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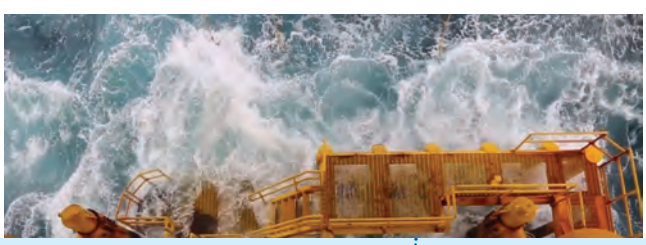

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(Editor-in-Chief)

WATER AND SUSTAINABILITY: PRESERVING OUR MOST PRECIOUS RESOURCE

Water is the lifeblood of our planet, an invaluable resource that sustains all living beings. As the world faces increasing challenges posed by climate change, population growth, and industrial development, the importance of water conservation and sustainable management has become paramount. We must take proactive steps to ensure the availability of clean, safe water for both present and future generations.

Sustainability lies at the heart of effective water management. It involves utilizing water resources in a way that meets the needs of the present without compromising the ability of future generations to meet their own needs. Sustainable water practices encompass various aspects, such as efficient use, pollution prevention, and ecosystem preservation.

Efficient water use begins at the individual level. By adopting simple habits like fixing leaky faucets, using water-saving devices, and practicing responsible irrigation techniques, we can reduce wastage significantly. Furthermore, governments and industries must prioritize water efficiency in their policies and operations, promoting the use of advanced technologies that minimize water consumption.

Preventing water pollution is another crucial aspect of sustainability. Industrial processes, agriculture, and improper waste disposal contribute to water contamination, endangering both human health and ecosystems. Implementing stricter regulations, promoting eco-friendly practices, and investing in water treatment infrastructure are essential steps toward safeguarding water quality.

Preserving ecosystems that sustain water resources is equally vital. Wetlands, rivers, and forests play a crucial role in maintaining water cycles and mitigating natural disasters. Protecting and restoring these ecosystems through conservation efforts, afforestation programs, and sustainable land-use practices can contribute to maintaining a healthy water balance.

International cooperation is essential to address water challenges on a global scale. Sharing best practices, technology transfer, and collaborative research can enhance water management efforts worldwide. Furthermore, promoting awareness and education about water conservation and sustainability can empower individuals to make conscious choices in their daily lives.

Water is not an infinite resource. As the demands on it increase, we must recognize the urgent need for sustainable practices. It is our collective responsibility to preserve and protect water, ensuring a sustainable future for ourselves and generations to come. Let us take the necessary actions today to secure a water-secure world for tomorrow.

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CM KCR Promises Water Flow from Palamuru Project by August, Announces Development Initiatives for Rangareddy District

In a public meeting held as part of the 'Haritha Haram – decennial celebrations of Telangana Formation Day' at Tummaluru village in Rangareddy district, Chief Minister K Chandrasekhar Rao (KCR) assured the people that the Palamuru Rangareddy lift irrigation scheme would soon become a reality. Despite the hurdles created by the Congress party, the government is determined to ensure the completion of the project at the earliest. The Chief Minister announced that efforts are underway to release water for drinking and irrigation purposes by August this year.

KCR urged the people to question the Congress party regarding their actions that led to a stay from the Supreme Court, causing a halt in the project's progress. He highlighted that approximately 85 percent of the project had already been completed, emphasizing that if not for the roadblocks created by the Congress party, water would have been flowing from the project by now.

Assuring the residents of the Palamuru region, KCR stated that if the BRS (Telangana Rashtra Samithi) party is re–elected, it will undertake many more schemes for their benefit. As a testament to this commitment, he announced the sanctioning of a medical college and Metro rail connectivity from BHEL to Maheshwaram. The Chief Minister also mentioned that Telangana holds the record for planting the highest number of saplings in the world, with 270 crore saplings planted so far.

Addressing the water scarcity issue in Rangareddy district, KCR revealed plans to link Godavari water to Himayat Sagar and Gandipet reservoirs to meet the drinking water needs of the region. Furthermore, he instructed officials to allocate Rs 100 crore for the free distribution of fruit plants to the public starting this year. KCR proudly stated that Telangana ranks first in paddy production due to the significant improvement in the state's green cover, which has seen a 7.7 percent increase.

Highlighting the achievements of Telangana since its formation, the Chief Minister emphasized that the state leads in several areas, including per capita income, power consumption, safe drinking water supply, and paddy production. During the meeting, KCR presented an appointment letter to Bhagyalakshmi, the wife of Forest official Srinivas Rao, who was tragically killed in an attack by anti–social elements in the old Khammam district. He announced her appointment as Deputy Tahsildar in the Revenue Department.

In summary, Chief Minister KCR assured the people of Rangareddy district that water from the Palamuru Rangareddy lift irrigation scheme would be released by August. Despite opposition from the Congress party, the government remains determined to complete the project. KCR also announced various developmental initiatives, including a medical college and Metro rail connectivity, for the benefit of the Palamuru region.

Thiruvananthapuram Outskirts to Benefit from AMRUT 2.0: Major Water Supply Projects Improve Access to Safe Water

Thiruvananthapuram Corporation, as part of the Atal Mission for Rejuvenation and Urban Transformation (AMRUT) 2.0 scheme, has proposed two major water supply projects on the outskirts of the city. The projects aim to enhance water supply and provide connections to households currently lacking access to safe water, particularly in the Chanthavila and Kattayikonam wards. Technical sanction has been granted to these projects, representing a significant step toward fulfilling the promise of 100% water connections for the city's households, as outlined in the Corporation Budget for 2023–24.

The first project involves the laying of a transmission main line stretching 16 km from Peroorkada to Manvila, including interconnections and associated work, at an estimated cost of 66.1 crore. This initiative is expected to significantly improve water supply to 1.22 lakh households residing in the Kinavoor, Nalanchira, Ulloor, Edavacode, Sreekaryam, Attipra, Pongumoodu, Alathara, Akkulam, Powdikonam, Kazhakuttam, and

Pound Kadavu wards. Many of these areas currently face drinking water scarcity, with water supply limited to just a few days per week.

The second project focuses on developing a water distribution network for the Chanthavila and Kattayikonam wards, which are situated near the city's border. With an estimated cost of 30.94 crore, this endeavor aims to add 4,000 new water connections and extend distribution lines over a total distance of 80 km.

While these projects will significantly benefit residents on the city's outskirts, it is important to note that the AMRUT 2.0 initiative poses a financial challenge for the Corporation. The Union government's contribution has been reduced from 50% in AMRUT 1.0 to one–third of the project cost in the current phase. Consequently, the Union government, the State government, and the local body will each contribute approximately 33% of the project expenses.

The decision to prioritize areas on the outskirts of the city, where a substantial number of households still lack access to water connections, aligns with the objective of ensuring equitable access to safe water for all residents. Additionally, efforts to improve water supply in areas that are already reasonably covered will enhance the overall water infrastructure and service delivery in Thiruvananthapuram.

By implementing these projects, the Thiruvananthapuram Corporation aims to address water scarcity, enhance water access, and fulfill its commitment to providing water connections to every household in the city. These initiatives represent significant strides toward achieving sustainable urban development and improving the quality of life for residents in Thiruvananthapuram.

Punjab Granted Rs 3,569 Crore for 195 Water Projects under State Water Action Plan

In a significant development, the Ministry of Housing and Urban Affairs (MoHUA) has approved 195 projects worth Rs 3,569 crore under the State Water Action Plan in Punjab. This announcement was made during a conversation between Union Petroleum Minister, Shri Hardeep Singh Puri, and Punjab Chief Minister, Sdr Bhagwant Mann.

During the discussion, Shri Hardeep Singh Puri also addressed the concerns raised by the Chief Minister regarding the flexibility of the Atal Mission for Rejuvenation and Urban Transformation (AMRUT) 2.0 and the inclusion of Mohali as a Smart City. Minister Puri explained that the selection of 100 Smart Cities had been carried out through a two–stage competitive process, and states were free to develop additional cities using the same model.

Moreover, Minister Puri took the opportunity to outline the process followed for the AMRUT mission, which focuses on improving piped water supply through infrastructure projects in 500 cities across India, including 16 cities in Punjab. For this purpose, a State Annual Action Plan amounting to Rs 2,767 crore, with central assistance, has been sanctioned. Additionally, under AMRUT 2.0, the central government has committed Rs 1,836 crore for projects and Rs 60 crore for administrative and operational expenses to further enhance the implementation of works in AMRUT cities.

To address any budgetary difficulties faced by the state government in implementing the flagship scheme, it can request a grant from the Finance Commission. In this regard, the central government has already released over Rs 900 crore from the 15th Finance Commission to Punjab for its Urban Local Bodies (ULBs) during the financial years 2021–22 and 2022–23.

The approved projects under the State Water Action Plan entail several key initiatives, including the development of 609 million liters per day (MLD) water treatment plant capacity, the provision of 2.74 lakh new tap connections, and the establishment of 13,767 new sewer connections. These projects, collectively valued at Rs 862 crore, will contribute significantly to improving the water infrastructure in the state.

This funding allocation and project approval are expected to have a transformative impact on Punjab's water management and urban development efforts. The state government can now proceed with the implementation of these crucial projects, ensuring enhanced water supply and improved sanitation services for the benefit of its residents.

Haryana CM Announces 1,517–Crore Gurugram Water Supply Project to Be Completed by May 2026

In a recent development, Haryana Chief Minister Manohar Lal Khattar has revealed a significant water supply project for Gurugram, Manesar, and Bahadurgarh, amounting to 1,517 crore. The project has been carefully designed, considering the projected population growth in the region by the year 2050. It aims to meet the anticipated water demand of approximately 1,504 cusecs for these cities.

The key highlight of the project is the construction of a 69–kilometer–long covered water supply line, utilizing mild steel pipes. This pipeline will

stretch from Kakroi to Basai, ensuring a seamless water supply network. The entire project is scheduled to be completed by May 2026.

Chief Minister Khattar chaired a meeting with officials from the irrigation and water resources department to discuss the revamping of the Gurugram water supply system. The gathering also deliberated on the proposed Mewat feeder pipeline project, which has been estimated to cost 750 crore. Both projects are aimed at providing uninterrupted drinking water supply and treated water for irrigation to the residents of the region.

Emphasizing the significance of the Gurugram water supply project, Khattar stated that it would guarantee improved and uninterrupted water supply to Gurugram and Manesar, aligning with the anticipated population growth by 2050. Additionally, the Mewat feeder pipeline project has been carefully planned to address the water needs of the Mewat region by the same year. The implementation of this project, slated to commence soon, is expected to conclude by March 2027.

The Mewat feeder pipeline project was conceptualized and approved by the department earlier this year, in February. It aims to address the issue of saline underground water in certain areas of Mewat by providing clean canal–based water to the local population.

Upon completion of these ambitious projects, the residents of Gurugram, Manesar, and Mewat will benefit from uninterrupted drinking water supply. Moreover, special provisions have been made to facilitate the utilization of treated water for irrigation purposes by industries and farmers in the region.

Chief Minister Khattar expressed confidence that these projects would serve as a significant boon for the people of Gurugram, Manesar, and Mewat. The initiatives not only address the pressing issue of water scarcity but also aim to enhance the overall quality of life for the residents in the region.

Delhi Water Minister Urges LG's Approval for Water Augmentation Projects to Tackle Water Deficit

In an effort to address the persistent water deficit in Delhi, the Water Minister, Saurabh Bhardwaj, has reached out to Lieutenant Governor V K Saxena, seeking approval for crucial water augmentation projects. The projects include the rejuvenation of lakes and the installation of tube wells on Delhi Development Authority (DDA) land.

Delhi has been grappling with a staggering water deficit of nearly 300 million gallons per day (MGD), a problem that is projected to worsen with the upcoming land pooling and redevelopment initiatives by the central government and the DDA, as well as other commercial developments. The city heavily relies on neighboring states, specifically Haryana and Uttar Pradesh, for water supply from the Yamuna and Ganga rivers. However, the government's efforts to secure additional water from these states have yielded no positive results thus far.

Minister Bhardwaj, acknowledging the pressing water scarcity issue, has requested the LG's intervention in procuring extra raw water for the people of Delhi from Uttar Pradesh and Haryana. To address the situation sustainably, the Delhi government has implemented a groundwater extraction plan, which involves the installation of tube wells and large–scale groundwater recharge efforts. Notably, Delhi recharged more water than it extracted in the year 2021–22, according to a report by the Central Ground Water Board.

Furthermore, the government is actively rejuvenating lakes and water bodies across the city, including those owned by the DDA, upon obtaining the necessary permissions. Over 35 water bodies and six lakes have already been successfully rejuvenated. However, Minister Bhardwaj expressed disappointment over the withdrawal of consent by the DDA for the rejuvenation of Bhalswa Lake, which could have provided 20 MGD of water.

Obstacles persist as the DDA has only granted permission for a fraction of the requested tube wells and lake and water body rejuvenation projects.

Out of the 401 tube wells applied for, only 110 have received approval, and out of the requested 422 projects, only 61 have been granted permission. These hurdles significantly impede the efforts of the Delhi Jal Board (DJB) to augment the water supply in the city.

Official estimates indicate that approximately two crore residents of Delhi require approximately 1,300 MGD of water for their daily needs. However, the DJB can only supply around 1,000 MGD, resulting in many areas grappling with severe water shortages. Presently, Delhi receives 612 MGD of water from Haryana through two canals and the Yamuna, and 253 MGD from Uttar Pradesh through the Upper Ganga Canal. The remaining water is drawn from ranney wells and tube wells installed throughout the city. In areas facing water deficits, the DJB provides water through 1,200 tankers.

The timely approval of water augmentation projects by the LG and the cooperation of the DDA are crucial steps in addressing Delhi's water crisis. The implementation of these projects will not only alleviate the current water deficit but also ensure a sustainable water supply for the residents of the capital city.

Sagnik Das

Sagnik Das is a dynamic professional from the ESG domain, specializing in water and sustainability. With expertise in project management, design, and sustainable solutions, he has served both international and domestic clients across Industrial, Commercial, Institutional, and Government sectors. Highly skilled in business development, market research, and sales, Sagnik excels in relationship–building and strategic problem–solving. He has diverse knowledge spanning desalination, water/wastewater management, process engineering, and asset management. Passionate about ESG and sustainability, he evaluates new technologies and drives market growth. A self–motivated professional with a strong network, he thrives in driving innovation and creating a positive environmental impact.

Can India harness the power of AI and IoT to achieve Water Resilience through Wastewater Treatment?

It is surprising, but a true fact that we spend about 7% of our individual lifetime generating wastewater from the aggregated duration spent in personal hygiene activities, encompassing the use of toilets and bathrooms.

India, home to 18% of the global population, has access to a mere 4% of the world's water resources, placing it among the nations grappling with severe water scarcity. A report from NITI Aayog warns that by 2030, 21 major Indian cities, including Delhi, Bengaluru, Hyderabad, Mumbai, and Chennai, will exhaust their underground water reserves. This alarming situation will impact 100 million individuals and deny 40% of the population access to safe drinking water. The consequences of water scarcity extend beyond the welfare of the Indian people and cast a shadow over the country's GDP. A World Bank report underscores the potential economic losses of up to 6% due to water scarcity, exacerbated by the effects of climate change, which could also ignite conflicts in various nations. India, with its rapidly growing population and expanding urbanization, confronts significant water management challenges. Effective treatment of wastewater plays a vital role in mitigating water pollution and ensuring the availability of clean water for diverse purposes.

This is where the integration of Artificial Intelligence (AI) and the Internet of Things (IoT) in wastewater treatment can bring about significant benefits for India, including improved efficiency, cost savings, and better environmental outcomes. By leveraging these technologies, India can address its water management challenges and ensure a sustainable future for its growing population. The demand for clean water in India is increasing with its growing population and industrialization. Wastewater treatment is a crucial component in managing water resources, but the country is facing significant challenges in this area. The rapid urbanization and industrialization in India have led to an increase in wastewater generation, putting immense pressure on the country's water resources and wastewater treatment facilities.

Effluent treatment processes are intricate and face challenges in ensuring water quality while bearing high operational costs. Yet, the amalgamation of data–powered smart applications alongside

AI, ML, and IoT technologies is transforming the efficiency of sewage treatment facilities, rainwater collection systems, and ultrafiltration initiatives. By optimizing operations, these advanced technologies reduce energy and chemical consumption, resulting in cost savings and improved safety.

Advanced ML frameworks, like Deep Neural Network (DNN) architectures, Random Forest models, and Variable Importance Measure (VIM) examinations, evaluate different effluent factors such as suspended particles, waste materials, and chemicals, along with operational factors like time delays and temperature. The primary objective is to develop control strategies that enhance the quality of treated water while minimizing operational expenses.

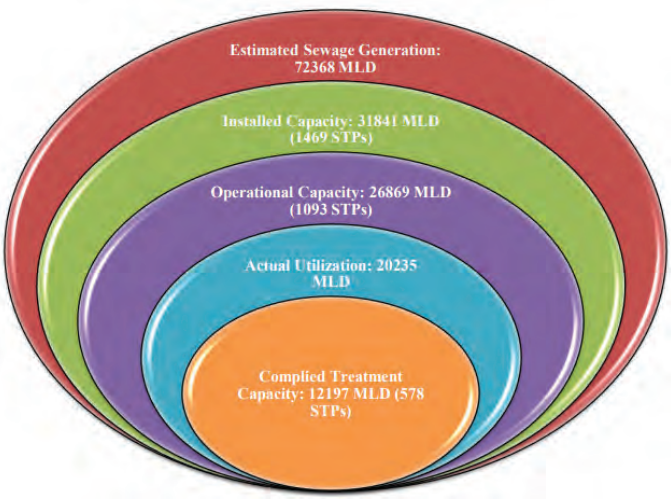
Usually, more than 50% of the energy utilized in water treatment facilities is attributed to aeration. With new AI tools, plant data can be analyzed to determine optimal set points for aerators, leading to energy savings of up to 30%. Performance prediction, fault detection, and troubleshooting insights are facilitated by cloud–based analytics platforms, utilizing data obtained from RO plants, sewage treatment plants, and cooling towers.

Larger establishments leverage efficient data and communication infrastructures to manage sensor–based system components effectively, implement smart process control for effluent

AI–based automation further facilitates rainwater harvesting in buildings

Sewage Flow

The system uses advanced sensors and monitoring equipment to collect real–time data on water quality, flow rates, and other parameters.

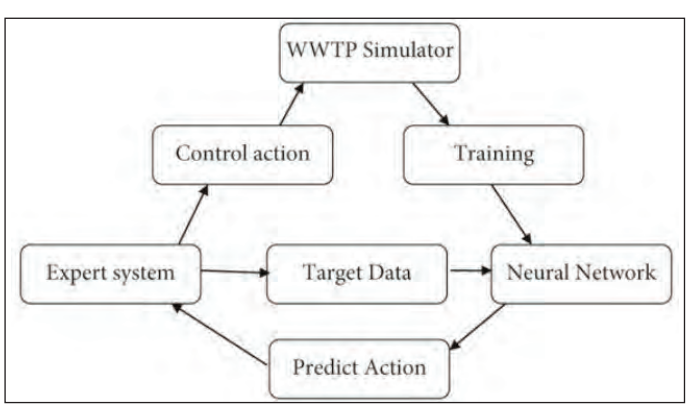


India Sewage Generation

treatment, and automate the overall process. As an example, the Delhi Jal Board has recently embraced AI–driven technology to enhance water treatment in its four sewage treatment facilities. These IoT–enabled plants utilize AI software to share real–time data, enabling automation. Sensors continuously monitor plant health and equipment conditions. AI–driven predictive analysis software and controls for wastewater networks identify elevated water levels in sewer systems, detect blockages, and issue timely warnings. Additionally, they can swiftly detect potential safety risks such as pipeline ruptures.

Data simulations and digital twins are also aiding plant operators in preparing for specific adverse scenarios, enhancing treatment efficiency, and ensuring public safety. These advancements reduce operational costs, improve plant availability, and enhance security.

AI–based automation further facilitates rainwater harvesting in buildings. Automated mechanisms oversee the diversion of rainwater from rooftops, simultaneously tracking the levels of moisture, temperature, and cistern capacity through sensory devices. In the event of heavy rain, the roof and cistern can be automatically drained to create space for additional rainwater harvesting.



A system for the control of a WWT plant with hybrid AI

The integration of AI, IoT & Data Analytics in wastewater treatment can help India address these challenges by optimizing the treatment process, reducing operating costs, and improving overall efficiency. AI and IoT can assist with predictive maintenance, optimizing chemical usage, and water quality monitoring, enabling authorities to take swift action to prevent water pollution. Numerous nations across the globe have already embraced the utilization of AI and IoT in their wastewater management systems, yielding encouraging outcomes. In Singapore, the national water agency PUB has deployed a smart water management system that uses AI to optimize the operation of the island's water supply network, resulting in cost savings of $15 million per year. In the United States, the City of Atlanta has deployed an IoT–based smart sewer system that uses sensors to monitor sewer lines for leaks and blockages, resulting in cost savings of $80 million over five years. The benefits of AI and IoT in wastewater treatment are not limited to cost savings and improved water quality but also extend to public health and environmental sustainability. AI and IoT can help optimize the wastewater treatment process by enabling real–time monitoring and control, adjusting chemical dosing rates, and predicting equipment maintenance needs. This can lead to improved treatment efficiency, reduced energy consumption, and lower operating costs.

AI and IoT technologies can also improve resource recovery by identifying opportunities to extract valuable nutrients and energy from wastewater. AI algorithms can analyze large amounts of data from various sensors and devices, enabling better decision–making and optimization of treatment processes. By employing IoT–enabled predictive maintenance, it is possible to prolong the lifespan of assets and diminish the necessity for capital expenditures. Real–time monitoring and control can help treatment facilities meet increasingly stringent environmental regulations and avoid penalties. Despite the promising potential of AI and IoT in wastewater treatment, there are still challenges to overcome, including the high cost of implementing these technologies and the need for a complete rewrite of existing code stacks for better integration. However, as technology advances and costs decrease, it is likely that AI and IoT will play an increasingly important role in wastewater treatment and water management in India.

Although there is no official data, we can anticipate a minimal presence of AI and IoT in the current Indian Wastewater Treatment Market. Integration of AI and IoT in wastewater treatment can bring significant benefits to India, including improved efficiency, cost savings, and better environmental outcomes. By leveraging these technologies, India can overcome its water management challenges and ensure a sustainable future for its growing population.

Current State & Challenges in Wastewater Treatment in India

As per the 2021 CPCB report, India produces a staggering 72,368 MLD (million litres per day) of sewage, yet only 31,841 MLD (43.9%) undergoes treatment, revealing a substantial disparity in wastewater management. This gap has led to untreated sewage being discharged into rivers and other water bodies, causing severe water pollution and

health hazards. The inadequate wastewater treatment infrastructure has also resulted in the loss of valuable resources like water, energy, and nutrients.

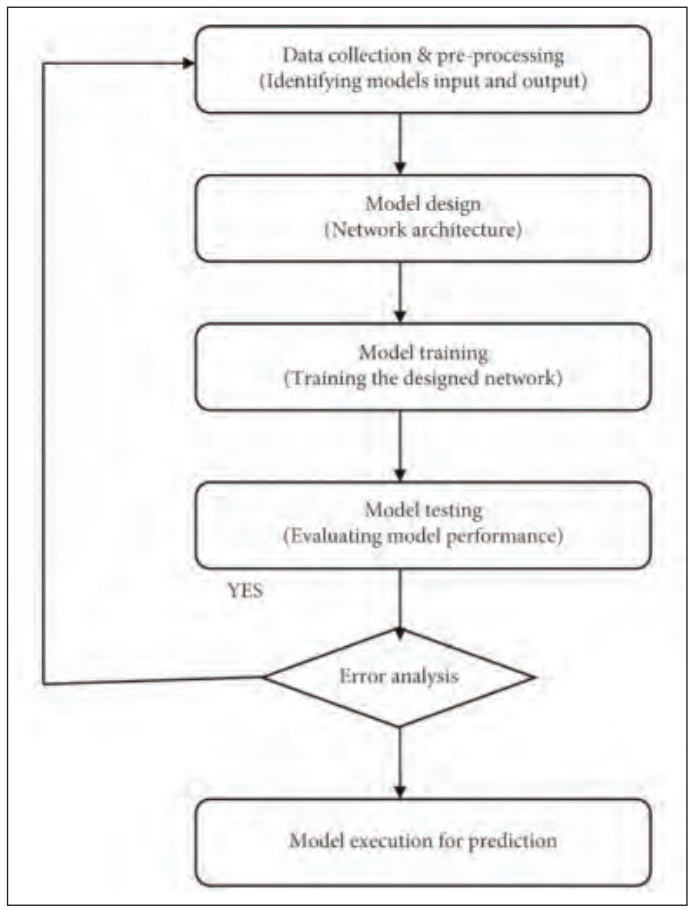
India faces numerous challenges in managing its wastewater, including inadequate treatment facilities, high levels of pollution, and increasing water scarcity. The integration of AI and IoT in wastewater treatment can help India overcome these challenges by:

- Optimizing the treatment process
- Reducing operating costs
- Enhancing monitoring and control
- Improving decision–making
- Facilitating better sludge management

The Potential of AI in Technology for Treating Wastewater (Attachment of Pic – 4)

The use of artificial intelligence (AI) in wastewater treatment has the potential to revolutionize the way we manage waste and protect our water resources. AI technology offers a range of solutions that can help reduce water pollution, increase clean water availability, and optimize water management systems for more cost–effective and sustainable infrastructure.

One of the most significant benefits of AI in wastewater treatment is its ability to detect toxic contaminants and analyze water quality in real time. By providing real–time data, AI can help decrease water contamination and increase the availability of clean water. This means that water treatment facilities can quickly identify and address potential contamination issues, leading to better overall water quality.



Steps of the model development process

In addition to real–time monitoring, AI can also be used to build smart water systems that can adapt to changing conditions and optimize water management solutions. This includes the ability to adjust water usage and treatment processes based on current conditions, such as weather patterns, water levels, and water quality. By optimizing water usage and treatment processes, facilities can reduce costs, increase efficiency, and ultimately create more sustainable infrastructure.

One example of AI's transformative potential in wastewater treatment is its ability to save up to 20 to 30% of operational expenditures by decreasing costs and optimizing the usage of chemicals in water treatment. By leveraging AI techniques, such as machine learning and pattern recognition, facilities can model and optimize the water treatment process, including pollutant removal from water. This results in more cost–effective and sustainable water treatment solutions.

The use of AI in wastewater treatment is not new, and several studies have demonstrated the benefits of AI technology in this field. For example, a study conducted in China found that AI algorithms were effective in predicting water quality parameters, such as dissolved oxygen and pH levels, with an accuracy rate of over 95%. Another study conducted in the United States found that AI–based models were able to accurately predict the concentration of pollutants in wastewater, leading to better overall water quality.

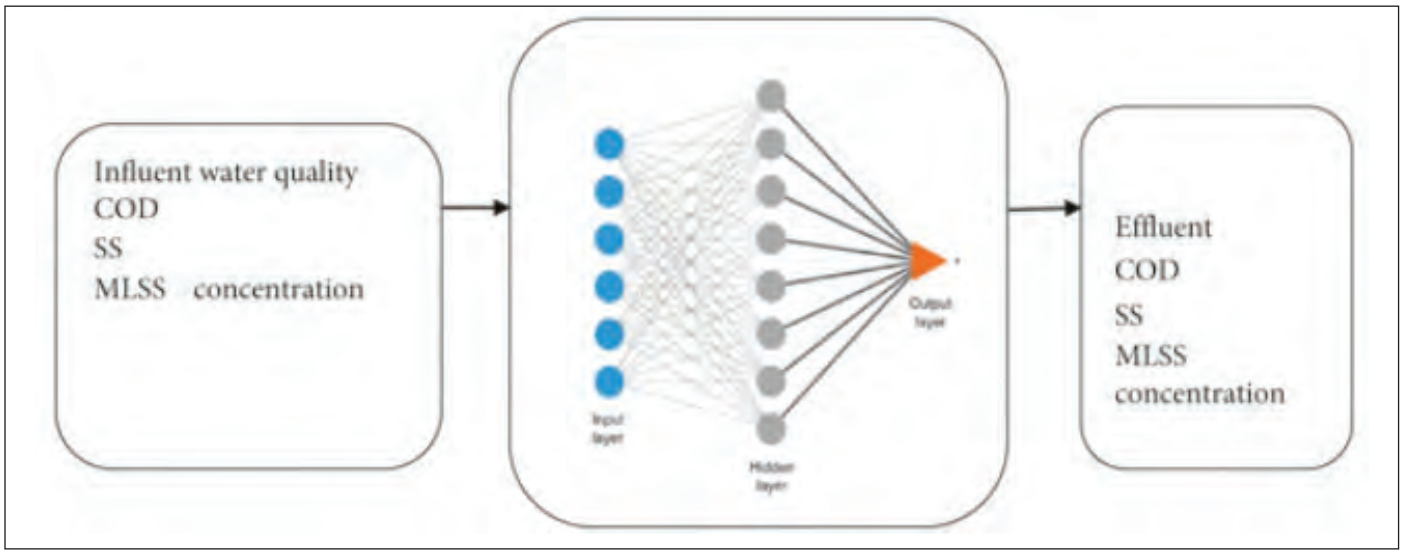
By leveraging AI technology, water bodies can build smart water systems that are cost–effective, sustainable, and adaptable to changing conditions. This technology can help to ensure that our water resources are managed effectively and efficiently, leading to a more sustainable future for all.

In conclusion, the use of AI in wastewater treatment has the potential to be a game–changer in the way we manage waste and protect our water resources. By providing real–time monitoring, optimizing water management solutions, and reducing costs, AI technology can help to create a more sustainable infrastructure that benefits both the environment and our communities.

Maximizing ROI through the power of IoT investments

Investments in IoT projects for wastewater treatment can result in significant returns on investment (ROI) through various means, such as:

- **Reduced operating costs:** IoT–based systems can optimize energy consumption, chemical usage, and other operational expenses, resulting in lower costs.
- **Improved asset utilization:** IoT–enabled predictive maintenance can extend the life of assets and reduce the need for capital



The model AN architecture for predicting concentration of COD, SS, and MLSS

investments.

- **Enhanced regulatory compliance:** Real–time monitoring and control can help treatment facilities meet increasingly stringent environmental regulations and avoid penalties.
- **Resource recovery:** AI can identify opportunities for resource recovery, generating additional revenue streams.

To realize these benefits, it is essential for organizations to carefully plan and execute IoT projects, focusing on clear objectives, robust technology infrastructure, and effective change management.

The combined potential benefits of AI & IoT in Wastewater Treatment for India

AI and IoT technologies can offer several benefits in the wastewater treatment sector, such as:

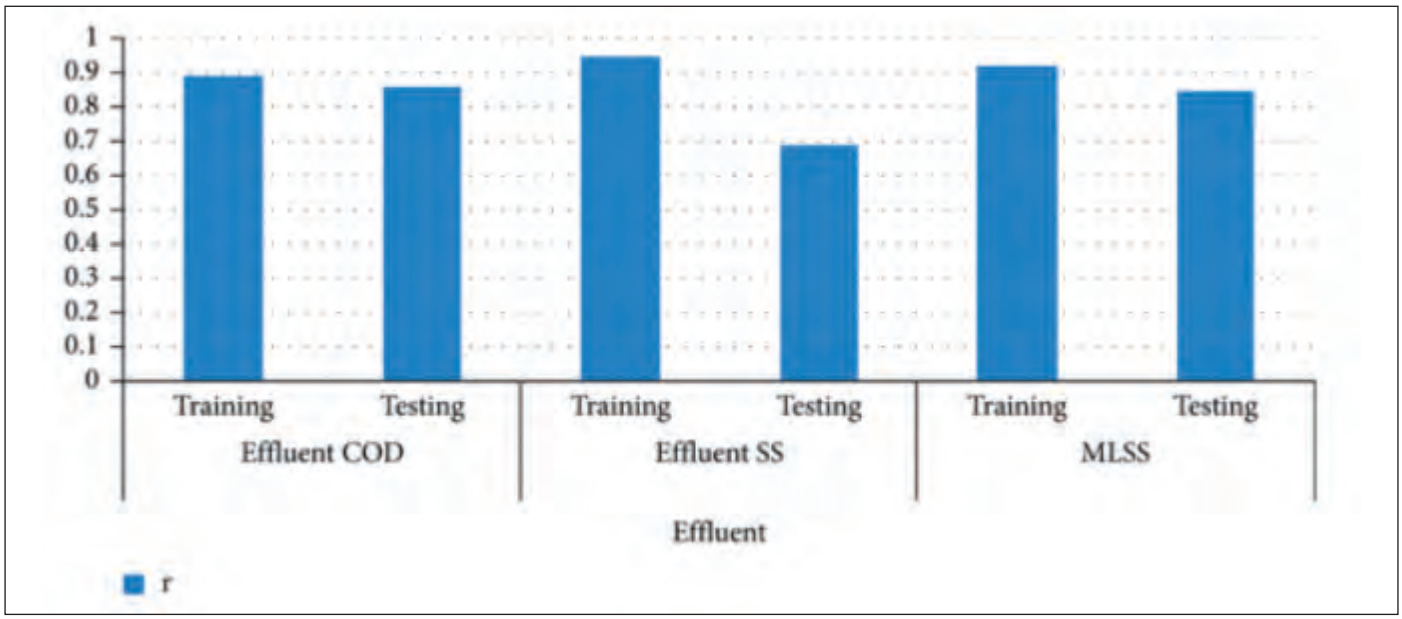
- **Improved efficiency:** AI algorithms can analyze large amounts of data from various sensors and devices, enabling better decision–making and optimization of treatment processes.
- **Predictive maintenance:** IoT devices can monitor the health of equipment and infrastructure, allowing for early detection of potential issues and reducing downtime and maintenance costs.
- **Resource recovery:** AI can help identify opportunities for resource recovery, such as extracting valuable nutrients and energy from wastewater.
- **Real–time monitoring and control:** IoT–based systems can provide real–time data on water quality and other parameters, enabling better control and management of treatment processes.
- **Enhanced decision support:** AI can assist operators and decision–makers with predictive analytics, scenario analysis, and optimization, leading to better decision–making and improved performance.
- **Optimized Treatment Process:** AI and IoT can help optimize the wastewater treatment process by enabling real–time monitoring and control, adjusting chemical dosing rates, and predicting equipment maintenance needs. This can lead to improved treatment efficiency, reduced energy consumption, and lower operating costs.
- **Reduced Operating Costs:** By automating various aspects of the treatment process, AI and IoT can help reduce labour costs, minimize chemical usage, and lower energy consumption. As demonstrated in the case study mentioned earlier, the use of IoT technology resulted in a 40% decrease in chemical costs by reducing usage by 10–20%.
- **Enhanced Monitoring and Control:** IoT–enabled sensors can provide real–time data on water quality parameters, such as turbidity, pH, flow rate, and chemical composition. This data can be used to make informed decisions and adjust treatment processes as needed, leading to more efficient and effective wastewater treatment.
- **Improved Decision–Making:** AI algorithms can analyze the vast amounts of data generated by IoT sensors to identify patterns, trends, and anomalies. This can help plant operators make more informed decisions regarding treatment processes, maintenance schedules, and resource allocation.
- **Better Sludge Management:** AI and IoT can help optimize sludge management by monitoring sludge levels, predicting dewatering requirements, and assisting in the scheduling of sludge disposal. This can result in optimizing resource utilization and minimizing the environmental footprint.

In conclusion, the integration of AI and IoT in wastewater treatment has the potential to revolutionize the sector in India, addressing critical challenges and improving overall efficiency.

Few Case Studies and Practical References of AI & IoT

Delhi Jal Board creates AI–powered system for purifying wastewater

Delhi Jal Board (DJB) has developed a unique technology to clean



Correlation coefficient (r) of different effluents.

sewage water for the first time. The technology is run with AI software, which shares real–time data and monitors the health of the plant, machine, and equipment. The DJB has set up a pilot plant to treat four million gallons of sewage water per day. The process involves making the drain water go through an electrocoagulation reactor, which removes iron sludge from the water. The new technology is expected to help in cleaning sewage water more efficiently and effectively. It will also help in reducing the environmental impact of untreated sewage water on rivers and other water bodies. The development of this technology is a significant step towards achieving sustainable development goals related to clean water and sanitation.

IoT and AI in Action: Saving India's Polluted Lakes

A collaboration between IBM Research and The Nature Conservancy India has demonstrated the power of IoT and AI in addressing water pollution. The team used physical IoT data and earth observation satellite images to estimate water health and quality across space and time. This innovative approach to water monitoring has the potential to provide actionable insights for future water management projects in India.

AI and IoT in Meat Processing Wastewater Treatment:

A major producer of processed meat products partnered with a system integrator to control their chemical dosing and set an economical fixed rate throughout the day, using IoT technology. Through the utilization of IoT technology, the system integrator facilitated the client in monitoring chemical dosing, optimizing %NTU removal, and enabling dosage adjustments to be carried out either on–site or remotely. As a result, chemical costs were reduced by 40% by minimizing usage by 10–20%. Turbidity sensors connected via IoT are employed to provide real–time water quality data to the central control unit, both pre and post–DAF processing. The control unit collects data on turbidity, pH, flow rate, and chemical composition. Then it sends a 4–20mA analogue signal to the pump base to adjust the coagulant feed rate to optimize the desired %NTU removal or other key process indicators.

Data collected by the system integrator is used for artificial intelligence in their proprietary software to cut costs for clients and allow for continual improvements over time.

IoT–based Wastewater Treatment System at Mumbai International Airport

Mumbai International Airport Limited (MIAL) implemented an IoT–based wastewater treatment system, which has resulted in significant improvements in the efficiency and effectiveness of the treatment process. The system uses advanced sensors and monitoring equipment to collect real–time data on water quality, flow rates, and other parameters. This data is then used to control and optimize the treatment process, resulting in better water quality, reduced energy consumption, and lower operating costs.

Biofouling is also a major issue at these large–scale airports, causing millions of dollars of damage to industrial and public water infrastructure. Thus AI–based Biofouling Detection and Control in the wastewater treatment industry is prevalent. AI algorithms can be used to analyze data from sensors and imaging devices to detect biofouling in real–time and predict its progression. This enables operators to take preventive measures, such as adjusting treatment processes or deploying targeted cleaning, reducing the impact of biofouling on infrastructure and treatment efficiency.

Saaf Water: Groundwater Quality Monitoring Tool

Saaf Water, the winner of the 2021 Call for Code Challenge, is a groundwater quality monitoring tool that uses AI and IoT to monitor water health, agrochemical pollution, farm runoffs etc. The tool is promising,

timely, and has great potential for use in protecting water resources for both human health and ecological stability.

Smart Technology in Water and Wastewater Treatment at a Beverage Factory

The integration of IoT and AI in water and wastewater treatment can lead to significant improvements in efficiency and cost reduction. Smart sensing technology and machine learning models have demonstrated their ability to optimize, model, and automate critical water–related processes. IoT can also improve water efficiency in industries such as the beverage sector, as demonstrated by a case study where IoT was used to monitor and manage water usage in a beverage factory.

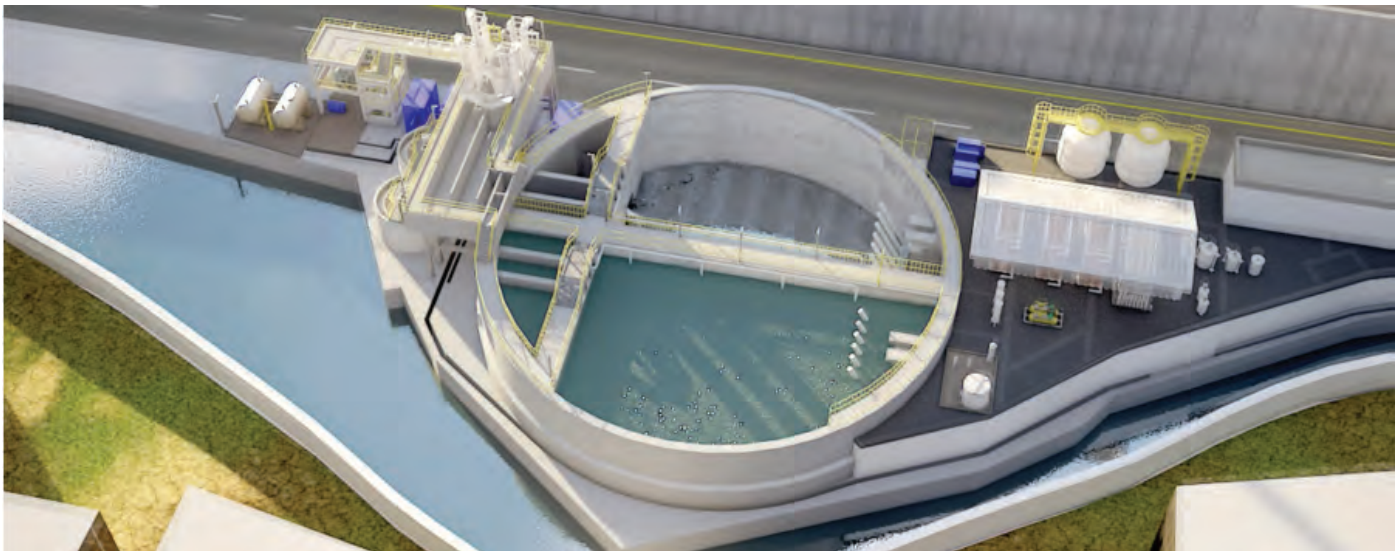
Smart Irrigation & Wastewater Reduction

Agriculture is the largest water–using sector & polluter in India, with a significant portion of groundwater being used for irrigation purposes. Smart irrigation systems that leverage AI can minimize water usage and optimize water resources, leading to more sustainable agricultural practices.

Challenges and Future Prospects (Attachment of Pic – 2)

AI–ML models also play a crucial role in controlling and managing water reservoir systems, encompassing tasks such as water level measurement and risk prediction. AI–based flood prediction and forecasting systems enable governments to proactively respond and mitigate disasters and their devastating impacts. As an example, the Central Water Commission, in collaboration with a technology multinational corporation, utilizes ML and inundation modelling, which leverages real–time river measurements to forecast floods and issue alerts to affected regions. These real–time predictions are based on extensive datasets and are being expanded to cover most river systems in India.

The agricultural sector alone accounts for approximately 70% of global freshwater usage. The implementation of AI–based precision irrigation systems, computer algorithms, and modelling in water management has already proven beneficial to farmers in various countries, including India. Additionally, government bodies and water research organizations rely on ML models to predict groundwater availability and analyze its characteristics. Data–driven models outperform physical models by accurately determining specific groundwater attributes using fewer input data and simpler model structures. With the influx of data analytics, cloud–based AI tools, smart sensors, and ML applications, the monitoring and management of the world's most precious natural



resources are advancing. Water 4.0, or Smart Water, is on the horizon, and it is poised to aid organizations, industries, and governments in their pursuit of Sustainable Development Goals.

Despite the promising potential of AI and IoT in wastewater treatment, there are still challenges to overcome. These include the high cost of implementing AI and IoT technologies, the need for a complete rewrite of existing code stacks for better integration, and the reproducibility crisis in AI research. However, as technology advances and costs decrease, it is likely that AI and IoT will play an increasingly important role in wastewater treatment and water management in India. In conclusion, the integration of AI and IoT in wastewater treatment can bring about significant benefits for India, including improved efficiency, cost savings, and better environmental outcomes. By leveraging these technologies, India can address its water management challenges and ensure a sustainable future for its growing population. India can significantly benefit from the adoption of AI and IoT technologies in the wastewater treatment sector, addressing the pressing challenges of water pollution, resource scarcity, and infrastructure deterioration.

By leveraging these technologies, the country can improve the efficiency and effectiveness of its wastewater treatment systems, enhance resource recovery, and promote sustainable development. With the right investments, planning, and execution, AI and IoT can help India unlock the immense potential of its wastewater treatment sector, contributing to a cleaner, healthier, and more prosperous future.

6.5MLD Water Treatment Plant, Munger, Bihar

RURAL WATER SUPPLY: CHALLENGES AND SUSTAINABLE SOLUTIONS

SUBODH DHIMAN
Director, RD Enviro Engineers & Consultants

Subodh Dhiman, the founder of RD Enviro Engineers, has played a pivotal role in establishing the company as a prominent player in the field of environmental engineering. His dynamic approach and leadership, coupled with a highly qualified team, have been instrumental in providing exceptional engineering, project execution, and consulting services. His dedication to sustainability and meticulous attention to detail has been key factors in garnering the trust and satisfaction of his clients.

Access to clean and reliable water supply is a fundamental human right and essential for maintaining optimal health, hygiene, and overall well–being of not only humans but also animals and other living beings. Clean water is vital for drinking, cooking, sanitation, and various daily activities that support a healthy and dignified life.

In addition to human well–being, access to clean water is crucial for sustaining ecosystems and biodiversity. It provides habitats for aquatic species and supports the overall balance of nature. Reliable water sources are essential for agricultural activities, ensuring food security and livelihoods for communities dependent on farming and livestock.

Water is an essential component in various aspects of life, whether it's driven by a growing population, rapid urbanization, climate change, or rising expectations from individuals and businesses. India, currently one of the world's most populous nations, is confronted with a formidable challenge in ensuring access to clean water for its continuously expanding urban and rural population.

India is currently grappling with an unprecedented water crisis, characterized by severe water scarcity affecting over 40% of its population. Several major cities across the country have even reached a critical point where groundwater levels have depleted to zero. This alarming situation is exacerbated by projections from the World Bank, which estimate that by 2030, India's water

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demand will exceed its supply by nearly 50%. This poses a substantial challenge in meeting the water needs for both domestic and commercial purposes.

Rural Water Management

Rural India is home to a significant population, 65 percent, that faces numerous water–related challenges. Panchayats and villages in several states lack access to safe drinking water, relying on high levels of fluoride and arsenic contaminated sources that pose severe health risks. Even the existed water supply infrastructure were unreliable and inadequate maintenance exacerbate the problem, leading to water scarcity during dry seasons and wide spread flooding during rainy seasons.

Ensuring sufficient water supply in rural areas has been a persistent challenge. However, through collaborative endeavors and the implementation of innovative strategies, significant strides are being made to enhance rural water supply and work towards sustainable development goals.

A substantial portion, approximately 65 percent of the total population residing in rural India, faces numerous challenges related to water availability. Panchayats and villages in various states struggle with inadequate access to safe drinking water, relying on sources that are contaminated with high levels of fluoride and arsenic, posing significant health risks. The existing water supply infrastructure in these areas is often unreliable, and the lack of proper maintenance aggravates the problem. As a result, water scarcity becomes a prevalent issue during dry seasons, while heavy rainfall leads to widespread flooding during the monsoon seasons. Addressing the issue of water supply in rural areas has been a persistent challenge.

Bihar, a state with predominantly rural population, has encountered significant challenges in ensuring sufficient access to safe drinking water.

Booster Pumping Station, Narela, Delhi

Improving rural water supply in India is a complex task that requires a multi–faceted approach. While significant progress has been made, there is still a long way to go in achieving universal access to clean water in rural communities.

6 Lac Litres Capacity ESR, Rewa, MP

However, collaborative efforts and the implementation of innovative strategies are playing a crucial role in improving the situation and working towards achieving sustainable development goals.

By focusing on sustainable water management practices, promoting community participation, and leveraging technological advancements, progress is being made to enhance rural water supply systems. This includes initiatives such as rainwater harvesting, groundwater recharge, decentralized water treatment, and the establishment of reliable and resilient water infrastructure.

Efforts are being directed towards building and improving rural water infrastructure under the ambitious Jal Jeevan Mission (JJM) to increase access to clean water in rural communities. Since its inception in 2019, the Jal Jeevan Mission, the flagship scheme of the government, has made significant strides in providing functional water tap connections to rural households. As of June 25, 2023, the mission has successfully connected an additional 91.5 million rural households, reaching a total coverage of 123.85 million households out of the country's total of 194.49 million rural households. This accounts for an impressive coverage of 63.65 percent of the total numbers of households in India.

The Jal Jeevan Mission with a huge budgetary allocation of INR 3.6 lac crore for rural water supply is being implemented with a mission–oriented approach, as evident from its progress. It has effectively covered all households in 80,009 panchayats, spanning across 1,67,846 villages in 132 districts. The scheme has ensured assured tap water supply for these households, marking a significant milestone in improving water accessibility in rural areas.

The remarkable progress achieved through the Jal Jeevan Mission underscores the government's unwavering commitment to ensuring clean, safe and dependable water supply for rural population in India. It marks a significant stride towards the mission's overarching goal of achieving functional tap water connections throughout rural India.

Notably, eight states and union territories have accomplished the commendable feat of attaining 100 percent water supply coverage for their populations. Additionally, other prominent states have made substantial headway, with coverage ranging from 70 percent to 95 percent of their respective populations.

These achievements demonstrate the concerted efforts and dedicated approach taken by both the government and the concerned states in improving water accessibility for rural communities. It exemplifies their commitment to addressing the water needs of the population and signifies a crucial step forward in realizing the mission's objective of providing universal tap water connections across rural India.

Water Supply Scenario in Bihar

Bihar, a state with predominantly rural population, has encountered significant challenges in ensuring sufficient access to safe drinking water. The state has faced issues related to both water quality and inadequate infrastructure. Contamination of water sources, including wells, rivers, and groundwater, has been a major concern. Recognizing the importance of addressing these challenges, the government has implemented various initiatives aimed at improving infrastructure and promoting safe water practices.

For the past few years, the Government of Bihar has been actively and diligently working towards the goal of providing 'har ghar jal' (water to every household) under the Jal Jeevan Mission (JJM) scheme. The state has achieved remarkable success, with a coverage rate of 96.37 percent (as on 25 June 2023) of their households. Out of a total of 16.63 million households, functional tap water connections have been made available to 16.02 million households thus far. Efforts are underway to connect the remaining households with functional tap water connections, ensuring access to clean and reliable water for all residents of Bihar.

While progress has been made, sustained efforts are required to ensure reliable and safe drinking water supply in Bihar's districts. Continued

Rural Water Supply Project, Bihar

investment in infrastructure, water treatment facilities, community participation, and awareness campaigns will contribute to addressing the water supply challenges and improving the quality of life for the residents.

RD Enviro Contribution

RD Enviro Engineers & Consultants Pvt. Ltd. (RD Enviro), with a dedicated team of experienced engineers and management professionals has been working in Bihar to build a robust water supply infrastructure system and have executed projects that help in making clean and safe drinking water provision to households.

The company has recently completed a project in water quality affected areas of Araria and Madhepura districts where iron contamination was prevalent in groundwater sources. It has designed, constructed, tested and commissioned water supply schemes with iron removal treatment plants having activated carbon based technology. It has constructed 32 numbers of Iron Removal Plants (IRPs) of various capacities from 1.6 MLD (million litres daily) to 3.2 MLD capacities that has helped provide safe drinking to over 6000 households mainly affected by the contaminated water sources.

Since its establishment in 2009, RD Enviro has successfully completed numerous water supply, liquid waste management, and solid waste management projects in various states like Bihar, Delhi, Madhya Pradesh, Haryana, Jharkhand, Maharashtra, Rajasthan, UP and other states. The company has gained a reputation for providing exceptional engineering, project execution, and consulting services to a wide range of corporate and government clients.

RD Enviro firmly believes in the importance of implementing sustainable and environmentally friendly technologies, considering the challenges we currently face. By harnessing its diverse core competencies and staying updated with the latest industry knowledge, the company consistently strives for excellence in every project it undertakes. With a strong emphasis on attention to detail, RD Enviro adheres to strict project timelines, ensuring the utmost client satisfaction throughout the entire project lifecycle.

Way Forward

Improving rural water supply in India is a complex task that requires a multi–faceted approach. While significant progress has been made, there is still a long way to go in achieving universal access to clean water in rural communities. There are almost 71 million rural households that still need to be connected under the JJM scheme. Addressing infrastructure gaps, mitigating water contamination, and implementing sustainable solutions are vital steps forward. Continued efforts, coupled with community participation, technological advancements, and adequate financial investments, will pave the way for a brighter future, where every rural inhabitant in India has access to safe and reliable water supply, promoting health, prosperity, and overall development.

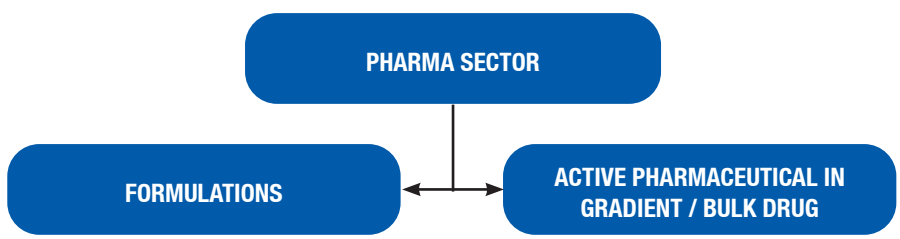
PHARMA API

(ACTIVE PHARMACEUTICAL INGREDIENT) INDUSTRY EFFLUENT & TREATMENT

Amit Udgirkar
Owner,Raditech Solutions

Indian Pharma Industry has grown at a CAGR of 5.64% during FY 11–16. The pharma market in FY 16 was US$ 27.57 Billion.

Structure of the Pharma Sector in India



API Industries

India became the third largest global generic API merchant market in 2016, with a 7.2 percent market share.

The major challenge in API Industry is Environmental sustainability today. Big Scale Industries do make every attempt to work towards it & resolve these issues. However, the major parameters creating nuisance are:

- Recalcitrant /Non–biodegradable COD
- Ammoniacal Nitrogen

Recalcitrant / Non–biodegradable COD

As all are aware, the recalcitrant COD in Pharma effluent is due to solvents present in the process. The solvents used are Methanol, MDC (Methylene Dichloride), THF, DMSO, Isopropyl Alcohol (IPA), Toluene, and many more…

As the Pharma API industry manufactures products based on Market demand and there are many parallel lines, where various products are under manufacture. Hence, the effluent generated is unknown in the form of its parameters.

Ammoniacal Nitrogen

As mentioned above, along with various solvents, there are a few products that are amine–based, which results in Ammoniacal Nitrogen (NH3–N) in the effluent. This stream is generally segregated as High COD but as ammonia is not free hence not removed in the solvent strippers and this will be carried to MEE condensate creating issues in ETP again.

The following are the sources of Effluent generation in the API Industry:

- Layer Separation – This is the last stage of API manufacturing. Here, the product layer is separated from the Aqueous layer. This Aqueous Layer is effluent and will be collected either in drums or else pumped to the High COD stream collection Tank.

Generally, Layer Separation is controlled using manual operations. Hence, the extent of the product being taken to the Aqueous layer depends on the personal expertise & interpretation of the operator. Any mistake in the same can lead to more solvents in the effluent. The operators always try to achieve more product yield and hence, they let solvents go in the effluent.

- **Centrifuge Separation –** This is also the type of product separation and the water thus separated will be taken to High COD Stream Collection Tank
- **Reactor 1st wash –** Generally Reactor first wash by water/solvent is taken to High COD Stream Collection Tank.
- **Reactor 2nd wash –** Some Industries take this to the High COD stream, but major industries take it to ETP i.e. Low COD stream to reduce the load on the High COD Stream.
- **Utility Waste –** utility waste comprises Cooling Tower blowdown, Boiler blowdown, WTP RO Reject, and DM regeneration waste. This stream will not have high COD but will be having High TDS.
- **Floor wash –** Floor wash from the factory is generally considered a Low COD stream unless somebody drains oil/solvents during floor washing.

It is a well–known fact that if the effluent is segregated by High COD, High TDS, and Low COD–Low TDS, the designed system delivers the best efficiency. However, despite this fact, various industries don't pay attention to simple discipline & manage somehow the disposal.

Pharma API effluent is not the toughest one... rather no effluent is the toughest one!! We all understand the raw materials used in the process. It will come in traces in the effluent.

As per current trends, industries look at their effluent as a dirty, turbid stream with COD & BOD, which brings nothing else than headaches to Pollution control board agencies. But, effluent is nothing else than the diluted product they manufacture.

Now, if we segregate the Effluent streams, it will look something like this –

Streams	High COD – High TDS	Moderate TDS	Low COD – Low TDS
Layer Separation	✓		
Centrifuge Waste	✓		
1st Reactor Wash	✓		
2st Reactor Wash	✓		✓
3rd Wash Onwards			✓
Utility Waste		✓	
Floor Wash			✓

*** 2nd wash always been issue for ETP. So, segregation of this stream varies as per product.**

Segregation is complete now. Let us move to how we formulate the Design Basis for Pharma API effluent. Few points to remember before we move to Design Basis.

1. Pharma API Industry manufactures various products as per market demand. Also, there are various products at a time being manufactured. Due to these points, major challenge in API is – effluent varies in quality & quantity almost every day.
2. High COD streams like Layer Separation, Centrifuge Waste & 1st Reactor wash not necessarily have more TDS. It does have COD due to solvents present in it.
3. High COD streams are generated batch wise whereas Low COD streams are generated continuous basis. This point is very important when designing pre–treatment for ETP.
4. During Wastewater Audit, it has been observed that the solvents are wasted in effluent to achieve better product yield. This not only wasting it but creating more load on the High COD Effluent.
5. 2nd Reactor wash stream is generally sent to Low COD stream. Here, Biological system is very critical as the same have aerobic bacteria. Bacteria are absolutely like human beings which requires oxygen, Good food and healthy environment. If you disturb them

by giving solvents, system gets disturbed. Many occasions, if the system gets disturbed to major extent, it requires external aid for recommissioning.

6. Floor washing effluent is again an issue when it comes to formulation of design Basis. Discipline in the operating staff can only keep the parameters in control.
7. Few Pharma Industries use Silica columns for specific products, from where there can be leakage of silica possible. Silica can create issues in Reverse osmosis & Multi Effect Evaporators and can reduce the CIP frequency.
8. Utility streams are moderate in TDS & doesn't contain major COD & BOD. This stream (After Neutralisation) directly can be added after biological systems before filtration unit. This can reduce Hydraulic load on Biological system.
9. TDS of any effluent need to be monitored as Organic & inorganic. Organic TDS can be reduced by striping & biological systems. For Inorganic TDS removal, RO & Evaporators are required.

Design Basis Formulation

Low COD – Low TDS Stream

Major effluents in this category are – Reactor 3rd Washings onwards, Floor washings and Utility waste.

Utility waste contains – WTP RO Reject, DM regeneration waste, Cooling Tower blowdown, Boiler blowdown etc.

The general parameters found in the Low COD stream are –

pH	6.5 – 8.5
COD	3000 – 5000 mg / lit
BOD	1000 – 2000 mg / lit
TDS	3000 – 6000 mg / lit
Ammoniacal Nitrogen	Nil – 50 mg / lit
Solvents	Traces
O&G	10 – 20 mg / lit

*** After taking so much care & followed discipline, there should not be any solvents coming to ETP. However, some traces of solvents like Methanol may come to ETP. Methanol with few other solvents is biodegradable if comes in ppm level.**

High COD Stream

This stream creates major issues in treatment. This comprises Aqueous Layer, Centrifuge waste, 1st & 2nd Reactor washing.

Aqueous Layer may not be a high TDS stream but the same is at extreme pH @1 or pH@14. It requires to be neutralized and due to this, TDS increases marginally.

While generating requirements for ETP & ZLD, Major pharma Industries share the High COD effluent parameters as COD, TDS & pH only. For the ETP suppliers, it is very much required to get many details to design the system accordingly.

- For solvent removal, the Solvent stripper is used. Only providing COD values will not solve the purpose. Industries to list out the solvents they use in their process. Following are the major solvents being used in the process.

Mathanol	**TBME**	**Heptane**
MDC	**Ethyl Acetate**	**THF**
IPA	**DMSO**	**DMF**
Hexane	**EDC**	

- If there are amine–based products, Ammoniacal nitrogen for the waste stream needs to be monitored regularly. If possible, it is always better to segregate the stream and treat it separately even for neutralization. Ammonia is not in free form, hence can't be completely removed even in the solvent stripper. A separate small system can be provided for this stream treatment.

General High COD Stream Parameters

pH	6.5 – 8.5
COD	50,000 – 100,000 mg / lit
BOD	Can't be generalised
TDS	50,000 – 60,000 mg / lit
Ammoniacal Nitrogen	Nil – 2000# mg / lit
Solvents	2% – 10%

*** After Neutralisation**
 # To be segregated

ISSUES & INDICATIVE SOLUTIONS TO IT:

1. Design Basis Formulation

Very few Industries know what their effluent is, and how to Reduce, Collect & Segregate it. But, this is a mandatory & important step in Design Basis Formulation.

Though API plants use almost similar solvents, there can be some minor/ major changes in some raw materials. It impacts on their effluent pattern & parameters. e.g. Usage of amines makes effluent rich in ammoniacal nitrogen, Usage of Silica column may leach some silica, Usage of toxicants like cyanide can make the effluent toxic etc.

Solvent percentage in effluent varies & it completely depends on the production practices and the Disposal of the effluent. The fight between

Product Yield & effluent generation is age old and is continued. However, there have been improvements in the process such as recovering precious solvents and save them from getting dirty as part of effluent. After primary modifications at process side, reduction in the effluent is quite possible.
For Pharma API units, design Basis formulation needs following steps

- Know your own effluent & its sources first
- Reduce the effluent at source by either recovering solvents or modifying the process.
- Rather than segregating it as per conventional methods, segregate as per their parameters
- Parameters should not be Very High or Very Low, it should be optimum or in range, which helps designer to design best suitable system for you
- Water balance diagram is very important in pharma API as only RO permeate goes out of the loop. Other all effluents are treated in loop.

2. Read between Effluents

When you list our all–effluent sources & its parameters, you should use the experience to segregate it as per their parameters. Generally, the segregation is High TDS–High COD–Low TDS–Low COD etc.
But for API, the effluent segregation should be based on Toxicants, Reducing agents, Solvents, Low TDS & Low COD effluent.
Concentration of low volatile solvents & its azeotropes carries an important role in High COD streams.

3. Biological ETP issues

Operating ETP is a major challenge in Pharma API due to following facts –

- Solvent usage & by mistake disposal
- MEE condensate having Low volatile solvents mixed with Raw Low COD ETP stream disturbs ETP

Indicative solution to first issue is disciplined disposal of the effluent & proper monitoring of every effluent drain. Second issue is discussed further in MEE point later in this article.

4. Reverse Osmosis (RO) Design & Operations

- Actual TDS of the RO reject is very less and thus gives higher hydraulic load on MEE
- If the max. recovery is not possible practically, higher hydraulic load is again on MEE.
- Indicative Solution
- RO systems are generally designed for higher recoveries in today's time ~80% in API industry.
- RO designs are done based on higher TDS levels, resulting in very high TDS in reject in projections. In reality the rejects TDS is low, and it gives higher load on MEE
- RO projections to be done on TDS range and not on max. TDS.
- Optimum recovery projections to be considered while designing MEE system.

5. Zero Liquid Discharge (ZLD) Doesn't work – It is obvious!

Generally, ZLD systems comprises Stripper for solvent–based effluent (from layer separation & Centrifuge from process), Multi–effect Evaporator for mixed stream of Stripper bottom & ETP RO Reject mixed effluent, followed by ATFD for treatment of MEE bottom product.
Stripper Design

- TDS of the effluent fed to Stripper is 4–5% and COD is almost 5–10%. In today's scenario, when stripper is designed for Effluent, it is generally designed on hydraulic load rather than its solvents by majority suppliers.
- Generally Effluent strippers are designed with packed bed design with fixed height of packed bed. Unfortunately, for majority cases, proper solvent stripping calculations are not done while designing the system or even steam requirement is not calculated properly.
- Everybody talks about % of solvents / water in top product, which is kept as 70%/30% majority times. Stripper is not evaporator & hence the top product should contain very less water & majority solvents.
- No suppliers talk about what is % solvents carried to MEE system through stripper bottom. This is obvious as even End user doesn't know what they will be feeding to stripper (everyday, the composition changes).
- Ammoniacal nitrogen presence can be a major failure of ZLD system as it interferes almost in everything. If significant concentration of NH_3–N is in the effluent in, it can't be treated like other solvents. NH_3–N presence interferes in evaporation as well and it also shows its presence in MEE condensate which need to be treated again.

Indicative Solutions

- End user should recognize the effluent generation pattern & solvent concentrations in the effluent.
- The concept & attitude of " ETP can eat anything" need to be changed.
- Theoretical requirement & Actual solvent usage to be monitored
- Surprisingly strippers are designed based on Flow & COD. Stripper is required to be designed based on the solvents (can be) present & not COD levels.
- Designer & End user to choose the solvents from list based on their experience & design stripper not only on hydraulic basis but based on the solvents present in the feed. Here, projections are to be done for each concentration range of the solvents for stripping.
- Ammoniacal Nitrogen stream to be segregated & to be treated separately if NH3–N is significant in concentration.
- There is a possibility that Actual feed stream to stripper varies a lot from designed values due to Azeotrope formation, carryovers & solubility issues. But the stripper operations will not be drastically out of design.
- Customers/End users should understand that their own effluents require higher Steam consumption in stripper to get separated & should not hype on the opex in that case. Generally, when customers doubt on higher opex on papers, end up with even more opex in actual plant. This is true for API industries.
- Ultimately, stripper needs to be designed properly & not just hydraulically fabricated.

MEE Issues

- MEE feed is a mixed stream from Stripper bottom (TDS 4–5%) &

ETP RO Reject (TDS 0.5–2%). High COD stream is generated batch wise and RO reject is on continuous basis hence, TDS varies from 0.5% – 3.5% based on hydraulic ratio of both the streams. System need to take care of it

- Stripper doesn't work efficiently & present gifts of volatile solvents & NH3–N to MEE, which interferes in MEE operation. Here, stripper plays very important role in MEE operations.
- MEE achieves Evaporation duty on raw water but not on effluent – API effluent vary in quality & can have scaling potential salts present in it. Tubes tend to chock more often and the same results in inefficient Evaporation operation. Also, presence of solvents plays important role in inefficient operations.
- Selection of Evaporation type is equally important – chosen Falling film results in scaling of tubes more often.

Indicative Solutions

- MEE need to be designed for TDS range than Min. Or Max TDS
- Majority Industries opt for Forced circulation evaporators whereas few goes for falling film, which results in continuous chocking of MEE Tubes.
- Steam temperature plays an important role in MEE designing. If the same is kept high at >100 Deg C, first effect tends to get chocked more – Many customers fail to understand why it is done by supplier! First effect high temperature results in low HTA and thus helps in reduce the cost & Opex.
- Many suppliers come with an idea of using Adiabatic Evaporator, which is nothing but cooling tower which runs on the feed stream to MEE effluent. They showcase some evaporation in the Adiabatic evaporator thus achieving lesser steam consumption. The idea is good & workable mainly in summer time & tends to fail esp. in the rainy seasons. For Pharma API, it's not a wiser decision as the MEE feed also contain solvents.
- Tube diameter also carries an important role. If the tube diameter is less, automatically costs are lowered & thus the recirculation flowrate also will be less. These low diameter tubes are difficult to clean when get chocked by hardness / silica.
- Effluent Velocity inside tubes, if kept low, it tends to scale more and lowers the efficiency.
- One more very important point while designing the MEE system is Boiling Point elevation (BPE). Majority of times, the same is not considered, but plays vital role in MEE HT calculations. e.g. NaCl is having BPE of 7–8 deg c at 40% as against 18–22 deg C for CaCl2 at 50–55%. Hence, it is always advisable to consider the salts which may be present in the effluent. Salts can be calculated based on complete water balance diagram across factory.

ATFD Issues – ATFD product is not powder but only lumps – ATFD product quality depends on the organics present in the ATFD feed (MEE Product). If there are more organics present, the ATFD product will have more lumps.

Indicative Solution – High boilers will be carried to ATFD from Stripper & MEE and hence, there won't be any control on it, but the major control end user can have – Efficient stripper & MEE installation & operations.

MEE Condensate can't be recycled or even can't be treated with existing system

- MEE Condensate contains low volatile solvents & sometimes, Ammoniacal nitrogen which have COD ranging from 3000–5000 mg/lit. This is an extra generated effluent & is approx. 50% of the effluent fed to ETP.
- ETP is designed using conventional biological process. This condensate sometimes, can become shock load to ETP resulting in killing the bacterial culture & washout the MLSS.
- Majority of API today facing this issue.

Indicative Solution –

- MEE condensate can be treated using advanced oxidation process (AOP) before it is fed to biological system. AOP converts the complex compounds into simple chain & the resultant can be fed to biological process. Thus, the bacterial culture can be saved from toxicants.
- AOP comprises use of Hydrogen peroxide, Ozone & UV together, combination of which generate Hydroxyl radicals. These have the highest oxidation potential amongst available oxidants. It breaks the complex molecule into simple chain. The resultant simple molecules can be easily broken using existing biological process.

Major issue –

- While generating the enquiry, End Users should think about how they will ask the suppliers to demonstrate the plant with full capacity. Generally, when suppliers install the plant the effluent generation is hardly 40–50%. It impacts suppliers & End users both.
- When End user reaches to plants 100% capacity after 2–3 years from installations, they again need to go for ETP & ZLD expansion/ modification. This happens due to parameter change because of additional products, changed mandates, relocation or under–designed plant etc. Hence, any plant average life today in 6–7 years.
- Performance can be validated by various ways, e.g. opting for bigger raw effluent tanks, etc.
- It is always advisable to hire expert people from Industry so that better enquiry document can be prepared & the same way suppliers can be selected.

Abbreviations

- **AOP –** Advanced Oxidation Process
- **ATFD –** Agitataed Thin Film Dryer
- **BPE –** Boiling Point Elevation
- **COD –** Chemical Oxygen Demand
- **ETP –** Effluent Treatment Plant
- **HT –** Heat Transfer
- **MEE –** Multieffect Evaporator
- **NH_3–N –** Ammoniacal Nitrogen
- **Opex –** Operating Cost
- **RO –** Reverse Osmosis system
- **UV –** Ultravoilet
- **ZLD –** Zero Liquid Discharge

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INTERNET OF THINGS (IOT) FOR WATER MANAGEMENT

Mandarr Kkamthe
Senior Product Manager
Water, Asian Contec Ltd. (Stanlay)

Mandarr Kkamthe has been working in the water sector for 12 very fruitful years. He was previously associated with organizations like JUSCO, Suez Environment, Vishvaraj Environment Pvt. Ltd., Siemens, GE, etc. During this time, he achieved much in terms of expanding program offerings and enhancing the quality of existing systems.

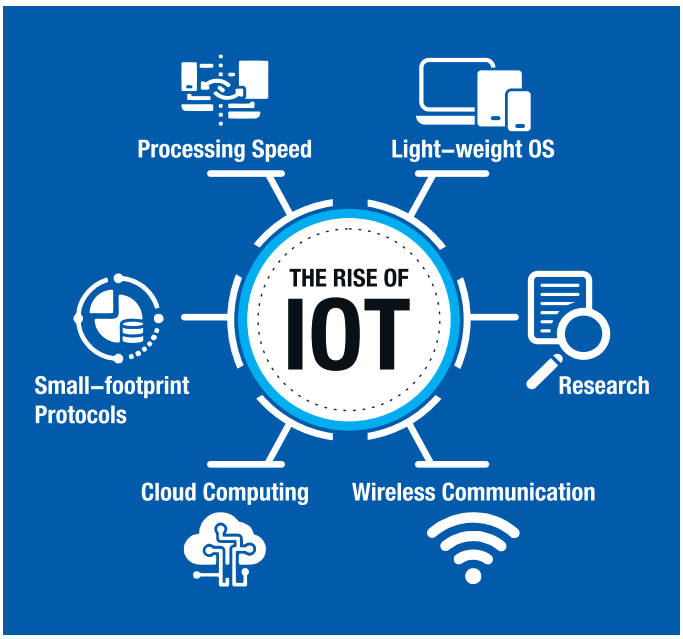
It is often said that water is the world's most valuable commodity. With rapid urbanization – nearly 70% of the world's population lives in cities – it is estimated that almost half of the population will live in water–stressed areas by 2025. This means that water will become one of the biggest expenses for cities in the future and will directly impact economies.

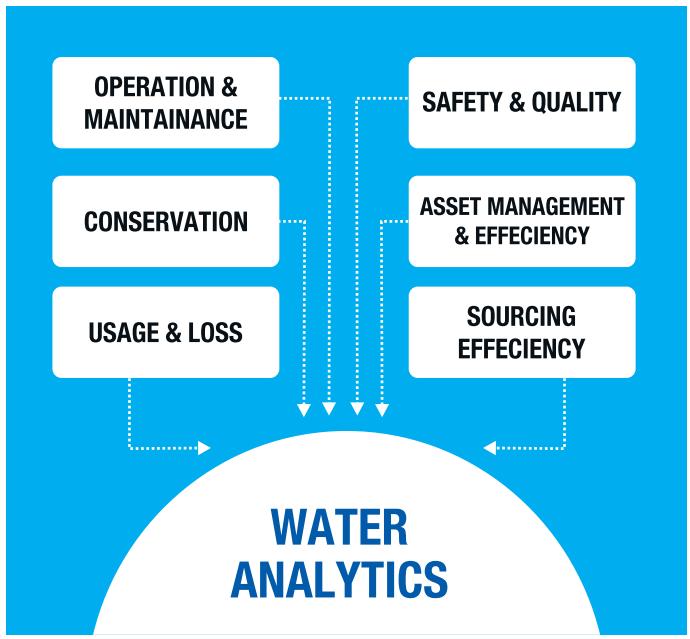
As infrastructure is updated, utilities can implement Internet of Things (IoT) technology throughout to help make water management more efficient and safer for consumers and workers. These smart devices and sensors can help with real–time data collection and alerts to prevent issues from occurring and reduce the workload on the workers responsible for physically checking every inch of infrastructure.

Given the strong digital presence in our everyday life, it might be hard to believe that many utilities still track devices and data manually. This outdated and inefficient process can lead to old, inaccurate, and incomplete measurements of data and assets. When upgrading, utilities need to think about how to scale to thousands – or even millions – of sensors, water meters, and valves. When handled correctly, the infrastructure update can unlock new insights and reach unprecedented levels of efficiency.

Objectives Of Smart Water Management

- The primary objective of smart water management is reasonable and sustainable usage and recycling of water resources. The growing population, increasing environmental issues, and pressure on the food and agriculture sector make water an even more precious asset.
- In this respect, water management technologies and activities pursue the following objectives:
- Improve water quality and prevent contamination by chemical waste and natural pollution such as acidification. In order to improve and maintain the quality of water, companies use sensors and IoT technology for real–time monitoring and control.
- Enhance the efficiency of water systems such as water collectors, treatment plants, distribution mains, and wastewater recycling centers. Using IoT and data solutions for asset management, companies can keep important measurements such as water pressure, temperature, flow, etc. at hand, integrate predictive maintenance, and avoid breakage and downtime of equipment.
- Implement leakage control by using smart water management devices equipped with leak and moisture sensors. Given that almost $3 billion are spent on fixing the damage caused by leakage yearly, leakage control is essential to keep water resources and budgets safe.
- Practice consumption monitoring via IoT–based water management systems. It helps to optimize and keep under control the usage of water resources at different levels – households, communities, countries, and the whole planet.





IoT Water Management Solutions

- The Internet of Things offers new solutions for improving water management, to maximize efficient use of this precious resource. Comprehensive water management strategies can reduce water costs by up to 20%, which has a real impact on cities. Water projects can be particularly complex since many cities rely on aging infrastructure, and the IoT also presents opportunities for municipalities to reduce operational expenses around construction, maintenance, and more.
- Whilst traditional major infrastructure assets such as trunk mains, pumps, or reservoirs have been instrumented for years using systems such as SCADA, the vast majority of the reticulation network – the final pipe network that delivers water to a customer's premises – has always been "dark" to the utility. That is, utilities rely almost exclusively on the customer acting as their sensor – when there's a fault, the customer phones up to complain.
- Here are a few of the ways IoT can improve water management:
  - Water leakage detection
  - More efficient systemic water management
  - Water quality and safety monitoring
  - Quality control on water reserves
  - Transparency on consumption
  - Prescriptive maintenance of infrastructure

How the Internet of Things Assists in Determining Water Demand in a City

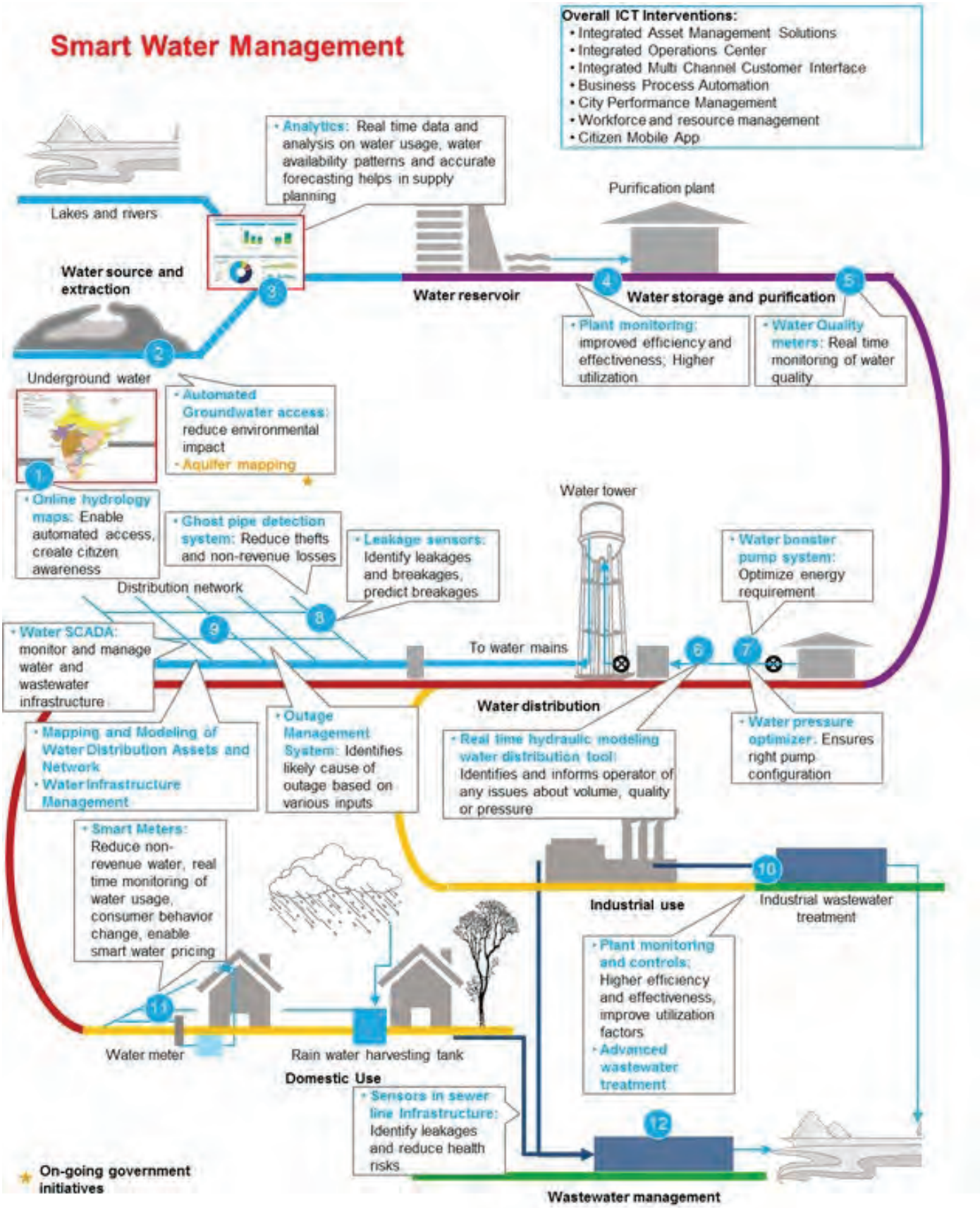
One of the crucial challenges of water management as well as conservation in a city is to determine the amount of water that any particular city is going to utilize during the next day. This can be calculated to precision with the use of predictive analytics. This is done by keeping track of the history of water consumption in the city on any given day. Based on the historical data collected and analyzed by predictive analytics and combined with the consideration of special events, holidays, as well as the weather in that city, we can determine the amount of water that the entire population is going to consume in one day.

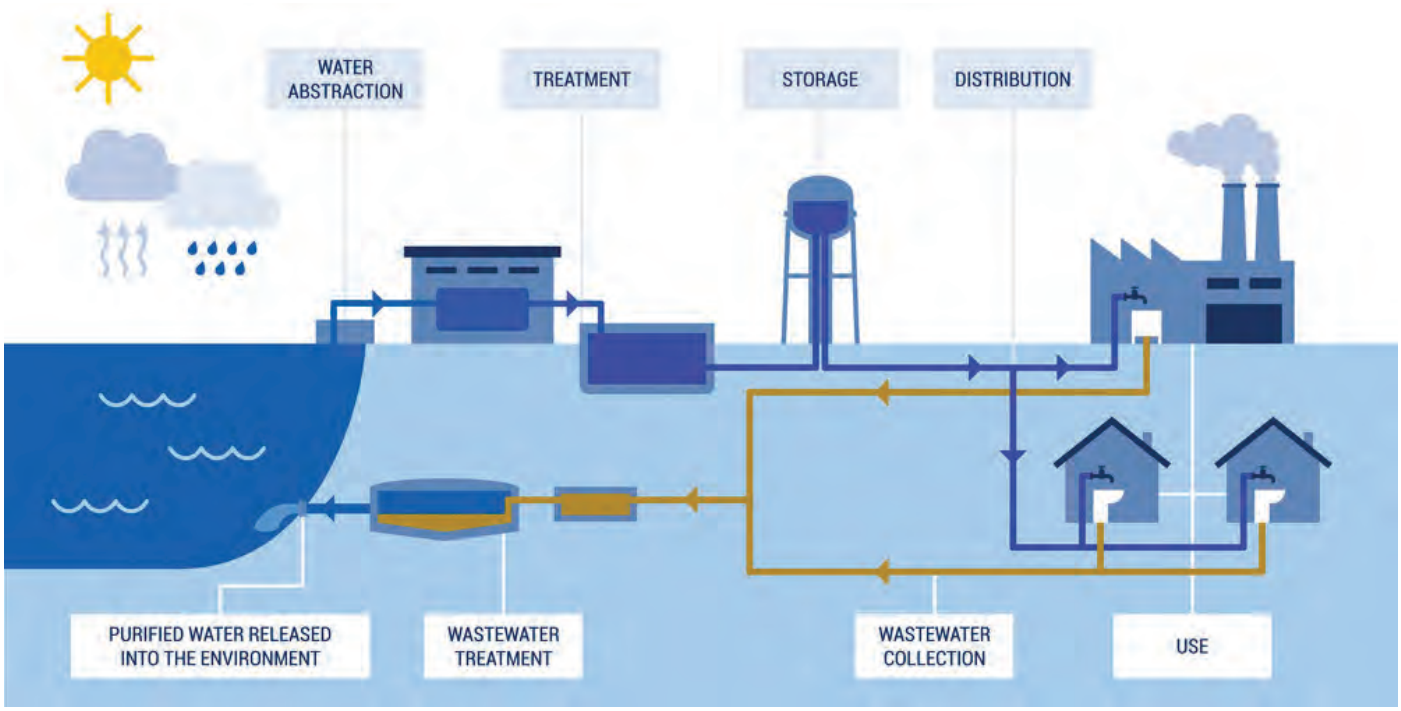
Let us take into consideration the collective consumption of water on a winter day as well as a summer day. It is a known fact that the consumption of water is comparatively very less during winter. This we could easily determine from the historical data collected as well as the fact that there is less water consumed for washing as well as bathing purposes during winters. On the other hand, take into consideration a day like Holi where there is a huge amount of water consumed throughout the day. Given the fact that water often gets wasted unnecessarily during such festivities, it would not be wrong to say that there is comparatively more consumption of water during summer.

This is also where the importance of historical data, as well as predictive analysis, comes into consideration. When we have knowledge about the amount of water that is required for overall consumption in a city on any given day, it becomes easy for the water authorities to maintain the level of water in a water reservoir/ tank and then pump the water into overhead tanks as required throughout the day.

Not only this, but the Internet of Things technology also helps in scheduling the maintenance as well as the shutdown of pumps on a regular basis. There are optimization techniques that can beforehand convey to the residents of a city the unavailability of water at any particular point in time. This helps the water regulation authorities not only meet the adequate water demands in a city; rather it also aids in the conservation of resources and energy.

Another advantage of the Internet of Things in water management is the reduction in energy pricing and consumption. Keeping in mind the goal


Smart Water Management
Overall ICT Interventions:
• Integrated Asset Management Solutions
• Integrated Operations Center
• Integrated Multi Channel Customer Interface
• Business Process Automation
• City Performance Management
• Workforce and resource management
• Citizen Mobile App
• Analytics: Real time data and analysis on water usage, water availability patterns and accurate forecasting helps in supply planning
Lakes and rivers
Purification plant
Water source and extraction
Water reservoir
Water storage and purification
• Plant monitoring: improved efficiency and effectiveness; Higher utilization
• Water Quality meters: Real time monitoring of water quality
Underground water
• Automated Groundwater access: reduce environmental impact
• Aquifer mapping
• Online hydrology maps: Enable automated access, create citizen awareness
• Ghost pipe detection system: Reduce thefts and non-revenue losses
• Leakage sensors: Identify leakages and breakages, predict breakages
Water tower
• Water booster pump system: Optimize energy requirement
Distribution network
To water mains
• Water SCADA: monitor and manage water and wastewater infrastructure
Water distribution
• Mapping and Modeling of Water Distribution Assets and Network
• Water Infrastructure Management
• Outage Management System: Identifies likely cause of outage based on various inputs
• Real time hydraulic modeling water distribution tool: Identifies and informs operator of any issues about volume, quality or pressure
• Water pressure optimizer: Ensures right pump configuration
• Smart Meters: Reduce non-revenue water, real time monitoring of water usage, consumer behavior change, enable smart water pricing
Industrial use
Industrial wastewater treatment
• Plant monitoring and controls: Higher efficiency and effectiveness, improve utilization factors
• Advanced wastewater treatment
Water meter
Rain water harvesting tank
Domestic Use
• Sensors in sewer line Infrastructure: Identify leakages and reduce health risks
On-going government initiatives
Wastewater management



of meeting the water requirements in a city, predictive analytics can be used to calculate the price of energy during different hours of the day. This information can then be used for scheduling the pumps throughout the day in such a way that there is no loss of unnecessary energy or resources.

Major Components of IoT Water Management

IoT Water Flow Meters

By using smart IoT water flow meters, manage the flow between multiple distribution lines. Save power by knowing how much water flow is needed for a specific distribution line. You can even prevent the non–revenue water loss caused by meter inaccuracy and recover lost revenue and deliver more accurate billing.

Smart Water Meter

An IoT smart water meter tracks the quality, pressure, and consumed quantity of water in a household or industry. An IoT smart water sensor can be used to track the flow of water across the entire plant and over the distribution channels. Helping in leakage detection, to reduce water wastage.

IoT Water Valve

When a water pipe bursts, not only the water gets wasted, worth thousands of dollars, but the entire water distribution system is affected. You can prevent such accidents by installing IoT water valves in your water distribution network. The IoT water valve can be controlled remotely via the internet by using a mobile application.

Intelligent Pricing

IoT smart water management solutions let you get configurable, intuitive, and insightful analytics to analyze the data collected from IoT water sensors and price the water according to the demand of the water we can price the water differently in winter and summer. This strategy can influence the water consumption habits of households and industries.

Water Quality Testing

The IoT water quality measuring system monitors the quality of water in real–time using various sensors which sense pH level, conductivity, TDS, Salinity, and Temperature to know the live water quality status of water. Proximity sensors alert the officials by notifying them via the cloud in case someone tries to pollute the water body.

Illustration:

https://www.youtube.com/watch?v=EnL_uP_GrjQ

CONCEPT OF WATER BUDGETING

Sarang Satish Kulkarni
Bharatiya Jain Sanghatana

With over 8 years of experience, Sarang Satish Kulkarni is a Subject Matter Expert (SME) in Water Resources, currently working with Bharatiya Jain Sanghatana. He has a diverse range of experience in working with various geographical and geological typologies in India. Sarang's expertise lies in groundwater development and management, based on the concept of aquifers. Sarang has worked extensively with stakeholders such as academic institutions, partner NGOs, corporates, national/international organizations, and government including the Ministry of Jalshakti, Ministry of Panchayat Raj, Ministry of Rural Development, and NITI Aayog, as well as local communities to support development initiatives and promote strategic engagements for sectoral development in the water domain.

Backdrop:

On account of climate change effects, increasing population and increasing demand of water from different sectors, the water resources are becoming more vulnerable. The mind set of people towards ownership of the water is again serious issue, where most of the people think that water is their private property. The water is being used without any control. Supply side approach is used extensively while planning and implementing soil and water harvesting interventions. On this backdrop the wise management of available water resources with supply side and demand side management of the water resources has become the need of time.

Water Budget:

The water budget mostly works on the principles of operating the Saving Bank Account opened in any bank. In bank accounts we save amount whenever is possible and we withdraw amount as per requirement. However, while doing so, we generally consider our present and future needs and then withdraw the amount. But, in no case we can withdraw amount more than our total savings in the account. The more amount we save in the bank account the more interest we can earn. The zero balance in the bank account means zero interest in the bank. The water we get every year through rainfall/ precipitation in the form of runoff, ground water and surface water and soil moistures are works like our savings and the water required for drinking, domestic use, agricultural use, commercial use, industrial use etc. work as our withdrawals from the water bank.

A water budget is a measure of the amount of water entering and the amount of water leaving a hydrological system/cycle for the set period of time. It is the process which mainly assess the volume of available water in the form of surface water, groundwater recharge and soil moisture. It also calculates the water required for different needs like human, livestock, agriculture throughout the year and finally action plans are developed to recover the deficit of water if there is a gap between the water available and water required. In short, water budgeting tool helps communities to understand the amount of water available for different uses and plan their water needs, mainly drinking water and cropping pattern, within available amount of water in watershed area/ village.

Water budgets commonly go well beyond the quantification of available water and identification of its locations in the watershed/ village. Understanding the flow dynamics of water in the watershed/ village are key aspects of the water Budget. The origin, the movement and the interactions between soil moisture, surface water and groundwater are studied in water budgeting. The water cycle, evapotranspiration, ground water and surface water flows and inter basin transfers (import and exports) etc. are taken into account while preparing the water budget.

Need of Water Budget:

- To know the availability or shortage of water for drinking/ domestic/ agriculture/ industrial/ ecological purpose and to plan accordingly.
- To create awareness among the water users about water availability, water requirement and ways of effective and efficient use of water for different purposes.
- To plan and develop water resources within watersheds/villages.
- To maintain the balance in the ecological system.
- To promote sustainable management of green water, surface and groundwater through active participation of stakeholders at different level.
- To facilitate a shift from intensive irrigation based cropping systems to low water intensive crops
- To achieve localised SDG number Six
- General information required for Water Budgeting:
- Following information is required for water budgeting.
- Weather information –Rainfall, temperature, humidity, evaporation, evapotranspiration, etc.
- **Topographic information:** Slope of land, soil type and geohydrology of the watershed. Census data like population, livestock number (Cow, Buffalo, Ship, Goat, Poultry, etc.),
- Agriculture information for example cropping pattern, area in acre or hectare under different crops, land under irrigation in acre or hectare, barren land area in acre or hectare etc. Availability of water resources in the watershed for example number of waterbodies (storage/ harvesting tanks, percolation tanks, cement nala bund, earthen nalla bunds, etc.) with its dimensions to calculate the capacity. Industries working in the watershed region (if any) has to be studied and understand for qualitative water budgeting. Various maps like Toposheet, Contour map, Soil map, Present Land use map, proposed land use map, Cadastral map, Map showing proposed land treatments and drainage line treatments etc. are required for water budgeting. The participation of community in the process of water budgeting is key and accordingly community should be motivated and oriented. Once community come to know whether they are part of water surplus/deficit watershed/village they may prepare to undertake necessary actions to use water effectively and efficiently. It is expected that village/ watershed community shall practice to display the total water budget at common community platform in the village.

Generally following data is required for water budgets of the watersheds/ villages.

Sr. No.	Particulars of Information
1.	Name of the Watershed/ Village
2.	Number of watershed/ Census code of Village
3.	Name of Block and District
4.	Present Population
5.	Average annual rainfall(mm)
6.	Cattle population (Cow, Bullocks, Buffalos etc.)
7.	Ship/ Goat Population
8.	Chicken/ Hen / Cock population
9.	Number of cottage industries / small enterprises
10.	Watershed area having slope more than 20%
11.	Watershed area having slope 5% – 20%
12.	Watershed area having slope less than 5%
13.	Area under Forest (ha)
14.	Farm Pond (no)
15.	Area under Social forestry (ha)
16.	Afforestation and grass land development by Agriculture Department (ha)
17.	Contour Bunding (ha)
18.	Contour Trenching (ha)
19.	Terracing (ha)
20.	Earthen Nalla Band having catchment of 10 – 40 ha (numbers)
21.	Earthen Nalla Band having catchment of 40– 80 ha (numbers)
22.	Earthen Nalla Band having catchment of 80–500 ha (numbers)
23.	Farm Pond (30m*30m*3m (no)
24.	Farm Ponds (100*100*3m (no)
25.	Sunkan Pond (no)
26.	Recharge pit (no)
27.	Cement Nalla Band (no)
28.	Village Pond (no)
29.	Percolation tank (no)
30.	Other if any

Components of the Water Budget:

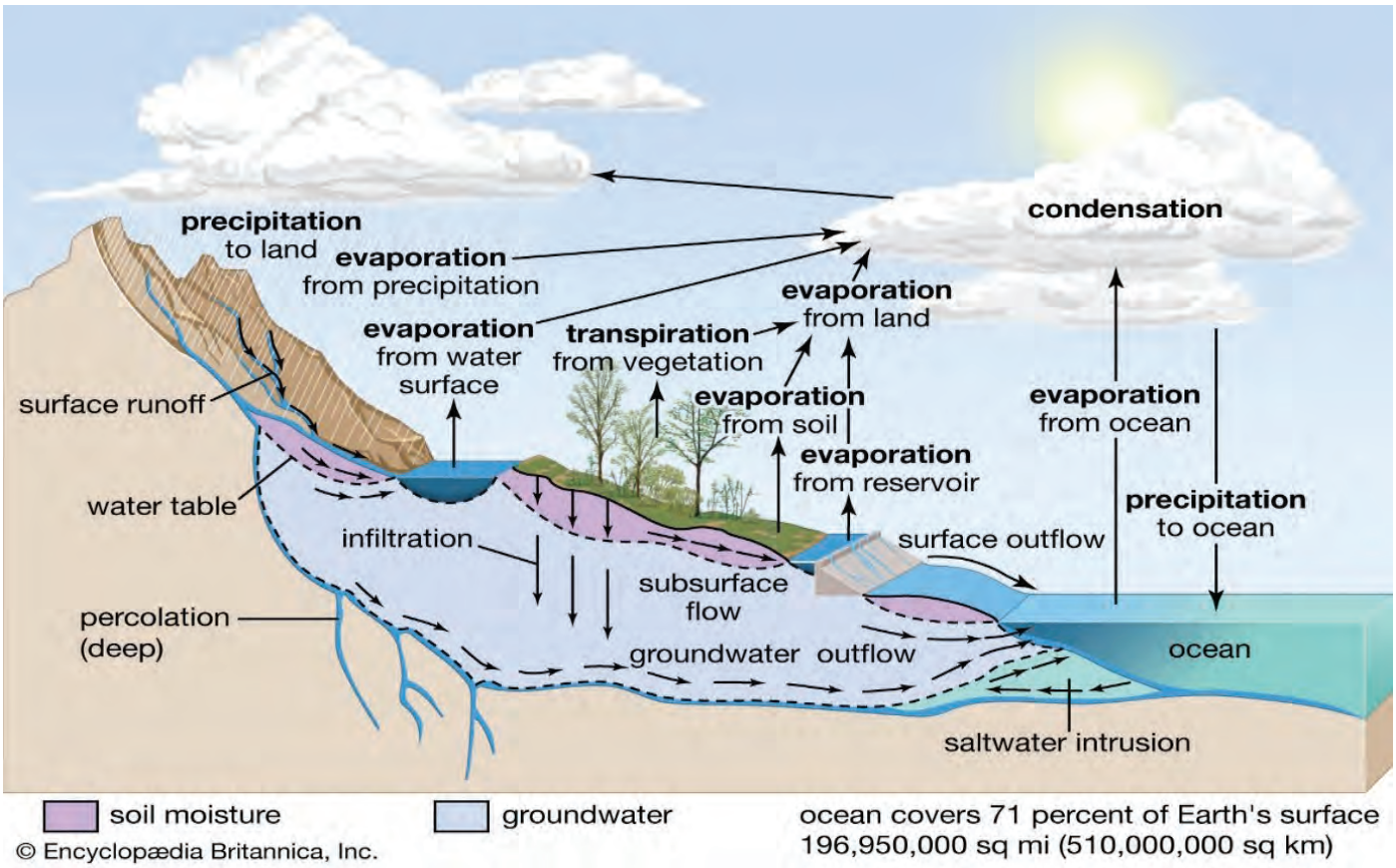


Figure 1: Water Cycle (Ref. https://www.britannica.com/science/water–cycle)

Fig.1 Water Cycle (Ref. https://www.britannica.com/science/water–cycle) The most basic equation for water budget is based on the hydrological cycle, where water moves from atmosphere to the different destinations of the surface of the earth and finally back to the atmosphere.

$$P = I + ET + R$$

Where, P = Precipitation, I = Infiltration, ET = Evapotranspiration, R = Runoff Precipitation:

The precipitation is major input to the water budget under natural conditions. We receive precipitation in different forms. Precipitation is the process of transforming the water vapour into a liquid or solid form, depending upon the temperature of air near the clouds. The term precipitation is a common term. It includes a variety of forms of precipitation. It includes mist, rain, hail, sleet and snow. The term precipitation and rainfall are always used synonymously. Precipitation mainly depends on the water vapour present in the atmosphere. When the air temperature is well below the freezing point, clouds may form tiny ice crystals. Rainfall is most common form of precipitation occurring in almost all parts of the world. In tropical regions, precipitation is expected completely as rainfall. In the polar regions, precipitation is expected to be completely as snowfall. In mid latitudes, at high altitudinal zones, precipitation occurs as snowfall, sleet and ice. All these are called as forms of precipitation.

Interception:

Interception is the process of retaining water on the leaves of vegetation. A small amount of rainfall is intercepted by vegetation. Interception can amount up to 15–50% of precipitation, which is a significant part of the water balance.

Evaporation:

Evaporation is the process of converting a liquid (or) solid into a gas, through the transfer of heat energy. Heat energy can convert water mass (or) ice into a vapour. Evaporation occurs more rapidly when there is increase in temperature and also flow of wind. It also depends on the boiling point and vapour pressure. A temporary increase in temperature results in increased evaporation and also increased precipitation. Water gets evaporated more rapidly in dry air.

Following are the factors affecting evaporation.

- Air Temperature

- Relative Humidity
- Incoming radiation
- Wind speed
- Duration of bright Sun shine
- Geomorphic conditions of the region.

The amount of water getting evaporated from a free water surface is measured using evaporimeters or pans.

Transpiration:
Transpiration is the process of releasing the water absorbed by the plants through their root system after utilizing the nutrients for building their tissues, in a specified time. Vegetation including numerous growing plants, play a significant role in the hydrologic cycle.

The water which is drawn into the plants rootlets from the soil moisture, owing to osmotic pressure moves up through the plants stems and leaves. Through the stomatal openings, the water is released out as water vapour. The amount of transpiration depends on the density and size of the vegetation existing in place. The amount of water used for irrigating the crops get transpired into the air. Transpiration is dominant during the growing season of crops in agricultural lands.

Most of this happens during day time, when photosynthesis is active in plants. Transpiration is limited due to the shortage of soil moisture in some places.

The controlling factors of transpiration are:
- Temperature
- Solar radiation
- Wind
- Soil moisture.

The total water loss due to evapotranspiration is known as evapotranspiration.

Runoff:
Runoff is the quantity of water that is discharged ("runs off") from a drainage basin during a given time period. The term runoff refers to the overland flow of water, after every rainfall or snowmelt. The overland flow starts when the rate of rainfall is greater than the rate of infiltration of the soil and increase in the amount of slope.

Following are some of the factors that affects the runoff in the watershed.
- The topography of the watershed/ village
- Shape of the watershed
- Drainage Network in the watershed and its minimum and maximum length
- The soil type and depth of the soil
- Vegetation cover
- Rainfall – Intensity
- Duration of Rainfall.
- Distribution of Rainfall.
- Direction of Storm Movement.
- Soil Moisture Conditions.

Infiltration:
Infiltration is the downward percolation of rainwater into the soil horizons. The downward movement of water happens in the top soil layer, especially through the smaller pore spaces present in the soils. Infiltration is governed by two forces as gravity and capillary action. The smaller pores offer greater resistance to gravity, very small pores pull water through capillary action in addition to and even against the force of gravity. The rate of infiltration varies from soil to soil. It depends on the hydrologic properties of soils, like porosity and permeability.

The process is also known as percolation. The percolating rainwater ultimately reaches the groundwater zone. The process of infiltration happens only when there is space available for addition of water within the soil surface. This depends on the porosity of the soil and the rate at which previously infiltrated water can move away from the surface through the soil.

The maximum rate that water can enter into a soil layer in a given subsurface condition is known as the infiltration capacity. Infiltration rate in soil science is a measure of the rate at which a particular soil is able to absorb rainfall or irrigation. The rate decreases as the soil becomes saturated. If the precipitation rate exceeds the infiltration rate, runoff will usually occur unless there is some physical barrier.

Following factors affects the rate of infiltration.
- Porosity and permeability of the soils
- Structure and texture of the soils
- Surface entry possibilities of the soils
- Transmission through the soil
- Already available soil moisture and its depletion
- Characteristics of the fluid.

Base Flow:
The rainwater that is falling over the ground surface percolates down through the soil and reaches the groundwater zone. Depending upon the groundwater ecosystem i.e. geology and rock openings for example fractures/ joints, etc, groundwater table and aquifer characteristics, the groundwater comes out of the aquifer and contributes to the rivers, lakes or the oceans. This flow of groundwater is known as base flow. It depends on the hydrologic properties of rocks forming the groundwater systems.

Major Units & Conversion factors for Water Budget:
1 hector area = 2.5 acres
1 hector area = 10,000 sq. meters
1 acre = 40 are
1 Cubic meter water =1000 litre
1 Ha mm water = 1 ha x 1 mm = 10 cubic meter water
1 TCM = 1000 cubic meter water = 1,000,000 litre water
1 Ham = 1 crore litre water

Calculating water budget of watershed area/ village:

Sr. No.	Particulars	Remarks
1.	Water Received from Rainfall of the watershed area/ village in cum = Total area of watershed / village (Ha) x Average annual rainfall (mm) x 10	
2.	Water available in the form Soil moisture which is also known as Green water (30% of serial number 1) = ...cum	The proportion of 10% groundwater recharge depends on geography and geology of the area as well as soil profile and soil infiltration rate. These factors are necessarily to be considered to finalize this percentage. The excess or shortage of percentage of groundwater recharge can be adjusted with surface runoff)
3.	Water available in the form of Groundwater (10% of sr. no.1) = ...cum	
4.	Water available in the form of surface runoff (25% of sr. no.1) = ...cum	
4.	Water lost due to evaporation (35% of sr. no.1) =..... cum	
5.	Gross water available in the watershed = Water received from rainfall – (water loss due to surface runoff + water loss due to evaporation) + water received from canal or inflow from upstream watershed area.	
6.	Water required for domestic use = Population x 55 lit. per day x 365 days / 1000 = ———————— cum	
	Water required for livestock = Livestock no x 35 lit per day x 365 days /1000 = ———————— –– cum.	
	Water required for Agriculture	Should be calculated by types of crops that are taken in kharip, rabi and summer crops and their water requirement. The water required for perineal crops should also be taken into account.
7.	Run off that can be harvested in existing watershed treatments. (This should be calculated by knowing the area under different treatments and number of various soil and water harvesting structures.	Pl. check the table given on page number 10 for more details.
8.	Total Runoff available for harvesting = water available in the form of surface runoff (cum) – total water harvested with the help of different structures in watershed area (cum)	

Runoff that can be harvested with existing watershed treatments:

Sr. No.	Type of intervention/ Treatment	Potential water harvesting per ha/number
1.	Area under Forest (ha)	0.224 TCM /ha
2.	Forest Pond (no)	2.00 TCM / No
3.	Afforestation and grass land development by Agriculture Department (ha)	0.224 TCM /ha
4.	Contour Banding (ha)	0.45 TCM/ ha
5.	Vegetative Contour Banding	0.45 TCM/ Ha
6.	Contour Trenching on 0–4% slope (ha)	0.27 TCM/ ha
7.	Contour Trenching on 4–8% slope (ha)	0.318 TCM/ha
8.	Terracing (ha)	1.512 TCM/ha
9.	Earthen Nalla Band having catchment of 40– 80 ha (numbers)	3.00 TCM / No
10.	Earthen Nalla Band having catchment of 80–500 ha (numbers)	6.00 TCM /no
11.	Farm Pond (30m*30m*3m (no)	2.196TCM/No
12.	Farm Ponds (100*100*3m (no)	28.236 TCM/No
13.	Sunkan Pond (no)	0.90 TCM/ No
14.	Recharge pit (no)	0.60 TCM / No
27.	Cement Nalla Band (no)	8.00 TCM / No
28.	Village Pond (no)	10 TCM / No
29.	Percolation tank (no)	20 TCM/ No
30.	Other if any	–

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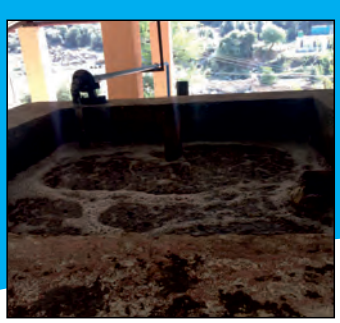

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ABENGOA STARTS COMMERCIAL OPERATION OF PHASE TWO OF THE TAWEELAH DESALINATION PLANT IN ABU DHABI

Abengoa, the international company that applies innovative technology solutions for sustainability in the infrastructure, energy, and water sectors, in consortium with the company SEPCOIII, has started commercial operation of phase two of the Taweelah desalination plant (Abu Dhabi), following the successful completion of the contractual tests. This is the largest reverse osmosis desalination plant in the world (909,218 m3/day) and the first to combine the production of drinking water with the generation of clean energy. The project is located at the Taweelah Power and water generation complex, 45 km north of Abu Dhabi (United Arab Emirates).

Specifically, testing for Taweelah group two was successfully completed on April 9. Following the successful completion of the contractual tests, commercial operation of phase two of the Taweelah desalination plant has been declared by our client, the leading developer, investor, owner and operator of power generation and desalinated water production plants, ACWA Power, TAQA and Mubadala.

Previously, in phase one of Taweelah, which entered commercial operation and was delivered to the customer in mid–2022, Abengoa managed to desalinate 450,000 m3/day. The plant produces 909,218 m3/day (phase one + phase two), making it the world's largest plant in production. The Taweelah desalination plant guarantees supply to the city of Abu Dhabi (approximately four and a half million people) throughout the year and is the first large–scale plant in the emirate to combine the production of drinking water with the generation of clean energy, thanks to the installation of a photovoltaic solar field with a capacity of more than 70 MWp. The project will reduce the energy demand of the desalination plant in a sustainable manner. Furthermore, this project, located on the coast of the Persian Gulf, is part of the plan developed by the government of the United Arab Emirates to encourage private participation in the development of the country's infrastructures.

Abengoa has been the technologist at the Taweelah plant and has developed the design, engineering, supply of the main equipment, supervision of assembly, commissioning, and commissioning. The Taweelah desalination plant meets each one of the drinking water parameters required by the Emirate of Abu Dhabi, including hardness, alkalinity, LSI (Langelier Saturation Index), SDI (Silt density Index), pH, or Boron content.

Abengoa once again demonstrates its capacity to develop complex projects from the technical point of view, and to adapt to adverse working conditions, in very diverse countries, providing an optimum response to the client's requirements. It also consolidated its position as a leading company in the desalination sector worldwide, and strengthened its presence in the Middle East, where it has a very extensive portfolio: in Saudi Arabia, the Jubail 3A desalination plant (600,000 m3/day), Rabigh III (600,000 m3/day) and Shuaibah III (250,000 m3/day), all completed; Dubal (47,750 m3/day), in the United Arab Emirates, in operation; and Salalah (114,000 m3/day), in Oman, also completed.

Shrinath Garg
Responsible for Business Developments activities in India & neighboring countries for Abengoa

Shrinath Garg is a Mechanical Engineer with PGEMP in Marketing & Finance, having around 19 years of experience in water & wastewater sector in multiple roles. Presently he is responsible for Business Developments activities in India & Neighboring countries for Abengoa which mainly targets Desalination, WWTP, Solar & T&D projects. He was associated with various Indian & International organizations like Thames water, Veolia, Mott Mac, JUSCO (Tata), etc. and played significant roles from project development till commissioning. He is also a Life Members of Indian Water Works Association (IWWA), Mumbai since 2013."

Abengoa, winner of the Global Water Award for desalination plant of the year by Taweelah

Abengoa, the international company that applies innovative technology solutions for sustainability in the infrastructure, energy and water sectors, has received the Global Water Intelligence (GWI) desalination plant of the year award for the Taweelah plant. The awards ceremony took place on May 9 at the Estrel Congress Center in Berlin (Germany), as part of the Global Water Summit, a high–level event where the companies that lead the international panorama of the water sector have met.

The Global Water Award for desalination plant of the year was presented during the gala dinner held in Berlin. Antonio Lara, Abengoa's Director of Water Operations, stated that "the Taweelah plant is the largest desalination plant in the world in commercial operation which produces 909,000 m3 daily, the award received has been a fair recognition of Abengoa's excellent team of professionals, and especially in the Taweelah project. "

The organization of the Global Water Awards has highlighted the Taweelah desalination plant that "represents a historic step towards the decarbonization of the emirate's thermal desalination system. This desalination plant includes a solar photovoltaic plant to supply more than 30 % of its energy which will reduce Abu Dhabi's carbon footprint by 2.5 million tons of CO2 per year, marking the beginning of a new era of sustainable desalination in the emirate."

At the same time, Taweelah's project is a benchmark from a financial point of view. As announced by GWI, "by taking advantage of solar power generation, it was possible to overcome the challenge of energy price competitiveness in Abu Dhabi, managing to supply water below USD 0.50/m3. Taweelah is also the first desalination project to be qualified as a "sustainable loan".

In the desalination plant of the year category, Abengoa competed with the Bahri desalination barge (Saudi Arabia), Qingdao Baifa Phase 2 (China) and Shuqaiq 3 (Saudi Arabia) projects.

Other awards granted by GWI to Abengoa

This award granted by the GWI to Abengoa in the category of desalination plant of the year 2023 by Taweelah adds to the company's track record in which it already has:

- Three awards for desalination company of the year, in 2015, 2013 and 2009.
- Twice finalist for desalination company of the year, in 2018 and 2020.
- Desalination Project of the Year Award, for the Shuaibah plant, in 2020.
- Developer of the Year Award, in 2007.
- Desalination Plant of the Year Award for Rabigh3 in 2022.

About Abengoa

Abengoa applies innovative technology solutions for sustainability in the infrastructure, energy and water sectors. (www.abengoa.com). Abengoa offers integral solutions for industrial clients and public institutions in the areas of desalination, water treatment, wastewater treatment and reuse of urban and industrial wastewater, and hydraulic infrastructures (regulation, transport, distribution, irrigation, hydroelectric power plants and systems for hydrological management)

Abengoa takes pride in successfully executing Chennai Minjur 100,000 m3/day desalination plant which was the first and largest SWRO (Seawater Reverse Osmosis) project at that time under the DBOOT modality (Design, Build, Own, Operate and Transfer). We firmly believe due to technological advancements & hybrid mechanisms, we can ensure water security to the people on a long term basis & in a cost–effective manner.

Safeguard
Your Health with

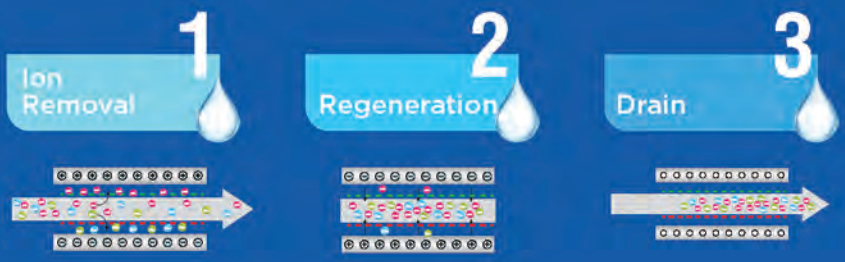
Advanced Drinking Water Treatment Solutions

Drinking water treatment is not just a matter of convenience; it is a crucial step in safeguarding our health and well-being. With the arrival of summer, when the risk of water-borne diseases amplifies, it becomes even more important to prioritize clean and safe drinking water. The scorching heat and the challenges associated with polluted water sources create a breeding ground for harmful microorganisms, putting us at greater risk of illnesses. Inadequate drinking water treatment and access to clean water further compound the problem, making it essential to address the dangers lurking in our water supply.

Understanding the Importance of Drinking Water Treatment for a Safe Summer

The role of drinking water treatment in mitigating the risks of water-borne diseases is paramount. These diseases primarily spread through the consumption of contaminated water, where impurities find their way into our water sources. During the summer months, when water scarcity and improper storage practices prevail, the chances of water contamination escalate. Compromised sanitation infrastructure, insufficient drinking water treatment, and improper handling and storage techniques contribute to the deterioration of water quality, putting our health in jeopardy. To combat these risks effectively, we must embrace innovative drinking water treatment solutions that can remove impurities and contaminants, ensuring safe drinking water for all.

At the forefront of revolutionary drinking water treatment technologies stands Liqui De-ionization (LDI). Let's see how this innovative approach revolutionizes drinking water treatment, ensuring the safety and well-being of individuals and communities.



Revolutionizing Drinking Water Treatment with LDI Technology

Liqui De-ionization (LDI) technology redefines the removal of impurities and contaminants from water while preserving its essential minerals. LDI strikes a perfect balance between eliminating impure mineral salts and retaining the natural goodness and essential minerals present in water.

LDI technology utilizes a pair of parallel carbon electrodes separated by a porous membrane to create an electric field. This process attracts and captures ions present in the water, reducing the concentration of impurities. The result is deionized water of exceptional purity, free from contaminants.

Not only does LDI technology remove impurities, but it also provides an added layer of protection against water-borne diseases by improving our immunity with essential minerals. Its advanced filtration methods effectively target ions, ensuring the water we consume is pure. Adopting LDI technology fortifies our defenses against diseases which tend to become more prevalent during this time of year.

With its transformative capabilities, LDI technology offers a sustainable and long-term solution to combat the risks associated with water. By harnessing the power of LDI technology, we can treat our water and transform it into a safe and reliable resource for consumption.

LDI Water Purifier:

Treating Water to Deliver Safe and Refreshing Drinking Water

Within the realm of water purification, LDI Water Purifier stands as an innovator in ensuring safe and refreshing drinking water, especially during the summer season. By harnessing the power of LDI technology, this advanced machine effectively treats water, eliminating impurities, including harmful chemicals, from the water supply. LDI Water Purifier provides a reliable and efficient drinking water treatment solution, delivering purified water that is not only free from contaminants but also enriched with essential minerals. With its low maintenance requirements and high energy efficiency, it becomes an ideal choice for homes, offices, and various commercial settings, providing peace of mind and promoting good health.

In the realm of drinking water treatment, Liquiclear's LDI technology shines as a beacon of hope, especially in the face of the challenges posed by water-borne diseases during the summer season. By tackling the risks associated with water, Liquiclear's water treatment solutions offer a dependable means to protect public health and enhance overall well-being. Embracing these advanced technologies becomes paramount in our quest to safeguard public health, curb the transmission of water-borne diseases, and ensure a summer that is not only safe but also rejuvenating.

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17–19 October, 2023
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https://www.ifat–india.com/

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22–24 November, 2023
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https://www.seacoastal–tourism.com/

SRW Water Expo
4–6 January, 2024
Chennai, India
https://www.waterexpo.in/

Water India Expo
17–19 January, 2024
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https://www.waterindia.com/

Water Today's Water Expo
28 February–1 March, 2024
Izzathnagar, Kothaguda, Telangana
https://www.waterexpo.biz/

Buyer/Seller:
Karnataka Co.Operative Milk Producers Federation Limited

Ref. Number: 58710838
Tender Number: KMF/ENGG/TUMUL–MEGA DAIRY/2022–23
Requirement: Design, Supply, Installation, Testing & Commissioning of Steam generation system, including steam header, steam piping, PRS insulation, structural Support & other utilities like Air compressor, water Treatment plant, suitable for 10LLPD expandable to 15LLPD capacity liquid milk processing plant along with 3LLPD capacity condensing plant, 1.5LLPD capacity curd plant on turn key basis for Tumkur Milk Union.
EMD: INR 2,200,000
Closing Date: 12/05/2023
Location: Tumkur – Karnataka – India

Buyer/Seller:
Bhiwandi Nizampur Municipal Corporation

Ref. Number: 58580291
Tender Number: 87/2022–2023
Requirement: Augmentation to bhiwandi nizampur water supply 100 MLD scheme for Construction of jack well, over head pump house, retaining wall, sub station, rcc bridge, raw water and pure water MS rising mains, conventional WTP
Closing Date: 09/05/2023
Location: Bhiwandi – Maharashtra – India

Buyer/Seller:
Haryana State Industrial And Infrastructure Development Corporation Limited

Ref. Number: 58392324
Requirement: Construction of 57 MLD WTP and all contingent works there to in all respect along with 120 months of operation and maintenance at IMT kharkhoda, district sonipat
Closing Date: 03/05/2023
Location: Sonipat – Haryana – India

Buyer/Seller:
Haryana State Industrial Development Corporation Limited

Ref. Number: 58151818
Tender Number : 2023_HBC_264464_1
Requirement: Construction of 57 mld wtp ... planning, design, engineering, procurement, construction, installation, testing, commissioning of 57 mld water treatment plant (wtp) alongwith oand m of 10 years at imt kharkhoda
Tender Detail: Construction of 57 Mld Wtp ... #*. Planning, Design, Engineering, Procurement, Construction, Installation, Testing, Commissioning of 57 Mld Water Treatment Plant (Wtp) Alongwith Oand M of 10 Years at Imt Kharkhoda
Document Fees: INR 50,000
EMD: INR 10,281,000
Closing Date: 03/05/2023
Location: Karnal – Haryana – India
Contact Details: Haryana Board Corporation||hsiidc||kharkhoda||industrial Area kharkhoda

Buyer/Seller:
Madhya Pradesh Power Generation Company Limited

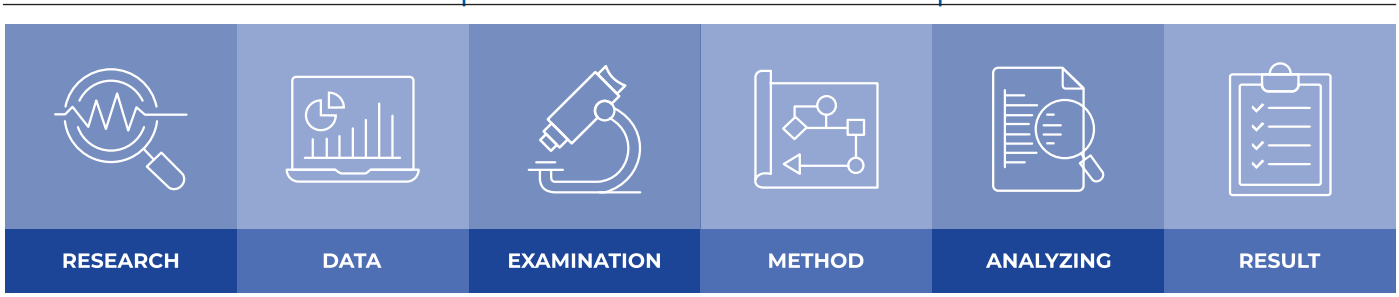
Ref. Number: 58772465
Tender Number: 2023_MPPGC_257602_1
Requirement: Work contract for routine maintenance of system and equipments of wt plant, pt plant and pump house, clarified water and filter water pump house, cw pump house, raw water pump house, dozing system (hp, lp dozing pumps) etc. of 210 mw atps
Document Fees: INR 1,000
EMD: INR 43,000
Tender Estimated Cost: INR 2,151,318
Closing Date: 01/05/2023
Location: Chachai, Madhya Pradesh, India
Contact Details: Madhya Pradesh Power Generating Company Limited||chief Engineer(gen.)–amarkantak Thermal Power Station, Chachai, MPPGCL ATPS Chachai

Corrigendum – 1
Published On: 02/05/2023

Corrigendum Details: Deadline has been changes from May 1 2023 12:00AM to May 8 2023 12:00AM
Corrigendum Document: Available Corrigendum Document For Download
Buyer/Seller: Panchayat Raj Department
Ref. Number: 59437877
Tender Number: 2023_HRY_276380_1
Requirement: Village Jailaf,block– Narnaul, Laying of Rcc Waste Water Pipe Line
Tender Estimated Cost: 409,000
Closing Date: 08/05/2023
Location: Narnaul – Haryana – India
Contact Details: Haryana Government||panchayati Raj Haryana||xen Panchayati Raj Narnaul jailaf

Corrigendum – 1
Published On: 02/05/2023

Corrigendum Details: Deadline has been changes from May 1 2023 12:00AM to May 8 2023 12:00AM
Corrigendum Document: Available Corrigendum Document For Download
Buyer/Seller: Panchayat Raj Department
Ref. Number: 59438550
Tender Number: 2023_HRY_276419_1
Requirement: Village Dohar Khurd, Block– Narnaul, Laying of Waste Water Pipe Line From H/o Lalchand S/o Ramchander to Pond
Tender Estimated Cost: 607,000
Closing Date: 08/05/2023
Location: Narnaul – Haryana – India
Contact Details: Haryana Government||panchayati Raj Haryana||xen Panchayati Raj Narnaul Dohar Khurd



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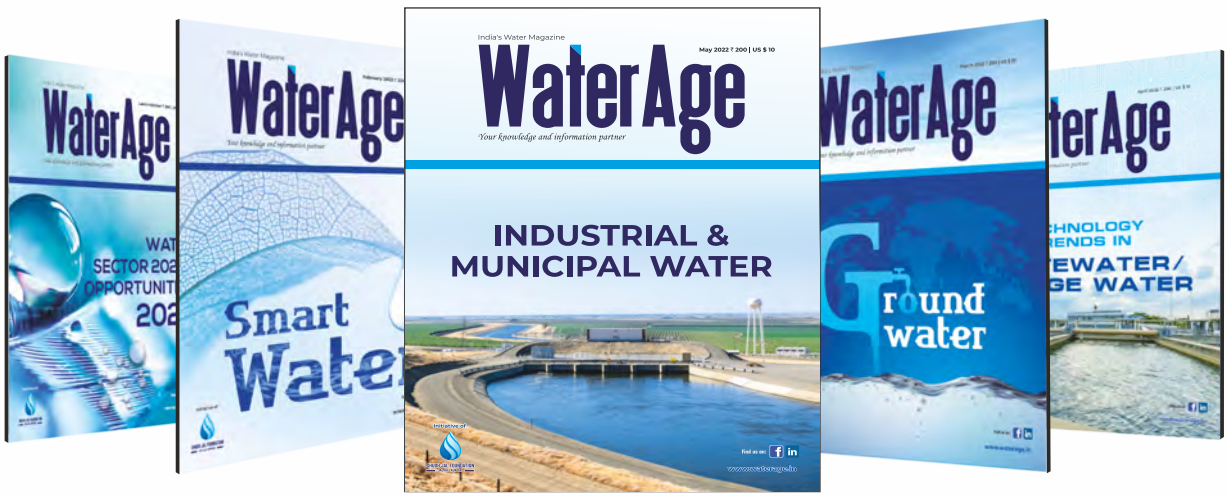

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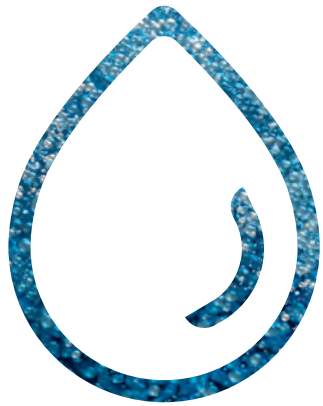

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Indus Waterways

Water & Wastewater Solutions

Indus Waterways providing consultancy for total water management and treatment solutions for Water and Wastewater Treatment, started business in 2009 and since then provided services to hundred of clients in Industries, Municipal and Hospitality sector

SERVICES TO PROVIDED BY CONSULTANT

- Detailed survey of proposed network of sewar line.
- Preparation of sewer network showing GL/IL.
- Location type design of manholes, intermediate sump well/lift well.
- Calculation of sewage generation.
- Type of treatment of sewage.
- Specification of mechanical and electrical equipment of sewage network STP & ETP.
- Preparation of drawing.
- Preparation of bill of quantities, detailed estimates BOQ and estimate based on MES SSR – 2020 and market analysis for Non-SSR items for sewage network STP & ETP.

FIELD OF EXPERTISE

H.O.: SCO 146-147, Sector-34A, Chandigarh-160022, T.: +91 172 5275055, 4012755
Corp. Office: 605, Bhikaji Cama Bhawan, Bhikaji Cama Place, New Delhi-110 066, Tel.: +91 11 41551444, 45524715
E-mail: induswaterways@gmail.com

ENGINEERING EXCELLENCE

RYSA INFRATECH PVT. LTD. (RIPL) is a fast-growing EPC company established in the year 2015. RIPL is an enlisted contractor with Military Engineer Services (MES) for:

- Pre-Engineered Building & Infrastructure
- Water & Wastewater Treatment Projects
- Sewage Disposal and Water Distribution Network
- Electro-mechanical utility services
- Low Tension Electric Works
- Incinerators


SEWAGE TREATMENT PLANTS


LOW TENSION ELECTRIC WORK


WATER TREATMENT PLANTS


WATER DISTRIBUTION

COMPLETED PROJECTS

RYSA Infratech Pvt. Ltd.

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