GOVERNMENT OF INDIA
MINISTRY OF HOUSING AND URBAN AFFAIRS

MANUAL ON WATER SUPPLY AND TREATMENT SYSTEMS (DRINK FROM TAP)

PART C: MANAGEMENT
FIRST EDITION

CENTRAL PUBLIC HEALTH AND ENVIRONMENTAL ENGINEERING ORGANISATION
https://mohua.gov.in || https://cpheeo.gov.in

MARCH 2024

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In Collaboration with

MARCH 2024

In keeping with the advancements in the sector, updates as and when found necessary will be hosted on the Ministry's website: http://mohua.gov.in and CPHEEO website: http://cpheeo.gov.in. The readers are advised to refer to for further updates.

हरदीप एस पुरी
HARDEEP S PURI

आवासन और शहरी कार्य मंत्री
पेट्रोलियम एवं प्राकृतिक गैस मंत्री
भारत सरकार
Minister of
Housing and Urban Affairs; and
Petroleum and Natural Gas
Government of India

MESSAGE

In 2010, the UN General Assembly recognised "the right to safe and clean drinking water and sanitation as a human right that is essential for the full enjoyment of life and all human rights." Providing safe and reliable water to our rapidly increasing urban population, in alignment with Goal 6 of the Sustainable Development Goals, will enhance the quality of life and ease of living, leading to increased productivity and economic development in the country.

India's urban water sector is under immense pressure due to the increasing population, rapid urbanisation, and climate change. To ensure sustainable and resilient urban water management, transformative changes are required. The Atal Mission for Rejuvenation and Urban Transformation (AMRUT), launched in June 2015 by the Hon'ble Prime Minister Shri Narendra Modi ji, caters to that purpose by providing water supply facilities in 500 Class-I cities. Its tremendous success and citizen acceptance led to the launch of the AMRUT 2.0 Mission which aims to make all Indian cities 'water secure' and provide functional tap connections to all urban households. The AMRUT 2.0 mission advocates for the "Drink from Tap" facility to ensure safe and reliable water for urban citizens.

This revised manual on Water Supply and Treatment will serve as a useful guide for state governments, urban local bodies, parastatal agencies, and other stakeholders for effective and efficient planning, implementation and management of water supply systems with the "Drink from Tap" facility.

I compliment the AMRUT Division, Central Public Health & Environmental Engineering Organisation (CPHEEO), Expert Committee for the preparation of this manual, as well as the support extended by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH and the WAPCOS study team in preparing this document.

(Hardeep S Puri)

New Delhi
03 November 2023

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कौशल किशोर
KAUSHAL KISHORE

आवासन और शहरी कार्य राज्य मंत्री
भारत सरकार
Minister of State for Housing & Urban Affairs
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संदेश

जल आपूर्ति और जल शोधन प्रणालियों पर अदयतित नियम-पुस्तिका का लोकार्पण करते हुए मुझे बेहद हर्ष और इसके उददेश्यपरक होने की गहन अनुभूति हो रही है। यह आवासन और शहरी कार्य मंत्रालय की एक अत्यंत महत्वपूर्ण पहल है। इस यात्रा पर आगे बढ़ते हुए हमें याद रखना चाहिए कि अदयतित नियम-पुस्तिका केवल दिशानिर्देशों का संकलन मात्र नहीं है अपितु यह भारत के भविष्य की एक पथ-निर्देशिका भी है। यह हमारे नागरिकों से स्वच्छ, सुलभ और सतत जल का एक वचन है। यह एक विकसित राष्ट्र के निर्माण के प्रति हमारी प्रतिबदधता है जहां जल निर्बाध रूप से बहता है, और हर एक नल आशा की नई किरण लाता है। यह जनमानस के साहस और सामर्थ्य के प्रति कृतज्ञता है जो विपरीत परिस्थितियों में भी एक उज्जवल भविष्य के लिए प्रयासरत रहते हैं।

इस नियम-पुस्तिका के तीन प्रमुख भाग हैं। इसके भाग 'क' में इंजीनियरिंग, भाग 'ख' में संचालन और रखरखाव और भाग 'ग' में प्रबंधन को शामिल किया गया है।

इस नियम-पुस्तिका में जल आपूर्ति प्रणालियों के निर्माण और प्रबंधन की उन जटिलताओं पर गहराई से विचार किया गया है जो विविध प्रकार के क्षेत्रों में अपनाई और विकसित की जा सकती हैं। इसमें विभिन्न जल स्रोतों से जल संग्रहण के लिए नवीन कार्यनीतियाँ प्रस्तुत की गई हैं जो यह सुनिश्चित करती हैं कि संग्रहित किया गया यह जल उपभोग के उच्चतम गुणवत्ता मानकों को पूरा करता है। इसकी एक उल्लेखनीय विशेषता 'नल से पीयें जल' की सुविधायुक्त दबावयुक्त 24x7 जल आपूर्ति प्रणालियों पर ध्यान केंद्रित करना है। यह परिवर्तनकारी

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दृष्टिकोण, जिसे अक्सर कम करके आंका जाता है, लाखों लोगों के जीवन में क्रांति लाने की क्षमता रखता है। नल से सीधे स्वच्छ और सुरक्षित पेयजल की उपलब्धता एक सुविधा से कहीं अधिक बढ़कर है; यह जन स्वास्थ्य, महिला सशक्तिकरण और सामाजिक प्रगति की आधारशिला है। इसलिए इन प्रणालियों को लगन और विश्वास के साथ लागू करना हमारा दायित्व है।

'नल से पीयें जल' सुविधाओं के महत्व को रेखांकित करने के लिए, हमें उनकी प्रभावशीलता पर विचार करना चाहिए। घरों के भीतर स्वच्छ पानी की उपलब्धता का अर्थ है कि बच्चों की स्कूलों में अधिक उपस्थिति दर्ज होगी, महिलाएं आर्थिक गतिविधियों में सहभागी बन सकती हैं, और लोग दूषित जल से उत्पन्न होने वाली बीमारियों से चिंतामुक्त होकर खुशहाल जीवन जी सकते हैं। यह एक स्वस्थ और समदर्शी समाज के निर्माण की दिशा में एक ऐतिहासिक कदम है।

अमृत (अटल नवीकरण और शहरी परिवर्तन मिशन) और इसका अनुवर्ती मिशन अमृत 2.0 इस दृष्टिकोण को आगे बढ़ाने में महत्वपूर्ण भूमिका निभा रहा है। इस प्रकार की पहल, प्रत्येक नागरिक को बुनियादी सेवाएं प्रदान करने और शहरी परिदृश्य को बदलने की भारत सरकार की प्रतिबदधता को रेखांकित करती है।

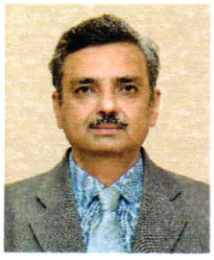
आइए ! हम सभी सार्वजनिक और निजी क्षेत्रों, विशेषज्ञों और नवप्रवर्तकों के साथ मिलकर इस नियम्-पुस्तिका को एक साकार परिवर्तन का रूप प्रदान करें। आइए ! हम ज्ञान, प्रौदयोगिकी और सामूहिक इच्छाशक्ति का भरपूर उपयोग करते हुए यह सुनिश्चित करें कि प्रत्येक भारतवासी 'नल से पीयें जल' से किसी भी स्थान या परिस्थिति में सहजता से पानी पीने का आनंद ले सके।

हम सभी साथ मिलकर एक ऐसे भविष्य का निर्माण कर सकते हैं जहां जल सिर्फ एक संसाधन नहीं बल्कि जीवन, समृदधि और सम्मान का प्रतीक हो।

(कौशल किशोर)

नई दिल्ली
27 अक्तूबर, 2023

मनोज जोशी
सचिव
Manoj Joshi
Secretary



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MESSAGE

India is a part of the global trend towards increasing urbanisation in which more than half of world's population is living in cities/towns. This phenomenon has been driven by factors such as industrialization, rural-to-urban migration, and economic opportunities in urban areas. Cities hold tremendous potential as engines of economic and social development. For Indian cities to become growth oriented and productive, it is essential to develop an excellent urban infrastructure by utilizing cutting-edge technology and sustainable infrastructure investments.

Water is an essential human requirement and lack of clean water has a significant influence on the health of urban people as well as the economic growth of urban areas. Therefore, it is utmost important to develop water supply infrastructure to ensure effective service delivery and sustainability.

To meet the aforesaid objective, Central Public Health and Environmental Engineering Organisation (CPHEEO), which is the technical wing of the Ministry has updated and revised the existing manual on Water Supply and Treatment as Manual of Water Supply and Treatment Systems (Drink from Tap) in three Parts – Part A-Engineering, Part B-Operation & Maintenance and Part C-Management to provide guidelines to Policy Makers, Public Health Engineers, Field Practitioners and other Stakeholders for planning, design, operation & maintenance and management of water supply systems with "Drink from Tap" facility to be taken up under various Central Missions like AMRUT 2.0 and State programs.

I would like to commend the untiring efforts of Dr. M. Dhinadhayalan, Adviser (PHEE), CPHEEO and Chariman of Expert Committee, Members of Expert Committee, AMRUT Division, Central Public Health & Environmental Engineering Organisation (CPHEEO) and the support extended by Deutsche Gesellschaftfür Internationale Zusammenarbeit (GIZ) GmbH, Germany, Government of Germany and WAPCOS study team, who were associated with the task of accomplishment of the manual for the benefit of water supply sector.

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GOVERNMENT OF INDIA
MINISTRY OF HOUSING AND URBAN AFFAIRS

FOREWORD

It is with immense pride and enthusiasm that I introduce the "Manual on Water Supply and Treatment Systems (Drink from Tap)" revised and updated by the Ministry of Housing and Urban Affairs. This comprehensive Manual stands as a testament to our unwavering commitment towards achieving Drink from Tap facility that will ensure efficient, sustainable, and accessible water supply for our growing urban communities.

Water, the essence of life, is a fundamental right of every individual. As our cities expand and population increases, the demand for this precious resource becomes more pressing than ever. In this context, a robust framework that encompasses every aspect of water supply and treatment is indispensable. This manual, divided into three crucial parts - Engineering, Operation & Maintenance, and Management - addresses these aspects comprehensively.

Part A: Engineering focuses on the foundation of any water supply system encompassing planning, design and implementation. By delving into detailed planning and design methodologies, technological innovations, and contemporary practices, this section equips professionals and field practitioners with the knowledge required to create efficient and resilient water supply infrastructure with decentralized approach using District Metered Areas (DMA) concept. The manual not only emphasizes conventional treatment technologies but also introduces cutting-edge technologies that have the potential to revolutionize water supply systems, ensuring sustainable service delivery and adaptability to changing urban landscapes.

Part B: Operation & Maintenance recognizes that the creation of a water supply system is only half the journey; efficient operation and vigilant maintenance are imperative to ensure its longevity. This section outlines best practices, procedures, and guidelines for maintaining the functionality of water supply systems. From routine upkeep to troubleshooting, the insights shared here will contribute to uninterrupted water supply services for urban residents by continuous monitoring and control of Non-Revenue Water (NRW) as well as monitoring and surveillance of drinking water quality using smart technologies.

Part C: Management acknowledges the multifaceted nature of water supply systems, necessitating a holistic managerial approach. By elucidating management practices, policy frameworks, and governance strategies, this section offers guidance to

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administrators and policy-makers. This part of the manual emphasised the need for Capacity Building, Asset Management and Public Private Partnership which are crucial for successful management of a Drink from Tap Water Supply System. Therefore, effective management ensures equitable distribution, financial sustainability, and the ability to adapt to dynamic urban requirements considering climate resilience.

In conclusion, the "Manual on Water Supply and Treatment Systems (Drink from Tap)" will serve as a beacon, illuminating a path towards an improved urban water management landscape.

I extend my gratitude to Dr. M. Dhinadhayalan, Adviser (PHEE), CPHEEO and Chariman of Expert Committee, Members of Expert Committee, Special invitees, CPHEEO Officials, GIZ and WAPCOS Study Team, who have contributed to this manual with the zeal to promote the practice of "Drink from Tap". It is my sincere hope that this resource becomes an indispensable companion for professionals and stakeholders engaged in the vital task of providing clean and accessible water to our urban communities.

Together, let us forge ahead in our mission to build sustainable, liveable and water secure cities, where the availability of safe water is never compromised.

(**D Thara**)

New Delhi

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सत्यमेव जयते

स्वच्छ भारत
एक कदम स्वच्छता की ओर

भारत सरकार
आवासन और शहरी कार्य मंत्रालय
निर्माण भवन
GOVERNMENT OF INDIA
MINISTRY OF HOUSING AND URBAN AFFAIRS
NIRMAN BHAWAN
नई दिल्ली-110011, तारीख 20
New Delhi-110011, dated the 20

PREFACE

Water security remains a pressing concern encompassing issues related to both quantity and quality. Contamination of surface water sources and depletion of groundwater reserves have become a significant challenge threatening long-term sustainability. Additionally, preventing contamination of drinking water from the distribution system to household underground storage sumps is a vital challenge to tackle for safeguarding public health. These challenges are crucial to address for ensuring the availability and quality of this essential resource.

The earlier Water Manual (1999) recommended that the water supply projects in urban areas shall be planned, designed and implemented to achieve 24x7 pressurised water supply system (PWSS). It also suggested to adopt residual pressure of 7m for the towns having single storey buildings, 12m for 2 storeyed buildings and 17m for 3 storeyed buildings and so on. But the Manual was grossly missing the concept of Operational Zones (OZs) and District Metered Areas (DMAs). Therefore, in the past, the Urban Local Bodies (ULBs) planned, designed and implemented water supply projects considering large size networks (large zones) without properly following the residual pressures as recommended in the earlier Manual. This led the system to shift to intermittent mode just after the commissioning of the project. At present, in almost all the towns, water supply is intermittent with a duration ranging from 2-6 hrs/day which results into contamination of water in the pipeline during non-supply hours, high Non-Revenue Water (NRW) and inequitable water supply. Due to intermittent water supply the cities are grappled with many Operation & Maintenance (O&M) and Management challenges.

Therefore, it is crucial to plan, design and implement projects by changing the conventional planning to a decentralized approach, establishing OZs and DMAs with a specific number of house service connections (HSCs), increased residual pressure and ensuring 100% metering to make the system self-sustainable. The renewed system will address the O&M and Management challenges which the systems are currently facing.

During O&M high level of NRW is an operational burden and thus monitoring and control of NRW is very crucial. Urban water service providers/utilities are unable to cover their

O&M costs due to high NRW which leads to revenue loss and increased operational costs. The constant need for repair and maintenance of aging infrastructure is essential to ensure its efficient and effective operation and maintenance of the system. Another foremost issue is lack of water quality monitoring and surveillance during O&M which is the key for sustaining the success of the project with Drink from Tap (DFT) and effective service delivery.

Urban water service providers are confronted by significant management issues due to lack of capacity and financial resources. Therefore, it is important to engage Public Private Partnership (PPP) for efficient implementation, O&M and Management of the 24x7 PWSS.

India's dream of becoming a developed nation hinges on overcoming these water-related challenges. Imagine a scenario where every household enjoys the privilege of continuous pressurised water supply with the assurance of safe drinking water directly from the tap which is the vision that drives Govt. of India initiatives like Atal Mission for Rejuvenation and Urban Transformation 2.0 (AMRUT 2.0). Achieving this vision is not just an aspiration but an imperative for a progressive, healthy and prosperous India.

Keeping in view the above the Ministry has revised the existing Manual with the focus on operationalizing the existing intermittent water supply systems to 24x7 PWSS with an objective to provide drink from tap and its ease of O&M and management. The Expert Committee constituted under the chairmanship of the undersigned with the Technical Support of GIZ in June 2020, has brought out 3 parts of the Manual to address the challenges in the planning, design, implementation, operation & maintenance and management of 24x7 PWSS.

Part A Manual (Engineering- Planning, Design and Implementation) addresses the consistent and secure supply of clean water and provides guidelines for planning, design and implementation of 24x7 water supply with Drink from Tap in urban areas based on operational zones & DMAs. It also provides guidelines for planning, design and implementation of Regional Water Supply System (RWSS) for both urban and rural areas. The prevention of contamination of water within distribution systems and household storage is emphasized along with the crucial transition from the existing intermittent water supply to 24x7 PWSS and achieving 100% metering for ensuring sustainability of 24x7 PWSS.

The Part B Manual (Operation and Maintenance) addresses challenges related to the operation and maintenance of 24x7 PWSS. It underscores the importance of maintaining aging infrastructure efficiently, offering guidance on strategies for constant repair and upkeep to extend operational life. Controlling Non- Revenue Water (NRW) through water audits and effective management is vital to reduce losses and enhance efficiency with guidance on water quality monitoring and surveillance is also included in Part B Manual.

Part C Manual (Management) emphasises the need for comprehensive reforms including legal framework, institutional strengthening, enhanced coordination, stakeholder engagement, PPP and investments in modern technology and infrastructure for emerging drink from tap projects. The need for a skilled and knowledgeable workforce to operate and maintain complex water supply systems is addressed. Financial sustainability is a key concern and provides strategies for managing finances to support effective management of water supply systems. An integrated approach is deemed crucial to ensure sustainable water services capable of meeting the growing demands of India's urban population and providing high-quality water supply particularly in the context of climate change.

We envision this revised Manual as a blueprint for the future of urban water supply and treatment systems in India. It represents our unwavering commitment to creating systems that are not only efficient but also resilient, sustainable and equitable. Our goal is clear to ensure that every urban dweller can turn on the tap and access safe, clean water without hesitation throughout day and night.

This comprehensive Manual is the outcome of tireless efforts, interdisciplinary expertise and a collective dedication to enhancing urban water supply and treatment systems across our great nation. It has been meticulously curated to encompass the ever-evolving landscape of water supply management, from cutting-edge technologies to best practices in governance and partnership models, placing us firmly on the path toward a future where every urban citizen enjoys equitable access to clean, safe and reliable drinking water.

The first Expert Committee meeting was held in March 2021. In the past two and a half years, eight (8) meetings of the Expert Committee and fourteen (14) meeting of Working Groups were held to finalize the draft of the Manual. The Expert Committee consulted with various stakeholders during National and Regional workshops on 24x7 PWSS during the preparatory phase of the Manual and also during the National Consultative Workshop on the draft Manual held on 12th & 13th June 2023 to get the feedback/ comments/ suggestions on the content. The Editorial Committee, constituted under the chairmanship of the undersigned, had twenty one (21) meetings between June and Oct, 2023 and deliberated and incorporated the feedbacks/ suggestions in the Manual.

I express my profound gratitude to the Ministry of Housing & Urban Affairs, Government of India for extending all support and encouragement in the revision of the Manual. I would like to express my deep gratitude to Shri Manoj Joshi, Secretary (HUA), Ministry of Housing and Urban Affairs, Government of India for his constant encouragement and lending never ending support to the team in the journey of revision of the Manual.

I would like to extend my heartfelt gratitude to Ms. D Thara, Additional Secretary & National Mission Director (AMRUT) for her inspiration, constant guidance and support without which it might not have been possible to complete this massive task of revising the Manual.

I am also privileged to express my sincere thanks to Ms. Roopa Mishra, Joint Secretary & National Mission Director (SBM), Ministry of Housing and Urban Affairs for her support in finalization of the Manual.

I would like to express my profound gratitude to GIZ for providing technical and financial support for the preparation of the Manual. My heartfelt gratitude to Shri Ernst Deoring, Former Cluster Coordinator, Shri Christian Kapfensteiner, Cluster Coordinator, Smt. Laura Sustersic, Project Director, Dr. Teresa Kerber, Project Director, Smt. Monika Bahl, Senior Advisor & Shri Rahul Sharma, Technical Advisor, GIZ for extending their support in the preparation of the Manual. They left no stone unturned to enrich the contents of the Manual by adopting participatory approach and inviting experts and all those who are working on the ground in the country as well as abroad. They flawlessly conducted all the meetings and looked after the comfort of all the members of the Committee and all those who participated in deliberations.

I also extend my gratitude to AFD for providing technical support in drafting a few chapters and to IPE Global for their contribution to enrich the Manual.

Three Working Groups were carved out of the Expert Committee to speed up the gigantic task of revision of the Manual. I would like to extend my special thanks to Dr. Sanjay Dahasahasra, Former Member Secretary, Maharashtra Jeevan Pradhikaran & Co-chairman of Working Group (Part A Manual), Dr. PN Ravindra, Former Chief Engineer, Bangalore Water Supply and Sewerage Board & Co-chairman of Working Group (Part B Manual) and Prof. V Srinivas Chary, Professor & Director of the Centre for Urban Governance, Environment, Energy and Infrastructure Development, Administrative Staff College of India (ASCI), Hyderabad & Co-chairman of Working Group (Part C Manual) for their continuous guidance, time, dedicated efforts and painstaking efforts in finalizing all three parts of the Manual and being instrumental at all stages in the journey of revision of the Manual.

I extend my heartfelt gratitude to the esteemed Members of the Expert Committee, the dedicated Editorial Committee and the invaluable Special Invitees for their selfless dedication and remarkable contributions to the Manual. Their collective expertise and diverse perspectives have significantly enriched the depth, accuracy and overall quality of the Manual. The Expert Committee's wealth of knowledge, the Editorial Committee's meticulous refinement and the specialized insights of the Special Invitees have played a pivotal role in shaping this resource into an invaluable and comprehensive guide.

I would like to extend my appreciation for Dr. Ramakant, Deputy Adviser (PHE) & Member Secretary of the Expert Committee, for his continuous support and untiring commitment towards completing the Manual. I would also like to extend my appreciation for Shri Vipin Kumar Patel and Smt. Chaitra Devoor, Assistant Advisers (PHE), CPHEEO & Member Coordinators of the Expert Committee for their restless and dedicated support in completing the assignment. I would also like to acknowledge my other colleagues from CPHEEO for extending their support.

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Together, let us chart a course towards a future where every urban dweller can turn on the tap and access safe, clean water without hesitation. Let us strive relentlessly to create water supply systems that are not just efficient but also resilient, sustainable and equitable. 24x7 PWSS with Drink from Tap is not just for sophistication but is a basic necessity.

(Dr. M. Dhinadhayalan)
Adviser (PHEE) &
Chairman of the Expert Committee

New Delhi
6th November 2023

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ABBREVIATIONS

ABBREVIATIONS AND SYMBOLS

ADB	Asian Development Bank
AE	Assistant Engineer
AI	Artificial Intelligence
AIIH&PH	All-India Institute of Hygiene and Public Health
ALFs	Area Level Federations
AMC	Aurangabad Municipal Corporation
AMRUT	Atal Mission for Rejuvenation and Urban Transformation
AR	Augmented Reality
ARR	Accounting Rate of Return
ASLB	Accounting Standard for Urban Local Bodies
BIS	Bureau of Indian Standards
BISON	Bangalore Information System on Networks
BOQ	Bill of Quantities
BSUP	Basic Services for the Urban Poor
BWSSB	Bangalore Water Supply and Sewerage Board
BWUE	Bureau of Water Use Efficiency
CAA	Constitutional Amendment Act
CAG	Comptroller and Auditor General of India
CAGR	Compound Annual Growth Rate
CAPEX	Capital Expenditure
CBUD	Capacity Building for Urban Development
CDP	City Development Plan
CEPT	Centre for Environment Planning and Technology
CGWA	Central Ground Water Authority
CGWB	Central Ground Water Board
CIP	Capital Improvement Plan
CIPFA	Chartered Institute of Public Finance and Accountancy
CIR	Capital Improvement Reserve
CIS	Costumer Information System
CMC	City Municipal Corporation
CMMS	Computerized Maintenance Management System
CMWSSB	Chennai Metropolitan Water Supply and Sewerage Board
CPA	Critical Path Analysis
CPCB	Central Pollution Control Board

CPHEEO	Central Public Health and Environmental Engineering Organisation
CPM	Critical Path Method
CRM	Customer Relationship Management
CSO	Central Statistical Officer
CSOs	Civil Society Organisations
CSP	City Sanitation Plan
DAS	Distributed Acoustic Sensing
DBB	Design Bid Build
DBFOT	Design Build Finance Operate and Transfer
DBO	Design Build Operate
DBR	Doing Business Report
DCF	Discounted Cash Flow
DEA	Department of External Affairs
DEAS	Double Entry Accrual-Based Accounting Systems
DJB	Delhi Jal Board
DMA	District Metered Area
DPR	Detailed Project Report
DSS	Decision Support Systems
DTS	Distributed Temperature Sensing
EBIT	Earnings Before Interest and Taxes
EE	Executive Engineer
EE	Environmental Engineering
EIA	Environmental Impact Assessment
EIRR	Equity Internal Rate of Return
EoDB	Ease of Doing Business
EPA	Environmental Protection Agency
EPC	Engineering, Procurement and Construction Contracts
ERP	Enterprise Resource Planning
FG SSC	Focus Group on Smart Sustainable Cities
FIRR	Financial Internal Rate of Return
FNPV	Financial Net Present Value
FV	Future Value
GIS	Geographic Information System
GoI	Government of India
GPF	General Provident Fund

H&UDD	Housing and Urban Development Department
HAM	Hybrid Annuity Model
HMWSSB	Hyderabad Metropolitan Water Supply and Sewerage Board
HRM	Human Resource Management
IA	Internal Audit
IBT	Increasing Block Tariff
ICIP	Infrastructure Capital Improvement Plan
ICT	Information and Communication Technology
IDFs	Infrastructure Debt Funds
IE	Independent Engineer
IEC	Information, Education and Communication
IFAC	International Federation of Accountants
IGR	Investible Grade Rating
IHSDP	Integrated Housing and Slum Development Programme
IoT	Internet of Things
IPC	Inter Personal Communication
IPCC	Intergovernmental Panel on Climate Change
IPHE	Institution of Public Health Engineers
IPIP	Initial Performance Improvement Project
IRR	Internal Rate of Return
ISO	International Organization for Standardization
IT	Information Technology
ITES	IT Enabled Services
ITU	International Telecommunication Union
IUWRM	Integrated Urban Water Resource Management
IUWSMP	Integrated Urban Water Supply and Management Plan
IVR	Interactive Voice Response
IWRM	Integrated Water Resources Management
IWWA	Indian Water Works Association
JE	Junior Engineer
JJM	Jal Jeevan Mission
JNNURM	Jawaharlal Nehru National Urban Renewal Mission
KL	Kilolitre
KPI	Key Performance Indicator
KUIDFC	Karnataka Urban Infrastructure Development and Finance Corporation

L/Cs	Letters of Credit
LAN	Local Area Network
LIBOR	London Interbank Offered Rate
LIMS	Laboratory Information Management System
LOA	Letter of Association
LPCD	Litres per Capita per Day
MEPH	Masters in Engineering Public Health
MIP	Management Indicator Panel
MIS	Management Information Systems
ML	Machine Learning
MLA	Member of Legislative Assembly
MLD	Million Litres Per Day
MoF	Ministry of Finance
MoHUA	Ministry of Housing and Urban Affairs
MoJS	Ministry of Jal Shakti
MoU	Memorandum of Understanding
MoUD	Ministry of Urban Development
MPoS	Mobile Point of Sale
MSPs	Managed Service Providers
MWRRA	Maharashtra Water Resources Regulatory Authority
MWSS	Metropolitan Waterworks and Sewerage System
NABARD	National Bank for Agriculture and Rural Development
NEERI	National Environmental Engineering Research Institute
NESL	Nagpur Environmental Services Pvt. Ltd
NGOs	Non-Governmental Organisations
NMC	Nagpur Municipal Corporation
NOC	No Objection Certificate
NPV	Net Present Value
NRSA	National Remote Sensing Agency
NRSC	National Remote Sensing Centre
NRW	Non-Revenue Water
NWP	National Water Policy
O&M	Operation and Maintenance
OBPS	Online Building Permission System
OCW	Orange City Water Private Limited

OD	Organisational Development
OECD	Organisation for Economic Co-operation and Development
OPEX	Operational Expenditure
PAN	Presence Across Nation
PBMC	Performance Based Management Contract
PDCA	Plan Do Check Act
PHE	Public Health Engineering
PHED	Public Health Engineering Department
PHEO	Public Health and Engineering Organisation
PI	Profitability Index
PIA	Project Implementing Agency
PIMS	Project Information Management Systems
PIs	Performance Indicators
PIU	Project Implementation Unit
PMU	Project Management Unit
PPPs	Public Private Partnerships
PPWSA	Phnom Penh Water Supply Authority
PSC	Public Sector Company
PSP	Public Service Provider
PUB	Public Utilities Board
PV	Present Value
PWD (WR)	Public Works Department (Water Resources)
RCUES	Regional Centre for Urban and Environmental Studies
RDBMS	Relational Database Management System
RFP	Request for Proposal
RFQ	Request for Quote
RTK	Real Time Kinematics
RWAs	Resident Welfare Associations
SAP	Systems Applications and Products
SBM	Swachh Bharat Mission
SCADA	Supervisory Control and Data Acquisition System
SCM	Smart City Mission
SDE	Spatial Database Engine
SDGs	Sustainable Development Goals
SEC	Singapore Environment Council

SHGs	Self Help Groups
SIA	Social Impact Assessment
SJPNL	Shimla Jal Prabandhan Nigam Limited
SLA	Service Level Agreements
SLB	Service Level Benchmarks
SMC	Surat Municipal Corporation
SMS	Short Message Service
SMU	Specialist Municipal Undertaking
SOPs	Standard Operating Procedures
SPEAR	Seamless System for Prediction and Earth System Research
SPU	Seattle Public Utilities
SPV	Special Purpose Vehicle
STP	Sewage Treatment Plants
SWM	Smart Water Management
SWOT	Strengths Weaknesses Opportunities Threats
SWRA	State Water Regulatory Authority
TERI	The Energy Research Institute
TNA	Training Needs Assessment
ToR	Terms of Reference
ToT	Training of Trainers
TWAD Board	Tamil Nadu Water Supply and Drainage Board
TWW	Treated Wastewater
UDD	Urban Development Department
UFW	Unaccounted for Water
UIDSSMT	Urban Infrastructure Development Scheme for Small and Medium Towns
UIG	Urban Infrastructure and Governance
ULB	Underwater Locator Beacon
ULBs	Urban Local Bodies
UPWM&RC	Uttar Pradesh Water Management and Regulatory Commission
VFM	Value For Money
VGF	Viability Gap Funding
WACC	Weighted Average Cost of Capital
WAN	Wide Area Network
WATCO	Water Corporation of Odisha

WIA	Water Industry Act
WPI	Wholesale Price Index
WSS	Water Supply and Sanitation
WTP	Water Treatment Plant

GLOSSARY

GLOSSARY

A

Annuity, a contract that requires to make payments, either immediately or in the future.as per agreed terms.

Appropriate Discount Rate, the real (i.e., not inflation adjusted) weighted average cost of capital (after taxes payable by the concession business)

Archaic, very old-fashioned design and/or old system

B

Biological Contamination, the presence of living organisms, such as parasites, bacteria, protozoan or viruses, also referred to as microbes or microbiological contaminants.

BOT, Build, operate and transfer, a type of contract that allows the contractor to build and operate a project for a mutually agreed period and then transfer back in working condition to the authority

C

Chemical Contamination, harmful chemicals can get in the water from many sources, including fertilizers, pesticides, or other chemicals that have been applied to land near the water.

Cognizance, Detailed perception, knowledge about or understanding of something

Covenants, a written deed or agreement or promise between two or more parties especially for the performance of agreed works with agreed penal provisions.

Cyanobacteria, bacteria capable of photosynthesis such as blue-green algae. It represents the earliest known form of life on the earth. They are ubiquitous in ponds, lakes, streams, rivers & wetlands.

D

Data Analytics, a science of analysing raw data to make conclusions about information

Delineated, portrayed precisely

E

EPC, engineering, procurement, construction - a type of contract where the payment is made pro-rata on completion of the engineering, procurement and construction stages

Escalation Matrix, a system that defines when escalation should happen and who should handle incidents at each escalation level.

Eutrophication, a gradual increase in the concentration of phosphorus, nitrogen, and other plant nutrients in an aging aquatic-ecosystem such as a lake causes eutrophication.

F

Fostering, encourage desirable development

Fragmented, disorganised, disunited

G

Geomorphology, study of the physical features of the surface of the earth and their relation to its geological structures

Glacial Retreat, process of a glacier shrinking or receding in size over time. This occurs when amount of ice melting or sublimating from the glacier exceeds the amount of snow or ice accumulation.

H

Hybrid Annuity Model, a model of annuity wherein 40% of the Capital cost quoted would be paid on completion of construction (called EPC-Annuity), while the remaining 60% of the cost will be paid over the life of the project as annuities along with operation and maintenance cost (O&M) expenses (called BOT-Annuity).

I

Impetus, something that makes a process or activity happen

Intergovernmental, relating to or conducted between two or more governments

L

Liquidity Ratio, is the ratio between the liquid assets and the liabilities of bank or an institution. It is financial metric which can determine a company's ability & capacity to fulfil the short-term loan commitments.

M

Macro-Economic, It is branch of economic that studies the behavior & performance of an economy as a whole

Marine Heatwaves, a period of unusually high ocean temperatures and is defined by its duration and intensity.

Multifaceted, having many aspects or sides

O

Operating Efficiencies, ability to reduce waste of time, effort and materials as much as possible, while still producing a high-quality service or product.

P

Paradigm, model or pattern or regime

Parastatal, refers to a government entity or agency that operates independently of the formal government structure, but is ultimately accountable to the government such as semi-autonomous, state-owned, quasi-governmental, public enterprise, government-owned corporation, and statutory corporation.

Pilferage, loss due to act of stealing or theft

PPP Model, A Public-Private Partnership (PPP) model is a partnership between the public sector and the private sector for the purpose of delivering a project or a service traditionally provided by the public sector.

R

Rejuvenation, restoration to its original or near original like structure

Ring Fence, It is virtual barrier that segregates a porter of an individual's or company's financial assets for the rest.

Risk Mitigation, removal or lessening the risks involved

Robust Tariff Policy, a sustainable tax policy to recover costs and revenue generation

S

Simulating, imitate the real on ground situation

SLBs, A hand book on Service level benchmarks have been issued by MoHUA which in urban water supply sector includes coverage of water supply connections, per capita supply of water, extent of metering of water connections, extent of non-revenue water, continuity of water supply, quality of water supplied, cost recovery in water supply services, efficiency in redressal of customer complaints, and efficiency in collection of water supply-related charges

Socioeconomic, economic activity that affects and is shaped by social processes

Stakeholder, anyone who can affect or be affected by the urban water service delivery

Solvency ratio, is a financial metric that measures a company's ability to meet its long-term debt obligations. It is calculated by dividing the company's total liabilities by its total assets.

Sub-optimal, less than optimal meaning lesser to highest standard or quality

T

Tangible Benefits, benefits that are quantifiable and measurable

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1. INTRODUCTION

Urban water service delivery is getting affected by water scarcity, water contamination, ageing or lacking infrastructure and climate change related issues (sea level rise, flooding, increased frequency and magnitude of extreme rainfall, heat waves, etc.). the current context calls for improved management and governance capacity in urban water service providers/utilities and these become even more important for accelerating the transition from intermittent water supply to 24×7 Pressurised Water Supply Systems (PWSSs) with Drink from Tap facility which is in line with Sustainable Development Goal – 6.

Urban water service providers/utilities must consider incorporating management practices to enable efficiencies in various service delivery domains pertaining to service quality, organisational development, financial viability, stakeholder engagement, infrastructure strategy and performance, operational optimisation, resilience and business continuity. In addition, urban water service providers/utilities must consider adopting management approaches including leadership and innovation, strategic business planning, knowledge management, measurement, and continual improvement management as a means to deliver quality, efficient and sustainable water services.

The overall objective of Part C of the Manual is to provide urban water supply service providers/managers with guidance, tools and resources in order to help them strengthen their operational and managerial capacities. In conjunction with the guidance contained in Part A and Part B, Part C is intended to facilitate urban water service providers/utilities to provide services in line with national norms as defined in the Service Level Benchmarks (SLB), which were notified by Ministry of Housing and Urban Affairs (MoHUA) in 2008. Part C also aims to make engineers/managers aware about innovative and cutting-edge management strategies and approaches relevant for the urban water sector. This manual also aims to sensitise engineers/managers of urban water service providers/utilities on the need for inclusion, equity, and customer focus in service delivery.

2. PRESENT SCENARIO IN MANAGEMENT OF URBAN WATER SECTOR

Urban water service providers/utilities are facing numerous challenges. Rapid urbanisation is causing an increased demand for water which coupled with depletion and/or pollution of local water sources is forcing cities to tap distant sources of water at high transmission costs. The water supply assets are usually not well maintained which is leading to contamination, huge water losses and hampering efficient and sustainable service delivery. Urban water service providers/utilities are unable to cover their Operation and Maintenance (O&M) costs due to high Non-Revenue Water which leads to lost revenues and increased operational costs. Urban water service providers/utilities are operating under severe human resource constraints with limited availability of skilled and experienced staff and many positions remaining vacant. These factors, along with climate variability, are creating unprecedented challenges for urban water service providers/utilities.

3. MAJOR CHALLENGES IN MANAGEMENT OF URBAN WATER SECTOR

Urban water service providers/utilities are facing the following challenges:

a) Fragmented and Inadequate institutional arrangements
b) Outdated legal and regulatory framework
c) Financial viability related challenges
d) Limited accountability, transparency and stakeholder engagement
e) Inadequate capacity and skills
f) Lack of Public-Private Partnerships (PPPs) in urban water sector

g) Inadequate infrastructure planning and asset management
h) Data Collection and Management Information Systems
i) Climate Change and Resilience

4. ADDRESSING THE MAJOR MANAGEMENT CHALLENGES

Several management challenges are impacting the planning, operation, and maintenance of urban water supply systems in Indian cities and towns. Addressing these challenges is crucial to ensure efficient and sustainable water supply to each and every urban resident. This Manual presents a detailed analysis of the major management challenges faced by the Indian urban water supply sector and outlines strategies to achieve a successful transformation.

a) Fragmented and Inadequate institutional arrangements: The responsibility for urban water supply service delivery is fragmented among various government departments and agencies at different levels, these include Urban Local Bodies, state water boards, and other state government departments (Public Health and Engineering Departments). Lack of coordination and clear division of roles among these agencies are resulting in inefficiencies in urban water service delivery.

To address this challenge, comprehensive reforms are needed, including development of appropriate legal frameworks, strengthening institutions involved in service delivery, improved coordination among various institutions for better management of water supply systems. As a first step in the process of institutional strengthening, it is suggested that urban water service providers/utilities, irrespective of their present institutional arrangements, should ring fence the water service function with dedicated staff and resources. The dynamic nature of the urban water supply services in the country makes it difficult to define a standard staff structure and thus a transitional approach which evolves with the growth in population and revenues is recommended.

Further, in order to ensure overall service delivery efficiencies, it is recommended that dedicated cells for GIS/design, NRW reduction and communication be institutionalized. A market-based services approach is recommended for engineering/ operations, technical support and other support services.

b) Outdated legal and regulatory framework: 'Public Health' is a state subject and thus state governments are responsible for legislating on this subject. While state governments have been vested with the constitutional mandate of providing water supply services in both urban and rural areas (Seventh Schedule, Article 256, Constitution of India, List II – State List), with the enactment of the 74th Constitutional Amendment Act, 1992 (74th CAA), the mandate for provision of water supply services in urban areas has been devolved to Urban Local Bodies (ULBs).

The Central government continues to play a major role in the sector. States need to be encouraged to adopt public health laws. In order to ensure uniform public health legislation across states, the central government has facilitated drafting of three Public Health Acts, namely, Model Public Health Bill (1987); the National Public Health Bill (2002); and the National Health Bill (2009). However, only eight states have a public health law/draft in place.

Regulation of the water sector is often weak, leading to non-compliance, unauthorized connections, and illegal water use. Effective regulation and enforcement mechanisms are essential to ensure adherence to standards and to promote responsible water use. Provision of 24×7 PWSS with Drink from Tap facility and creation of "water secure" cities require a paradigm shift in urban water service delivery which involves moving away from the "state-centered" model towards a "market-centered" approach. An independent regulatory authority is important to ensure equitable distribution of water resources among

various uses, quality of service delivery which meets the requirements of the SLBs and protection of the interests of the consumers and other stakeholders. The focus of regulation in the urban water sector must be on tariff setting, service quality, and consumer protection.

c) **Financial viability related challenges**: Most urban water service providers/utilities face financial challenges due to high non-revenue water, unrealistic tariffs, low tariff collection rate, and inadequate cost recovery. Robust financial management practices are crucial to ensure efficiencies in urban water service utilities. The fixation of water tariff is of utmost importance for ensuring financial sustainability of an urban water service provider in the short, medium and long term. Water tariff must have a fixed component which would be same for all user categories and a marginal cost of consumption which will vary according to different category of consumers. In addition, urban water service providers must also transition from a cash-based accounting system to an accrual-based accounting system.

d) **Limited accountability, transparency and stakeholder engagement**: Transparency and accountability in the urban water sector to stakeholders is often lacking, making it difficult for citizens to understand water service provision related details, tariff structures, and investment decisions. Improved transparency and accountability mechanisms are necessary to build public trust and ensure efficient resource allocation. Further, meaningful participation of various stakeholders in decision-making processes related to water supply management is also often lacking. Engaging all key stakeholders can lead to better understanding of local needs and concerns and foster a sense of ownership among consumers.

   Urban water service providers/utilities must engage with all stakeholders in order to ensure that consumer questions and concerns regarding new projects are addressed, and that various stakeholders support reform agenda, to ensure speedy and smooth implementation of programs and to ensure behaviour change among consumers which in turn can result in reduction of water use and promotion of water conservation.

e) **Inadequate capacity and skills:** A shortage of skilled professionals and technical expertise in urban water service providers/utilities poses challenges in planning, operation, and maintenance of water supply systems. Building institutional capacity and investing in workforce development are crucial to improve overall water governance for achieving 24x7 pressurised water supply system with Drink from Tap and its effective Operation & Maintenance.

f) **Lack of Public-Private Partnerships (PPPs) in urban water sector:** The implementation of PPPs in the water sector has been met with mixed results in India. Balancing private sector efficiency with public interest, equitable access, and affordability remains a challenge. There is merit in leveraging the investments and expertise which exists with the private sector, however, such partnerships need to be structured well.

   In the context of moving towards 24×7 PWSS with Drink from Tap facility, urban water service providers/utilities are encouraged to explore various types of Public Private Partnerships (PPPs) to leverage the investments and expertise which exists with the private sector. Chapter 8: Public-Private Partnership at 8.4 outlines decision making steps to achieve 24×7 water supply through PPP. Risk Management, the allocation of risk between the public sector agency and the private player and mechanisms to mitigate these risks, is a critical aspect to be considered. Considering past experience in urban water supply PPP projects, and due to the limited capacity of the public service provider to carry out complex PPP projects for the entire city at one go, a two-stage approach has been suggested for any upcoming 24×7 water supply projects to be developed on PPP basis, namely, stage 1 – Pilot zone 24×7 PWSS based on a performance based management contract covering key performance indicators and stage 2 – scale up to the

city level 24×7 PWSS.

g) **Inadequate infrastructure planning and asset management**: Lack of comprehensive infrastructure planning and asset management leads to suboptimal investments, inefficient resource allocation, and difficulties in maintaining and upgrading water infrastructure. Good asset management is of crucial importance in an urban water service provider/utility to ensure good quality and efficient service delivery without compromising the financial health and efficiency of the organization. Asset management can help urban water service providers/utilities move from crisis management (repair when it breaks down) to informed decision making. Urban water service providers/utilities should prepare an asset management plan along with adopting asset management strategies including decision-making techniques, operational strategies and plans, maintenance strategies and plans, capital works strategies, and financial and funding strategies.

h) **Data Collection and Management Information Systems:** Accurate data/information collection, analysis, and management are essential for informed decision-making. However, most urban water service providers/utilities lack robust data collection systems and data-driven management information systems and reporting practices which impede decision making.

   A robust Management Information System (MIS) is crucial for urban water service providers/utilities as it enables access to accurate, timely, sufficient, and relevant information to the management for effective decision-making. Development and improving MIS is an ongoing process, as organizations take advantage of new technologies and methodologies. Urban water service providers/utilities must consider adoption of Smart Water Management (SWM) innovations which promote sustainable consumption of water resources through a coordination of water management capacities and ICT especially IoT technologies, solutions and systems. Urban water service providers/utilities must also institutionalise mechanisms for cyber security which can enhance the integrity, confidentiality, and availability of the MIS and ensure protection of critical information assets.

i) **Climate Change and Resilience**: Climate change impacts on water availability and extreme weather events pose significant challenges to urban water supply management. Building climate resilience and incorporating climate adaptation measures in water planning are crucial. Urban water service providers/ utilities need to adapt their operations and institutional arrangements to address the challenges posed by climate change. To emphasize that a holistic approach needs to be adopted for building resilience against climate change and this should include capital, socio economic, institutional and operational measures. In addition, urban water service providers also need to integrate disaster management practices to build resilience of the water supply system to cater disasters and unexpected events.

5. COMPOSITION OF CHAPTERS

Chapter 1: Introduction is aimed at introducing the term “management” in an urban service provider context. The chapter outlines the key attributes of an effectively managed urban water service provider/utility and the management approaches that need to be adopted by urban water service providers/utilities to ensure effective management.

Chapter 2: Legal and institutional framework outlines the existing legal and institutional framework for the urban sector in India. Specifically, the chapter presents the roles of the central, state and local governments in the urban water sector. The chapter also presents recent policies, advisories, investment programs as well as data and information initiatives in the sector. It also discusses the need for regulation in the urban water sector.

Chapter 3: Institutional Strengthening and Capacity Building presents strategies for strengthening the institutional and staffing structures for urban water service providers/utilities. The chapter recommends a transitional approach to institutional strengthening and staffing which develops over time linked to growth in population and revenues. The chapter also recommends setting up of dedicated cells to focus on certain technical areas. The chapter also provides guidance on capacity building and details out how to scope trainings develop a Human Resource Development (HRD) plan and training calendar.

Chapter 4: Financial Management outlines the strategies for ensuring financial sustainability of the urban water service providers /utilities in the short, medium and long term. In addition, the chapter also makes a case for the accrual-based accounting system and recommends that urban water service providers make a shift from cash-based systems to accrual-based systems.

Chapter 5: Stakeholder Engagement defines the term “stakeholders” in an urban water service provider/utility context and identifies the various stakeholders that urban water service providers must consider engaging with. The chapter also outlines the steps for engaging with various stakeholders and the engagement tools segmented by type of stakeholder.

Chapter 6: Asset Management defines the term “asset management” and explains the need for robust asset management in an urban water service provider/utility context. The chapter outlines steps for implementing an effective asset management plan. The chapter also presents asset management strategies which urban water service providers/utilities should consider adopting, including decision-making techniques, operational strategies and plans, maintenance strategies and plans, capital works strategies, and financial and funding strategies. It also includes two case studies – Barwon Water (reference of place) and Bangalore Water Supply and Sewerage Board (BWSSB).

Chapter 7: Management Information System (MIS) outlines the need for a robust MIS, its characteristics and functions. It also outlines the details for am MIS in an urban water supply network. The chapter also presents the recommended design for an MIS in an urban water service provider context. The chapter also includes the following case studies – Surat Municipal Corporation and Chennai Metropolitan Water Supply and Sewerage Board (CMWSSB).

Chapter 8: Public Private Partnerships outlines the need for PPPs and presents a definition of the same. It also talks about the myths and misconceptions regarding 24x7 PWS PPPs. The chapter also lists out the decision-making steps to achieve 24x7 water supply through PPP. The chapter also has a section on risk management – including how to identify various risks and how to develop risk mitigation strategies. The chapter recommends a two-stage approach for any upcoming 24X7 water supply project to be developed on PPP basis, namely, stage 1 – Pilot zone and stage 2 – scale up to the city level.

Chapter 9: Building Resilience to Climate Change and Disaster Management starts with an introductory section on how climate change is a challenge for urban water service providers/utilities and the impacts of climate change on water services in India. The chapter also outlines the strategies for building resilience to climate change / variability. The chapter also includes a framework for building a climate resilience plan. A sub section details out the climate change related planning in India. The chapter includes the guidance related to disaster management which is a part of the Indian Standard (IS 17482:2020), *Drinking Water Supply Management System — Requirements for Piped Drinking Water Supply Service*. The chapter includes experiences of urban water service providers/utilities in addressing climate change including case study of Zero Day study of Cape Town, South Africa.

CHAPTERS

CHAPTER 1: INTRODUCTION

1.1. Present Challenges being faced by Urban Water Service Providers/Utilities and need for a Management Approach

Urban water service providers/utilities are facing numerous challenges, including the following:

Rapid increase in population of Urban Centres: In 2011, India's urban population was 377.16 million, which rose to 461 million in 2018 (as per United Nation's World Urbanisation Prospects – 2018 revisions). It is estimated that much of the population increase between 2018 and 2050 will take place in urban areas and the country's urban population will double to 877 million by 2050. This extraordinary scale of urban population growth poses a huge challenge with respect to provision of water supply services. The rapid increase in urban population requires tapping of new water sources and enhancement of existing ones to meet the ever-increasing demand. Further, as cities expand geographically there is also a need to undertake expansion of the water supply network to cover newly included areas.

Limited water resources and increasing demand are pushing cities to tap distant sources of water: While fresh water sources are finite, the demand from different uses (domestic, agricultural, industrial, etc.) is increasing. The increasing demand for water coupled with depletion and/or pollution of local sources of water is forcing cities to tap distant sources which, in turn, is resulting in higher transmission losses and increasing cost of water.

Archaic water supply infrastructure: Lack of periodic maintenance and rehabilitation of urban water supply infrastructure is not only reducing its operational life but also disproportionately increasing maintenance costs. Urban water service providers/utilities continue to operate poorly maintained assets much beyond their designed utility period/life. This leads to loss of scarcely available water from the existing distribution system and hampers sustainable service delivery. The non- revenue water (NRW) level is quite high in Indian cities with huge volumes of treated water being lost during transmission and distribution.

Management, financial and governance constraints: Urban water service providers/utilities are operating under severe human and financial resource constraints. There is limited availability of skilled, experienced staff and many positions remain vacant. Urban water service providers/utilities are unable to cover their operation and maintenance (O&M) costs due to high NRW, which leads to lost revenues and increased operational costs. Further, the absence of political will for implementation of reform agenda, lack of engagement with consumers, limited focus on inclusion is resulting in sub optimal service delivery.

These factors, along with climate variability, are creating unprecedented challenges for urban water service providers/utilities. Combined impacts of sea level rise, river flooding, increased frequency and magnitude of extreme rainfall, heatwaves, water scarcity, water pollution, ageing or lacking infrastructure calls for improved management and governance capacity in urban water service providers/utilities and these are of crucial importance in order to accelerate the transition to 24×7 Pressurised Water Supply System (24×7 PWSS).

In this context, it becomes important for all urban water service providers/utilities to adopt management approaches that will enable them to organise their resources and activities in order to ensure excellence, equity and sustainability in service delivery and, also make them resilient to future challenges and shocks.

While every urban water service provider/utility must adopt management approaches suitable for its unique set of opportunities and challenges which will be based on their respective contexts, there are certain common approaches and tools that can help urban water service providers/utilities ensure effective service delivery and build resilience to future challenges.

1.2. Objective of the Manual

This manual is intended to provide engineers/managers of urban water service providers/utilities with guidance, tools and resources required for strengthening their operational and managerial capacities. In conjunction with the guidance contained in Part A and Part B, Part C is intended to facilitate urban water service providers/utilities to provide services in line with national norms as defined in the Service Level Benchmarks (SLBs), which were notified by Ministry of Housing and Urban Affairs (MoHUA) in 2008, pertaining to coverage, quantity, quality, reliability, sustainability, and cost recovery of water services.

This manual provides information on existing legal framework, institutional arrangements, and key initiatives (policies and advisories, programmes/schemes, and data/information management initiatives) in the urban water sector in the country. It also aims to make engineers/managers aware about innovative and cutting-edge management strategies and approaches relevant for the urban water sector. It provides guidance on themes including institutional strengthening and capacity building, financial planning and accounting, asset management, Management Information Systems (MIS), Public-Private Partnerships (PPPs), resilience building and contingency planning which are crucial for strengthening urban water service delivery. This manual also aims to sensitise engineers/managers of urban water service providers/utilities on the need for inclusion, equity, and customer focus in service delivery.

1.3. "Management" in an Urban Service Provider/Utility Context

The term **management** refers to the process of planning and organisation of resources and activities of an entity/organisation to achieve its goals in the most effective and efficient manner possible. Efficiency is described as the ability of the entity/organisation to undertake its roles and activities properly at minimal costs while effectiveness is defined as the completion of tasks within prescribed timelines to yield tangible results.

Effective management would help urban water service providers/utilities ensure efficient and effective service delivery that is, ensuring that good quality (Drink from Tap) water supply is available to all consumers (domestic, commercial, industrial, and institutional) as per prescribed timelines and at minimum costs.

1.3.1. Key Attributes of an Effectively Managed Urban Water Service Provider/Utility

There are seven key attributes of an effectively managed urban water service provider/utility, which cover various service delivery domains including, operations, infrastructure, stakeholders (including consumers), service quality and financial performance (Figure 1.1).

1. **Service Quality:** The urban water service providers/utilities must ensure "fit for purpose" (well-suited) water supply which meets the existing requirements under the BIS Drinking water specification IS 10500:2012; Second Amendment and Government of India's (GoI's) SLBs which were notified by MoHUA in 2008, along with being consistent with consumer, public health, ecological, and economic needs.

2. **Organisational Development**: The urban water service provider/utility must recruit and retain a workforce that is competent, trained, and motivated. Urban water service providers/utilities must work towards creating a participatory, collaborative work culture dedicated to continual learning, improvement, and innovation. They must also work towards application of organisational development (OD) approaches in order to create an open, diverse, inclusive and equitable work environment. The urban water service providers/utilities must invest in regular and periodic opportunities for professional development and career enhancement of its employees through training, capacity building, exposure visits, etc. Such opportunities must take into cognisance the differing needs and expectations of all genders and age groups that comprise the workforce. Along with capacity building inputs on technical aspects, there is also a need to sensitise officials on soft skills such as customer orientation, social equity, stakeholder engagement, etc. The details of human resource and OD, staffing and capacity building approaches that can be adopted by urban service providers/utilities are outlined in section 3.2 of Chapter 3: Institutional Strengthening and Capacity Building.

3. **Financial Viability:** The urban water service provider/utility must plan for the full life cycle cost of its operations. They should maintain an effective balance between long-term debt, asset values, O&M expenditures, and operating revenues. Further, the urban water service provider/utility must put in place user charges that are (a) consistent with community expectations and acceptability, taking into account affordability and the needs of disadvantaged/marginalised households and (b) adequate to recover costs (recovering O&M costs in the short term and capital costs in the long term). The urban water service provider/utility must also institutionalise robust systems for billing and collection of payments. They must also leverage opportunities available to diversify revenues and raise capital through adoption of new business models. Financial planning is critical for ensuring operational and financial viability and financial management approaches and tools are outlined in section 4.1 of Chapter 4: Financial Management of Water Utilities. In addition, involvement of the private sector can help not only in leveraging financial resources but also in achieving service excellence. The merits of involving the private sector to achieve 24×7 PWSS along with learnings from engaging with the private sector in urban water sector are presented in Chapter 8: Public - Private Partnership.

4. **Stakeholder Engagement:** The urban water service provider/utility must engender understanding and support from all stakeholders (the term “stakeholder” has been defined as anyone who can affect or be affected by the urban water service delivery), including consumers (domestic, commercial, industrial, and institutional), Resident Welfare Associations (RWAs), Civil Society Organisations (CSOs), Non-Governmental Organisations (NGOs), elected representatives, regulatory authorities, etc. The service provider/utility must actively engage with all stakeholders in order to understand their needs, to consult/apprise those regarding decisions that may affect them and to raise awareness and prompt behaviour change. The urban water service provider/utility must remain committed to delivering reliable, responsive, and affordable services in line with GoI’s SLBs. In order to understand and respond to consumer needs and expectations the urban water service provider/utility must utilise innovative communication methodologies and tools. The service provider/utility must also institutionalise robust systems for consumer grievance redressal, consumer feedback and mechanisms for communication with stakeholders during emergencies. Details on mapping relevant stakeholders and how to engage with them is presented in section 5.3 of Chapter 5: Stakeholder Engagement.

5. **Infrastructure Strategy and Performance:** The urban water service provider/utility must conduct detailed assessments related to the condition of and costs associated with critical infrastructure assets. It must plan infrastructure investments consistent with community needs and priorities, anticipated growth, and system reliability goals. The infrastructure investments must factor in adaptation strategies to account for climate change/variability, disasters, emergencies, etc. The urban water service provider/utility must maintain the condition of all assets over the long-term at the lowest possible life cycle cost and acceptable risk. In addition, the urban water service provider/utility must also ensure that asset repair, rehabilitation, and replacement efforts are coordinated with the community in order to minimize disruptions and other negative consequences. Section 6.6 of Chapter 6: Asset Management explains the asset management strategies in an urban water supply context.

6. **Operational Optimisation:** The urban water service provider/utility must ensure ongoing, timely, cost-effective, reliable, and sustainable performance improvements in all facets of its operations so as to improve public health status and protection of the environment. The urban water service provider/utility must also undertake performance monitoring making use of automated and Information Technology (IT) enabled “smart” systems. Data and information gathered from such monitoring systems must be used to guide performance improvement action. The service provider/utility must strive to minimise resource use, loss, all forms of waste and any other impacts from day-to-day operations. Details on development of an MIS have been presented in section 7.4 of Chapter 7: Management Information System (MIS).

7. **Resilience and Business Continuity:** The urban water service provider/utility must effectively anticipate, respond to, and avoid risks/problems. It must work towards proactively identifying, assessing, establishing tolerance levels for, and managing a full range of risks (including interdependencies with other services, legal, regulatory, financial, environmental, safety, physical and cyber security, knowledge loss, talent, and disaster related risks). It must also plan for service/business continuity in the face of any natural or human-made disasters and/or emergencies. Climate change and variability is a real threat for the urban water service providers/utilities as it is likely to affect the sources of water on which the entire operations depend. Urban water service providers/utilities need to accept climate change and climate variability as immediate threats and must start working towards building its resilience to address and mitigate such threats. Details on how urban water service providers/utilities can assess the risks arising out of climate change/variability and how they can make the systems resilient to such exogenous shocks are presented in section 9.1 of Chapter 9: Building Resilience for Climate Change and Disaster Management.

The urban water service managers can fill the checklist attached as **Annexure 1.1** to assess their current status with respect to the seven attributes mentioned above.

Figure 1.1: Attributes of an Effectively Managed Service Provider/Utility and Key Management Approaches

1.4. Management Approaches for Creating Effectively Managed Urban Water Service Providers/Utilities

Global experience has demonstrated that the following approaches have helped ensure effective management of urban water service providers/utilities by providing a supportive context for working towards service excellence, equity, and sustainability.

1. **Leadership and innovation:** Leadership is critical to effective organisational management, particularly in the context of leading and inspiring change within an organisation and its surrounding community. The term "Leadership", in this context, refers both to individuals who can be effective champions for improvement, and to teams that provide resilient, day-to-day management continuity and direction. Leaders have an important responsibility to engage proactively with all stakeholders, to promote the organisation as a valued, competent, and trustworthy community asset, and to collaborate with external partners. Leaders must ensure that there are enough opportunities to incorporate both technical and managerial innovations. The experience from Odisha where the Secretary, Housing and Urban Development Department (H&UDD), Government of Odisha has spearheaded the initiative towards 24×7 Drink from Tap PWSS in Puri and other Urban Local Bodies (ULBs) demonstrates how leaders can bring about systemic changes through innovative approaches and help achieve results that may not seem possible at first. Odisha has demonstrated smooth and speedy implementation of many innovative interventions related to housing, water supply, slum upgradation, etc.

2. **Strategic business planning**: Urban water service providers/utilities must have a business plan which can serve as an analytical framework for decision making. A business planning exercise will allow an urban water service provider/utility to (a) assess current conditions and conduct a Strength, Weaknesses, Opportunities, and Threats (SWOT) analysis; (b) characterise a continuum of possible and likely future conditions and their underlying causes and effects; and (c) establish vision, mission, objectives, strategies, along with their underlying organisational values. A business plan must be dynamic and adaptable, allowing the urban water service provider/utility to capitalise on new and emerging opportunities and it must be prepared through a consultative process engaging internal and external stakeholders so that it adequately reflects community values, needs, and interests. The business plan must also incorporate specific implementation steps that will allow the urban water service provider/utility to move from its current level of performance to achieving the national SLBs. The business plan should drive and guide utility objectives, measurement efforts, investments, as well as its operations. After developing a business plan, it is important that the urban water service provider/utility integrates tracking of progress and clear accountability mechanisms into its management framework and revisits the plan on a regular basis.

3. **Knowledge Management:** Knowledge management, another cornerstone of effective urban water service provider/utility management, is critical to ensuring reliable service delivery. Knowledge management must span Standard Operating Procedures (SoPs), Human Resource Management (HRM), OD business and operating systems, and data integration and utilisation. By ensuring that processes are well documented, SoPs regularly updated and creating shared knowledge among various employee categories, an urban water service provider/utility will be able to respond effectively to the inevitable knowledge loss resulting from employee turnover or unexpected absences. An effective knowledge management system should be flexible and open to the use of new and evolving technologies.

4. **Measurement**: Measurement is critical to management improvement efforts associated with the seven attributes mentioned in Section 1.3.1 and is the backbone of successful continual improvement management and strategic business planning. An urban water service provider/utility must measure its performance on the service delivery indicators outlined in the SLBs. Measurement must be planned as a continuum starting with basic internal tracking and moving to more sophisticated baselining and trend analysis. Further, the service provider/utility must ensure that the results are evaluated, communicated (internally and externally), and addressed in a timely manner.

5. **Continual Improvement Management:** Continual improvement plays a central role in effective urban water service provider/utility management and is crucial to making progress on the attributes outlined in Section 1.3.1. Continual improvement management includes (a) conducting a comprehensive self- assessment, with staff engagement, identify management strengths, areas for improvement, priority needs, etc.; (b) conducting consultations with key stakeholders to identify improvement opportunities; (c) following up on improvement projects underway; (d) establishing and implementing performance measures and specific internal targets associated with those measures; (e) defining and implementing related operational requirements, practices, and procedures; (f) defining supporting roles and responsibilities to derive clear accountability for conducting assessments and implementing performance improvements; (g) implementing

measurement activities such as regular evaluation through operational and procedural audits; and (h) responding to evaluations through the use of an explicit change management process. Continual improvement management is further supported by gap analysis, establishment of SoPs, internal trend analysis and external benchmarking where appropriate, best practice review and adoption, and other continual improvement tools. It can be used as a framework to help utilities understand improvement opportunities and establish explicit service levels, guide operational decisions, form the basis for ongoing measurement, and provide the ability to communicate clearly with customers and key stakeholders.

1.5. Case Studies

1.5.1. Hyderabad Metropolitan Water Supply and Sewerage Board

Following an organisational review which was undertaken by a team comprising of research staff from the Regional Centre for Urban and Environmental Studies (RCUES) Osmania University, Chief Engineers (O&M and Projects), Director (Finance) and a select group of senior personnel from all the functions, an organisational reform initiative was implemented at the Hyderabad Metropolitan Water Supply and Sewerage Board (HMWSSB) which included the following elements:

- The organisational structure, reporting relationships, function interface, identification of function redundancy and creation or extension of new functions/jobs or work areas was undertaken.
- A new job nomenclature reflecting the transition of a uni-functional engineer to multi-functional managers spanning the entire organisation was implemented.
- The job descriptions for various levels of personnel and function classification were revised to match the level of responsibility, authority, and accountability of each position.
- Documentation of gaps or deficiencies in knowledge and skills for implementation of the corporate plan was prepared.
- Formulation of service conditions and regulations including procedures for implementation of the new charter. This included introduction of an "instant sanction" scheme where powers for sanctioning water and sewerage connections were delegated to the lowest supervisory level.

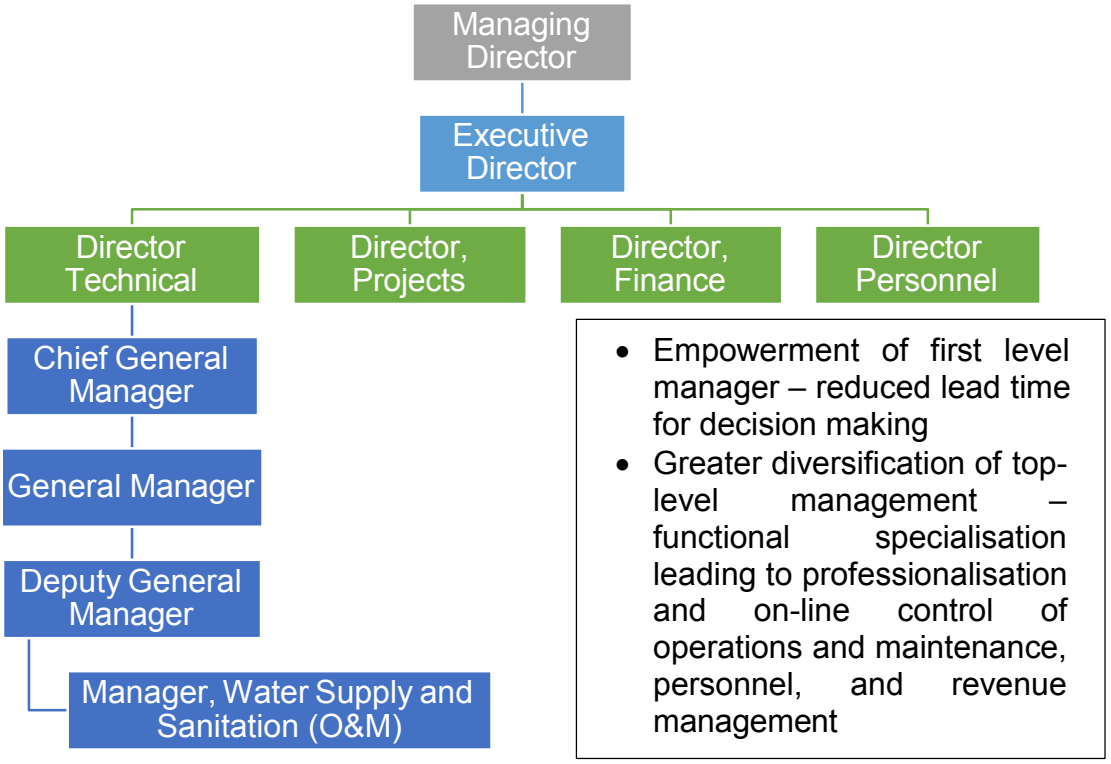


Figure 1.2: Revised Organisational structure of HMWSSB

1.5.2. Phnom Penh Water Supply Authority, Cambodia

Cambodia's **Phnom Penh Water Supply Authority (PPWSA)** transformed a war- ravaged water utility into a model that stands for other cities to emulate. Since 1993 with a long series of transformations that started within PPWSA's top management, based on a culture of change and donor support, led to a significant turnaround. Over two decades, PPWSA went through major changes that resulted in the water utility transforming into a successful water service provider in the region.

Political support for the reform process came with the country's Hon'ble Prime Minister giving full support. The top management was restructured, and dynamic younger personnel with higher and more suitable qualifications were promoted to senior posts with additional responsibilities. The water authority was granted autonomous status with independent management. The factors that contributed to this turnaround included investing in staff and providing incentives, promoting transparency, involving civil society, and investing in modern management procedures and technology.

Other improvements included establishing a consumer database, reducing NRW to less than 6%, improving collections, metering all of the utility's water supply coverage, and introducing 24×7 PWSS. Operations were also made more efficient by overhauling old infrastructure and streamlining the billing process. Because of these reforms, the PPWSA has widened its distribution network from serving 40% of the population in 1993 to universal coverage with clean, affordable water.

The poor living in slums were allowed to pay in instalments within 10 to 20 months during which interest is charged. There is a 30% subsidy for the poor which was cross- subsidised. The strategy

of cost recovery was also successful in reinforcing autonomy. The successful implementation of the strategy led to less reliance on the government than anticipated on tariff increases. This reduced the price obstacles for the poor to manageable proportions.

Lessons learned:

- The PPWSA has shown that it is possible for reforms to become successful if the governance framework is supportive and public utilities can make profits or at least break-even, with affordable tariffs and timely supply of water. It needs to be recognised that the reform does not happen overnight, the changes in institutional arrangements and management practices took over two decades.
- The success of PPWSA is a result of several factors including a General Director with vision and leadership to push through a culture of change, a desire for change at the local political stakeholder level, sufficient autonomy to be able to implement reforms as well as donor backing and shared objectives between line ministries, employees, and donors.
- This case illustrates that a public sector utility can implement a management approach more akin to that of a private sector company based on results and incentives.
- Risks which were identified during the transformation included the financial viability of PPWSA, the security situation within the country, and government's inability to carry out reforms. The ability to mitigate these risks based on the factors changes on different aspects such as annual reviews of tariffs, programme to finance the cost of connections for the poor and allowing for flexibility in policy formulation and institutional proposal proved successful.

1.6. Contents of the Manual

The manual is organised into nine chapters. While Chapter 1 defines management and introduces management attributes and strategies in an urban water service provider/utility context, Chapter 2 provides a background on the urban water sector in India. Chapters 3 to 9 provide guidance and tools on how to build management and operational capacities and develop attributes of efficient urban water service providers/utilities as defined in Section 1.3.1.

CHAPTER 2: LEGAL AND INSTITUTIONAL FRAMEWORK

2.1 Legal Framework

State governments have been vested with the constitutional mandate of providing water supply services in both urban and rural areas (Seventh Schedule, Article 256, Constitution of India, List II – State List). However, with the enactment of the 74th Constitutional Amendment Act, 1992 (74th CAA), the mandate for provision of water supply services in urban areas has been devolved to Urban Local Bodies (ULBs).

The actual devolution of functions and financial resources to ULBs has been slow and uneven across states. ULBs continue to face legislative and administrative constraints. Shortages in human resources often results in poor planning of infrastructure and tardy implementation of projects which in turns leads to inadequate and inefficient service delivery. Despite decentralisation, ULBs remain dependent on capital subsidies and sometimes even operating costs, from state governments. The situation is especially complicated in smaller ULBs where connected parastatal and state authorities are involved in service delivery as compared to mega cities and large ULBs who have operational independence and encouraging financial support from various sources to manage service and infrastructure levels.

Despite water supply and sanitation being designated as municipal responsibilities following the enactment of the 74th CAA, all tiers of the government continue to have a role to play in the urban water service delivery. Sections 2.1.1 and 2.1.2 outlines the role of Central and State governments, respectively.

2.1.1 Central Government

2.1.1.1 Ministries, Departments, and Other Institutions Involved in Urban Water Sector

Ministry of Housing and Urban Affairs (MoHUA) plays a significant role in the urban water sector by setting the overall policy framework and guidelines along with designing and implementing missions, programmes, and schemes aimed at improving urban water supply infrastructure and promoting sustainable service delivery. MoHUA is responsible for the implementation of missions such as Atal Mission for Rejuvenation and Urban Transformation (AMRUT) 2.0 and Smart Cities Mission (SCM) among others.

The **Department of Water Resources, River Development and Ganga Rejuvenation, Ministry of Jal Shakti (MoJS)** is responsible for laying down policy guidelines and programmes for the development, conservation, and management of water as a national resource. It is also responsible for planning and co-ordination in relation to diverse uses of water, water laws and legislations, addressing inter-State and trans-boundary water issues and general policy guidelines and programmes for assessment, development, and regulation of water resources. **Department of Drinking Water and Sanitation, MoJS** through Jal Jeevan Mission (JJM) seeks to provide safe and adequate drinking water through individual household tap connections to all households in rural India by 2024.

Central Public Health and Environmental Engineering Organisation (CPHEEO), which is MoHUA's technical wing, is responsible for establishing norms and technical standards for design and construction of urban water supply related infrastructure. CPHEEO also plays a vital role in the processing the schemes posed for external funding agencies including multilateral

and bilateral funding agencies and institutional financing.

Central Ground Water Board (CGWB), Department of Water Resources, River Development and Ganga Rejuvenation, MoJS is mandated to develop and disseminate technologies and monitor/implement national policies for the scientific and sustainable development and management of India's ground water resources, including their exploration, assessment, conservation, augmentation, protection from pollution and distribution, based on the principles of economic and ecological efficiency and equity.

Central Water Commission (CWC) is a technical organisation for water resources presently functioning as an attached office of the MoJS, Department of Water Resources, River Development and Ganga Rejuvenation, Government of India. The CWC is responsible for initiating, coordinating and furthering (in consultation with State Governments concerned) schemes for control, conservation, and utilisation of water resources for the purpose of flood control, irrigation, navigation, drinking water supply and waterpower development. CWC also undertakes planning, construction, and execution of any such schemes if required.

Central Pollution Control Board (CPCB), a statutory organisation under the Ministry of Environment, Forest and Climate Change, constituted under the Water (Prevention and Control of Pollution) Act, 1974 has been vested with the responsibility of monitoring of water quality.

The **Bureau of Indian Standards (BIS)**, Department of Consumer Affairs, Ministry of Consumer Affairs, Food and Public Distribution is responsible for developing and publishing Indian standards, implementing conformity assessment schemes, recognising and operating laboratories for conformity assessment, implementing hallmarking and conducting capacity building programmes on quality assurance.

Niti Aayog (National Institution for Transforming India) is an apex public policy think tank of the Government of India and the nodal agency tasked with catalysing economic development and fostering co-operative federalism through the involvement of state governments in the economic policy making process using a bottoms-up approach.

Bureau of Water Use Efficiency (BWUE) has been established by the Government of India for promotion, regulation, and control of efficient use of water in irrigation, industrial and domestic sectors.

2.1.1.2 Government of India's Commitments on 2030 Agenda for Sustainable Development

The Central government is also responsible for making commitments at global and regional forums for ensuring improved and universal access to urban water services. As a signatory to the 2030 Agenda for Sustainable Development, the Government of India is committed to the achievement of **Sustainable Development Goals (SDGs)**. From the perspective of urban water supply, SDG 6 (Clean Water and Sanitation) and SDG 11 (Sustainable Cities and Communities) are important. Refer Table 2.1 for details of the SDG wise targets.

Table 2.1: Sustainable Development Goals

	6.1 By 2030, achieve universal and equitable access to safe and affordable drinking water for all
	6.3 By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally
	6.4 By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity
	6.5 By 2030, implement integrated water resources management at all levels, including through transboundary co-operation as appropriate
	6.6 By 2030, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers, and lakes
	6.B Support and strengthen the participation of local communities in improving water and sanitation management
	11.1 By 2030, ensure access for all to adequate, safe, and affordable housing and basic services and upgrade slums
	11.5 By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations

2.1.2 State Governments

State governments fund investments in the urban water sector either through their own programmes or by providing supplementary funding for missions / schemes / programmes sponsored by the Central government. The state governments are also involved in planning, designing and execution of water supply related projects in cities and towns through either Public Health Engineering Departments (PHEDs), state owned corporations (for example, Uttar Pradesh *Jal Nigam* and Maharashtra *Jeevan Pradhikaran*) or specially constituted state boards (for example, Tamil Nadu Water Supply and Drainage Board). The responsibility for design, planning, implementation and Operation and Maintenance (O&M) of urban water supply is usually split between the state and local governments. Section 2.2 outlines the various institutional arrangements that exist for urban water supply in India.

2.1.3 State Public Health Acts

Constitution of India places obligations on the State governments to ensure protection and fulfilment of right to health to all, without any discrimination, as a fundamental right, by interpretation, under Articles 14, 15, and 21 (fundamental right to life, equality and non-discrimination); Article 23 (prohibition of traffic in human beings and forced labour); and Article 24 (prohibition of employment of children in factories, etc.); and also urges the State, under the Directive Principles of State Policy, to strive to provide to everyone certain vital public health conditions such as right to work, to education and to public assistance in certain cases (Article 41); just and humane conditions of work and maternity relief (Article 42); raised level of nutrition and the standard of living and to improve public health (Article 47); and protect and improve environment and safeguard forests and wild life (Article 48); and identifies certain concomitant fundamental duties like obligating every citizen to protect and improve the natural environment (Article 51).

Since "Public Health" is a state subject, state government are responsible for legislations on this subject. In order to ensure uniform public health legislation across states, the central government has entrusted various agencies to draft model Public Health Acts. As of now three such drafts are in place; the Model Public Health Bill by Central Bureau of Health Intelligence (1987); the National Public Health Bill by National Institute of Communicable Diseases (2002); and the National Health Bill by the Ministry of Health and Family Welfare's (MoHFW's) Task Force (2009).

As of now, only 8 states have a public health law/draft in place. Some states have revised the legislations in order to address the challenges of implementation. Tamil Nadu has revised its Public Health Act which was promulgated in 1939 with 13 amendments. It is recommended that all states must enact their respective Public Heath Acts. These acts should include provisions for penalising ULB that are not able to supply good quality water supply to households under its jurisdiction.

2.2 Institutional Arrangements for Water Supply

There are several types of institutional arrangements for urban water supply in the country, these include:

- **Single Agency/Institution** where a single agency is responsible for provision of water supply including both capital works and Operation and Maintenance (O&M). This agency could be either a municipal body/ULB or a State department/agency. There are also some institutions that single handedly manage water supply in urban, peri urban as well as rural areas. For instance, Tamil Nadu Water Supply and Drainage Board (TWAD Board) is responsible for provision of water and sewerage services in the entire state (including urban, peri-urban and rural areas) except the Chennai Metropolitan Area which is managed by the Chennai Metropolitan Water Supply and Sewerage Board (CMWSSB).
- **Multiple Agencies/Institutions** where multiple agencies are involved either independently or with overlapping responsibilities in planning, design and construction of water schemes, maintenance of bulk assets and internal city-wide distribution and O&M. These agencies could be PHEDs, state owned corporations or ULBs.
- **Decentralised System-Through Parastatal** where the service provision has been decentralised. In such cases, while the central/state urban or water supply and sanitation

department is responsible for planning, administrative and technical approvals, scheme funding, setting performance standards, etc., the implementation and O&M of the projects is the responsibility of the parastatal – example, the Shimla Jal Prabandhan Nigam Limited (SJPNL) and Water Corporation of Odisha (WATCO).

- **Metropolitan Level Specialised Water Boards:** In metropolitan cities, planning, implementation and O&M of urban water supply is undertaken by statutory bodies such as Delhi Jal Board (DJB), Bangalore Water Supply and Sewerage Board (BWSSB), Hyderabad Metropolitan Water Supply and Sewerage Board (HMWSSB), and CMWSSB.

Table 2.2 summarises different institutional roles for urban water service delivery across various states.

Table 2.2: Comparative Institutional Roles for Urban Water Services Delivery among Select States

Type of agency	Jurisdiction	Responsibilities		State Examples
		O&M	Capital works	
State-level specialist agency	Entire state	State-level specialist agency		Kerala (KWA) Jharkhand (WSSD + JUIDCO) Orissa (WATCO) Tripura PWD (WR)
	Small/large cities	Municipal Authority	State- level specialist agency	Karnataka Maharashtra Tamil Nadu Punjab Uttar Pradesh
	Small cities	State-level specialist agency		Karnataka (some cities)
Metropolitan-level Specialist agency	Metropolitan centres	Specialist Metropolitan Agency		Bangalore, Chennai, Hyderabad, Guwahati
Specialist municipal undertaking (SMU)	Large cities, Metropolitan centres	Specialist Municipal Undertaking		Delhi Shimla
Public Health Engineering Departments (PHED)	Entire state	Public Health Engineering Department (PHED)		Rajasthan, Bihar, Chhattisgarh, Himachal Pradesh
	Small cities	Municipal Authority	PHED	Andhra Pradesh, Madhya Pradesh
		PHED	State agencies	Rajasthan (e.g., Kota Urban Improvement Trust + PHED)

Type of agency	Jurisdiction	Responsibilities		State Examples
		O&M	Capital works	
Municipal Departments	Municipal Corporations	Municipal Department		Gujarat, Maharashtra, Tamil Nadu, Andhra Pradesh, Madhya Pradesh, Punjab (some cities)

2.3 Initiatives in the Urban Water Sector

In the last few decades, there has been many initiatives in the urban water sector driven primarily by the Central government. These can be grouped into three categories, namely, policies and advisories; investment programmes; and data/information collection initiatives.

2.3.1 Policies and Advisories

2.3.1.1 National Water Policy 2012 (NWP 2012)

The NWP 2012 has been formulated to govern the planning and development of water resources and to ensure their optimum utilisation. The first National Water Policy was adopted in September 1987 and it was subsequently reviewed and updated in 2002 and 2012.

While the scope of the NWP 2012 is very vast (covering ecological aspects, changes due to climate change, etc.) it has certain specific recommendations for urban areas. The NWP 2012 recommends that urban water supply needs should be met preferably from surface water sources and where alternative supplies are available, a source with better reliability and quality should be assigned to domestic water supply. It recommends that where exchange of sources between uses is possible preference must be given to domestic water supply. It also recommends reuse of urban water effluents from kitchens and bathrooms, after primary treatment, in flush toilets, ensuring no human contact.

In addition, the policy recommends that urban domestic water supply systems must collect and publish water accounts and audit reports indicating leakages and pilferages and the same should be reduced taking into due consideration of social aspects. It also suggests that water supply and sewerage schemes should be implemented simultaneously and that water supply bills should include sewerage charges. The policy also calls for incentivising recycle and reuse of water, after treatment to specified standards, through a properly planned tariff system.

The policy also states that the planning, development, and management of water resources needs to consider local, regional, state, and national context and must be environmentally sound and focused on human, social and economic needs. in addition, it points to the need for Integrated Water Resources Management (IWRM) taking river basin/sub-basin as a unit. Highlighting the limits on enhancing the availability of utilisable water resources and increased variability in supplies due to climate change, the policy underscores the importance of demand management.

2.3.1.2 Guidelines to Control and Regulate Ground Water Extraction

Ground water resources are rapidly depleting due to uncontrolled extraction and are facing risk

of contamination/pollution due to rampant dumping of untreated wastewater. In this background, the Central Ground Water Authority (CGWA) has framed guidelines for regulation and control of groundwater in September 2020.

Provisions Pertaining to Use of Ground Water for Drinking and Domestic Use in Residential Apartments/ Group Housing Societies in Urban Areas: For grant of No Objection Certificate (NOC) for ground water extraction, the project proponent has to furnish the details as per the guidelines issued by the CGWA. NOC for new/existing wells shall be granted only in cases where the local Government water supply agency is unable to supply requisite amount of water in the area. For all residential apartments/Group Housing Societies where ground water requirement is more than 20 m^3/day installation of Sewage Treatment Plants (STPs) has been made mandatory and it is recommended that treated water from STPs be utilised for toilet flushing, car washing, gardening, etc. The NOC for residential apartments/Group Housing Societies is valid for a period of five years from the date of issue or till such time that local government water supply is provided to the area, whichever is earlier.

Proponents also have to pay ground water abstraction charges based on the quantum of ground water extracted, as per the following rates 0-25 m^3 per month – no charge, 26-50 m^3 per month at Rs. 1.00/m^3 and more than 50 m^3 per month at Rs. 2.00/m^3.

Delegation of Powers against Illegal Groundwater Withdrawal: CGWA has appointed the District Magistrate / District Collector / Sub Divisional Magistrates of each Revenue District/Sub-Division as authorised officers, who have been delegated the power to seal illegal wells, disconnect electricity supply to the energised well, launch prosecution against offenders, etc., including grievance redressal related to ground water in their respective jurisdictions. In order to further decentralise and strengthen the monitoring and compliance mechanism, officials of concerned Departments of Revenue and Industries of the States/UTs have been suggested to be appointed as authorised officers in consultation with the State/UT Governments.

2.3.1.3 Bharat Tap

Bharat Tap initiative was inaugurated in May 2022 and is aimed at providing low-flow, sanitary-ware at scale, thereby reduce water consumption at source. Details on water efficient fixtures is included in Chapter 15: Water Efficient Plumbing Fixtures, Part A of this manual.

2.3.2 Investment Programmes

2.3.2.1 Atal Mission for Rejuvenation and Urban Transformation (AMRUT) 1.0

AMRUT was launched as the first water focused Mission in 2015, in 500 major cities comprising of nearly 60 per cent of the country's urban population. The key objective of AMRUT 1.0 was to provide universal coverage of water supply through augmentation or rehabilitation of existing water supply systems and water treatment plants as well as universal metering.

Under AMRUT 1.0, 1,348 water supply related projects worth ₹ 42,970 crores were grounded, of which 1,013 projects worth ₹ 19,803 have been completed. The remaining projects are at advanced stage of implementation. So far, 141 lakhs household water tap connections have been provided through AMRUT 1.0 and in convergence with other schemes. In addition, 63,470 km of water pipelines have been laid, water treatment plants of 3,340 MLD capacity have been created while construction of treatment plants of 3,350 MLD is in progress.

Reform Agenda: The reform agenda under AMRUT comprised of 11 reforms which were aimed at improving delivery of citizen services, bringing down the cost-of-service delivery, improving financial health of service providers, augmenting resources, and enhancing transparency. The mission made tremendous progress with respect to the reform agenda. Credit rating work was completed in 468 cities, out of which 163 cities received Investible Grade Rating (IGR), including 36 cities with rating of A- and above. Further, Rs. 3,840 crores were raised through municipal bonds by 10 ULBs (including Ahmedabad, Amravati, Bhopal, Ghaziabad, Hyderabad, Indore, Pune, Surat, Visakhapatnam, and Lucknow). Cities were awarded an incentive of up to Rs. 26 crores (at Rs. 13 crores per Rs. 100 crore) for issuing municipal bonds. Online Building Permission System (OBPS) was implemented in 2,471 cities including 455 AMRUT cities. This reform has helped improve India's rank in Ease of Doing Business in construction permits to 27 (from 181 in 2018) in World Banks' Doing Business Report (DBR) 2020. Further, 89 lakhs conventional streetlights were replaced with energy efficient LED lights, leading to estimated energy savings of 195 crore units per annum & reduction in CO2 emission by 15.6 lakh tons per annum. Field survey for energy audit was completed in 413 cities and energy audit was completed in 358 cities. 11,100 water pumps were identified for replacement with energy efficient pumps. With regard to capacity building, 52,327 functionaries and elected representatives across the country were trained.

2.3.2.2 Atal Mission for Rejuvenation and Urban Transformation (AMRUT) 2.0

The Government of India launched AMRUT 2.0 in October 2021. AMRUT 2.0 aims at making around 4,700 towns/cities "water secure" household tap water connection in all ULBs. It is envisaged that AMRUT 2.0 will build upon the progress achieved under AMRUT 1.0. The admissible elements related to water supply under AMRUT 2.0 include water source improvement and augmentation, freshwater treatment, extension of water distribution system in uncovered areas, augmentation of existing water distribution system, sustainability of quality and quantity of water supply, reuse of treated wastewater, provision of 24×7 Pressurised Water Supply (24×7 PWS) and ensuring last mile connectivity to households.

The total outlay of AMRUT 2.0 is INR 2,97,000 crores, including central share of ₹ 76,760 crores. This includes ₹ 10,000 crores central share and another ₹ 10,000 crores states' share for continuing financial support to AMRUT 1.0 up to March 2023.

The objective of AMRUT 2.0 is to provide universal coverage of water supply in around 4,700 ULBs, by providing 2.68 crore household tap connections, thereby benefitting around 10.7 crore people. Rejuvenation of water bodies and urban aquifer management will be undertaken to augment sustainable fresh water supply. Recycle and reuse of treated wastewater is expected to cater to 20 per cent of total water needs of cities and 40 per cent of the industrial demand. Under the Mission, freshwater bodies will be protected from getting polluted to make natural resources sustainable. So far, 3126 water supply projects costing ₹ 90,541 crore have been approved and of these, 577 projects amounting to ₹ 21,741 crore are having provision of 24×7 piped water supply.

The defining features of AMRUT 2.0 include:

- Upscaling from 500 cities covered under AMRUT with 1 lakh+ population to all cities, thereby covering 100% of urban India.
- Promoting circular economy of water through formulation of City Water Balance Plan for each city, focusing on recycle/reuse of treated wastewater, rejuvenation of water bodies

and water conservation.

- Promotion of digital economy through being a Paperless Mission
- *Pey Jal Survekshan* to be conducted in cities to ascertain equitable distribution of water, reuse of wastewater and mapping of water bodies with respect to quantity and quality of water through a challenge.
- Technology Sub-Mission for water will leverage latest global technologies in the field of water.

AMRUT 2.0 aims to provide 24×7 PWSS with Drink from Tap facility in at least one ward or District Metered Area (DMA) with around 2,000 households in all AMRUT cities. In this regard, MoHUA issued "Guidelines for Planning, Design and Implementation of 24×7 Water Supply Systems" in December 2021, to help cities make this transition. The mission also aims at encouraging implementation of smart IT-based solutions for implementation and monitoring, including Supervisory Control and Data Acquisition System (SCADA), GIS and Digital Twin, etc.

AMRUT 2.0 is also focused on leveraging private investments through Public-Private Partnerships (PPP). Cities having a population of one million or more are mandated to take up PPP projects worth at least 10 per cent of their total project fund allocation, which could be on Annuity/Hybrid Annuity/BOT Model**.**

The mission also seeks to promote *Aatma Nirbhar Bharat* by encouraging start-ups and entrepreneurs. Seventy-six start-ups have been on board, and these are being partly funded through AMRUT 2.0. An Urban Water Information System through the National Remote Sensing Centre (NRSC) is planned which will lead Aquifer Management System**.** In addition, an Information, Education, and Communication (IEC) campaign will be implemented to spread awareness among masses about conservation of water. Target-based capacity building programme will also be conducted for all stakeholders including contractors, plumbers, plant operators, students, women, and others.

Reform Agenda: AMRUT 2.0's reform agenda will focus on strengthening of ULBs and water security in cities. Major reforms include rejuvenation of water bodies, rain water harvesting in all institutional buildings, reducing Non-Revenue Water (NRW) to less than 20%, meeting 20% of city water demand and 40 % of industrial water demand through recycled used water, dual piping system for bulk users through building byelaws, unlocking value and improving land use efficiency through proper master planning, improving credit rating and accessing market finance including issuance of municipal bonds and implementation of OBPS. Further, notification on property tax and increasing circle rates periodically and user charges covering O&M costs is a mandatory reform under AMRUT 2.0.

2.3.3 Data and Information Initiatives

2.3.3.1 Service Level Benchmarking

The erstwhile Ministry of Urban Development (MoUD), in order to shift the focus from mere infrastructure creation to delivery of service outcomes, formulated a set of standardised Service Level Benchmarks (SLBs) for environmental services (including water, waste, solid waste and drainage) as per International Best Practice and brought out a "Handbook on Service Level Benchmarking" in 2008. The SLBs are a minimum set of standard performance parameters that are commonly understood and used by all stakeholders across the country. The SLBs have also become the cornerstone of implementing and monitoring urban reform agenda being

implemented as part of various centrally sponsored schemes.

By collecting information on a set of common indicators, cities can track their performance over time, and this will put them in a better position to set their priorities. The water supply related indicators are presented in Table 2.3.

Table 2.3: Service Level Benchmark – Indicators Related to Water Supply

S. No.	Indicator	Benchmark
1	Coverage of water supply connections	100%
2	Per capita supply of water	135 LPCD
3	Extent of NRW	20%
4	Extent of metering	100%
5	Continuity of water supplied	24 hours
6	Efficiency in redressal of customer complaints	80%
7	Quality of water supplied	100%
8	Cost recovery	100%
9	Efficiency in collection of water charges	90%

2.3.3.2 Water Quality Standards

Water is defined as safe if it is free from biological contamination (guinea worm, cholera, typhoid, etc.) and within permissible limits of chemical contamination (excess fluoride, brackishness, iron, arsenic, nitrates, etc.) as per IS-10500:2012 Standard of Bureau of Indian Standards (BIS).

Urban water service providers/utilities are required to monitor the water quality as per BIS Drinking water Specification (IS 10500:2012). Details have been provided in Section 7.4.2 of Chapter 7: Water Quality Monitoring and Surveillance, Part A of this manual.

2.4 Regulation in the Urban Water Sector

2.4.1 Need for Regulation

Provision of 24×7 PWSS with Drink from Tap facility and creation of “water secure” cities require a paradigm shift in urban water service delivery which involves moving away from the “state-centered” model towards a “market-centered” approach. A “market- centered” approach is important on the following counts:

- To promote water as an economic good (as water is a scarce good).
- To target full cost recovery of water including O&M and capital costs.
- To restructure the role of governments to a facilitator rather than a direct provider of services.
- To leverage private sector participation in urban water service delivery including private investments and technical expertise. The participation of private service providers can contribute to service delivery improvements.

In this background, an independent Regulatory Authority for the urban water sector becomes very important. An independent regulatory authority is important to ensure equitable distribution of water resources among various uses, quality of service delivery which meets the requirements of the SLBs and protection of the interests of the consumers and other stakeholders. The focus of regulation in the urban water sector must be on tariff setting, service quality, and consumer

protection.

While typically the model is to have a single regulatory authority, water sector regulators encompass many oversight mechanisms including an authority, a ministry, an asset holding company or authority, a customer group, independent experts and/or the service provider itself through self-regulation. Regulations are usually stipulated in legislation, contracts, byelaws, personal commitments, and service charters and are enforced by the regulator through a set of tools which include penalties, financial incentives (both positive and negative), license withdrawal, etc.

2.4.2 Previous Attempts at Regulation in the Water Sector in India

Regulatory reforms, in terms of setting up of an independent national level regulatory authority for water supply, have been mostly absent in India. This can be attributed to the fact that "water" is a subject that remains under the jurisdiction of the state (sub- national) or city/town (local) governments.

While some attempts have been made at the state (sub-national) level towards establishing independent autonomous bodies to regulate the water sector, most of these entities have been mandated to undertake only water resource management (allocation of the available water resource across different uses) and water pricing (pricing for different uses – agriculture, industrial, domestic, and others) related functions and haven't played any role in regulating urban water service delivery (refer Box 1). Further, although autonomous, these institutions lacked the power to set criteria for all water uses and/or to determine tariff rates, develop and manage groundwater resources, implement the human right to water, and set out environmental requirements for water regulation.

Box 1: Setting Up of Sub-National Level Autonomous Regulatory Authorities in India

In 1997, the Government of Andhra Pradesh enacted the **Andhra Pradesh Water Resources Development Corporation Act** and set up an autonomous body for promoting and operating irrigation projects, command area development, harnessing the water of the rivers in the state, flood control and schemes for drinking water and industrial water supply. The authority was not able to achieve its objectives as they were much larger than its scope.

In 2005, the Government of Maharashtra enacted the **Maharashtra Water Resources Regulatory Authority (MWRRA) Act** with a view to set up an independent regulatory authority in the state to regulate bulk water supply as well as to provide guidelines for fixing water rates for agriculture, industrial, drinking, and other purposes. Details on Maharashtra Water Resources Regulatory Authority are presented in Box 2 and Figure 2.1.

In 2006, the Government of **Arunachal Pradesh enacted the Arunachal Pradesh Water Resources Regulatory Authority Act** on similar lines as that of MWRRA Act 2005. It was envisaged that the regulatory authority would have the power to fix water tariffs for both irrigation and non-irrigation purposes, based on the principle of full cost recovery for the cost of Irrigation Management, Administration, and Operation and Maintenance of the project.

In 2008, the Government of Uttar Pradesh enacted the **Uttar Pradesh Water Management and Regulatory Commission (UPWM&RC) Act** with the view of setting up a regulatory commission which would regulate the state's water resources, facilitate and ensure judicious, equitable and sustainable management, allocation and utilisation of water resources. It was

also to fix the rates for water use for agriculture, industrial, drinking, and other purposes and carry out flood control activities.

There have been some attempts at regulation at a local level in some cities, including Delhi and Hyderabad. In October 2011, the Government of Delhi announced its plan to revamp the entire water management and distribution system under the guidance of Planning Commission, Government of India. This included a proposal to create a "new administrative regime" involving an urban water regulatory body on the lines of the Delhi Electricity Regulatory Commission to streamline the water management system and to fix water tariffs. However, the model was considered inadequate as the regulatory body lacked the mandate for water conservation and water quality and there was no defined criterion of equitable sharing. The implications of potential trading on water entitlements were also unclear. Further, it was feared that powerful landowners, industrialists, large scale farmers, etc., may influence the authority in water allocation which would adversely affect the interests of poor and disadvantaged groups. Due to the above reasons, the proposal never saw the light of the day.

There have also been some attempts at corporatisation of government owned utilities in order to allow them to mimic privately owned entities and adopt a more commercial focus on operations while maintaining distance from the government. However, most of the regulations, till date in the sector, have been through contracts.

Box 2: Maharashtra Water Resources Regulatory Authority (MWRRA)

With the aim of ensuring rational decision making for the development of the Water Supply and Sanitation (WSS) sector, the Government of Maharashtra decided to establish an independent water regulator consisting of technical and economic experts. The **Maharashtra Water Resources Regulatory Authority (MWRRA)** was established under the MWRRA Act 2005 as a quasi-judicial body to regulate sectoral allocations, water tariffs, water entitlements, changes in water use/diversion of water use and compensation for such changes in water use. The MWRRA establishes a regulatory mechanism for overseeing the relationship between the service provider and water users, and fixation of water tariff structures. MWRRA is also responsible to determine, enforce, and resolve the disputes of entitlement within water user entities.

The main functions of MWRRA are:

a) Regulate water resources within the state;
b) Facilitate and ensure judicious, equitable and sustainable management, allocation, and utilisation of water resources;
c) Fix rates for use of water for agriculture, industrial, drinking, and other purposes, and update them periodically with the objective that the water charges should reflect the full recovery of cost incurred during the water supply cycle, including the capital costs.

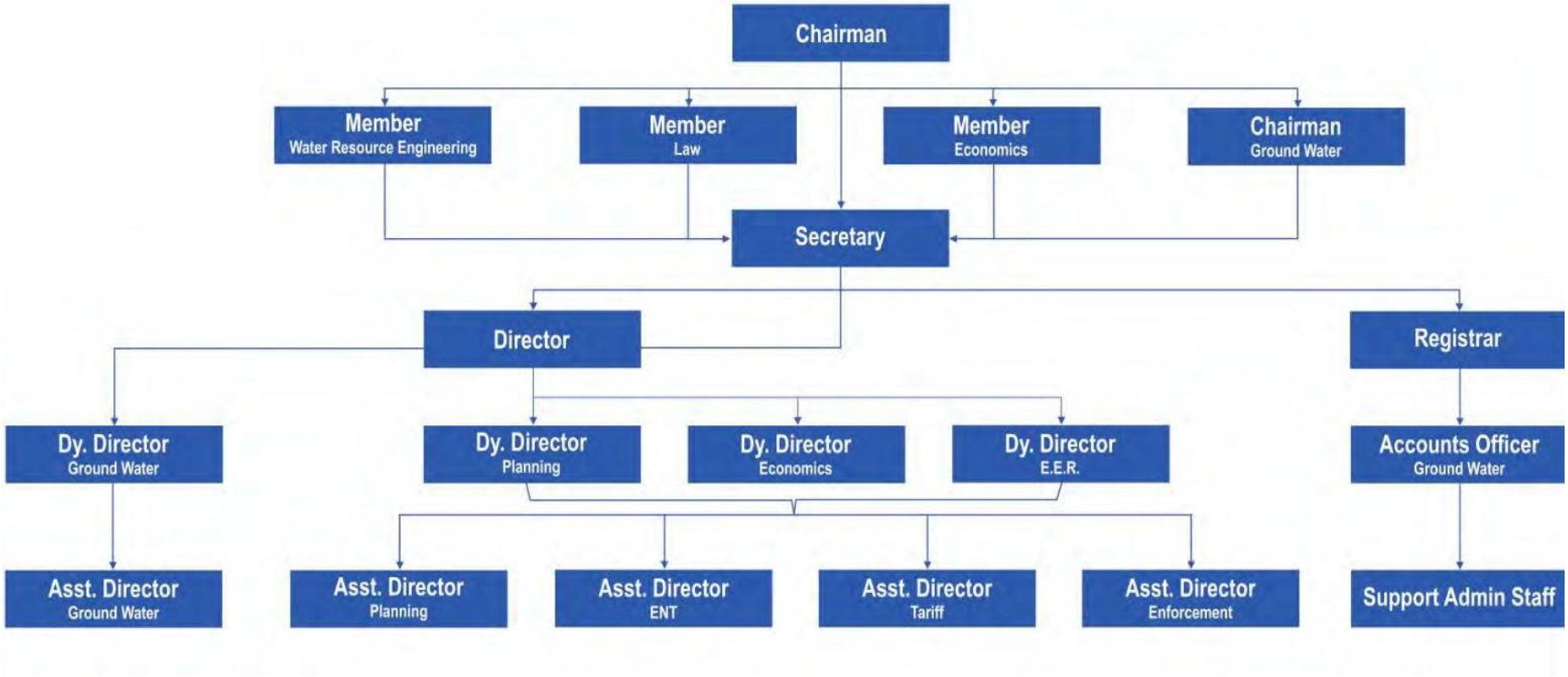


Figure 2.1: Organisational Structure of Maharashtra Water Resources Regulatory Authority

2.4.3 Setting Up of a State Water Regulatory Authority

An independent Regulatory Authority for the urban water sector becomes very important in the current context where there is a definite shift towards 24×7 PWSS with Drink from Tap facility and creation of "water secure" cities. This shift is based on recognising water as an economic good, ensuring full cost recovery of water including O&M and capital costs, restructuring the role of governments as facilitator instead of provider of services and leveraging the resources that exist within the private sector. An independent regulatory authority is important to ensure:

- equitable and fair distribution of water resources among various uses.
- ensuring good quality of service delivery which meets the requirements of the SLBs; and
- protection of the interests of the consumers and other stakeholders.

It is recommended that states should consider establishing a State Water Regulatory Authority (SWRA) for water. The powers of the proposed SWRAs must be driven by two key functional objectives:

- interests of the users/consumers.
- interests of the market including the private service providers in the Water Supply and Sewerage (WSS) sector.

The SWRA is expected to stimulate free and fair competition in the sector and develop a conducive environment for improvements in the service delivery for the end- users/consumers as well as sustainability of private service providers. In order to achieve this objective, the SWRA should be sufficiently empowered to take decisions and give orders regarding key economic matters such as terms of competition, price of services, distribution of various service or other benefits among various stakeholders.

The proposed powers and functions of the SWRA are as follows:

- determining the entitlements for various categories of water use;
- determining the priority of equitable distribution of available water at the following points – at source, at water resource project, at sub-basin, and at river basin levels during periods of scarcity;
- establishing a tariff system and fix criteria for water charges at sub-basin, river basin and state level so that there is full recovery of the cost of the irrigation management, administration, operation, and maintenance of water resources project. It will also review and revise water charges on a regular basis;
- ensuring that cross-subsidies between categories of use, if any, given by the government are offset by stable funding from such cross-subsidies or government payments to assure that the sustainable O&M of the water delivery systems are not jeopardised in any way;
- administering and managing interstate water resources apportionment on river systems;
- reviewing and clearing water resources projects proposed at the sub-basin and river basin level to ensure that these conform with the Integrated State Water Plan, are environmentally viable and in line with various state obligations;
- with respect to water entitlements, determining criteria and monitoring the issuance of entitlements, modifying entitlements for diversion, storage and use of the surface and subsurface waters, and fixing the criteria for trading of water entitlements annually or

seasonally;

- in times of water scarcity, the SWRA will have powers to adjust the quantities of water to be made available to all users and permit temporary transfer between users and categories;
- establishing a system of enforcement, monitoring and measurement of the entitlements for the use of water that will ensure that the actual use of water, both in quantity and type of use follow those issued by the SWRA;
- it will promote efficient use of water and minimise wastage and fix reasonable use criteria for each category of use.

The SWRA will be responsible to ensure that the revenues of water service providers are protected when they are not allowed to adjust tariffs or impose them. The revenues that are lost because of this need to be assured through appropriate allocations from other sources. For example, if a water service provider is not covering the costs of the service for external and non-technical reasons, the SWRA could issue a notification making it mandatory for allocating a certain share of property tax collections for water services.

CHAPTER 3: INSTITUTIONAL STRENGTHENING AND CAPACITY BUILDING

3.1 Institutional Strengthening and Staffing

3.1.1 Need for Strengthening Institutional Arrangements

Water supply and sewerage services are municipal responsibilities following the enactment of the 74th Constitution Amendment Act (74th CAA). However, the implementation of the 74th CAA varies across states and Urban Local Bodies (ULBs) continue to face "administrative and legislative" constraints. Further, the arrangements for provision of water services vary depending on the institutional capacities of the ULBs.

There is a need to improve/strengthen institutional arrangements for urban water services in order to ensure that there is:

- clarity of roles and responsibilities across multiple agencies that are involved in urban water service delivery to ensure improved service delivery;
- gradual shift to a clear separation of the water supply function in a municipality which in turn will result in (i) a corporatised functional style; (ii) self-sufficiency in terms of technical and financial capacities; and (iii) improved service outcomes especially in the context of the move towards 24×7 PWSS with Drink from Tap facility;
- leveraging of the capacities that exist with the private sector;
- focus on inclusion of all citizens and a gradual shift from consultation to collaboration and empowerment.

3.1.2 Historical Review of Proposals for Institutional Strengthening

The need for improvements in the institutional arrangements for the delivery of urban water supply services has been recognised for long. While various recommendations on ideal staffing structures have been made these have not been implemented in their entirety. A summary of the key recommendations on the institutional strengthening and staffing of urban water services is presented below.

3.1.2.1 Report of the Environmental Hygiene Committee (October 1949)

The Environmental Hygiene Committee was constituted by the Ministry of Health, Government of India in June 1948, to consider the steps required for the implementation of the recommendations of the Health Survey and Development Committee regarding environmental hygiene. The Terms of Reference (TOR) includes an investigation of the field of environmental hygiene with special reference to water supply (among other subjects). The broad summary of its recommendations with respect to urban water supply were as follows:

- Public Health Engineering (PHE) should form a separate self-sufficient organisation in the Ministry of Health both at the centre and in the provinces.
- Each province should have a Public Health Act.
- A separate cadre of Chief Public Health Engineers should be created for each province and the Municipal Health Engineering services should be provincialised.
- Control laboratories with research capabilities under the office of Chief Public Health Engineer should be established.
- Assessment of training needs for grassroot level staff such as water works operators

should be undertaken.
- PHE should be made an essential qualification for such positions.

A few of these recommendations have been implemented and some recommendations need reconsideration in the current context which have been summarised in Table 3.1.

Table 3.1: Recommendations of the Environmental Hygiene Committee

Recommendations implemented	Recommendations to be reconsidered for implementation
Creation of PHE Department at state level	Creation of a cadre of public health engineers starting from district- municipal-circle-chief PHE positions
Establishment of Public Health Laboratory at district level	Making PHE a mandatory qualification for those leading the water service function in various entities
Setting up of Central Public Health and Environmental Engineering Organisation (CPHEEO) at central level (initially with the Ministry of Health & later with Urban Ministry)	

3.1.2.2 Manual on Operation and Maintenance (O&M) of Water Supply Systems (CPHEEO, 2005)

The manual on O&M of Water Supply System (CPHEEO, 2005) provided guidance on the strategy for improving the organisation structure for O&M of water supply system. The key recommendations from this manual were:

- **Organisation Structure:** The manual suggested that municipalities should define roles and responsibilities of the staff and, if necessary, re-organise their staff structure. Each staff member of the organisation should be trained for their respective jobs and only well qualified, experienced, and efficient personnel should be appointed.
- **Defining Job Description:** The manual suggested that a well-defined job description should be provided to each appointed staff member with reference to the O&M plan.

3.1.2.3 Recommendations on Municipal Cadres (Capacity Building for Urban Development (CBUD) Project, 2014)

In 2014, under the Capacity Building for Urban Development (CBUD) Project, a detailed document on the *Approach Towards Establishing Municipal Cadres in India* provides details on the state-wide organisational structure for urban development and ideal municipal structures, including numbers of staff across various municipal functions and categories, for effective service delivery. The functional categorisation of staff in the municipality proposed is presented in Table 3.2.

Table 3.2: Staff Functional Groups for Municipal Services and relevant Roles for Water Service Delivery

Functional Groups	Services under each Cadre	Relevant roles
Municipal Administrative Service	Executive Service	Administration, visioning, and programme development
	Social Development Service	
Municipal Technical Service	Urban Planning Service	Plan implementation and convergence with urban planning
	Engineering Service	Construction and O&M of waterworks
Municipal Finance Service	Accounts Service	Financial resource planning
	Municipal Revenue Service	Billing and collection of water charges

Based on the learnings from the CBUD Project, each state must reflect on its past and present experiences of managing its water supply services and assess its human resource roadmap.

While there have been several recommendations made on institutional structures that would help improve service delivery, these have been difficult to implement given challenges such as staff shortages, limited capacities, and overlapping roles and responsibilities which continue to plague the urban water supply sector. There is, thus, a need for rationalisation of the various recommendations in order to build organisational capacity to deliver on the emerging agenda of the Government of India related to 24×7 PWSS with Drink from Tap facility, increased engagement with the private sector for meeting service level benchmarks, climate variability induced risks, etc.

3.1.3 Proposed Institutional Strengthening – A Transition Approach

The dynamic nature of the water supply services in the country makes it difficult to define a standard staff structure which could fit all. It is, therefore, recommended that the institutional structure and staffing of water supply service providers/utilities should be developed over time linked to growth in population and revenues. Further, non- performing institutions should be dissolved.

3.1.3.1 Rationale for Adopting a Transition Approach

- **A single institutional and staffing structure does not fit all.** Municipalities of varying sizes vary in their ability to pay for staffing, and this is a key consideration for staffing. It is, therefore, necessary to consider a “transition” approach on staffing and institutional strengthening which is linked to population served and revenues earned.
- **Not necessary for the water service provider to undertake all functions on its own.** It is possible to outsource multiple functions across the value chain. Such an arrangement could be more economical, and a cost-benefit analysis should be undertaken to assess the same. Considering the possibilities of outsourcing some functions, staffing should be rationalised both in terms of numbers and skills required.
- **Staffing structures should consider emerging priorities and challenges** such as Integrated Urban Water Resource Management (IUWRM), water sensitive design, 24×7 PWSS with Drink from Tap facility, climate variability/change induced risks. An assessment

of available human resources should be done by competent state level authorities prior to recommending institutional structures and determining capacity building needs as the institutional transition progresses.

3.1.3.2 Premises for Proposed Institutional Arrangements

The proposed institutional arrangements are based on the following premises.

- The recommendations are exclusive for water supply, sewerage, and drainage functions. The other technical functions being performed by ULBs are not being considered.
- A degree of specialisation for the function within the existing arrangements is necessary in line with the overall transition approach that is being proposed.
- The need for functional autonomy for the urban water service provider/entity.
- The need for performance monitoring of service level benchmarks to ensure that service provision is being delivered at the highest possible levels.

3.1.3.3 Defining Core Functions of Urban Water Service Providers

The core functions of any urban water service provider are – Technical, Commercial, and Financial. In addition, Water Quality Monitoring, Public Relations, Information and Communications Technology (ICT) and Legal are important staff functions. The description of these core functions is in Table 3.3.

Table 3.3: Core functions and Responsibilities of Urban Water Service Providers

Core Function	Description of Responsibilities
Technical (core function)	• Overall responsibility for provision of safe and secured water supply • Planning, managing of water and sewerage networks • Construction and repair of networks including non-routine maintenance • Asset management – conducting and operating the water service as a business and not a one-time project • Wastewater treatment and pumping • O&M
Commercial (this function is organised around a seamless commercial cycle from meter management to bill collection)	• Customer database management • Meter reading • Billing and collection • Grievance redress • Smart commercial loss reduction with analysis and assessment of patterns of water consumption, customer category analysis, and demand profiling

Core Function	Description of Responsibilities
Financial – this is an important function that needs to be separated. However, in the short term, this could be performed by the existing accounts department in the municipality, but it should have one person from the water section coordinating and leading on it	• Accounting • Business plan and finance • Purchasing • Inventories
Additional or Cross Cutting Functions	
Laboratory – this should be independent. The function could also be outsourced	• Quality control of water distributed in the network and at the point of supply • Quality control of effluents at wastewater treatment plants • Monitoring raw water sources • Process and water quality control at water intake, during treatment, transport, pumping, and storage
ICT and Management Information System (MIS) – this is an important function because of the increasing use of automation and the delivery of this function requires specialised skills	• Develop strategic plan on increasing automation of typical services • Develop plan for procurement of hardware and software • Specialised training for employees on specific software
Public relations	• To enhance the customer face for the water function and provide regular information on water supply services
Legal	• This is a specialised function and should be outsourced

3.1.4 Ring Fencing of the Water Supply Function

The water supply function is complex and requires special skills, not just to improve service levels but also, to respond to Government of India's mandate of "making cities water secure". As the first step in the process of institutional strengthening, municipalities must ring fence the water service function with dedicated staff who have clearly defined roles and responsibilities (Figure 3.1). In such an arrangement, with clear reporting lines and accountability, there is scope for increased specialisation as the size of the municipalities increases.

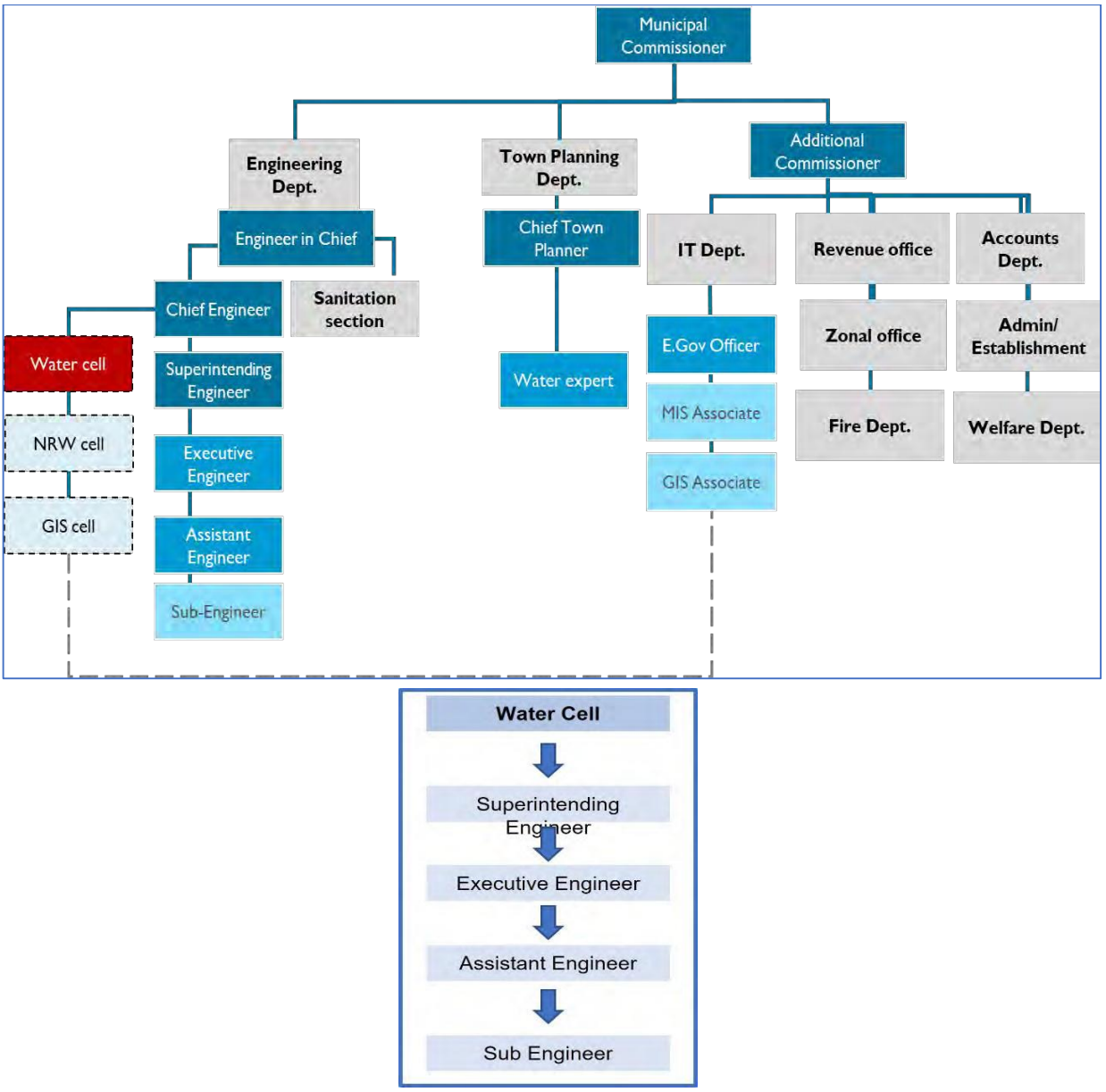


Figure 3.1: Ring Fencing of water supply function, structure of water cell

3.1.5 Proposed Staffing Norms

The staffing norms proposed below have been rationalised based on prevailing institutional arrangements and are dependent on the size of the city/town. As the revenues increase, the staff numbers should increase as per the defined standard. The staffing norms for technical positions are presented in and those for technical support functions are presented in.

For the water service to be self-reliant, revenues need to be enhanced and managed well. Since it is proposed that the water service will be ring-fenced, with increasing revenues, it is recommended that dedicated staff be available for the water service function. The staffing norms for the technical position and technical support positions are as proposed in Table 3.4 & 3.5.

The staffing norms for the revenue function for the ring-fenced water service are as proposed in Table 3.6.

Table 3.4: Staffing Norms for Technical Positions as per Size of the City/Town

TECHNICAL POSITIONS									
Position	**Norm**	**Size of city/town**							
		<25 K	**25 K – 1.0 L**	**1 L – <3 L**	**3 L – 5 L**	**5 L – <10 L**	**10 L – 20 L**	**20 L – 50 L**	**>50 L – 1 Cr**
Engineer in Chief	For metropolitan city								1
Chief Engineer Projects	1 for 50 L								1
Chief Engineer O&M	1 for 50 L								1
SE Projects	1 for 40 L						1	2	3
SE O&M	1 for 10-20 L				1	1	2	4	6
EE Projects	1 for 10 L				1	2	3	8	12
EE O&M	1 for 5 L		1	1	2	4	8	16	30
AEE/AE Works	1 per 2 L		1	2	4	8	15	32	50
AEE/AE O&M	1 per 1 L	1	2	4	8	16	32	64	120
JE Civil	1 per 20 K – 30 K/4 K connections	1	5	12	25	50	100	200	350
JE Mechanical	1 per 3 pump house & 1 per WTP		1	2	3	4	5	7	10
JE Electrical	1 per 5 pump house & 1 per WTP			1	2	3	3	4	6

Table 3.5: Staffing Norms for Technical Support Positions as per Size of the City/Town

TECHNICAL SUPPORT POSITIONS									
Position	**Norm**	**Size of city/town**							
		<25 K	**25 K – 1.0 L**	**1 L – <3 L**	**3 L – 5 L**	**5 L – <10 L**	**10 L – 20 L**	**20 L – 50 L**	**>50 L – 1 Cr**
Valve men/plumber with assistant	1 per 2000 connections	2	10	30	50	100	200	500	1000
Meter reader (in case of no SCADA)	1 per 2000 connections	2	10	30	50	100	200	500	1000
Pump operator with assistant	1 per every pump house in every shift		6	15	24	30	45	60	90
Electrician	1 per every pump house in every shift		3	6	10	12	18	24	35
WTP operator with assistant	1 per WTP in every shift		3	3	6	6	9	12	15
Watchman	1 per pump house & WTP campus		3	6	10	12	18	24	35
For O&M of SCADA	Separate staff in 3 shifts								
Water quality monitoring (treatment plant/distribution network)	1 per WTP in every shift and (+) separate staff for distribution system		3+1	3+1	6+2	6+2	9+3	12+4	15+5

Table 3.6: Staffing Norms for Revenue Functions as per Size of the City/Town

REVENUE FUNCTIONS									
Position	**Norm**	**Size of city/town**							
		<25 K	**25 K – 1.0 L**	**1 L – <3 L**	**3 L – 5 L**	**5 L – <10 L**	**10 L – 20 L**	**20 L – 50 L**	**>50 L – 1 Cr**
Revenue officer	1 for revenue of 50 L to 1 cr. per month		1	1	2	3	5	12	34
Accountants	1 for revenue of 10 – 20 L per month		2	4	6	12	24	62	160
Clerk/Office manager	As required	2	4	8	10	15	30	70	200

3.1.6 Creation of Dedicated Cells

As the urban water service providers/utilities begin the process of transition, it is recommended that the following key functional structures be created for overall service delivery efficiencies:

- **Design-cum-GIS Cell** should be created under the jurisdiction of Engineer-in- Charge in all municipalities. This cell should have a "Design Expert" with a master's degree in PHE/Hydraulic Engineering and must also include a "GIS Expert".
- **NRW Reduction Cell or an "Inter-Departmental Task Force on NRW Reduction"** should be created with representation from the Technical, Financial, and Commercial Departments.
- An **"Inter-Departmental Task Force on Communication",** with representation from the PR Unit, Commercial Department, and Technical Department, should be created.
- **Public Health/Environmental Engineering (EE):** The cell is recommended to be set up for all Class I and Class II cities with adequate staff (engineering staff with sub-ordinate staff) and experienced staff with PHE/EE degree or master's qualification and training/past working experience.

3.1.6.1 Design-cum-GIS Cell

To improve the quality of the Detailed Project Reports (DPRs), both in terms of design and estimations, it is recommended that urban water service providers/utilities create a design-cum-GIS cell. The Government of India's guidance on 24×7 PWSS includes a specific recommendation on hydrological modelling and these specialised cells that include GIS expertise will be required. The staffing recommendations as per the population served is shown in Figure 3.2 & 3.3

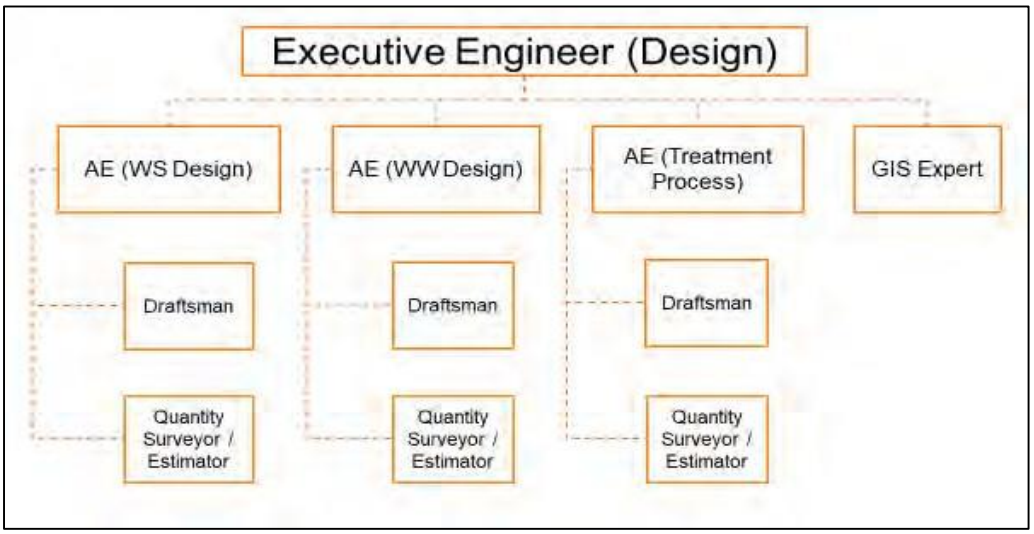


Figure 3.2: Design Cell Composition: > 10 lakhs

For cities with population between 5 lakhs to 10 lakhs, the Design Cell will report to the executive engineer. There will be one assistant engineer each for water supply design and wastewater design. They will be supported by one draftsman and one quantity surveyor/estimator each. The GIS Expert too will be placed in this cell.

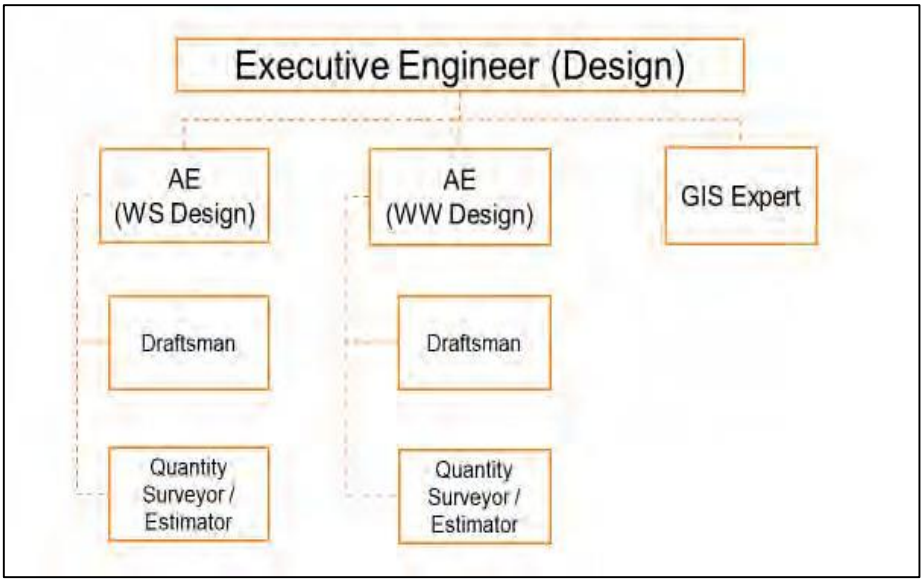


Figure 3.3: Design Cell Composition: 5-10 lakhs

For cities with population of more than 10 lakhs, the specialisation is greater with the introduction of separate skill sets for design of treatment processes.

A Design Cell is not considered economical for cities with less than 5 lakhs population and it is recommended that such cities either outsource the work or get it done from the cells in the cities with more than 5 lakhs population through government approvals.

3.1.6.2 Inter-Departmental Task Force on Non-Revenue Water (NRW)

Managing NRW is key to improving operational efficiencies and revenues for urban water service providers/utilities. It is recommended that all cities with more than 3 lakhs population constitute an inter-departmental task force on NRW headed by the Municipal Commissioner/Managing Director (in case of a parastatal). The proposed departmental representation is given in Table 3.7.

Table 3.7: Proposed Departmental Representation

Core Department	Constituent Units
Technical Department	• Distribution Network • Water Meter Installation (new connections) • Water Meter Service and Repair • Water Leakages & Damages Emergency Department • Asset Management • Planning, Design, and Supervision
Commercial Department	• Meter Reading • Billing and Collection • Customer Management
Finance Department	• Business Plan and Finance (this is proposed as an important function in the short to medium term)

The concept of NRW Cells is not new to India and was implemented in Surat. For further details, see Box 1.

3.1.6.3 Inter-Departmental Task Force on Communication

Communication is an important function for an urban water service provider as it helps in establishing and/or strengthening engagement with the consumers and other stakeholders. Effective communication contributes to increased revenues, effective redressal of grievances and awareness generation. Headed by the Municipal Commissioner/Managing Director (in case of a parastatal), the inter-departmental task force on communication should have representation from the following departments/functional areas:

- PR Unit – External communication
- Commercial Department – Billing & Collection
- Customer Management – Grievance redressal
- Technical Department – Customer relations – Metering Management

Box 1: NRW Cell in Surat

The Surat Municipal Corporation (SMC) had reported NRW at 20.4% under the SLB framework, but the reported NRW had low reliability due to the absence of volumetric metering in the water supply system. In response to rising consumer complaints about low pressure, leakages, and disruptions in the system in 2006-07, the SMC adopted a systematic approach of leakage mapping and leak repairs, along with a city-wide water audit. In 2007, the SMC set up an NRW Cell as an institutional response to provide clarity for planning, implementation, and monitoring of water supply services. The NRW Cell had the mandate to plan, develop, implement, and monitor an action plan for reduction of NRW, conducting periodic water audits, undertaking leakage mapping and repairs in a phased manner.

The Municipal Commissioner headed the NRW Cell that included Civil Engineers, Instrumental Engineers, Electrical/Mechanical Engineers, etc. The NRW Cell was guided/supervised by an NRW Committee comprising of City Engineer, additional City Engineer – Civil, additional City Engineer – Electrical, and Hydraulic Engineer. They were supported by six assistant engineers, one deputy engineer, and one nodal officer from each of the seven zones of the city. Staff from SMC's hydraulic department was involved in execution of the repair and related works.

The creation of the NRW Cell increased accountability and the early enthusiasm also yielded results. However, these mechanisms were not backed with adequate and appropriate resourcing and the NRW cell soon lost the initial momentum due to resourcing and structural limitations. Although the NRW Cell was headed by the Municipal Commissioner, it was largely housed within the hydrologic department which focused more on technical losses and leakage mapping. Insufficient attention was given to commercial losses and improving revenues. Cross-cutting initiatives like NRW require resourcing that cuts across departmental silos and need integrated planning, sustained institutional building, and diligent process transformation. The key limitation of the NRW Cell was that it did not consider commercial losses and its focus was mainly on leakage detection and repairs.

3.1.7 Public Health/Environmental Engineering

The cell should be established for technical inputs to the ULB in the process of planning and designing, including rehabilitation of the water supply infrastructure of the cities. Also, involvement of the unit must be regularly taken in Town Planning, Master Planning, O&M of the WTP, and overseeing the water quality monitoring of WTP and distribution system. The unit is recommended to be set up for all Class I and Class II cities with adequate staff (engineering staff with sub-ordinate staff) and experienced staff with PHE/EE degree or master's qualification and training/past working experience having the capability to give inputs in planning, designing, and operation of water supply system. Any decision related to the review of existing or selection of new technology must be vetted by the cell. Selection of such persons in the cell must be through a screening process by a committee headed by the Cities Commissioner/Administrative Head and Chief Engineer of the PHED, state department of the concerned zone. The strength of the cell (i.e., engineer and sub- ordinate) shall be decided by the same committee. To ensure effective and sustained functioning, KPI shall be drawn the Chief Engineer, PHED of the zone, and the performance of the cell must be monitored twice a year by the same committee. More information on the setting up and performance of cells can be had from government publications, manuals, and advisories published from time to time. Regular exposure of the members of the cell to technical seminars and workshops is a must to attain current knowledge and networking with subject experts.

3.1.8 Use of Market-Based Services

Not all activities to be performed by the urban water service provider need to be done in-house. In fact, there is an increasing trend to outsource certain functions. The decision on outsourcing is governed by a cost-benefit analysis, i.e., an understanding on whether it is more economic in the long run to outsource some services through performance-based contracts or whether to hire staff to perform the functions in- house. Hiring of staff is time-consuming and once hired, along with the salary (perks and increments as applicable), the retirement entitlements also need consideration and thus, this may be more difficult to implement. On the other hand, outsourcing through a performance-based contract is often more economical.

A market-based services approach is based on identification of a set of service providers who can help ULBs prepare plans and implement a variety of services for a market-based fee. Such services can be categorised into three groups, engineering/operations, technical support services, and other support services.

1. **Engineering/Operations Services:** A variety of services pertaining to engineering and operations are possible to be outsourced at each step in the urban water supply value chain and these could be in the following formats:

    - Public-Private Partnerships (PPPs) for constructing facilities: These are used for development of large facilities, such as water treatment plants, and usually see participation by larger contractors with regional or national reach.
    - O&M of facilities: These are largely management contracts without any commercial risks and are suitable for O&M of water treatment plants and/or distribution systems. It is also common to have construction combined with an O&M contract for 2–3 years.
    - Maintenance contracts/supply contracts: These contracts have evolved from service contracts to being more performance based. They include services like pump repair, motor rewinding, chlorination, redressal of leakage complaints, supply of

disinfectants, water tankers, etc.

2. **Technical Support Services**: Urban water service providers also use market- based services for project development and management, as well as for various technical studies, such as water and energy audits.
3. **Other Support Services:** Urban water service providers also use several other services that can help improve performance. These particularly relate to financial management and consumer interface-related services, such as computerised accrual accounting systems and consumer grievance redressal systems.

In order to ensure regular use of market-based processes by urban water service providers/utilities, it is essential that these services are easily available from reputed and reliable suppliers, are affordable in relation to potential benefits and are of good quality. Support from the state government through empanelment of consultants and building their capacity would help provide the right impetus to this process. The capacity of local technical consultants needs to be strengthened to provide such services in a cost-effective manner. Other measures, such as bundling of contracts and clustering, can help reduce prices and make the contracts viable. There is also a need to create awareness about the benefits of the market-based services approach in terms of saving costs, improving cost recovery, and consumer satisfaction.

3.1.9 Use of PPPs for ensuring 24×7 PWSS

In the context of moving towards 24×7 PWSS, urban water service providers/utilities are being encouraged to explore various types of PPPs. While the different types of PPPs possible have been discussed in section 8.7.2 of Chapter 8: Public - Private Partnership, there is a minimum staffing that is required for effective PPP operations and the same are detailed below.

- Minimum staffing to oversee PPP operations in the urban water service provider/utility
  - Executive Officer Water Supply – 1
  - Water Supply O&M Expert – 1
  - Design Engineer Water Supply – 1
  - Electromechanical Engineer – 1
  - Procurement Engineer – 1
  - Finance Officer – 1
  - Accountant – 1

- Minimum staffing from the PPP operator
  - General Manager – 1
  - Operation Manager – 1 for each distribution lines; 1 for connections; 1 for pumping machinery; 1 for treatment
  - Pump operators; WTP operators; valve men; plumbers; assistants & watchmen as assessed for O&M purposes
  - Office Staff – as required

3.2 Capacity Building and Human Resource Development

3.2.1 Understanding Capacity Building and Human Resource Development

Capacity building in the urban water sector has historically been confined to event- based administrative training, rather than being a long-term process-oriented exercise. Capacity building needs to be institutionalised in the planning and implementation process starting from the ULB to state to central level programmes.

Capacity building is a continuous initiative which depends on two interrelated concepts:

- First, strengthening of institutions at all levels to deal more effectively and efficiently, with all aspects of sustainable water service delivery, including the creation of a favourable policy environment, water resources assessment (both quantity and quality), planning, management, and programme and project formulation, implementation, and evaluation.
- Second, development of human resources at all levels including education, training, and the creation of working conditions that will lead to job satisfaction and high-quality performance.

Capacity building depends on adequate institutions and institutions depend upon human resources. An ideal institutional structure with staff not adequately trained to perform their roles has less potential than a poor structure with high-quality people. An effective institution along with high quality human resources are the best assurance of achieving the objectives.

3.2.2 Scoping capacity building

Capacity building programmes should aim to improve the attitude, knowledge, and/or skills of staff through learning experiences to achieve effective performance in the delineated role and to develop their abilities to satisfy the current as well as future needs of the organisation. The human resources managing the water supply services need to be trained not just on technical aspects but also on “soft skills” like leadership, time management, team building, conflict resolution to enable them to discharge their role effectively. The training and capacity-building programmes should be customised to suit different levels covering various technical, managerial, and leadership aspects.

The respective state departments need to develop a systematic training and capacity building plan for professionalisation of all actors engaged in the urban water supply service delivery. As a pre-requisite, each state department is encouraged to prepare a comprehensive training needs assessment of all concerned staff at all levels to ascertain skill gaps. The details of training delivery and duration are to be decided by the state.

Training needs can be classified as follows:

- **Short Term**: The primary aim of the short-term trainings is to improve the competence of the employees. The specific training needs can be identified through job analysis and training assessment and can be organised as in-house training programmes.
- **Long Term**: Long-term training needs address the future demands of the organisation and should be addressed by deputing staff to undergo formal educational programmes in urban water supply services. The evaluation of short- term training programmes should lead to assessment of long-term training needs. The states and ULBs need to associate with universities, technical colleges, public/private sector institutes offering formal programmes leading to certification or degree/diploma in urban water supply services and works.
- **Technical Training Needs**: Water supply services and works are an integration of

various fields of technology, such as civil engineering, architecture, mechanical engineering, electrical engineering, chemistry, etc. The technology and technical aspects related to this field of work evolve rapidly and thus an extensive understanding of technology is essential for the employees. Technical trainings are not only required in water works and O&M, but also for innovation and integration of emerging concepts like climate resilience and circular economy.

- **Managerial Training Needs**: The processes of planning, organisation, and finance in urban water supply services and works improve the effectiveness and bring sustainability to O&M. There is a dire need for strategy formulation and efficient decision making based on information, engineering, and management. Thorough understanding of the procedures of routine tasks along with periodic monitoring and evaluation of activities needs to be ensured through effective management systems. These trainings should also focus on cutting-edge management systems like asset management, MIS, PPP arrangements, project management and structuring, tendering procedures, etc., along with enhancement of capacity of managers.
- **IT Training**: The use of technology for day-to-day work is increasingly becoming important. This is, therefore, a key consideration and includes training on relevant portals, applications, daily monitoring software, etc.

3.2.3 Developing a Human Resources Development Plan

Professionalisation of urban water supply sector requires a detailed review of the current practices, identification of existing service delivery gaps, mapping of competency of existing human resources, and the development of new procedures and processes, along with training need assessment of relevant human resources for various roles in managing urban water supply systems. A systematic training and capacity building plan should cover:

- training needs assessment (TNA) and capability development plan;
- selection of participants – eligibility criteria, selection procedure, evaluation mechanism, nomination procedure, etc.;
- development of annual training plan calendar;
- mapping and identification of key training institutes/key specialists based on thematic TNA;
- development of training content and shortlisting of modes of imparting training;
- logistic arrangement and infrastructure assessment for training;
- evaluation, feedback, learning report, and documentation;
- assessing training budget requirements and mapping of potential source of funds.

3.2.4 Capacity Building – Emerging Areas

A comprehensive approach to capacity building is required which not only focuses on the technical aspects but also aims to improve the management and financial sustainability of urban water supply services and operations. Some emerging areas for training are:

- Technology innovation: GIS and network modelling; SCADA;
- Automation (IT, ITES, IoT, AI);
- Metering/meter management;
- GIS-based asset management;

- Use of hydraulic models for planning, design, rehabilitation, and operation of water distribution systems;
- Computerised maintenance management system;
- National policies & GoI programmes: 24×7 PWSS; IUWRM; PPP + community engagement; sustainability + tariff policies;
- How to reduce NRW;
- Recycling technologies to cater to reuse of water;
- Technologies for rejuvenation of water bodies;
- How to enter into PPP arrangements – concepts, types, various "do's and don'ts" – to move to 24×7 PWSS;
- Water testing using recent technologies.

In addition to technical skills, training in soft skills is equally important.

3.2.5 Capacity Building – Target Groups

Capacity building efforts needs to cover all stakeholders in the municipality including technical staff, municipal functionaries, contractors and their staff, elected representatives and citizens. The purpose of capacity building is to enhance the functional knowledge and improve the job-related skills of targeted groups. Training and capacity building activities need to cater to specific requirements of stakeholder groups and their roles in urban water service delivery. In addition to the technical staff, training should also be done for "decision makers", i.e., elected representatives and government officials, especially town planners. The areas of training segmented by target groups is provided in Table 3.8:

Table 3.8: Areas of Training Segmented by Target Groups

Elected Representatives	• Budgetary allocations and permissible projects • Brief introduction and emerging trends and technologies in water supply – climate resilience, IUWRM, 24×7 PWSS, smart solutions for water management, SCADA, rainwater harvesting, rejuvenation, and reuse of water • Leadership and team management skills • Digital literacy • Water governance and institutional management • Orientation on City Water Balance Plans and City Water Action Plans
Town Planners	• Land monetisation • Form-based planning, local area plans, and town planning schemes
	• Preparation of master plans • Integration of GIS and Water Network Technology • Integration of new schemes with existing water supply schemes

The broad areas of soft skills trainings segmented by target group are given in Table 3.9:

Table 3.9: Broad Areas of Soft Skills Trainings Segmented by Target Group

For Elected Representatives	Leadership, Team Management
For Technical Staff and Contractors	Digital Literacy (specific modules will depend upon the staff's job and responsibilities), team management, time management, handling customer grievances
For Administrative Staff	Digital Literacy (specific modules will depend upon the staff's job and responsibilities), time management, handling customer grievances

3.2.6 Developing a Training Calendar

3.2.6.1 Stages for Training Delivery

Training delivery for any organisation needs to be in two stages.

- First, foundation/induction/onboarding training which is done for new recruits at time of joining and before posting. It includes aspects of management, job requirement as well as field experience.
- Second, mid-career training, envisaged to be for skill enhancement or refresher course may be done before promoting or posting to a higher level.

Both these trainings need to be incorporated in the training calendar.

3.2.6.2 Modes for Training Delivery

There are various modes for delivery of training programmes and the same are elucidated below:

Training at Regional, State, and ULB Levels: Within the state, the relevant departments are mandated to develop training plans and devise policies for promotion/increments based on training availed. State level officers are encouraged to undergo training at national training institutions and/or institutions abroad. Regional workshops must be organised for dissemination of knowledge pertaining to emerging urban water supply trends and/or technologies. At the ULB level, all staff must be provided with opportunities for training. ULB staff should be encouraged to participate in courses organised by reputable institutions in the state. Training for lower level of functionaries should be conducted in the local language.

Online Training: There are many platforms available for imparting online training. Empaneled institutions by CPHEEO/Ministry of Housing and Urban Affairs (MoHUA) can be involved in development and imparting of online training modules. The training modules should have a mix of presentation of concepts, case studies followed by discussion, problem-solving scenarios, videos, etc. A stable and reliable internet connection is essential to conduct such programmes and this factor must be assessed while determining the training mode.

On-the-Job Training: On-the-job training is a method wherein the operators are provided training at the workplace itself. It helps the operators to develop and practice technical/managerial/administrative skills required in O&M of urban water supply services. On-the-job training helps the trainee operators in learning theoretical and practical concepts

simultaneously and develop expertise in the field. This must be considered as the primary method of training, every time a new system for operation or maintenance is introduced.

Training of Trainers (ToT): The ToT model aims to engage experienced trainers in coaching new trainers who are less experienced on a particular topic or skill, or with training overall. ToT is imperative for effectively conveying the knowledge and skills from the trainer to the trainees. ToT programme is designed for the trainers to refresh the skills they already possess and to learn approaches of training that would help them in teaching their skills further to the urban water supply O&M trainees. A ToT programme should clearly explain objectives and need of training for urban water supply services professionals, demonstrate existing and upcoming technologies in the sector, and explain the process of carrying out systematic TNA. Usage of appropriate audio-visual aids and participatory learning activities needs to be promoted. It should be ensured that with the new or improved skills, the trainers are able to organise training programmes to support other trainees to develop skills.

One of the critical problems with training programmes is that the training courses seek participation of staff who may not be directly involved in the specific area on which training is being imparted. See Box 2 for an example of a successful model for designing training programmes.

Box 2: Capacity Building Exercise in Water Supply and Wastewater Management for Engineers of Municipalities of Tamil Nadu

The Capacity Building Exercise in Water Supply and Wastewater Management for Engineers of Municipalities in Tamil Nadu was formulated for municipal engineers under a World Bank programme. The aim of the capacity building exercise was to develop a comprehensive understanding of the practical aspects of continuous water distribution systems through interactive lectures, hands-on trainings, and field visits.

A total of 150 municipal engineers with a minimum residual service life of 10 years were selected after a test. The training was given in six batches of 25 engineers, and was divided in two components:

- Component 1: Five days classroom and hands-on residential training at Chennai;
- Component 2: Classroom training and site visits to various installations of Manila Water and Maynilad – two successfully implemented ADB aided projects for continuous water distribution and NRW reduction.

The training was facilitated by Tamil Nadu Water Investment Company Limited, Maynilad Water, and a local NGO at Manila. It covered technical, operational as well as managerial aspects of 24×7 PWSS and NRW reduction.

Focus areas: The focus areas of the training include Hydraulic Design of Water Supply and Distribution Systems; Hydraulic Design of Sewerage Systems; Gradual switch over to continuous pressurised system from the present intermittent supply system; Project Cost Estimation & Project Control; Design of District Metering Areas; Reduction of UFW/Leakage; O&M Aspects from intake to pumping to distribution; Pump Maintenance and Pipe Condition monitoring; Takeover/Handover protocols from contractors; Different Contract Structures/Arrangements; SCADA/ICT systems; Water and Energy Audits, leak identification; New trends in treatment technologies – for both water supply and sewage.

3.2.7 Scoping of Training Institutions and Courses

PHE/EE education in India is largely provided by engineering institutes, while very limited training provided through institutes of public health. Through engineering institutes, teaching, and training in PHE/EE is offered both at pre-service and in- service level. Pre-service teaching and training in PHE/EE include diploma, degree (graduate), and post-graduate courses affiliated to various state technical boards, institutes, and universities. Whereas in-service training is mainly provided by GoI recognised engineering and public health training institutes.

3.2.7.1 Pre-service teaching and training in PHE/EE

1. **Diploma in PHE/EE:** State-run PHE Departments, some state technical education boards and universities are offering diploma courses in PHE/EE. Presently, the numbers of institutes or boards awarding these diplomas are limited. Details of such programmes will be made available, ULB may refer MoHUA website for updated information in this regard.
2. **Degree Courses in PHE/EE:** PHE/EE education at undergraduate level is mainly offered to students pursuing civil engineering. All engineering colleges through their departments of civil engineering provide such teaching and training. The study duration of the entire course is four years of which PHE/EE is only a small component. It is necessary for PHE/EE degree programmes to include courses on environmental chemistry and microbiology, principles of environmental science and engineering, applied hydraulics and fluid machines, ecology, water supply engineering, industrial safety, microbiology, solid waste management, air pollution and control, wastewater, noise pollution and control, energy engineering, occupational hazards and industrial hygiene, disaster management, transport of water and waste water, hazardous waste management, industrial waste management and environmental impact assessment, etc.
3. **Post-Graduation Courses in PHE/EE:** Post-graduate teaching and training is mainly offered by engineering colleges which have facilities for post-graduate teaching in civil engineering and EE. The All-India Institute of Hygiene and Public Health (AIIH&PH), Kolkata is the only institute of public health in the country which awards Masters in Engineering Public Health (MEPH) degree. The uniqueness of this training programmer which differentiates it from other engineering institutes/universities providing either M. Tech or M.E. degree is that the teaching and training at AIIH&PH lays emphasis on core public health domains. In contrast to this, engineering institutes/universities/organisations provide training on EE covering broad domains of water and wastewater management. However, they lack the foundation of public health courses as taught in AIIH&PH, Kolkata.

The two-year P.G. programme is recommended/sponsored by the Ministry of Housing and Urban Affairs (MoHUA) for in-service engineers working in water supply and sanitation agencies, including ULBs. These courses can address the long-term training needs of the staff members. The names of the recognised institutes for post- graduate courses are presented in Table 3.10.

Table 3.10: Post-graduate Courses in PHE/EE

S. No.	Institute	Course Duration
1	Indian Institute of Technology Delhi, New Delhi	24 months
2	Veermata Jijabai Technological Institute, Mumbai	24 months
3	Visvesvaraya National Institute of Technology, Nagpur	24 months

S. No.	Institute	Course Duration
4	Sri Jayachamarajendra College of Engineering, Mysore	24 months
5	Motilal Nehru National Institute of Technology, Allahabad	24 months
6	Shri G.S. Institute of Technology and Science, Indore	24 months
7	Indian Institute of Technology Bombay, Mumbai	24 months
8	Malaviya National Institute of Technology, Jaipur	24 months
9	Anna University, Chennai (Centre for Environmental Studies)	24 months
10	Indian Institute of Technology, Kharagpur	24 months
11	Jawaharlal Nehru Technological University, Hyderabad	24 months
12	All India Institute of Hygiene and Public Health, Kolkata	24 months

3.2.7.2 Short-Term Course in PHE/EE

Short-term courses can help the existing staff in improving their competency. This programme has been tailored in such a way that diploma engineers working in state PHE departments/water supply and sewerage boards/ULBs get adequate exposure towards the concepts and nuances of PHE, so that they can apply the same in the field. At present, this short-term course is conducted at two institutes *viz.* Anna University, Chennai and Sri Jayachamarajendra College of Engineering, Mysore and is of three months duration.

3.2.7.3 Refresher Course in PHE

Refresher courses on various aspects of design, construction, O&M of water supply and sanitation facilities including solid waste management are conducted on regular intervals by the ministry through different academic, research, and professional institutions and state departments. The duration of refresher courses varies from one week to four weeks.

Beside these refresher courses, PHE departments of different states also conduct refresher courses on recent advances in water and sanitation. Organisations such as Indian Water Works Association (IWWA) with its branches in 27 cities in different states, AWWA through its Indian affiliate AWWA India Association, Institution of Public Health Engineers (IPHE), Kolkata, National Environmental Engineering Research Institute (NEERI), Nagpur, along with their partner institutes provide short-term and refresher courses on different aspects of PHE and EE.

The list of refresher courses offered by CPHEEO are presented in Table 3.11.

Table 3.11: CPHEEO – List of Refresher Courses

S. No.	Name of the Refresher Course	Place	Conducting Agency	Duration
1	Water Works Supervisors Course	Nasik Road	MEETRA., M.J.P.	4 weeks
2	Water Works Supervisors Course	Palasuni, Bhubaneshwar	P.H. Dept.	4 weeks
3	Water Works Management (Junior level)	Thiruvananthapuram	K.W.A.	3 weeks
4	Water Supply System Management	Chennai	TWAD Bd.	1 week

S. No.	Name of the Refresher Course	Place	Conducting Agency	Duration
5	Water Supply System Management	Nasik Road	R&T.C., M.J.P.	10 days
6	Pipes & Conduits	Nasik Road	—do—	12 days
7	Pipes & Conduits	Mumbai	C.T.I. & R.C., M.C.G.B.	9 days
8	New Development in Water Treatment	Kolkata	AIIH & PH	10 days
9	Structural Design on Water Treatment Plants and Other Related Structure	Nagpur	V.N.I.T.	1 week
10	Water Treatment Plant Design	Nagpur	V.N.I.T.	1 Week
11	Public Health Engineering Structures	Chennai	TWAD Bd.	9 days
12	Filter Operation	Nasik Road	R&T.C., M.J.P.	10 days
13	Filter Operation	Chennai	C.M.W.S.S. Bd.	12 days
14	Care & Use of Chlorinators	Mumbai	C.T.I. & R.C., M.C.G.B.	1 week
15	Care & Use of Chlorinators	Chennai	C.M.W.S.S. Bd.	1 week
16	Water Analysis	Kolkata	AIIH & PH	4 weeks
17	Water & Wastewater Analysis	Jaipur	P.H.E.D.	4 weeks
18	Chemical Analysis of Water	Chennai	TWAD Bd.	7 days
19	Preventive Maintenance and Leak Detection in Water Distribution System	Nasik Road	R&T.C., M.J.P.	10 days
20	Preventive Maintenance and Leak Detection in Water Distribution System	Mumbai	C.T.I. & R.C., M.C.G.M.	1 week
21	Preventive Maintenance and Leak Detection in Water Distribution System	Chennai	TWAD Bd.	10 days
22	Corrosion Control	Chennai	C.M.W.S.S. Bd.	1 week
23	Total Quality Management	Thiruvananthapuram	K.W.A.	1 week
24	Computer Aided Design of Pipelines and Pipe Network for Water Supply and Sewerage Systems	Nagpur	V.N.I.T.	1 week
25	Computer Application in PHE Structures Design	Indore	S.G.S.I.T.&S.	10 days
26	Rainwater Harvesting	Kolkata	I.P.H.E.	-do-

S. No.	Name of the Refresher Course	Place	Conducting Agency	Duration
27	Cathodic Protection	Mumbai	C.T.I. & R.C.M.C.G.B.	1 week
28	Computer Application for Water Distribution System Management and Water Treatment Plant Design	Mysore	S.J.C.E	-do-
29	Computer Aided Design of Water Supply & Sewer Network	New Delhi	AIILSG	10 days
30	Computer Application for Water Distribution System Management	Chennai	Anna University	10 days
31	Computer Application for Water Distribution System Management	Mumbai	AIILSG	10 days
32	Computer Aided Design of Water and Wastewater Treatment Plants	Allahabad	MNNIT	1 week
33	Scientific Source Finding	Gandhinagar	G.J.T.I.	1 week
34	Maintenance & Management Related to Municipal Water Works	Chennai	TWAD Board	1 week
35	Surface Drainage in Medium and Small Towns	Bhopal	AIILSG	1 week
36	Laying of Water Mains & Sewer Lines	Chennai	CMWSS Bd.	1 week
37	Ground Water	Kolkata	I.P.H.E.	1 week
38	Treatment of Arsenic, Iron & Fluoride in drinking water	Kolkata	I.P.H.E.	1 week
39	Operation and Maintenance of W.S. and Sanitation	Kolkata	AIIH & PH	10 days
40	Water Quality Surveillance	Mysore	S.J.C.E.	12 days
41	Positive Preventive Maintenance of Water Supply and Sewerage System	Bhopal	AIILSG	1 week
42	Plumbing & Non-Plumbing Mains for Water Supply System- Design, Operation & Maintenance	-do-	-do	-do-
43	Total Quality Management in Water Supply System	-do-	-do	-do-
44	Water Supply from Ground Water Sources – Quantity/Quality and Ground Water Recharge	-do-	-do	-do-
45	Preparation of Water Supply Projects	-do-	-do	-do-
46	Tender & Contract	-do-	-do	-do-

S. No.	Name of the Refresher Course	Place	Conducting Agency	Duration
47	Water supply & Sanitation to Buildings	Kolkata	I.P.H.E.	1 week

3.2.8 Rewards and Recognition

As the urban water supply service providers/utilities transition towards a more "corporatised" style of functioning, staff accountability and promotions should begin to be linked to achievement of "key performance indicators" (KPIs) – the complexity to be linked to the position that is held at that point.

Some proposed KPIs for technical staff could include as per **Annexure 3.1**:

It is also recommended that staff of urban water supply service providers/utilities above the grade of assistant engineer must have completed a diploma course in PHE and their promotion should include this as a mandatory criterion. As the transition progresses, the completion of training in PHE could be made mandatory from entry level.

3.2.9 Community Partnership and Norms for Jal Sathis/ Water Companions at DMA/ Ward Level

Community partnership is considered essential for sustainable and effective drinking water distribution management system. Onboarding community members (Jal Sathis/ Water Companions) as partners is key for efficient delivery of drinking water supply related services at consumers' doorstep. Selected community members (Jal Sathis/ Water Companions) from the SHGs, community-based organizations, RWAs etc., of the respective service area shall be engaged to act as a bridge between the water supply authority & the consumers.

The community partners (Jal Sathis) must be selected from the same community where their services are expected and shall be given responsibility of at least 400 to 600 households in the DMA or Municipal Ward. The roles and responsibilities of these community partners shall be as below;

- Reading water meters
- Doorstep water bill generation & distribution
- Collection of water user fees through MPoS machine (Digital Payment)
- Field testing of water quality at user end
- Facilitation of consumer complaint redressal
- Facilitating new water connections
- Support to Regularize unauthorized connections
- Sensitizing public on water conservation, health & hygiene aspects

The water supply authority shall provide periodical trainings and orientation to their Jal Sathis/ Water Companions on their functional roles and responsibilities. The Jal Sathis/ Water Companions partnership shall be on a performance linked incentive model. For example, a case study of Odisha community partnership model is cited herewith for reference.

Odisha has onboarded Jal Sathis (Friends of Water) as change agents from the members of the local Women SHGs, mostly housewives of lower- or middle-income families and deployed them at Ward level in all 115 Urban Local Bodies of the State on a performance linked incentive model. Their involvement as trusted partners in State's water journey guaranteed near 100 per cent revenue return as well as a catalytic ingredient towards increased consumer delight along with socio economic empowerment of the women. Government of Odisha has signed MoUs with local SHG Federations for 2 years initially and the MoU is renewable on performance base thereafter.

The incentive structure is as below;

Sl. No.	Activity	Incentive for Jal Sathis/ Water Companions
1	Mobilization and Awareness Creation among consumers for initial 3 months	Rs. 4,000/- per month
2	Water Tariff Collection	5 per cent of total collection
3	New Residential Water Connection	Rs. 100/- per connection
4	New Commercial Connection	Rs. 200/- per connection
5	Regularizing unauthorized Connection	Rs. 100/- per connection
6	Water Quality Testing	Rs. 20/- Per Test

However, the States/ULBs can have their own model to engage Jal Sathis/ Water Companions for carrying out the activities as mentioned above. It is recommended to engage one Jal Sathis/ Water Companion for 400-600 households in the DMA or Municipal ward. The States/UTs may decide minimum renumeration to the Jal Sathis/ Water Companions as per the prevailing norms.

CHAPTER 4: FINANCIAL MANAGEMENT OF WATER UTILITIES

4.1 Financial Management

A robust financial management system ensures effective and efficient utilisation of financial resources. Financial Management maturity model has the following components – accounting and financial reporting, budgeting and financial sustainability, internal audit, external audit, internal controls, and governance.

A robust financial management system requires strengthening of all components as indicated in the graphic given in Figure 4.1:

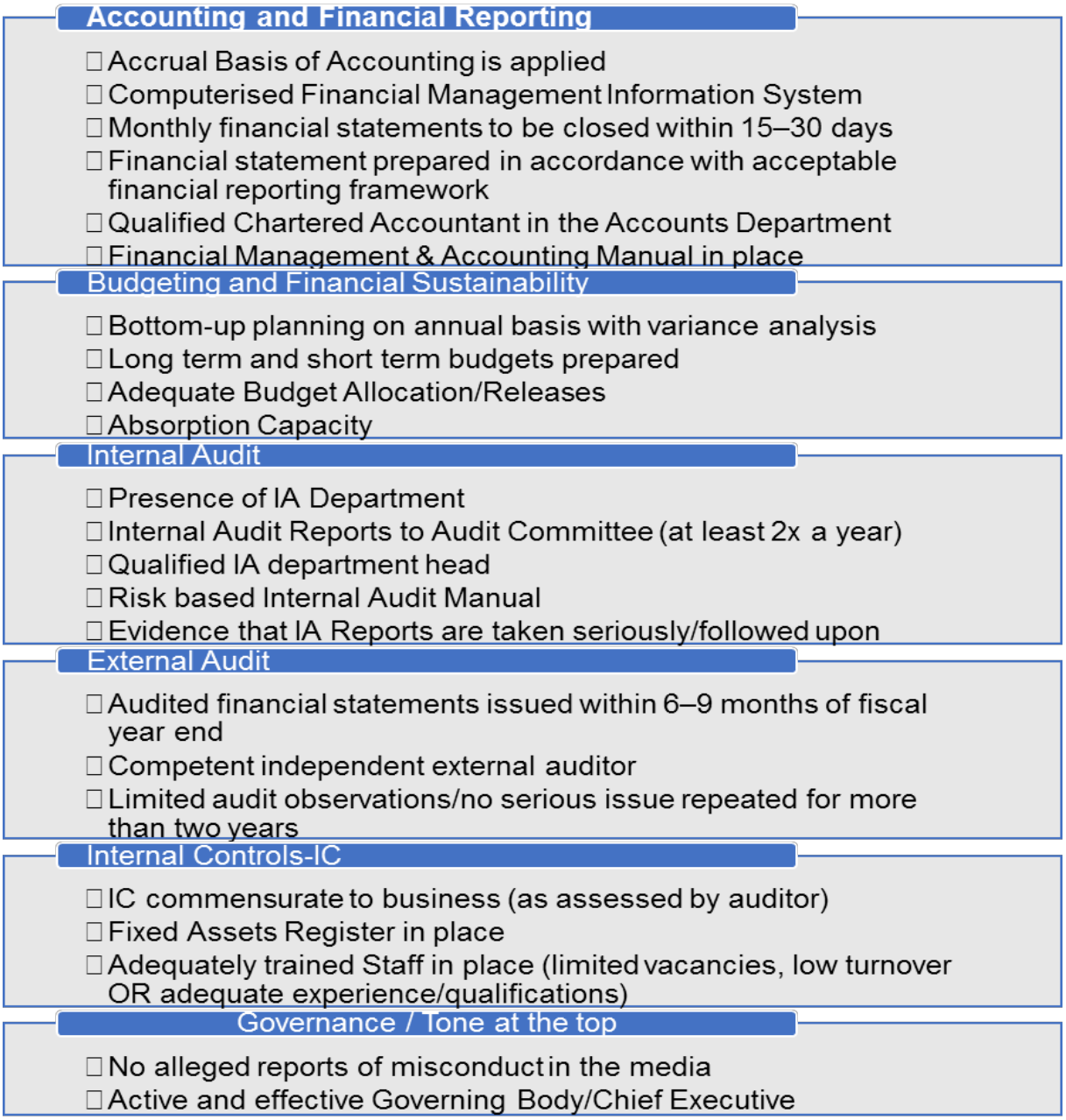


Figure 4.1: Components of Robust Financial Management System

4.1.1 Components of Financial Management

Financial Management comprises planning, budgeting, monitoring, auditing, disbursement, accounting, fund flow, cost optimisation, and effective procurement with efficient use of resources. These have been discussed in other sections of this chapter.

4.1.2 Financial Sustainability for Water Utilities Sector

Every urban service provider is required to be financially viable in order to be sustainable. To achieve financial sustainability, the focus should be on the following factors:

- **Governance Issues**: improve the water sector governance in relation to execution, planning, and implementation.
- **Centralisation and Decentralisation of Water Utility Functions**: to integrate the water utility among the network of Urban Local Bodies (ULBs) and distribute the work responsibilities to workforce in a planned way to monitor their performance and assessment accordingly.
- **Standard Operating Procedure & Framing of Policies**: policies, procedures, methodologies, and governing laws related to water must be well defined and documented so that every stakeholder can refer to the same.
- **Capacity Building and Training**: to reform in order for each stakeholder to achieve the objective of urban water supply at 24×7 on annual basis.
- **Technology Adaptation and Best Practices Adoption**: to address the technical issues and reforms and adaptive smart electronic gadgets and systems for security, timely service to users and cost-effective methods. Also, remain keen to adopt best water sector practices.

4.1.3 Financial Ratios

Financial ratios are helpful in analysing financial data of entities and identifying correlations between financial variables. Financial analysis reveals trends in ratios over the historical and the projected period, which can identify potential financial weaknesses and strengths. An entity's financial capacity can be assessed by its ability to match or exceed the benchmark or threshold set for various financial ratios. This threshold can be set at market or industry acceptable levels or can be entity specific. The broad categories of financial ratios are as follows:

4.1.3.1 Operating Performance Ratios

Operating ratio is defined by the operating expenses (excluding debt service and depreciation) and operating revenues. A healthy utility should have an operating ratio of about 0.75. The average for Indian water utilities is 1.63, which requires huge subsidies from central or state governments. A first step in getting the finances of a utility in order is to ring-fence the water utility operations. This will allow management of finances purely for the water utility's operations. It will require increasing its revenue base, meaning more connections. Tariff level is the most important component of revenues apart from the number of consumers. Reducing the operating ratio will also require reducing operating expenses, which means increasing staff productivity while reducing energy costs and other expenses. The better these ratios are, the better it is for shareholders as explained in Table 4.1.

Table 4.1: Operating Performance Ratios

Ratio	Formula	Purpose	Applicable Sector
Fixed asset turnover	*Revenue/Average Net Fixed Assets*	Measures effectiveness in using fixed assets to generate revenue	Capital intensive industries, e.g., energy, telecommunications, airline
Total asset turnover	*Revenue/Average Total Assets*	Measures ability to generate revenue given the entity's asset base	All sectors
Accounts receivable turnover	*Revenue/Average Accounts Receivable*	Measures the number of times the business can collect the average accounts receivables in a year	All sectors where trade and service provision are predominant activities
Accounts payable turnover	*Cost of Sales / Average Accounts Payable*	Measures the number of times the business can pay off its average accounts payable during the year	All sectors where trade and service provision are predominant activities
Revenue per employee	*Revenue/Average Number of Employees*	Measures employee productivity	Service-oriented industries, e.g., IT, health, education, telecommunications
Days in receivables	*Average accounts receivable * 360/revenue*	Measures the average number of days required to recover accounts receivable	All sectors where trade and service provision are predominant activities
Days in accounts payable	*Average accounts payable * 360/cost of sales*	Measures the average time span of unpaid payables	All sectors where trade and service provision are predominant activities
*Average means "(beginning of year balances plus end of year balances), divided by 2."			

4.1.3.2 Profitability Ratios

Profitability Ratios assess the entity's ability to generate earnings as compared to its expenses and other costs incurred during the reporting or projection period as explained in Table 4.2.

Table 4.2: Profitability Ratios

Ratio	Formula	Purpose	Applicable Sector
Net income margin	Net profit after tax/net revenue	Measures profitability from all operations	All sectors
Operating profit ratio	Earnings before interest and tax/net revenue	Measures profitability from core operations	All sectors

Ratio	Formula	Purpose	Applicable Sector
Return on assets	Net income/average total assets	Measure effectiveness in using assets to generate profits	Capital intensive industries, e.g., energy, telecommunications, airlines
Return on equity	Net income/average equity	Measures effectiveness in using shareholders' investments (capital) to generate profits	All sectors: generally, where entities are funded mostly by shareholders rather than creditors
Return on capital	Net income/average equity + average debt	Measures effectiveness of leverage in generating profits	All sectors: generally, where entities are financed with mix of debt and shareholders' capital
*Average means "(beginning of year balances plus end of year balances), divided by 2."			

4.1.3.3 Debt Ratios

Debt ratios measure the capital structure of the entity and help assess if the capital structure is optimal. If the debt ratio exceeds the industry average or the optimal structure for the entity, it would be indicative of higher financial risk as explained in Table 4.2.

Table 4.3: Debt Ratios

Ratio	Formula	Purpose	Applicable Sector
Debt ratio	Total liabilities / total assets	Measures the amount of leverage used by the entity	All sectors
Debt–equity ratio	Total debt/total equity	Measures the commitment from entity creditors versus what shareholders have invested	All sectors
Interest coverage ratio	Earnings before interest but after taxes/interest expense	Measures the ability of the entity to pay interest on outstanding debt with its available earnings	All sectors
*Average means "(beginning of year balances plus end of year balances), divided by 2."			

4.1.3.4 Debt Service Coverage Ratio

The debt service coverage ratio is a financial ratio that measures the ULB's ability to service its current debts by comparing its net operating income with its total debt service obligations. In other words, this ratio compares an entity's available cash with its current interest, principle, and sinking fund obligations.

Debt Service Coverage Ratio = Operating Income/Total Debt Service Costs

Net operating income is the income or cash flows that are left over after all of the operating expenses have been paid. This is often called earnings before interest and taxes or EBIT. Net operating income is usually stated separately on the income statement.

Given that the debt service coverage ratio measures a firm's ability to maintain its current debt levels, a higher ratio is always more favourable as it indicates that there is more income available to pay for debt servicing.

4.1.3.5 Solvency and Liquidity Ratios

Solvency Ratios show whether the entity's cash flow is sufficient to meet its debt service obligations for long-term liabilities. The lower a company's solvency ratio, the greater the risk that it may be unable to meet its long-term debt service obligations in a timely manner.

Liquidity Ratios determine an entity's ability to meet its short-term obligations in the ordinary course of business. Solvency and Liquidity Ratios are given in Table 4.4.

Table 4.4: Solvency and Liquidity Ratios

Ratio	Formula	Purpose	Applicable Sector
Debt service coverage ratio	Free cash flow from operations/debt service requirement (interest and principal)	Measures the adequacy of operating cash flows to service debt	Capital intensive industries, e.g., energy, telecommunications, airline
Self- financing ratio	Free cash flow from operations after debt service/average capital expenditure Free cash flow from operations = cash flow from operations – capital expenditure	Measures the adequacy of operating cash flows to finance capital expansion and replacement	Capital intensive industries, e.g., energy, telecommunications, airline
Current ratio	Current assets/current liabilities	Measures the ability to pay short-term creditors using assets that are convertible to cash within one year without having to liquidate investments or long-term assets	All sectors, particularly industrial, transmission, distribution, airline where the need for working capital is prominent
Quick ratio	Current assets – inventory – prepaid expenses/current liabilities	Measures the ability to pay short-term creditors using cash and cash equivalents (assets that are easily convertible to cash)	All sectors

*Average means "(beginning of year balances plus end of year balances), divided by 2."

4.1.4 Financial Management Assessment Indicators

4.1.4.1 Budget Management

- **Order of Fund Management:** The allocation of budgetary support must be ranked in order of the priority sector mechanism defined under SOP and investment portfolios.

- **Credibility and Substantial Progress:** The optimisation of public financial resources must be reviewed periodically to avoid any deficit under budget allocation for ULB actual results.
- **Optimum Overhead Allocation:** The budget overhead must be managed to achieve the water mission for each class of demand. This can be achieved by promoting socially efficient water use, reducing non-revenue water (NRW), and reducing water pollution. The natural resistance such as drought, climate change study should be taken into considerations.
- **Capacity Building:** The review procedure and continuous training for stakeholders' forms an important component for the success of the water mission. Moreover, it optimizes the allocation of financial resources across demands raised under Budget.
- **Documentation of Incentive and Non-Incentive Schemes:** the socioeconomic and environmental water utility financial resources must be addressed and backed up in a strong documentation and approved by a designated nodal officer.

4.1.4.2 Liquidity Management/Working Capital Management

The ULBs must assess the working capital requirements under their budgeting process and periodical evaluation at regular intervals for the identified gaps. The gaps should be addressed by the ULB/PMU/PIA on the requirement basis.

4.1.4.3 Petty cash and Cash Management System

Cash Management involves management of cash inflow and outflow on periodic basis. A ULB's cash asset management method involves ensuring that all process-generated revenues are effectively realised, booked, and used transparently in the best possible manner for planned activities to result in gains for the organisation. The management of cash resources holds the central position in the area of short-term financing decisions. Holding of cash carries the opportunity cost of earnings, which is determinable if the cash is either under use within the organisation or is under investment elsewhere.

4.1.4.4 Review of Periodical Financial Reports and Action

The financial statements prepared by the Water Utilities Service Providers must be reviewed by the officials of PMU/PIU primarily. Thereafter, internal audit review and external auditor appointed by CAG must review the same independently before issuing their report. After getting reports by ULB, financial statements should be reviewed including the settlement of the queries.

4.1.4.5 Cash Flow Statement

Cash flow forecasts should be based on reasonable assumptions and prepared in consultation with the executing agency and/or implementing agency. Sometimes optimistic revenue projections are made to demonstrate project financial viability. The reasonableness test will be to compare the results based on such assumptions with the historical track record (For example, if the historical tariff increases have not been regular every year, or below inflation, it will be unreasonable to assume an annual inflation-linked tariff increase). Very high increases or profit percentages may be unrealistic, as the government or regulator is unlikely to permit them. Assumptions will include, among others, exchange rates used, applicable tariff, user fee or toll charges, and the methodology for their determination and revision; demand; basis for estimating operations and maintenance (O&M) costs; income and business taxes; and depreciation rate.

Forecasts should be updated, at the minimum, after any material change of scope and additional financing, at midterm review and at completion. The updated forecasts provide information on the potential financial impact of the implementation issues.

This statement has three main categories: operating cash flows, investing cash flows, and financing cash flows. Operating cash flows are net cash flows from the normal course of business operations of the entity. Investing cash flows refers to the net cash flows spent on fixed assets or properties and equipment. Financing cash flows consist of net external funds such as borrowings, grants and subsidies, and the associated interests and charges on these external funds.

4.1.4.6 Accounts Receivable

Accounts receivable equivalent in months is a measure of collection period or the time it takes to collect water bills. While 2–3 months is reasonable, the average for the Indian water utilities is 4.9 months, with 60 per cent having it greater than 3.0 months. Efficient utilities resort to measures, such as strict disconnection policies against delinquent consumers, information campaigns, collection reminders, incentives, and penalty systems for early or late payments, and providing more customer-friendly environment for receiving payments.

4.1.4.7 Tariffs

In setting tariffs, the first consideration must bear consistent transparent tariff policy endorsed by the Government. Government subsidies to the sector, as well as so-called “cross subsidies” within the sector, need to be clearly outlined. Demand management through higher rates for high consumption and a lifeline rate where there are urban poor should be considered in the tariff structure. Mechanism for tariff adjustment must be defined. Ideally, an independent regulatory authority to monitor and approve tariffs must be established. Water utilities need to generate from tariffs a cash flow that will cover O&M costs, debt servicing (both capital repayment and interest), and provide a contribution to capital development.

4.1.4.8 Financial Analysis

Financial analysis of the project executing and/or implementing entity aims to evaluate whether the concerned entity is financially robust enough to undertake the project and operate and maintain the project assets. This involves assessing the ability of the entity to operate as a going concern, to operate and maintain the entire network of assets including the project, and to fund recurrent costs. The institutional capacity of the project-operating entity to implement the project should also be assessed. Financial analysis and evaluation are highly skilled tasks and should be performed by experienced finance professionals with thorough knowledge of the country, sector, and project. Financial due diligence of ULB projects broadly comprises several interlinked activities. These include:

(i) financial management assessment;
(ii) preparation of cost estimates and financing plan;
(iii) financial analysis;
(iv) financial evaluation; and
(v) designing funds flow, accounting, and auditing requirements.

Each of these aspects will affect the others (e.g., financial management capacity will affect all

the other aspects of financial due diligence, cost estimates and financing plan affect financial viability, etc.).

A financial evaluation is required to assess financial viability in cases where a project or a project component is intended to recover all costs without any external support. The financial evaluation is performed in real terms at the project/component level, after excluding the impact of inflation, on an after-tax basis. This is required at the project/component level.

Methods for financial analysis: Several methods are available for conducting financial analysis. The following examples may be used in isolation or in combination with other methods:

- **Common-Size Analysis** – comparing the behaviour of one financial parameter against a base parameter or variable. This analysis allows analysts to spot trends over time and against peers.
- **Comparative Ratio Analysis** – use of financial ratios and variance analysis to compare movements from one period to another.
- **Peer comparison** – comparing performance of the entity against entity/entities in the same sector or entities of similar nature or size.
- **Benchmarking** – comparing performance of the entity against industry norms.

4.1.4.9 Economic Analysis

Economic analysis should justify both the choice of public involvement and the form it takes. Economic of Water Sector analysis involves the examination of:

(i) current and future demand;
(ii) existing sources of supply, their costs, and any intended investment that may compete with the project;
(iii) the contribution of the proposed project to sector demand, cost reduction, or technological innovation;
(iv) the extent of direct government involvement in the sector either as a producer or financier and any government subsidy to or taxation of the sector; and
(v) whether additional physical investment embodied in the project under consideration is the best solution to the problem at hand.

4.1.4.10 Demand Analysis

As part of project preparation or feasibility study, demand analysis establishes the existing and future consumer demand for goods and services to be produced by a project and provides a basis for estimating the project's economic benefits. A project that fails to attract an adequate level of demand for its output, at an appropriate price, will not be operating efficiently and will create a misuse of scarce resources. Market research and user surveys can be used to estimate demand at different price levels. Project demand should also be assessed in the context of the likely total future demand for and supply of the product to establish how far the project will take market share from existing producers and whether its output will have an impact on the market price. Decisions on project scale should allow for the impact of proposed tariffs on the level and timing of project demand.

4.1.4.11 Alternative Analysis

Economic efficiency requires that the proposed project represents the most efficient option among available feasible alternatives for addressing the identified problem. In many cases, this means that the selected project should have the lowest discounted cost per unit of output or outcome. However, when project alternatives have very different benefit flows, for example, because of quality differences, alternative analysis cannot be based on the cost comparison alone, and the most efficient project option is the one with the highest ENPV, provided that its investment is within budget. In some cases, alternative analysis may be supplemented by multi-criteria analysis, depending on the data available. Alternative analysis should be carried out as part of project preparation.

Economic viability requires that a project is designed such that its net economic benefits are sustained during the project's economic life. This includes demonstration of the financial and institutional sustainability of a project. Assessing financial sustainability requires two types of analysis: financial evaluation of the project and financial analysis of the project-executing and/or implementing entity. The former focuses on the ability of the project to generate sufficient incremental cash flows to cover its financial costs (capital and recurrent costs). In this regard, analysis of the cost-recovery objectives and mechanisms of the project is important. Without full cost recovery, a financial evaluation will be meaningless. In the case of full cost recovery, the financial net present value (FNPV) discounted at the project's weighted average cost of capital (WACC) must be greater than zero, and the financial internal rate of return (FIRR) must be greater than WACC.

4.1.4.12 Analysis Matrix

- Analysis of Financial Statements and Operational Indicators
- Analysis of Financial Models of Water Utilities
- Analysis of Cost-of-Service Delivery
- Analysis of Water Utility Credit Worthiness
- Performance Measurement on Periodic Basis

The responsibility of ULB is to provide services and the expenditure of such services should be incurred out of the collected revenues. Revenue collection and expenditure management in the right way can be evaluated to assess whether the municipal government is doing its responsibilities. To test the efficiency and effectiveness of revenue collection and expenditure management, qualitative and quantitative indicators can be used. Current revenues do not always match current expenditures. As a result, there may be either a surplus or deficit. Therefore, recurrent surplus is a significant indicator for assessing financial performance of ULBs as it contributes towards infrastructure development. Generating revenue surplus is a difficult task for small and medium-sized Indian ULBs because of poor revenue collection and inadequate transfer from higher level of governments. Expenditure management tool, if effectively used, may be helpful to such ULBs in achieving recurrent surplus.

4.1.4.13 Time Value of Money

The value of money received today is different from the value of money received after some time in the future. An important financial principle is that the value of money is time dependent. This principle is based on the following four reasons as explained in Table 4.5:

Table 4.5: Reasons for change in Time Value of Money

Inflation	Under inflationary conditions the value of money, expressed in terms of its purchasing power over goods and services, declines.
Risk	Re. 1 now is certain, whereas Re. 1 receivable tomorrow is less certain. This "bird-in-the-hand" principle is extremely important in investment appraisal.
Personal Consumption Preference	Many individuals have a strong preference for immediate rather than delayed consumption. The promise of a bowl of rice next week counts for little to the starving man.
Investment Opportunities	Money like any other desirable commodity has a price, given the choice of Rs. 100 now or the same amount in one year's time, it is always preferable to take the Rs. 100 now because it could be invested over the next year at (say) 18 per cent interest rate to produce Rs. 118 at the end of one year. If 18 per cent is the best risk-free return available, then you would be indifferent to receiving Rs. 100 now or Rs. 118 in one year's time. Expressed another way, the present value of Rs. 118 receivable one year hence is Rs. 100.

4.1.4.14 Present Value

It is a method of assessing the worth of an investment by inverting the compounding process to give present value of future cash flows. This process is called "discounting". The present value of "P" of the amount "A" due at the end of "n" conversion periods at the rate "i" per conversion period.

The value of "P" is obtained by solving the following equation: P = A (1 + i).

4.1.4.15 Determining the Discount Rate

The WACC is the cost at which the project financing will be secured. WACC is used as the discount rate to estimate the FNPV of the project cash flows. The WACC is based on the financing plan for the project and computed only for the project sources of financing, and not for the entity. There are many principles for estimating the cost of different sources of financing.

Debt with Fixed Interest Rates: Fixed interest rate remains unchanged for the life of the debt, irrespective of market conditions (e.g., loans from ADB's concessional resources). The cost of debt will include the interest, service charges, commitment fees, front-end fees, maturity premium, and any other charges, as defined in the debt contract.

Debt with Variable Interest Rates: Variable interest rates respond to market movements and change during the life of the debt. A fixed swap rate for the corresponding tenor should be considered. The London Interbank Offered Rate (LIBOR) fixed swap rate corresponding to the average maturity of the project loan can be taken as a proxy for the likely average cost over the life of the loan. If the exact tenor is not published by the Treasury, the project team may apply the nearest period for which a rate is available or seek assistance from the Treasury to obtain the relevant rate. For projects that are implemented with private sector participation (e.g., public–private partnerships), the cost of equity needs to be assessed based on market considerations, since the investors will have several investment options.

Grants also have an opportunity cost. While the equity has an expectation of returns, no such expectation can be attributed to grant funds. For this reason, the cost of grant funds can be estimated as equal to the comparable interest rate for highly liquid government bonds (e.g., 10-year treasury bonds) adjusted for project tenor, without any adjustment for project risks.

4.1.4.16 Calculating Weighted Average Cost of Capital

Where there are multiple sources of funding (as reflected in the project's financing plan), a single cost of capital can be derived by averaging all the cost of funds considering the financing allocation. This is referred to as the WACC, which acts as a proxy to the overall cost of capital raised for the project. Given that it is purely an estimation, the WACC may not be fully reflective of the market opportunity cost of capital. Thus, the WACC should not be equated to value for money or minimum required rate of return expected by private equity investors.

The following steps should be taken to calculate WACC:

(i) Estimate the nominal cost of each funding source.
(ii) Calculate after-tax nominal cost of each funding source using applicable tax rate.

Calculate after-tax real cost of each funding source using applicable inflation rate. If the after-tax real cost is negative, it should be treated as zero.

Calculate the weighted average of the after-tax real cost of each funding source using the funding ratio as weights. The resulting WACC is the estimated capital cost incurred by the project owner necessary to implement the project.

4.1.4.17 CAGR – Compounded Annual Growth Factor

CAGR stands for the **Compound Annual Growth Rate.** As the name implies, it is an average growth year-over-year for a given period. CAGR is calculated for an investment over a period of years. In simple words, CAGR helps measure how much you have earned on your investment every year. Some important point about CAGR:

1. CAGR is the Compound Annual Growth Rate, which is the same for all years.
2. CAGR is different from the general growth rate.
3. CAGR is repetitive in nature, while the traditional growth rate can be different for each year.
4. CAGR is helpful to find the overall growth rate for an investment.
5. CAGR calculation requires three essential components, i.e., present value (PV), future value (FV), and the number of years, to find the growth rate of your investment.

CAGR is the **rate of return** that is required for the investment growth from opening amount to closing amount, assuming that the profits were reinvested at each year-end of the investment's life span. Basically, CAGR is a number or percentage (growth rate) based on which your investment grows every year.

1. CAGR = $\left(\frac{\text{End Value}}{\text{Start Value}}\right)^{\frac{1}{\text{Years}}} - 1$ or CAGR = $\left(\frac{\text{FV}}{\text{PV}}\right)^{\frac{1}{\text{n}}} - 1$

Where, FV is future value, PV is present value, and n is the number of periods. These values same as

1. FV = end value,
2. PV = start value, and
3. N = years (number of years).

If you already know the overall growth rate, i.e., (FV-PV)/PV for over a period of days, use the following formula instead. It means if you know the number of days instead of years.

2. CAGR = $(1 + \text{growth rate})^{\frac{365}{\text{days}}} - 1$

Here, (1 + growth) = (End value/Start value) (1/years) = (365/days)

4.1.4.18 ARR – Accounting Rate of Return

ARR indicates the profitability from investments using simple estimates which helps in evaluating capital projects. This method divides the net income from an investment by the total amount invested in obtaining the ARR. Using ARR will enable the investors to decide on viability and profitability of capital projects to be undertaken. It also helps investors analyse the risk involved in the investments and conclude if the investment would yield enough earnings to cover the risk level.

It is one of the widely used financial ratios and comes handy during the decision- making process when different projects must be compared and selected. However, ARR calculation does not consider the interest accrued, taxes, inflation, etc. This makes it an insufficient method for huge and long-term capital investments. The ARR defines the measurement of investment return over the period of project.

ARR (Accounting Rate of Return) = Average Accounting Profit/Average Investment

4.1.4.19 Computation of Internal Rate of Return (Project IRR and Equity IRR)

The internal rate of return (IRR) method considers the time value of money, the initial cash investment, and all cash flows from the investment. But unlike the net present value (NPV) method, the IRR method does not use the desired rate of return but estimates the discount rate that makes the present value of subsequent cash inflows equal to the initial investment. This discount rate is called IRR. IRR definition: IRR for an investment proposal is the discount rate that equates the present value of the expected cash inflows with the initial cash outflow.

This IRR is then compared to a criterion rate of return that can be the organisation's desired rate of return for evaluating capital investments.

Calculation of IRR: The procedures for computing the IRR vary with the pattern of net cash flows over the useful life of an investment.

IRR = Low rate + NPV at Low Rate / (NPV at Low Rate - NPV at High Rate) * (High Rate - Low rate)

Acceptance Rule

The use of IRR, as a criterion to accept capital investment decision involves a comparison of IRR with the required rate of return known as cut-off rate. The project should be accepted if

IRR is greater than cut-off rate. If IRR is equal to cutoff rate, the firm is indifferent. If IRR is less than cut off rate, the project is rejected.

Thus, If IRR ≥ Cut-off Rate or WACC	Accept the Proposal
If IRR ≤ Cut-off Rate or WACC	Reject the Proposal

The IRR is a metric used in financial analysis to estimate the profitability of potential investments. IRR is a discount rate that makes the NPV of all cash flows equal to zero in a discounted cash flow analysis.

- The IRR is the annual rate of growth that an investment is expected to generate.
- IRR is calculated using the same concept as NPV, except it sets the NPV equal to zero.
- IRR is ideal for analysing capital budgeting projects to understand and compare potential rates of annual return over time.

The analysis for estimating the IRR and NPV of the project costs and benefits measured in economic prices over a specified period of time.

4.1.4.20 Assessment of Net Present Value

The NPV technique is a discounted cash flow method that considers the time value of money in evaluating capital investments. An investment has cash flows throughout its life, and it is assumed that an amount of cash flow in the early years of an investment is worth more than an amount of cash flow in a later year. The NPV method uses a specified discount rate to bring all subsequent cash inflows after the initial investment to their present values (the time of the initial investment is year 0).

The NPV of a project is the amount, in current value of amount, the investment earns after paying cost of capital in each period. Net present value = Present value of net cash inflow - Total net initial investment, since it might be possible that some additional investment may also be required during the lifetime of the project, then appropriate formula shall be: Net present value = Present value of cash inflows - Present value of cash outflows. It can be expressed as below:

Net Present Value = PV of Inflows - PV of Outflows

NPV is the difference between the present value of cash inflows and the present value of cash outflows over a period of time. It is a tool of capital budgeting to analyse the profitability of a project or investment. The NPV calculated at the discount rate should be greater than zero or positive for a project to be acceptable. When analysing (mutually exclusive) alternatives, the alternative with the greatest NPV is preferred.

4.1.4.21 Pay Back Method

Payback period is the time required to recover the initial cost of an investment. It is the number of years it would take to get back the initial investment made for a project. Therefore, as a technique of capital budgeting, the payback period will be used to compare projects and derive the number of years it takes to get back the initial investment. The project with the least number of years usually is selected.

It ignores the time value of money. All other techniques of capital budgeting consider the concept of the time value of money. Time value of money means that a rupee today is more valuable than a rupee tomorrow. So other techniques discount the future inflows and arrive at discounted flows. The payback period defines that period in which investment under project is paid back to equity owner. The formula is as follows:

Pay Back Period = Total Initial Capital Investment/Annual Expected After-tax net cash flow

4.1.4.22 Profitability Index (PI)

This will indicate the return assessment whether project is accepted or rejected based on the investment cash flows over the period of project. The assessing formula as follows:

Profitability Index (PI) = Sum of discounted cash inflows Initial cash outlay / Total discounted cash outflow

4.1.4.23 Risk & Sensitivity Analysis

The financial cost-benefit evaluation is performed on the most likely scenario (the base case). However, it is only an estimate. The potential risks to the outcome and their impact on the FIRR and FNPV need to be evaluated. Risks need to be assessed in terms of severity of impact and probability of occurrence. The sensitivity of the project performance (FNPV, FIRR) to such risks should be assessed. Common risks include capital cost overrun, time overrun, delays in tariff revisions, lower demand, and underachievement of project objectives. The risk and sensitivity analysis may be divided into the following steps:

(i) Identify risk events or risk factors;
(ii) Determine severity of impact and probability of occurrence;
(iii) Calculate the effect of the impact on base case FNPV and FIRR and summarise results and identify mitigating actions.

Sensitivity analysis is the determination of how the movement of an independent variable affects a dependent variable for a given set of assumptions. The switching value is defined as the percentage change in the independent variable to reduce the FNPV to 0. The sensitivity indicators and switching values provide an objective guide to assessing key risks and designing mitigation measures and covenants.

Sensitivity Indicator – The ratio of the percentage change in NPV to the percentage change in a selected variable. A high value for the indicator indicates project sensitivity to the variable.

The sensitivity analysis may identify one or more risks that could be serious for the project's financial viability. For instance, a delay in tariff revisions, lower than anticipated off take or less than anticipated improvements in efficiency, may undermine anticipated cash flows. If there is higher probability of occurrence of such risks, such risks should be rated as substantial or high, reported in the RRP together with suitable mitigation measures, and monitored during implementation.

Some examples of risk mitigation:

(i) Restructure the financing plan to reduce WACC;

(ii) Change the project scope; and/or
(iii) Re-evaluate cost estimates, e.g., cheaper ways of implementing project.

The analysis of the possible effects of adverse changes on a project. Values of key variables are changed one at a time, or in combinations, to assess the extent to which the overall project result (NPV, IRR) would be affected. Where the project is shown to be sensitive to the value of a variable that is uncertain, that is, where relatively small and likely changes in a variable affect the overall project result, mitigating actions at the project, sector, or national level should be considered.

4.1.4.24 Critical Path Method & Pert Method

The critical path method (CPM) is a technique that's used by project managers to create a project schedule and estimate the total duration of a project.

The CPM method, also known as critical path analysis (CPA), consists in using a network diagram to visually represent the sequences of tasks needed to complete a project. Once these task sequences or paths are defined, their duration is calculated to identify the critical path, which determines the total duration of the project. CPA helps:

- Identify task dependencies, resource constraints, and project risks;
- Accurately estimate the duration of each task;
- Prioritise tasks based on their float or slack time, which helps with project scheduling and resource allocation;
- Identify critical tasks that have no slack and make sure those are completed on time;
- Monitor your project progress and measure schedule variance;
- Use schedule compression techniques like crash duration or fast tracking.

The PERT chart identifies the critical path to estimate the minimum amount of time that will be needed to execute all the tasks of a project. This is done by examining the breakdown of the project, estimating the duration of each activity, the dependencies between them and the order in which they must be completed.

4.1.4.25 Gantt Chart

A Gantt chart is a stacked bar chart that contains project tasks on a vertical axis and timelines that represent task duration on a horizontal axis. Summary elements, task dependency relationships and milestones in the project schedule are all depicted. By preparing Gantt chart, one can easily see:

- The start date of the project schedule;
- What the project tasks are;
- Which team member is working on each task;
- When activities start and finish;
- The completion percentage for each activity;
- How tasks group together, overlap and link with each other;
- Task dependencies such as finish-to-start, start-to-start, finish-to-finish, and start- to-finish;
- Milestones and project phases on the schedule;
- The critical path of the project;

- the finish date of the project.

4.1.4.26 Cost-Benefit Analysis

The cost-benefit evaluation is a discounted cash flow analysis performed in real terms on an after-tax basis in the presentation currency. The cash flows over the economic life of the project should be estimated in the presentation currency of the executing agency and/or implementing agency, which will usually be the national currency in which the executing agency and/or implementing agency earns and incurs the major portion of its revenues and costs. Where some of the cash flows occur in currencies other than the presentation currency, the assumptions pertaining to exchange rates used for converting such foreign currency cash flows to the presentation currency should be stated.

Estimating economic benefits and costs associated with the proposed project requires establishing “with project” and “without project” scenarios and comparing the two. The without project scenario is not necessarily the business as-usual case, as there may be instances where the current position is untenable and some steps toward mitigation are needed even without the proposed project. Monetary values of project benefits and costs, associated with outputs and inputs, must be identified in the years in which they arise. Any external effects affecting the rest of the economy but not reflected in market transactions by the project itself — such as adverse or beneficial environmental impacts — where they can be identified, must also be included.

4.1.5 Financial Modelling

The model is usually characterised by performing calculations and makes recommendations based on that information. The model may also summarise events for the end user and provide direction regarding possible actions or alternatives. There are various kinds of financial models that are used according to the purpose and need of doing it. Different financial models solve different problems. While majority of the financial models concentrate on valuation, some are created to calculate and predict risk, performance of portfolio, or economic trends within an industry or a region.

Among different types of financial model, DCF model is the most important. It is based upon the theory that the value of a business is the sum of its expected future free cash flows discounted at an appropriate rate.

Also referred to as the “Comparable” or “Comps”, it is the one of the major company valuation analyses that is used in the investment banking industry. In this method, we undertake a peer group analysis under which we compare the financial metrics of a company against similar firms in industry. It assumes that similar companies would have similar valuations multiples, such as EV/EBITDA.

4.1.6 Cost Control and Cost Reduction Measures

The cost accounting system and their accounting standards guide (www.icmai.in) the ULB for cost reduction and optimisation of cost in techno-commercial assessment, based on standard and actual data which may be prepared by the subject expert and results, are used for better financial accounting and management. The records can be prepared using electronic software which may be further modified using excel analysis on day-to-day basis under leadership of ULB management. The results are variably better on periodic basis and continuous improvement plan may be prepared.

The effectiveness of the costing system depends on the definition of cost centres and cost objects for each ULB and it is further broken into sub cost objects and cost drivers for better cost allocation and decision making. As an example, if a present costing system is established for the water and sanitation services of a ULB, the proposed costing system should define broad categories of cost centres based on the activities ranging from sourcing to consumption of the water and sanitation service.

The objective of service-based accounting is to arrive at the income and expenditures for services separately and to assess the service delivery viabilities. This is possible through the adoption of cost-accounting principles and standards of direct expenses and the capturing of indirect and overhead expenses through allocation and apportionment procedures. As a result of the ring-fenced accounting procedure adopted, the accounting system should be able to provide the overall cost of a service and revenue for a period and per unit of service.

The costing system should use the account codes defined under the financial accounting system. The costing reports are primarily for management decision making. These reports include cost sheets for each stage in the process and at an overall level. The main benefit of implementing the costing system under ULB is cost reduction, cost management, and maintaining the quality of service on long-term basis.

4.1.7 Framework of the Municipal Performance Index

The verticals that are covered by the Index include:

Services Sector (weightage 30%): Education Health Water & Wastewater SWM & Sanitation Registration & Permits Infrastructure

Finance (weightage 20%): Revenue Management, Expenditure Management, Fiscal Responsibility, Fiscal Decentralisation

Technology (weightage 15%): Digital Governance Digital Access Digital Literacy,

Planning (weightage 15%): Plan Preparation Plan Implementation Plan Enforcement

Governance (weightage 20%): Transparency and Accountability Human Resource Participation Effectiveness

4.1.8 Financial Controls

There is a need to adopt financial controls which have the target of generating recurrent surplus through appropriate planning and expenditure control systems. Local governments are becoming increasingly dependent on their own source revenues to cover recurrent expenditures. Municipalities are among the local urban government's dependent on local revenue sources to finance some of public infrastructure and services.

Therefore, the ULBs should try to meet the recurrent expenditure out of its own source revenues. The legislatures should not only appropriate money, but they should also ensure that funds are spent according to their intent, in an economic and efficient manner and produce the intended results. So far as the transfers from upper tiers of government are concerned, these should be expended efficiently in accordance with the direction. In view of the above, there is a need to adopt financial controls for expenditure management.

Recurrent surplus or deficit is the difference between recurrent income and recurrent expenditure. Income consists of two broad components, own source, and government grant. Expenditure side includes specific payment made out of the grant and other O&M payment made out of the own source receipts. The controls are to be exercised in the following manner:

Control 1: This control covers tied revenue grants received from upper tiers of governments. The grant should only be expended for the intended purpose. However, a ULB should also exercise financial control to ensure that the amount of any tied grant is either equal to or more than the specific expenditures.

Control 2: A ULB should try to meet the administrative, O&M costs (all expenses other than those covered by tied grants) out of its own source revenue collection. The control is exercised when own source receipt is more than the expenditure.

Exercising above controls altogether ensures recurrent surplus only. If a ULB exercises either of the controls, there will be a decrease in recurrent deficit. In case a ULB fails to exercise either of the controls, as above, it is obvious that there will be recurrent deficit.

4.1.9 Expenditure Management

ULBs are not sure either about adequate resource mobilisation at their own level or about adequate and timely transfer of fund from upper tiers, constraining the working. It has become a necessity of the present days that ULBs should provide services within available resources and to generate revenue surplus for infrastructure development.

Management of expenditure demands for appropriate planning relating to expenditure control and it begins with preparation of realistic budget and implementing budgetary control system. So far as the Indian ULBs are concerned, budgets are generally seen as a statutory requirement and the purpose is limited to providing sanctions for expenses and revenues. Small and medium-sized Indian ULBs should think of exercising some other sort of financial control for expenditure management as preparation of budget and budgetary control cannot be effectively used.

4.1.10 Asset Management

Asset management is the process of inventory, valuation, use, strategic portfolio reviews, reporting and auditing of municipal assets as part of the decision-making process of local governments. The system is based on simple, easy-to-use screens and is fully web-enabled which will make it possible to deploy the system in multiple ULBs from a central data centre. Transition to a fully online accounting system will ensure that the data is captured in the system at the point of creation and is immediately available for real-time reporting and effective decision making. Perhaps most importantly, the system is fully integrated to the ULB's various revenue and expenditure sources which will enable the administration to generate easy to understand reports summarising the ULB's key financial indicators on real time.

- Assets are valued in compliance with accounting standards and 10-year forecasts and are generally based on extrapolation of past expenditures.
- 10-year forecasts are based on asset management data including expected life, renewals, and service levels. Clear underpinning assumptions are stated. Expenditures are classified according to asset management categories.
- Asset valuations and revaluations have a high level of confidence. Financial forecasts are

tied exclusively to asset management systems.

- All financial data have a very high level of confidence.
- Financial modelling is used to simulate various capital expenditure scenarios and impacts on life cycle costs and service delivery.

4.1.11 Internal Audit & Internal Controls

Real-time audit of transactions will ensure error-free environment and avoidance of fraud and manipulation by any insider and/or outsider. An internal audit wing may be established by ULB for internal control mechanism and transparent resolution. The external internal audit may be appointed for the said routine financial transactions and non-financial activity which is within the scope of the internal auditors. The statutory auditor may also refer to the internal control mechanism, which involves a joint effort between internal auditor and the ULB management.

4.1.11.1 Audit Committee

An Audit Committee will be formed to overview the Audit Function. The composition of the Audit Committee will be decided by the Steering Committee.

Frequency: The audit will be conducted on a quarterly basis.

Timeline: The Internal Audit report should be submitted within 30 days from the end of quarter. Internal Audit Report will be submitted to the PIA with a copy to PMU.

The PMU will place the report in the Audit Committee along with its observations/comments.

The PMU will follow the same internal control and authorisation procedures as defined for MOUD for implementation of components. The PIAs will follow the authorisations and internal control systems as described in their respective Acts. In addition to above, the PIA will follow the procedures defined in different sections of ULB for budgeting, accounting, and reporting.

4.1.11.2 Types of controls

(i) **Organisational** – which defines the authority and responsibility of individuals and/or sections, e.g., organisation charts showing the division of duties amongst staff, and departmental instructions for the conduct of the duties of each officer or section.
(ii) **Segregation of Duties** – no one officer should process and record a transaction from start to finish, e.g., the officer placing an order for goods or services must not sign the cheque for payment.
(iii) **Physical** – secure areas for stores, documents, etc., e.g., controlled stationery such as blank cheques must be kept in a locked safe and their use accounted for.
(iv) **Authorisation and Approval** – all transactions are authorised at the appropriate level, e.g., only officers of a specified grade or above may sign cheques.
(v) **Arithmetical and Accounting** – all transactions are arithmetically correct and are accounted for, e.g., use of sequentially numbered documents, regular bank reconciliations, etc.
(vi) **Supervision** – of day-to-day transactions, e.g., “spot checks” by senior officers of all activities.
(vii) **Management** – review of results, e.g., monthly financial and management accounts, internal audit reports, etc.

The three fundamental elements that generally make up any transaction:

- Authorisation – the initiation of the transaction.
- Custody – the handling of assets involved in the transaction.
- Processing – the creation of documentary evidence of the transaction

4.1.11.3 Effective and Efficient Use of Resources

- Assess whether tariffs are set for partial cost recovery, whether they are adequate to cover cash O&M costs.
- Assess if tariffs are insufficient to recover O&M costs and make appropriate arrangements for subsidy from the governments.
- Extent of metering at different levels and management of NRW.
- Metering, billing, and collection efficiency, and accounts receivable management.
- Income affordability assessment.

4.2 Financial Accounting and Planning

The municipal governments have always been maintaining accounts in a cash-based system. The flaws in such a system are obvious – financial statements are not indicative of actual financial position and the true financial performance of the municipality cannot be assessed, resulting in ineffective financial planning.

Information gaps in the cash-based system can be addressed by moving to an accrual-based system. The same will help generate more accurate picture of the financial position of the entity and make information readily available for effective financial management.

As the pressure on the municipalities to become self-reliant grows, municipal governments will increasingly be forced to look to generate funds from alternative sources like the open financial markets (e.g., municipal bonds).

This requires a certain degree of fiscal discipline and transparency that would be possible only by making the transition. The Citizen's Right to Information is expected to force the governments to maintain its records better and as the citizen participation in governance increases, the municipalities will be expected to provide an accurate picture of the financial position coupled with an ability to respond to increasingly sophisticated questions in a timely manner. Some of the key expectations from the new accounting system for ULBs are as follows:

a) Assist stakeholders to assess the ULB's financial position, including the level of financial sustainability.
b) Develop a robust financial reporting system that would satisfy the requirements of the banking system/debt markets as the ULBs approach these channels for funds.

    i. Aid in making the ULB's performance transparent and accountable to people.
    ii. Assist all stakeholders in evaluating efficiency and effectiveness of financial performance.

A transition to a double-entry, accrual-based accounting is a complicated one that requires a close co-ordination between all the stakeholders. Some of the key operating guidelines that came to be adopted during the entire process are:

Process Re-Engineering is a Necessary Pre-Requisite: Definition of rules, guidelines and operating processes is essential for a successful implementation.

Standardise Processes: The various municipalities cover City Corporation, Municipalities and Town Panchayats. One critical determinant of a scalable and manageable solution is the standardisation of processes across all the ULBs. Standardised processes ensure that they are easier to manage and more importantly, lessons learnt from one ULB can easily be applied to the other ULBs.

Software Enabled Processes: The software deployment of e-Gov Financials is being done in parallel to the deployment of the processes. This ensures that there is an early adoption of the software and that the users do not have to go through two stages of learning. A standardised process for all the ULBs has ensured that the same software application will be deployed for all the ULBs – which greatly reduces the maintenance cost projections.

Software for Non-Accountants: One of the key requirements of the software team was to develop software that could be used by non-accountants. This required the provision of screens that are easy to navigate and use, with the actual accounting treatment handled by the system as a background process.

Finance Management: The focus of the implementation must be effective Finance Management, not mere bookkeeping. This calls for proper control procedures like budgetary controls built into the system as well as a reporting tool which is embedded into the accounting software.

Proactive Information Disclosure: e-governments foundation is making all attempts to embody this in all its products. In line with this approach, the financial management system is expected to provide information at an aggregate level focusing on the financial position of the ULB to the citizens via delivery mechanisms like the city portal.

4.2.1 Accounting System

The following principles need to be kept in mind while developing financial management systems in urban water service providers:

Going Concern: The financial statements of ULB are prepared assuming that the ULB is a going concern, that is, the ULB will continue to be in operation for an infinite period and ULBs will not be curtailing the materiality of the scale of operations. Accounting policies have been so adopted that it conforms to the assumption of a going concern and operations being continued on a perpetual basis, e.g., in case demand raised is not collected in the current year, the same is taken as an arrear.

Consistency: This principle assumes that the accounting policies being followed by ULBs are consistent at periodic intervals and adopted financial year which may also be a calendar year. Significant accounting policies of ULB should be adopted in such a manner that it is consistent from one financial period to another, and any variance may also be disclosed with reference to such item included under financial statement, e.g., in case straight line method is used for charging depreciation, the same should be used consistently and should not be changed every year.

Accrual: Revenues and costs are accrued, that is, recognised as they are earned or incurred (and not as money is received or paid) and recorded in the financial statements of the periods to which they relate. If the ULBs are not following the accrual system in its entirety, then the items or the transactions, for which the accrual system is not followed, shall be disclosed.

4.2.2 Accounting Methodology (Cash Based and Accrual Based)

4.2.2.1 Cash-Based Accounting

Under the cash-based system, revenue items are recognised only when cash receipt of such transaction is actually received, regardless of the timing when the revenue was actually accrued. Similarly, expenditure transactions are recognised under books of accounts only when cash is actually paid, irrespective of the timing when the expenditure is accrued. This accounting method does not take into consideration the accrual concept of receivables, payables, non-cash items of expenditure, provisions, etc., due to which it is difficult to ascertain the real financial position of the ULB. The cash basis of accounting records transactions only on receipt and payment of cash (for income and expenditure items) and not when such income and expenses accrue to ULBs.

As a result, an analysis of the true and fair view of the activities of the ULBs is not possible as income accrued (but not received) and expenditure incurred (but not paid for), are not reflected in the financial statements of the ULBs. The adoption of this method is necessary for cash management under ULB accounts structure which is significant to comply with budgetary and legislative guidelines as per state laws adopted by ULB.

4.2.2.2 Double Entry Accrual-Based Accounting Systems (DEAS)

Under this system, the recording of the transactions in which revenues, costs, assets, and liabilities are reflected in the books of accounts of the period in which they accrue and arise, not based on cash event, or say, irrespective of actual receipt or payment taking place during the period.

The basic feature of a DEAS is that it considers timing of each event and makes a distinction between capital and revenue items. Therefore, accrual-based accounting helps in accurately determining the financial performance and financial status of a ULB for any period and on any date.

This system of accounts provides the following important aspects which fix the accuracy of accounting system followed by ULB:

- Under the accrual system, revenue is recognised when it is earned and the claim of the entity in respect of which such revenue is recognised becomes reasonably enforceable. Thus, an item of income constitutes revenue even if cash was not received against it.
- Expenditure is recognised when the liability for payment arises even if the payment is not made at that time.
- The system matches expenditures for a particular year with the income earned in that year, thus providing a basis for a correct understanding of the true operating performance of a ULB in a particular year.
- Accrual-based accounting clearly distinguishes between items of a revenue nature and items of a capital nature, which helps in the correct presentation of financial statements

of income and expenditure account and balance sheet for reporting financial year as adopted by the ULB.

- Under the accrual system of accounting, costs, which are not charged to the income and expenditure account, are carried forward and kept under continuous review. Any cost that appears to have lost its utility or its power to generate future revenue is written off.
- The surplus or deficit, as shown at the year-end under the accrual accounting system, represents the true and correct financial position of the ULB, which is based on the transactions of the year.
- Information available through accrual-based accounting assists in proper financial analysis and reporting and better financial management.
- The financial statement prepared by a ULB under the accrual system of accounting presents a proper picture of what it owns and what it owes.
- Accrual-based accounting facilitates better knowledge of the "full" cost of services and helps in identifying the financial viability of rendering services. With accrual- based accounting, the cost incurred for providing specified services is more readily available and ascertainable, thereby enabling decision makers to identify the subsidy granted and the extent of recovery of cost.

The introduction of a modern web-based system requires in-depth training for accounting staff and for other departments that need to utilise the improved information. The new accounting and financial reporting systems also require adaptive changes at the state and city levels for each ULB under it. Also, capacity building and training of ULB staff and connected stakeholders on a continuous basis for adoption of best practices and reporting bugs of the system, if any, which may be fixed with the System Controller.

The following reports can be generated using an entry accrual system of accounting.

- Trial Balance;
- Income and Expenditure Statement;
- Balance Sheet;
- Receipts and Payments Account; and
- Cash Flow Statement.

The following Accounting Manuals and Code of Laws can be referred for best accounting practices for ULB to adopt the true and fair accounting practices.

- UP Municipalities Act 1916;
- UP Municipal Corporation Act 1959;
- UP Municipal Account Code and Municipal Corporation Accounts Rules (including amendments);
- National Municipal Accounts Manual issued by the Ministry of Urban Development, Government of India.

Above two accounting approaches are discussed, where each one has their own significance of accounting procedures, but for getting best financial reporting, the double accounting entry method is preferred due to their vast coverage of income and expenditures along with provisions. ULB can adopt the same under customised software or ERP system on real-time basis to centralise the information and getting quick analysis over generated reports for better implementation of financial plan under each sector.

The successful conversion or full implementation to a DEAS is not an end, but rather a beginning in the process of reforming the financial management of ULBs. Certain reforms can be undertaken only after the successful conversion from single entry cash-based accounting system to a DEAS by the ULB.

4.2.3 Financial Reporting System

The results of the project financial evaluation and financial analysis are presented in water utility project documents. The documents are:

(i) During processing: financial analysis linked document, covenants in the legal agreement.
(ii) During implementation: audited project financial statements, auditors' opinions, and quarterly progress reports.
(iii) At completion: project completion report.

4.2.4 Indian Accounting Standard for Urban Local Bodies (ASLB)*

To adopt best practices, any ULB can adopt the general accepted accounting principles along with Indian accounting standards and convergence standards. The ULBs/water service providers must also refer to the Guidance Note and Accounting Standard Guidelines issued by the Apex Accounting Body of India as per Table 4.6:

Table 4.6: List of Indian Accounting Standards

AS Number	Accounting Standard Title
1	Presentation of Financial Statements
2	Cash Flow Statements
3	Accounting Policies, changes in Accounting Estimates and Errors
4	The Effects of Changes in Foreign Exchange Rates
5	Borrowing Costs
9	Revenue from Exchange Transactions
11	Construction Contracts
12	Inventories
13	Leases
14	Events After the Reporting Date
16	Investment Property
17	Property, Plant, and Equipment
18	Segment Reporting
19	Provision, Contingent Liabilities and Contingent Assets
20	Related Party Disclosures
21	Impairment of Non-Cash-Generating Assets
23	Revenue from Non-Exchange Transaction (Taxes and Transfers)
24	Presentation of Budget Information in Financial Statements
26	Impairment of Cash-Generating Assets

AS Number	Accounting Standard Title
31	Intangible Assets
32	Service Concession Arrangements: Grantor
33	First-Time Adoption of Accrual Basis Accounting Standards for Local Bodies (ASLBs)
34	Separate Financial Statements
35	Consolidated Financial Statements
36	Investment in Associates and Joint Ventures
37	Joint Arrangements
39	Disclosure of Interests in Other Entities
39	Employee Benefits
42	Social Benefits
43	Financial Reporting under Cash Basis of Accounting
44	Guidance Note on “Accounting for Investments” for Local Bodies

** Source: https://www.icai.org/Resources.html?mod=1*

4.2.5 Creating Robust Accounting System Architecture for Urban Water Service Providers

The accounting modules should include the following sub-modules such as budgeting, fixed assets, current assets, inventory, payroll, projects under implementation, liabilities, etc. In addition, administrative modules, such as building permissions, project monitoring, a birth and death registration system, a marriage registration system, a grievance addressing system, legal cases to follow up, a project/programme database, slum data management, a solid waste management system, a wastewater management system, a streetlight management system, an advertisement revenue system, and the ULB’s website where the user-friendly information is available, with just a click by the stakeholders to get real-time service on 24×7 basis, should also be included.

Multiple approaches have been adopted to implement financial management module technology solutions for accounting in municipalities. A comparative analysis of the solutions implemented on technical and functional parameters can meaningfully inform future implementation attempts. The accounting modules should have sub-modules to provide more detailed information under each segment such as financial accounting and administrative modules, database of consumers, and MIS wherever required. This would facilitate better analysis of accounting records and data.

4.2.5.1 Web-based e-Governance Application Modules

Today’s era is a digitalised world where web-based products are preferred due to high- speed hardware and internet access available throughout the country. This is a convenient and a relatively cost-effective solution. Under this system, application is run on a central server.

The capital investment is low. The data compilation of different ULBs is centralised into auto mode and no additional processing is required. The system software needs to be deployed only at the central server. The software should be expandable to connect to different terminals within the ULB through wireless systems. It may also be possible that the ULB would adopt the various

modules in a phased manner.

4.2.5.2 Application Based on Client Server Technology

This technical support is in a single location only and is not dependent on any outside agency for data transfer or communication. By following this system, the processing and communication of the data is fast.

The disadvantage is the high cost and the difficulty of using the same application software by multiple ULBs, as well as the costly and time-consuming generation of MIS from multiple ULBs. It is also difficult to maintain application software at different WAN locations across the nation.

4.2.5.3 Indicative Accounting Modules and Reporting

The customised software is important in the digital world to process the information as per the requirements of law and achievement of business objectives on a real-time basis with an edge of speed and accuracy plus integrated approach. The following accounting modules may be considered for customised requirements of urban water service providers which are as per Table 4.7:

Table 4.7: Statement Showing Accounting Modules for Urban Water Service Providers

Expenditure Accounting Modules	Revenue Modules	Administrative Modules
• accounting system • Budget system • Payroll system • Fixed assets and depreciation system • Inventory system • Sub-ledger systems for receivables and payables • Projects under implementation • Accounting systems under different funds/grants • Accounting systems including cost accounting for different services and utilities • Management information reports • Miscellaneous licenses related to water supply and sewerage	• Taxpayers' database for all revenue items (property tax, leases, trade license, rental, etc.) • Demand raising systems for various revenue items • Accounting for revenue collections including online and counter collections in multiple centres • Analysis tools for demand collection balances • Accounting systems including cost Accounting for different services and utilities • Hoarding system • Management information reports • Miscellaneous licenses related to water supply and sewerage	• Building permission • Birth and death registration system • Marriage registration system • Grievance addressing system Legal cases to follow up • Project/program me database • Slum data management • Solid waste management system • Wastewater management system • Streetlight management system • Management information reports • Contingent liabilities and notes to accounts • Website of the ULB

* The above table may vary from ULB to ULB as per state laws.

4.2.5.4 Separate Bank Accounts

The operational bank accounts location-wise and project-wise, grant- and subsidy- wise, loan-wise, and for specific and regular purpose should be maintained separately by ULB.

4.2.5.5 Budget vs Actual Expenditure

The sources of funds of ULBs are:

(i) Central and State Government grants; and
(ii) ULBs own revenue.

ULBs should have more autonomy in raising revenues and for augmentation of their own resources. Efforts should be made for enhancing tax collection capacity of ULBs through provision and training of staff, provision of electronic tax payment, and improved assessment processes.

The Chief Municipal Officer shall prepare the budget estimates before the 15th of January of each year. The chairperson shall present the budget estimates to the municipality not later than 31st January of each year and it shall be passed by the municipality prior to the 15th of February of each year. Budget proposals duly approved by the Municipality are then sent to the government. Findings on the budget estimates are as follows:

Unrealistic Preparation of Budget Estimates

Budget estimates play a vital role in the process of budgetary control. Scrutiny of records of test checked ULBs revealed that the budget estimates were prepared by the ULBs without considering the actual income and expenditure in the preceding year and the expected trend. The State Government also failed to review these budget proposals after submission in a proper way. The major deficiencies noticed are detailed below:

(i) Budget estimates of receipts and expenditure were not based on the actual receipts/expenditure in the previous years but prepared by increasing a certain percentage in the estimates of previous year irrespective of the actual figures.
(ii) The budget estimates were forwarded to the State Government without ascertaining actual receipt and expenditure of previous year.

Due to non-preparation of budget estimates on sound footings, the actual receipt varied in materiality. To avoid this situation, every state government must state that ULBs were being directed to prepare budget estimates on actual receipt basis.

4.2.5.6 Claims Reconciliation Sheet

The computerised software must be equipped to provide the claim statement customer-wise, location-wise, and category-wise to assess the validity of the claims with back-up documents by proper officer.

4.2.5.7 Uniform Accounting Formats

Consolidated financial statements should be prepared using uniform accounting policies for like cash transactions. If it is not practicable to use uniform accounting policies in preparing the

consolidated financial statements, that fact should be disclosed together with the proportions of the items in the consolidated financial statements to which the different accounting policies have been applied.

4.2.5.8 Centralised Database System

A Municipal Database Management Cell may be established to take care of securely maintaining the data and providing centralised access to all locations and remote areas for the smooth functioning and real-time results of financial management system.

4.2.5.9 User-friendly System

The design of customised software should be based on the need based of the users and provide 24×7 access for all utilities.

4.2.5.10 Ring Fencing

The accounting system should also have modules to capture expenditures under various grant funds and for various services and utilities of the ULB, including the following:

a) Water supply, sewage, and drainage;
b) Solid waste management;
c) Roads development and maintenance;
d) Slum service;
e) Commercial projects like hospitals and schools; and
f) General administrative services.

4.2.5.11 Financial Forecasting

Financial planning and forecasting include budgeting of funds for the future requirements to water utility service provider and ULBs. The financial planning made under the following heads as under:

- Customer Demand and Supply Metrics
- Capital Investment Proposals
- Human resources Management & Requirement assessment
- Expenditure Management
- Revenue Management
- Grant & Convergence Scheme
- Arrears management
- Discounting Policy
- Liquidity Management
- Centralisation and Decentralisation of Activities
- Uniformed Accounting System & Manual for Consolidation

4.2.5.12 Arrear Management

Each ULB shall develop a comprehensive arrears management strategy outlining how it will deal with arrears in each primary category of bill credit facilities that it serves. The strategy shall

include:

a) a clearly defined approach for each of the main category of credit facilities it serves;
b) an operational plan covering the main components of arrears management including segmentation, policy and debt restructuring solutions, organisation and capabilities, processes and systems and measurements.

4.2.5.13 Billing & Collection

- Inflexible and inappropriate payment arrangements for customers
- Inadequate management information does not identify debtor accounts
- Failure to take account of customer complaints
- Failure to take action on overdue accounts
- Late billing and ineffective arrangements for revenue collection
- Inadequate accounting for bad debts

4.2.6 Capital Improvement Reserve

To establish and properly fund a capital improvement reserve account, ULB and water utility service provider must develop a plan that outlines new projects and system expansion, as well as equipment replacement needs. To develop the plan, review existing planning documents, such as your infrastructure capital improvement plan (ICIP), utility master plan, engineering studies, etc.

These planning documents evaluate existing system conditions, establish asset rehabilitation, maintenance priorities, and system expansion needs and often include cost estimates for these improvements. One of the most comprehensive plans is an asset management plan. The development of CIR includes five steps which are designed to help you manage and accordingly plan for your system's future.

- Asset Inventory
- Level of Service
- Determining Critical Assets
- Life Cycle Cost Analysis
- Long-term Funding

4.2.7 Public Private Partnership (PPP)

Project implementation and O&M of infrastructure projects has been one of the major challenges faced by the ULBs. The multitude of activities including planning, project implementation, service delivery, O&M, and public administration is one of the major reasons for inefficiencies in project management by the ULBs especially during implementation of big-ticket projects. Hence, there is a need to align the institutional structure to facilitate efficient project management.

This may be addressed by undertaking implementation through a separate SPV (registered under the Companies Act) preferably under the PPP model. PPP model in project management aims to address the institutional challenges, by allowing the ULB to focus on its core strengths like planning, policy, regulation, and monitoring while leveraging on the private sector

experience in project implementation and delivery. It also transfers significant portion of the project viability risks on the private sector. Some of the key benefits of a PPP implementation mode in municipal bond financing are as follows:

- PPP structure brings down the project implementation risks considerably allowing the project to access funds at competitive rates.
- It allows the ULB to act as a regulator while the private sector can focus on the day-to-day delivery of the services.

It brings in efficiencies in project tracking and monitoring and provides regular up-to-date information disclosure to the investors on the project progress. This is particularly relevant for investors in taking a periodic call on value of assets under management.

PPPs are typically long-term contracts which allows for greater innovation and efficiency in project planning and execution by the private sector, thereby bringing down the life cycle cost of project. Private sector participation in project implementation and O&M also provides a comfort to the investors that the demand risk associated with the project is manageable. PPPs incentivises the private sector to deliver projects on time and within budget. It also helps in extracting long-term value-for-money through appropriate risk transfer to the private sector over the life of the project – from design/construction to operations/maintenance.

4.2.8 Financial and Capital Markets

4.2.8.1 Escrowed Revenues

Addressing risk perception of investors is crucial. Setting up of an escrow mechanism is one of the key solutions for this. The objective of escrowing is to earmark specific revenue streams of the ULB for debt servicing to improve visibility and certainty of cash flows to Investors, thereby improving credit quality and issue rating of the bonds. The identified revenue streams would have to be sufficient to meet the repayment obligations of the ULB.

Municipal assets should be subject to mortgages, provided that the assets are non- essential for the provision of mandated services. State laws governing municipalities should provide for the distinction between essential municipal assets and commercial/non-essential municipal assets. Rules should be made to provide for the tests to determine which category a municipal asset falls under. State laws should then provide clearly that commercial/non-essential municipal assets will be subject to general debt enforcement laws and can be attached by lenders in whose favour security was validly created for loans taken in accordance with the relevant municipal law.

4.2.8.2 Joint Venture/MOU/Agreements/Contracts

The Union Cabinet, chaired by the Hon'ble Prime Minister Shri Narendra Modi, was apprised of a Memorandum of Understanding (MoU) signed between India and Denmark on co- operation in the field of Water Resources Development and Management.

Broad areas of co-operation envisaged in the MoU are:

- digitalisation and ease of information access;
- integrated and smart water resources development and management;

- aquifer mapping, groundwater modelling, monitoring and recharge;
- efficient and sustainable water supply at household level, including reduction of NRW and energy consumption;
- river and water body rejuvenation to enhance livability, resilience and economic development;
- water quality monitoring and management;
- sewage/wastewater treatment including circular economy for reuse/recycling of wastewater, including comprehensive sludge management and maximising use of renewable energy in field of water supply and sanitation;
- climate change mitigation and adaptation, including nature-based solutions;
- river centric urban planning including urban flood management.

The MoU will thus broadly strengthen co-operation in the field of water resources development and management, rural water supply, and sewage/wastewater treatment through direct collaboration between officials, academics, water sectors, and industry in the areas under scope of co-operation.

4.2.8.3 Bonds and Issuance of Financial Instruments

To attract the private investors, it is important to announce the liberal policies and procedures in terms of water, energy, agriculture, environment, and urban development sectors, where massive fund requirements cannot be met by public expenditures but can be made possible through private partnerships/support.

4.2.8.4 Innovative Finance for Development Solutions

Innovative Finance can mean different things to different people. We include under this heading any financing approach that helps to:

- **Generate Additional Development** funds by tapping new funding sources (that is, by looking beyond conventional mechanisms such as budget outlays from established donors and bonds from traditional international financial institutions) or by engaging new partners (such as emerging donors and actors in the private sector).
- **Enhance the Efficiency of Financial Flows** by reducing delivery time and/or costs, especially for emergency needs and in crisis situations.
- **Make Financial Flows More Results-Oriented** by explicitly linking funding flows to measurable performance on the ground.

4.2.8.5 Debt Management

Another objective of implementing and practicing financial management in a ULB is to examine how debt management is developed and implemented. Simply stated, debt is an obligation to pay or return something at a future date. The term “debt” refers to all local government debt regardless of length, type, instrument, or lender. Short-term debt is to be paid off in one year or less and long-term debt in more than one year. Bank or central government loans, bonds, and leasing are examples of types of debt. One major responsibility for local elected representatives is making decisions about borrowing money. Long-term debt places a claim against future governmental revenues or assets that may reach far into the future. A ULB must establish an effective debt management programme to help preserve its long-term fiscal viability.

4.2.8.6 Cash Management

A ULB's cash asset management involves ensuring that all process-generated revenues are effectively controlled and utilised in the best possible manner to result in gains for the organisation. The management of cash resources holds the central position in the area of short-term financing decisions. Holding of cash carries the opportunity cost of earning, which is determinable if the cash is either under use within the organisation or is under investment elsewhere. The basic objectives of cash asset management are:

a) To ensure availability of cash according to a payment schedule; and
b) To minimise the amount of idle cash. Effective cash asset management encompasses proper management of cash inflows and outflows, including:

- Improving forecast of cash flows;
- Synchronising or aligning cash inflows and cash outflows;
- Using floats, wherever necessary;
- Accelerating collections;
- Optimizing available funds.

4.2.8.7 Credit Assessment

Most municipal bonds in India have been raised to finance water supply and sewerage projects. This is because the Municipal Acts allow the levy of user charges, making it technically easy to measure consumption, bill, and collect user charges and penalise for non-payment. Furthermore, the amount and frequency of expected revenues can be predicted with some certainty. Capacity building of Municipal Commissioners as to the importance of financial management and time-bound preparation of financial statements can lead to an increase in efficiency.

Use credit rating as a dynamic managerial tool for assessing current level of borrowing capacity, along with other performance parameters including economic base, service levels, recovery of user charges, and sustainability of proposed investments. Credit rating process should not be a one-time assessment but should provide feedback to city management on whether the reform implementation is leading to the desired impact on credit quality. Infrastructure debt funds (IDFs) and mutual funds could be encouraged to invest in municipal bonds by improving transparency and disclosure norms to increase investor confidence.

4.2.8.8 Alternatives of Financing

- National Bank for Agriculture and Rural Development (NABARD)
- Housing & Urban development Corporation Limited
- International and Bilateral Funding
- Community Funding
- Funds of Corporate Social Responsibility
- Public Private Partnership

4.2.8.9 Inter ULB Fund Transfer on Short Term or Long-Term Basis

For short-term and long-term working capital requirements, the ULB may exchange agreements

for fund requirements with interest or without interest basis.

4.3 Tariff Assessment

The water tariff structures used in urban water supply vary across the states like the institutions involved in its provision. A water tariff structure is a set of procedural rules used to determine the conditions of service and monthly bills for water users in various categories. The water charges can take the form of non-volumetric flat-rate tariff, non- volumetric water tax, uniform metered tariff, metered block tariffs, or a combination of the above. A non-volumetric flat rate is usually charged in the absence of metering where the monthly water bills are independent of water consumed. The flat rate could be charged either based on the size of the ferrule or could be set by the concerned authority.

The price of water is essentially assessed to maintain the service delivery by the water utility service provider in terms of economic price rather than social goods. To make the ULB financially sustainable and meet the cost for day-to-day operations, select the correct economic price of water. This is because water, if undervalued or underpriced, is always overused, or over exploited.

4.3.1 Objectives of Water Tariff Fixation

The fair valuation of water tariff is quite complex and difficult, but it should be based on a rationale approach for the user's community. The water tariff policy and principle are the basis of financial sustainability and full cost recovery (O&M in long term and short term).

The main objectives to be kept in mind while setting water tariffs (Dale Whittington, 2002) are given in Table 4.8:

Table 4.8: Objectives of Water Tariff Fixation

Revenue Sufficiency	The main purpose of tariff introduction is cost recovery and the maintenance of the system. The revenue from the water users should be sufficient to pay the O&M cost of water utility operations, repay loans undertaken to replace and expand the capital stock, and provide a return on capital at risk. The return on capital must be adequate for equity and debt mix under financial analysis.
Economic Sufficiency	The economic cost must be sufficient to cover the water user utilities for consumer-based decision. For the usage of better water utility facilities at the doorstep of the consumer, the consumer must be willing to pay sufficient charges, as implemented by the area ULB. The aggregate benefits must be given to users at relative water supply cost. The volumetric water charges should be set equal to the marginal cost of supplying water. The marginal cost of supplying water can be approximated by the average increment cost (AIC), i.e., the average cost of water from the next water capacity expansion project. Alternatively, the AIC of additional water may be the unit cost of reducing unaccounted for water.
Uniform (Equity)	The water tariff for category-wise must be similar and uniform. This system will be helpful to pay the water bills for the water services availed by the users.

Public Acceptance	The water user tariff should be published and accepted by the public in general and various political, social, and financial groups of the society.
Simplicity and Transparency	It should be simple to calculate for the ULB (adequate modern Infrastructure) and to verify for users. Tariffs for water services are based on several factors and assumptions such as cost recovery, sustainability, debt servicing, and reinvestment. The determination of a tariff of a particular segment of the customer profile may vary according to the policy and principles, objectives of the utility, and political and social criteria.
Ease of Implementation	The implementation of the revised tariff should not encounter significant barriers in terms of legal authority, administration competence, information requirements, or billing procedures. A balanced approach is required for the pricing strategy of the water tariff.

4.3.2 Alternatives for Water Tariff Structures

The best practices adopted for water tariff are divided under two parts of retail water pricing – single part tariff and two-part tariff. Both options of tariff structure are defined as under:

4.3.2.1 Single Part Tariff – Variable Tariff (Volumetric Consumption Based)

Uniform volumetric tariffs: Under this model, users must pay in direct proportion to their consumption and the corresponding water charges vary entirely based on their consumption. But in most cases, water is provided at subsidised tariff to the masses based on their affordability to pay. It is assumed under this tariff that full cost recovery is possible. The average cost of water supply is the same for all. The average cost per KL is computed based on the total water supplied and the total cost incurred at various levels. This average cost per KL is the base tariff charged to all customer groups. The subsidies provided under this model are on the base cost. Social equity, water conservation, water availability to poor people, and relevant cost recovery are key aspects of this tariff structure.

Volumetric increasing block tariff (IBT) model: IBT provides more than one price for water used, where each price applies to a customer's use within a defined block. Prices rise with each successive block. The water slabs are determined based on consumption pattern of the public. For the development of the model, the slabs are adopted based on per capita water consumption norms defined for local bodies, which forms the base for the design. Hence, this model is more tuned towards the determining of tariff for local bodies based on their type.

The average cost per KL is computed based on total water supplied and total cost incurred at various levels. The weights are derived based on water consumption norms. These weights define the corresponding level of per capita water consumption and depict the ratio for the tariff in these slabs. Water consumption slabs are defined based on water norms for various types of households and full cost recovery is also possible under this method. Economic efficiency, water conservation, market driven tariff, and relevant cost recovery are key aspects of this tariff structure.

Tariff model based on cost incurred in servicing different types of consumer: This model is somewhere in between the ULB based pricing and uniform tariff. In this model, it is suggested that at the ULB level itself, cost will be segregated between the different categories of consumers based on data on water pumped. For all ULBs, cost should be aggregated consumer category

wise and cost per KL will be calculated. The subsidies, if any, can be provided on it. ULB are incurring different costs for supplying water to different groups of customers categorised as commercial, public standpost and households. As the cost of production is different for these groups of customers, hence, the tariff should also be different for them. **The Variable Tariff Structure explained above**, among all structures, IBT is a popular one which is recommended by expert first choice and followed in developing countries. As per ADB, in India, 20 out of 32 follow the IBT price structure. The structure is chosen due to key aspects defined under the model. In most of the IBT block structures, the first block of the tariff is deliberately set below cost to promote equity. In the design of IBT, much attention is given to the size and price of the first block.

However, an incorrect structure of the IBT leads to several shortcomings, such as difficulties to set initial block, mismatch between prices and marginal costs, conflict between revenue sufficiency and economic sufficiency, absence of simplicity, transparency, and implementation, etc.

The main advantages of IBT are as follows:

a) IBT promotes equity because it forces wealthy households to cross subsidise poor households.
b) The price associated with the highest block can be made very high to discourage "wasteful" water use.
c) With more water usage at economy level, the cost could increase. IBT can match with the increasing marginal cost.

4.3.2.2 Single Part- Fixed Tariff Structure

In ULBs, which do not have metering for households, a flat tariff has to be used as the norm. This would be a period charge (say, one hundred rupees per month), irrespective of the volume of water consumed. Some variants that are used in different cities in India include variation based on number of taps, number of bathrooms, etc. Also, the tariff could vary based on the size of connection (ferrule). Further, in some cases, water is charged as a cess based on property tax or water tax, and it is represented as a tax based on the value of the property.

4.3.2.3 Two Component Tariff Structure

Single part tariff can be either fixed (with predetermined lump sum amount) or variable tariff (charge on water consumption basis): Whereas two-part tariff is component of both. A water user's monthly bill may include two distinct components: a part based on the volume of water used, and another part based on the factors other than water use. ULB spends on fixed costs and variable costs to supply water. The fixed cost includes establishment, load-based power costs, depreciation, loan, servicing cost, etc. The fixed costs are fixed in the short run only. The variable cost includes pumping costs, water treatment costs, O&M costs, etc. Hence, a two-part tariff based on the fixed costs incurred by the ULB and another based on the marginal cost is one option. The economic theory associated with full cost recovery in capital intensive utilities focuses on:

a) Efficient pricing to achieve full cost recovery (of water supplied); and
b) Optimal capacity given natural monopoly (of infrastructure).

Hence, this is a two-part tariff structure recovering both a fixed charge and a variable charge and would be an ideal tariff structure. This would match with the requirement of the consumer in obtaining a benefit from water connection (fixed) and a benefit from the use of water (variable with volume of water consumed).

4.3.3 Evaluation of Tariff Models

The following models of tariff are as under:

4.3.3.1 Fixed Charge Tariff Structure

Fixed charges provide stable cash flow if set at appropriate level. People who use large quantities of water pay the same as those who use little. The tariff does not send a message about the cost of additional water. To make this approach affordable it must be differentiated by having different tariffs depending on ability to pay.

4.3.3.2 Uniform Volumetric Tariff Structure

The key to volumetric tariff structures is to set them at levels which adjust automatically to changing consumption. It is possible, moreover, to differentiate set of consumers by geographical/social barriers. This allows people to pay according to how much they actually use. If again, the key is to this at or near marginal cost of water.

4.3.3.3 Increasing Block Tariff

Only if the size of the blocks is well-designed. For those who can afford it, it is a general rule that people do not consider the costs their water use imposes on the utility. Higher charges penalise poor families with large households and/or shared connections.

4.3.3.4 Decreasing Block Tariff

Block tariffs decrease work only if the sizes of the blocks are well-designed. The danger is that this may facilitate higher consumption categories with better affordability, and it may, in the medium-to-long term, work against the poor and categories with less affordability.

4.3.3.5 Pricing Strategy

A robust pricing strategy needs to be developed. This would include consideration on following factors while deciding the appropriate tariff structure.

4.3.3.6 Uniform State Level Tariff

Utilities may set a single tariff to be applicable for the entire state or giving each ULB the freedom to adopt a different tariff level or tariff approach. The current system is a state level tariff with variations by type of ULB or based on debt obligations of the ULB's cost components.

Other factors

- Unaccounted for water
- Connection costs
- Metering

- Tariff for public standposts

4.3.4 Tariff Fixation for Projects

The fixation of water tariff for water project investment decision is utmost important for evaluating the sustainability of water projects in short-term, medium-term, and long- term project scenarios. The fixed and variable component of water tariff structure play an important role for fixation of water tariffs to various categories of consumers under a ULB. The water tariff must include a fixed component for every category of water user along with marginal cost of consumption under each category of consumers. The water tariff is also subject to public awareness and consultation where people are willing to pay the water user charges to address the NRW issues and water metered issues.

For example: A project's life is set at 30 years by the ULB, which is divided into a five- year plan criteria. In the early commencement years, the repair and maintenance of water capital structure requires less, whereas in future years, after a certain age of the project (e.g., eight years), it requires regular repair and maintenance for effective water services to consumer. Therefore, the accuracy in estimation of capital expenditure with provision of contingency up to 15 per cent may also be planned by the ULB for effective disposal of services over the project life.

To fix the tariff for year-on-year basis, the following factors must be considered:

1. Fixed part of water tariff – may be provisioned for each category of consumers to make a pool of funds for substantial nature of expenses.
2. Variable cost of consumption – it may be provisioned on fixed basis or based on actual consumption and tariff slabs may also be given like in electricity distribution criteria.
3. Evaluation of water tariff as per capital expenditure of project.
4. Public awareness and consultation.
5. Effective recovery procedures of water tariffs.
6. Contingency recovery.
7. Capacity building and training for ULB employees.
8. Consideration of inflation index for yearly basis.
9. Higher tariffs for higher consumption people.
10. CAGR factor application over project life.

4.3.4.1 Tariff Revision

It is recommended that the water utilities prepare tariff revision at every financial year for the perusal of either the state government or an independent state regulator. This would ensure the estimation of annual expenses for ensuring year and water tariffs reflecting real costs. The water charges may be revised based on following approaches:

(i) Water tariffs may be directly linked with the power tariffs and hike in power tariffs should be reflected in water charges, i.e., for every increase in power tariffs.
(ii) To provide increase based on inflation index such as consumer price index or wholesale price index. Such inflationary revision would be necessary when there are significant changes in costs or service levels. Acceptability of such increases would be better as the reason for the increase is likely to be well known.

4.3.4.2 Revenue Management

Water tax is another tax, whose collection is low and not increasing. Most of the ULBs are running water supply in huge deficits. Huge arrears have piled up due to non- payment of tax.

ULBs can raise revenue by rationalizing the rates and widening the coverage. For instance, more revenue can be raised from tax on advertisement other than newspaper, through licensing of additional space, introduction of different rates for different areas, different modes of advertisement, and different sizes of advertisements.

Revenue from entertainment tax at present is being levied by the State Government, in the category of assigned taxes which implies that the tax may be continued to be levied and collected by the State Government, but net revenue after deducting collection charges may be allocated to ULBs on the basis of revenue collection.

With a view to diversifying their tax structures, some more taxes may be included in the existing taxes under the Act to enable ULBs to raise more of their own tax revenue. In some states, the taxes we are suggesting are already in operation. These innovative taxes may be tax on waves and signals by telephone and power companies, tax on glow signboards by different companies at their outlets and kiosks for advertising, levy on different types of services like beauty parlors, cable television, private hospitals and nursing homes, coaching institutes, private school buses, and other similar services.

4.3.5 Cost Management

4.3.5.1 Cost Recovery in Water Supply Services

The total operating revenues expressed as a percentage of the total operating expenses incurred in the corresponding time period. Only income and expenditure of the revenue account must be considered, and income and expenditure from the capital account should be excluded.

Cost recovery = [(b/a) * 100]

a) **Total annual operating expense:** It should include all operating expenses (for the year) such as electricity, chemicals, staff, outsourced operations/staff related to water supply, bulk water purchase costs and other O&M expenses. It should exclude interest payments, principal repayments, and other capital expenses.

b) **Total annual operating revenues**: It should include all water supply-related revenues (billed) during the corresponding time period, including taxes/cess/surcharges, user charges, connection charges, sale of bulk water, etc. This should exclude capital income such as grants, loans, etc.

c) **Rationale:** Financial sustainability is critical for all basic urban services. In services such as water supply, benefits received by the consumers are more direct and can be quantified. Therefore, through a combination of user charges, fees, and taxes, all operating costs may be recovered. Therefore, this indicator is critical for measuring overall cost recovery, the benchmark value for which is 100 per cent. Cost recovery objectives provide a basis for tariff fixation, enable setting targets for revenue mobilisation and cost control in the delivery of water supply services.

4.3.5.2 Key Indicators Analysis

1. What is the basis for the financial analysis data?
2. Is it transparent, accurate, reliable, and the subject of an auditor's report and opinion, or prepared by a consultant with a reliable financial management track record?
3. What are the current, or in the case of a "green field project," the most likely, financial performance weaknesses that should be given priority for correction (or prevention)?
4. Which indicators and covenants could be the most appropriate to achieve correction (or prevention)?
5. For ongoing operations, what are the deficiencies in cash management performance for at least the past three years (using audited annual financial statements)? How should they be corrected?
6. Which indicators and covenants could be the most appropriate to achieve correction?
7. What changes are necessary to ensure an adequate capital structure (debt/equity including reserves) for the executing agency? How can they be affected?
8. What should be the time scale to achieve correction?
9. Which indicators and covenants could be the most appropriate to achieve correction?
10. Do the levels of revenue generation and collection need upgrading, prioritising the steps to achieve (i) short-term improvements and (ii) long-term improvements?
11. Which performance indicators should be included in periodic performance reports (i.e., not subject to covenants)?
12. Will ULB under water sector operational experts or consultants confirm that each level of operating costs is, or will be, operating at optimum efficiency and effectiveness?
13. If not, what performance levels are they proposing, and which financial performance indicators should be used to support their proposed operational performance upgrading?
14. Does (or will) the entity have a management system capable of developing and efficiently responding to the results of each proposed financial indicator and financial covenant?
15. Does the entity have qualified and experienced personnel who can interpret and monitor performance against the indicators or covenants?

4.3.6 Universal Water Metering

Universal metering measures water consumption assessed on the volume of water consumed for every household in the specified area through the installation of water meters that use a meter-based billing practice. To follow and implement the water metering, ULB collects user charges from each consumer where such water connection is installed with inlet pipe or connect with such customer water point. The installation cost and user charges must be collected in advance by the ULB from customer. The consumption and line losses may also be accounted with the help of line meters at each master point.

4.3.7 Risk Identification and Mitigation

When identifying risk events or risk factors affecting the project, one must select features of the project that may be highly sensitive to cost or revenue variables which could cause early or midterm financial failure. Typically, risks and uncertainties facing projects include, but are not limited to,

i. **Market risk:** the risk that the cash flows change in value due to market forces (e.g., price levels, interest rate, and foreign exchange rate). This risk can lead to changes in cost estimation resulting in cost overruns, or unexpected increase in operating and maintenance

costs, or incorrect tariff assumptions.

ii. **Completion risk and execution risks:** the risk that the project will encounter delay in implementation and the risk that project outputs will not be completed as intended. This can be caused by lack of funding, delayed approval, incorrect procurement, nonperforming contractors, delays in securing environmental clearances or payment of resettlement compensation, etc.

iii. **Regulatory risk:** the risk of change in regulations or policies, or failure to approve regulations or policies that impact revenue streams such as tariffs, tolls, or user fees adjustments. Political interference also affects forecasted revenue.

iv. **Demand risk:** the risk of significant change in demand projections or number of beneficiaries/users.

4.3.7.1 Determine Impact and Probability of Risk

The degree of impact and the likelihood of occurrence of risk scenarios should be determined in consultation with technical experts. The scenarios are defined by varying one variable at a time, keeping other variables constant.

Correlations, meaning how a change in one variable is likely to cause or be caused by a change to another key variable, must be identified. Then determining how the results of the sensitivity analysis should be considered lays the groundwork for creating scenarios to consider.

There are projects with little sensitivity to each of the variables taken independently, however, when a combination of these risk events is considered, they could substantially impact the project. For instance, a longer construction period usually results in higher construction costs and is often positively correlated with a delay in benefits, whereas increases in the number of beneficiaries tend to be negatively correlated with changes in tariff levels (higher tariffs usually result in a lower number of beneficiaries). Thus, any variables with high correlation should be varied jointly in a single scenario. Care must be exercised when creating scenarios and combining risk events, as the greater the aggregation, the less useful is the information.

4.3.7.2 Calculate the Impact and Probability on Base Case

The effect of changes to variables on the FNPV and FIRR should be calculated for each scenario.

4.3.7.3 Summarise Results and Conclude

Once the effect of changes to variables has been calculated, the results will provide insights on how a project behaves under each scenario. Where FNPV falls below 0, or where FIRR falls below WACC, the project is deemed highly sensitive to the variable(s). In these cases, it is necessary to identify actions that could mitigate these potential adverse effects.

4.3.7.4 Update Project Design and Covenants

The identified mitigating actions should be discussed with the executing agency and incorporated into project design and implementation arrangements. These should also be incorporated into legal agreements (where applicable) as covenants to ensure project financial viability.

4.3.8 Efficiency in Collection of Water Supply-Related Charges

Efficiency in collection is defined as the current year's revenues collected, expressed as a percentage of the total operating revenues, for the corresponding time period.

Collection efficiency = [(a/b) * 100]

a) **Current revenues collected in the given year**
Revenues collected for bills raised during the year. This should exclude collection of arrears as inclusion of arrears will skew the performance reflected. Collection efficiency is, in fact, an indicator of how many arrears is built up, and therefore only current revenues should be considered.

b) **Total operating revenues billed during the given year**
The total quantum of revenues related to water supply services that are billed during the year. This should include revenues from all sources related to water such as taxes, charges, cess, surcharges, sale of bulk water, etc.

Rationale: For a water utility, it is not adequate to have an appropriate tariff structure that enables cost recovery objectives but also efficient collection of revenues that are due to the utility. It is also important that the revenues are collected in the same financial year, without allowing for dues accumulate as arrears. It is, therefore, critical to monitor this indicator. The benchmark value for collection efficiency may be considered at 90 per cent, since it is possible that about 10 per cent of the dues may be delayed to the next year.

4.3.9 Co-operation and Co-ordination of ULB's and their organs

The ULB and water service providers must communicate the issue faced during the project feasibility and implementation thereof to get the best practices over it.

a) **Institution Infrastructure:** Primarily, each ULB is free to share their experience, strengths, resources, and best practices for water utility sector among other ULB on PAN India basis. It is important to establish the specific division of a few experts under each ULB for effective co-ordination to exchange information and expertise.
b) **Project Timelines:** it is important to focus the timelines of project since the stakeholders in projects face lack of co-ordination by ULB administrators. Projects, therefore, are delayed and turn into disputes between investor/developer on many issues related to the project. Improved co-ordination and effective exchange of communication among all project participants by ULB's will produce positive results.
c) **Investment Portfolio and Classification of Project:** Every ULB may form a specific division with nature of projects and investor portfolio to assess in terms of socioeconomic factor along with cost optimisation. Global investors are keenly interested in effective implementation of projects and effective communication by each ULB. Hence, ULB may appoint specific authorities to address and focus on globe investments towards project financial mix. The project progress report must be discussed and reviewed periodically by ULB along with investors and developers to address the difficulties/challenges faced by them.
d) **Capacity Development and Mutual Cross-sector Planning:** To achieve mutual benefits and equitable, reasonable, sustainable, along with optimisation study, every stakeholder should attend the capacity development programmes and meetings organised by ULB periodically. The cross-sector planning and forecasting of projects may

also be important for investment portfolio and fund management of projects.

4.3.10 Financial Mix of Segment Wise Water Utility and Analysis

a) **Present and Future Practice:** To study the segment-wise revenue and effective cost under each water component such as residential, non-residential, agricultural, industrial, energy produce, environment protection, social development, urban and rural development, infrastructure development, and other measures if any. Based on present water scenario and their effective financial sustainability, the future road map may be prepared and installed accordingly.
b) **Mobilisation of Financial Resources:** Based on the present study of water utility under each ULB, ULBs can define the standard budget of incomes and expenditure for financial resources and planned accordingly.
c) **Integration of Water Utility Financial Mix within and across other projects:** The ULB must study the financial impact across other utilities to achieve the best financial strength under the water utility segment.

4.4 Recommendations

4.4.1 State-Wide Reform Approach is Most Effective

The uniform municipal accounts must be based on accrual-based accounting with periodic budget assessment and a common technology platform for all ULBs, a central project management unit for reform management, centralised procurement, and uniform audit arrangements. The project management consultants must be on a contractual basis by ULB for support and guidance in this context.

4.4.2 Role of State UDD is Crucial for Reform Success

Municipal finance reforms are inherently complex, and, if left to individual ULBs too early in the reform process, the chances of success seem to reduce drastically. ULBs need extensive technical assistance and handholding for a sustained period before the system can run on an auto-pilot mode. The State Urban Development Department (UDD) would need to be prepared for a long-haul effort in terms of management change, technology implementation, and capacity building efforts.

4.4.3 State-Level Special Purpose Agency can Ensure Reform Continuity

State-backed entity for anchoring municipal reforms over the long term, with the required administrative autonomy and budget support lends stability and continuity to the reform attempts. The reform focus helps such entities imbibe best practices and roll them out to ULBs.

4.4.4 Past Experiences have Valuable Learning's to Offer and must be considered while Developing the Reform Strategy

While devising the reform strategy, it is important to look back at the State's past reform efforts, if any, and the learnings they offer. Given the likelihood that past reform learnings would be largely undocumented, an effective way to do this would be to consult key factors within the system as well as outside, before initiating the subsequent reform exercise.

4.4.5 Project Management and Supervision must be Decentralised

The project management and supervision structure must be defined and owned by the State UDD but must operate at multiple levels, namely, the State, the district (or regions appropriate), and at the ULB level. In addition to monitoring project progress in terms of timelines, the review mechanism must monitor key indicators of reform success. A minimum level of technical expertise (accounting and IT) must also be positioned at the decentralised level to address the needs of ULBs quickly.

4.4.6 A Clear Mandate for Accrual Accounting is Paramount

Legal amendments that lend sanctity to the accrual system of accounting at ULBs must be accorded paramount importance and need to be initiated from inception. These amendments, at a minimum, need to prescribe the basis of accounting, the content of financial statements and responsibility for preparation, and the requirement to get them audited. The amendments must also accord sanctity to the State Municipal Accounts Manual.

4.4.7 Others

- Role of incentives and disincentives in implementation.
- Accrual accounting reforms are not complete without on-boarding of audit.
- The right balance of external expertise and internal capacity is essential.
- Procurement and contract management being complex, increases the importance of building the required capacities.
- Reforms cannot reach fruition unless local capacities are created.
- Continued support arrangements are crucial.
- Adoption of a “digital-first” approach.
- IT implementation as a substitute for accounting reforms is a flawed proposition.
- Enables accountability towards stakeholders.
- Enables better service delivery.
- Facilitates effective utilisation of scarce resources.
- Ensures effective fiscal management and budgeting.
- Contributes to better cash management.
- Enables better performance management.
- Enables better risk management.
- Finance Integrated Municipal e-Governance System.

4.5 Best Practices in India for Financial Management

4.5.1 Municipal Accounting Reforms: Lessons Learned

The best practices adopted by the ULBs in India include adopting different models for accounting reforms, including centralised, decentralised and independent data management approaches for smooth functioning of ULB following real-time system to ULB offices and users. The number of turnover factors such as labour/employee rotation, system failure, data risk factors, and security policy may also be important factors for consideration. To adhere to system’s smoothness, independent state institution is required for maintaining the software and providing training for ULB staff.

4.5.2 Municipal Financial and Control Reforms of Vadodara Municipal Corporation (VMC)

The financial control reforms of VMC are an example for the rest ULB in India which may adopted the best practices of budgetary control, bills movement, and short-term liquidity/financial management. The budgetary approach is already discussed under section 4.2.2.1 of this chapter under cash-based accounting where the booking of revenue and expenditure is recognised on cash basis rather than accrual basis. The funds may be approved by the state government on the basis of the budget submitted by ULB on a periodic basis, and the same is called budgetary support by the government. The budget has various types, which may include master budget broken into fixed and flexible budget. The restatement of budgets can also be done based on the state laws and actual events that occurred or may accrued in the near future. The probabilities may be the basis of such hypothesis for decision making. The reforms must be based upon the practical difficulties faced by the present ULB. The approval of budget requires participatory approach and theoretical representation before elected representatives, who may record their satisfaction and forward it to the concerned department under state support mechanism. The VMC was preparing and presenting its budget, prior to reforms, under three heads by following the above-mentioned process.

Part I – Revenue Income and Expenditure Budget (Revenue Budget) Part II – Loan Receipts and Expenditure Budget (Loan Budget)
Part III – Budget for Deposits, Capital Grants, etc. (Suspense Budget)

Some of the lessons a ULB can refer to for adopting the best practices are subject to the base scenarios under each ULB.

4.5.3 Financial Management Improvement in Bhubaneswar Municipal Corporation (BMC)

The BMC faced the main challenge of generating and applying funds in the best optimum mix. The costing of services to users is also important, but the lack of information from the users and the ineffective costing factors is another challenge that may lead to failure. BMC was following a cash-based single-entry accounting system for maintaining the municipal accounts and all the limitations of the single-entry accounting system were prevailing. There was no proper budgeting system under BMC and, hence, to overcome the regular challenges faced by BMC, accounting reforms were needed as under:

1. The existing financial management system, including financial records and statements, was reviewed and analysed in order to understand past revenue and expenditure trends of BMC.
2. Potential short-term interventions required to strengthen revenue base and expenditure management of BMC were identified through consultative process with administrative and elected officials of BMC and other stakeholders, including the community.
3. The Orissa Municipal Accounting Manual was developed in accordance with the stipulations of NMAM.
4. External support was provided to BMS for a period of 12 months to implement the action plan, and also to provide training to staff on DEAS.
5. A provisional opening balance of financial statements was prepared and published in auto

mode. The accounting system is currently maintained with the help of Tally software and is managed by the ULB without the support of consultants.

4.5.4 Best Practices for ULB under Karnataka State

The Karnataka State ULB has 213 associate entities that serve different locations across the state. To regulate the working of all ULB under a state, a Karnataka Municipal Reform Cell (KMRC) is formed for centralised monitoring of activities. All the concerned ULBs share the customised software where the accounting system is centralised and uniform for all ULBs to understand the accounting in better way. The accounting system is user-friendly and can be run by the ULB staff easily, with a skill training session on frequent basis. The system operates on real-time basis and can be shared among the authorised participants by KMRC. The following lessons can be taken away by the ULB:

1. A single set of accounting policies and guidelines is followed by all the ULBs in the state, leading to unified system of accounting across the ULBs.
2. Computer software and information technology (IT) systems can be maintained and monitored by a centralised team located at the MRC office.
3. Centralised training facilities are available to all ULB staff, and their knowledge can be utilised in any other ULB in case of staff transfers.
4. All the ULBs have a similar set of records, which could lead to the consolidation of information and data for policy reviews and accounting reforms.
5. The centralised database can be subjected to analysis and reviews for management information and overall state-wide monitoring and benchmarking.

4.5.5 Municipal Administration System of Bhopal Municipal Corporation (BMC)

Bhopal Municipal Corporation (BHMC) is in the process of developing a comprehensive and fully integrated e-governance solution called the Municipal Administration System (MAS) under the Department for International Development (DFID)-funded Madhya Pradesh Urban Services for the poor programme. The MAS is based on systems analysis and programme development application of integrated enterprise resource planning software. The overall concept of MAS is based on a centralised system architecture approach. The main objective of MAS is the creation of citizen-friendly services, thus improving transparency and efficiency in municipal services. The following takeaways a ULB can adopt are as under:

1. **Municipal Transaction Processing System:** This will provide an online transaction-processing interface for all the functions and services of BHMC.
2. **Municipal Management Information System:** This will generate all the analytical and exception reports required by the senior management of BHMC for decision making.
3. **Citizens Interface System:** This will provide information and services to the external users of MAS, including citizens, government, financial institutions, donor agencies, contractors, etc.
4. **Municipal Monitoring and Evaluation System**: This will integrate the baseline data (selected information from the other initiatives and surveys such as UN habitat data, Census Survey, GIS, etc.) with the MAS data for tracking progress of municipal reforms and programmes.

4.5.6 International Examples of Using Financial Information for Improved Governance

A comprehensive global study on the implementation of accrual accounting at the local government level is not available. The International Public Sector Financial Accountability Index – 2021 **Status Report (IFAC, CIPFA (2021), International Public Sector Financial Accountability Index 2021 Status Report)** discusses the implementation of accrual accounting at the national level. Since, in India, the national government follows cash basis of accounting, the map shows India under cash basis of accounting. 30 per cent of governments in 165 jurisdictions covered have comprehensively moved to accrual accounting while another 40 per cent are making the transition. The report states that increasing importance is being given to this subject across the globe.

The country briefs presented here, apart from discussing the benefits derived through financial reporting, attempt to give a cursory view of the process of conversion from cash to accrual accounting.

Australia: The transition to accrual accounting has been achieved at all levels of government, the reform benefits have been derived by multiple agencies (McPhee (2006)).

Focus on the process and creating an environment for reform has enabled Australia to implement accrual accounting across governments.

Canada enjoys the benefits of accrual accounting in obtaining objective information for analysing the accountability of local governments. Performance audits are possible. Canada seems to have used the implementation of accounting standards as a tool to migrate to accrual accounting and the focus on information to stakeholders seems to have helped. The focus was on getting the right information through financial accounting: increasing transparency, supporting resource allocations, and adopting strategy-oriented decision making. To reach this end, initiatives like outcome based.

Despite a lot of effort gone into region-specific and locally sensitive reforms, Germany is yet to achieve accrual accounting across the country.

New Zealand: Early start, focused approach, and involvement of stakeholders, combined with empowerment through regulations have enabled New Zealand to implement accrual accounting at all levels of government.

South Africa has been a leader in reforms. As far as the municipal reforms are concerned, South Africa has set a precedence in various ways: legislative changes, accounting and audit reforms, introduction of technology, and transparency. The transparent reporting system has enabled an objective analysis of the ground realities. The audit reporting uses info graphics to clearly establish audit outcomes, material irregularities, specific risk areas, fruitless wasteful expenditure, auditees' financial health indicators, auditees' key controls, and other practical steps.

The analysis of experiences from different countries clearly brings out that the accrual accounting transition has been undertaken with the objective of the flow of financial information for decision-making in relation to various aspects of governance. This creates a demand-pull towards reform. Understanding the performance, addressing the risks faced, improving the controls, enhancing

the transparency of information to stakeholders, increasing the accountability of institutions and persons concerned, and, above all, providing objective information for decision making are the key objectives that drive the reform process.

CHAPTER 5: STAKEHOLDER ENGAGEMENT

5.1 Need for Stakeholder Engagement and Awareness Generation

Urban water service providers must engage with their stakeholders in order to address various consumer questions and concerns regarding new projects, ensure their support for reform agenda, speedy and smooth implementation of programmes, such as 24×7 PWSS with Drink from Tap facility, and ensure behaviour changes among consumers to reduce water use and promote water conservation. As urban water service providers move towards professionalising their service delivery, they must essentially effectively engage with all stakeholders.

Ensuring Support for New Projects: There may exist many questions and concerns among consumers regarding new projects. In the past, some projects have met with resistance from stakeholders as they were not kept well informed about project benefits and implementation details. Stakeholder engagement is essential to address the need for information regarding new projects and to prevent resistance and resultant delays. Stakeholder engagement is necessary to ensure that all stakeholders are on board while undertaking any new project. Engagement of stakeholders must be ensured in all stages of project development and implementation including preparation of Detailed Project Report (DPR), allotment of land for infrastructure creation, laying of water supply infrastructure, and issuing of water connections.

Ensuring Support for Reform Agenda: Reform agenda, such as universal metering, tariff rationalisation, and increased bill collection, cannot be implemented unless all stakeholders are on board and understand the needs, benefits, and advantages of such reforms. Extensive engagement is required to explain the benefits of reforms to consumers and other stakeholders.

Ensuring Success of Government of India Programmes/Initiatives (24×7 PWSS with Drink from Tap facility): Government of India is progressing towards water service delivery model with various interventions in the pursuit of ensuring 24×7 PWSS with Drink from Tap facility. Ensuring stakeholder engagement during planning and implementation of such ambitious initiatives is extremely crucial to ensure smooth and efficient implementation.

Ensuring Behaviour Change and Promoting Water Conservation: Constant engagement with consumers is important for seeking their support for reducing water use and ensuring the conservation of water. There is a need to make consumers aware about the need for reducing water use, ways of reducing use, encouraging adoption of water- efficient plumbing and fixtures, as well as encouraging the use of treated used water for certain uses.

5.2 Stakeholders in an Urban Water Service Provider Context

5.2.1 Defining the Term "Stakeholder"

In an urban water service provider context, a stakeholder can be defined as "*any person, group, or organisation who can be affected, either directly or indirectly, by the service delivery, as well as those who are engaged in functions across the water value chain including water resource development, water transmission (from source to the city/town), operations and system maintenance, etc.*".

5.2.2 Stakeholders in an Urban Water Service Provider Context

Stakeholders, in an urban service provider context, can be segmented into two categories, namely: External and Internal. External stakeholders of an urban water service provider/utility include a variety of individuals, groups, agencies, and organisations, including government departments/agencies (at both state and local level), political parties, regulators, media, national/state-level experts, consumers and their associations, Civil Society Organisations (CSOs), Non-governmental Organisations (NGOs), private sector, banks, and other Non-Banking Financial Companies (NBFCs). Internal stakeholders of an urban water service provider/utility include engineering staff, functional/support departments (such as human resource development, accounts, and finance), and local elected representatives (local Members of Legislative Assembly (MLA) and councilors). Table 5.1 presents an indicative list of stakeholders and their specific responsibilities related to urban water service delivery. All urban water service providers should identify the key stakeholders from this indicative list and develop a strategy for engaging with them and making them aware.

Table 5.1: Indicative list of stakeholders and their specific responsibilities related to an urban water service delivery

Stakeholder group	Stakeholders	Responsibilities
EXTERNAL STAKEHOLDERS		
State level		
Government departments/agencies	State Government	• Development of water-related policies and programmes • Funding (full/partial) of water supply projects
	Water Resource Departments	• Development, management, and protection of water sources
	Ground Water Boards	• Protection of groundwater sources
	Public Health and Engineering (PHE) Department/other parastatals	• Construction and/or Operation and Maintenance (O&M) of water supply schemes and projects
Political parties	Politicians from various parties	• Have the potential to influence their constituency on behaviour change
Regulator	State Pollution Control Boards	• Responsible for monitoring and regulatory functions
	Regulators for water resource development	
Media	Radio, television, print media, social media	• Ensure wider reach of water-related messages
National/state- level experts	National/state-level experts (with specialisation in water and environment management)	• To provide inputs related to technical aspects and communication, etc.

Stakeholder group	Stakeholders	Responsibilities
Private sector	Private sector companies	• To be engaged in some components of urban water service delivery
Financial companies	Banks and NBFCs	• Potential role in financing private sector agencies
Local level		
Consumers	Urban households Commercial establishments Institutions Industries	• Consumers/end users of a water services • Directly affected by service delivery • Need to be taken on board for any changes in tariffs, metering, and regular payment of user charges • Key stakeholders for ensuring water conservation
Associations of consumers	Resident Welfare Associations (RWAs) Trader associations Associations of various types of industries	• Associations of consumers/end users of water services • Their members are directly affected by service delivery
		• Need to be taken on board for any changes in tariffs, metering, and regular payment of user charges • Key stakeholders for ensuring water conservation
Civil Society Organisations	Women Self Help Groups (SHGs)	• Can play the roles related to metre reading and bill distribution • Report unusual wastage of water
Non-Governmental Organisations	Working with poor communities (slums, informal settlements)	• Can help support inclusion interventions
INTERNAL STAKEHOLDERS		
Team members – technical/engineering	Employees, third-party service providers (if any)	• Operationalise the organisation's objectives and goals
Support function departments	Accounting, Human Resource Development, Finance, Operations, etc.	• Ensure effective co-ordination between operations and support functions
Elected representatives	Local MLA and councillors	• Responsible for decision making related to metering, tariff rationalisation, etc. • Can play the role of influencers for the consumers

5.3 Stakeholder Engagement – Definition and Steps

5.3.1 What is Stakeholder Engagement?

Stakeholder engagement is a process whereby an organisation undertakes a systematic identification, analysis, planning, and implementation of actions aimed at communicating with its stakeholders and building awareness. Stakeholder engagement has consultation, communication, building awareness, and relationship building as its cornerstones. Figure 5.1 shows the four cornerstones of stakeholder engagement.

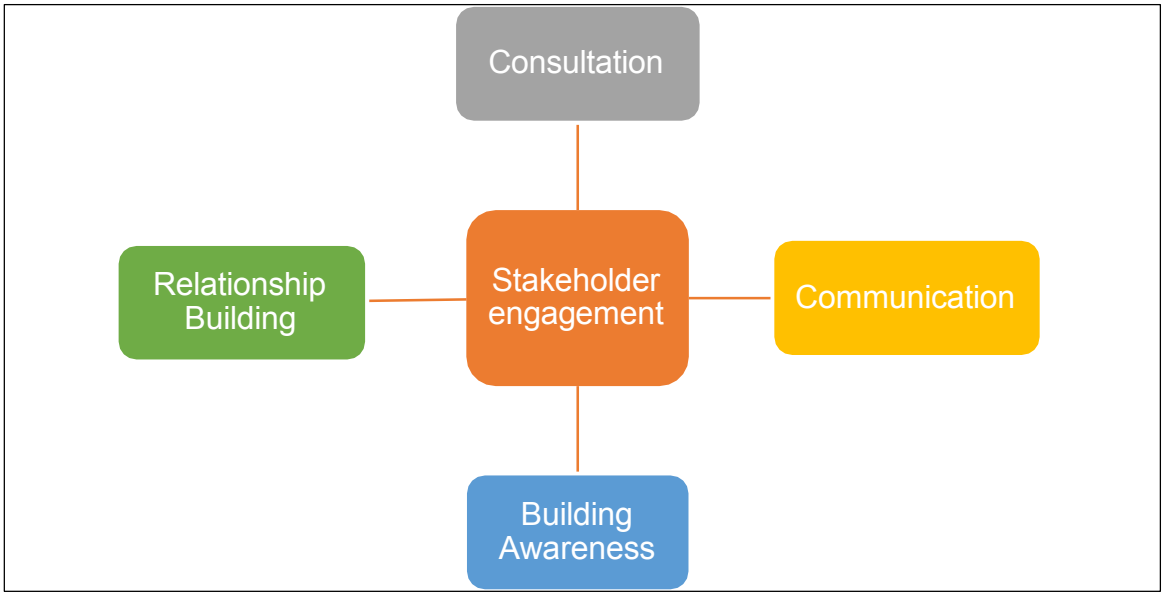


Figure 5.1: Four cornerstones of stakeholder engagement

5.3.2 Steps for Undertaking Stakeholder Engagement

Stakeholder engagement is a set of four activities including (1) stakeholder analysis, (2) developing a stakeholder engagement strategy, (3) implementation of the strategy, and (4) feedback and revisiting of goals of the engagement strategy. These activities are to be carried out by a dedicated stakeholder engagement team within the urban water service provider/utility.

Figure 5.2: Stakeholder engagement – Processes

5.3.2.1 Stakeholder Analysis

Stakeholder analysis refers to the process of identifying the needs, expectations, interests, and influences of various external and internal stakeholders. In order to identify all stakeholders, the urban water service provider/utility should refer to the list of indicative stakeholders provided in Table 5.1.

The stakeholders should be listed in a table or spreadsheet along with their relative interest, influence, and potential level of impact on a project/operation or on urban water service delivery. It must be borne in mind that a particular stakeholder could have multiple reasons for its interest. The identification of interests must be done from each stakeholder's perspective and could be challenging. A stakeholder with high influence and high degree of interest would control key decisions and have strong ability to facilitate action for/against the urban water service delivery. Each stakeholder can be mapped, using the stakeholder influence and interest matrix presented (shown in Figure 5.3).

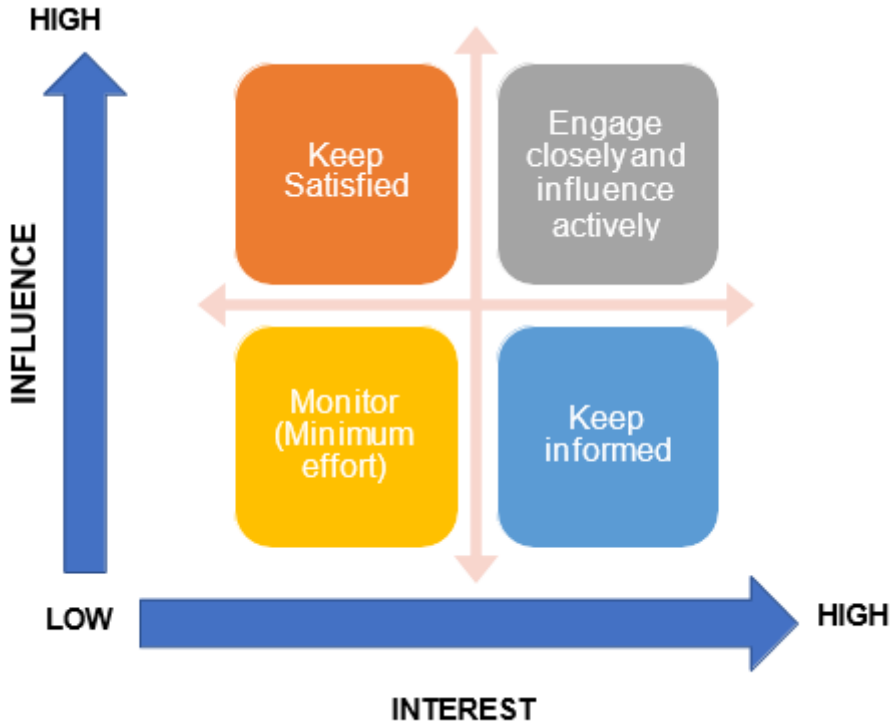


Figure 5.3: Stakeholder Influence and Interest Matrix

5.3.2.2 Developing a Stakeholder Engagement Strategy

Based on the interest and influence matrix prepared, stakeholder engagement strategies would need to be developed. For each stakeholder, the urban water service provider/utility will have to define whether it is engaging with them at present, if yes, what is the nature of the present engagement? What are the goals for future engagement as well as the ambition regarding the level of engagement? The format for the same is presented in **Annexure 5.1**. The strategy must also include a budget for the implementation of the engagement strategy.

5.3.2.3 Implementing of the Engagement Strategy

This step includes the implementation of the engagement with the prioritised stakeholders.

Section 5.4 presents the various methods for engaging with consumers and/or their associations, elected representatives, and internal stakeholders. The service provider may choose from the menu of tools and methods listed based on their needs and goals for the engagement.

5.3.2.4 Feedback and Revisiting of the Goals

This step includes collecting feedback from stakeholders on the engagement process and based on the same revisiting the goals of the strategy to redefine or tweak engagement goals, methods, and tools.

5.4 Stakeholder Wise Communication, Awareness Generation, and Engagement Methods and Tools

For most government stakeholders, the communication and engagement channels are well defined and institutionalised in the form of inter-government/inter-agency co- ordination mechanisms; however, there is a need to institutionalise and strengthen the engagement mechanisms and processes targeting local stakeholders such as consumers, consumer associations, elected representatives, and Community Based Organisations (CBOs) / NGOs. The following sections will dwell on how to build the engagement with the latter.

5.4.1 Consumers and Their Associations

Urban water supply service providers/utilities must effectively engage with **consumers and their associations** in order to:

a) understand their needs and aspirations with regard to water service delivery;
b) encourage them to support implementation of new initiatives such as 24×7 PWSS with Drink from Tap facility;
c) elicit their support for reforms such as universal metering, rationalisation of tariffs, and ensuring regular payments of user charges;
d) elicit support for water conservation by reducing use and wastage, as well as adoption of water-efficient plumbing and fixtures; and
e) communicate in times of crisis such as disasters and other exigencies.

The engagement with domestic consumers (households) must ensure that all subsets of consumers based on their land tenure (formal/informal), as well as income categories (poor, economically weaker sections, middle- and high-income households) are adequately consulted at frequent intervals of time. The process of engagement must ensure that different population groups including women, men, aged and differently abled persons, etc., are consulted so as to understand the different roles played by them in water collection, storage and use, and their varying needs.

There are various methods for engaging with individuals, households, and communities for sharing information, generating awareness, and motivating them to practice desired/positive behaviours. These include:

1) Inter Personal Communication (IPC)
2) Social Mobilisation
3) Mass and Mid Media

4) Information, Education, and Communication (IEC) Materials
5) Social Media

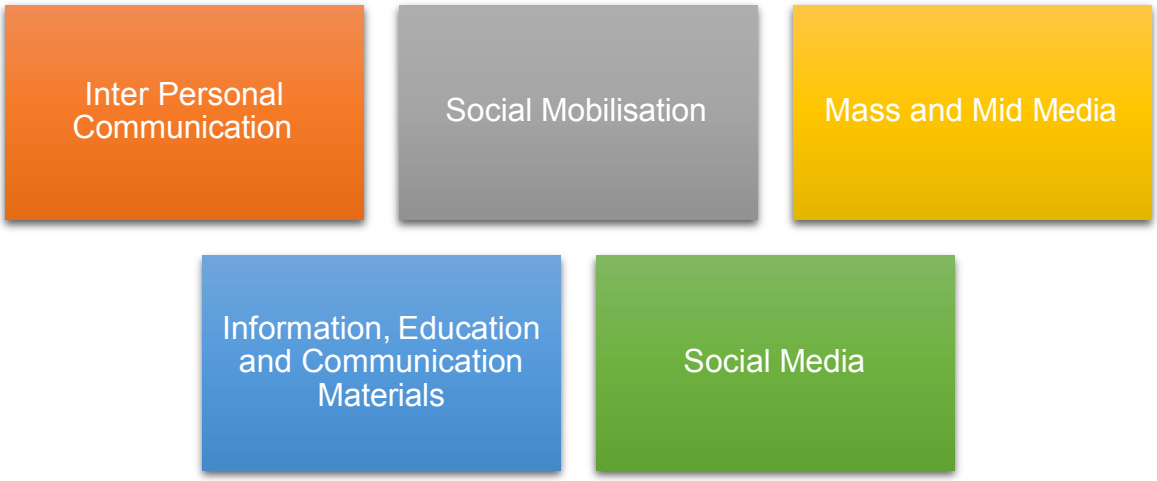


Figure 5.4: Various methods/tools of engaging with consumers – sharing information, awareness generation, and behaviour change

Urban water service providers/utilities must adopt an integrated approach using most or some of these methods/tools for engaging with individuals, households, and communities.

5.4.1.1 Inter Personal Communication (IPC)

IPC is an interactive process between two or more people and is aimed at eliciting support for a new idea/innovation, increasing awareness, and creating increased interest and willingness among the target audience to practice desired behaviours. IPC can be either totally open or directive – that is, focusing on a particular issue or theme.

This method of engagement ensures two-way communication wherein the target audience can clarify their concerns by seeking information. Such clarification/communication would help the customer/citizen to adopt positive practices related to water use, water conservation, use of water-efficient plumbing and fixtures, regular payments of water bills in a long run.

Face-to-face communication helps build rapport between the communicator and target audience. This method is also suitable for all types of audiences and can be used even for uneducated/illiterate audiences. IPC tools usually include flip charts, pamphlets, and posters, etc.

5.4.1.2 Social Mobilisation

Social mobilisation includes mobilising and initiating a dialogue among a community to deal with critical issues of water supply and also provide a platform for the community to participate in the decision-making process. The same can also be used to engage and motivates a wide range of stakeholders to raise awareness and motivate them for behaviour change. This method combines IPC with a broader community and social approach. Few popular social and community mobilisation activities include community meetings and/or events. Social mobilisation also uses tools such as leaflets, IPC videos and flipbooks, etc.

5.4.1.3 Mass and Mid Media

Mass and mid media are a group of tools, which use various media platforms, to raise mass awareness and promote desired behaviours. These supplement IPC and social mobilisation efforts by reinforcing and raising the credibility of the messages.

Mass media includes television, radio, and newspapers while mid media includes hoardings, banners, flex boards, roving billboards, posters, bus panels, wall writings.

Mass and mid media require careful content creation for high appeal and credibility along with simple and less text and more visuals/graphics for maximum recall value by the target audiences.

5.4.1.4 Information Educational and Communication (IEC) Materials

IEC materials are one of the most effective tools for awareness generation and community engagement. IEC materials are used to disseminate messages which are educational in substance, such as messages regarding reduction of water consumption and water conservation.

IEC materials are used in inter-personal communication and community mobilisation. Effectiveness of IEC materials depend on relevance, appeal, uniformity, simplicity of the content and language, accuracy of information, length of the material, cultural appropriateness. IEC material includes leaflets, posters, brochures, pamphlets, flipbooks, flashcards, nukkad shows (literal translation – roadside shows), etc.

5.4.1.5 Social Media

Social media has emerged as a new and innovative way of engaging with individuals and communities. Through social media platforms, information and messages in audio and visual/video formats can be shared very easily to a large population. Social media platforms include microblogs, social networking sites, and video sharing sites.

Following are some of the most popular sites and tools:

- Facebook – useful for communicating news and building communities.
- Twitter – helps stay connected to followers and influencers by sending quick updates or relevant timely information in an interesting manner.
- YouTube – helps upload and share video clips.
- WhatsApp – a chat application to reach to vast audience in a short span of time.

Social media increases an organisation's ability to communicate with various stakeholders, including clients, regulators, volunteers, traditional media, and the general public at one go.

5.4.2 Elected Representatives

It is crucial for urban water supply service providers/utilities to engage with **elected representatives**, including local MLA and councilors, as the implementation of certain reform agendas such as rationalisation of tariffs to cover O&M costs, universal metering, etc., would require their support. Also, local elected representatives (including local members of Parliament, MLAs, and councilors) have the potential of playing the role of influencers for behaviour change

towards the reduction in water use, water conservation, adoption of water-efficient plumping and fixtures, etc.

In almost all urban centres, current water tariffs are very low and do not cover even a fraction of the O&M costs. If urban water service providers/utilities have to move towards financial sustainability, they must rationalise tariffs, along with improving billing and collection systems, so that they can cover O&M costs in the short to medium term and capital costs in the long term. Similarly, in order to implement initiatives, such as universal metering, it is important to get the elected representatives on board given their role as influencers for the end consumers.

The main method for engaging with elected representatives is political advocacy and the same can be undertaken through periodic meetings/consultations supported by evidence building through research. The research can help build a case for the adoption of the reform agenda and sharing experiences from other parts of the world can help get elected representatives interested and engaged in such reform agendas.

5.4.3 NGOs and CSOs

Engagement with **CSOs/NGOs** is also important to ensure that the constituencies they work with or represent (such as urban poor, women, differently abled persons, etc.) are adequately consulted regarding their needs and aspirations with regard to urban water service delivery, which are taken into cognisance while planning service delivery improvements.

5.4.4 Internal Stakeholders

Internal stakeholders include team members, engineers, and functional specialisation departments. Engagement with this stakeholder can be undertaken by institutionalising and/or strengthening internal communication mechanisms including personal contact, email, intranet, or modern employee communication platforms.

There are four types of internal communication, which need to be institutionalised include:

- Vertical: communication between employees on different hierarchal positions;
- Downward: communication from managers or leaders to employees;
- Upward: communication from employees to managers and leaders; and
- Horizontal: communication between individuals on the same hierarchal levels.

Inter-departmental communication channels must also be institutionalised to ensure constant communication between operations, human resource, finance, and accounts teams.

Regular communication and meetings with worker's unions should be conducted so that their issues and challenges are known and addressed. These meetings will also facilitate sharing of key decisions by the management which could affect/interest the workers.

5.5 Case studies

5.5.1 Singapore 10-litre Challenge

"10-litre challenge" is a programme being implemented by the Public Utilities Board (PUB) and

the Singapore Environment Council (SEC) which is aimed at motivating every individual in the country to reduce their daily water consumption by 10 litres as explained in Figure 5.5.

An awareness campaign was launched which aims at motivating individuals to reduce water consumption. The campaign shares seven water conservation measures and devices to achieve a saving of 10 litres per person per day, which include taking shorter showers, washing soiled utensils in a filled sink, using washing machine only on full load, reusing rinse water from washing machine for flushing the toilet or mopping the floor, repair leaks promptly, using half flush for liquid human waste, and monitoring the bills regularly.

Figure 5.5: Singapore 10-litre Challenge

5.5.2 Citizen Volunteers for Awareness Generation and Behaviour Change under Swachh Bharat Mission (SBM)

Under the SBM, the Urban Local Bodies (ULBs) are required to engage citizen volunteer (the number of the volunteers depends upon the size of the ward), who are designated as interpersonal communicator(s) and are entrusted with the responsibility of engaging with each household in the ward on regular basis. The citizen volunteers have to motivate and sustain behavior change at the ground level with respect to key sanitation and waste management practices.

The citizen volunteers have to sensitise households on their role to make their cities garbage free, trigger among them a sense of intolerance to garbage, alert them to the benefits of a clean surrounding and specify the behaviours they can adopt to contribute to that vision. For achieving

garbage-free outcomes, households and citizens would be sensitised on segregating household waste into two bins, taking ownership to maintain cleanliness of their immediate neighbourhoods, educating others about the importance of cleanliness and harmful effects of single-use plastic, and triggered to reduce their usage. For sanitation and used water management, households and citizens would be sensitised about the harmful effects of grey and black water from kitchens and toilets not being safely contained, transported, and managed, maintaining community toilets in a functional manner, providing feedback after using public toilets, and ensuring periodic desludging of their septic tanks.

Under SBM, states and ULBs are required to make use of existing IEC material designed at the national level, in addition to developing their own creative content, depending on the local and cultural context. In addition, states have to ensure that at least three comprehensive multi-media campaigns are created and placed in public domain including (1) in favour of garbage-free city, (2) usage and maintenance of toilets, especially public and community toilets, and (3) safe disposal of used water.

5.5.3 Pey Jal Survekshan

The Pey Jal Survekshan, under Atal Mission for Rejuvenation and Urban Transformation (AMRUT) 2.0, has been launched by Ministry of Housing and Urban Affairs, in September 2022, to assess the service level compliance of any city with respect to quality, quantity, and coverage of water supply, sewerage and septage management, extent of reuse and recycle of used water and conservation of water bodies. The Pey Jal Survekshan serves as a monitoring tool and an accelerator for the AMRUT while also fostering healthy competition among cities. Along with self-assessment of service levels by ULBs, direct observation by assessors and citizen's feedback will be sought from different parts of the cities to capture the level of satisfaction in service delivery.

5.5.4 Jal Sathis, Odisha

Under the "Universal access to water supply programme" being implemented in Odisha, active community engagement was sought as a part of the planning and implementation process. The programme collaborated with *Jal Sathis*, who are women SHGs created under Mission Shakti. The *Jal Sathis* serves as a bridge between the implementing agencies – Public Health and Engineering Organisation (PHEO), Water Corporation of Odisha Limited (WATCO), and the consumers. It is a performance-linked incentive-based partnership with the women SHGs and the Area Level Federations (ALFs). The programme has selected, trained, and engaged with around 1,500 ward wise SHGs and The *Jal Sathis* has played a variety of roles in the implementation of the programme including:

- Connecting the unconnected households and regularising unauthorised connections;
- Conducting field level water quality indicator tests using water testing kits;
- Meter reading, bill generation, bill distribution and collection of user charges at the doorstep. The *Jal Sathis* has been equipped with Mobile Point of Sale (M-PoS) machines to collect revenue from the consumer's doorstep;
- Consumer feedback and facilitating complaint management; and
- Sensitising the communities for doing away with the use of ground water.

CHAPTER 6: ASSET MANAGEMENT

6.1 Need for Asset Management

Degradation of water supply infrastructure is a natural and inevitable process, which not only increases the operational costs and capital investment needs but also poses a threat to the system's reliability, quality of service, and the liability of the water service provider. Urban water service engineers/managers are constantly confronted with the challenging task of deciding which components of the water supply system to rehabilitate or replace.

Most water service engineers/managers are faced with the challenge of reducing unacceptably high levels of non-revenue water (NRW). In addition, they also must raise their service levels to ensure a 24×7 PWSS that meets the increasing demand for water from domestic, commercial, and industrial users and must expand the distribution networks to cope with a rapidly growing population and spatial expansion of their service area. The manner in which an urban water service provider manages its assets determines its success in addressing these challenges.

Good asset management is of crucial importance in an urban water service provider/utility to ensure that consumers have access to a 24×7 drink from tap quality water supply, and service delivery is efficient without compromising the financial health and efficiency of the organisation.

6.2 What is Asset Management?

Asset management is the practice of managing infrastructure capital assets to minimise the total cost of owning and operating them, while delivering the desired level of service. Asset management can help urban water service providers/utilities move from crisis management (repair when it breaks down) to informed decision making. Asset management can help urban water service providers/utilities ensure more efficient operations and sustainable service delivery while making prudent use of the systems' limited resources.

Asset management, in the context of urban water service providers/utilities, is a very complex process. Its complexity is due to the intrinsic nature of urban water infrastructure, that is, presence of a large number of assets that are varied in terms of age, condition, location, and criticality. Further, the investments made for creation of assets are gargantuan. Added to this is the challenge of inspecting, maintaining, and replacing buried assets (underground pipelines, etc.). Lack of information, finance, and skills often makes acquiring, commissioning, maintaining, overhauling, and replacing assets at the optimum time very challenging.

In order to undertake asset management, urban water service providers/utilities need to put in place a set of policies and plans. Further, strong commitment towards development and implementation of processes that cover aspects such as asset acquisition, operation and maintenance (O&M), overhaul, replacement, and disposal is of crucial importance. The urban water service provider/utility must also be ready to institutionalise mechanisms/tools that can enhance the effectiveness of the above-mentioned processes by setting service levels, computing life cycle asset costs, maintaining an asset register, monitoring asset condition and performance, and carrying out risk analysis of possible asset failure.

An integrated asset management approach can help reduce costs and improve performance. Such integration requires the smooth linking of the existing network infrastructure to the master planning process and other rehabilitation, replacement, and upgrading projects. In asset

management, mapping of all components of the water supply system on a Geographical Information System (GIS) is important. The guidelines issued by Central Public Health and Environmental Engineering Organisation (CPHEEO) for planning, design, and implementation of 24×7 water supply systems recommend the use of GIS for mapping all the existing, proposed, and executed infrastructure along with GIS simulating modelling. Urban water service providers/utilities should procure a suitable software for asset management.

6.3 Asset Management in Urban Water Service Providers/Utilities

Asset management, in the context of urban water service providers, includes (a) asset performance management and (b) asset prioritisation (Figure 6.1).

Asset performance management includes the following:

1) Assess past, current, and future/predicted performance for any asset in the network, including both linear and vertical assets;
2) Monitor pump's operating points for any given period and compare with the best behaviour to calculate efficiencies;
3) Assess tank storage and tank turnover for any given period;
4) Calculate water losses (real and apparent) for any period and/or zone;
5) Institutionalise systems for automatic alerts for asset failures or inadequate asset operation.

Asset prioritisation includes the following:

1) Define key aspects or criteria: Definition of key aspects that can drive pipe prioritisation. The urban water service provider/utility can define any aspect taking into consideration both the data available in the solution as well as the specific context and requirements of the utility and the region.
2) Calculating the scores: Individual scores for each pipe can be obtained using flexible decision tree method, statistical analysis, or linear interpolation methods.
3) Building multi-criteria decision-ranking system: After the key aspects are defined (under step 1), and scores for each pipe and aspects are calculated (under step 2), the urban water service provider/utility should combine multiple aspects to build its multi-criteria decision-ranking system.
4) Prioritisation/identification of priority pipes.
5) Action plans: Based on the prioritisation results, the urban water service provider/utility should be able to create and compare different alternative action plans and be able to include different actions associated with the different assets and priorities.

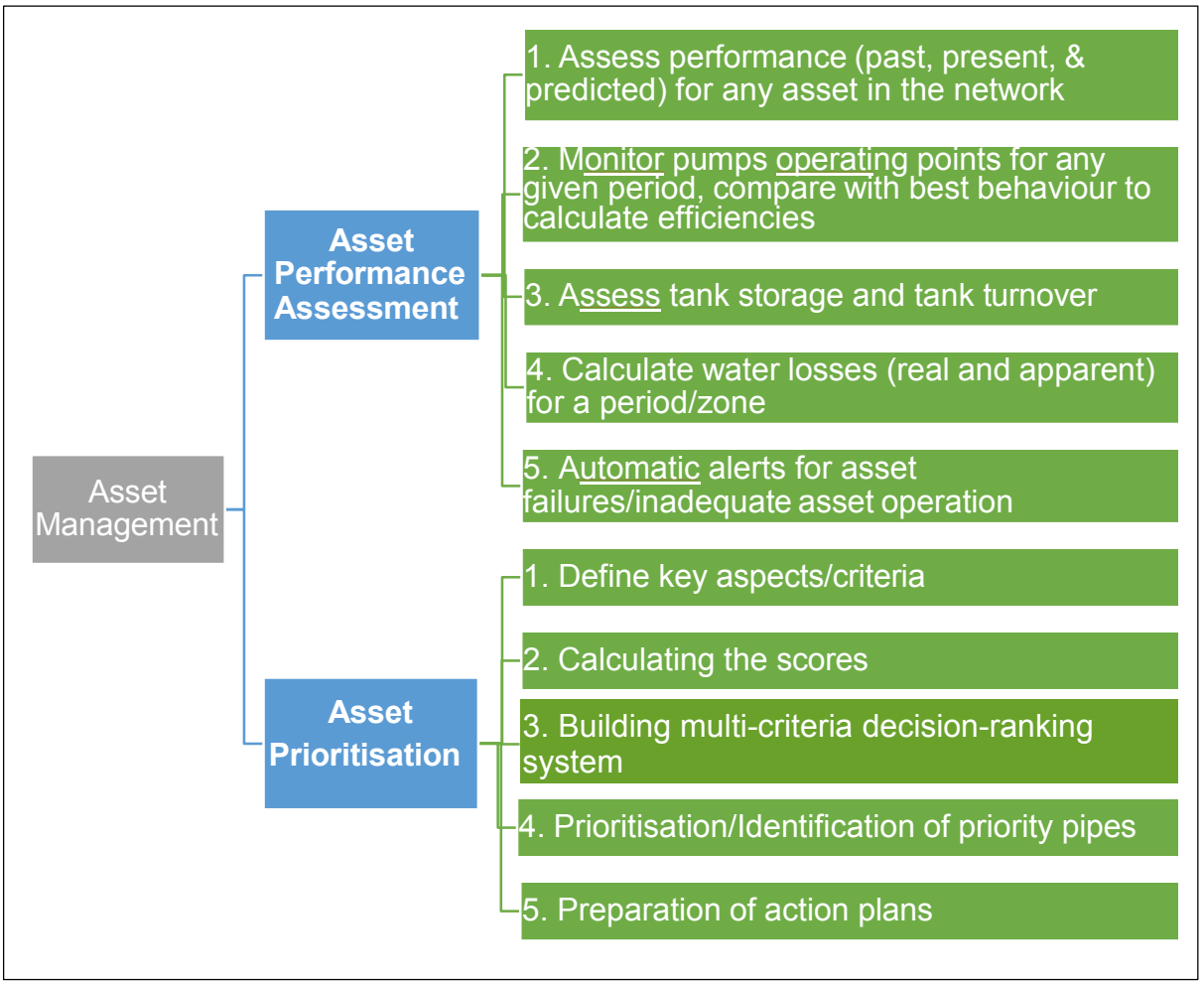


Figure 6.1: Asset Management – Asset performance assessment and asset prioritisation

6.4 Management of Assets of Drinking Water Supply System — Guidelines (IS 18182:2023)

The IS 18182:2023 has been formulated to ensure effective management of assets and focuses on the details of managing the physical assets at the operational level. This standard is intended to provide guidance on the assets typically owned or operated by drinking water utility engaged in collection, treatment, pumping, storage, and distribution of drinking water. This standard provides the guidelines to collect and process reliable inventory, historical process, failure, and operational data about technical assets of a drinking water supply system. A reliable database that supports analysis of failures and of operational data (including a description of the condition of facilities or units) is of significance when establishing a risk-based investigation to determine priorities for maintenance and rehabilitation. The data provided should be used for systematic management of assets and benchmarking purposes.

6.5 Steps for effective asset management

For implementing effective asset management, urban water service providers/utility managers need to undertake the following steps in a sequential manner (Figure 6.2):

- Step I: Institutionalise an asset management policy and create an asset management strategic plan;
- Step II: Define service levels, Standard Operating Procedures (SOPs) and Key

Performance Indicators (KPIs) along with implementation and monitoring plans to measure and achieve the targeted service and performance levels;

- Step III: Understand the demand changes;
- Step IV: Establish asset data foundation;
- Step V: Assess condition of all assets;
- Step VI: Identify potential risks and evaluate consequences of failure;
- Step VII: Perform life cycle cost analysis; and
- Step VIII: Develop an asset management plan.

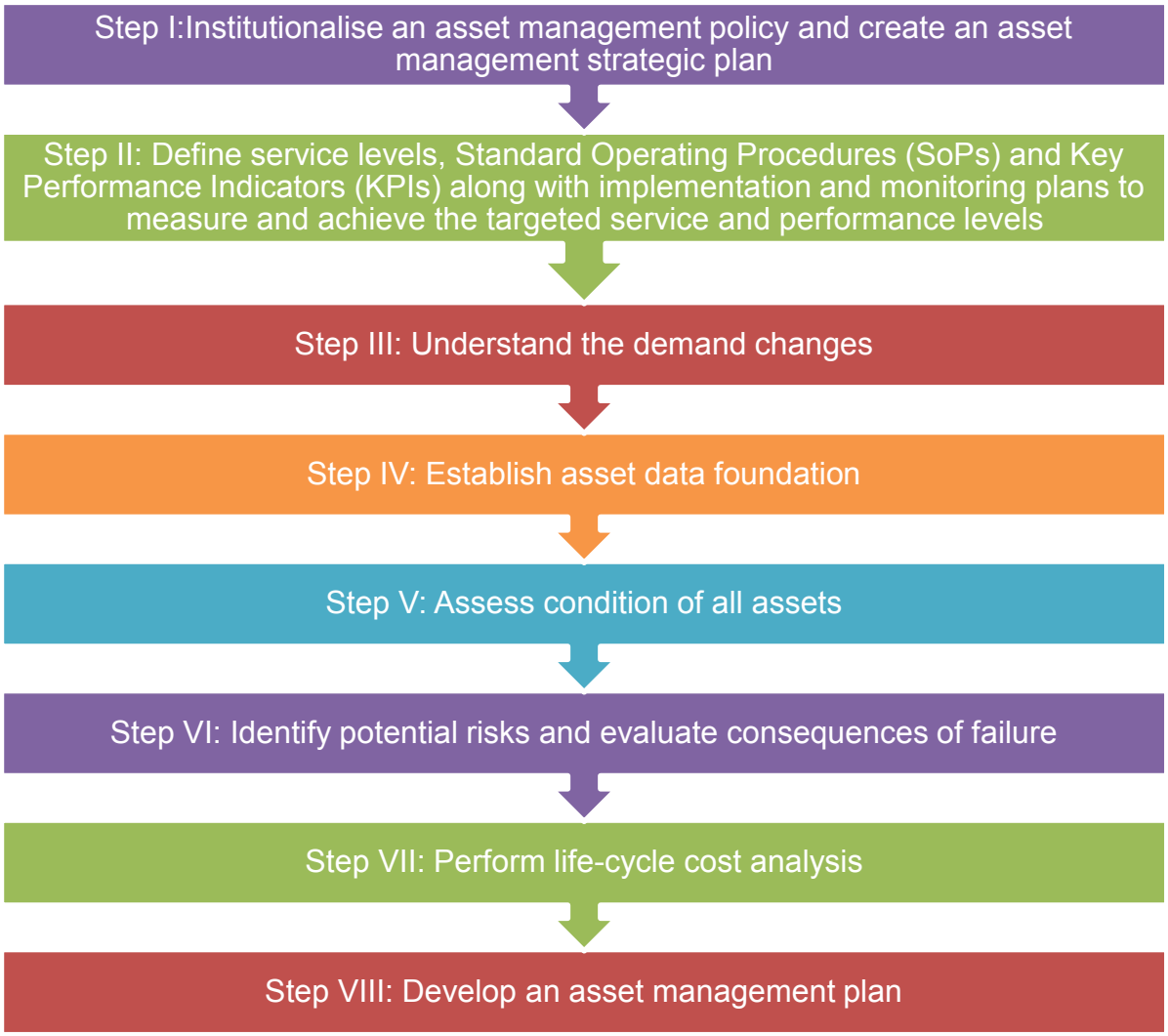


Figure 6.2: Steps for effective Asset Management

6.5.1 Asset Management Policy Statement

Urban water service providers/utilities need to prepare an Asset Management Policy/statement to ensure that all stakeholders, especially internal stakeholders (staff, management, and other technical consultants) are aware of the fact that an integrated asset management approach is being adopted by the organisation. It will allow internal stakeholders to truly appreciate the value of such an approach for achieving the service, financial, and sustainability goals of the organisation and will ensure that they are able to incorporate these principles in all daily tasks and operations. Box 1 presents a sample asset management policy statement as a reference.

Box 1: A sample asset policy statement

The organisation will, at all times, practise the highest level of asset management including (a) asset planning based on demand forecasts and targeted service levels; (b) maintenance of reliable integrated asset records that facilitate good governance; (c) maintenance, rehabilitation, and replacement of assets based on life cycle costing, condition monitoring, and risk assessment; and (d) clear accountability for asset acquisition, security, operation, inspection, maintenance, and disposal.

6.5.2 Defining service levels, SOPs, and KPIs along with implementation and monitoring plans to achieve the targeted service and performance levels

Establishing service level targets, SOPs, and KPIs along with monitoring achievements for the same will enable utility engineers/managers to make informed decisions related to asset acquisition and management.

Service levels could be described in terms of the availability of water supply, which can be further measured through indicators such as number of interruptions, period of interruptions, and response times. Customer service-level targets must be set through a consultative process with all different categories of customers (domestic, commercial, institutional, and industrial) and must be reviewed regularly.

Identifying and documenting **SOPs that define the optimal operational requirements and operating procedures for all components of the water supply system** (including pumping stations, treatment plants, service reservoirs, and distribution system, etc.) should be undertaken. The SOPs should be specific to each installation, and the process would have evolved over a period of time integrating the learnings over time. The SOPs should cover the following themes:

- Routine operations;
- Monitoring performance and fault detection;
- Fault reporting and rectification;
- Recommissioning;
- Reporting structure and contact details;
- Reporting format frequency and response mechanism;
- Escalation matrix (in case of the incident is not brought under control within a stipulated time);
- Management (performance and condition monitoring, energy management, asset management);
- Water management, if the responsibility of the water source sustainability is with the pump station, with budgeting, management, etc.; and
- Integrated Water Resource Management (IWRM).

Relevant safety requirements and procedures should be highlighted under the respective SOPs.

Urban water service providers/utilities must define KPIs aimed at assessment and prioritisation of water supply systems. Table 6.1 presents a sample list of KPIs for a water supply system.

Table 6.1: A sample list of KPIs for a water supply system

Designation	Unit
Non-revenue water	%
Network replacement	%/year
Pipe failure	#/100 km per year
Real water losses in network	m^3/km/year
Real water losses in service connections	Litres per service connections per day
Energy efficiency of pumping installations	kWh/(m^3.100 m)
Energy in excess per unit of input volume	(kWh/m^3)
Energy in excess per unit of the revenue water	(kWh/m^3)
Ratio of the total energy in excess	(-)
Unmetered consumption	(%)
Service level connection failure	#/1000 service connections per year
Tested water volume capacity	(days)
Disruption caused by pipe failures	Hour/100 users/year
Disruption caused by service connection failures	Hour/100 users/year
Real water losses	%
Infrastructure value index	(-)

Urban water service providers/utilities should also create matrices for monitoring the asset performance:

- Cost of ownership of assets (Life cycle Cost of Assets = Energy Loss against each asset + O&M + Asset Renewal Costs)
- Estimate cost of underperformance, breakdowns, and its long-term implications and risk
- Sustainability perspective shall be estimated form economic, social, and environmental costs, and its effects

6.5.3 Demand Forecast

Undertaking a demand forecast exercise is crucial for urban water service providers/utility managers to plan requirement of assets for system expansion and/or upgrades that may be essential to sustain defined service levels and KPIs. Further, it will help plan, acquire, and commission new assets or replace existing assets which do not meet the defined service levels. The demand forecast exercise must factor in various scenarios based on assumptions.

For a robust demand forecasting exercise, reliable, detailed, and timely information/data is critical. Data sources such as government records of building approvals, land releases that estimate population growth, etc., could be useful for forecasting demand.

6.5.4 Understanding the Asset Base

Collecting data: All assets of an urban water service provider must be identified and listed with their location, age, value, etc. Having information on existing assets is critical for implementation of an asset management exercise. In order to prepare a robust asset database or asset register, the urban water service provider/utility must institutionalise processes which allow for collection

of past data as well as regular collection and collation of information regarding current assets.

The basic data needed to assess the urban water infrastructure asset condition should include the following:

1) Detailed information on all assets including name, type, location, dimension, material, installation year, etc.;
2) Functional and physical condition of the assets including reports on hydraulic behaviour of assets and performance assessment reports;
3) Data on asset maintenance activities, failure reports, and complaints;
4) Data on billing and operational costs including costs for network-related O&M, energy costs, personnel costs, amortisations, interest, revenue, etc.

In many cases, such data is neither collected nor recorded. Further, many times the available data doesn't align with the requirements. Water utility engineers/managers are required to collect a lot of data which needs time and thus is not undertaken due to lack of time. There is, thus, a need to prioritise the key data points that are non- negotiable and encourage staff to collect the same.

The following methods could be used for collecting information/data on assets:

- Review service area and facility maps, GIS databases, and other databases (if available).
- Perform visual inspections of the urban water supply system facilities and service area.
- Conduct discussions with system management and staff with current or historical knowledge of system assets.

Urban water service providers/utilities may also include photographs of their assets to further document location and condition. Documenting the latitude and longitude data of each asset will aid in creating GIS maps. Urban water service providers/utilities should identify critical assets that have a significant bearing on the operating cost, operational efficiency, reliability, and sustainability.

Asset Management Information System: The data, thus collected, must be stored and used in various activities using information systems, including GIS, Customer Relationship Management (CRM), Costumer Information System (CIS), Enterprise Resource Planning (ERP) system, and Supervisory Control and Data Acquisition System (SCADA), Computerised Maintenance Management System (CMMS), Laboratory Information Management System (LIMS), among others. Such systems must be suitably connected and integrated with the Asset Management Information System.

Asset classification: Urban water service provider/utility must also establish an asset classification method. The assets can be classified from various perspectives for their management. In order to manage them effectively, asset records should be classified. Assets can be classified in the following order: major function or process, sub-function, type, and component. Classification facilitates data collection, reporting, and comparative analyses.

Managing critical assets: The critical assets that are dynamic in nature, such as motors and pumps, require close monitoring, maintenance, and upkeep. They should have clearly chalked out operational procedures and maintenance schedules as the failure of such assets would have serious consequences and the risk of such failures should be assessed and managed. The performance of these critical assets would have a significant bearing on the energy efficiency and reliability of the plant, and it directly or indirectly contributes to the major share of the operating cost of the pump house in terms of O&M and asset renewal costs. In the absence of adequate information on the condition and performance of these critical dynamic assets, the operation, maintenance, and asset renewal decisions may not be optimum. A computerised system which contains a number of key modules to allow planning and acquisition of assets, maintenance of records, and scheduling of asset replacement is critical. The system should develop a risk matrix to plot the probability of failure versus the consequence of failure based on the matrix presented in Table 6.2.

Asset register: Urban water service providers/utilities need to work towards improving the quality and coverage of their asset records. They must seek to collect and collate the following information for all assets – date of asset acquisition, description of the asset, maintenance history, original cost, current valuation, asset type, expected life, inspection frequency, risk rating, location (tied to a GIS), performance information, and unique identifier code. The asset register should be based on an asset hierarchy which will help organise assets in an asset register.

Each asset in the inventory must have a unique asset identification number (Asset ID) to enable easier asset identification, allowing systems to search and query data more effectively and make valuable data more readily available. An asset numbering system can be developed using any of the existing approaches, such as sequential numbering, existing internal numbering system, existing external numbering system, new number system, or random numbering system created using a software. Asset IDs should be logical, consistent, unique, avoid duplications, allow room for growth, and allow for drilling down using a hierarchical structure. An asset management software can enable automatic creation of IDs for any new assets added to the inventory. In a system using a geospatial software, the Asset ID can be a random number and the software will allow the system to look for assets by location. An asset ID number should ideally provide information on asset class/category, location, size, ownership, and other unique identifiers. Examples of Asset IDs are (a) A BCD EFG 1 = Water (W), Facility name (BCD), equipment name (EFG), equipment number (1); (b) W MPS PMP 1 = Water System (W), main street pump station (MPS), Pump (PMP), number of pump (1).

Asset record systems could include card indexes, spreadsheets, customised software from vendors, or computer applications developed in-house by the urban water service provider/utility. Of all these options customised software systems developed by vendors could be the most cost-effective and time-efficient option. Such systems will also allow for integration with other systems (such as financial, customer services, maintenance, and GIS) along with ensuring generation of a variety of reports that can help engineers/managers monitor assets and make decisions. An illustration of an Asset Management Systems Module is presented in Figure 6.3.

Urban water service providers must consider using digital twin for asset management in line with the guidelines issued by CPHEEO for planning, design, and implementation of 24×7 water supply systems. Digital twin allows for integration of data from various sources such as SCADA, GIS, hydraulic modelling, consumer information, and historical data into a cloud-based single platform to deliver cost-effective, real-time operations management, energy management, and asset

management.

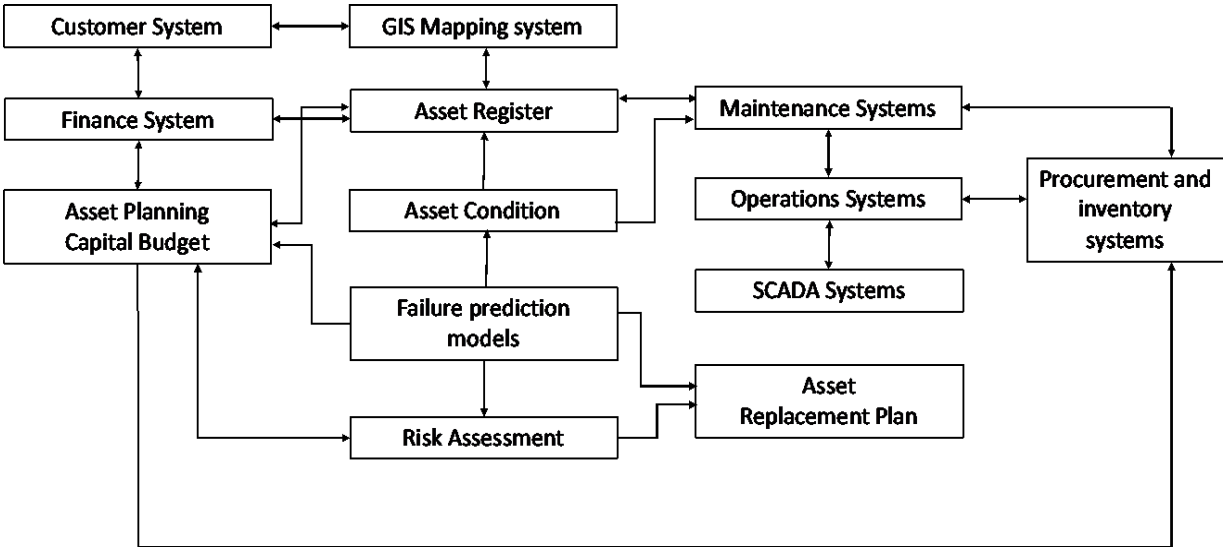


Figure 6.3: Illustration of an Asset Management Systems Module

6.5.5 Condition Assessment of Assets

Asset condition can range from brand new, to worn out, and failing. Condition monitoring allows urban water service providers/utilities to predict when an asset would need repair and replacement and how much longer an asset can be used. Asset condition monitoring allows planning for maintenance, rehabilitation, or replacement in order to minimise service delivery interruption and costs.

Urban water service providers/utilities can develop a scale for condition classes on lines similar to the one shown in Figure 6.4. Assets with high cost and higher risk can be prioritised for more sophisticated condition classification. The condition classification can also be separated as per asset type (i.e., underground pipes versus above-ground pumps). Condition ratings can also be established by tracking causes of failures. Condition monitoring can be carried out through analogue, digital, or visual methods.

For condition assessment, also refer to section 2.7.2 of Chapter 2: Planning, Investigations, Design and Implementation, Part A of this manual.

Figure 6.4: Sample of Condition Classes for Assets

6.5.6 Identify asset risk and potential for failure

The term “risk” is defined as the probability of failure multiplied by the consequence of failure. If both the probability of failure and consequence of failure are high, then the risk is too high and should be reduced to an acceptable level or eliminated. There are risks involved in the delivery of water supply and it becomes critical for service providers/utilities to identify and manage asset

risks in order to achieve and sustain agreed service levels while operating within the available budgets.

Urban water service providers/utilities need to undertake a five-step risk management process, which includes (a) establishing risk context and framework, (b) identifying risks, (c) evaluate risks, (d) manage risks, and (e) monitor and review. Refer to Figure 6.5.

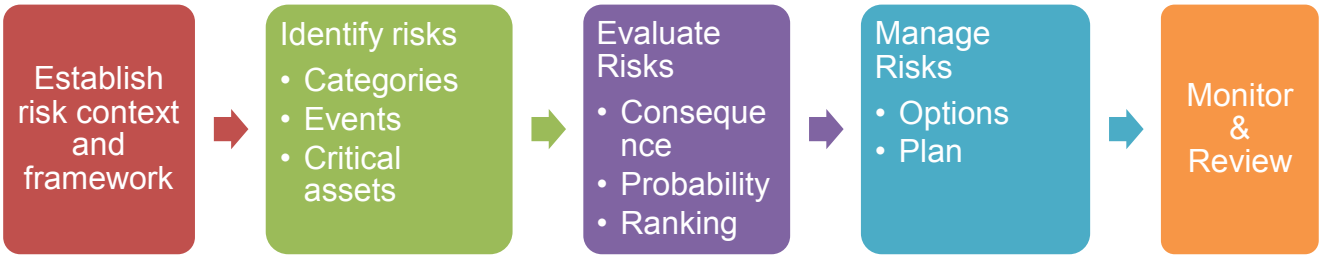


Figure 6.5: Risk management process

Risk identification must be undertaken following a consultation with managers and the findings must be recorded in an asset register. After identifying a risk, it must be rated to identify the degree of intervention required to achieve an acceptable risk level. Assets with a very high consequence of failure and quite likely for failure are termed as "critical assets" and their management requires a number of actions. For example, having backup systems (such as alternative power supplies) and units on standby, or holding key spare parts. The matrix below (Table 6.2) can be used for identifying risk levels and the cells highlighted are critical assets.

Table 6.2: Risk Matrix

Probability of failure		**Consequence of failure**				
		Very low	**Low**	**Medium**	**High**	**Very high**
Very low	1	1	2	3	4	5
Low	2					
Moderate	3					
Quite likely	4					
High	5					
Very high	6					
Almost certain	7					

6.6 Asset Management Strategies

Asset management strategies which urban water service providers/utilities should consider adopting include (Figure 6.6):

1) Decision-making techniques;
2) Operational strategies and plans;
3) Maintenance strategies and plans;
4) Capital works strategies; and
5) Financial and funding strategies.

Figure 6.6: Types of asset management strategies to be adopted by urban water

6.6.1 Decision-making

Asset management involves taking a number of decisions regarding what assets to acquire, rehabilitate, or replace and when to undertake maintenance. Decision making regarding asset management must take into account the concept of life cycle costing which is defined as "getting the maximum service from an asset or groups of assets for the least cost during their lifetime". Life cycle costs include initial acquisition costs, maintenance, refurbishment, and disposal costs.

In order to arrive at the likely cost of maintenance, operation, renewal, disposal cost, and economic life, the starting point will be to collect and study the following aspects – supplier and bidding information, service provider/utility records, and utility's management experience. Estimated forecasts of the costs for maintenance, operation, renewal, and disposal are sufficient to make decisions.

It is important to thoroughly assess the sensitivity of computed results to different assumptions in order to make them robust. It is also critical for different categories of staff (engineering and finance/accounting staff) to work together when applying any decision-making technique as asset management involves both physical assets and their financial consequences.

6.6.2 Operational Strategies and Plans

In order to ensure full utilisation of assets, urban water service providers/utilities need to adopt operational strategies. Such an approach will also ensure optimal life cycle unit costs. For water services, the following operational strategies are advised:

- Ensure asset utilisation is not wasted. For example, pumping water and then losing the value of utilisation through leakage.
- Reduce demand for overused assets which in turn avoids the risk of failure or early replacement and thus underuse of an asset.
- Establish a target range for asset utilisation and measure and report on actual performance against this target.
- Have emergency plans which will ensure service continuity in a possible crisis situation.
- Ensure operators are fully trained and aware of asset performance expectations so that they can meaningfully contribute to asset monitoring and management.

6.6.3 Maintenance Strategies and Plans

Maintenance is aimed at slowing down asset deterioration and extending the period before which rehabilitation or replacement is required. Maintenance needs to be a mix of preventive and breakdown maintenance (repairing unplanned faults). Unfortunately, in most urban water service

providers/utilities, there is very little focus on preventive maintenance which results in lower service performance, higher life cycle costs, and shorter asset life. Unplanned/breakdown maintenance costs are two to three times more than planned maintenance and are harder to manage. A proper maintenance management system translates the targeted asset service and utilisation levels into maintenance activities. Refer to Figure 6.7.

Figure 6.7: Maintenance Management System overview

Maintenance strategy should cover the following aspects: (a) how will maintenance be organised (skills-based or location-based), (b) what will be the service delivery method (in-house or outsourced), (c) what is the expected functional asset performance, (d) asset interaction with other assets, (e) information and records requirements, and (f) maintenance prioritisation.

Maintenance objectives should include desired maintenance performances, such as response times, productivity, safety, and asset availability.

Maintenance work plans should outline the SOPs and they must also consider previously assessed risk rating, criticality, and condition. Maintenance plans must detail out activities such as inspections; planned remedial action; and unplanned work (addressing breaks or overflows). Results of implementing maintenance plans must be monitored and performance assessed against the set objectives. Maintenance plans and procedures must be drawn after considering other information, such as O&M manuals, drawings, photos, manufacturer-recommended maintenance, and maintenance priority. In addition, maintenance planning must also be informed by understanding when an asset is likely to fail – due to capacity overload or due to wear and tear.

As mentioned in Section 6.3.4, maintenance information must be included in the asset register. In the case of CMMS, it can help establish an inspection schedule based on a set of criteria. Further, once the inspection reports are updated, the system can also enable generation of work orders to inform the maintenance crew of the tasks they need to carry out and the materials needed.

6.6.4 Capital Works Strategies

Capital works include works taken to create a new asset or to improve the condition of an existing one. Budgeting for capital works usually covers assets needed to cope with urban growth, comply with new government regulations, and for renewing or replacing existing assets (planned or unplanned). Capital works process is presented in Figure 6.8. Plans for capital works extend over 5-, 10-, or 20-year periods because of the different technical lifespans of the assets and the long lead time needed for some asset acquisition and works.

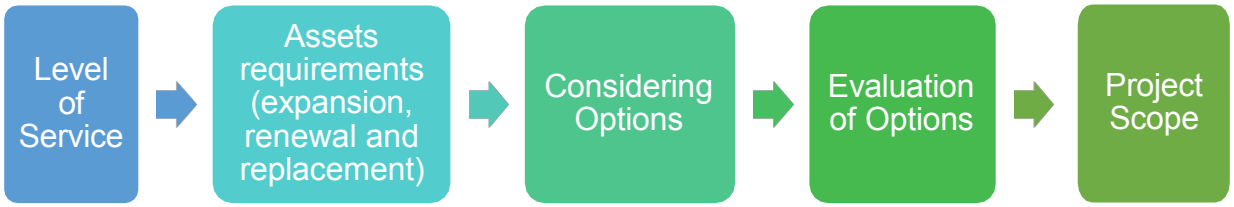


Figure 6.8: Overview of Capital Works

Level of service: Capital works planning begins with a demand forecast and assessment of the present condition of the existing asset base and comparing the same with the expected level of service.

Asset requirements: Based on the above, the urban water service provider/utility is required to estimate asset requirements for expansion, renewal, and replacement. All three subcategory of asset requirements (expansion, renewal, and replacement) should be assigned different priorities if the urban water service provider/utility is not in a position to undertake all proposed capital works. The decision should consider the following four failure modes of an asset, namely, mortality, capacity, level of service, and financial efficiency.

Considering options: Options which an urban water service provider/utility must consider while undertaking capital works planning are deferral, accepting a higher risk of failure, and design change. Service provision can also be considered as an operational cost rather than as a capital cost. For example, the urban water service provider/utility might consider leasing assets owned and operated by others.

Evaluation of options: At this stage, all options have to be evaluated using techniques such as risk analysis, cost-benefit analysis, and life cycle costing before zeroing in on the preferred course of action. The urban water service provider/utility must bear in mind that the objective here is to achieve a balance between capital costs, operating costs, affordability, risks, and service continuity.

Project scopes for implementation: At this stage, all approved projects must be described in detail, and they should be a part of annual or long-term work programmes. This is aimed at ensuring that all involved fully understand the project's scope and expected results.

KPI for project progress: The following indices on KPIs are indicative and should be discussed and agreed upon before these are adopted. Table 6.3 indicates the method of calculation of the KPI.

Table 6.3: KPIs and method of calculation

KPI	Method of calculation
Network Asset Management & network rehabilitation	
% completion of background/topographical data	% of supply area
% completion of unverified Network Asset Register	% of pipe length
Number of network data discrepancies	Actual number of areas to be investigated in the field
% of network data validated	% of pipe length
% of network data with condition assessed	% of pipe length

KPI	Method of calculation
% implementation of bulk metering & zoning	% of recommended work executed in the field
Level of data integration achieved	Deliverable & activity schedule
Network rehabilitation study (% completed)	Deliverable & activity schedule
Network rehabilitation work (% completed)	

6.6.5 Financial and Funding Strategies

Asset management is not restricted to engineering and O&M inputs and financial planning have an important role to play in many aspects of asset management. Financial management expertise is of critical importance for asset-intensive urban water utilities where physical assets make up most of the total assets. In urban water utilities, the annual expenses for new assets and asset renewal are significant, and most of the operating costs (for depreciation, energy, and maintenance) are driven by the asset base.

Urban water service providers/utilities need to

1) prepare long-term financial forecasts to better manage cash flows and ensure timely asset acquisition and renewal. Assets, income, cash flow, and costs are interdependent. The forecasts have to be worked through repeatedly to get the most balanced and achievable result;
2) identify any shortfalls in funding to cover the capital works plan;
3) test the impact of various revenue scenarios;
4) assess the possibility of using public–private partnerships for financing and operating assets (wherever possible); and
5) judge the sensitivity of cash flows to varying assumptions and timings.

Financial KPIs: The following indices are indicative and should be discussed and agreed upon before these are adopted. Table 6.4 indicates the method of calculation of the KPI.

Table 6.4: Financial KPIs and method of calculation

Indicator	Unit
Personnel costs / Total staff	Rs per employee
Investments per year*100 / Total turnover	%
Maintenance and repair costs / Total water delivered	Rs per m^3
Electricity costs / Total water delivered	Rs per m^3
Material costs / Total water delivered	Rs per m^3
Other costs / Total water delivered	Rs per m^3
Operational costs / Total water delivered	Rs per m^3
Financing costs / Total water delivered	Rs per m^3
Personnel costs / Total number of connections	Rs per connection
Personnel costs / Total water produced	Rs per m^3

Indicator	Unit
Billing process costs Total water delivered	Rs per m^3
Billing process costs Total number outgoing invoices	Rs per bill
Maintenance costs Total length network	Rs per km network
Administrative costs Total number incoming invoices	Rs per incoming invoice
Fixed assets Water turnover	Investment rate Rs turnover
Administrative costs Total number of connections	Rs per connection

6.7 Asset Management Plan – Components

An asset management plan must have the following nine components:

6.7.1 Introduction

The introduction section of the Asset Management Plan should provide the necessary context for the plan. It should:

- Identify the purpose(s) of the plan;
- Present the urban water service provider's/utility's strategic plan and mission statement, which define the goals and frame the level of service;
- Provide an overview of the urban water supply system and its facilities, including general system design, water usage, population served (current and projected), water sources, etc.; and
- Explain how the urban water service provider/utility approaches asset management, such as a brief description of tools used for implementation of specific practices.

6.7.2 Staff Details

This component of the Asset Management Plan should include information on the system's staffing structure and the team responsible for asset management within the organisation. This component will enable the urban water service provider/utility to assess whether staff roles and responsibilities are appropriate and adequate. Clear and well-defined staff responsibilities will also allow team members to understand their individual roles in the implementation of the asset management plan.

This section should include:

- Details of the asset management team, including staff and any non-staff members (such as consultants or technical assistance providers);
- Detailed responsibilities of all staff and non-staff members identified as per the point above;
- An organisational chart;
- Details on any internal co-ordination mechanisms, such as standing committees; and
- Education and outreach efforts, such as methods for communicating with stakeholders and decision makers.

6.7.3 Growth and Demand

The asset management plan should also include details on the demand, sustainability, and technology changes that may come up in the future and can influence how the urban water infrastructure is managed.

6.7.4 Level of Service

“Level of service” is defined as how a water supply system operates and manages its assets to meet desired service levels. Level of service determines the investments and time required to maintain, renew, and upgrade water system infrastructure.

This component should include:

- measurable internal goals, which define system’s operations and performance;
- measurable external goals, which directly impact consumers;
- mechanisms for communicating the urban water service provider/utility performance toward its level of service to the consumers, including methods and frequency of communication; and
- mechanisms for receiving information from consumers regarding the satisfaction with the level of service and connected goals.

Effective asset management helps to ensure compliance with national drinking water regulations. This component of the Asset Management Plan should include a discussion of:

- the system’s compliance history with national drinking water regulations, along with plans for meeting future requirements;
- significant deficiencies, as determined by the government and regulation agencies and follow-up actions.

6.7.5 Asset Inventory

An asset inventory is a critical component of an Asset Management Plan. Urban water service providers/utilities must have an inventoried list or survey of all system assets (e.g., source, treatment, transmission, and distribution infrastructure). It should include each asset’s age, location, condition, criticality, probability of failure, consequence of failure, and remaining useful life. The inventory should recognise natural asset groupings – assets belonging to water source, treatment, and distribution should be grouped together.

Urban water service providers/utilities may also include photographs of their assets to further document location and condition. Documenting latitude and longitude data of each asset will aid in creating GIS maps. Urban water service providers/utilities should identify critical assets that have significant bearing on the operating cost, operational efficiency, reliability, and sustainability.

6.7.6 Operation and Maintenance

The proper O&M of an urban water supply system’s assets is a necessary element of an effective asset management programme. Proper use and service of assets are important to ensure the long-term viability of an urban water supply system. The strategy for O&M would vary based on each asset’s criticality, condition, and operating history. An urban water supply service

provider/utility must maintain a record of each asset's maintenance history, needs, and costs.

This component in the Asset Management Plan should discuss the system's operational activities (i.e., the basic activities necessary to keep a water supply system running) and maintenance activities (i.e., activities that help keep an asset in good working condition). These would include SOPs, Alternate Operating Procedures, Emergency Operating Procedures, routine maintenance, preventive maintenance, emergency/reactive maintenance, and deferred maintenance.

The plan should reference specific aspects of the water supply system's O&M manual.

6.7.7 Capital Improvement

Capital improvement planning determines a system's short- and long-term asset rehabilitation and replacement projections, based on the asset inventory and O&M data.

In the capital improvements component of the Asset Management Plan, the following should be included:

- Future capital projects (and anticipated associated expenditures) for plans to add new assets to the system that upgrade or improve existing capacity.
- Renewal projects (and associated expenditures) for plans to restore an existing asset to its original capacity, without increasing an asset's design capacity.

The asset management plan should include all projects within a minimum 5-year timeframe. However, a 20-year timeframe is preferred to accurately assess and plan for improvements. Reference to capital improvements beyond 20 years should also be included with a discussion of long-term financial planning.

If a system has already developed a Capital Improvement Plan (CIP), the asset management plan can reference it, specifically the timing and cost of the rehabilitations and replacements. Because the expected needs of the system will change, the CIP projects listed in the asset management plan should be updated as necessary to reflect those changes.

6.7.8 Financial Strategy

A financial strategy is necessary to ensure that the system has adequate sources of funding for current and future O&M and capital needs and is able to meet its established level of service goals.

The financial strategy component of the Asset Management Plan should include the following:

- Water tariff methodologies, including the system's current rate structure and plans for future rate modifications.
- The latest system's annual operating budget and capital budget.
- The types of reserve accounts that the system has (e.g., operating cash reserve, emergency reserve, short-lived asset reserve, capital reserve).
- System loans and bonds.
- Financial history and financial forecasts.

When developing this component, the urban water service provider/utility should review annual

financial statements, budgets, audits, and the system's master plan.

The system's financial projections should show predicted revenue and expenses over the next 5 to 10 years. To help inform these projections, the urban water service provider/utility should determine its financial health using financial ratios, including:

- Operating Ratio: The relationship between revenues and operating expenses (Operating Revenue/Operating Expense).
- Debt Ratio: How much debt the urban water service provider/utility is using to operate (Total Liabilities/Total Assets).
- Sales Ratio: How much of the system's revenue is generated from service fees/water charges (Sales/Total Revenue).
- Expense Ratio: Amount of operating expenses compared to total expenses (Operating Expense/Total Expense).

6.7.9 Preparedness

This component of the Asset Management Plan outlines the measures that the urban water service provider/utility will take to ensure that assets are sustained, in the event of an emergency or other unexpected situation(s). This component should discuss:

- Security measures used to ensure safe, continuous operations, e.g., locks, fences, SCADA systems, and backup generators.
- Description of an all-hazards approach to emergency preparedness (i.e., a comprehensive framework in preparing for, responding to, and mitigating the impact of a variety of disasters, emergencies, and security threats).
- Contingency plans used to ensure continuity of service. For example, certain assets (backup generators, surplus treatment chemicals, or an alternative water source) may only be needed on a contingent basis.

The asset management plan should adequately reference the urban water service provider's/utility's emergency response plan.

6.8 Case studies

6.8.1 Barwon Water, State of Victoria, Australia

The Barwon Region Water Corporation is a large regional water utility that services a number of regional towns and rural areas covering 8,000 km2 in the State of Victoria. Its customers rise sharply to about 500,000 in the peak summer season with the influx of tourists to the coastal towns and villages. Barwon Water's assets are valued at A$1 billion, and include 5,000 km of pipelines, 10 major reservoirs, 10 water treatment plants, and 9 water reclamation facilities.

Barwon Water prepares a detailed 5-year plan to align with the prevailing tariff-setting period and performance standards set by the regulator. It also has a 10-year capital expenditure plan that covers both system renewal and expansion and upgrades stemming from changes in standards, including water recycling.

To determine pipeline replacement, Barwon Water engages the Commonwealth Scientific and Industrial Research Organisation, the national science agency, to run the Pipeline Asset and Risk Management System — a simulation programme that seeks to determine the best balance

between affordable asset investment and preventing asset failure with consequent adverse impacts on service levels and meeting regulatory standards.

Within the context of the planning cycle, asset proposals are subject to a business case evaluation. Asset records are divided into aboveground and underground (pipeline) assets.

The Maintenance Management System holds information on asset types; maintenance schedules; maintenance history; and expected useful lives. The financial system also records assets, resulting in duplication since the source of information for both systems is usually the same. Asset records are continuously updated and records are fully computerised and used to develop asset and maintenance plans. They are also an essential part of the tariff-setting process.

Barwon Water gets the most from its assets by ensuring there are formal commissioning procedures, including training by equipment suppliers. SOPs are put in place and adhered to. Operators conduct equipment monitoring and reporting.

Maintenance is time based, following pre-set servicing intervals and not based on condition monitoring and asset classification. The utility determines maintenance scheduling based on information from equipment suppliers and in-house maintenance experiences. Maintenance activities are divided equally between planned and breakdown maintenance. When breakdowns occur, the general practice is to replace like with like, but sometimes the opportunity is taken to make a major change. There is a rolling water meter assessment and replacement programme, and a leak minimisation programme. Pressure-reducing valves are installed in areas with high pressure that causes pipe bursts.

A set of indicators is used to judge asset performance, some of which are obligations imposed by the regulator. However, the utility relies more on tracking actual performance and trends, such as energy usage, actual maintenance, and NRW, than on comparing planned with actual results.

In line with water sector regulations in Victoria, Barwon Water has its assets valued and recorded in its balance sheet. Depreciation is charged to its operating statement. Currently, 15% of the water production is unaccounted for.

6.8.2 Mapping Assets using GIS – A case of BWSSB

The Bangalore Water Supply and Sewerage Board (BWSSB) is responsible for the planning, management, and provision of water and sewerage services in the Bengaluru metropolitan area. To manage, rehabilitate, and expand its asset base, BWSSB has implemented a GIS. GIS acts as a decision-making tool by creating a network of information by mapping the utility's assets.

Key highlights and achievements: An asset management system is imperative for maximising the productivity of utility assets. It requires a sound understanding of the current condition and performance of the assets, optimal utilisation of assets, and minimising the expenditure and long-term investment needs of the utility. Therefore, it is essential to maintain accurate data sets of the assets. The use of GIS minimises the time spent on the production of physical network maps. The system provides timely and updated information regarding the assets, which is essential for the analysis and implementation of optimum solutions. The technology assists in capacity evaluation and required refurbishment in a time-bound manner. Current information is made

accessible across all offices and internal departments, thus improving co-ordination among them. The system promotes smooth operations and easy maintenance of vital records, thereby reducing operational costs and enhancing the efficiency of BWSSB. A comprehensive GIS enables database mapping to improve project planning and financial management for water and sewerage networks.

Implementation process: The BWSSB developed a GIS in 1998-99. As a part of this initiative, the BWSSB and other civic bodies of Bangalore (including Bangalore Development Authority, Bangalore Mahanagar Palike, Bangalore Electricity Supply Company Limited, and others) pooled resources and obtained aerial photography from the National Remote Sensing Agency (NRSA). Under the Indo-French protocol, BWSSB assigned the work of developing a GIS system to M/s SCE France in 1999. This led to the development of Bangalore Information System on Networks (BISON) applications for the operational activities of BWSSB. The GIS development was completed in 2002. In addition, Genesys International Corporation Ltd., an internationally known, ISO 9001-2000, GIS and mapping company, took charge of the implementation and maintenance of GIS at BWSSB with effect from November 2003.

Set up: The BWSSB head office is connected to all its divisional offices through LAN/WAN. The head office is equipped with server with 5 PIII workstations, plotter, scanner, and A3 colour printer, with ArcInfo 8.1, Arc SDE (Spatial Database Engine), ArcView 8.0, ArcPress and Oracle 8i RDBMS. The divisional offices are equipped with server with 2 PIII workstations and A3 printer, software – ArcView 3.1 and Oracle RDBMS. Further, all service stations have a desktop PC with printer.

The BISON module includes BISON expert at the head office which includes database, management, and data updating. The head office is equipped with a Management Indicator Panel (MIP) which serves as a decision support tool accessible to chairman and chief engineers. At the division and service stations, BISON light module is available which allows for updating, viewing, and cartography.

The system has seven applications – asset management, water supply maintenance, consumer management, sewage maintenance, billing system, water quality management, and employee management. The BISON application has data on all parts of the system and assets including buildings, consumer connections, manholes, valves, employees, pipelines, sewage lines, fire hydrants, reservoirs, offices, and pumping stations.

The GIS system is being used for the following functions:

- Planning pipeline layout: GIS data is being used in Planning Pipeline Layout for New Wards and CMC areas. Planning is carried out by identifying the main feeder line or nearby reservoir or nearby main sewer line to lay a new pipeline network for the new layout.
- L sections: L sections can be seen in GIS by clicking on any segment on the network data in display.
- Facilitating complaint management and maintenance work: System is designed to cater to the need for addressing complaints related to the water and sewerage network. The output from the system enables quick identification of location from the digital map and better appreciation of the problem, as a holistic view of the network area is available. Further, connectivity with service stations provides speedy implementation of corrective action. A database of all interactions is maintained and this serves as an input for periodic

analysis and decision making at apex level.

- Thematic analysis of water distribution: Water connection patterns like domestic, non-domestic, partial domestic, industrial, etc.
- Water quality check: Data on the results of water quality testing, done at the BWSSB laboratory, is stored in the GIS for analysis and corrective action, when required.

CHAPTER 7: MANAGEMENT INFORMATION SYSTEM (MIS)

7.1 Need for Management Information System

Lack of effective management has a negative impact on the performance of an urban water supply system. The efficient and effective performance of water service providers depends on a well-defined relationship between different functions and departments. The interaction between individuals at different management levels together with use of information in the decision-making process, is important to ensure service providers' performance.

In the absence of well-defined objectives, long and short-term planning, programming, and budgeting, the urban water service providers/utilities are unable to operate efficiently. The urban water managers/engineers need Decision Support Systems (DSS) for formulating and implementing programmes aimed at improving the efficiency and effectiveness of the water supply system in order to provide the best quality service to the consumer at the least cost.

In this background, a robust Management Information System (MIS) is crucial for urban water service providers/utilities. MIS is essentially a system for making available accurate, timely, sufficient, and relevant information to the management in order to facilitate decision- making. MIS is not a single system. It is typically composed of numerous systems that are integrated to support management decisions. A robust MIS system will allow the organisation to carry out its specific functions effectively and efficiently and in line with its objectives.

Urban water service providers/utilities are large organisations with many departments and a large number of employees. For efficient functioning, easy access to accurate information at all times is indispensable. At present, the majority of urban water service providers/utilities lack proper MIS – what exists is unregulated flow of incoherent information, which are siloed and not adequately analysed to support decision making nor documented for posterity. Decision making is largely based on prior experience or informal information gathered by the decision-maker.

A water supply system involves various components and installations, e.g., water intake, pumping systems, treatment, and distribution of water. There are a lot of parameters that need to be measured and monitored in order to deliver services, e.g., flows, pressure, and quantity of water supply. There are various methods/procedures to record these parameters and transmit. There is a need to develop an interactive centralised database/platform for compiling this information, which should either be real-time or updated with minimum time interval possible. Such an MIS with inbuilt dashboards which provide a clear picture of the entire system to the decision-making authorities as well as the operators.

In order to develop an effective MIS for urban water service providers, it is necessary to identify the potential sources of data in every functional area and generate reports needed by all users irrespective of their proficiency in data processing. Sound data foundation is the key to a robust MIS. Information systems must be simple and cost effective and should be designed in a participatory manner. The different information requirements of the various management levels must be supported by the MIS. It should be noted that information system is there to make the business process more efficient and consistent. Like in the old days, any small organisation should be able to use paper filing system to record and support the decision- making process. Unless data and business processes are well defined and practiced, MIS is typically not successful.

An MIS can be comprehensive like an **Enterprise Resource Planning (ERP)** or any customised integrated MIS developed for municipal corporations or a simple MIS sheet developed in-house. The selection of type of MIS would depend on the scope of operation and the service provider's/utility's requirement. In large and complex urban water service providers/utilities, measuring and monitoring service levels on a regular basis is difficult given the scale of operations and the fact that multiple departmental stakeholders are involved. The growth of Information Technology (IT), sensor-electronics, and ever-increasing internet connectivity has made it possible to create a network of sensor and gateways that can capture the data on quantity and quality of water supply regularly in an automatic manner, transfer the data and store it on internet cloud-based servers. Such physical devices that can connect to internet and share the collected information based on stipulated protocols are referred to as Internet of Things (IoT) and these have opened the possibilities of monitoring service level parameters objectively, regularly and over a long period.

7.2 Characteristics of a Robust MIS

MIS is composed of numerous information systems that provide specific functions. A list of typical information systems that make up the MIS are as follows:

- CMMS – Computerised Maintenance Management System
- GIS – Geographic Information System
- FIS – Financial Information System
- CIS – Customer Information System
- ERP – Enterprise Resource Planning System (this can combine FIS, CIS, and maybe CMMS)
- LIM – Laboratory Information System
- SCADA – Supervisory Control and Data Acquisition
- Hydraulic Model
- Asset Management System

Following are some of the characteristics of an effective and robust MIS:

- **System/Holistic Approach:** The information system should follow a system's/holistic approach which includes a detailed study of the system and its performance in light of the objective for which it has been constituted.
- **Management Oriented:** MIS must be management-oriented, that is, it is designed to ensure quick and easy access to accurate information which helps in decision making. For designing of MIS, a top-down approach, which implies that the system development starts from the determination of management needs and overall business objectives, must be adopted. The MIS development plan should be derived from the business plan. Management-oriented characteristic of MIS also implies that the management actively directs the system development efforts.
- **Need Based:** MIS design and development should be as per the information needs of managers at different levels including strategic planning, management control, and operational control levels. In other words, MIS should cater to the specific needs of managers in an organisation's hierarchy.
- **Exception Based:** MIS should be developed on the exception-based reporting principle,

which means that in an abnormal situation, i.e., the maximum, minimum, or expected values vary beyond tolerance limits. In such situations, there should be exception reporting to the decision maker at the required level.

- **Future Oriented:** MIS should not merely provide past or historical information; rather it should provide information, on the basis of future projections based on which actions may be initiated. The future objectives and needs of the service provider must be kept in mind while designing the MIS.
- **Integrated:** Integration is an important characteristic of MIS because of its ability to produce more meaningful information. For example, in order to develop an effective production scheduling system, it is necessary to balance factors such as set-up costs, work force, overtime rates, production capacity, inventory level, capital requirements and customer services, etc.
- **Long-term Planning:** MIS establishment is a long iterative process, and its improvement must be a continuous process. After designing and implementing, the system must be tested and evaluated to ensure improvement.
- **Sub-System Concept:** The process of MIS development is quite complex and thus the system, though viewed as a single entity, must be broken down into smaller more manageable sub-systems during the planning stage.
- **Central Database:** A central database is the mortar that holds the functional systems together. Each system requires access to the master file of data covering inventory, personnel, vendors, customers, etc. It seems logical to gather data once, validate it properly, and place it on a central storage medium, which can be accessed by any other sub system.

The above features are to be kept in mind if the MIS is developed in-house or through outside agencies.

7.3 Functions of MIS

MIS is an organised collection of procedures, software, databases, and devices used to provide routine information to managers and decision makers. MIS must perform the following functions in order to meet its objectives:

- **Data capturing:** MIS captures data from various internal and external sources of an organisation. Data capturing may be manual/online (digital) or through IoT-based sensors/equipment. End users typically record data about transactions on some physical medium, such as a paper form, or enter it directly into a computer system.
- **Processing of Data:** The captured data is processed to convert it into the required management information. Processing of data is done through activities such as calculating, comparing, sorting, classifying, and summarising. These activities organise, analyse, and manipulate data using various statistical, mathematical, operations research, and other business models.
- **Storage of Information:** MIS stores processed or unprocessed data/information for future use. If any information is not immediately required, it is saved as an organisational record. Stored data is commonly organised into fields, records, files, and databases.
- **Retrieval of Information:** MIS retrieves information from storage as and when required by

various users. As per the requirements of users, the retrieved information is either disseminated as such or is processed again to meet the exact management information demands.

- **Dissemination of Information:** Management information, which is a finished product of MIS, is disseminated to the users in the organisation.
- ERP is an integrated, real-time, cross-functional enterprise-wide transaction application, which supports all internal business processes of a company/organisation. In an urban water service provider/utility context, an ERP should support all core business processes such as production, distribution, operation and maintenance (O&M), inventory management and control, billing and collection, and finance.

7.4 MIS Development Process

MIS is a computerised integrated information system that receives inputs from multiple sources and processes, analyses the information received, and serves multiple objects, events, and end-users.

Development and improving MIS is an ongoing process, as organisations strive to take advantage of new technologies and methodologies. The evolutionary process that is to be followed to develop MIS consists of four sequential steps including planning, analysis and design, implementation, operation, and control as per Figure 7.1.

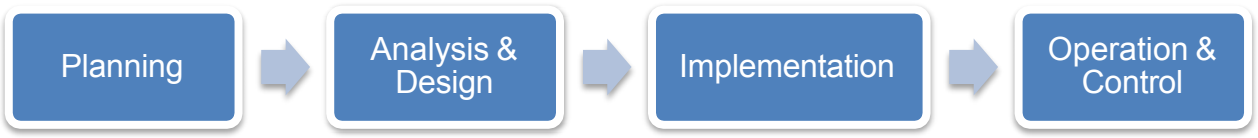


Figure 7.1: Evolutionary Steps to Develop MIS

Managers are responsible for both developing and using an MIS. Even though information specialists may recommend a particular system design, it is the manager's responsibility to approve its implementation and to make sure that the MIS caters to the existing leadership styles. The greater the user involvement at all stages of the life cycle, the more superior the end result.

It is recommended that at the onset, simpler designs, which are modular and scalable in architecture, are adopted using the principles of Plan Do Check Act (PDCA) cycle as per Figure 7.2 and continual improvement. The MIS system should help each executive in the decision-making process with problem identification, generation, and the evaluation of alternative courses of action. It should also help to acquire necessary feedback on implementing decisions to enable corrective action.

Figure 7.2: PDCA Cycle

The MIS should provide relevant data in a summarised form to all managers. The MIS must address the different types of information required for planning, control, and other managerial functions. It should also address the different types of information required at various management levels. The MIS system should be integrated with a centralised database to cut down on redundancies, overlaps, and costs.

The MIS system must be computerised, especially for large and complex urban water service providers/utilities or if the existing manual-based MIS is not able to provide timely information. The reports generated using the MIS should be relevant and meaningful, and they should be disseminated to the staff who need and use them.

An ideal MIS development has seven components, and these are depicted in Figure 7.3.

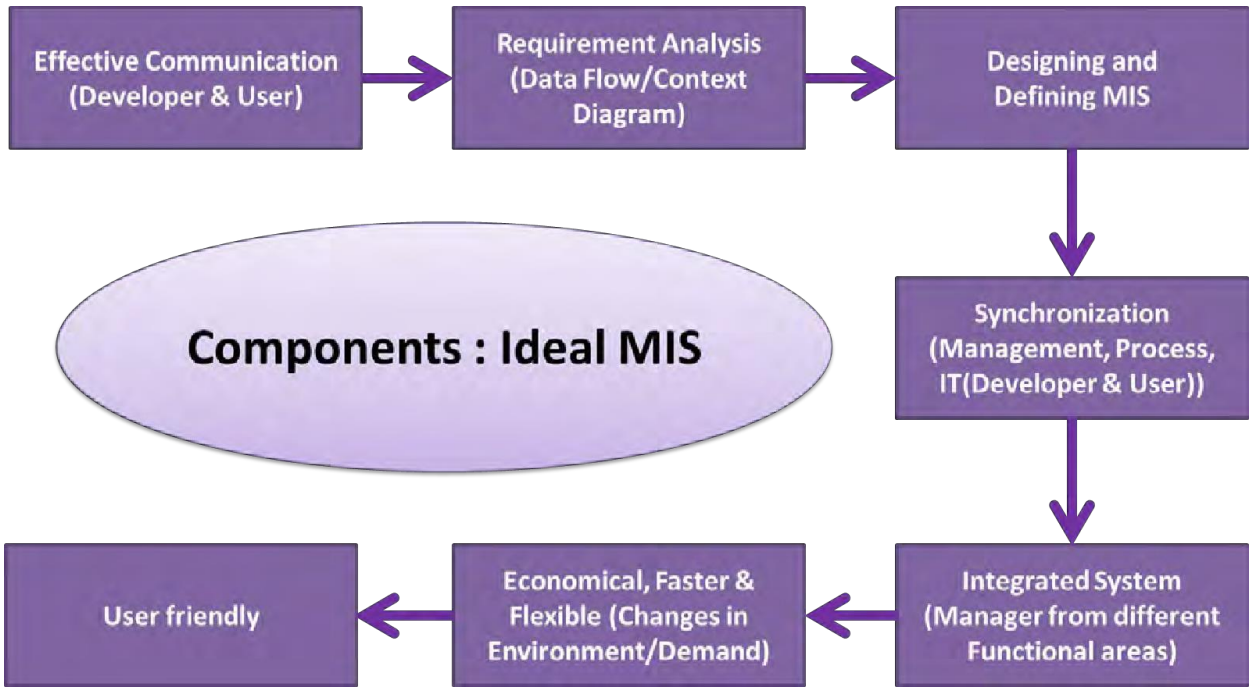


Figure 7.3: Components of MIS system

7.5 MIS for Water Supply Network

7.5.1 Applications

The MIS developed can have many applications as per requirement of the urban water service providers/utilities, some of these are discussed below:

I. Source and Intake

- Monitor water level in source and predict sustainability issues – the source can be accordingly augmented and managed effectively, if required, to ensure long-term sustainability of the source and that of the overall water supply scheme.
- Automate pumping operations and monitor pump health to enable predictive maintenance and reduce repair and maintenance issues.

II. Water Treatment Plant (WTP)

- Monitor output of WTP (quantity and quality of water) to ensure standards are being met – adequate quantity of prescribed quality on regular basis, i.e., continuous supply in long-term/full design period of the scheme.
- Enable regular preventive and predictive maintenance to minimise repair and maintenance costs and to reduce/eliminate impact on environment and citizens.

III. Pipeline and Storage

- Ensure functionality through continuous monitoring and visibility to different management levels and citizens to ensure issues, if any, are escalated and resolved within defined SLAs.

IV. Distribution Network

- Ensure consistent service delivery at habitation/household level to ensure high user satisfaction.
- “Drink from Tap” is effectively implemented.
- Identify leakages, unauthorised connections, and lower non-revenue water (NRW) to maximise value for money paid by users (O&M charges).

Refer to 7.5.3 Water Supply Network-Data Capture/Automated Generated for MIS section table for details.

7.5.2 Features of MIS for Water Supply Network

In an urban service provider context, an MIS system should have the following features:

a. Dashboards with metrics/KPIs and GIS-enabled views/reports for service provider/utility/State level for remote monitoring. Examples of dashboard online and mobile application are shown in Figures 7.4 and 7.5.
b. Automated alerting mechanism to determine outages, quality conformance issues, etc., with an escalation matrix (through SMS, notifications on mobile/web).
c. The solution should send data from the source via device directly via gateway to both cloud (central server at ULB/State level) as well as the local operator (at source level) through local area network to ensure redundancy (in case of connectivity failure from gateway to cloud).
d. The solution should have provisions for fraud detection (e.g., identify if real device is sending data from the actual installed location).
e. The solution should be able to store data locally on gateway for a minimum of six months to prevent any data loss in case of failure of connectivity via internet to cloud (through cellular network or fixed broadband); devices should store data for 30 days in case of connectivity issues to gateway or cloud.
f. The solution should support bi-directional data flow (wherever possible), with over-the- air firmware updates (changing frequency of data transmission, remote calibration, security patches, fixing bugs, etc.), and enable remote control.

Figure 7.4: Typical Dashboard for Water Pump – Remote Monitoring System

Figure 7.5: Mobile Application

7.5.3 Water Supply Network-Data Capture/Automated Generated for MIS

Indicative list of data collected for MIS from source to tap:

Table 7.1: Indicative list of data collected for MIS

Component of System	Data Captured	Reporting
Source	- Intake of Water (quantity) - Source Water level - Quality Check (including colour)	AI/IoT-based report – comparison with designed parameters
	- Screenings Volume - Pre-sedimentation losses & depth of silt/sludge accumulated	
Pumping	- Discharge - Hours of Operation - Operating Pressure - Energy Consumed (kWh) - Efficiency of pump - System & Head Curve for operation - Power Supply, Power factor, power tripping events	AI/IoT-based report – comparison with designed parameters
	- O&M including preventive maintenance - Inventory of spares & equipment - Losses	Input-based reports
Transmission	- Discharge - Hours of Operation - Quality Monitoring - Operationalisation of Valves - Surge Pressure - Losses	AI/IoT-based report – comparison with designed parameters
Treatment Plant	- Inlet Quality & Quantity - Hours of Operation - Level Transmitter & Indicator - Filtration Losses - Chemical Dosing - Quantum of Sediment/Sludge - Quantity of back wash water - Quantity and Quality of recycled water - Pressure and Flow Rate of Blackwash water - Chlorine Dosing - Power Supply, Power factor, power tripping events	AI/IoT-based report – comparison with designed parameters

Component of System	Data Captured	Reporting
Service Reservoir	- Level Transmitter & Indicator - Discharge - Inflow - Outflow - Quality Checks - Hours of Intake/Filling - Hours of Supply	AI/IoT-based report – comparison with designed parameters
	- O&M including preventive maintenance - Inventory of spares & equipment - Losses	Input-based reports
Distribution	- Discharges of each DMA/Operational Zones, Bulk Meter, Consumer Meter	AI/IoT-based report – comparison with

	- Pressure/Head (critical points)
	- Quality Parameters at Consumer end
	- Consumer Meter
	  o No. of years in operation & last tested report
	  o Operational/Non-Operational/Damaged Meter
	- Efficiency of data loggers
	- Billing on water usage/lump sum billing
	- Water Balance
	- Leakages/Waste of water at consumer end
		designed parameters/input-based reports

Few suggestive MIS reports to be included:

a) Bulk Water Supply System
b) Pumping System
c) Distribution System (Zone/DMA/Ward wise details)
d) Water Losses/NRW losses
e) Electricity Consumption
f) Illegal Connection
g) New Water Connection
h) Water Contamination
i) Water Quality & Surveillance
j) Billing and Collection
k) Complaint Registration and Redressal system

Various reports to be generated and their exact formats will have to be decided by the engineers/managers concerned so that the MIS together with norms that have been set up will

clearly highlight the performance indicators.

7.6 Data Analysis and Reporting Systems

If the urban water service provider/utility has limited scale of operation and has financial constraints a **manual system** can be considered. Using a manual system is possible only for smaller urban service providers/utilities with few parameters per entry.

While MIS will help in acquiring and collating the data/information, for processing the same and to make it in a format suitable for decision making there is a need for ERP system.

While an ERP proves to be a game changer for an organisation in a long-term perspective, there are some advantages and disadvantages (Table 7.2) which the managers/engineers of urban water service providers/utilities must keep in mind while designing and implementing an MIS.

Table 7.2: Advantages and Disadvantages of ERP

Why ERP?	Advantages of ERP	Disadvantages of ERP
Business integration and automated data update	Reduction of lead time, cycle time	Time consuming implementation
Linkage between all core business processes and easy flow of integration	Better customer satisfaction, increased flexibility, quality, and efficiency	Difficulty in integration with other system
Flexibility in business operations and more agility to the company	Improved information accuracy and decision- making capability, resource utilisation, and supplier performance	Risk of implementation failure
Better analysis and planning capabilities	Reduced quality costs, quick decision-making, forecasting, and optimisation	Difficulty in implementation change
Critical decision-making		Risky to use only one vendor ERP is very expensive to procure and implement. In addition, ERP forces you to only operate within their system, greatly limiting the flexibility to add and integrate other expert systems

Information systems under ERP: The following are the main and sub information systems of urban water supply systems under ERP (Table 7.3) from which the MIS reports can be generated:

Table 7.3: Main and Sub Systems of ERP

Main system	Sub Systems
Financial Management	Including but not limited to payroll, revenue management, general ledger, accounting, funds
Project Management	Including but not limited to engineering planning and design, construction, contracts, and monitoring
Human Resources Management	Including but not limited to manpower planning and recruitment, capacity development, and training
Material Management	Including but not limited to purchasing, inventory control, including asset management
O&M Management	Including information on O&M
Marketing Management	Including but not limited to customer information including redressal and feedback, demand forecasting, market planning, customer services, etc.
Renewal and Repair Alerts System	Including but not limited to water supply network, pumping stations, reservoirs and water treatment, distribution system, house service connections, etc.
Financial Health Status	Including but not limited to revenue, expenditure and this information needs to be updated on weekly basis

The IoT-based MIS has further increased the effectiveness of the overall water supply system management. A single engineer, or a few engineers, are generally responsible for many aspects of the water supply system and each site is required to be visited regularly. It is difficult to simultaneously monitor all components under their jurisdiction closely. Even for senior management at ULB/division/state level, a vast area is under their supervision, and it is difficult to monitor the same on real-time basis without using IoT.

Improvement in monitoring introduced by IoT are as follows:

1. Ease of monitoring: A single dashboard allows monitoring of all components of the system on real-time basis and allows the following improvements:

    - functioning of various components and their control;
    - improved service delivery by monitoring quantity and quality of water supplied on real-time basis;
    - identifying the problems/issues and their prompt resolution;
    - monitoring the aspects will inculcate reactive approach toward the issue and help in better future planning.

2. The system can provide alert for preventive maintenance which is otherwise difficult to keep track of.
3. Better customer satisfaction with improved service levels through faster response time and lesser number of outages (e.g., remote dashboards across levels and preventive maintenance). Improvement of service delivery will induce user satisfaction and encourage community to pay for the services.

4. The requirement to enter the data manually is minimal and hence the accuracy of data is increased.
5. IoT aids the senior management to effectively monitor and intervene in a timely manner.
6. Alleviation of issues (social, economic, and health) resulting from inaccessibility to potable water in adequate quantity; improved transparency and accountability.
7. Reduced cost of operations and improved life of water supply schemes (e.g., leak detection, preventive maintenance, optimizing resource requirements).
8. Data-driven and evidence-based planning for new schemes/modifications through advanced analytics (e.g., demand patterns, electricity reliability, source reliability, temporal water quality variation, etc.).
9. Long-term sustainability of water sources through improved source monitoring.

Apart from this, there are **free of cost tools** as well as **open-source software** available which can be used for data collection and analysis. Data can be collected through Google sheets/form and analysed through Excel spreadsheets, etc. Other tools for analysis and reporting include but are not limited to open street maps, contour marker, QGIS, EPANET, and other cloud-based applications.

7.7 Organisational Structure and Management Levels

In order to achieve the objectives of a robust, efficient, and sustainable system, efficient organisational structure and administration is necessary. Managers are responsible for influencing how the agency is organised to attain its objectives. The organisational structure should be such that it allows co-ordination between all units of O&M, human, financial and material resources and that the latter (human, financial, and material resource) are constantly available for carrying out the O&M activities.

7.7.1 Management Levels – Responsibilities

Management activities and centres of decision are organised according to the authority and co-ordination (functional). Normally, any urban water service provider/utility has three decision centres, namely, strategic at senior level, tactical at middle level and operational at lower level.

An urban service provider/utility will have organisational units to suit its size and complexity. In an urban service provider/utility that serves only one local area, all managerial functions can be carried out at the local level. However, metropolitan and regional agencies will need to regroup senior and middle management centrally and delegate operational management to local or area levels. Depending on the number of localities for water supply, the urban service provider/utility may set up intermediate (circles), regional (divisions), or sub-regional (sub-divisions) for operational management of O&M with a concentration of technical resources such as equipment, qualified staff, workshops, transport, etc., to supervise and support operations at local level.

7.7.1.1 Senior Management (Strategic)

Senior management responsibilities include taking strategic decisions which will have long- term effect. These will include setting objectives for quantity and quality of water, setting priorities for expansion of coverage and setting targets to be achieved, administration of personnel matters

and efficient use of funds, conservation of water (prevention of wastage of water), arranging for a situation analysis and taking up long term planning and forecast of the agency's ability to provide coverage at lowest cost, raising productivity levels, ensuring that best safety procedures are followed, etc.

7.7.1.2 Middle Management (Tactical)

Middle management is concerned with tactical decisions which are effective in the medium- term. These are concerning how efficiently and effectively resources are utilised and how well operational units are performing, prepare medium-term plans including procurement and distribution of resources, expanding coverage of services, reducing water losses, reducing costs, and increasing productivity, monitoring water quality, etc.

7.7.1.3 Lower-level Management (Operational)

Operational decisions apply to short term. Operational management is aimed at ensuring that operational units work efficiently and last as long as possible, work for reducing and controlling leaks, undertake measurement of flows and pressures and monitoring the performance of the water supply system, ensure quality control of water in production and distribution, implement preventive maintenance programmes, improve efficiency, increase productivity and reduce costs, and establish lines of communication with community and foster good public relations.

7.7.2 Reporting system

The reporting system/elements as per the management levels is elucidated below:

- Operational control level – Handling transactions, processing data, preparing detailed reports of various activities, lists, documents, schedules, summary.
- Management control level – obtaining operations data, sorting, analysing and prioritising, modifying all information to the requirements for higher level, planning, scheduling, identifying out of control situations, making decisions, reporting.
- Strategic planner level – response to the queries, projections with regard to objectives, resources, and policies of organisation.

The reporting can be through print media or through a dashboard flashing the updates and alerts on the monitors/mobile.

7.7.3 Management/Performance Indicators

The results of actions by managers at the strategic, tactical, and operational level are measured by management/performance indicators. These indicators represent a situation, an event or a change brought about by an action aimed at achieving a target set by the agency. These indicators allow the management to set targets, monitor the O&M, evaluate the performance of the agency, and take necessary decisions and corrective actions.

- **Performance Indicators (PIs)** can be considered as a management tool to evaluate the degree of an undertaking's efficiency and effectiveness.
- **Efficiency** is the extent to which the resources of an undertaking are utilised to provide the services, for instance, maximising service delivery by the minimum use of available

resources.

- **Effectiveness** is the extent to which declared or imposed objectives, such as levels of services, are achieved. PIs can also be used for quantitative comparative assessment of performance between urban water service providers/utilities or comparing the past and present or actual performance against predefined targets.

Measuring service levels of civic agencies implies measuring outcomes, and indirectly also reflects on institutional capacity, financial performance, and other parameters. Service level parameters can be measured either from an urban water service provider/utility manager's/planner's perspective or from a citizen's or consumer's perspective. In addition, to facilitate comparison between cities/service delivery jurisdictions, and changes in performance overtime, it is important that the performance levels are benchmarked, and monitored against those benchmarks. The MoHUA (erstwhile MoUD) has issued a handbook on **Service Level Benchmarks** in 2009. In the handbook, indicators of four sectors: water supply, sewage, solid waste management, and storm water drainage, are set with specific definitions. These minimum performance parameters are commonly understood and used by all stakeholders. Depending on the specific needs, additional performance parameters can be defined and used.

The International Organization for Standardization (ISO) developed **international standards for activities related to drinking water and sewerage services** and published the "Guidelines for the Assessment" and the "Guidelines for the Management of Drinking Water Utilities and for the Assessment of Drinking Water Services: ISO24512" in 2007.

Each agency has to choose appropriate methods for evaluating effectiveness in achieving its objectives. Illustrative performance indicators are presented in **Annexure 7.1**.

7.7.3.1 How to use the indicators?

Performance indicators and the information generated thereon, can be the basis for the decision-making process involving determining targets, deciding priorities, drafting schedules of O&M, assigning responsibilities and distribution of human, material, and financial resources. In the planning process, these indicators provide the basis for preparing long, medium- or short-term plans with appropriate finances allocated in the budgets. These performance indicators provide a measure of what has been achieved so that the results can be evaluated, and disparities corrected. Based on the results, the targets and indicators need to be changed so as to be nearer to reality.

Some uses of these indicators are as follows:

a) Maintenance information which can be used to assess changes in conditions of installations and equipment and to identify potential problems such as weaknesses of structure, reliability of equipment or obsolete equipment and also to determine how long the facilities can function usefully.
b) The maintenance activities can be reformulated to achieve maximum yield at minimum cost.
c) The data can be used for preparation of the budget. The best justification for next year's budget is an accurate record of the previous year's activities, costs, workload, growth, and production. Similarly, the records on use of spares and materials and performance of

equipment can be used to document the importance of the programme and get adequate financial support.

d) The trend in the agency's workload can indicate where the workload has increased or where the performance has deteriorated, requiring more staff.
e) The need for new equipment can also be justified while preparing the budget. Age is not necessarily the only factor for replacing the equipment. Record on production, use and cost of maintenance to keep the equipment operational may also substantiate the need for replacement.
f) The review should bring out the need for buying new equipment. Additional equipment (including safety equipment) may become necessary from a review of the performance, either due to the hiring of staff or the need for developing equipment for a specific purpose.
g) The review should provide an assessment of what spares and consumables are required for the next year/future.
h) The review can also bring out the need for economy, for hiring external specialised agency or hiring additional staff for attending to routine or breakdown maintenance or repair work.
i) The indicators can be used to measure productivity, reduction in breakdowns, or frequency of breakdowns linked to productivity levels so as to achieve a reasonable level of maintenance with minimum cost.

7.8 Smart Water Management (SWM)

The increasing availability of intelligent Information and Communication Technology (ICT) enabled means to manage and protect water resources have promoted the development of new solutions. Smart Water Management (SWM) innovations promote the sustainable consumption of water resources through a co-ordination of water management capacities and the integration of ICT products, solutions, and systems. ICTs, and especially IoT technologies, provide cities and citizens with the means to gather real-time data on water quality from thousands of locations and to pinpoint problems in the neighbourhood or even at household level.

Within urban environments, the implementation of SWM can make significant improvements in water distribution, helping to decrease losses due to NRW, and helping to enhance wastewater and storm water management. These improvements can increase the efficiency of the urban water sector as urban water service providers/utilities will be able to recover costs from NRW, including the detection of illegal connections. (ITU FGSSC, 2015). Some examples of ICTs for water management in cities/towns are listed below:

a. **Smart pipes and sensor networks:** Integrating smart pipes and sensors within the urban water supply system enables key functions such as the detection of events based on the monitoring of flow rate, pipe pressure, stagnant points, slow-flow sections, pipe leakage, backflow, and water quality. This constitutes the data required to optimize the operation of current networks. IoT sensors can now be installed at a substantially lower price with new battery powered networking solutions. This will also help in monitoring the quality of recycled water.
b. **Smart metering:** Smart metering allows urban water service providers/utilities to provide clear water consumption information which can help customers to track and control their water usage and identify immediate savings on their water bills. This can enable a better distribution network and consumption planning due to its real-time monitoring capabilities. This will also help in achieving sustainable goals by optimizing the revenue collections.

c. **Geographic Information Systems (GIS):** GIS allows visualization and analysis of water resources and human activity data by linking geographic information with descriptive information. This is highly valuable for urban water management in assessing water quality and day-to-day operations on a local and regional scale, including watershed management. Geo-tagging of all assets and pumping stations with linked piped networks gives accurate information about water issues location.
d. **Supervisory Control and Data Acquisition (SCADA):** Water utilities have been using SCADA systems for a long time in managing real-time alarms and efficiently operating plants and networks. Higher-level applications for water management based on ICTs can be listed such as determining times of peak water use, identifying potential system leaks, and setting billing rates.
e. **Network models, optimisation tools, and decision support:** Network model-based water management has evolved over the years to improve the quality, quantity, and operations costs of water supply systems through comprehensive modelling applications. These technologies contribute to calculating and forecasting consumption, reducing costs through the optimisation of operations, planning, and evaluating strategies, and also conducting vulnerability studies to inform strategy design. Models including machine learning and deep learning techniques are emerging in the development of optimisation tools and decision support tools for network management of urban water resources. Water utilities have a lot of data at their disposal and now this data can be analysed using advanced software tools.
f. **Digital Twin Technology**: Digital twin technology is a revolutionary concept that has gained increasing popularity in recent years, and it has now started to make its way into the water supply industry. The technology involves creating a virtual replica of a physical system, such as a water supply system, and using real-time data to simulate its behaviour and performance. A digital twin can replicate the physical network in water supply systems, including all pipes, valves, pumps, and other components. Real-time data collected from sensors installed throughout the network can be fed into the digital twin, allowing operators to monitor the system's behaviour and identify potential issues before they occur. One of the significant advantages of digital twin technology is that it allows operators to optimize the performance of the water supply system. By simulating different scenarios and testing different configurations, operators can identify the most efficient and effective ways to manage the network, such as reducing energy consumption, improving water quality, and reducing maintenance costs. Another benefit of digital twin technology is that it can help to improve the resilience of the urban water supply system. By simulating different scenarios, such as extreme weather events or equipment failures, operators can identify potential vulnerabilities in the network and develop contingency plans to ensure the continuity of the water supply. Digital twin technology is a powerful tool for water supply system operators. It allows monitoring and optimizes network performance, improves resilience, and enhances the quality of service delivered to consumers.
g. **ERP based manpower, salaries, income, and expenditures:** Any urban water service provider must have ERP/software systems to manage manpower, salaries, income, and expenditures, etc.
h. **Citizen engagement apps for water management and grievance redressal:** A 360 degree-based (web, mobile app, IVR/phone, email, SMS, social media) platform to inform citizens on water consumption or water saving environmental tips. Some apps allow the collection of data on water quality, locations, and water use habits and generate real-time

maps to share with citizens and local administration. These apps are aimed to help citizens conserve water by providing information such as how much water is being consumed and tips for reducing water use. Such systems also allow for speedy redressal of citizen grievances related to water supply.

i. **Analytics and dashboards:** Every stakeholder involved in water management shall have access to the relevant information**.** Predictive reports using the AI and machine learning algorithms should be used to forecast future water requirements and how to meet them so that urban service provider/utility remains aware and does the needful for its fulfilment.

Emphasis should be made to develop MIS in-house as the officials of the urban water service provider/utility have better understanding of their requirements from MIS. But in case of lack of in-house capability for development of the above applications, the urban water service provider/utility may use technical expertise through external agency for development of customised application. The eligibility criteria for the same should be quite exhaustive and should cover (though not be limited to) background of the agency, qualification criteria, experience, and past performance record of the agency in the relevant field, financial capability of the firms, evaluation methodology, credentials of the agency, etc.

7.9 Integrated MIS and Suggested Technology

Initiatives to develop web-based integrated MIS covering all urban service providers/utilities/State Departments, would assist in having a readily available decision- making tool, reporting and various analytics. The integrated MIS would also enable introduction of common system and procedures for all the urban service providers/utilities/State Departments. It would be cost effective as a single module would be developed and replicated all over the country. Licensing of software users will be minimised resulting in huge savings. Big Data, Cloud servers managed by Managed Service Providers (MSPs)1, Digital Twin Technology, IoTs, and AI can also be introduced. The integrated MIS module can be a great assisting tool to state and central government for taking up minor and major decisions in water supply sector for respective ULB/State Department viz. budgeting/allocation of funds, estimation based on the analytics, etc.

Figure 7.6 and Figure 7.7 show a typical schematic of measurement and monitoring of water supply system and system architecture.

Figure 7.6: Measurement & Monitoring of Water Service Delivery

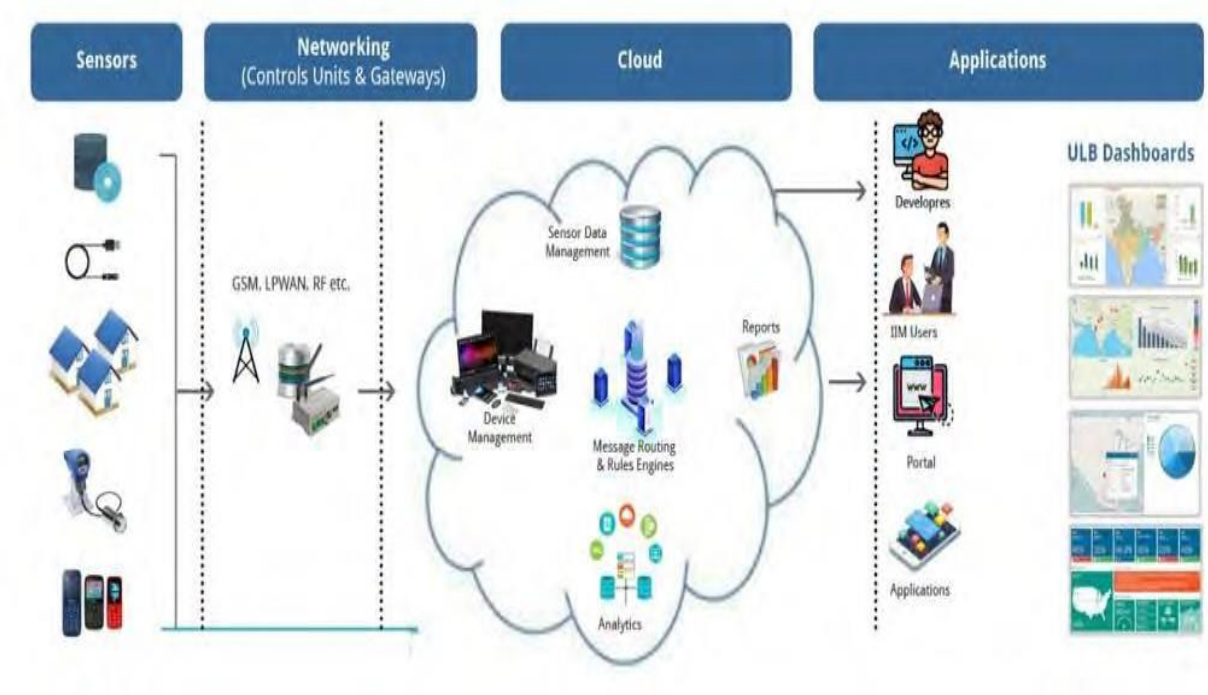


Figure 7.7: IoT Architecture

7.10 Cyber Security

Adherence to cyber security requirements can enhance the integrity, confidentiality, and availability of their MIS, ensuring the protection of critical information assets.

The essential cybersecurity requirements for an effective MIS are mandatory.

- To safeguard sensitive information and protect against potential threats, several key measures must be implemented.
- Comprehensive access control system should be established to ensure authorised personnel have appropriate access privileges, while limiting unauthorised access attempts.
- Employing strong user authentication methods such as passwords, biometrics, or multi-factor authentication.
- Regular software updates and patches must be applied promptly to address vulnerabilities and safeguard against emerging threats.
- Encryption protocols to secure data transmission and storage, preventing unauthorised interception or tampering.
- Robust firewalls and intrusion detection systems are vital components of an MIS, fortifying the network infrastructure against unauthorised access and malicious activities.
- Continuous monitoring and logging of system activities enable timely detection and response to potential security breaches.
- Comprehensive employee training and awareness programmes should be conducted to promote a culture of cybersecurity and equip personnel with the knowledge to identify and report potential threats.

7.11 Case Studies

7.11.1 Surat Municipal Corporation (SMC), Surat, Gujarat India

Surat had been experiencing a high rate of population growth. Delivery of civic services by the SMC was grossly inadequate. Within the organisation, the departments were functioning in silos and there was little interaction between senior officers and field staff. As a result, the management had incomplete information about actual conditions in the city. The post-plague transformation of Surat is the result of ULBs efforts to convert a crisis into an opportunity. The systematic approach that the SMC took to achieve this goal has now evolved into a unique MIS.

The overall goal of these initiatives was to evolve a robust and integrated MIS. Enabled by information technology, it would eventually become the engine for e-governance. The main objectives of the MIS were as follows:

1. Monitoring the main activities of each function within the ULB with appropriate performance indicators.
2. Facilitating co-ordination among concerned departments.
3. Providing relevant information to decision makers and those responsible for implementation.
4. Result orientation which allows measurement of efficiency and effectiveness.

The most significant building blocks of this MIS are as follows:

1. **Activity Reporting System:** This is a system of monitoring and reporting information on public health engineering activities in all wards and zones of the city. Under this system, the Sanitary Supervisor of each ward office prepares a daily report of all activities performed in the ward. The report is submitted to the zonal office at the end of each day. Each zone compiles the reports of all wards in the zone and sends these to the Municipal Commissioner's office early next day. A daily activity report is put up before the health and engineering department committees which meet daily, and the reports are discussed in detail and decisions taken jointly.
2. **Grievance Redressal system:** SMC introduced a public grievance redressal system to receive and address the complaints of citizens about any municipal services. Complaints are received through all possible modes including in person, telephone, fax, pager, or internet round the clock. The complaints are assigned different priorities, e.g., to be attended immediately/within 24 hours/within 48 hours/within 72 hours/within 7 days. The complaints are monitored every day by concerned staff. Appropriate MIS reports are prepared to monitor and assess the efficiency with which the complaints are being handled and redressed.
3. **Management Information System:** The SMC has been computerizing the operations of its departments and zones since about five years. Simultaneously, an MIS cell was established to ensure networking of the zone offices and departments with the head office and to provide an integrated MIS for the whole organisation. The monitoring systems described above are also integrated with this system. MIS of the SMC generates about 14 reports using online data feed from departments and zones.

7.11.2 Chennai Metropolitan Water Supply and Sewerage Board – Oracle ERP

Chennai Metropolitan Water Supply and Sewerage Board has been using the Oracle ERP system since as early as April 2007. The following computer application modules have been implemented covering the head office, 15 area offices, 200 depot offices, 2 central stores, quality control wing, Sewerage Treatment Plants, region 1, region 2, and training centre.

- Billing and Collection (Oracle Receivables)
- Payables, Receivables, Cash Management, Fixed Assets, Projects, and General Ledger (Oracle Financials)
- Oracle Purchasing and Inventory
- Payroll, GPF and Pension (Energise Application and Integrated with Oracle apps)

Billing and Collection System: In order to have a single application and single database for billing and collection system, the existing Oracle ERP system, web-based system, and internet-based payment have been migrated into new web-based billing and collection system using open source (PHP and PostgreSQL) since March 2022. The following are the envisaged benefits for implementation of new web-based system.

- Three ways of receipts are merged into one way of receipt collection with instant update.
- Workflow setup has been introduced to control the changes of data at different levels.
- DCB can be taken from area to consumer level with all components like tax, unmetered

charges, metered charges, meter and sewer charges.

- Separate consumer login has been provided to view the status of record.
- Officials can view any records anywhere using Internet.
- Official login is provided to navigate the functionalities which are used to view the consumer records and change the consumer records.
- MIS reports are provided to top management to take necessary action to improve collection.

CHAPTER 8: PUBLIC-PRIVATE PARTNERSHIP

8.1 Need for Public-Private Partnerships (PPPs)

Creating new infrastructure along with augmenting and upgrading existing infrastructure for better services are mandates of urban water service providers. The existing water supply infrastructure suffers from high degree of operational inefficiencies with high level of non-revenue water (NRW). Further, the absence of effective metering, coupled with poor billing and collection practices have resulted in lower cost recovery rates. While the cost of water production and distribution is very high, the cost recovery is poor, resulting in limited availability of funds with urban water service providers for routine maintenance and investments in a new infrastructure and/or rehabilitated water supply system.

Given this background, urban water service providers are facing the following challenges:

- Finding investment for high capital cost facilities with long-term paybacks, such as pipeline networks, treatment plants, and pumping stations; and
- Limited capacity to ensure adequate funding and budgets for efficient operations. Urban water service providers lack the capacity to operate all components of an urban water supply system. This is especially the case in small and mid-sized cities. The result is that they may not have adequate expertise to implement a complex project such as a 24×7 PWSS.

In order to address these challenges, various urban water service providers have explored the option of Private Sector Participation in the development of infrastructure and its operation and maintenance (O&M) by seeking investment and/or O&M expertise and O&M expertise internal to the utility requires a market competitive wager and compensation plan, which is also difficult to do in the absence of adequate revenue recovery.

The last few decades have seen a significant increase in overall spending on urban water infrastructure through a series of missions led by Government of India (GoI) along with creation of an enabling environment to help cities managing their services in an efficient and sustainable manner. While some cities have initiated actions for converting their existing intermittent water supply systems into continuous 24x7 PWSS, the estimated infrastructure investment requirements far exceed the resources available from government sources. Government budgetary allocations can at best cover only partial fund requirements, underscoring the necessity of Private Sector Participation to address the existing gap in developing 24x7 PWSS.

Under AMRUT 2.0, PPP projects are mandatory in million plus cities and at least 10 per cent of total fund allocation at the city level is expected to be committed to PPP projects. Any city which is planning to migrate to a 24x7 PWSS from the current intermittent one is advised to select at least one District Metered Area (DMA) of around 2,000 connections, as a pilot zone, to demonstrate the concept. It is recommended that in cities with diverse economic, cultural, behavioral or user patterns, two or more DMAs, with at least 2,000 connections each, be selected as a part of pilot zone. These can be implemented first, through PPP in the pilot zones, before proceeding ahead with city-wide implementation.

8.2 What is PPP?

Public-Private Partnership (PPP) is a contractual partnership between the public and private

sector agencies, with the aim of easing the finances, effective designing, efficient implementation, and operations of infrastructure facilities, which were traditionally considered to be provided by the public sector.

The Department of Economic Affairs, Ministry of Finance, Government of India, defines PPP as: *"A PPP means an arrangement between Government or statutory entity or Government-owned entity on one side and a private sector entity on the other, for the provision of public assets and/or related services for public benefit, through investments being made by and/or management undertaken by the private sector entity for a specified period of time, where there is a well-defined allocation of risk between the private sector and the public entity and the private entity receives performance-linked payments that conform (or are benchmarked) to specified and pre- determined performance standards, measurable by the public entity or its representative."*

The major differentiators of PPP projects are:

- **Contrary to traditional public procurement**, in a PPP, the private developer bears a relevant share of the financial and/or operational risk of the project. Thus, the distinguishing feature between PPP and traditional public procurement is whether an appropriate share of risk has been transferred to the private developer.
- **PPP also differs from full privatisation**. PPP is **NOT a privatisation (or divesture)**, which usually means that the government is no longer involved in the life of the privatised entity. PPP incorporates the concept of partnership, where both parties share the overall responsibility for service delivery. The ownership remains with the respective government agency and the private developer represents government agency by sharing its responsibilities.

8.3 Myths and Misconceptions regarding 24×7 PWSS PPPs

There are several myths and misconceptions regarding the concept of PPP. PPP arrangements for 24×7 PWSS, etc., and some of these are clarified in Table 8.1.

Table 8.1: Myths and Realities regarding 24×7 PWSS PPPs

Myths and Misconceptions	Realities and Clarifications
Private sector's profit motive is incompatible with the public entity's service motive	**No.** The key is to harness the private sector's profit motive by incentivising them to provide better quality service and letting them earn a reasonable return. If the contract is well structured and balanced, it should be a win-win-win project.
24×7 PWSS PPPs increase user tariffs	**Not necessarily.** In all PPP contracts, tariff determination is the responsibility of the ULB/public authority. To avoid any dispute, the future trajectory for a tariff would typically be known to all bidders and approved by a relevant authority either before or during the bidding stage. When appropriate safeguards such as effective regulation and/or adequate competition are in place, there are no arbitrary price increases.

Myths and Misconceptions	Realities and Clarifications
Money for 24×7 PWSS PPPs comes from private "pockets"	**Initially and in most cases, yes.** But the private sector will make those initial investments provided they can recover the same either from the users or the Public Service Provider with a reasonable return. In some types of PPP, the private sector brings in only expertise and no funds.
Once a private partner is brought in, there is little or no role for the public entity	**No.** The public entity's role changes from implementation of the water supply system to monitoring authority, ensuring Key Performance Indicators (KPIs) set in a contract are met.
PPPs do not provide value for money (VFM)	**No.** The primary reason for opting for a PPP option is to bring VFM for all stakeholders, i.e., similar service level for consumers at a lower cost or improved service level for the same price.
Private operators do not provide 24×7 PWSS or focus or improve service in low-income area	**No**. Service improvement in a low-income area is normally one of the priority services defined in the contract for any 24×7 PWSS project. Also, the private sector works on the scope of work as designed by the Public Service Provider. International experience shows that the private operators have achieved major successes to improve service for the underprivileged consumers**.**

Contradictory to these myths and misconceptions, typically PPPs offer some major advantages over a traditional procurement system, such as:

- **Easier/Faster Funding Mechanisms** – The private firm does not have the constraint of working within yearly budgetary allocations (which is usually a critical factor in public sector funding) and can borrow money as required, which can be spent efficiently and in a timely manner.
- **Quality/Efficiency Enhancement** – The private firm should bring with it management and operational efficiencies that will improve service quality because of faster decision-making mechanisms. Linking expectations of service levels with the performance of the private firm will deliver improved results. Further, private operators will have improved access, intent, and capability to implement a new technology that could enhance services and customer experience.
- **Citizen-friendly Technological Interventions** – Users are kept informed by the publication of performance data. Private entities may leverage access to state-of-the-art technological interventions while creating user-friendly interfaces for more transparency and citizen awareness.
- **Diverse/Flexible Problem Solvers** – Private firms are more flexible and experimental in their approach to solve related problems. There could be a gradual change in the work culture of the employees resulting in a more flexible structure that allows individuals to show more initiative.

8.4 Decision-making steps to achieve 24×7 PWSS through PPP

Among many factors that determine whether to engage private developer/operator to achieve 24×7 PWSS in a city on PPP basis, financial viability is one of the most important one. A realistic

financial projection, i.e., a financial model, of the project through implementation period is the prerequisite to assess financial viability. To assess whether a project is financially viable and acceptable to all stakeholders, particularly to the bankers or private investors, it is imperative to have a very strong and reliable financial model for the project. The financial analysis will determine the viability of the project based on the costs involved and the expected revenues.

8.4.1 Considerations in the Project Costs and Project Revenue

Project Costs: The financial model should also consider the contingency, cost escalation linked to the phasing of the project and Wholesale Price Index (WPI), interest during construction, etc. In addition to these costs, other soft costs, such as expected fees for raising finance for the project, cost for maintaining the performance security with the Public Service Provider, costs relating to independent engineer/independent auditor fees, etc., are to be considered. Refer to Figure 8.1.

Project Revenue: Project revenues are the income generated from service provision. The revenues can be divided into two broad categories: direct revenues and indirect revenues. However, it may be noted that it is not only the increase in the tariff structure, but other measures such as: increasing the number of connections within the service area; ensuring maximum billing and collection; and reducing leakages/NRW within the service area, may also be considered to improve the financial viability of the project. Refer to Figure 8.1.

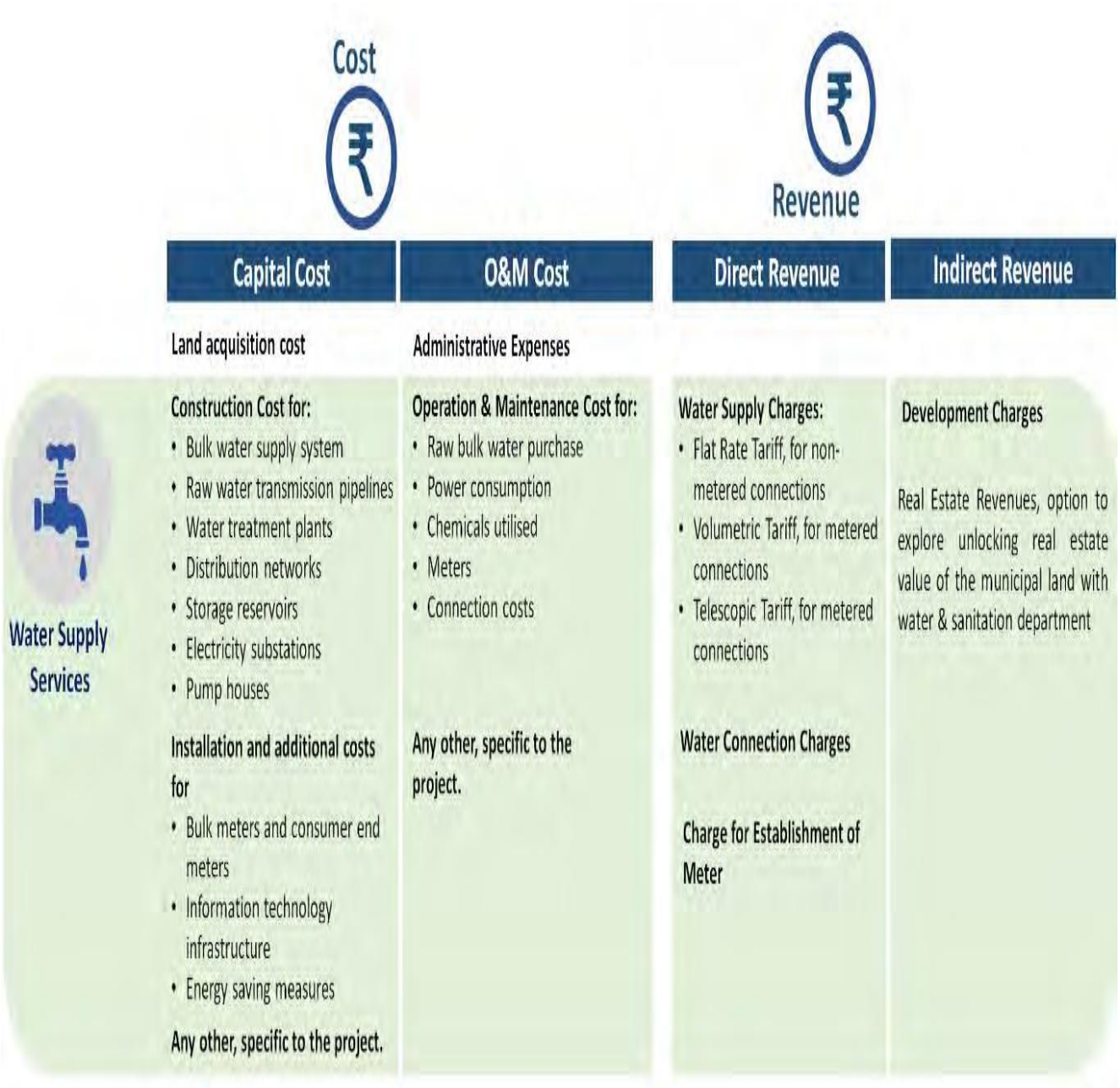


Figure 8.1: Costs and Revenues in WS Project

Based on the projected financial model and cash flows the next step is to compute the Internal Rate of Return (IRR) of the project. Possible benchmarks for the equity holders could be returns that are generated through similar projects or returns that are assumed to be reasonable by a private developer in the water supply sector. Regarding the overall return for the project, the estimated IRR is then compared against Weighted Average Cost of Capital (WACC) to assess whether the project is commercially viable.

Project Internal Rate of Return (IRR) > Weighted Average Cost of Capital

The WACC is a minimum return that a project must earn on its asset base to satisfy its creditors, owners, and other providers of capital. WACC is calculated as:

WACC = (1–t) (E/K)*Ce + (D/K)*Cd

Where;

t = Percentage of income tax applicable E = Amount of equity in the project
D = Amount of debt in the project K = Total Capital = D+E
Ce = Cost of equity OR minimum return expected by equity investors Cd = Cost of debt OR Interest rate of debt

The value of the WACC will be directly related to the risk perceived in the project by the investors. In simple words, the Project IRR should be equal or marginally better than the WACC. Similarly, the equity IRR should be equal or marginally higher than the minimum return expected by the equity investor (Ce).

Equity Internal Rate of Return (EIRR) > = Ce

It may be noted that the EIRR would typically be calculated for an economic life of the proposed asset class, which would normally be linked to the technical lifecycle of the asset class, i.e., project period. If in case the EIRR for a preferred project period is not sufficient, then the PSP may consider different project structure, including increase in a project period (only if the asset life allows to increase the project period) or providing VGF to make a project viable for a preferred project period.

8.4.2 Applying for support through the Viability Gap Funding (VGF) Scheme

VGF is considered necessary when the project returns are insufficient to re-coup the capital investment by the private operator. Normally, VGF would be provided during the construction period of a particular project to reduce the private operator's capital investment in the project.

Following are the key aspects of the revised VGF Scheme 2020:

- The concessionaire shall be eligible for a VGF only if it is selected through competitive bidding and responsible for financing, construction, maintenance, and operation of the project during the concession period and the bidding parameter is lowest VGF required.
- The project should provide a service against payment of a pre-determined tariff or user charges.
- The VGF shall be in the form of a capital grant during the construction period.
- For the water and wastewater PPP projects, the VGF under this scheme is restricted to a maximum of 30 per cent of the total project cost. If in case the PSP proposes to provide any further assistance to the project over and above the said VGF out of its own budget, it shall be restricted to a further 30 per cent of the total project cost.

8.4.3 Project Implementation Route – PPP or Traditional EPC

The final decision on whether to execute the project through the publicly funded route or through PPP arrangements must be taken after assessing the following four parameters, namely:

1. **Return on the proposed investment**: Assessment to establish whether the projected returns from the proposed investment are attractive enough for a private entity to enter into a contractual relationship. If the project returns are attractive, then the project would be suitable to be considered for execution through PPP.
2. **Enabling policy and establishment environment**: Assessment to establish whether the policy and administrative environment is suitable for PPP, whether the private sector can provide the service that is intended, and whether involving the private sector will generate savings in service cost.
3. **Value for Money (VFM)**: Assessment to establish that the private developer can offer "better quality of outputs for a given cost" OR "lower costs for a given quality of outputs". Refer to Box 1 for more information.
4. **Acceptance by the Stakeholders**: Assessment to establish the degree of acceptance among all key stakeholders regarding the likely decision. Stakeholders must include prospective users, employees of the PSP or state agency currently managing the service (if any), and public representatives. The concerns of these stakeholders should be addressed before taking the final decision.

The PPP has an inherent advantage over EPC because in PPP the concession period starts from the date when all the conditions prior to construction are met which includes the construction period as well as revenue period, so it is in the interest of concessionaire to finish the work asap to avoid reduction of revenue years and thereby getting punished not only for increase in cost (delay in construction) but also in reduction in revenue (lesser years of revenue earning).

Box 1: Value for Money (VFM) Analysis

A public service must be provided by a private developer that can offer **"better quality of outputs for a given cost" OR "lower costs for a given quality of outputs".** This allows a project to maximise user satisfaction and optimise the use of public resources. VFM will be achieved if the project lifecycle cost for delivery by the private party is less than that for delivery by the public sector. VFM is a multi- faceted concept with both internal and external drivers, including timeliness, innovation, quality, and cost. From a decision-maker's point of view, there is an additional VFM driver in the degree to which sound capital allocation can be made. More projects are often available than the capital to undertake them, so political priorities determine which projects are realised.

When infrastructure projects exceed budgets, they tend to crowd out the realisation of other projects because of an unforeseen lack of resources. By maximising VFM, PPP projects increase project timeliness and cost control, thus giving decision- makers greater higher budget certainty and the ability to prioritise projects more accurately. While the financial analysis may design a bankable PPP, it does not mean that PPP is a better solution than traditional procurement. The VFM analysis will:

- determine whether to start tendering a project on PPP basis;
- be able to assess the impact of transferring risks back and forth;
- appropriately design a risk allocation that provides optimal VFM; and
- decide whether to award a PPP contract, if in case the final bid is not as per expectations.

The quantitative VFM Analysis would typically be undertaken using a tool known as "Public Sector Comparator (PSC)". PSC involves comparing the fiscal cost of a PPP delivery option with that of a traditional public delivery option. Calculating the PSC can be complicated – several adjustments are needed to ensure a fair comparison, e.g., the cost of staff involved in the government project, which generally is not taken into account. Adjustment of various costs is required to consider differences between these options, such as tax implications or risk allocation. Discounting the cost streams of these different options to reach a present value figure should provide a better choice for development of a project.

On establishing that the project makes technical, economic, fiscal, and financial sense for the private developer/operator with an adequate business case and that it should provide VFM for all stakeholders involved, the private service provider may determine (a) whether or not to realise the project on a PPP basis; and (b) whether VGF is required and, if required, the percentage share of the VGF support. The schematic in Figure 8.2 depicts a broad decision tree to establish viability of the project to be developed on a PPP basis:

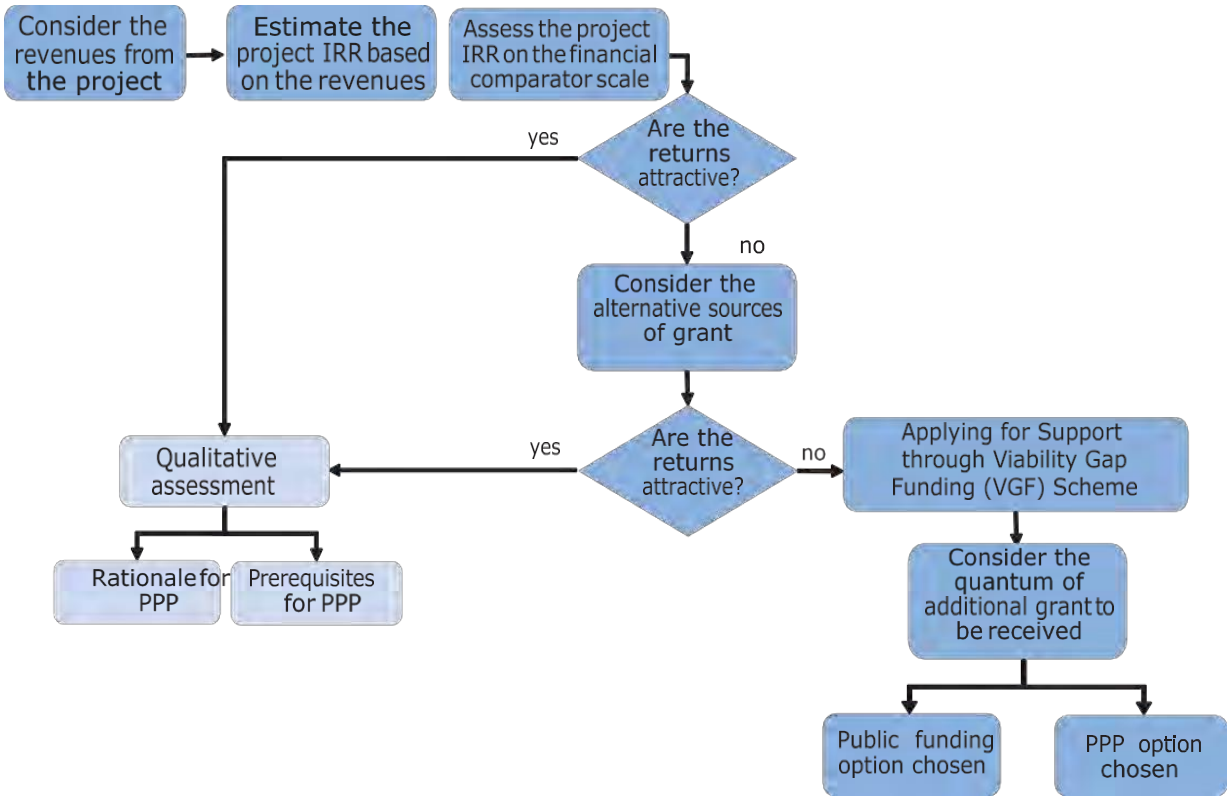


Figure 8.2: Process Flow for Assessing the Viability of Private Investment

8.5 Risk Management

8.5.1 Risk Identification

Once determined to be developed through PPP, the allocation of risk between the PSP and the private player is a defining characteristic, where the private player accepts significant risks related to the design, construction, and operation of the project. Each stage in the project development process carries certain risks. The risk categories shown in Table 8.2 are relevant

to any PPP projects and may impact the implementation of the project.

Table 8.2: Risk categories that impact implementation of PPP projects

Risk category	Description
Early Project Development Risk	Developmental risks, such as the quality and comprehensiveness of preparatory work that may result in problems at a later stage if not well conducted, management of the procurement process in a transparent manner, obtaining various statutory and regulatory clearances, acquisition of land (if required) and getting the buy-in of key stakeholders, could be addressed to a large extent through credible project development studies and extensive stakeholders' consultations. Some of these activities would also be specified as conditions precedent in the concession agreement. The PSP must identify, at the pre-feasibility/feasibility phase, any planning or approvals that can be obtained by them before the detailed designs for the project are finalised, e.g., any rezoning and land-use consents, right-of-way for bulk water pipeline, etc. These approvals must then be obtained before the project is put to tender.
Private player related risks	To ensure that the selected private partners have the required experience and financial capability, the qualification process is important and qualification parameters should be appropriately specified so that there is sufficient competition and yet ensure that only bidder of the desired capability are selected to implement the project. The concession agreement should have clauses which set out certain minimum equity- holding commitments for the private developer/operator to ensure their continued commitment to the project. Some factors which could exacerbate this risk and must be guarded against, include: • Poor track-record of the developer having financed, implemented, and operated a comparable infrastructure facility of a comparable scale and scope. • The private developer deploys a less experienced team than proposed in the bid. • Poor financial health or a highly leveraged (committed projects and contingent liabilities) financial health of the developer due to which it is unable to (a) fund its own equity and (b) garner lender comfort on "limited recourse financing". Provide a credible Sponsor Support Commitment to bridge financing gap.
Project Authority (PSP) related Risks	The PSP is responsible for key aspects of the PPP arrangement which, if not managed at the time of project development puts the entire partnership at risk. Some (not exhaustive) list of the authority related risks that are critical are as follows: • Ensuring that the planning of the project and scope of work has been done by PSP.

Risk category	Description
	• Ensuring that dedicated funds are available/created or special taxes levied to generate the funds and that the dedicated funds are ring-fenced. • Check the willingness to pay by the citizens in case the tariff is rationalised. • In some cases, giving assurances for supply of fixed volumes of raw water/treated water to the private operator and the penalties for non-compliance. Credit enhancement mechanisms such as letters of credit (L/Cs) or guarantees, or a state/government support agreement may be necessary.
Political risks	• Risks related to land acquisition/expropriation • Political opposition to the project • A poor public decision-making process, which will expose the project to claims and lawsuits The PSP must retain the political risks as they are largely outside the control of the private developer/operator but can be mitigated by proper policy planning by the PSP.
Legal/Policy/ Regulatory Risk	• This covers the risk of legislative changes, the risk associated with project approvals and permits, tax legislation and potential liabilities generated by the project. • It is mainly associated with the rules and conditions governing entry into and undertaking of specified activities, and unanticipated changes that may have an adverse effect on the project. The nature of legal risks is diverse and there is no single source of risk. • The allocation of the legal risk is often done on a case- by-case basis, considering which partner best can control the risk and the source of the risk.
Procurement Risk	This is the risk associated with the procurement process. It includes risks arising from the organisational form (lack of experience with the PPP process, lack of commitment from the public or private partner), co-ordination risks between the public and the private partner (interface risk), excessive contract variations and late changes to the design. As with legal risk, the sources of these risk factors are multiple, and no single partner can handle them all. Consequently, each risk must be addressed separately in the negotiations and allocated accordingly before it can be determined which partner carries the largest risk.

Risk category	Description
Financing Risk	• This is the sum of the risk factors concerning the financing of the project. • It relates to timely closure of adequate and cost-effective debt-finance for the effective implementation of the project. • Long-term exchange rate risk for international contractors is a major financial risk. Inflation risk could not sometime be entirely compensated.
Construction Risk	• This covers events related to the construction stage of the project and can include events such as late delivery, non-compliance with specified standards, significant additional costs, technical deficiency, and external events (including environmental risks) triggering compensation payments to third parties. • Time and cost overruns often pose the gravest challenges to public agencies/government authorities.
O&M Risk	The O&M risk is in two parts: (i) the cost of poor construction decisions materializing in the O&M phase, and (ii) risks arising as a function of the operation of the asset. Generally, the overall O&M risk is always transferred to the private partner. If the O&M risk is not transferred to the private partner, the incentive to design and build infrastructure with efficient life cycle costs is reduced. Some of the critical factors which could exacerbate this risk, and must be guarded against, include: • Deficiencies in project completion which impact the operating characteristics of the infrastructure facility • Technology, whether it is tested and stable, or new/untried, or obsolete. The nature of technology will have a direct bearing on availability of adequate supply of appropriate critical spares, or trained/skilled manpower • Cost of routine and major maintenance, as well as the frequency and downtime impact on the infrastructure facility • Cost of asset replacement, refurbishment, and modernisation as well as the frequency and downtime impact on infrastructure facility
Demand/Revenue Risk	This covers the variability in demand for a particular service, e.g., where demand for the total volume of treated water is lower than what was expected when the PPP contract was agreed, irrespective of the appropriate performance of the private partner. The risk is that the revenue stream realised from the project is lower than the projections based on which the viability of the infrastructure facility was assessed and financed.

Risk category	Description
Other Risks	Most of the residual risks such as force majeure, risk of governmental action (early termination of the contract or expropriation) also referred to as political risk, changes in law or regulation, are usually addressed in the concession agreement. The remedy for commercially insurable risks is usually insurance cover that the concessionaire is expected to take. Environmental and social risks are identified in the EIA/SIA undertaken as part of the project preparation process. It is important to implement a plan to ensure that the project is insulated from the risks of land acquisition, environmental advocacy, and social issues, such as resettlement and rehabilitation and compensation claims, so that implementation is not hampered.

8.5.2 Developing risk mitigation strategies

Once the risks have been identified, and allocated appropriately, the next activity to be undertaken is developing credible risk mitigation strategies. Risk mitigation strategies are developed with the intention of reducing each party's exposure to risk. At the same time, such strategies inherently increase the likelihood of achieving (or bettering) the project's base case scenario. It is recommended here that in addition to identification and allocation of risks and development of mitigation measures, the PSP must also develop a dispute resolution mechanism. Once project implementation begins with the private developer, it is necessary to ensure that a regulatory body is formed which would formally handle any disputes that might arise during the concession period. Figure 8.3 depicts a schematic process for allocating various risks between the public service provider and the private developer/operator.

8.6 Factors which contribute to the success of 24×7 Water Supply System PPP Projects

Based on experience of PPPs in 24×7 water supply in India, the following are some of the common factors which contribute to the success of a PPP Project in 24×7 water supply sector (Table 8.3).

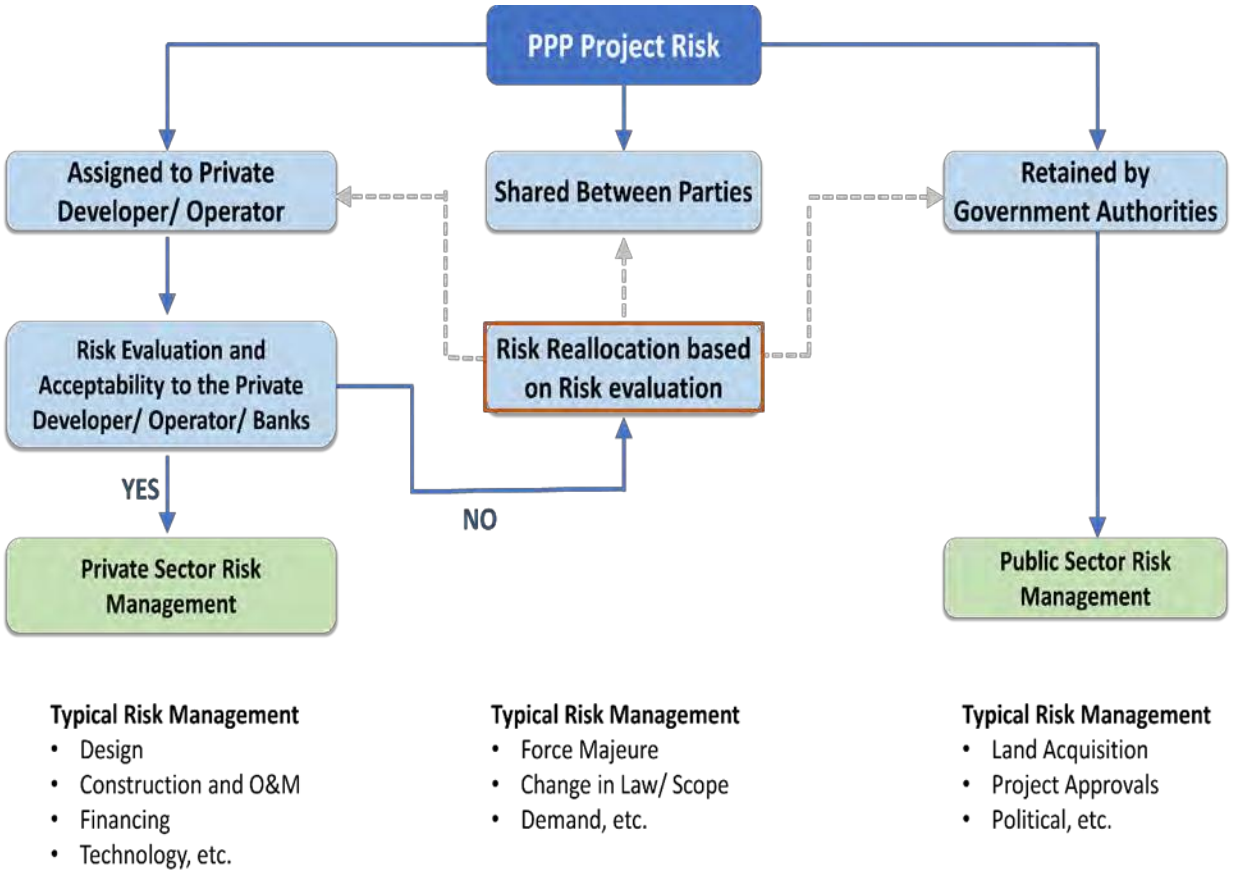


Figure 8.3: Schematic Process for Risk Allocation

Table 8.3: Factors for the success of 24×7 water supply project PPPs

Activities	Explanation
Inclusiveness	
Stakeholders' consultations	It is imperative to have a continuous dialogue with all stakeholders (private developers/operators, different departments and consumers' organisations, larger communities as applicable, etc.), at the time of project preparation including in the implementation and O&M phases, to accommodate all legitimate views/concerns and take appropriate mitigation measures.
Enabling regulatory and legal environment	
Water byelaws to be notified	Connection, disconnection, water tariff, etc. are regulated by water byelaws. All relevant government authorities must notify the water supply related tariff rules to create the enabling legal framework. The tariff should have clear pricing factors and define the process for their levy.
Regulations and clearances	Private operators should not be given the onus of obtaining Right of Way, land acquisition, shifting utilities, recovery of old arrears. These should be the responsibility of the municipality although, if considered necessary, the private operators may be incentivized for some of these tasks, e.g., shifting of utilities.
Land acquisition and moving of utilities	The clarity and timeline should be defined before pre- procurement activities, the public entity should have an explicit idea on timing, type of implementation agencies to be involved and an outline of costs on a case-to-case basis.

Activities	Explanation
Administrative approvals	Legislative Body approval for the project should be in place prior to bidding.
Capacity of the Public Service Provider	
Comprehensive project design	There are certain pre-requisites to providing an equitable and continuous water supply to the service area. For example, it is important to have the hydraulic model ready for the entire city, considering the expected population and commercial/industrial growth of the city in the future.
Benchmarking of existing service levels/ assets	Benchmarking of existing service levels/assets is essential to fairly analyse the performance of private operator during project implementation.
Defined project boundary and scope	Project scope with the baseline is the responsibility of the PSP, to avoid any confusion and disputes at a later stage. Recently, increasing numbers of PPP contracts incorporate a preliminary six-month period to measure and agree on the initial conditions. In case of major discrepancies between the original conditions given in the RFP and found in the initial six-month period, the contract provisions may be modified appropriately. The methodology for such post-bidding variations must be clearly specified in the contract, be transparent, and be known to all bidders prior to bidding. However, in the first place, it should be avoided, and for that purpose, the pilot project should be done first to get a good data for structuring the project for whole city.
Technical proposal needs to be assessed	PPP contracts should not be finalised just based on the financial evaluation. The technical evaluation of the bidder's proposal must be done to ensure that the bidder has understood the project and has the relevant experience. Inadequacies in this area may delay project execution and affect quality of works.
Adequate time for bidding process	Adequate time needs to be provided at the time of bidding and adequate information must be made available to all bidders well in advance. Bidders should also be allowed to assess the existing water supply system to prepare a good bid.
Appropriate risk sharing mechanism	Generally accepted MoF/NITI Aayog norms to be adopted for the concession agreement/bid document.
Availability and quality of raw water (or treated water, in case of water distribution PPP project)	Such related issues to be addressed adequately and may be covered under the force majeure events.
Optimal use of water resources	There is a need for optimal utilisation of water resources. The PSP should consider using recycled water for non-potable uses for its domestic and commercial/industrial consumers.
PSP's employees	Clarity on the roles and responsibilities of the PSP's employees/deputation employees post-project implementation.

Activities	Explanation
Financial Status	
Financial strength of the PSP to be assessed	This is critical to avoid issues relating to payments to the private developer. Sources of funds for the project should clearly be demonstrated in RFP document. Credit rating of PSP to be made and published in the RFP document. Also, budget allocated to the project to be mentioned in RFP document. In cases where financial status of Public Service Provider is weak, State/Central Government guarantee should be available for the project.
Willingness to pay	Public Service Provider may conduct this survey to assess the acceptance of the proposed tariff structure to fund the proposed interventions in service provision.
Payment guarantee mechanism should be in place	Important to have clarity on the payment guarantee mechanism along with appropriate payment structure, periodicity and timeliness, defaults, and performance evaluation. **Escrow Account and Agreement** Payment shall be made to the Concessionaire through Escrow Account which shall be opened by the Authority in accordance with Escrow Agreement (executed between authority, concessionaire, and Escrow Bank). Authority shall ensure that escrow account is funded all times with an amount equivalent to at least the next three months' payment due to PPP operator. **Step-in Rights to Lenders and Substitution Agreement** Concession Agreement should provide step-in rights to lenders of project through proper Substitution Agreement (executed between authority, concessionaire, and lenders).
Political Risk	
Political and administrative support	Ensure political and administrative commitment for the project.

8.7 Achieving 24×7 PWSS through PPP – A two-stage process

Considering the past experience in urban water supply PPP projects, and due to the limited capacity of the public service provider to carry out complex PPP projects for the entire city at one go, a **two-stage approach** has been suggested for any upcoming 24×7 PWSS project to be developed on PPP basis:

- **Stage I**: Develop 24×7 PWSS in a pilot zone on PPP basis, demonstrating a concept of both 24×7 PWSS and PPP to all stakeholders concerned. It is recommended that the PSP will implement this Stage I over a duration of five years. The objective is to provide more realistic financial and technical feasibility inputs to the PSP while drafting the DPRs and defining project structure for city- wide implementation (in Stage II).
- **Stage II**: The outputs/learnings from Stage I will be utilised to design the project structure for city-wide implementation at this stage.

8.7.1 Stage I: Pilot Zone 24×7 PWSS – Performance-Based Management Contract (PBMC)

Any city, that is planning to develop 24×7 PWSS, a shift from its current intermittent one, is advised to select at least one DMA of around 2,000 connections, as a pilot zone, to demonstrate the concept of PPP through PBMC. It is recommended that PSP identifies an area within the city as the DMA which represents the city's economic/cultural structure appropriately. The scope of work should also include the condition assessment of WSS assets at DMA and the city level. The condition assessment will give a true picture of scope of work and help preparing the better cost estimates for Stage II project. This ensures qualitative participation of good PPP developers and operators. In cities, having a diverse economic, cultural, behavioural or user patterns, where any one DMA may not be able to represent the entire city appropriately, the selection of two or more DMAs, with at least 2,000 connections each, as a pilot zone of Stage I project is recommended.

Benefit of Condition Assessment: *Including the condition assessment of WSS assets at DMA and the city level in the Stage I scope will give a true picture of scope of work and help prepare the better cost estimates for Stage II of the project. This ensures qualitative participation of good PPP developers and operators.*

Advantages of Conditional Assessment:

1. *Helps classify the pipeline network under three parameters (as a percentage of the total network):*
   a. *Pipeline to be replaced.*
   b. *Pipeline to be rehabilitated.*
   c. *Pipelined to be retained as is.*
2. *Estimate the likelihood that a water mains/distribution line may continue to provide satisfactory service, both now and in the future.*
3. *Help determine the remaining service life of the water main or distribution.*
4. *Make better decisions regarding maintenance of the pipelines like allowing some water mains/distribution lines to remain in service longer; prevent some pipeline failures from occurring by intervening sooner; make decisions more confidently (with less chance of error).*
5. *Find active leaks.*

A recommended PPP model, PBMC is a form of private sector engagement where the current assets are provided to the private operator for O&M based on well-defined KPIs. PBMCs are intended to promote savings, efficiency, and responsiveness, which are expressed in terms of performance expectations or KPIs linked to budget, service, and management. These contracts clearly state the overall targets to be achieved by the contractor, but the specific processes to achieve such results are left to the contractor's discretion. Thus, this results-oriented contract differs from service or management contracts that focus principally on inputs and procedures. Through the PBMC, a private firm can be hired to implement a 24×7 PWSS in the pilot zone with a (partially) variable remuneration based on performance achievements linked to KPIs.

The main objective of the Stage I project is to estimate the accurate status of the baseline information, with a fair degree of accuracy, for a city-level implementation of 24×7 PWSS PPP project. It will also make public sector ready to undertake more complex PPP project at a city-level, by improving their understanding about issues in 24×7 PWSS as well as the concept of PPP.

Following are the key outputs envisaged at Stage I:

- Determination of clear scope-of-work for the 24×7 PWSS projects in Stage II for the private developer/operator.
- Estimation of total project cost with a fair degree of accuracy.
- A validation of PPP concept and workability of the same.
- Generation of interest among private developers/operators.
- Selection of a suitable structure for Stage II, which is city-wide implementation.

Karnataka's Prior Experience with PBMC

The Karnataka Urban Infrastructure Development and Finance Corporation (KUIDFC) introduced a PBMC in pilot zones (covering about 10 per cent of the population of each city) of three cities of Belgaum, Gulbarga, and Hubli-Dharwad. The objective was to test PSP in water services management to bring water supply services to pressurised 24×7 standards.

The private operator was recruited as an "operator-consultant," as its responsibilities included the detailed engineering design for extending and improving the distribution system with associated investment planning before operating the system over two years (including billing and collecting tariff proceeds on behalf of the municipalities). The private operator was not directly in charge of construction works, but procured them separately on behalf of KUIDFC, acting as its procurement agent. In terms of remuneration, the private operator received a fixed fee during the design phase, with a bonus linked to capital expenditure savings, if any. During the operations phase, the remuneration was a combination of fixed fees (60%) and performance-based fees (40%), with performance indicators related to NRW reduction and continuous supply.

The PBMC model implemented in Karnataka was successful. By 2010, the private operator had supported an increase in domestic coverage from 50 per cent to 100 per cent and brought service levels to 24×7 standards in the pilot areas.

In 2014, KUIDFC and Hubli-Dharwad municipality initiated a bidding process for scaling up the water supply improvements for the remaining parts of the city under a similar PBMC. In 2017, a new contract was awarded to the consortium of private players, which were different from the Phase I private developer, to implement 24×7 PWSS in the entire city.

8.7.2 Stage II: City level 24×7 PWSS

Once the PSP has established the concept of 24×7 PWSS in an identified pilot zone(s), it will consider replicating the same across the entire city. However, since the PSP would have already established service-level benchmarks in the pilot zone(s) and assessed the CAPEX and OPEX requirements with a fair degree of accuracy, it may consider adopting a different project structure such as Design, Build, Finance, Operate and Transfer (DBFOT)/Concession Contract, Annuity/HAM or Design, Build Operate (DBO) based on the suitability analysis. The project structure for 24×7 PWSS PPP could consider transferring initial funding risk either partially or completely to the private developer. In cases where private funding may not be possible and/or the ULB has a required funding for the project, the PSP will consider different project structures like DBO, where full funding responsibility will be with the PSP, and private developer/operator's expertise would be utilised mainly to improve the water supply system in performance-based operations contract.

8.7.2.1 Design Build Finance Operate and Transfer (DBFOT)/Concession Contracts

DBFOT PPP model has evolved from public sector's inability to not only finance the required investment in a project but also its limited capacity related to designing and O&M. The private operator, during the agreed contract tenure, funds the required investment and recovers the same mainly through user charges. Post completion of contract tenure, the private sector not only transfers the project assets but also the technical know-how to operate and maintain the facility to the PSP.

Manila Water and Maynilad

In the early 1990s, Metropolitan Manila suffered from an old and inefficient water system. Three quarters of the homes in the eastern half of Manila lacked 24-hour service and only 8 per cent had sewerage connection. Almost two-thirds of the water produced was lost to leaks, poor metering, and illegal connections. In addition, Metropolitan Waterworks and Sewerage System (MWSS), the government agency responsible for delivering water and sewerage services to residents, was heavily indebted. Hence the necessary investments for maintenance and services could not be realised.

In 1995, this situation prompted the Philippine government to enact the National Water Crisis Act, which set the framework for fundamental changes in the sector. The government decided to divide the MWSS system into two geographically separate concession zones:

- East (40 per cent of the population) awarded to Manila Water Company
- West (60 per cent of the population) awarded to Maynilad Water Service

Dividing the area was expected to facilitate the tasks of the regulatory agency by allowing it to make comparisons between the two regions, as the same bidder could not win by rules both concessions. However, this geographical division made the operation much more complex to structure with issues such as network interconnections to address.

Concession terms

Under the terms of the concession contract, the two private operators were vertically integrated utility responsible for both water and sewerage services within the respective area. They were authorised to collect and own revenues from water tariffs, but have to pay for operating costs, investments plus a concession fee to the government (mainly to service the historical debt of MWSS). At the same time, they were responsible for expanding the network to meet ambitious performance targets, including:

- Elevating water pressure;
- Uninterrupted 24-hour service within five years;
- Immediately complying with Philippine national drinking water safety and water effluent standards;
- Providing universal water coverage within 10 years and 83 per cent sewerage and sanitation coverage within 25 years.

To achieve these targets, it was estimated that US$7 billion of investment would be needed over the contract period. Under the concession agreement, the ownership of the asset base was retained by MWSS and all additional assets invested by the concessionaires were to be turned over to MWSS at the end of the concession period (a compensation mechanism was foreseen in that regard).

Tariff procedures

Since the award of the concessions, tariffs have been set by the board of MWSS upon recommendation of its regulatory office. Procedures for tariff adjustment were nevertheless defined in the concession contract, including annual adjustment for inflation as well as the possibility of extraordinary price increases in case of force majeure. In addition, there was a five-year rebasing system, which guaranteed a certain rate of return to the concessionaires. Such system was actually based on an "Appropriate Discount Rate" to be determined by the MWSS regulatory office (defined as the prevailing rate of return for similar infrastructure projects).

The selection criterion for awarding the concession contracts was the lowest average water tariff bid. To increase the chance of having a large discount on water tariff following the introduction of private operators, long overdue tariff adjustments were made prior to the bidding phase (tariff went up by 38%). Having a large tariff rebate as a result of the bidding process was very important to ensure that the deal would be accepted by the public. The bidding results were actually beyond the most optimistic expectations as one of the bidders proposed a base rate amounting to only one-fourth of MWSS tariffs at the time of bidding.

- Pre-project rate: 8.56 PHP/m^3
- West zone: Maynilad winning bid: 4.97 PHP/m^3
- East zone: Manila Water winning bid: 2.32 PHP/m^3

However, these very low bids raised the question of whether a "loss-leader" strategy was applied (i.e., a private consortium offers highly competitive bids with the objective of securing a concession and recouping any short-term losses by renegotiating a tariff increase at the first possible opportunity).

Financial difficulties quickly emerged after the award of the concessions. In particular, the Asian financial crisis had a significant impact. The Philippine peso devaluation almost doubled MWSS's dollar-denominated debt service burden that had to be covered by the concessionaires. To alleviate these difficulties, a contract amendment was granted in October 2001 to allow tariffs to be adjusted more rapidly following exchange rate fluctuations. Hence, the tariffs' increase began to accelerate after that date. The tariffs, in real terms, started to exceed pre-concession levels (from 2002 for the West Zone and 2005 for the East Zone). In 2012, tariffs were around 50 and 100 per cent higher compared to the pre-concession period.

Efficiency gains

- Though the contractual target of reaching full coverage by 2006 was not met, the service coverage improved considerably as both concessionaires increased the number of water service connections dramatically. In the Western concession (Maynilad), coverage expanded from 67 per cent to 86 per cent. In the Eastern zone (Manila Water), coverage jumped from 49 per cent to 94 per cent.
- The level of water losses has decreased significantly since 1997, from 45 to 12 per cent for Manila Water in the Eastern Zone and from 66 to 39 per cent for the Western Zone concession Maynilad (2013 figures). The pace of progress was, however, much slower than planned.

Conclusion

Significant improvements have been achieved from the use of the PPP model for water services in Manila. Given the operational track record of MWSS, it is unlikely that these efficiency gains could have been done without the introduction of private operators. On the other hand, the project has faced difficulties: the tariff formula had to be revised quickly after the award, progress on sewerage services has been lower than expected, and prices went up after an initial drop. One of the concessionaires (Maynilad) even went bankrupt and public funding had to be provided to ensure service continuity before a new owner could be found.

Case Study – Nagpur "Drink from Tap" 24×7 water supply project

Nagpur is the first city in India which has gone for full city 24×7 water supply project implementation way back in 2011. The project was developed on DBFOT model wherein grant was also made available under JNNURM program. The project model is summarised below.

S. No.	Parameter	Description
1	Executing Agency	Nagpur Environmental Services Pvt. Ltd (NESL) – A wholly own subsidiary of Nagpur Municipal Corporation
2	Private Operator	Orange City Water (OCW)– 50:50 JV between Veolia India and Vishvaraj Environment. (After 9 years of operations Veolia now controls 100% of OCW)
3	Scope of Work	• Carrying out demand assessment studies for the hydraulic zones • Creation of DMAs through GIS mapping and hydraulic modelling • Augmentation/rehabilitation of water treatment plants • Laying out distribution pipeline network • Installation of house service connections (metered) • O&M of entire system for 25 years including billing and collection
4	Construction Period	5 years
5	O&M Period	25 years (from the start of construction period entire network is handed over to private operator)
6	Funding Pattern	70% funding under JNNURM 30% investment by private operator
7	Project Structure	PPP – DBFOT
8	Bid Parameter	Rate per cum (m^3) of water billed and paid for
9	KPIs	• Reduction of NRW • Achieving equitable distribution in phase 1 • DMA wise conversion to 24×7 water supply system in phase 2 • Required pressure at specific points • Maintaining treated water quality levels as per CPHEEO standards

10	Private Operator Responsibility	• Investment of 30% in the project • Execute entire scope of work as mentioned in 3 above • O&M of entire system and achieve KPIs
11	Escrow Arrangement	• NMC to pay operator each month for purchase of treated water through escrow arrangement • The escrow account would have three months equivalent amount all time • Lenders will have substitution rights
12	Current Status of Project	The project is under operations with substantial portion of the city under 24×7 water supply. Water supply and quality improved across the city.
13	Project Benefits	• Substantial improvement in the water supply and quality across the city • Better hydraulic model ensured equitable distribution across city • Better pressure reduced local pumping in the households • Metering improved revenue collection and also established sense of water conservation among the citizens

After the successful implementation of this pilot project and taking into account the lessons learnt, NMC scaled up the project for a full city implementation for the 2.5 million population. This project is the first of its kind in India. NMC accorded the contract to JV based on its lowest quote for per cubic metre rate of water billed and collected.

Accordingly, the JV partners incorporated an SPV in the name of OCW Private Limited. It has been operating and maintaining the entire water supply system since 2012.

The project was funded under JNNURM where 30 per cent of the NMC's share has been invested by OCW for the CAPEX work.

OCW has signed a 25-year PPP contract with NMC wherein it would involve carrying out O&M work for the entire 25 years and to do Capex/Rehabilitation Phase (IPIP) work simultaneously in the initial period. NMC handed over the project to OCW on
01/03/2012 (commencement date).

8.7.2.2 Annuity Models

In water supply projects, where revenue projections could be an issue for the private developers, even under the most favourable economic conditions and environment, it is, therefore, considered prudent to avoid transferring the revenue risk, i.e., user charges to the private sector. Sometimes, it would also be challenging to determine acceptable user charges, which would justify the private investment in the project. To avoid these issues, an annuity scheme is proposed, under which the private investment in the construction, maintenance, and operation of the 24×7 PWSS would be serviced through either monthly or quarterly annuity payments from the authority. These (approximately) uniform annuity payments would be made throughout the contract period. This "annuity" payment would be the bid parameter for being awarded the concession. The annuity method is considered to carry the least risk to the PPP investor on

recovery of investment.

8.7.2.3 Hybrid Annuity Model (HAM)

Sometimes, it is difficult for the PSP to budget high annuity payments or difficult to raise high capital costs to be incurred by the private sector to implement the project. In such cases, to further reduce the financing risk to the private sector, while keeping the design, implementation, and maintenance risk transfer at significant levels, the government proposed the hybrid annuity model (HAM). In the HAM, a substantial percentage of the project's cost (say, 40%–50%) is funded by the public sector entity, which is linked to agreed milestones during the construction period and *pari passu* (in per cent terms) with loan being disbursed by the project lender. The balance of deferred construction payments, maintenance payments, and stipulated interest on capital investment would be paid by proportionate monthly/quarterly payments through operations period post-COD, subject to meeting KPIs satisfactorily. The basic principles of the HAM contract are as follows:

a) Design and construction risks are entirely passed on to the concessionaire.
b) Milestone payments partial capital costs incurred until that point by the concessionaire.
c) In case of delayed completion, there are liquidated damages for every day of delay. In addition, annuity revenues would also be delayed, and the concessionaire is effectively penalised. Conversely, on early completion, a bonus may be paid to the concessionaire and the annuity revenues can start faster. However, under no circumstances the concession period is changed, until there are issues related to other than that pertains to Concessionaire.

Aurangabad Water Supply Project

Aurangabad Municipal Corporation (AMC), in its endeavour to supply continuous 24×7 water supply to its citizens, and to cater the incremental water demand of the growing city, initiated a development of city's water supply on PPP basis. AMC structured this Project under guidance of the Government of Maharashtra, ADB and DEA, and selected concessionaire in a two-stage bidding process, i.e., RFQ + RFP. In the RFP process, the bidding parameter was the requirement of the annual annuity, in the form of operational grant from AMC, for the first year of the concession period, to be escalated by 6 per cent per annum.

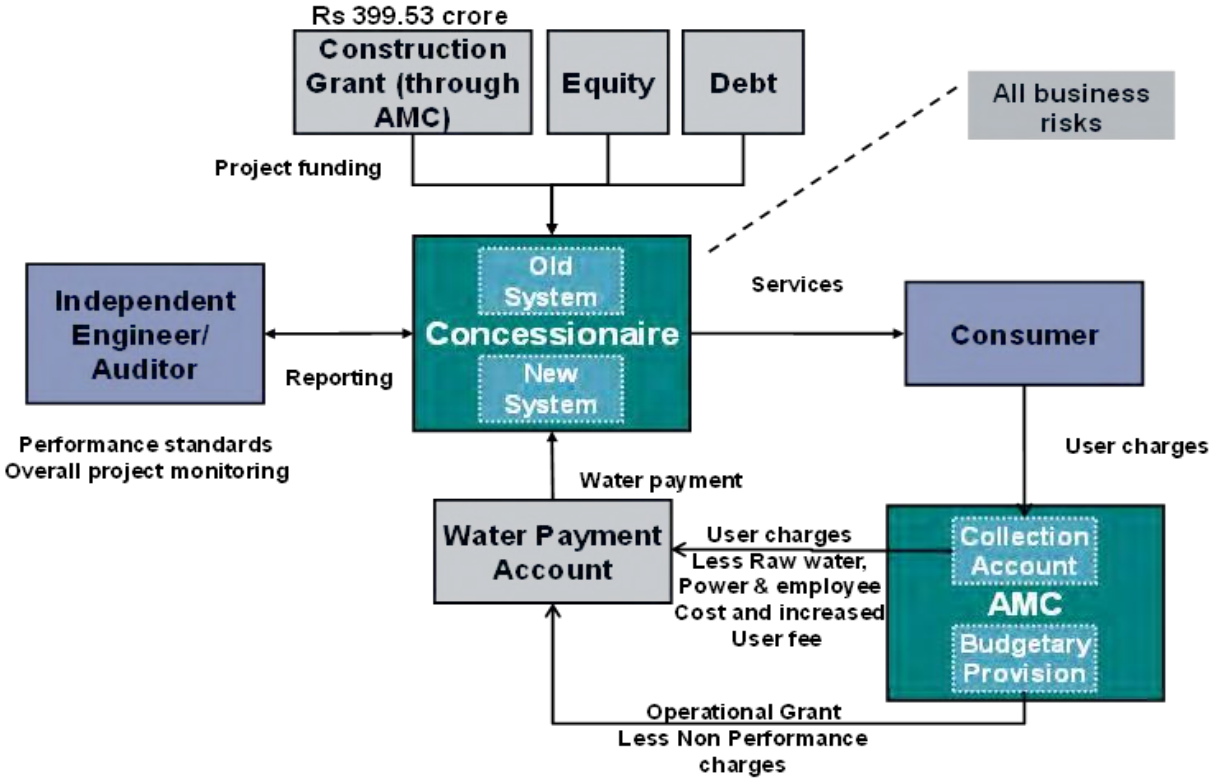
The Project, with its original scope limited to new water treatment plant, parallel transmission pipeline, and limited distribution network, with an estimated Project cost at about Rs 360 crore received an approval under UIDSSMT scheme in year 2009. UIDSSMT approved a grant of Rs 323.71 crore (UIDSSMT – Rs. 287.74 crore and Government of Maharashtra – Rs. 35.97 crore) to the Project. In 2009, it was decided to include other missing components, such as transmission and feeder mains, comprehensive distribution system to cater pressurised 24×7 water supply of the city and metering system. As a result of inclusion of these additional components and time delay, the cost of the Project increased to Rs 792.20 crore at the time of bidding. The Government of Maharashtra sanctioned additional grant of Rs 75.82 crore to partially meet this cost escalation, i.e., total sanction grant for the project is at Rs 399.53 crore. While this grant was available for the original scope of the project, the new components and cost escalation to the extent of about Rs 392.68 crore did not have any grant available and were expected to be funded by AMC's own sources. Considering the magnitude of the Project,

funding requirement and required skillsets, it was decided that the Project to be developed through PPP route.

The private developer (the "**Concessionaire**") had been appointed for a period of 20 years (the "**Concession Period**"), divided into 3 years of Construction and Rehabilitation Period and 17 years of O&M Period, with a broad scope:

a) Supply to the end users within the supply area, potable grade water as per CPHEEO norms.
b) Rehabilitate and O&M of the existing assets and existing water supply system.
c) Construct a new parallel water pipeline.
d) Construction, operation, and maintenance of new head works and approach bridge, new pumping machinery and electrical installation, water treatment plant including recirculation sump and new Master Balancing Reservoir/elevated service reservoir and ground service reservoir.
e) Construct and rehabilitate the transmission mains, trunk mains, feeder mains and distribution network including elevated service reservoir.
f) Undertake metering and increase the number of connections on behalf of the AMC.
g) Regularise illegal connections subject to the applicable law.
h) Build computerised billing and collection system.
i) Raise invoices on end users on behalf of AMC – on fixed rate during construction and rehabilitation period and on volumetric basis during O&M Period.
j) Collect user fees and connection charges from the end users.
k) Supply water to the area enroute the supply area, where AMC has already entered into agreement with the enroute customers.
l) Operate and maintain the water supply system.

The following schematic depicts the Project structure:



The revenue model is based on user charges and the AMC annual grant. The operator levies and collects user charges based on the prespecified tariff that differentiates between domestic and nondomestic consumers. During the construction and rehabilitation phase, the tariff structure is on a flat monthly basis. On completion of this phase, the tariff structure turns volumetric. Consumers in the higher categories of consumption are levied a higher per unit rate for the entire consumption. The concession agreement limits the operator's revenue in two ways because the annual grant and the tariff structure are predetermined. The operator has commercial freedom in all other respects and retains the upside of (i) optimisation of capital expenditure, (ii) operating efficiencies, and (iii) commercial efficiencies such as maximising connections, consumption, and collections.

8.7.2.4 Design Build Operate (DBO) Model

If in case the PSP has either internal financial capacity or an ability to raise funds from the market at a reasonable rate as compared to the private player, it may consider implementing 24×7 PWSS through DBO model. Over the years, many projects have been constructed under DBO schemes. Normally, the private technology provider would be responsible at the very least for the final design. The technology provider intervenes as a general contractor and must assume the operation during some initial years after the commissioning of the works.

Seattle Tolt Water Treatment Facility on a DBO Basis

Seattle Public Utilities (SPU), a municipally owned utility providing water, sewer, and solid waste services, contracted with a private operator in May 1997 in a partnership to permit, design, build, and operate the Tolt Water Treatment Facility. The facility was completed in 2001 to treat 120 million gallons of water per day from the South Fork of the Tolt River.

At the time the facility was being planned, the Environmental Protection Agency issued two regulations, the Disinfectant and Disinfection By-product Rule and the Enhanced Surface Water Treatment Rule, which, in part, govern water contaminants under the Safe Water Drinking Act. SPU was increasingly aware of the varying levels of natural organic material in Tolt water and recognised that they would not be able to meet these standards without filtration and treatment improvements. The pursuit of a PPP was, in part, an attractive option because of the technical expertise and innovation the private sector could offer SPU in meeting these environmental standards. Increased system reliability was also a top priority. Turbid water, or water made "cloudy" by suspended particles like sediment, occasionally caused plant shutdowns, often because of storms and their resulting runoff.

Qualified companies submitted bids covering the design, construction, and operation of the facility for a minimum of 15 years and extending up to 25 years. This process used qualification-based selection to consider overall value, not just upfront costs; only 40 per cent of the contractor selection criteria were based on price.

Early in development of the new water treatment facility, SPU had planned to follow the traditional practice of building the system through a competitively bid contract process. The city anticipated that it would cost $171 million, $115 million in construction, and $56 million in operations and renewal over 25 years. But following new authority from Seattle's City Council, SPU shifted to consideration of a DBO procurement. With the winning DBO bid projected to cost $101 million, the city estimated 40 per cent savings, or $70 million, over a conventional approach to DBO of a similar facility.

Tolt Treatment Facility Project Costs

In USD million	DBB Estimate	DBO Contract	Savings
Capital	115	65	50
Operations	56	36	20
Total	**171**	**101**	**70**

The initial 15-year O&M contract for the Tolt facility expired in 2016. Over the course of that contract period, the private partner had brought "a proactive approach" to maintain plant systems and components, trouble shooting, making repairs, and co-ordinating condition assessments to ensure the plant continues to operate well.

Owing to their performance and the tangible benefits of the PPP, SPU recently extended American Water's O&M contract an additional five years, to 2021.

8.7.3 Factors contributing to selection of PPP models

Based on the PPP project models mentioned above, the following are the major factors which contribute to the selection of a suitable model as illustrated in Table 8.4.

Table 8.4: Factors to be considered while selecting PPP options (OECD, 2006)

Factors	DBFOT/Concession Contract	Annuity/HAM	DBO
Situation assessment	Large scale projects; ULB's lack of access to capital for investment; Interest from private sector investors; lack of technical know-how and/or regular O&M; inefficient construction and contract management	Large scale projects; Lack of interest from private sector to take complete financial risk; inadequate funding availability with the authority for an initial investment and lack of expertise for construction/O&M of the system	Large/small scale projects; Reluctance from private sector to take any financial risk; inefficient construction and contract management
Regulatory and legal environment	Requires complex regulatory framework and advanced legal tools		Requires basic regulatory framework
Accountability of both parties	Private operator is accountable for end-to-end process, starting from development to revenue collection	Both PSP and private operator are actively involved; requires time to time monitoring by the PSP, based on which monthly/quarterly annuity payments are made.	The private entity is bound by the PSP through liability clauses for construction.
CAPEX Investment	Financing is done by private entity; sometimes public	Both private and public entity (general ratio: 60:40)	No investment by the private sector

Factors	DBFOT/Concession Contract	Annuity/HAM	DBO
	sector provides VGF support at the time of construction		

The respective PSP will require to go through the five main steps of the PPP project circle in order to select, develop, and procure the most appropriate PPP project in Stage II, i.e., city-level 24×7 PWSS.

8.8 PPP Project Lifecycle

The Project Lifecycle basically has three major elements: (a) Planning; (b) Financing and Execution; and (c) Monitoring. At no point will the cost of the project change unless it falls under the provision of change in scope/law which will be part of the concession agreement. Both "Planning"[1] and "Monitoring" are the core responsibilities of PSP.

8.8.1 Step I: Pre-Procurement

In this step, the PSP will finalise the enabling activities, namely selection of transaction advisors, ensuring baseline set-up, through activities like stakeholders' consultation, tariff rationalisation, getting all required approvals from ULB's general body/state government, creating a data room, etc. In this stage, the PSP will finalise the Tender Documents, covering instruction to bidders, the concession/contract agreement with all required annexure and project information memorandum. The schematic in Figure 8.4 depicts the broad activities to be conducted by the PSP at this stage.

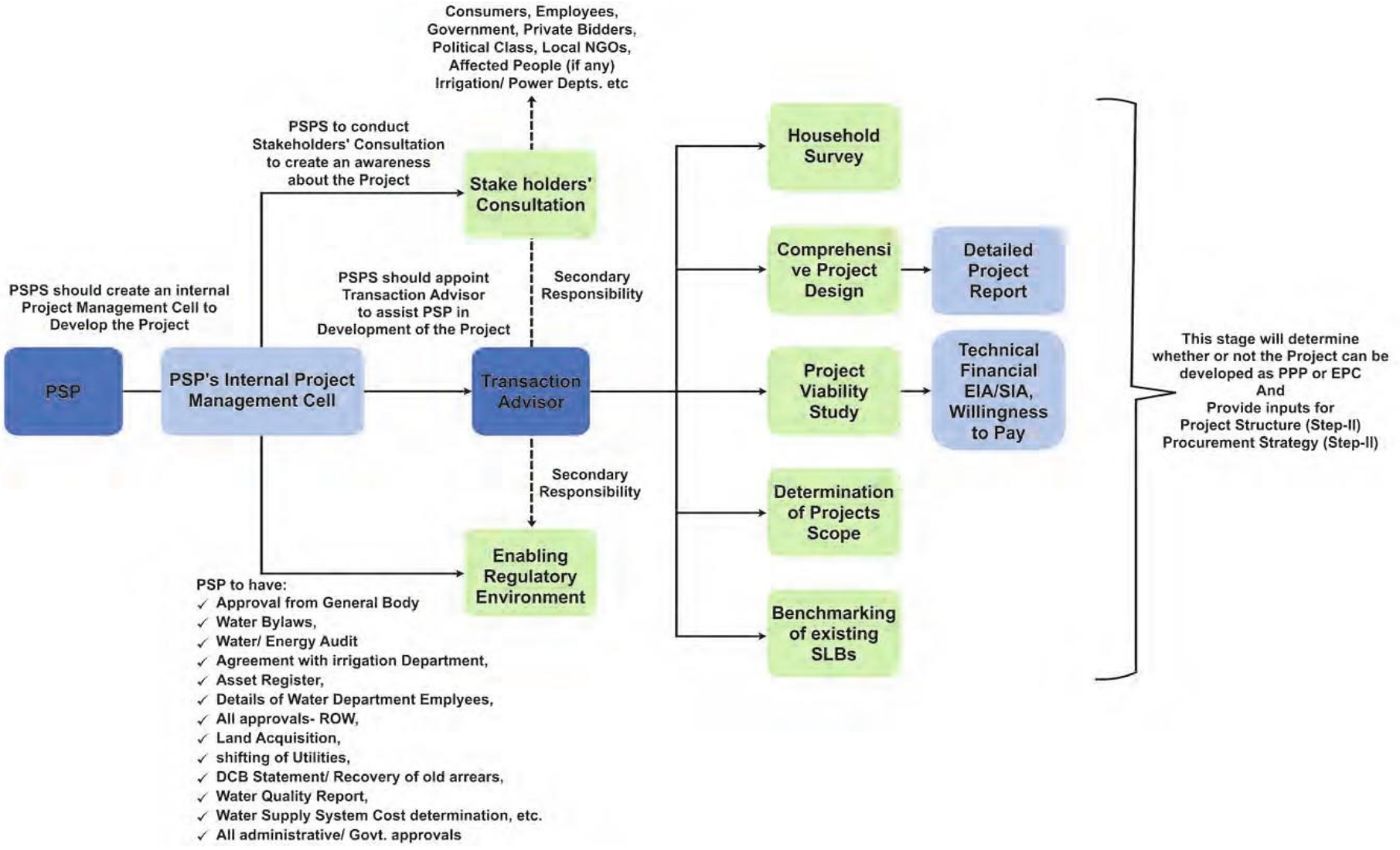


Figure 8.4: Activities to be conducted by the PSP in the pre procurement stage

8.8.2 Step II: Project Structuring

This step will provide appropriate inputs for the most suitable PPP project structure, i.e., either DBFOT/Concession Contract, Annuity/HAM, DBO, etc., to be adopted for the development of 24×7 PWSS in the entire city, as Stage-II project, in concurrence with all the stakeholders involved. This step involves the assessment of project feasibility covering various aspects such as technical, financial, legal, environmental and social, and risk analysis of the project (in an inclusive manner) to arrive at a contract structure.

The following tasks under this step will be the key to success of the PPP project.

- **Preparation of Detailed Project Reports:** DPRs involving the detailed technical scope, designs, BOQs are prepared by the PSP during the Project Structuring. Even in DBFOT Model, the benchmark design should be prepared by PSP only. Private entity can improve the designs by proposing more efficient options, however, the proposed designs should not lead to increase any costing the DPR. All designs are finally approved by the PSP and no change is accepted without the approval of the PSP. Also, if the private entity is proposing a change, then public authority should not be allowed to approve any change in cost.
- **Financial Modelling:** A detailed financial analysis is one of the most critical activities to determine the financial feasibility of the PPP project. The financial analysis will determine the viability of the project based on the costs involved and the expected revenues.
- **Risk Assessment:** Risk identification and allocation are fundamental factors in a PPP contract. It will determine the overall success during the project implementation. The typical approach of risk management involves the following activities: assessment, mitigation, and allocation between the stakeholders.

The schematic in Figure 8.5 depicts the broad activities to be conducted by the PSP in the project structuring stage:

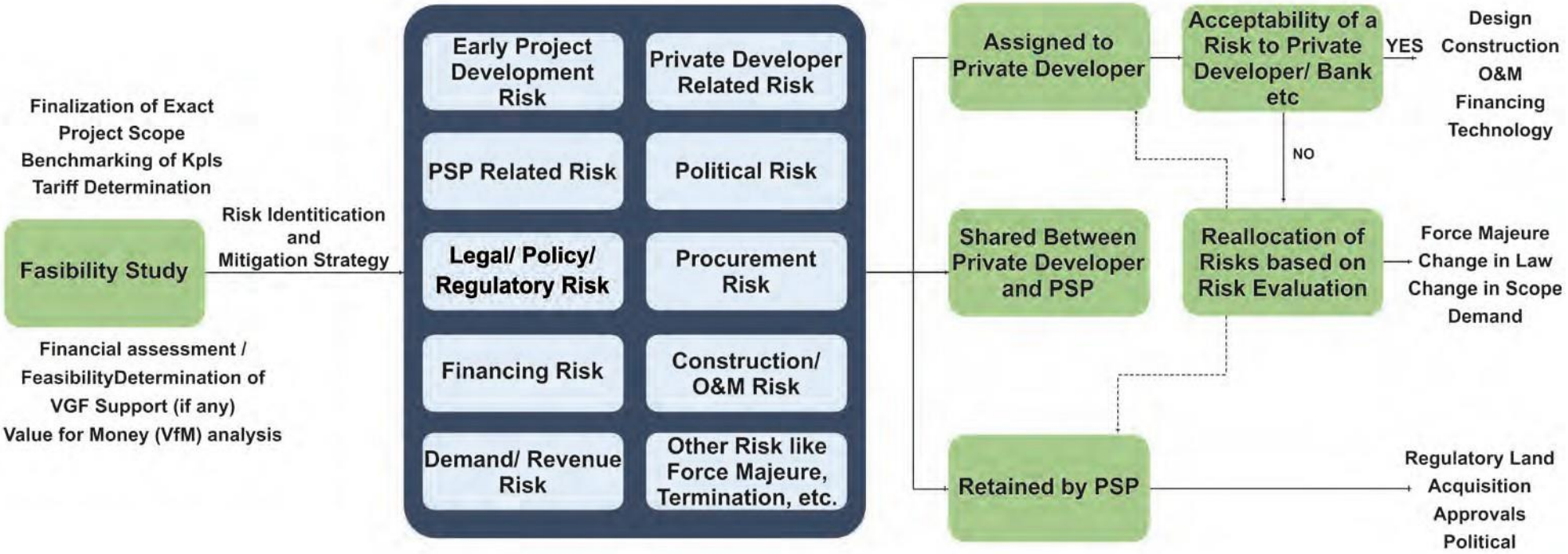


Figure 8.5: Broad activities to be conducted by PSP in project structuring stage

8.8.3 Step III: Procurement

To carry out a fair, transparent, and efficient procurement process for the selection of a private partner, a robust procurement process is key. The respective PSP will conduct an online single-stage procurement process to select a preferred bidder.

- Post-bid assessment and issuance of the LOA to the preferred bidder, the preferred bidder will establish an SPV for the signing of the contract.
- Once the prior conditions of both parties are fulfilled, the PPP contract will be signed with the SPV, and the successful bidder will officially become a contractor/concessionaire.
- Once the PPP contract is signed, both the PSP and SPV will have to fulfil their respective conditions precedent, as stipulated in the contract agreement before the construction/implementation starts. One of the main activities that the private partner undertakes is to achieve financial closure for the project.

The schematic in Figure 8.6 depicts the broad activities to be conducted by the PSP at this procurement stage:

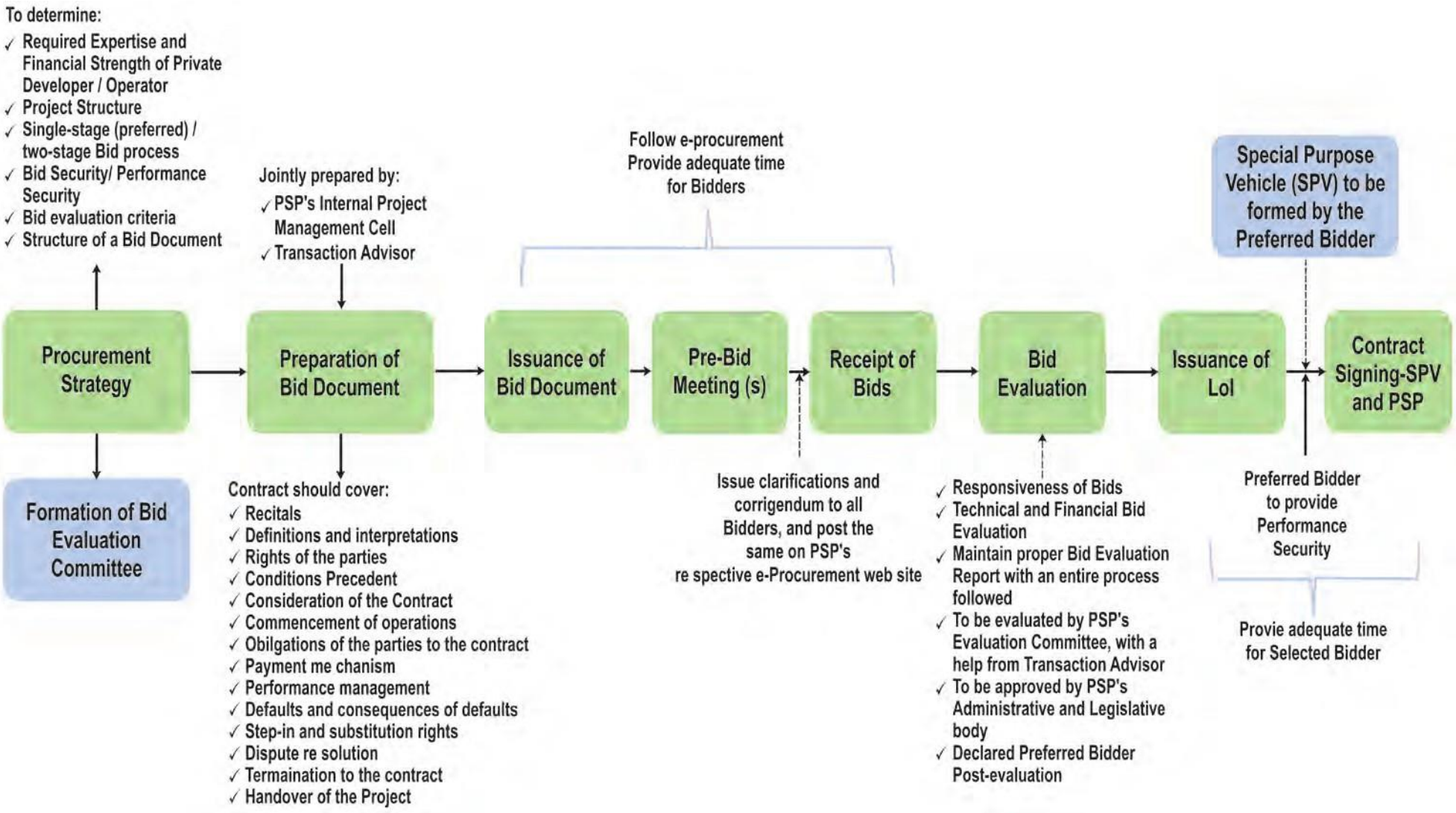


Figure 8.6: Broad activities to be conducted by PSP in Procurement stage

8.8.4 Step IV: Project Implementation

The concession period, that follows the conditions precedent, involves both the construction period as well as O&M period, as mandated in the contract. To successfully implement the project during the contract period, the following are critical:

- It is imperative to have a strong project management organisation from both public and private sides. Project management seeks to proactively manage the project to avoid or minimise the impact of risks and threats, during both construction and operation phases, associated with changes, claims, and disputes.
- For successful implementation of any PPP project, Monitoring is an integral part of "Project Implementation" phase. Monitoring is the responsibility of the PSP, for which the PSP may hire an independent engineer. A quantified periodic review of the overall project should be undertaken. This would include monitoring of KPIs, pricing, legal and regulatory environment, efficiency, O&M costs, etc.

The schematic in Figure 8.7 depicts the broad activities to be conducted by the PSP, the concessionaire (private developer) and the independent engineer during the implementation of the Project:

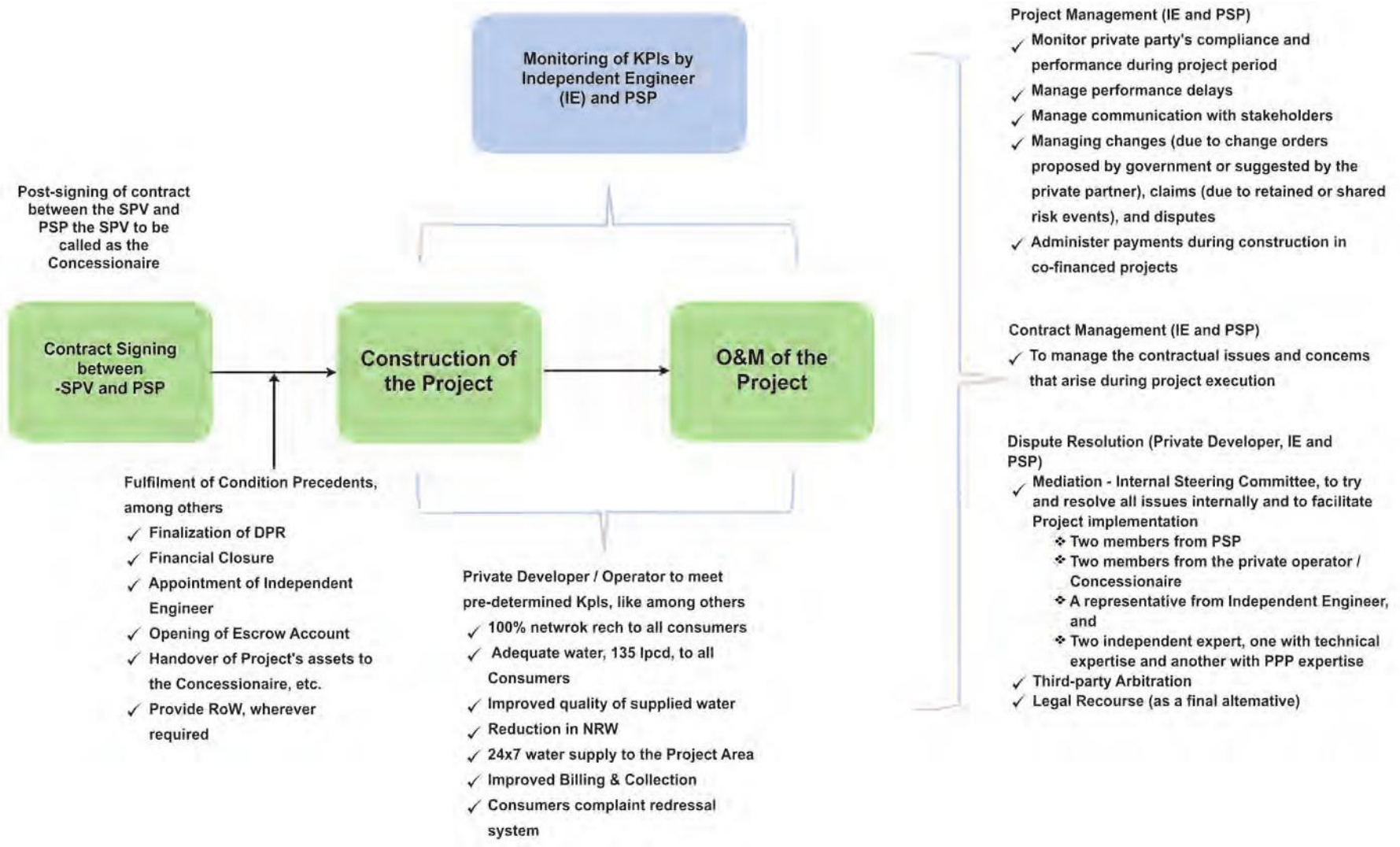


Figure 8.7: Broad activities to be conducted by PSP in project implementation stage

8.8.5 Step V: Project Handover

To successfully transfer all the assets, responsibilities, and knowledge to the PSP upon contract expiration, a well-drafted contract document will have detailed terms and conditions associated with the project handover. The schematic in Figure 8.8 depicts the broad steps to be ensured by the PSP at the time of expiry and handover of the Project:

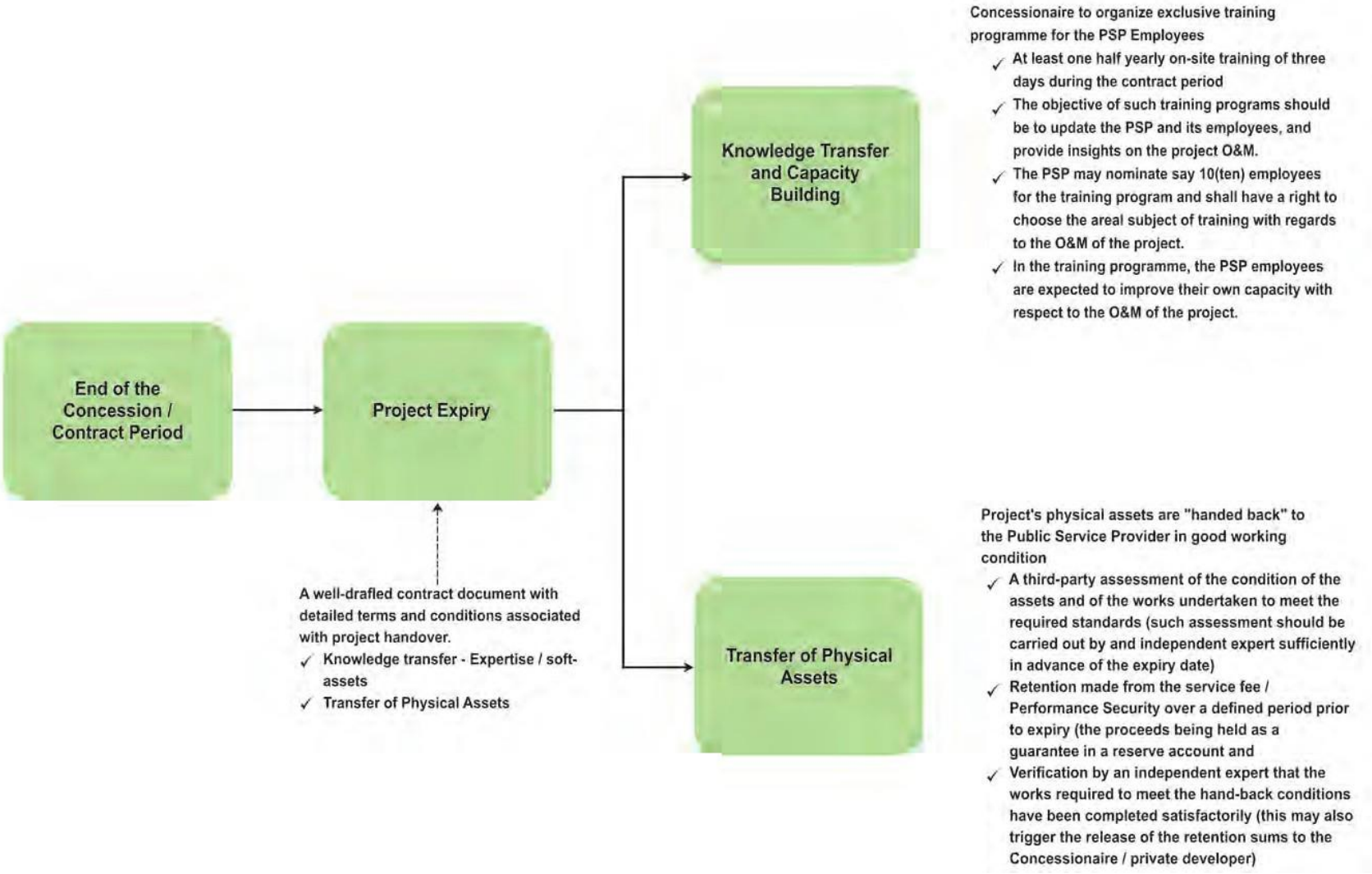


Figure 8.8: Broad activities to be conducted by PSP in project handover stage

CHAPTER 9: BUILDING RESILIENCE FOR CLIMATE CHANGE AND DISASTER MANAGEMENT

9.1 Climate change as a challenge for urban water service providers/utilities

As per the sixth Assessment Report of the Working Group-I of the Intergovernmental Panel on Climate Change (IPCC), "global surface temperature will continue to increase until at least mid-century and an increase of 1.5°C is expected during the 21st century unless deep reductions in carbon dioxide (CO_2) and other greenhouse gas emissions occur in the coming decades". The report also states that "the changes in the climate system that have been caused by global warming include increases in the frequency and intensity of high temperature extremes, marine heatwaves, and heavy precipitation, agricultural and ecological droughts in some regions, and proportion of intense tropical cyclones, as well as reductions in Arctic Sea ice, snow cover and permafrost". Further, the report underscores that "global warming is likely to further intensify the impact on the global water cycle, including its variability, global monsoon precipitation and the severity of wet and dry events".

Climate change will continue to impact the water cycle through temperature and precipitation changes as well as through rise in sea levels. The most likely impacts of global warming and climate change will be in the form of increase in temperature which will result in heatwaves and melting/thawing of glaciers, snow, sea ice, etc.; decrease in precipitation resulting in droughts; increase in precipitation leading to floods; and a rise in sea levels. These impacts will affect water availability as well as the operations of the urban water supply systems. Higher temperatures and reduced precipitation levels will result in slower replenishment rates of underground water resources and/or reduced availability of surface water which in turn will affect water availability. In addition, the episodes of floods and drought caused by climate change are likely to be frequent which will also affect the quantity and quality of water and are also likely to cause damage to the infrastructure. Urban water service providers need to accept the challenge of climate change and adopt measures that can help make water supply systems resilient.

Table 9.1 summarises some major effects of climate change, the associated hazards, and their impact on urban water supply services. Sections 9.3 and 9.4 detail out the strategies and measures that can be adopted by urban water service providers to build resilience to climate change.

Table 9.1: Climate effect, associated hazard, and impact on urban water supply services

Climate effect	Hazard	Impact on urban water supply services
Increase in temperatures	Heatwaves	Damage to urban water infrastructure/network Increase in pathogens in water leading to increased risk of disease and mortality • Intensification of urban heat island effect • Impact on water quality • Increase in demand for water

Climate effect	Hazard	Impact on urban water supply services
	Melting and thawing of glaciers, snow, sea ice, and frozen ground.	• Affects the seasonality of river flows which will lead to reduction in water availability in dry season/summer or even flash floods
Decrease in precipitation	Drought	• Reduction in raw water supplies due to reduced flow in rivers • Increased concentration of pollutants and minerals in water thereby affecting water quality
Increase in precipitation and severe weather	Flooding	• Pollution of groundwater resources, inundation of wells, etc. • Inaccessibility of water sources • Damage to infrastructure • Landslides around water sources can result in sedimentation and turbidity
Sea level rise	Flooding and saline intrusion into freshwater aquifers and estuaries	• Reduction in availability of drinking water • Impact on water quality

9.2 Impacts of Climate Change on Urban Water Services in India

Impacts of climate change on urban water services in India are outlined below:

9.2.1 Change in Water Quality

Presence of cyanobacteria, which is an indication of eutrophication, has been reported from many lakes, reservoirs, and brackish ecosystems in India. For example, 80 water bodies in central India, Hirakud reservoir (Odisha), Ganga River (at Kanpur), freshwater ponds (Central Kerala), Ambazari Lake (Nagpur), and some water reservoirs in Northeast India have reported presence of cyanobacteria.

Presence of turbidity in Water Treatment Plants (WTPs) has been reported in Sonia Vihar and Bhagirathi WTPs operated by Delhi Jal Board, resulting in a reduction of the production capacity. Water turbidity is attributed to glacier retreat in Himalayas, as the source of water is the Upper Ganga canal.

9.2.2 Insufficient and Poor Quality of Water Supply During Floods and Droughts

Insufficient access to water due to extreme weather events, such as floods and droughts, is common in Indian cities. Disruption of water services and contaminated drinking water are common in flood-affected areas. Areas that experience water stress and are susceptible to droughts also face disruptions in water services. In addition, during disruption of water services, drinking water is supplied through tankers which are of poor quality.

9.2.3 Sea-level Rise and Saline Intrusion into Fresh Water Coastal Aquifers

As a result of rise of sea levels, seawater ingression in coastal areas will cause contamination of the fresh water coastal aquifers.

9.3 Building Resilience to Climate Change

Resilience is defined as “the capacity of a water supply system to prepare for disruptions, to recover from shocks and stresses and to adapt and grow from a disruptive experience”. Urban water service providers/utilities will need to adapt their operations and institutional arrangements to address the challenges posed by climate change and climatic variations.

Every service provider/utility is likely to face unique climate change risks and associated impacts based on its local context. Urban water utilities need to adopt a holistic approach to building resilience against climate change which should include capital, socioeconomic, institutional, and operational measures (Figure 9.1). The service provider/utility could choose from potential measures based on the anticipated risks, their needs as well as the financial capacity.

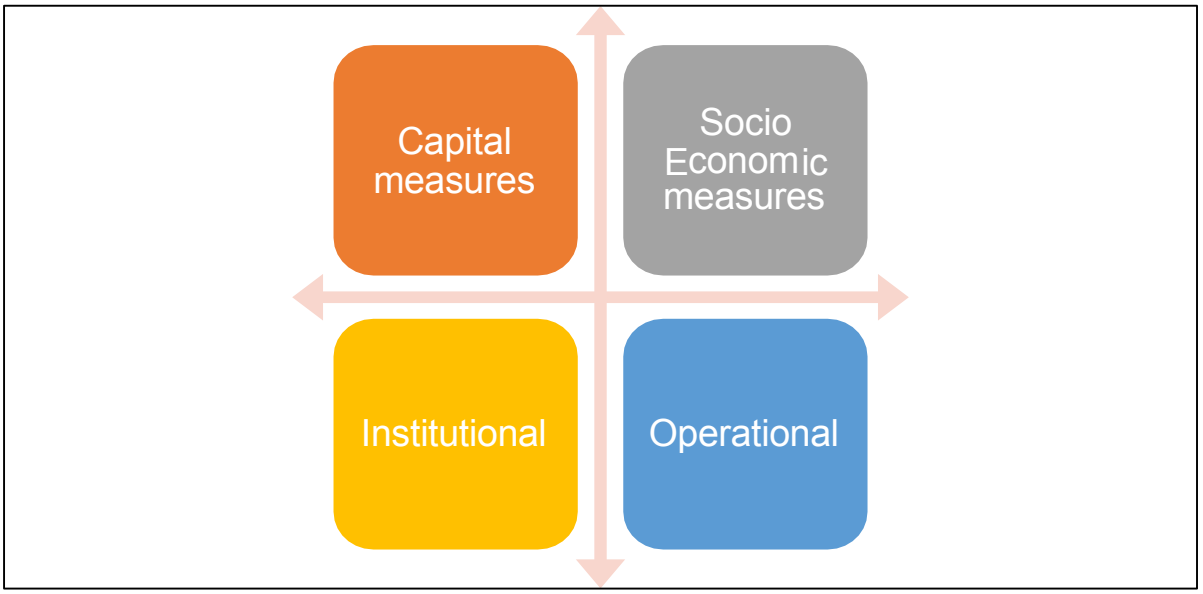


Figure 9.1: Components of holistic approach to addressing climate change/variability

The four categories of potential measures include:

- **Capital measures** pertain to either creation of new infrastructure and/or rehabilitation of existing water supply assets. Urban water service providers/utilities must create a master plan for all capital measures and such a plan must include prioritisation of various works proposed in the order of their importance, and efficacy for climate change risk mitigation. The master plan must also include a budget for implementation and potential sources of funding. Although capital measures will improve the functioning of the urban water supply system in the long term, such measures are usually costly and thus the urban water service provider’s managers/engineers should evaluate the feasibility of implementing these measures based on their organisation’s financial capability.
- **Socioeconomic measures** include changes/modifications in the current processes or

new ways of engaging with consumers so that they can be motivated towards behavioral changes for reduced exposure to climate change risks. Such measures could include adopting rain harvesting systems in apartment and residential areas, smart metering to ensure accurate and increased billing, encouraging water trading systems, virtual water, and consumer's educational campaigns on water conservation, etc. These measures have been detailed out in Section 9.4. Identification of consumer response to extreme conditions (such as droughts) will also assist the urban service provider/utility in identifying appropriate adoption measures. Socioeconomic measures do not include any construction or repair of infrastructure, they are least expensive among all four measures.

- **Institutional measures** include measures such as modifications in design standards and regulations. These could also include institutionalising mechanisms that will facilitate co-ordination among various stakeholders (various tiers of government, different agencies of the government as well as other Non-Governmental Organisations (NGOs) and Civil Society Organisations (CSOs)) in order to align efforts and to maximise efficacy of the interventions. While the implementation of institutional measures may be challenging given the multiplicity of institutions and lack of recognition to the efforts of NGOs/CSOs, they have the potential of substantially improving response to identified risks as well as black swan events (rare or unexpected events with significant consequences)/hazards/disasters. Further, measures such as modified design standards and regulations have the potential of improving service provider/utility operations in the long term.
- **Operational measures** pertain to changing the way the day-to-day tasks are performed by urban water service providers/utilities. Operational measures could include performing regular preventive maintenance and repairs activities (also using digital technologies, if required), and making commercial activities more effective. For example, a regular leak detection programme will help reduce non-revenue water (NRW) and decrease the amount of water wasted. Alternative operational measures should also be identified with due consultation with the experts to factor in dynamically changing technological solutions. These actions would ensure meeting the objective of higher service levels and reliability of water services.

As stated above, the potential measures and the associated implementation approaches for enhancing resilience to climate change will depend upon the unique geographical context of the service provider/utility and the risks that they are likely to face. While planning for building resilience of urban water service providers/utilities, the following aspects must be considered:

a) specific factors which may hamper their efforts towards building resilience for climate change – these would include factors such as the macroeconomic environment, infrastructure endowment, operational conditions, resource baseline resistance to changing conventional approach, working with new digital ecosystem players like cloud providers, data analytics team (for predictive analytics); and
b) The relative technical, financial, and institutional complexity of various measures.

9.4 Strategies to Build Resilience Against Climate Change/Variability

Urban water service providers/utilities may choose from the following list of resilience measures based on their local conditions:

9.4.1 Integrated Water Management

Urban water service providers/utilities are currently managing different components of the water cycle, that is, surface water, rainwater, groundwater, storm water, and wastewater separately. However, the ability of these isolated management systems to deliver services is increasingly being jeopardised due to rapid population growth, spatial expansion of cities/towns as well as climate change/variability. India's urban population is expected to reach 600 million by 2030, which will result in a demand supply gap of water by 50 BCM. With a business-as-usual scenario, it is impossible to bridge this wide gap. Most states have scored below 50 marks in the NITI Aayog Composite Water Management Index (CWMI) in 2018. The CWMI measures the overall progress made by states with respect to water management and the incremental improvement in performance over time. The index comprises nine themes (each having an attached weight) with 28 different indicators covering groundwater and surface water restoration, major and medium irrigation, watershed development, participatory irrigation management, on-farm water use, rural and urban water supply, and policy and governance. State's low performance on CWMI underscores the need to work towards adoption of integrated water management practices to plug the gap as well as to ensure sustainability and building resilience to climate change/variability.

An integrated urban water supply management approach, which includes coordinated management of all components of the water cycle (including surface water, groundwater, rainwater, storm water, and wastewater), is recommended. Such initiative would maximise the potential economic and social benefits for the city as well as lead to a wider catchment area without compromising on the sustainability of vital ecosystems. The main aim of an integrated approach is to reduce the city's water and carbon footprint, ensure sustainable management of local water resources and make water service delivery more efficient – all of which are aimed at building the city's resilience.

At a service provider/utility level, a multi-year Integrated Urban Water Supply and Management Plan (IUWSMP) must be prepared. This plan should integrate the following: principles of conjunctive use of water from different sources, demand side management to reduce the city's water footprint, and supply side interventions to make water service delivery efficient. Such a plan should set the city's long-term vision and recommend action related to its water resources as well as water service delivery. The plan must be adequately integrated with other plans at the city level such as the Master Plan, City Development Plan (CDP), and City Sanitation Plan (CSP).

9.4.1.1 Virtual Water as an Approach of Integrated Water Management

The term "virtual water" was originally developed in the context of water scarce Middle Eastern and North African countries which import a large portion of their food in order to substantially reduce water demand in domestic food production and compensate for lack of water. For these countries, importing food is virtually equivalent to trading water. The concept has subsequently been expanded to all goods. The water that is required for the production of a unit of commodity/product is termed as its "virtual water content", expressed in m^3/kg. Multiplying the virtual water content of a commodity/product with the quantity traded derives the volume of virtual water flow for that commodity/product. Recent years have seen increasing discussions on incorporating the virtual water strategy in national and regional water scarcity management, food trade policies as well as in integrated water resources management. Urban water service providers/utilities must explore this approach as a part of the integrated water management,

based on their local context and needs.

9.4.2 Diversifying Sources of Water Supply

Given that climate change will have far reaching impacts on water resources, urban water service providers/utilities need to work towards diversifying their water sources. Reliance on a single source may become increasingly risky in the near future, and thus urban water service providers/utilities must begin to think about ways in which they can affordably access alternative sources. Such an approach may include tapping groundwater aquifers, inter-basin water transfer, capturing unharnessed resources such as rainwater harvesting, desalination, or wastewater reuse.

Treated wastewater (TWW) reuse is an option available with urban water service providers/utilities to expand their water supplies. While urban India generates 62,000 MLD of wastewater, only 10–11 per cent of the total wastewater generated is safely treated and less than one per cent of TWW is reused.

Urban water service providers/utilities must also assess their capacity to switch between different sources of water, if required. Intake from different sources would require suitable modifications to the equipment, input requirements (including chemicals and electricity), as well as the technical capacity of the staff.

9.4.3 Enhancing Storage Capacity

In order to address the variation in availability of water across different seasons and months, urban water service providers must enhance water storage capacity through construction of additional reservoirs or enhancing the capacity of existing ones. Enhancing reservoir capacity will ensure that utilities facing seasonal variability in availability of water can fill up reservoirs during rainy seasons and the same can be used to bridge any shortfalls during dry periods. Seasonal reservoirs can also help capture storm water runoff and result in increased recharge of groundwater aquifers. For further details, refer to Chapter 4: Planning and Development of Water Sources, Part A of this manual. While enhancing reservoir capacities utilities would need to consider associated aspects such as land acquisition and resettlement of communities residing in such areas as these are tedious and time- consuming processes.

9.4.4 Reduction of Non-Revenue Water

High levels of NRW can result in water shortages during peak demand periods, thereby causing a reduction in the level of service and/or intermittent supply. NRW also results in revenue loss and increased operational costs for the utility.

Physical and commercial losses are pushing the NRW levels northward in Indian cities. While the GoI's Service Level Benchmarks (SLB) have set 20 per cent as an acceptable NRW level, Indian cities, on average, have 38 per cent NRW. Globally, the acceptable level of NRW is less than 20 per cent. The challenges posed by climate change are expected to require further reduction in this acceptable level. Hence, it is essential for urban service providers/utilities to address NRW given that the increased marginal cost of water and associated revenues are expected to meet the marginal cost of increased NRW reduction efforts.

All urban water service providers/utilities must undertake periodic NRW assessments and put in

place an NRW reduction strategy. To achieve this strategic objective, an action plan is recommended to be prepared which can incorporate options for active leakage control (at distribution mains, storage tanks, and service connection points), regularise illegal connections, and minimise free supply. All large utilities should consider institutionalising an NRW cell, while for other cities and towns, a district level/state level NRW cell must be put in place.

9.4.5 Demand Management

Demand management is being recognised as an important measure for enhancing climate resilience. Demand management can be implemented by ensuring universal metering of all connections, rationalisation of tariffs, and encouraging use of water efficient fixtures by consumers.

Water metering is the most efficient tool for reducing domestic water consumption. Metering ensures higher accountability for the consumer who pays for water according to actual use. Metering also ensures service providers/utilities are paid according to the volume of services they provide. Along with a robust tariff policy, metering can result in a significant drop in water demand. Urban water service providers/utilities must ensure that there is universal metering of all existing connections, domestic and non-domestic connections. Further, all water supply sources, treatment plants, and water distribution stations should have functional flow meters alongside consumer end metering. The concept of District Metering Areas (DMA) and smart metering should be encouraged.

Water tariffs can also be used as an effective tool for reducing demand and shifting behaviour towards rational use of water among users. Although it is a key instrument in water demand management, tariff adjustments can be politically challenging and thus difficult to operationalise. Urban water service providers/utilities must focus on the adoption of rational charges and tariffs, including removal of distorting subsidies and moving towards user charges that reflect at least Operation and Maintenance (O&M) costs in the short to medium term. Rigorous engagement and advocacy with political leaders (MLAs and councilors) should be undertaken to promote willingness to charge for water.

Use of water efficient fixtures can lead to considerable water savings. Labelling and rating of water efficient fixtures will enable consumers to identify enhanced water efficient fixtures without compromising on the performance. A rating of the water fixtures based on their water efficiency must be undertaken by Bureau of Indian Standards (BIS).

9.5 Framework for building a climate resilience plan for urban water service providers/utilities

World Bank Group's Water Global Practice has developed a framework which urban water supply service providers/utilities can adopt while planning for building resilience to climate change/variability. The framework is conceptualised as a three-step process which includes: (1) Knowing the system; (2) Identifying the vulnerabilities; and (3) Choosing actions (Figure 9.2).

9.5.1 Step 1: Knowing the System

This step is aimed at understanding the context in which the urban water service provider/utility operates. This step will help answer questions such as:

- What are the urban water service provider's/utility's objectives?

- What uncertainties may make it difficult for the urban water service provider/utility to achieve these objectives?
- What are the options for addressing these uncertainties?
- What tools, data, and models are available to help address these questions?

This step should be undertaken in a participatory manner through a one-day scoping exercise involving a team which could include sector experts, staff, and representative key stakeholder groups (such as associations of industries and commercial establishments, Resident Welfare Associations, CSOs, NGOs, environmental groups, elected representatives, etc.).

Task 1: Setting objectives and success metrics

The discussions should help define the objectives of the urban water service provider/utility and its expected level of service delivery measured in terms of service reliability. Through consultations, the service reliability metrics must be clearly defined. The discussions must focus on defining (a) the acceptable level of service disruption? (b) whether the utilities focus on ensuring 100 per cent reliability under all cases or it considering 80 per cent reliability sufficient while covering the remaining 20 per cent as a part of an emergency plan? (c) defining an acceptable recovery time based on type of disruption faced.

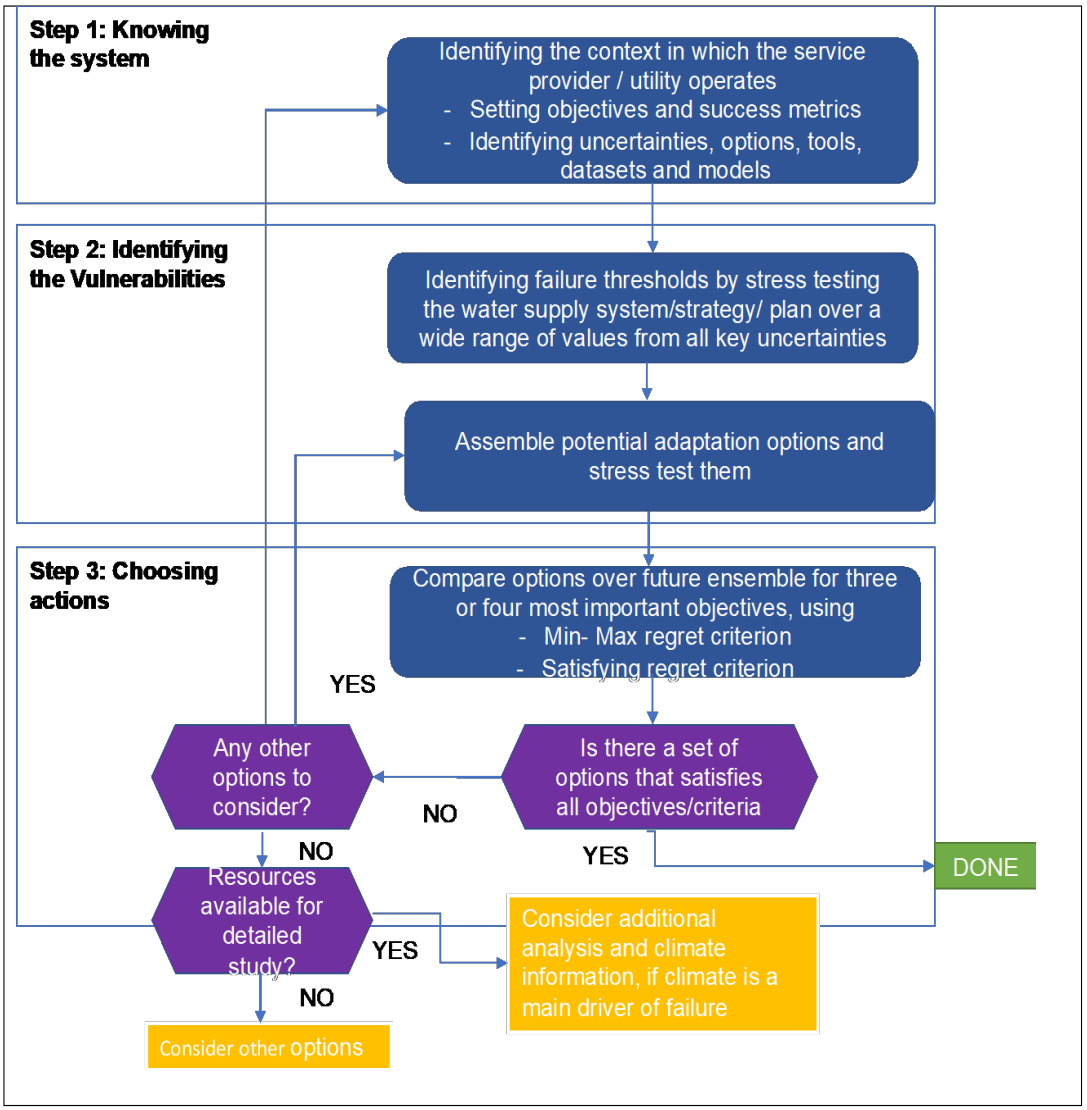


Figure 9.2: Framework for building a climate resilience plan for urban water service providers/utilities

Task 2: Undertaking cost and benefit analysis and financial risk measurement

An objective focused on an economic metric, which integrates climate and non-climate variables into either a cost-benefit or cost-effectiveness criterion, should be included as a part of the vulnerability analysis. Integration of economic variables is critical to understand if a combination of uncertain factors could result in some option(s) becoming non-viable. Once such non-viable options are identified these can be modified accordingly to reduce vulnerabilities. Adoption of this integrated approach also has the benefit of ensuring that complementary social and/or environmental interventions are planned parallelly rather than after the decision on a project/intervention. Such an approach ensures that the design of the solutions is more responsive and flexible.

Task 3: Identifying uncertainties

It is important to identify the main (both short and long term) causes of possible failures in the urban water system. At this stage, all sources of uncertainty must be defined – these could include threats (for example, increase in demand, contamination, or natural hazards) as well as opportunities (for example, increase in water availability) that the current system would be unable to deal with. Identification of threats and opportunities must address all infrastructure, institutional, operational, and financial aspects. All threats, including those that cannot be easily mitigated or that seem unlikely to materialise, should be identified and discussed with stakeholders. The list of uncertainties typically includes water availability and quality, costs and economics, demand, socioeconomic context (including how consumers would accept interruption of services), and feasibility considerations.

Task 4: Identification of possible actions

At this stage, the team must identify options and alternatives to manage the various sources of uncertainties identified under Task 3. The team must consider possible actions in the following four categories – capital, socioeconomic, institutional, and operational measures (refer to Section 9.3). These options can be in the form of policy decisions (water quality regulations), infrastructure projects (construction of additional reservoirs and pumping stations), or operational measures (institutionalising monitoring systems, tracking rainfall, or system losses).

Task 5: Identification of tools, data sets, and models

The final activity in Step 1 is identification of available data and models that can be used to assess the performance of options under future conditions. In some cases, the urban water service provider/utility may not have invested in the development of a water supply operations and planning model and here the service provider/utility needs to consider if the same is feasible for them to facilitate analysis and decision making in the subsequent phases. However, in cases where models may not be available, the urban water service provider/utility may consider using qualitative techniques for scenario building exercises as a part of Steps 2 and 3. Upcoming technologies like Artificial Intelligence (AI)/Machine Learning (ML) should be explored to develop models based on data.

9.5.2 Step 2: Identification of Vulnerabilities

At this stage, the experts and staff need to undertake a stress-test for the water system over a range of plausible futures and assess its performance under different conditions. This is to be done for status quo as well as for the different possible solutions, and their combinations. The performance of the solutions is measured against the objectives defined in Step 1. The stress-

test result will allow the urban water service provider/utility to get a clear understanding and description of conditions most likely to cause the service provider/utility to fail to meet one or more of its objectives. These conditions are summarised as scenarios that describe the combinations of factors that would either make the solution a success or failure. At this stage, analysis must also be conducted to identify options that help reduce vulnerability and improve the performance of both the system as a whole and of critical elements over the same range of futures.

Task 1: Identification of critical elements and development of plausible futures

At this stage, experts and staff identify the critical elements in the system which are essential elements for which failure would lead to the worst consequences – the identification must consider all assets and resources of the urban water service provider/utility. Further, they must also identify the magnitude of uncertainties identified in Step 1 and classify them into either high and low values or define best- case and worst-case scenarios. It is recommended to carry out such exercise at a regular period of time.

Task 2: Characterisation of vulnerabilities

Following the identification of critical elements and defining uncertainty ranges, there exist two options (or three options mentioned) before the urban water service provider/utility for conducting the vulnerability analysis – either through modelling or through qualitative techniques (or a combination of the two).

In urban water service providers/utilities where models or resources are available to develop them, the planning team can use the same to generate a model for each scenario and evaluate its performance. In case of resource constraints, the urban water service provider/utility may decide to consider only a few dozen future scenarios. For urban water service providers/utilities where models are not available, or too expensive to develop, qualitative techniques can be used to undertake the scenario building exercise.

9.5.3 Step 3: Choosing Actions

In Step 3, the experts and analysts organise the options to be able to identify robust, flexible strategies and examine the trade-offs among them in meeting the agreed objectives under the scenarios identified in Step 2.

Once the model has been run, or qualitative scenarios have been tested, results are collected in a database of outputs, which pertains to the performance of each option under scenarios explored. Using the results of the vulnerability analysis carried out in Step 2, analysts will be able to identify the options into modified or new strategies that are robust and helps achieve the urban water service provider's/utilities' objectives over a wide range of plausible futures. Experts and analysts must identify some choices that can be qualified as "no-regret", that is, they will work well under all future conditions, are easy to implement, and help improve service delivery as soon as they are put in place. These choices must be prioritised.

The experts and analysts must also identify trade-offs and clearly identify the strengths and limits of each action, or combination of actions. While the experts and analysts can make recommendations, however, the selection of actions rests with the urban water managers/decision makers.

9.6 Climate change related planning in India

On 30th June 2008, Government of India released the National Action Plan on Climate Change (NAPCC) which was intended to serve as a "blueprint for promoting the country's development objectives while also yielding co-benefits for addressing climate change effectively". NAPCC includes 8 missions and 24 other initiatives. The National Water Mission, which is one of the 8 missions under NAPCC, is aimed at ensuring integrated water resource management to help conserve water, minimise wastage, and ensure more equitable distribution both across and within states.

In August 2009, the Hon'ble Prime Minister in the Conference of State Environment Ministers announced that all states must prepare State Action Plans on Climate Change (SAPCC). It was recommended that the SAPCC should include climate profile of the state, a strategy of intended actions, and an outline of specific implementation activities for adaptation and mitigation. The same was to be prepared based on assessment of the state's vulnerability to climate change and associated risks and impacts of climate change. During 2010-11, most states undertook the preparation of their respective SAPCCs.

9.7 Disaster Management

As per the Indian Standard (IS 17482:2020), *Drinking Water Supply Management System — Requirements for Piped Drinking Water Supply Service*, all water suppliers/utilities should have a documented disaster management plan for implementation. The guidance related to disaster management as a part of the IS 17482:2020 is enumerated in the sections below.

9.7.1 Disaster preparedness

Natural disasters such as earthquake, floods, cyclone, draught, tsunami, landslides, and avalanches; and anthropogenic disasters such as nuclear, chemical, biological, explosions, act of sabotage, and terrorism could have life threatening and debilitating consequences on urban water infrastructure.

Disaster mitigation and management in an urban service provider context should be holistic with emphasis on prevention, mitigation, and preparedness. Risks due to disasters should form an integral part of the design development, construction practices and management, as well as O&M of water infrastructure.

9.7.2 Disaster Risk Assessment and Mitigation

The formulation of disaster preparedness plan for any location should comprise the following steps:

Step 1 - Identify the geomorphology; river, coastal, and cyclonic proximity; and climatic zone-related disaster risks.

Step 2 - Identify population, business-related disasters, and vulnerabilities.

Step 3 - Carry out risk assessment through Hazard Analysis (HAZAN) and Hazard and Operability (HAZOP) study and vulnerability analysis, including possible combining effects of multiple hazards. Also, include the effects on micro-climate and environmental biodiversity.

Coastal zones which are falling in high cyclonic flood zone, tsunami, seismic zones of high intensity, and landslide-sensitive areas should receive special attention.

Step 4 - Identify the socioeconomic, socio-political hazards, and vulnerabilities attributed to anthropogenic disasters.

Step 5 - Prepare a disaster risk mitigation plan supported with sufficient budgetary provisions.

Step 6 - The disaster resistant building construction and infrastructure development features shall form part of the submittal to the authority for statutory approvals.

Step 7 - Nominate a senior person/safety officer as controller for regulating, planning, and monitoring disaster preparedness plan for entire system/project. Carry out all constructions, installations, and operations in line with the disaster-resistant features for each of the vulnerabilities.

Step 8 - Prepare an evacuation plan and organise mock drills at regular intervals for creating awareness and response preparation among stakeholders involved.

Step 9 - Prepare operation manual for post-construction operation and upkeep of disaster resistant features and equipment. The basic action plan shall focus on capacity building among stakeholders involved, communication, co-ordination, role of information technology, role of every individual working at site, and role of emergency response cell in conjunction with the mitigation plans of local/state level authorities. The possible after-effects on human and natural habitats and mitigation plan shall form integral part of disaster preparedness plan for least damage to human life, built environment, and related ecosystems.

9.7.3 Post-disaster actions

In the event of a disaster, the following post-disaster actions have been recommended:

- line up and schedule emergency operations;
- notify State and Central Agencies of location and telephone numbers of the emergency operating centre or control command centre for the utility;
- make necessary alternate arrangement for emergency water supply, if necessary;
- notify and set up clear lines of communication with local authorities, such as police and fire;
- make arrangements with the local power utility to be prepared to disconnect power to the plant and to restore power after disaster as quickly as possible as a primary customer; make necessary arrangements with local companies to repair the damaged machineries in the system immediately so as to ensure water supply at the earliest;
- make arrangements with local companies to ensure that the plants are safe and put in operation as soon as possible; and
- arrange an adequate inventory of requisite workforce, material, and equipment reserved to meet the exigencies.

9.8 Experiences of urban water service providers/utilities in addressing climate change

9.8.1 Case study of Zero Day study, Cape Town, South Africa

Cape Town witnessed its “Day Zero” drought in 2018, when its storage reservoirs catering to 3.7 million people went below 20 per cent level. This triggered an alarm and the city’s municipality started imposing restrictions to delay further decrease to 13.5 per cent limit, when the water supplies would have been disconnected. However, winter rains improved the situation to avoid entering the day zero scenario. Less than normal rainfall for three years prior and unplanned water conservation and management practices exacerbated the situation.

Researchers from the Department of Earth System Sciences, Stanford University, and Geophysical Fluid Dynamics Laboratory, National Oceanic and Atmospheric Administration, have predicted that climate change will make the “Day Zero” drought in southwestern South Africa five to six times more likely, and such extreme events could go from being rare to common events by the end of the century. The study further highlighted that several cities that did not face such drought conditions may not be ready for the emerging risks and need to explore such risks and plan ahead.

To explore such risks, urban water service providers need to be aware of the reasons and meteorological conditions that could trigger to make drought conditions unavoidable. The researchers used Seamless System for Prediction and Earth System Research (SPEAR), a global climate modelling system developed at the Geophysical Fluid Dynamics Laboratory, to predict future scenarios. Urban water service providers should make use of such models to better forecast and plan which in turn will enable better management of such events and make these less catastrophic.

ANNEXURES

ANNEXURES

[ANNEXURE NUMBERING IS CHAPTER RELEVANT]

Annexure 1.1: Checklist for engineers/managers regarding current status of attributes of an effectively managed water service provider/utility

S. No.	Parameter	Yes	No
1	Are the water services being provided in line with the GoI's SLBs?		
2	Does the water quality adhere to the IS 10500:2012; Second Amendment?		
3	Are OD approaches being integrated to create an open, diverse, inclusive, and equitable work environment?		
4	Are regular and periodic opportunities provided to staff for professional development and career enhancement (including training, capacity building, exposure visits, etc.)?		
5	Are sessions held to sensitise staff on softer aspects such as customer orientation, social equity, stakeholder engagement, etc.?		
6	Is there an effective balance between long-term debt, asset values, O&M expenditures, and operating revenues?		
7	Are the existing tariffs adequate to recover O&M costs? Is there a plan to introduce volumetric tariff and metering to sustain O&M costs in the short to medium term?		
8	Is the organisation undertaking an annual financial planning exercise?		
9	Has the organisation mapped all key stakeholders?		
10	Does the organisation actively engage with all stakeholders in order to understand their needs and to consult/apprise them regarding decisions that may impact them?		
11	Has the organisation launched a communication campaign to educate the consumers on water conservation and other issues?		
12	Is there an up-to-date database on the condition of and costs associated with critical infrastructure assets?		
13	Does the organisation have an MIS?		
14	Does the organisation make use of automated and IT-enabled systems for service delivery and performance measurement / monitoring?		
15	Has the organisation undertaken a risk assessment for climate change/variability?		
16	Has the organisation initiated a plan for climate change risk mitigation?		

Annexure 3.2: KPIs for Technical Staff

For Technical Staff	• New projects that have increased coverage including the value of the projects • Increase in the number of connections • Increase in number of metered connections • Innovation/adoption of new technology for water supply and wastewater treatment • Expenditure on new projects and expenditure on O&M • Number of internal team meetings • Number of complaints redressed within specified timelines • Long-term and short-term training programmes attended
For Revenue Staff	• Increase in annual budget amount for water supply and sewerage functions compared to previous years • Timeliness of payments to vendors, contractors, and consultants • Funds raised from the market through bonds, grants, etc. • Timeliness of payment of pending staff claims • Increase in revenue • Reduction of O&M expenses vs revenue collection ratio • Recovery of arrears from customers • Number of complaints redressed • Long-term and short-term training programmes attended

Annexure 5.1: Checklist for stakeholders' analysis and for developing an engagement strategy

S. No.	Stakeholder category	Are you engaging with them at present?	If yes, what is the nature of engagement?	What are the goals for future engagement?	Engagement methods / tools	Duration for implementation (specific period/ongoing)
1	**Elected representatives**					
1 a)	MLAs	Yes / No				
1 b)	Councilors	Yes / No				
2	**Consumers**					
2 a)	Households	Yes / No				
2 b)	Commercial establishments	Yes / No				
2 c)	Institutions	Yes / No				
2 d)	Industries	Yes / No				
3	**Associations of consumers**					
3 a)	Resident Welfare Associations	Yes / No				
3 b)	Market Associations	Yes / No				
3 c)	Industrial Associations	Yes / No				
4	**Non-Governmental Organisations (NGOs)**					
4 a)	Insert names	Yes / No				
5	**Civil Society Organisations (CSOs)**					
5 a)	Insert names	Yes / No				

Annexure 7.1: Management/Performance Indicators – Water Supply Network

S. No.	Indicator	Method of calculation	Remarks
1	Coverage of area with water supply	Area with water supply/total area	Identify areas to be provided water supply in the future plans
2	Index of population covered by service (%)	Population served/total population streets	Is extension of main required?
3	Percent covered by service	Length of streets with water pipelines/total length of	How to serve the unserved population?
4	Service level	Quantity of water produced per day/population served	
4.1	Index of population served by public taps (%)	Population served by public taps/total population	
4.2	Average population served by one public tap	Population served by public taps/number of public taps	
5.1	Index of water distributed or measured (%)	Quantity measured or distributed/quantity produced	
5.2	Index of water distributed through public taps (unmeasured)	Quantity of water supplied through public taps/total quantity of water	
6	Water not accounted for	Water bills/water produced	
7	Staff productivity	Number of connection/number of Staff	
8	Operational costs per staff	Total O&M cost/staff number	
9	Operational cost per connection	Total O&M cost/number of	
10	Operational cost per KL of water produced	O&M cost/quantity of water produced in KL	
11	Production cost	Cost of production/quantity of	
12	Distribution cost	Distribution cost/quantity of water	
13	Index of use of production or treatment capacity	Quantity of water produced/installed	
14	Index of use of transmission line capacity	Quantity of water transmitted/designed	
15	Index of use of pumping station capacity	Quantity of water pumped per	
16	Index of use of reservoir capacity	Average quantity of water distributed/available storage capacity of	
17	Index of use of energy at treatment plant	Energy consumed per day/quantity of water pumped per day, i.e., KW/KL pumped	Is there a need for an energy audit by an external
19	Index of use of coagulant at treatment plant	Coagulant consumed per day/quantity of water treated	

S. No.	Indicator	Method of calculation	Remarks
		per day	
20	Index of treatment losses	Treated water produced/raw water received	
21	Index of water quality at treatment plant	Per cent samples with greater than	
22	Index of unwholesome samples in distribution system	Per cent unwholesome samples	
23	Index of disinfection at treatment plant	Per cent samples with less than desired	
24	Index of use of chlorine at treatment plant	Chlorine consumed per day/quantity of water treated per day (mg/L)	
25	Index of power failures at pumping stations	Hours of pumping lost/24 hours or designed pumping	
26	Index of other failures at pumping stations	Hours of pumping lost due to reasons other than power failure/24 hours or designed	
27	Index of failure of pumping mains	Hours of pumping lost due to transmission line defects/24 hours or designed pumping	
28	Mean time between failure of pumping equipment	Average of time interval between two successive failures of pumping equipment in	
29	Mean time between failure of pumping mains	Average of time interval between two successive failures of pumping mains in a	
30	Index of failures		
30.1	Power	Power failures/total	
30.2	Pumping equipment	Equipment failures/total failures	Is the equipment
30.3	Pumping main	Pumping main failure/total failures	
31	Level of maintenance at pumping stations	Number of prearranged preventive maintenance work	
32	Breakdown works	Number of break down works orders carried out by agency's staff	
33	Index of works done by outsiders	Number of breakdown works orders carried out by specialised agency	Is it economical compared to agency's own staff?
34	Distribution system (zone-wise)		
34.1	Index of supply timings	Actual hours of water distributed in a day/required	

S. No.	Indicator	Method of calculation	Remarks
34.2	Storage ratio	Quality of water distributed/quantity of storage	
34.3	Residual chlorine	Per cent samples with less than desired residual chlorine	
34.4	Bacteriological quality	Per cent unwholesome samples/total samples tested	
34.5	Storage reservoirs cleaning	Actual number of times cleaned/required number of times to be cleaned	
35	Level of maintenance of pipelines		
35.1	Number of leaks reported per day	Number of leaks/km of distribution system	
35.2	Index of leaks attended per day	Leaks attended per day/leaks reported per day	
35.3	Number of cross connections reported per thousand connections	Number of cross connections reported / number of connections (in thousands)	
35.4	Number of points with negative pressures		
36	Consumer connections		
36.1	Total number		
36.2	Domestic (%)		
36.3	Commercial (%)		
36.4	Industrial/bulk (%)		
36.5	Unauthorised connections		
37	Water audit		
37.1	Index of water distributed	Water distributed/water received at the	
37.2	Index of billing	Water billed/water	
37.3	Index of domestic supply (%)	Total domestic	
37.4	Index of commercial supply	Total commercial	
37.5	Index of industrial supply (%)	Total industrial	
37.6	Functioning of consumer meters	Number of meters non-functional/number of meters	Is there a need to change over to accurate and reliable
37.7	Connections with large consumption	Number of connections	Identify those connections with Large consumption whose meters are out of order
38.	Financial Indices		
38.1	O&M cost as per capita/per connection	Total O&M Cost/population served	
38.2	Cost of production of water/KL	Total O&M	

S. No.	Indicator	Method of calculation	Remarks
38.3	Energy costs as per cent of O&M cost	Energy cost/O&M cost	Are the energy costs going up?
38.4	Spares cost or repairs and replacement costs as per cent of O&M cost	Repairs & replacement cost/O&M cost	
38.5	Consumables cost as per cent of O&M cost	Cost of consumables/O&M	
38.6	Staff costs as per cent of O&M cost	Staff cost/O&M cost	
38.7	Operating ratio for the previous year	Operating revenue/operating expenses	Identify the reasons for fewer ratios. Is there a need for revision of
38.8	Current year's operating ratio (as on date of review)	Operating revenue for the year/operating expenses	Identify reasons for shortfall
38.9	Ratio of revenue demanded	Bills served or revenue demanded/budgeted demand	Identify reasons for shortfall
38.10	Ratio of consumer connections billed	No. of consumer connections for whom bills are served/total number of connections	Identify if bills are not served for those connections with large consumption
38.11	Ratio of revenue collected	Revenue collected/bills raised	If the connections with large sums due who have not paid their bills
38.12	Status of disconnection notices	Number of notices served/number of defaulters	Identify whether disconnection notices are served for connections with large sums
39	Safety record		
39.1	Number of accidents per Km or connection	Total number of accidents/total length of pipelines or no. of connections	
39.2	Per cent fatal accidents	Number of fatal accidents/total accidents	
40	Consumer satisfaction		
40.1	Number of consumer meets organised at section level	Number	
40.2	Number of consumer complaints per thousand	Number of consumer complaints received per	

S. No.	Indicator	Method of calculation	Remarks
	connections	day/number of connections in thousands	
40.3	Consumer complaints attended (no water/inadequate pressure/poor quality)	Average number of consumer complaints (weekly or monthly)/number of connections	
40.4	Ratio of consumer complaints attended	Number of complaints received/number of complaints attended on the same day	
40.5	Ratio of unattended complaints (spilled over to next day)	Number of complaints left unattended on the same day/number of complaints received	

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