent of the sewage that flows through the nallahs and the rest is discharged untreated into the Yamuna. The STP treats water to the secondary level with output parameters of BOD< 10, COD < 25–30 and TSS < 15. After that 19 MLD of STW is pumped to the PPCL power plant where it undergoes lime-softening treatment. The bulk of the water is utilized within the PPCL plant at this level of treatment. Only 1–1.5 percent of lime-softened water is sent for DM so it can be used in boilers. While DM is an expensive process that adds to the cost of production, this step is required even if freshwater were used. Lime-softening and DM take place within the power plant and utilize electricity generated by the plant itself. Moreover, both processes are required regardless of water source.

Transaction Mode: Ownership of the STPs vests with the Delhi Jal Board (DJB). As far as O&M is concerned, initially, it was agreed that DJB would provide free Sewage Treated Water (STW) to PPCL in return for free electricity to run the plants. However, since DJB had little interest in running the plant they signed an MOU with PPCL in 2004, in which PPCL had the right to use the STPs for as long as required provided they took care of operation and maintenance (O&M) responsibilities.

PPCL has in turn outsourced the O&M contract to Degrémont, an international water treatment company, which had built the plants for Japan International Cooperation Agency (JICA). PPCL's O&M contract with Degrémont is renegotiated every two years; for 2010–2012 it is Rs. 1.26 crores per year for both plants combined. As the STP is not located on PPCL premises they must buy electricity from the grid at commercial rates to run the STP and pump treated water to the power plant. This comes to a cost of Rs. 1.6 crores.

Unit Costs: The current O&M cost of producing STW, including electricity, is Rs. 2.86 crore or ~Rs. 4/KL. However, since variable costs change over the life of a plant Table 1 calculates the levelized annual cost of treatment including capital expenditure over a 20 year period. Since both Lime softening and DM are required regardless of water source the costs in Table 1 below are only for secondary level treatment. However, PPCL engineers note that given the quality of Yamuna freshwater they receive; further treatment costs are lower when using STW.

Levelized Annual Treatment Cost, PPCL

	Levelized costs*	
	Rs/KL	Rs/kWh
Total Costs (incl ROE)	~17	~0.05
Total Costs (excl ROE)	~15	~0.05

Source: Interviews with Degremont and Pragati Power Corporation Ltd; Delhi Electricity Regulatory Commission Tariff Order 2008–2011; IDFC Analysis.

* Levelized costs are calculated by dividing the net present value of the total cost into an equal annual per unit cost. A 10% discount rate is used.

Assumptions: All non-fixed costs escalate at 5.5% per year over 20 years. Capital expenditure is Rs. 2.5 crores per MLD, debt: equity ratio is 70:30, loan is for 10 years at 12.5% interest and Return on Equity (ROE) is DERC-approved at 14%. All estimates include pumping costs from the STP to PPCL.

Source: Quarterly research note by IDFC on 'Sewage wastewater recycling for industrial use', No. 12, June 2011

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