India Water, Wastewater & Industrial Effluent Market

SUBMITTED TO:

JAPAN EXTERNAL TRADE ORGANIZATION

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Executive Summary

India's Macroeconomic Backdrop

USD ~4.15 Tn

2026 Nominal GDP - 6th largest globally; real GDP growth >6.4%

USD 7+ Tn

2030 GDP projection - continued expansion trajectory

~10% YoY

CAPEX growth (GFCF), FY2025 to FY2026

USD ~740 Bn

2026 Forex reserves; CPI moderated to 4.45%

Target Sector Growth (CAGR)

Sector	Target CAGR
Services	10–12%
Manufacturing	9–11%
Infrastructure & Utilities	7–9%

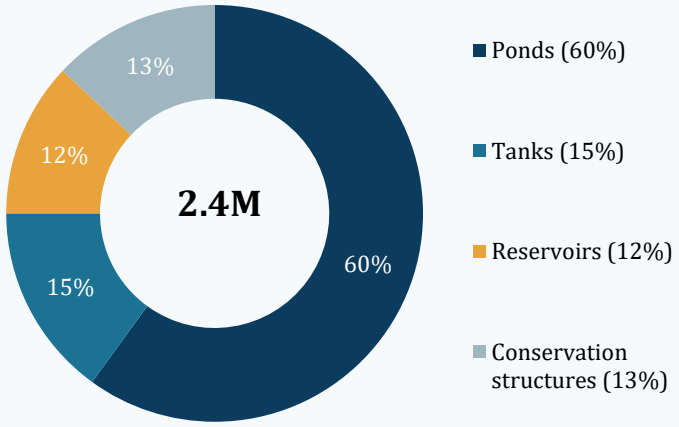
USD 27.5 Bn with around 1500 Japanese companies

- ✓ India–Japan bilateral trade reached USD 27.5 Bn in FY2025–26, continuing its upward trajectory from USD 25.2 Bn in FY2024–25.
- ✓ Japanese companies in India have reached ~1,500, with manufacturing firms accounting for around half of the total.
- ✓ Japanese FDI in India reached USD 48.1 Bn cumulatively through March 2026, making Japan India's 5th-largest source of FDI.
- ✓ Japan has committed JPY 10 Tn (~USD 67 Bn) of private investment in India over the next decade, reinforcing long-term capital commitment.

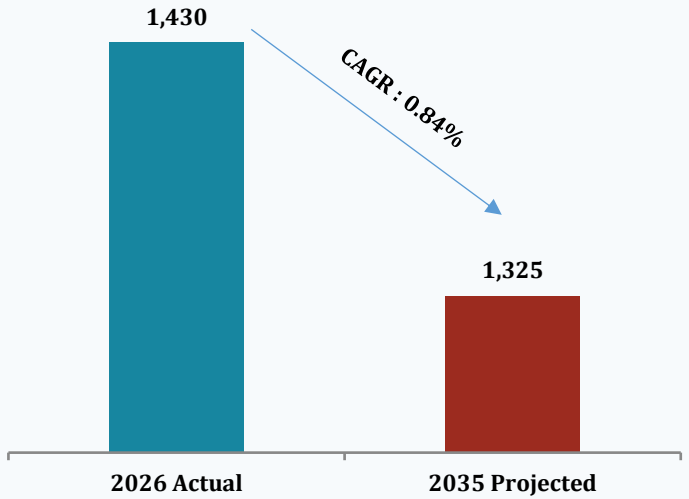
Sources: BDB Analysis based on secondary data from study reports, articles and government reports

India Water-stress Threshold Vs Water Need

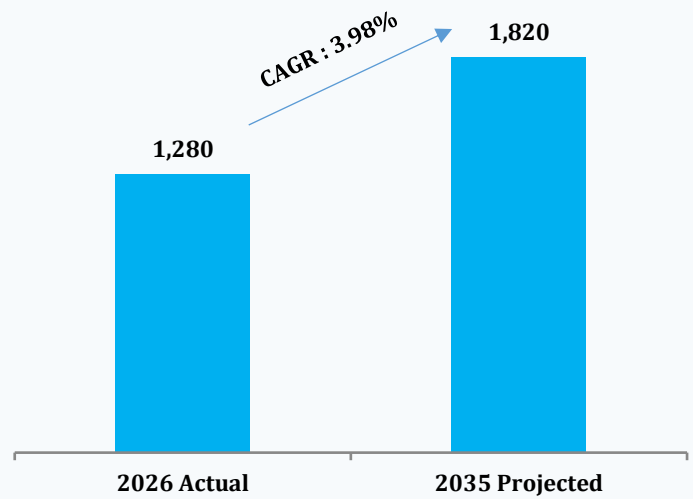
Water Bodies by Type



Per-Capita Water Availability (m^3/year)



India Water Need by 2035



- ✓ India supports 17–18% of global population with only 4% of global freshwater resources.
- ✓ Groundwater accounts for 30% of freshwater storage, supplying primary urban drinking water and agricultural demand.
- ✓ Current utilizable water availability sits around 30% of India's roughly 3,880 BCM total annual average.

- ✓ India's water requirement is projected to rise significantly, reaching ~1,820 BCM by 2035.
- ✓ It is majorly driven by population growth, urbanization and industrialization, further intensifying the country's water-stress challenge.

Sources: BDB Analysis based on reports and information from Ministry of Jal Shakti, Central Water Commission, CWMI (NITI Aayog), JM Financial Planning Commission/NITI Aayog CWMI, CWC..

Overview: Government Water Mission

Jal Jeevan Mission (JJM)

USD 8 Bn

Targets 100% Functional Household Tap Connections to 146 million homes.

AMRUT 2.0

USD 36 Bn

Universal piped water supply and sewerage expansion across 500 cities.

Namami Gange (NMCG)

USD 2.4 Bn

Targets 7,000 MLD of STP capacity along the Ganga basin by Dec 2026.

Atal Bhujal Yojana

USD 720 Mn

Community groundwater recharge with smart IoT monitoring.

PMMSY - Aquaculture's Parallel Funding Channel

- ✓ Total outlay: ~USD 2.74 Bn for FY21-25, extended through FY26. Subsidy runs 40% of project cost for general beneficiaries and 60% for women/SC/ST beneficiaries on cage culture and RAS.
- ✓ Andhra Pradesh alone received a dedicated USD 211.7 million allocation. A newer sub-scheme, PMKSSY, adds over USD 981 million (2023-24 to 2026-27) to formalize small fisheries enterprises and fund aquaculture insurance.

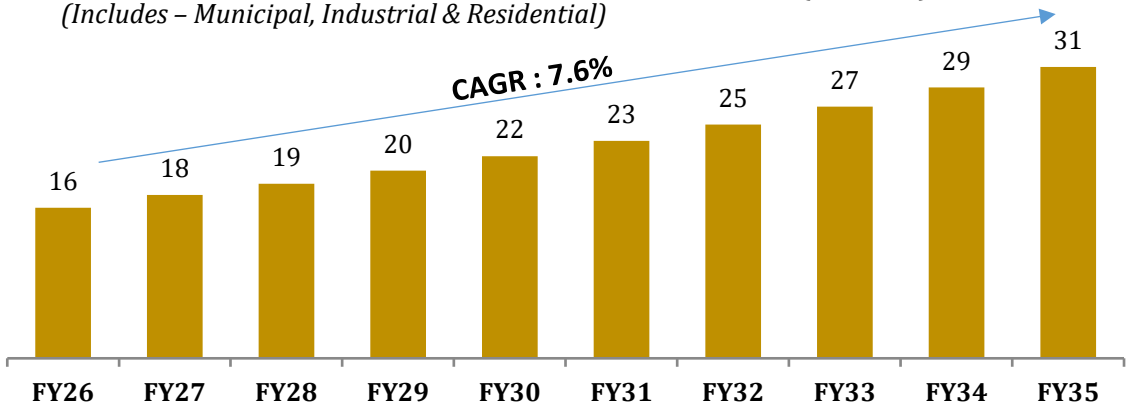
Sources: BDB Analysis based on reports and information from Ministry of Jal Shakti, Dept. of Drinking Water & Sanitation, NMCG, PIB, IBEF.

Overview: Wastewater, Sewage, National CETP & Aquaculture Market

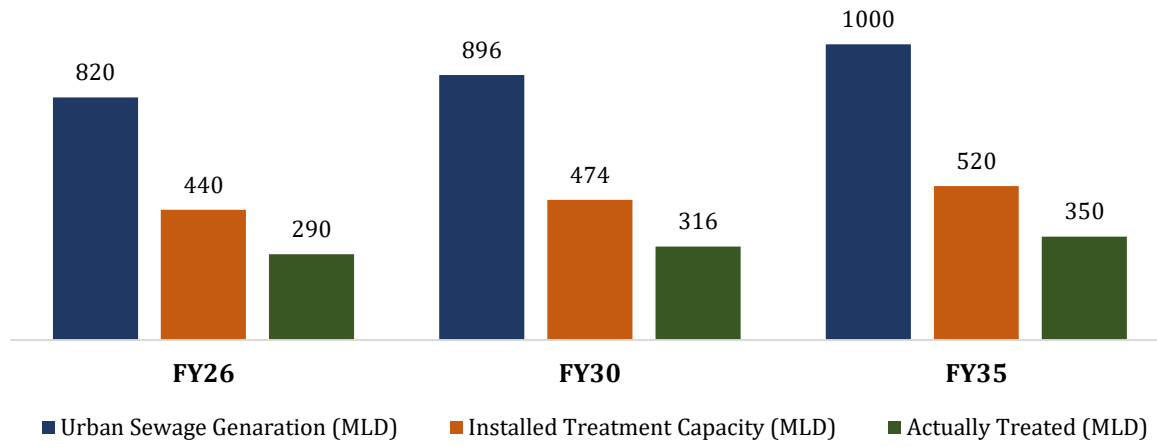
Focus Area Application

Market Size – Water –Wastewater FY26E – FY35P (USD Bn)

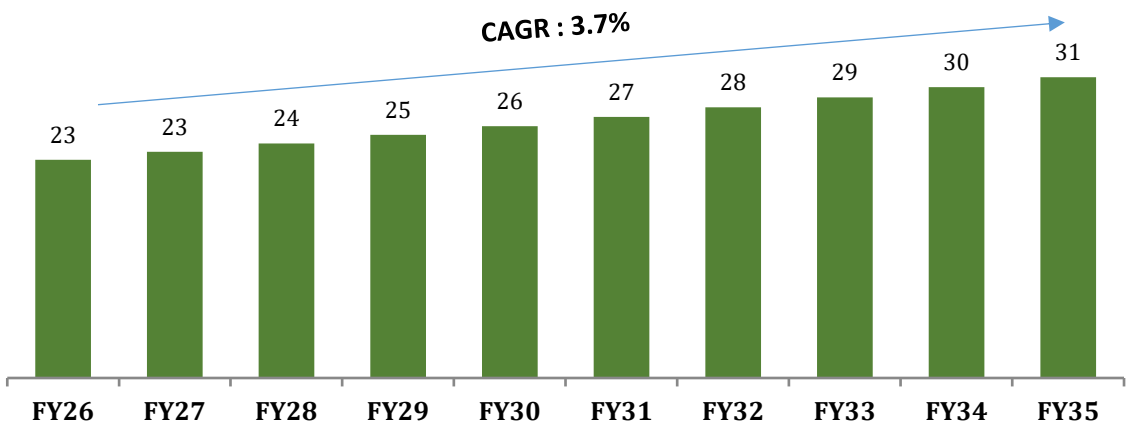
(Includes – Municipal, Industrial & Residential)



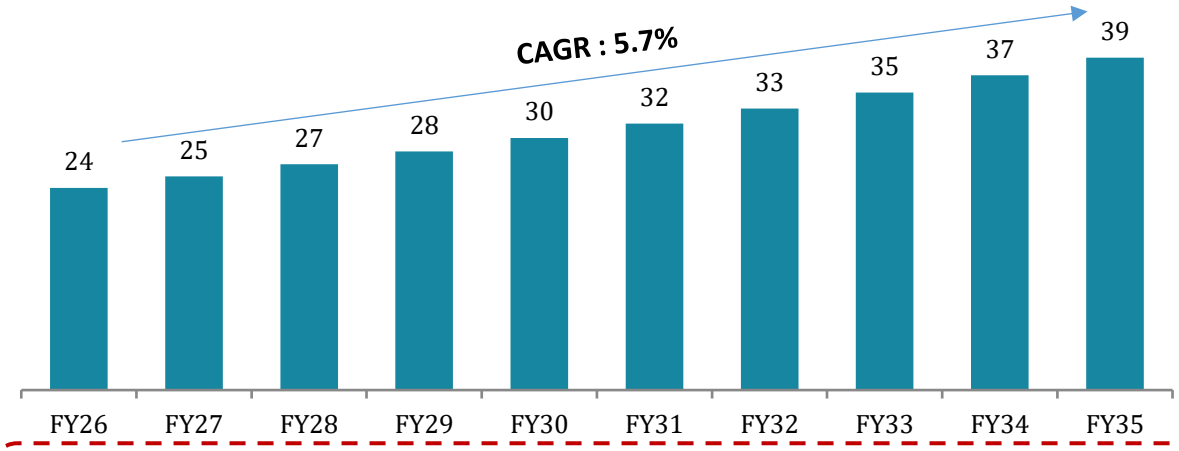
Urban Sewage: Generation vs. Treatment Capacity, ("00" MLD)



National CETP Capacity Outlook: FY26–FY35 ("00" MLD)



India Aquaculture Market Outlook FY26 – 35 (USD Bn)



Focus Application Area

Sources: BDB Analysis based on secondary data from study reports, articles and government reports

Industrial Infrastructure Snapshots

Gujarat Ecosystem

35 CETPs

767 MLD capacity, 6,483 units; 10 more underway

Vapi Estate

55 MLD CETP

Serving 1,400 chemical units

Vatva Estate

>250,000 mg/L

Ultra-high TDS via spray drying & evaporators

Tiruppur Cluster (TN)

19 CETPs

Operating under mandatory ZLD rules

Why the CETP Operator Is the Real Customer

- ✓ MSME chemical units rely on the CETP model because the capital cost of individual ZLD units is simply out of reach for most small operators.
- ✓ This shared-infrastructure structure is exactly why buyer/partner conversations here are usually with the CETP operator or industrial estate authority, not each individual factory - the single most important structural fact in this entire report for a Japanese technology supplier planning market entry.

Sources: BDB Analysis based on reports and information from Gujarat Pollution Control Board, GIDC, Tiruppur Dyers Association.

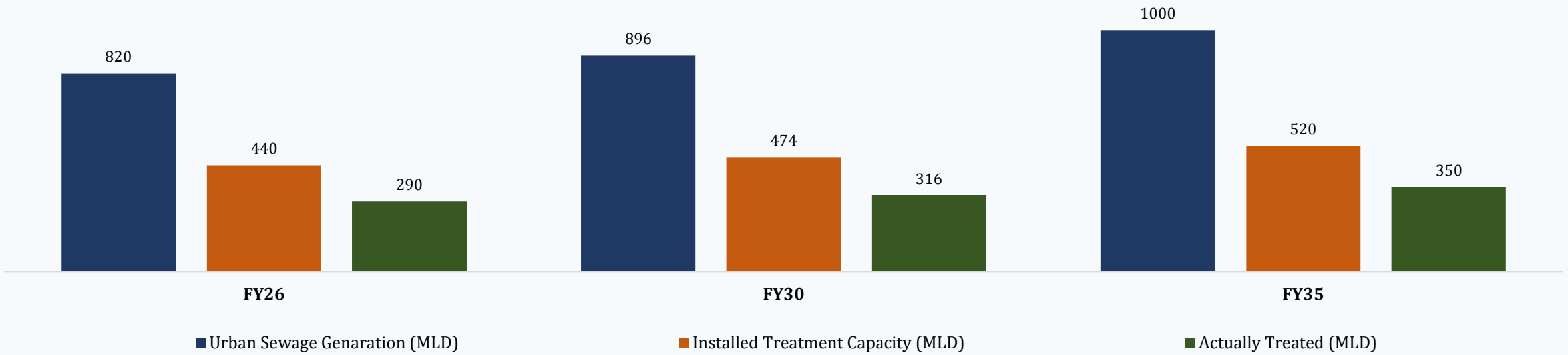
Region-wise CETP Details & Segments Catered

State / UT	Approx. CETPs	Dominant Sectors Served
Gujarat	~35–40	Chemicals, dyes & intermediates, pharmaceuticals, petrochemicals
Maharashtra	~25–30	Chemicals, textiles (Mumbai, Solapur), pharma, food processing
Tamil Nadu	~20–25	Textiles (Tirupur, Erode, Karur), leather (Vellore, Dindigul)
Uttar Pradesh	~15–20	Leather (Kanpur, Unnao), textiles, distilleries
Rajasthan	~15–18	Textiles & dyeing (Pali, Balotra, Jodhpur), chemicals
Haryana	~10–12	Textiles (Panipat), dyeing, mixed industries
Delhi	~10	Mixed small-scale industries (electroplating, chemicals, textiles)
Punjab	~8–10	Textiles & hosiery (Ludhiana), dyeing
Karnataka	~8–10	Textiles (Bellary, Peenya), steel, engineering
West Bengal	~8–10	Leather (Kolkata cluster), chemicals, dyeing
Andhra Pradesh & Telangana	~8–10	Pharma (Hyderabad), textiles, chemicals
Kerala	~5–6	Food processing, coir, rubber
Madhya Pradesh	~5–6	Textiles (Indore), chemicals
Odisha	~3–4	Steel, chemicals

Sources: Secondary Research

02
Wastewater Dynamics

Overview: Sewage Generation Vs Treatment Capacity



- ✓ Urban generation: 82,000 → 100,000 MLD | 2.2% CAGR, Installed capacity: 44,000 → 52,000 MLD | 1.9% CAGR, Actually treated: 29,000 → 35,000 MLD | 2.1% CAGR
- ✓ Sewage generation to reach ~100,000 MLD by 2035
- ✓ ~25% increase in urban sewage load
- ✓ Treatment capacity continues to lag generation
- ✓ Persistent treatment gap creates significant infrastructure demand
- ✓ STP expansion & wastewater reuse are key growth opportunities

Sources: BDB Analysis based on reports and information from Ministry of Jal Shakti

Water & Wastewater: Regulatory & Industrial Effluent Framework

India's Industrial Wastewater Regulatory & Enforcement Framework

- ✓ Water Act, 1974 + Environment Protection Act, 1986 form the core legal framework for industrial wastewater management.
- ✓ General effluent standards are prescribed under Schedule VI of the Environment (Protection) Rules, 1986, supplemented by industry-specific norms.
- ✓ CPCB provides standards, guidelines and technical directions, while SPCBs/PCCs enforce consent conditions and discharge limits.
- ✓ ZLD requirements may apply to specific industries/locations based on regulatory directions, environmental approvals or consent conditions.

CETPs: Centralized Treatment for Industrial Clusters

- ✓ CETPs provide centralized wastewater treatment for industrial clusters, particularly where individual MSMEs may face space, technology or cost constraints.
- ✓ Member industries pre-treat their effluent before discharge to the CETP, while the CETP is responsible for treating the combined effluent to applicable discharge standards.
- ✓ CETPs are subject to prescribed inlet/outlet standards and SPCB consent conditions; MoEFCC revised CETP effluent standards through S.O. 4(E), dated 1 January 2016.
- ✓ Fluctuations in member-unit effluent quality and quantity can affect CETP performance, making effective segregation, pre-treatment, monitoring and O&M critical.

Antibiotic Residue Standards: A Regulatory Gap

- ✓ A 2020 draft notification under the Environment (Protection) Rules, 1986 proposed limits for 121 antibiotic residues in treated pharmaceutical effluent and CETPs serving bulk-drug/formulation units.
- ✓ The proposed antibiotic-residue limits were not included in the final 2021 amendment, leaving a regulatory gap for antibiotic residues in pharmaceutical effluent.
- ✓ The issue remains relevant for Pharma/API CETPs, creating potential demand for advanced treatment, monitoring and compliance solutions as regulatory requirements evolve.

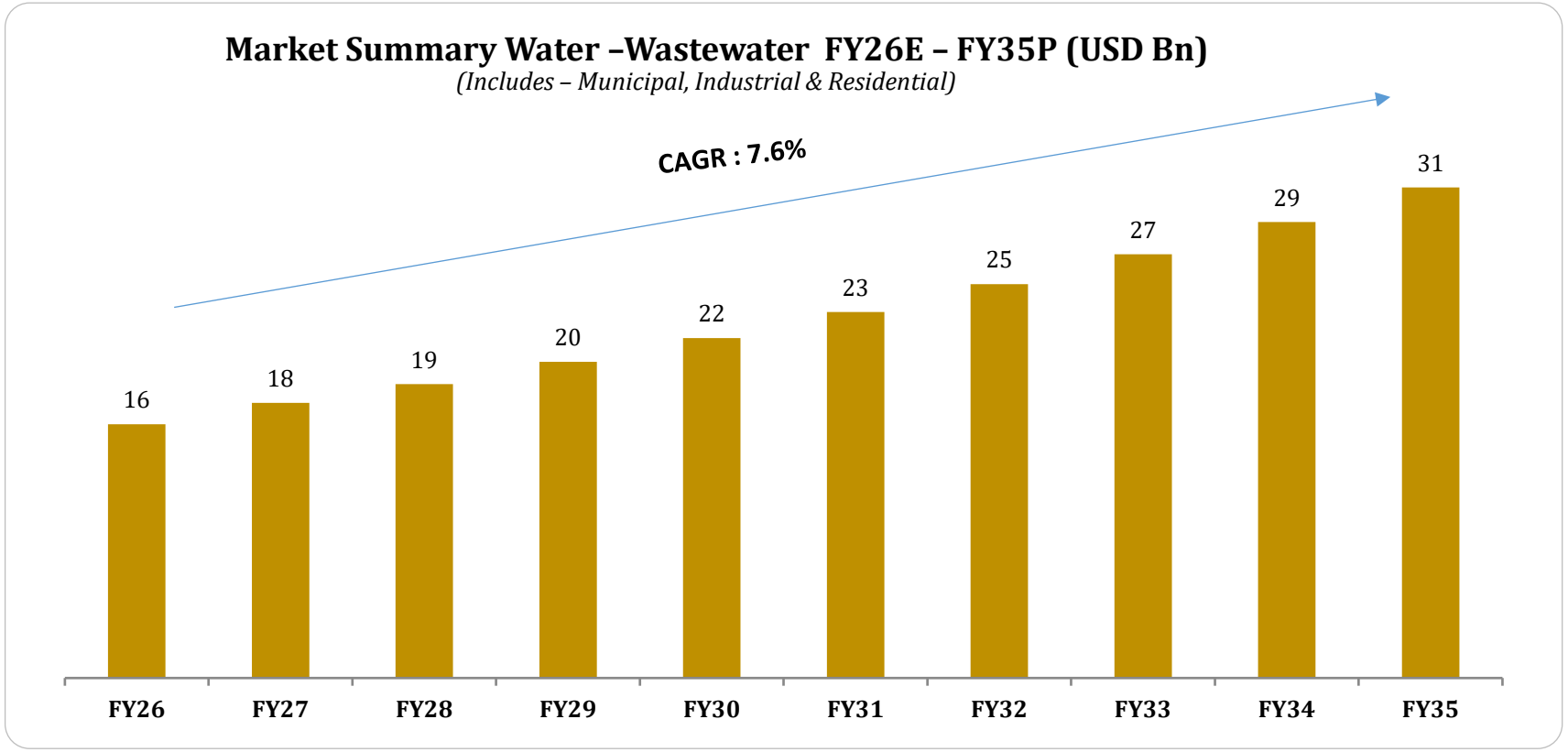
Industrial Effluent Framework

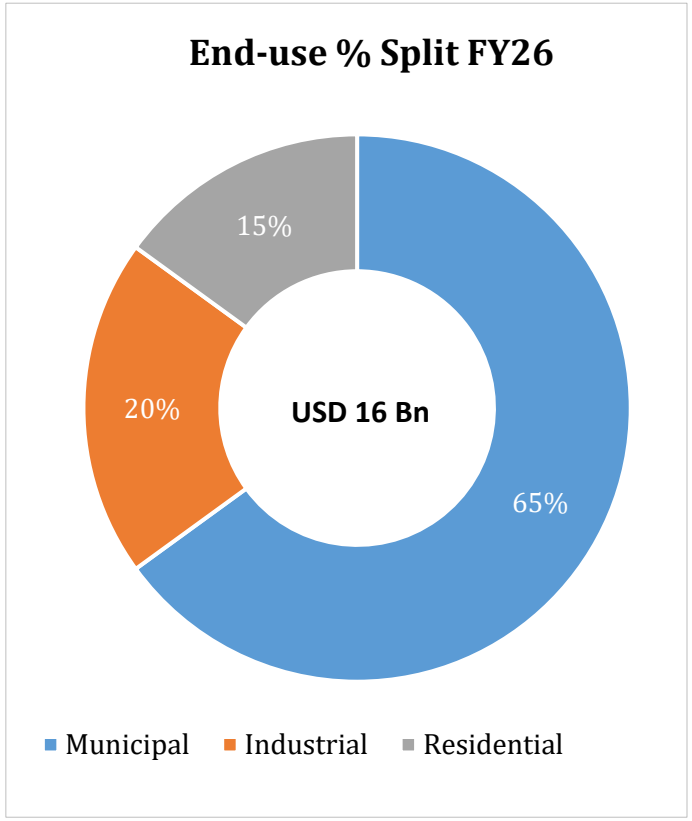
Parameter	Metro Cities & State Capitals	Non-Metro Areas & Towns	Industrial ETP Baseline
pH Level	6.5 – 9.0	6.5 – 9.0	6.5 – 8.5
BOD (Biochemical Oxygen Demand)	≤ 20 mg/L	≤ 30 mg/L	Industry specific
TSS (Total Suspended Solids)	< 50 mg/L	< 100 mg/L	Baseline monitored
Fecal Coliform	< 1,000 MPN/100 mL	< 1,000 MPN/100 mL	N/A
Oil & Grease	N/A	N/A	≤ 10 mg/L

Sources: BDB Analysis based on reports and information from CPCB General Standards (2017), State Pollution Control Board notifications.

03
Market Summary

Market Summary: Water –Wastewater *(Includes – Municipal, Industrial & Residential)*



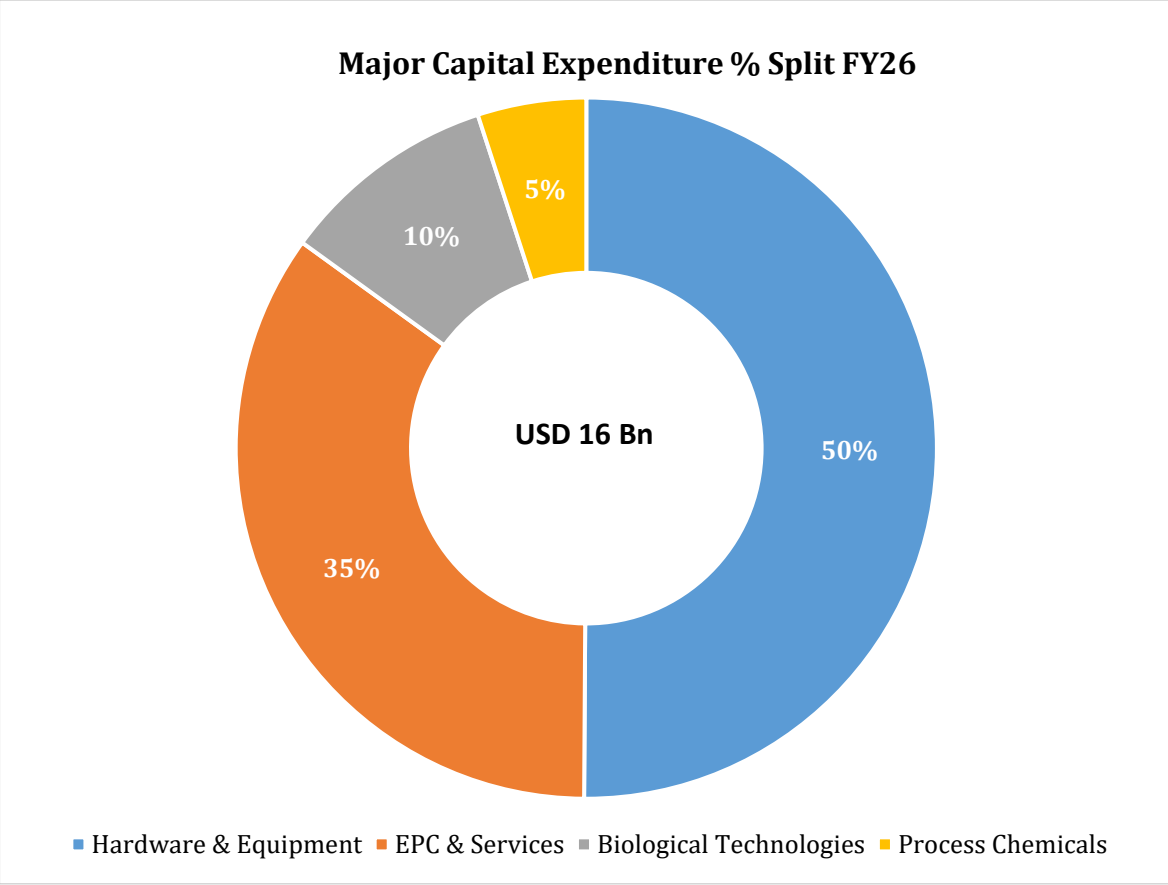


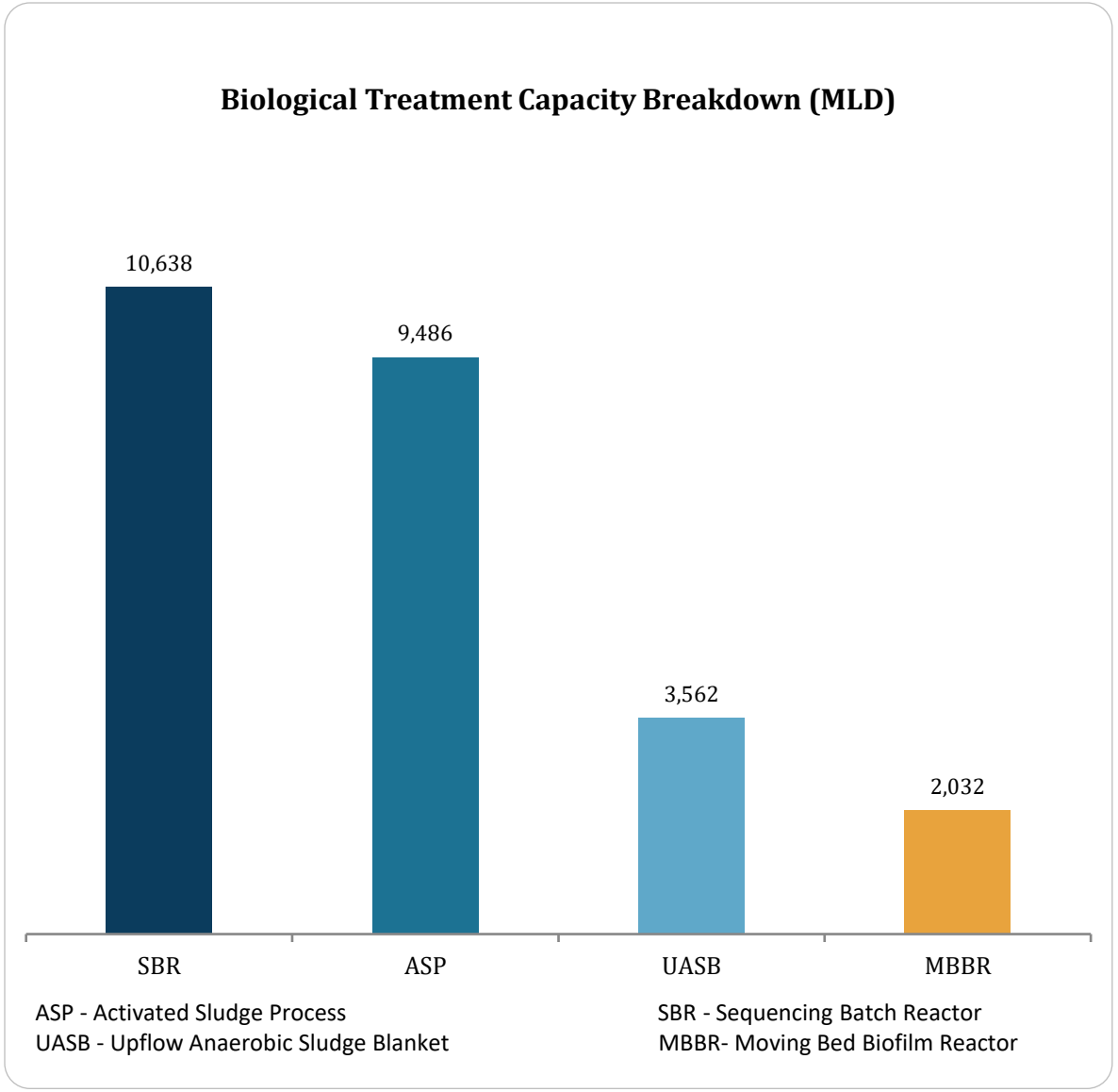
- ✓ The market is projected to nearly double from USD 16 Bn in FY26 to USD 31 Bn by FY35, indicating a strong long-term growth trajectory.
- ✓ The market is expected to grow at ~7.6% CAGR during FY26–FY35, reflecting sustained demand for water and wastewater treatment infrastructure.
- ✓ Municipal applications remain the largest demand pool, accounting for 65% of the 2025 market, followed by industrial (20.2%) and residential (14.8%) applications.
- ✓ Increasing urbanization, industrial wastewater generation and regulatory requirements are expected to sustain demand for treatment infrastructure, particularly across municipal and industrial applications.

Sources: BDB Analysis

Capital Expenditure & Biological Treatment Capacity Breakdown

(Includes – Water –Wastewater : *Municipal, Industrial & Residential)*





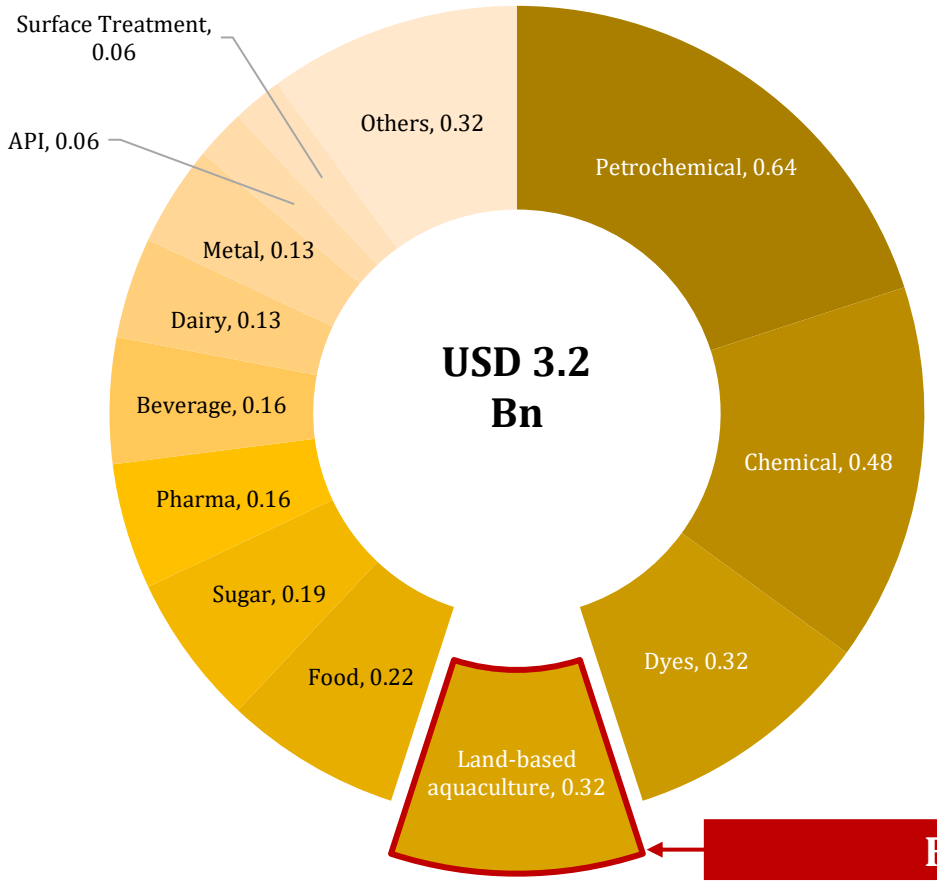
Hardware & Equipment and EPC & Services together account for 85% of spend - the two categories where Japanese suppliers can enter fastest via distribution alliances or EPC co-bidding.

Sources: BDB Analysis based on reports and information from CPCB, Ministry of Jal Shakti, AMRUT 2.0 progress reports

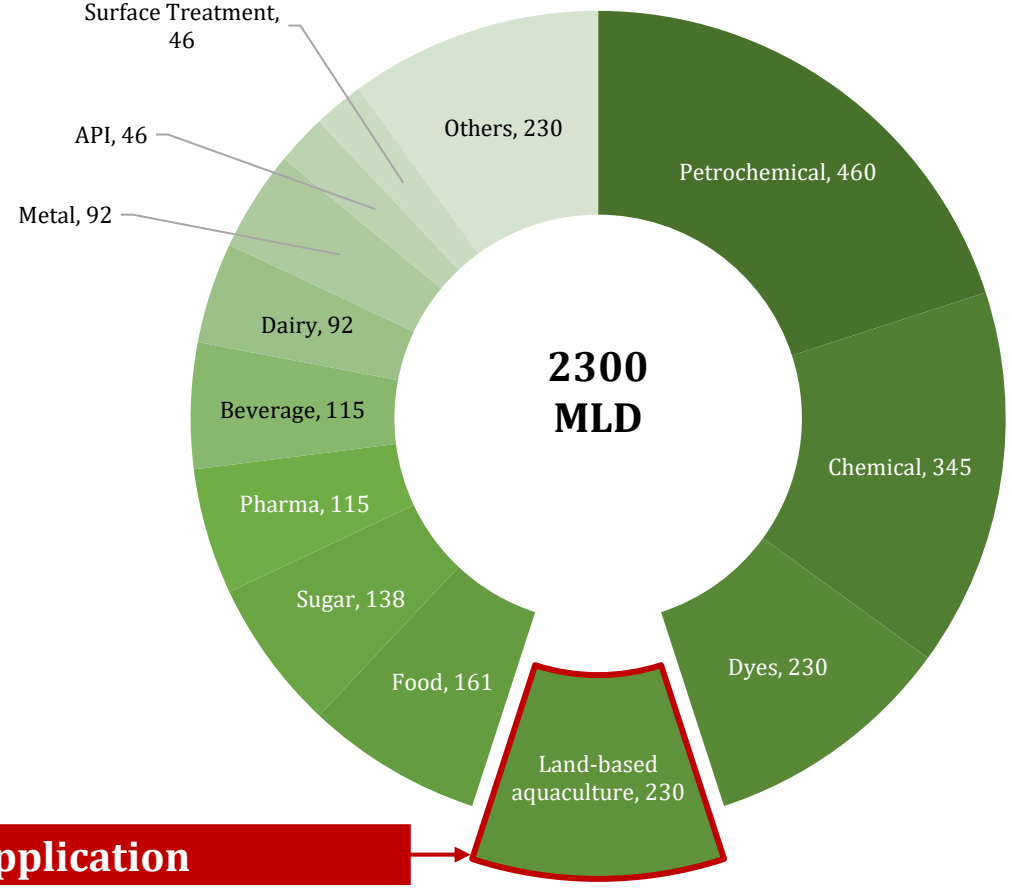
Market Summary: Industry Segment wise Application wise Water & Wastewater

(Value & Volume)

Water & Waste water Treatment Market by Value USD Bn FY26



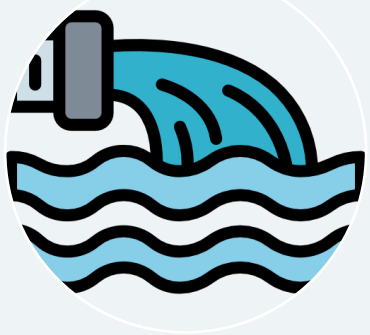
Water &Waste water Treatment Market by Volume MLD FY26



Focus Area Application

Sources: BDB Analysis based on CPCB, MPCB & CETP reports

Industrial Wastewater Treatment Process Flow Chart



Pre-primary Treatment

Key Technologies & Equipment:

Bar screens: Catch large debris and solid objects.

Grit channels: Allow heavy inorganic materials (like sand and silt) to settle out.

CPI oil skimmers: Remove free oils and grease from the wastewater

Primary Treatment

Key Technologies & Equipment:

Primary clarifiers: Utilize gravity settling to separate settle able suspended solids.

Dissolved Air Flotation: Uses micro-bubbles to float light suspended solids

Flocculators: Promote the aggregation of fine particles into larger, easily removable flocs.

Secondary Biological

BOD removal (Biochemical Oxygen Demand reduction)

Biological Treatment Systems:

ASP (Activated Sludge Process)

SBR (Sequential Batch Reactor)

MBBR (Moving Bed Biofilm Reactor)

Tertiary Purification

Key Technologies & Equipment:

Media filters: Remove residual suspended solids.

Ultrafiltration: Provides fine physical membrane filtration

Reverse Osmosis: Removes dissolved salts and total dissolved solids (TDS).

Ozonation: Acts as an advanced oxidation.

Zero Liquid Discharge

Key Technologies & Equipment:

Multi-Effect Evaporators: Evaporate water efficiently using multi-stage heat recovery.

Mechanical Vapor Recompression: Recompresses steam to minimize thermal energy consumption.

Crystallizers: Separate dissolved salts out into dry solid crystals

Sources: BDB Analysis based on reports and information from Secondary Research

04
Segment-wise Details

4.1 Chemical / Petrochemical / Dye

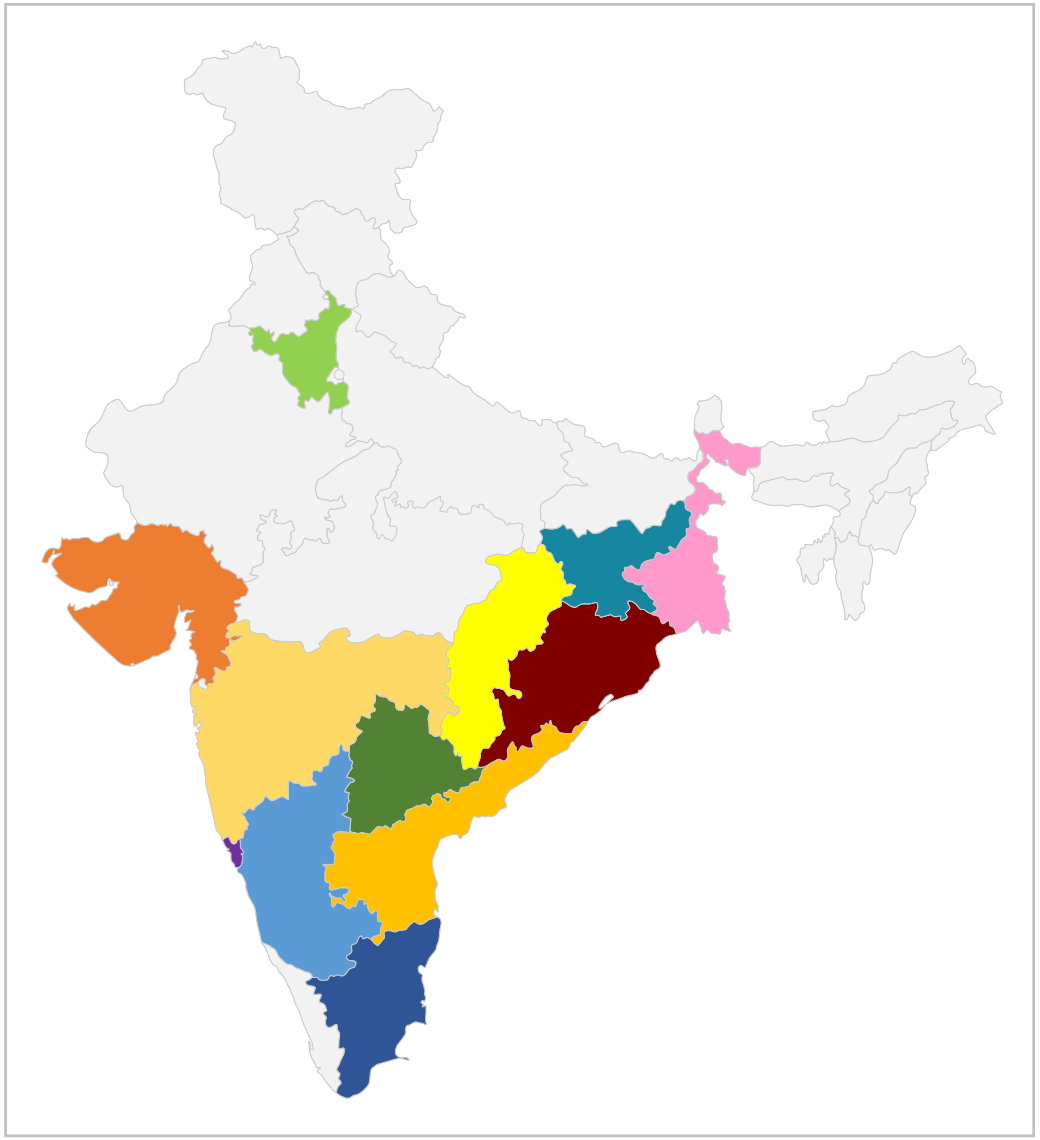
4.2 Pharma & API

4.3 Food / Beverage /Dairy / Sugar

4.4 Metal / Surface Treatment

4.1 Petrochemical Chemical Dye Industry

Segment-wise Major Industrial Clusters



Segment	Key States
Petrochemical	Gujarat, Haryana, Odisha, Andhra Pradesh, Karnataka
Chemical	Gujarat, Maharashtra, Tamil Nadu, Andhra Pradesh, Telangana
Dyes & Dye Intermediates	Gujarat, Maharashtra
Pharmaceutical	Telangana, Gujarat, Maharashtra, Tamil Nadu, Goa
API / Bulk Drugs	Telangana, Andhra Pradesh, Gujarat
Food Processing	Maharashtra, Haryana, Andhra Pradesh, Tamil Nadu, Karnataka, Odisha, West Bengal
Beverage	Maharashtra, Karnataka, Telangana, Tamil Nadu, Gujarat, Andhra Pradesh, West Bengal
Dairy	Gujarat, Haryana, Maharashtra, Karnataka, Tamil Nadu
Sugar	Maharashtra, Karnataka, Tamil Nadu, Gujarat
Metal	Jharkhand, Odisha, Chhattisgarh, Tamil Nadu, Andhra Pradesh, Gujarat, Maharashtra

Sources: Secondary Research

Regulatory & Monitoring Overview

Based on statutory guidelines from the Central Pollution Control Board (CPCB) and State Pollution Control Boards (SPCBs) under the Water (Prevention and Control of Pollution) Act, 1974, testing and approval periodicities for Red Category industries and CETPs operate across three frameworks:

1. **Real-Time & Continuous Testing**

    - **OCEMS Telemetry**: Red Category industries and Common Effluent Treatment Plants (CETPs) are mandated to run Online Continuous Effluent Monitoring Systems (OCEMS). Data for critical parameters (pH, BOD, COD, TSS, and flow rates) is logged and automatically transmitted to SPCB and CPCB servers at 15-minute intervals.

    - **Zero Liquid Discharge (ZLD) Systems**: For units operating under ZLD mandates, continuous sensors monitor conductivity and flow at reject streams and evaporation stages to ensure zero liquid leaves the premises.

2. **Periodic Physical Testing & Lab Audits**

    - **Third-Party Lab Verification**: Facilities must perform grab-sampling and get samples tested through SPCB-recognized or NABL-accredited laboratories. The testing frequency generally ranges from monthly to quarterly to re-validate online OCEMS calibration.

    - **Sludge Characterization:** Sludge generated from treatment processes must undergo hazardous characterization testing at least annually to determine safe disposal protocols.

3. **Regulatory Approval & Renewal Periodicities**

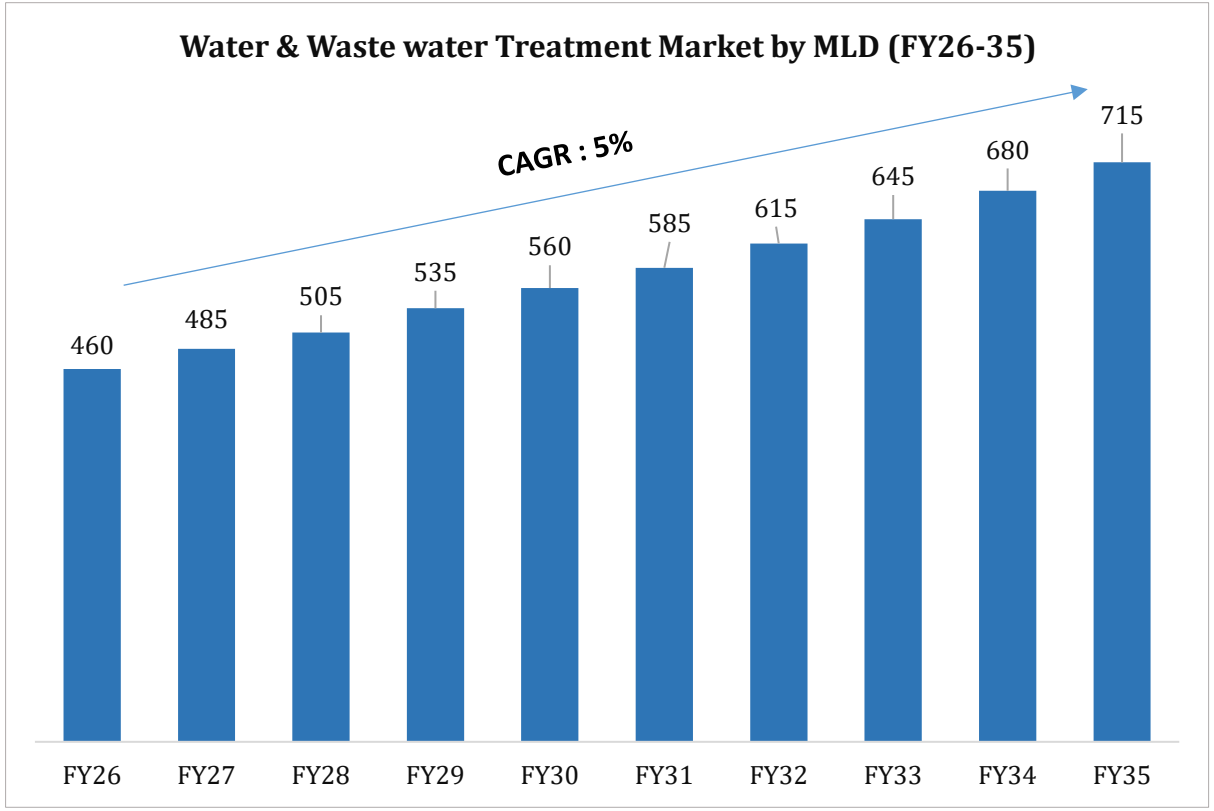
    - **Consent to Operate (CTO) Renewal**: Red Category facilities carry the strictest operational conditions, with CTO approvals issued for a validity period of 1 to 5 years (depending on the specific State Pollution Control Board's policies). Renewal applications must be submitted at least 90 days prior to expiry.

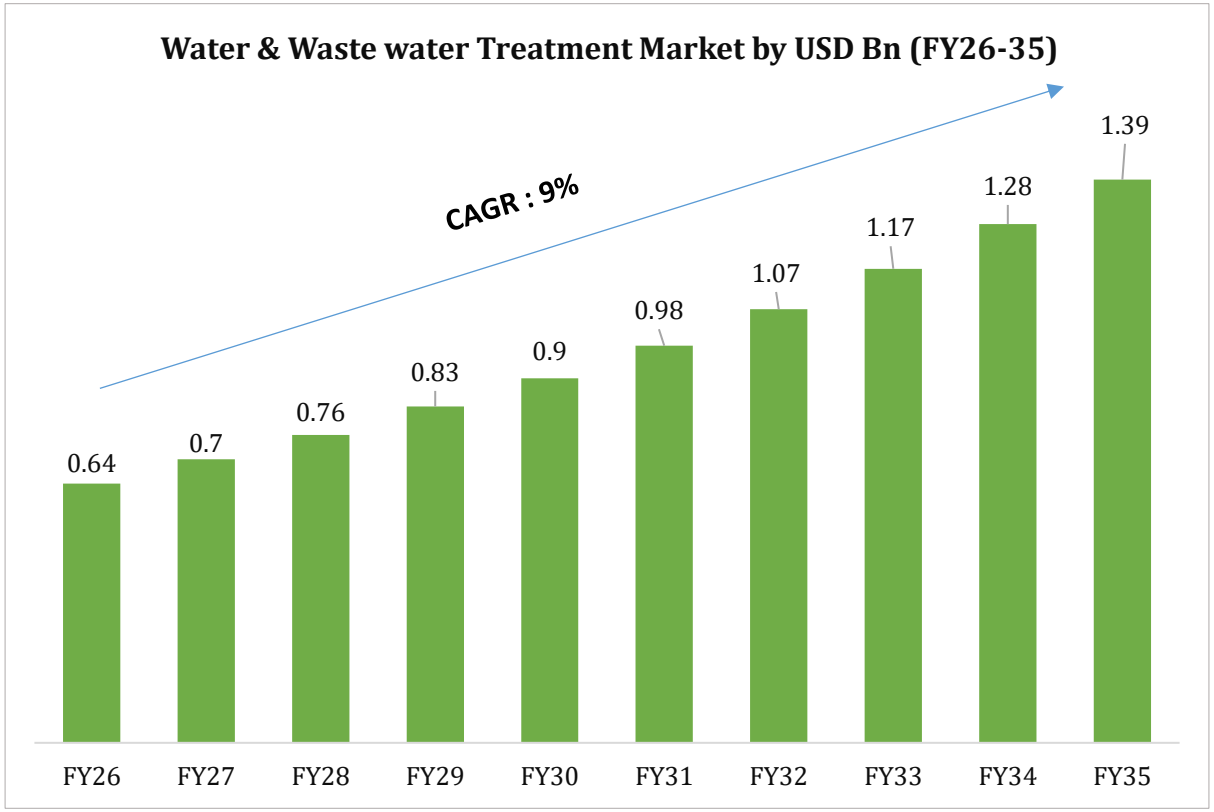
    - **Annual Environmental Audit (Form V)**: Units are legally required to submit an Environmental Statement (Form V) to the SPCB once every financial year (by September 30) detailing annual resource consumption and effluent discharge parameters.

Sources: BDB Analysis based on reports and information CPCB & SPCB

4.1.1
Petrochemical Industry

Petrochemical: Water & Wastewater Treatment Market



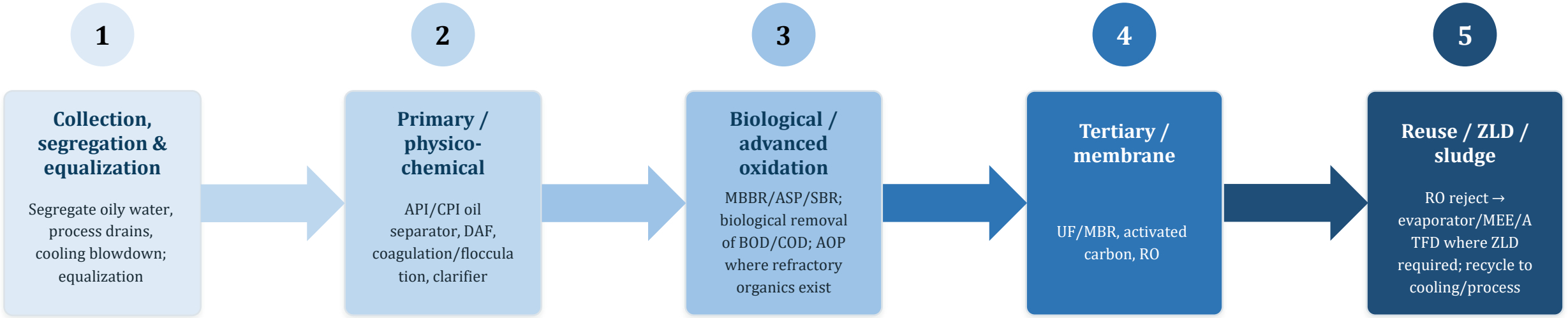


Key Market Highlights

- ✓ High-value market driven by refinery/petrochemical expansion, stringent effluent norms and increasing water reuse/ZLD adoption.
- ✓ Water & Wastewater treatment capacity is expected to increase from 460 MLD in FY26 to 715 MLD by FY35, registering ~5.0% CAGR.
- ✓ The wastewater treatment market value is projected to more than double from USD 0.64 Bn in FY26 to USD 1.39 Bn by FY35, at ~9% CAGR.

Sources: BDB Analysis based on CPCB, MPCB & CETP reports

Petrochemical: Production Process & Waste Generation
Stages/Characteristics/Equipment's/Current Practices & Major Suppliers



Typical wastewater characteristics / pollutants

- Oil & grease
- Hydrocarbons
- Phenols
- Sulphides
- Ammonia
- COD/BOD
- TSS
- high temperature; pH varies by process

Major equipment / machines

- API/CPI separator
- DAF
- Equalization tank
- Clarifier
- MBBR/ASP
- Activated carbon
- UF/RO
- Evaporator

Current Indian working practice / evidence

- Refinery/petrochemical facilities increasingly emphasize recycle and reuse
- Integrated ETP + RO/recycle is established practice

Representative major suppliers

- WABAG
- Thermax
- Ion Exchange
- Veolia
- SUEZ
- Aquatech

Sources: BDB Analysis based on CPCB, MPCB & CETP reports

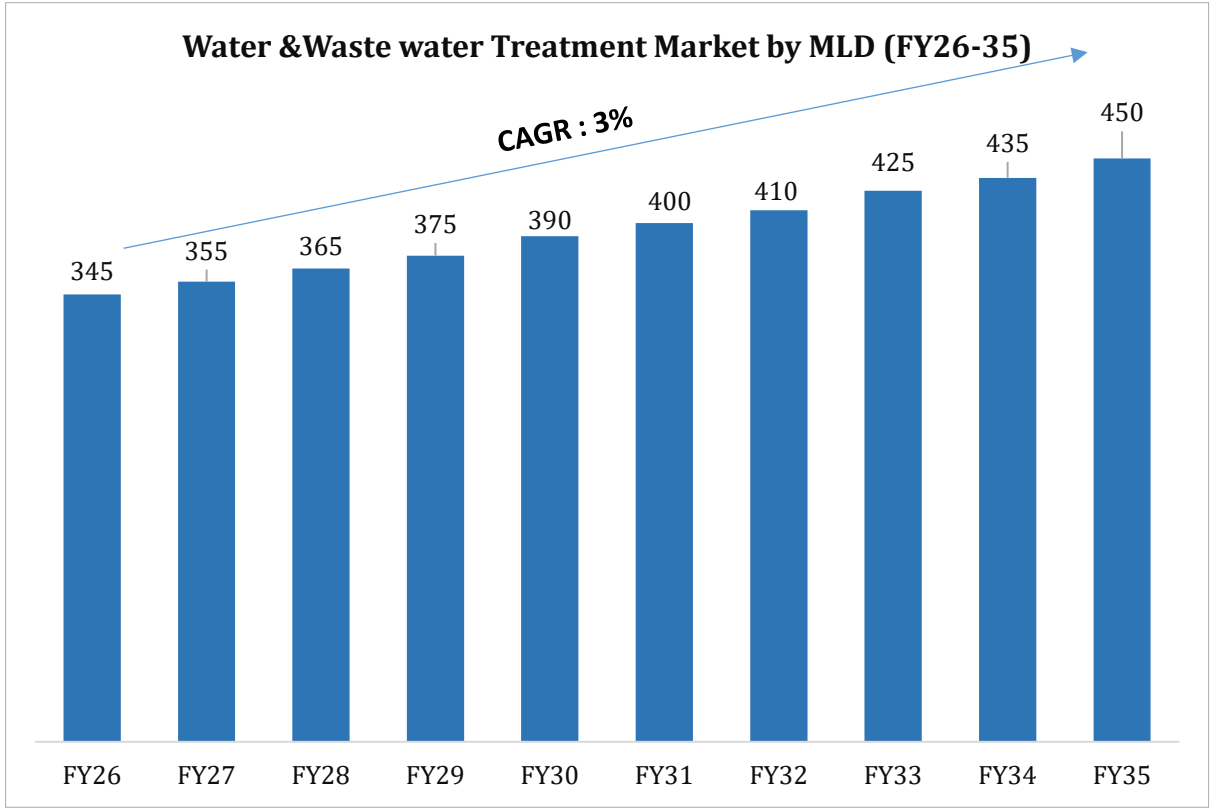
Petrochemical: Government Policies/Regulations/Initiatives

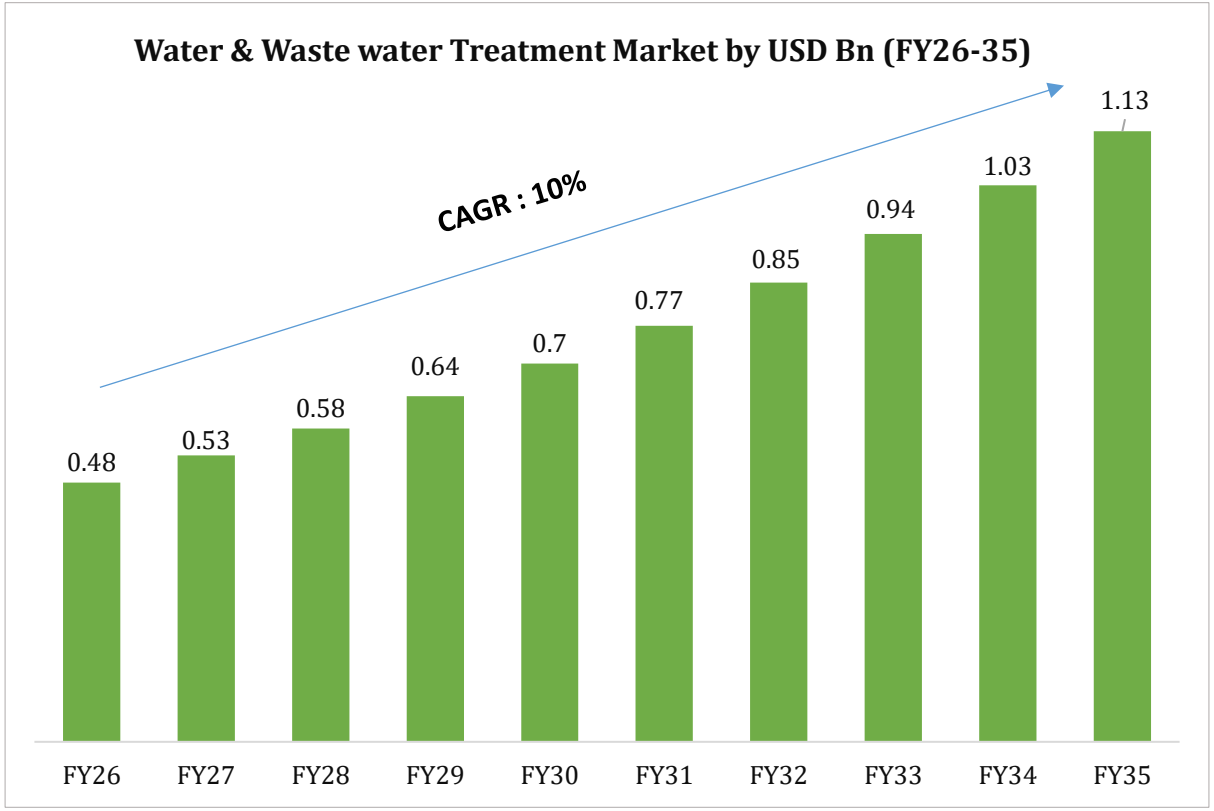
Policy / Regulation	Details
Water (Prevention & Control of Pollution) Act, 1974	Requires consent for discharge and pollution-control systems for refinery/petrochemical effluent.
Environment (Protection) Act, 1986	Provides central authority to prescribe refinery/petrochemical effluent standards.
Environment (Protection) Rules, 1986	Industry-specific/general effluent standards determine treatment requirements.
CPCB industry-specific standards	Direct: petrochemical/refinery standards determine ETP treatment.
OCEMS	Used for continuous compliance monitoring at qualifying high-pollution facilities.
ZLD requirements / Consent conditions	Applied selectively; particularly relevant to water-stressed locations and highly polluting complexes.
CETP model	Less dependent on CETP; large integrated facilities generally maintain captive ETPs.
National Framework on Safe Reuse of Treated Water, 2022	Promotes reuse for cooling/process applications.
Draft Liquid Waste Management Rules, 2024	Emerging direction toward stronger liquid-waste management and resource recovery.
NITI Net Zero Scenario	Promotes higher treatment efficiency and lower methane emissions.
State PCB requirements / CTO conditions	Critical: state-specific CTO determines actual ETP, reuse and monitoring configuration.

Sources: BDB Analysis based on CPCB, MPCB & CETP reports

4.1.2
Chemical Industry

Chemical: Water & Wastewater Treatment Market



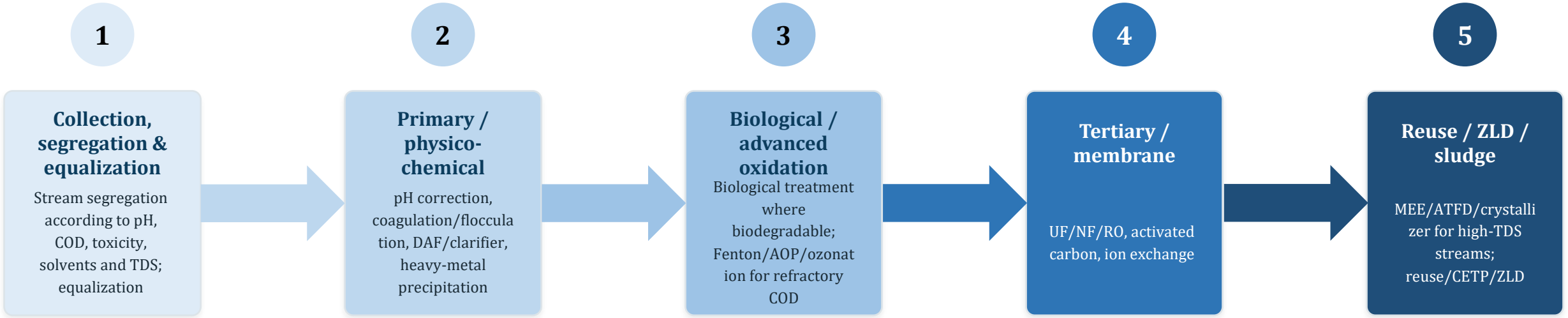


Key Market Highlights

- ✓ One of the largest high-value segments; complex COD, TDS, solvents and toxic compounds create strong demand for advanced ETP, RO and ZLD.
- ✓ Water & Wastewater treatment capacity is expected to increase from 345 MLD in FY26 to 450 MLD by FY35, registering ~3% CAGR.
- ✓ The wastewater treatment market value is projected to USD 0.48 Bn in FY26 to USD 1.13 Bn by FY35, at ~10% CAGR.

Sources: BDB Analysis based on CPCB, MPCB & CETP reports

Chemical: Production Process & Waste Generation
Stages/Characteristics/Equipment's/Current Practices & Major Suppliers



Typical wastewater characteristics / pollutants

- Highly variable pH
- High COD/TDS
- Solvents, acids/alkalis
- Salts
- Heavy metals, toxic/refractory organics

Major equipment / machines

- Equalization
- flash mixer
- Clariflocculator
- DAF
- Fenton/AOP
- MBBR
- RO
- MEE/ATFD

Current Indian working practice / evidence

- CETPs and captive ETPs are widely used in chemical clusters.
- Maharashtra PCB data show operating chemical CETPs with primary/secondary treatment and current inlet/outlet monitoring

Representative major suppliers

- WABAG
- Thermax
- Ion Exchange
- Veolia
- SUEZ
- Aquatech

Sources: BDB Analysis based on CPCB, MPCB & CETP reports

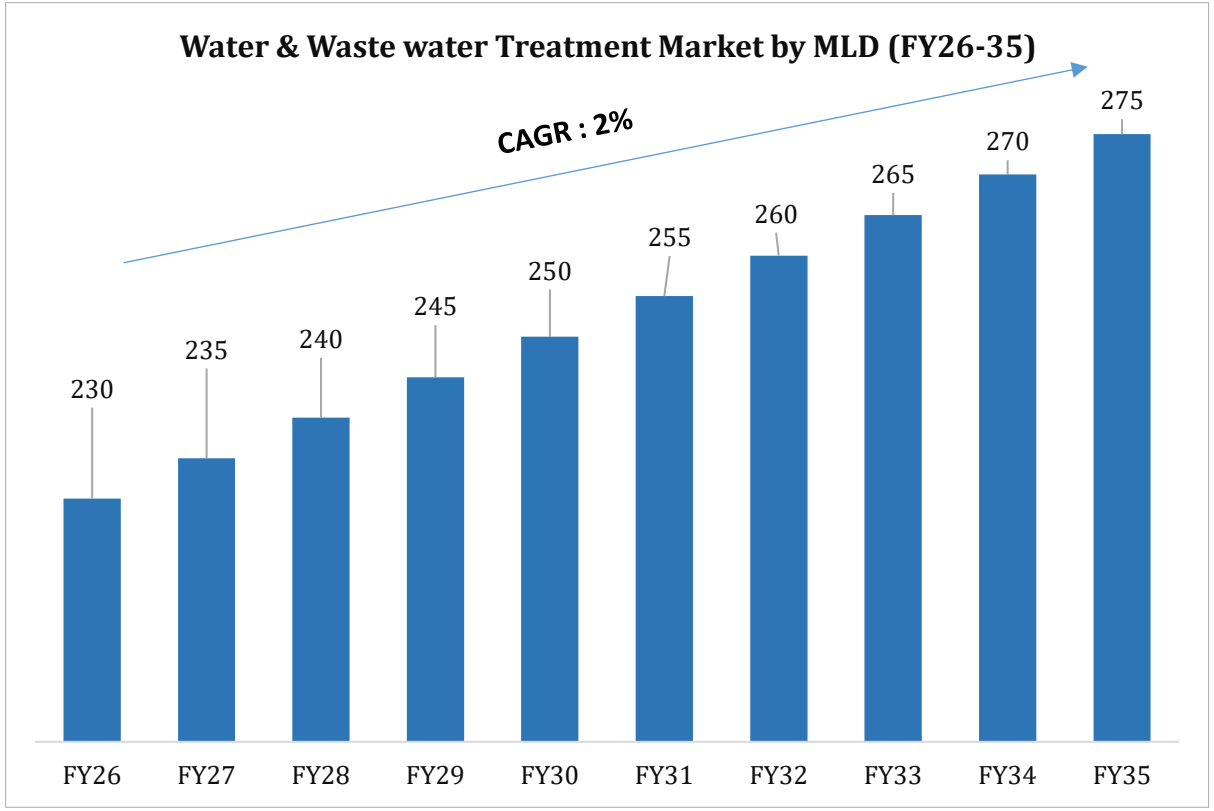
Chemical: Government Policies/Regulations/Initiatives

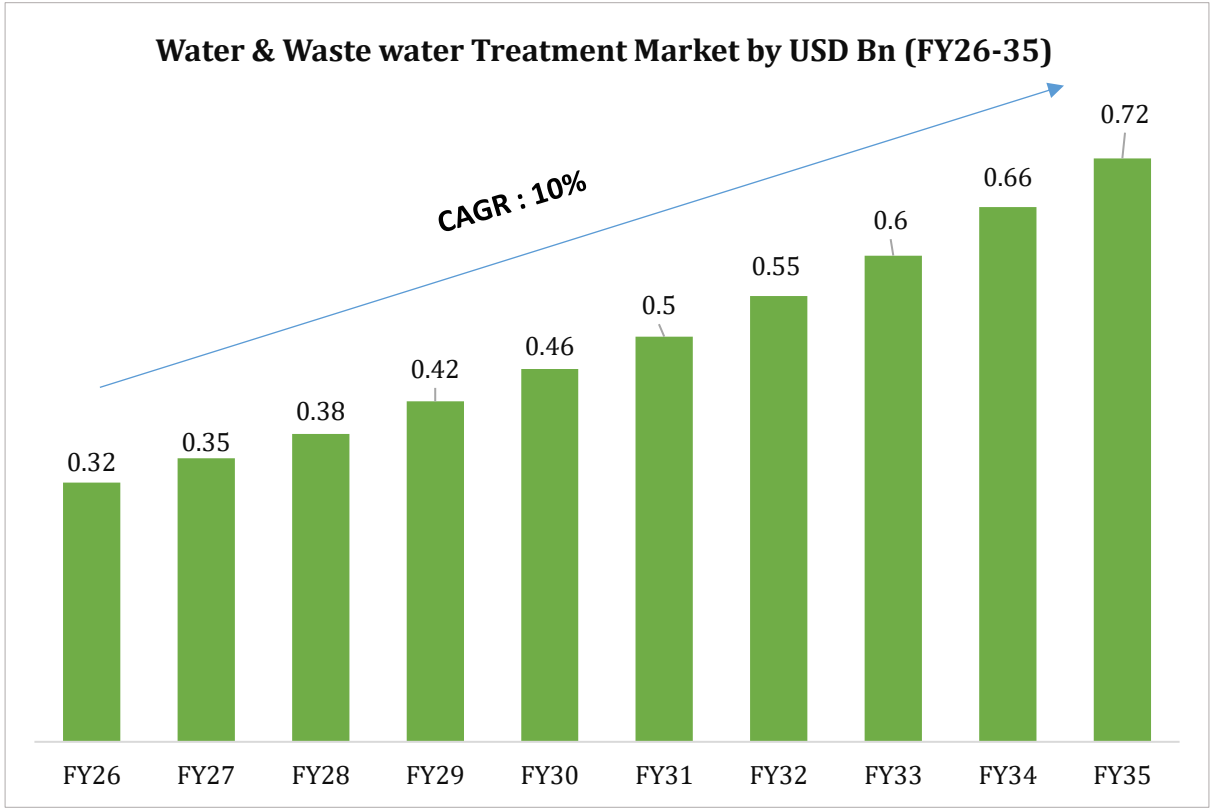
Policy / Regulation	Details
Water (Prevention & Control of Pollution) Act, 1974	Requires CTE/CTO and controlled discharge of chemical effluent.
Environment (Protection) Act, 1986	Forms the legal basis for chemical-industry effluent standards.
Environment (Protection) Rules, 1986	High relevance; industry-specific standards apply where notified, otherwise general standards.
CPCB industry-specific standards	Direct: organic/inorganic chemical standards influence treatment train.
OCEMS	High relevance for Red-category chemical industries/CETPs.
ZLD requirements / Consent conditions	High: frequently imposed where high-TDS/refractory effluent makes conventional discharge difficult.
CETP model	Very High: common treatment is important for MSME chemical clusters.
National Framework on Safe Reuse of Treated Water, 2022	High: encourages treated-effluent reuse and reduced freshwater withdrawal.
Draft Liquid Waste Management Rules, 2024	Encourages stronger treatment, monitoring and reuse.
NITI Net Zero Scenario	Encourages energy-efficient treatment and emissions reduction.
Bulk Drug Park Scheme	Indirectly applicable through chemical-support industries.
State PCB requirements / CTO conditions	Critical: GPCB/MPCB/TNPCB etc. can impose cluster-specific conditions beyond generic standards.

Sources: BDB Analysis based on CPCB, MPCB & CETP reports

4.1.3
Dye Industry

Dyes: Water & Wastewater Treatment Market



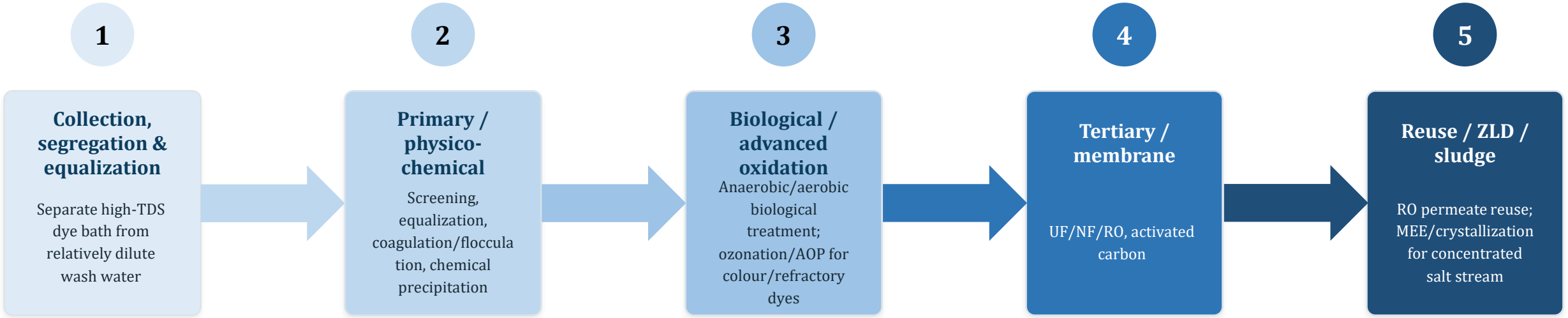


Key Market Highlights

- ✓ Strong replacement and upgrade opportunity due to high color, TDS, COD and chemical loading; ZLD adoption is a major growth driver.
- ✓ Water & Wastewater treatment capacity is expected to increase from 230 MLD in FY26 to 275 MLD by FY35, registering ~2% CAGR.
- ✓ The wastewater treatment market value is projected to USD 0.32 Bn in FY26 to USD 0.72 Bn by FY35, at ~10% CAGR.

Sources: BDB Analysis based on CPCB, MPCB & CETP reports

Dyes: Production Process & Waste Generation Stages/Characteristics/Equipment's/Current Practices & Major Suppliers



Typical wastewater characteristics / pollutants

- Strong color, high TDS/salts
- variable pH
- Dyes
- Surfactants
- Auxiliaries
- COD
- Heavy metals

Major equipment / machines

- Equalization
- Coagulation
- Flocculation
- Clarifier
- Biological reactor
- Ozone/AOP, UF/NF/RO
- MEE/crystallizer

Current Indian working practice / evidence

- Segregation of high-TDS dye-bath and lower-TDS wash water is an important current approach
- ZLD is widespread in some textile/dyeing clusters

Representative major suppliers

- WABAG
- Thermax
- Ion Exchange
- Veolia
- Aquatech

Sources: BDB Analysis based on CPCB, MPCB & CETP reports

Dyes: Government Policies/Regulations/Initiatives

Policy / Regulation	Details
Water (Prevention & Control of Pollution) Act, 1974	Requires consent and treatment before discharge of dyeing effluent.
Environment (Protection) Act, 1986	Supports specific standards for dye & dye-intermediate industries.
Environment (Protection) Rules, 1986	Specific dye/dye-intermediate standards drive ETP configuration.
CPCB industry-specific standards	Direct: dye & dye-intermediate standards.
OCEMS	Important for large dye/textile CETPs and qualifying units.
ZLD requirements / Consent conditions	Very High: ZLD/RO/evaporation is established in major textile/dye clusters.
CETP model	Critical: dyeing/textile clusters heavily depend on CETPs.
National Framework on Safe Reuse of Treated Water, 2022	Very High: supports RO permeate reuse in textile/dye clusters.
Draft Liquid Waste Management Rules, 2024	Supports improved cluster-level wastewater management.
NITI Net Zero Scenario	Encourages better-performing treatment systems.
State PCB requirements / CTO conditions	Critical: state PCB conditions often determine ZLD/RO/evaporation requirements.

Sources: BDB Analysis based on CPCB, MPCB & CETP reports

Major Companies, Key Projects & Equipment Adoption Trends

Why Equalization Matters More Here

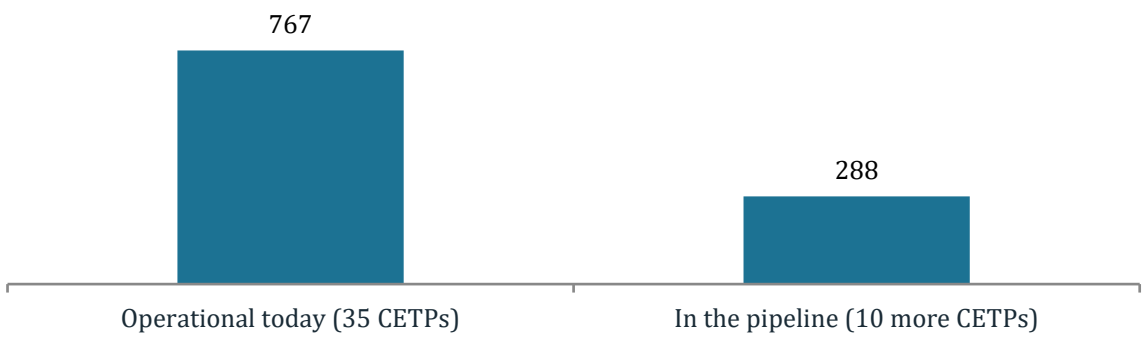
- ✓ Feed from member units varies constantly in pH, color, and load - without equalization, the biological stage downstream simply can't hold a stable microbial population.

The Instrumentation Opening

- ✓ Because a CETP blends unpredictable inputs from many small units, real-time monitoring at each stage boundary (pH, conductivity, color, DO) is where equipment and control-systems suppliers add the most value - and where the market is thinnest today.

Company / Entity	Role
VA Tech Wabag	Chennai HQ; 6,500+ projects in 25+ countries; FY26 order book USD 1.82 Bn (up 21% YoY), active across industrial water treatment for chemicals, petrochemicals, and steel.
Ion Exchange (India) Ltd	End-to-end water solutions: EPC, plant O&M, and water/specialty chemicals (~30-40% gross margins); also runs the Zero B consumer water brand
Enviro Infra Engineering Ltd (EIEL)	CETP/STP EPC contractor; delivered the Panipat 21 MLD textile-dye CETP under HSPCB
Varsha Enviro Technologies	CETP equipment manufacturer for textile, chemical, and MSME industrial estates
SR Paryavaran Engineers	Turnkey ETP/CETP EPC across textile, chemical, sugar, pharma, and F&B sectors since 1990
Tiruppur Dyers Association	Owns and operates roughly 19 CETPs serving the Tiruppur dyeing cluster
GIDC / MIDC / HSIIDC	Commission and own CETP infrastructure for chemical/dye industrial estates

Gujarat's CETP Capacity, Today vs. Planned (MLD)



Gujarat: By Far the Largest Concentration

- ✓ Gujarat runs 35 operational CETPs with roughly 767 MLD of combined hydraulic capacity, serving about 6,483 individual units - per Gujarat Pollution Control Board's own count.
- ✓ A further 10 CETPs (~288 MLD) are in the pipeline, a ~38% expansion on the operational base. Vapi GIDC (a 'Declared Chemical Estate') houses 1,400+ industries on a 55 MLD CETP built at ~Rs. 20 crore (~US$2.12 million).
- ✓ Vatva Industrial Estate (Ahmedabad, est. 1968) turns over Rs. 15,000+ crore annually via its GESCSL co-op, running spray dryers for effluent above 2,50,000 mg/L TDS.
- ✓ Ankleshwar/Panoli, Nandesari, Sachin/Pandesara, and Kalol round out the state's other major CETP clusters.

Sources: BDB Analysis based on reports and information from CAG.org.in, ScienceDirect (CETP reliability studies).

Gujarat: Why It Can be a Priority State for Industrial Wastewater Treatment

Industrial base & Cluster concentration

- ✓ Strong concentration of chemicals, petrochemicals, pharmaceuticals, dyes, textiles, engineering and other water-intensive industries.
- ✓ Multiple industrial estates and clusters create a concentrated customer base for wastewater-treatment technologies.
- ✓ GIDC has developed a large network of industrial estates, including sector-specific estates.
- ✓ Major clusters include Ahmedabad/Vatva, Ankleshwar, Vapi, Surat, Bharuch, Vadodara, Dahej and other industrial locations.
- ✓ The cluster structure supports the use of Common Effluent Treatment Plants (CETPs), particularly where many MSMEs operate within the same industrial area.

Complex wastewater profiles & Regulatory pressure

- ✓ Chemical, pharmaceutical, dye and textile industries generate wastewater with potentially high COD, colour, salts, toxic compounds, heavy metals and other difficult-to-treat pollutants.
- ✓ This increases the need for advanced treatment rather than only conventional biological treatment.
- ✓ Industries and CETPs are facing increasing pressure to improve treatment performance, discharge compliance and water reuse.
- ✓ Gujarat is also seeing movement towards ZLD and advanced water-reuse solutions in selected industrial clusters.

Sources: BDB Analysis based on reports and information from GIDC; CPCB; Ministry of Environment, Forest & Climate Change.

- Large, Diverse Industrial Base Creates Direct B2B Demand with complex industrial effluent requiring dedicated ETP/CETP, ZLD and water-reuse solutions. For example, Veolia's 2.1 MLD ZLD facility at Ankleshwar treats high-COD, high-TDS and ammonia-rich wastewater and achieves >65% water recovery for industrial reuse.
- Private Industrial Capex is Driving Advanced Treatment Solutions - The market is not limited to government projects - large industries are directly investing in advanced wastewater infrastructure. A recent example is Reliance Industries' ₹100–250 crore ETP project at its Jamnagar Green Energy Giga Complex, incorporating chemical + biological treatment and low-temperature sludge drying.

Current Requirements	Potential technology opportunity
Difficult-to-treat industrial effluent	Advanced biological / oxidation technologies
High TDS / salts	Membrane systems / RO
Water scarcity	Water recovery & reuse
Stringent discharge requirements	Advanced polishing systems
ZLD requirements	RO + evaporator / crystalliser systems
High energy consumption	Energy-efficient treatment
Manual operation	Automation & process control
Inconsistent treatment performance	Sensors + real-time monitoring
Sludge generation	Sludge minimisation / resource recovery
Compliance monitoring	Online monitoring & data systems

4.2 Pharmaceutical API

Market Overview & Major Cluster Regions

Concentrated in a Handful of Intensive Clusters

India calls itself the 'Pharmacy of the World', but API and bulk-drug manufacturing is actually concentrated in a handful of intensive clusters: Hyderabad's Patancheru-Bollaram zone, Ankleshwar in Gujarat, and newer Bulk Drug Parks in Gujarat (Jambusar), Himachal Pradesh (Una), and Andhra Pradesh (Nakkapalli).

PLI-Funded Capacity Is Expanding Fast

The government's Production Linked Incentive scheme has already funded 32 operational bulk-drug projects worth roughly USD 42.6 million, including Aurobindo Pharma's new 15,000 tpa Penicillin-G block - the first domestic Pen-G synthesis in three decades. Private pharma investment since 2021 is estimated at around USD 1.70 billion (Ministry of Commerce & Industry) - a strong signal that capacity, and with it effluent-treatment demand, keeps expanding.

Regulations & Current Monitoring Practices

Environment Protection Amendment Rules

A draft amendment (Environment Protection Amendment Rules, 2019/2020) specifically targets antibiotic-residue discharge limits from bulk-drug and formulation units, including their shared CETPs. CPCB and the Telangana, Gujarat, and Haryana SPCBs enforce this locally.

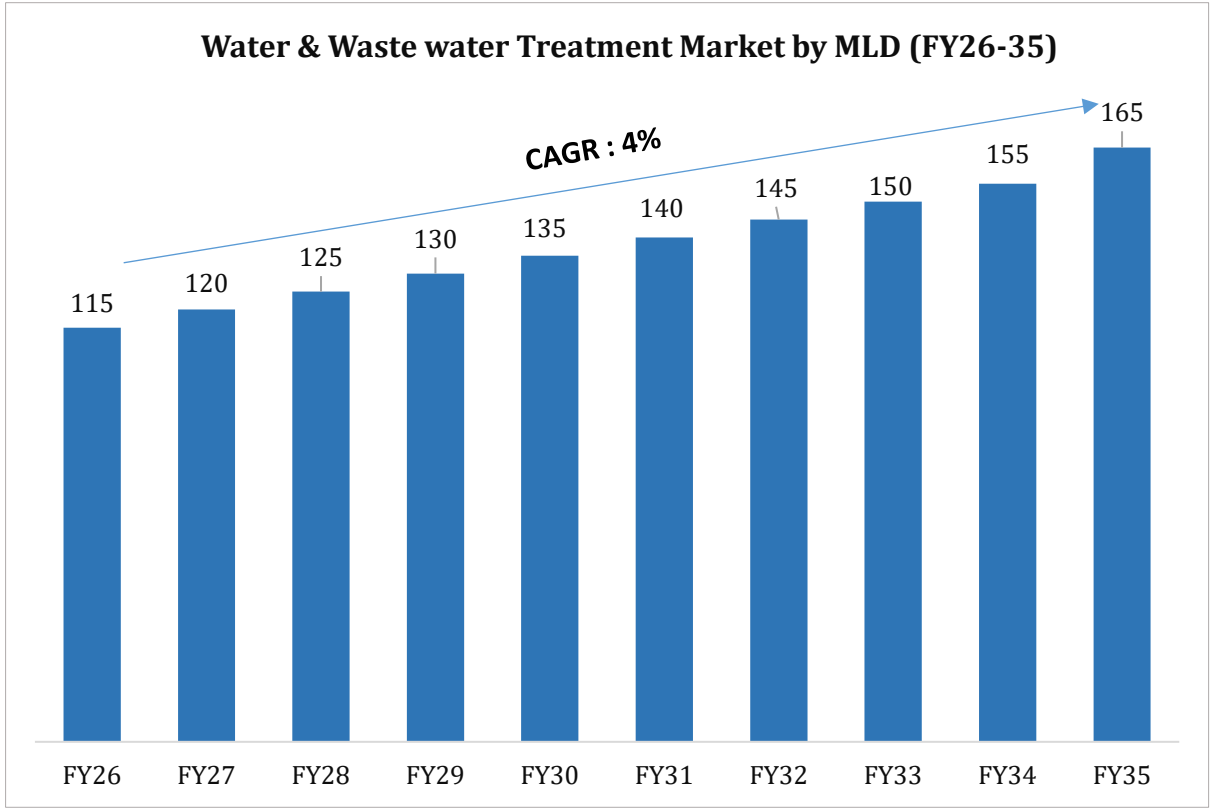
Environmental Risk & First-Mover Opportunity

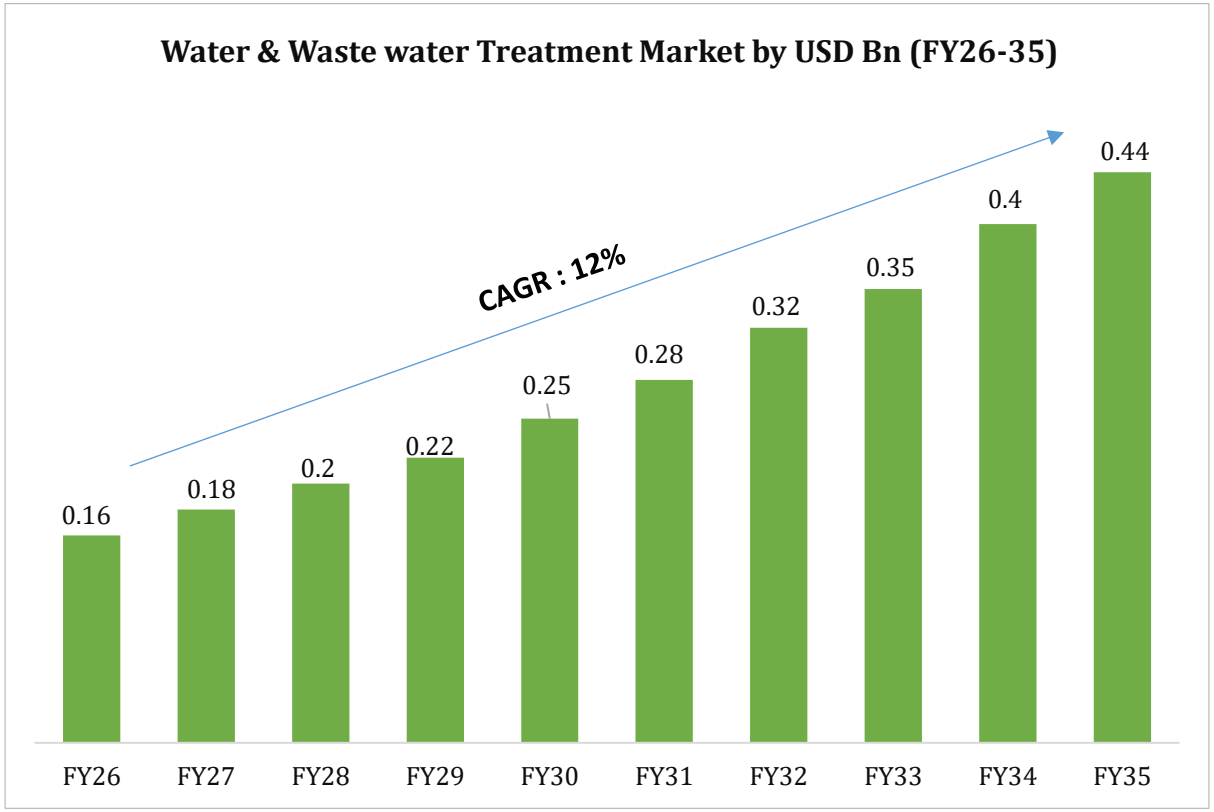
Treated effluent from a centralized facility was found to contain high levels of antibiotics, along with seven other pharmaceutical compounds. Groundwater in nearby villages also showed API (Active Pharmaceutical Ingredient) contamination, likely due to seepage.A qualitative study involving CPCB, SPCB and industry stakeholders also highlighted inconsistent adoption of stricter residue limits. The implementation of tighter limits continues to face delays.This regulatory gap creates a clear first-mover opportunity for companies that can offer effective pharmaceutical residue and API removal solutions before stricter standards become mandatory.

Sources: BDB Analysis based on reports and information from Drug Patent Watch, Policy Circle, IJPS Journal.

4.2.1
Pharmaceutical Industry

Pharmaceutical: Water & Wastewater Treatment Market



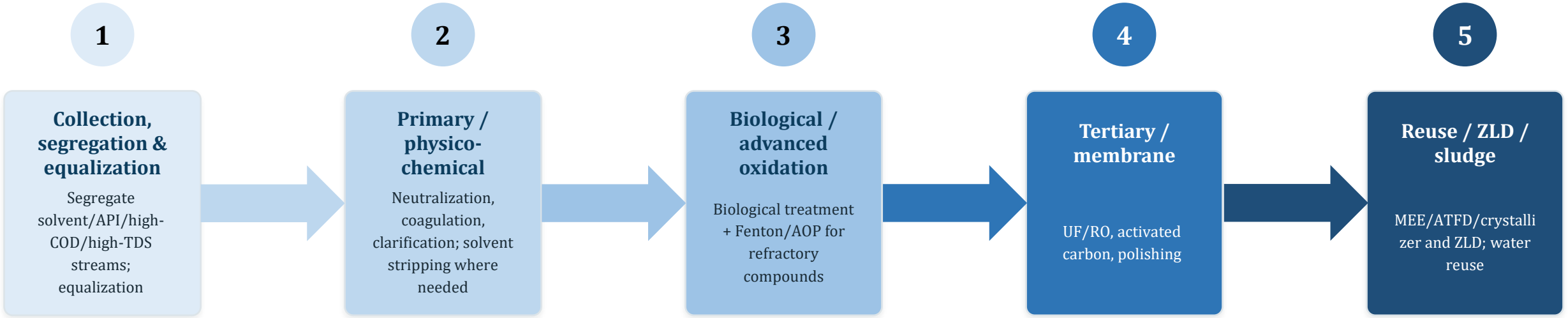


Key Market Highlights

- ✓ Fast-growing premium treatment market; stringent compliance, API residues and ZLD requirements significantly increase treatment value per MLD.
- ✓ Water & Wastewater treatment capacity is expected to increase from 115 MLD in FY26 to 165 MLD by FY35, registering ~4% CAGR.
- ✓ The wastewater treatment market value is projected to USD 0.16 Bn in FY26 to USD 0.44 Bn by FY35, at ~12% CAGR.

Sources: BDB Analysis based on Press Information Bureau Reports

Pharmaceutical: Production Process & Waste Generation Stages/Characteristics/Equipment's/Current Practices & Major Suppliers



Typical wastewater characteristics / pollutants

- pH variation, very high COD
- Solvents
- Ammonia
- antibiotics/API residues
- Toxicity
- Poor biodegradability's

Major equipment / machines

- Stripper, MEE, ATFD,
- Fenton/AOP
- Biological reactor
- RO
- UF
- Evaporator/crystallizer

Current Indian working practice / evidence

- ZLD is already prevalent in many primary pharma/API facilities.
- CPCB documentation identifies stripper/MEE/ATFD/biological/RO combinations

Representative major suppliers

- WABAG
- Thermax
- Ion Exchange
- Veolia
- Aquatech
- ZLD Technologies

Sources: BDB Analysis based on Press Information Bureau Reports

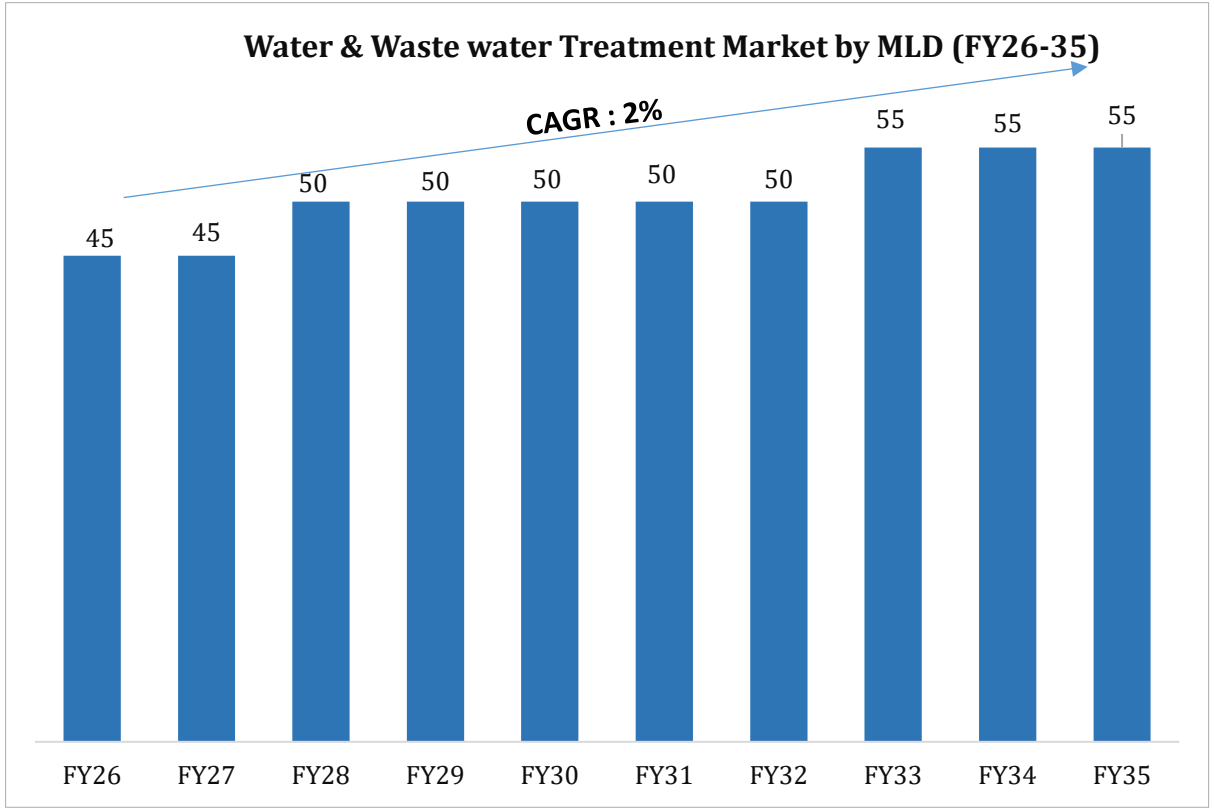
Pharmaceutical: Government Policies/Regulations/Initiatives

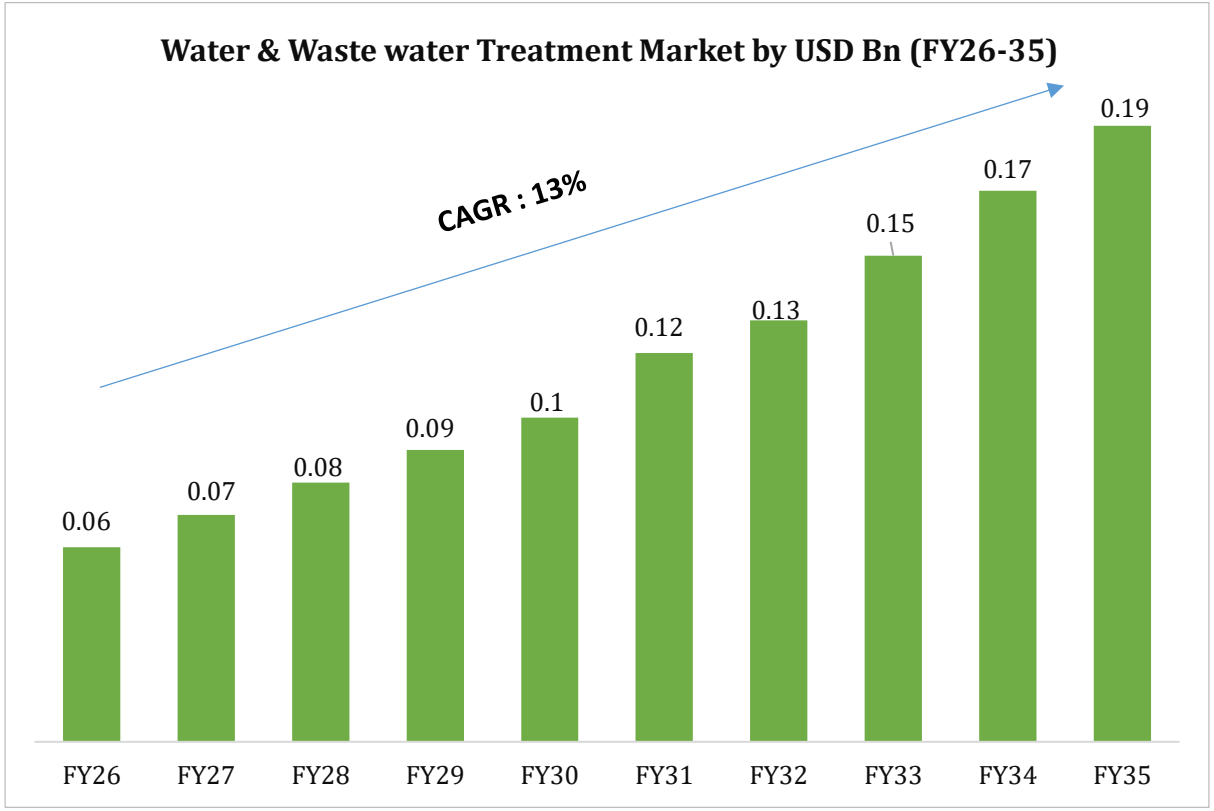
Policy / Regulation	Details
Water (Prevention & Control of Pollution) Act, 1974	Requires consent and compliant ETP for pharmaceutical effluent.
Environment (Protection) Act, 1986	Directly important because pharmaceutical effluent standards are notified under the Act.
Environment (Protection) Rules, 1986	Specific pharmaceutical standards: pH, BOD, COD, TSS, oil & grease, ammoniacal nitrogen and bio-assay requirements. (Central Pollution Control Board)
CPCB industry-specific standards	Direct: pharmaceutical standards and guidelines.
OCEMS	Mandatory/strongly specified: CPCB pharma guidance calls for OCEMS for pH, BOD, COD, TSS and flow in relevant discharge cases. (Central Pollution Control Board)
ZLD requirements / Consent conditions	Very High: CPCB pharma guidance specifically links ZLD to CTO conditions and reuse. (Central Pollution Control Board)
CETP model	Important for pharmaceutical clusters where common treatment is permitted.
National Framework on Safe Reuse of Treated Water, 2022	Very High: promotes recycle/reuse after advanced treatment.
Draft Liquid Waste Management Rules, 2024	Could strengthen treatment/reuse and monitoring requirements.
NITI Net Zero Scenario	Supports advanced, efficient wastewater treatment.
Bulk Drug Park Scheme	Very High: provides common environmental infrastructure for pharmaceutical manufacturing.
State PCB requirements / CTO conditions	Critical: SPCB CTO determines ZLD, monitoring and reuse requirements.

Sources: BDB Analysis based on Press Information Bureau Reports

4.2.2
API Industry

API: Water & Wastewater Treatment Market



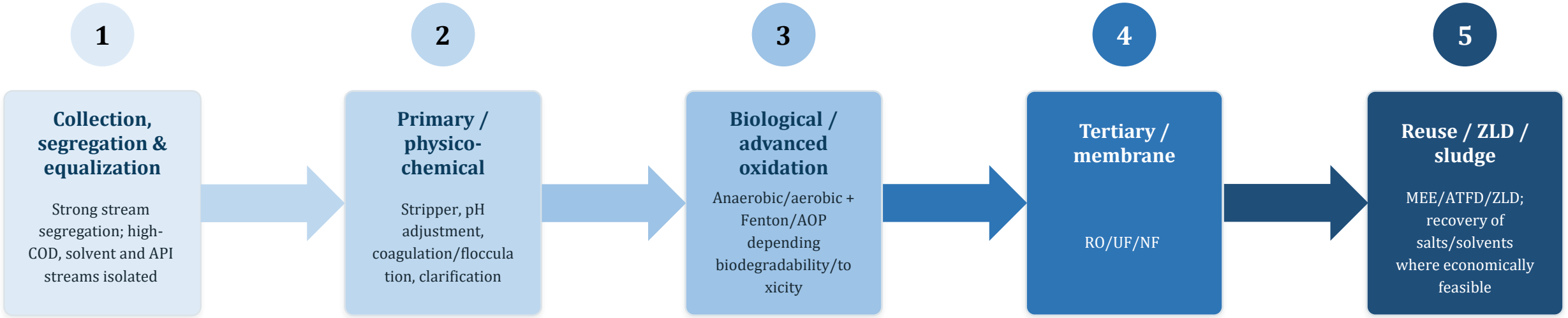


Key Market Highlights

- ✓ Water & Wastewater treatment capacity is expected to increase from 45 MLD in FY26 to 55 MLD by FY35, registering ~2% CAGR.
- ✓ The wastewater treatment market value is projected to USD 0.06 Bn in FY26 to USD 0.19 Bn by FY35, at ~13% CAGR.

Sources: BDB Analysis based on Press Information Bureau Reports

API: Production Process & Waste Generation Stages/Characteristics/Equipment's/Current Practices & Major Suppliers



Typical wastewater characteristics / pollutants

- Very high COD/TDS
- Solvents
- API residues
- Ammonia
- Organic acids
- Alcohols, acetone
- Methanol
- Toluene etc.

Major equipment / machines

- Segregation tanks
- Stripper
- Fenton
- ETP
- RO
- MEE
- ATFD
- Crystallizer

Current Indian working practice / evidence

- ZLD is already prevalent in many primary pharma/API facilities.
- CPCB documentation identifies stripper/MEE/ATFD/biological/RO combinations

Representative major suppliers

- WABAG
- Thermax
- Ion Exchange
- Aquatech
- ZLD Technologies

Sources: BDB Analysis based on Press Information Bureau Reports

API: Government Policies/Regulations/Initiatives

Policy / Regulation	Details
Water (Prevention & Control of Pollution) Act, 1974	Critical: stringent consent conditions for high-COD/API-bearing effluent.
Environment (Protection) Act, 1986	Directly applicable through bulk-drug/pharmaceutical effluent standards.
Environment (Protection) Rules, 1986	Bulk-drug manufacturing is covered within pharmaceutical standards, making advanced treatment/compliance particularly important. (Central Pollution Control Board)
CPCB industry-specific standards	Direct: bulk-drug standards and API-residue monitoring.
OCEMS	Very High: supports continuous monitoring of high-risk/API wastewater and ZLD/CETP systems.
ZLD requirements / Consent conditions	Very High / critical: ZLD is a major treatment model for bulk-drug/API clusters.
CETP model	Very High: Bulk Drug Parks are being developed with common CETP/ZLD infrastructure.
National Framework on Safe Reuse of Treated Water, 2022	Critical: supports maximum recovery of RO/MEE-treated water.
Draft Liquid Waste Management Rules, 2024	Particularly relevant because of complex/high-strength liquid waste streams.
NITI Net Zero Scenario	Encourages high-efficiency treatment and recovery/resource efficiency.
Bulk Drug Park Scheme	Critical: direct infrastructure driver for CETP/ZLD, solvent recovery and common waste management.
State PCB requirements / CTO conditions	Critical: especially important for API plants and Bulk Drug Parks.

Sources: BDB Analysis based on Press Information Bureau Reports

Waste Characteristics & Treatment/Recycling Needs & Major Companies, Key Projects & Equipment Adoption Trends

MEE Concentrate: Landfill or Co-Processing

MEE concentrate, carrying dissolved salts and residual API/solvent traces, usually goes to secured hazardous landfill or gets sent to cement kilns for co-processing, since it has high calorific value.

Spent Solvents: A Real Recovery Opportunity

Distillation-based recovery cuts hazardous-waste volume and raw-material cost at once. This is close to Japanese process and chemical engineering strengths.

Sludge Characterization Is a Services Gap

Sludge from the biological stage needs careful hazardous-waste characterization, given possible residual antibiotic or API content - and that characterization capability is missing at a lot of smaller facilities.

Company / Entity	Role
Aurobindo Pharma	New 15,000 tpa Penicillin-G block; large-scale API manufacturer with in-house ZLD
Bulk Drug Park - Jambusar (Gujarat)	In-principle approved park; common ETP/solvent-recovery infrastructure; expected completion H1 2026
Bulk Drug Park - Una (Himachal Pradesh)	Environmental Clearance secured Jan 2026; ZLD/CETP tender floated; tenure extended to March 2026
Bulk Drug Park - Andhra Pradesh (Nakkapalli)	Third in-principle approved park; timeline extended to March 2026 pending environmental clearance
NIPER network	Regulatory capacity-building; indirect influence on compliance standards

2025-26 Update: Real Ground Progress at Last

- ✓ After years of delay, Una secured its Environmental Clearance in January 2026 and floated tenders for ZLD facilities including CETP and steam systems.
- ✓ Jambusar's common infrastructure is expected complete by H1 2026 - the compliance-infrastructure window is now actively opening.

Sources: BDB Analysis based on reports and information from Drug Patent Watch, Policy Circle, PIB, biospectrumindia.com, medicaldialogues.in (2026 updates).

The Major Bulk Drug Parks in Detail

800+ Companies, 35% of National Output

Hyderabad's pharma engine (Genome Valley, Bachupally, Sanathnagar, Bollaram) now hosts an estimated 800+ pharmaceutical and biotech companies, and accounts for roughly 35% of India's drug manufacturing and about 40% of its pharmaceutical exports.

Named Players Headquartered Here

Dr. Reddy's Laboratories, Aurobindo Pharma, Divi's Laboratories, Hetero Drugs, Biological E, Bharat Biotech, Granules India, MSN Pharmaceuticals, Suven Pharma, Natco Pharma, Gland Pharma, and Laurus Labs.

Why This Concentration Matters

This isn't a marginal cluster - it's the core of India's API supply chain, which makes any credible monitoring or destruction technology a genuinely high-value proposition here.

Location	Scale & Funding
Jambusar, Bharuch (Gujarat)	800-2,015 acres; India's first bulk drug park; Centre funds 70% of common-infrastructure cost, capped at USD 105.8 million/park; expected completion H1 2026
Haroli, Una (Himachal Pradesh)	1,402 acres; ~USD201.0 million total cost, Centre covers ~90% (hilly-state rate); Environmental Clearance secured Jan 2026; tenure extended to March 2026
Nakkapalli, Anakapalli (Andhra Pradesh)	2,000+ acres (relocated from East Godavari); ~USD198.5 million sanctioned; planned 'Integrated Pharma Zone'; timeline extended to March 2026

~USD317.4 million Scheme, Six Years In

- ✓ Overall scheme outlay: ~USD317.4 million across all three parks, under the Dept. of Pharmaceuticals' 'Promotion of Bulk Drug Parks' scheme (notified 2020, tenure extended through FY 2026-27).
- ✓ Central assistance is capped at USD105.8 million or 70% of common-infrastructure cost per park (90% for hilly states).

Sources: BDB Analysis based on reports and information from PMC qualitative study, ERM Insights, ijdra.com.

4.3
Food
Beverage
Dairy
Sugar Industries

Market Overview & Major Cluster Regions

The Widest-Ranging Category in This Report

This category covers more ground than any other: dairy cooperatives in Maharashtra and Gujarat, sugar mills across Uttar Pradesh, Maharashtra, and Karnataka, breweries and beverage plants in Karnataka and Maharashtra, and regional food-processing clusters like the snacks-and-sweets industry around Bikaner, Rajasthan.

Sugar & Distillery: the Volume and Strength Extremes

Sugar mills generate roughly 1,000 litres of wastewater for every tonne of cane crushed - that volume alone makes treatment technology choice a major line item for this sub-sector. Distilleries, often co-located with sugar mills, produce 'spent wash' - the highest-strength effluent in this entire report, running 40,000 to 80,000 mg/L BOD.

Regulations & Current Monitoring Practices

Spent Wash: Among the Strictest Rules in This Report

CPCB requires biomethanation (anaerobic digestion for biogas) followed by composting or incineration for sugar-linked distillery spent wash. Direct discharge to land or water is banned outright, regardless of dilution. Standalone distilleries have to hit Zero Liquid Discharge in most states.

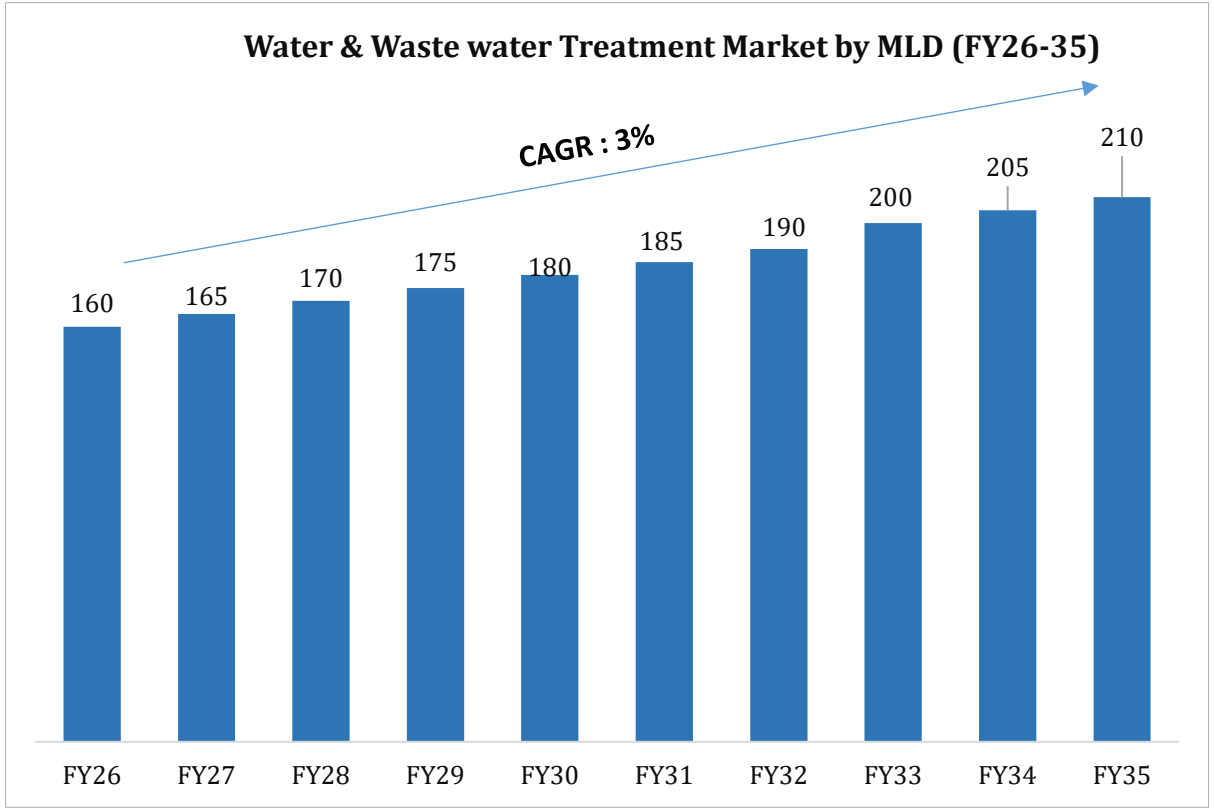
Dairy, Beverage & General Food Processing

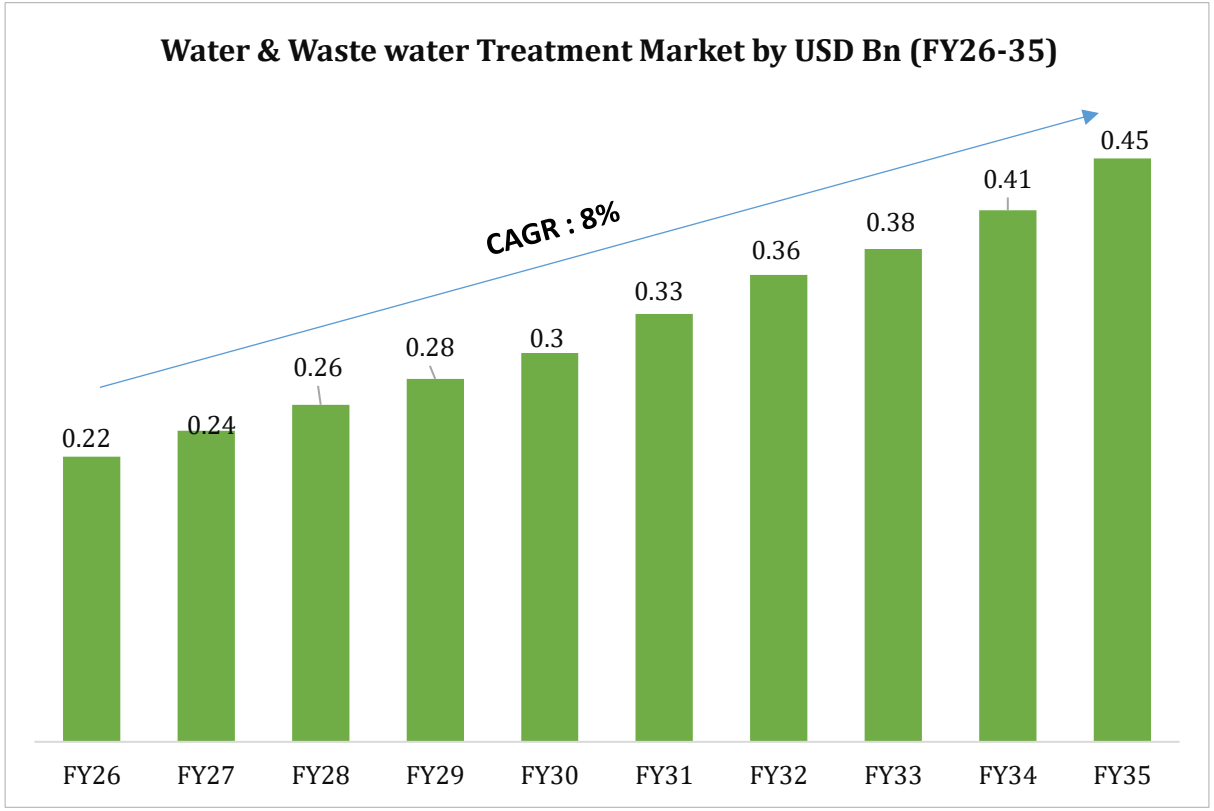
These sit under the standard CPCB/SPCB effluent norms, but get particular scrutiny for fats, oils and grease discharge, and for the surges that come from clean-in-place (CIP) cycles - a recurring compliance flashpoint for smaller processors.

Sources: BDB Analysis based on reports and information from SUSBIO, ScienceDirect (sugar wastewater review), Journal of Condensed Matter (Bikaner study).

4.3.1
Food Industry

Food: Water & Wastewater Treatment Market



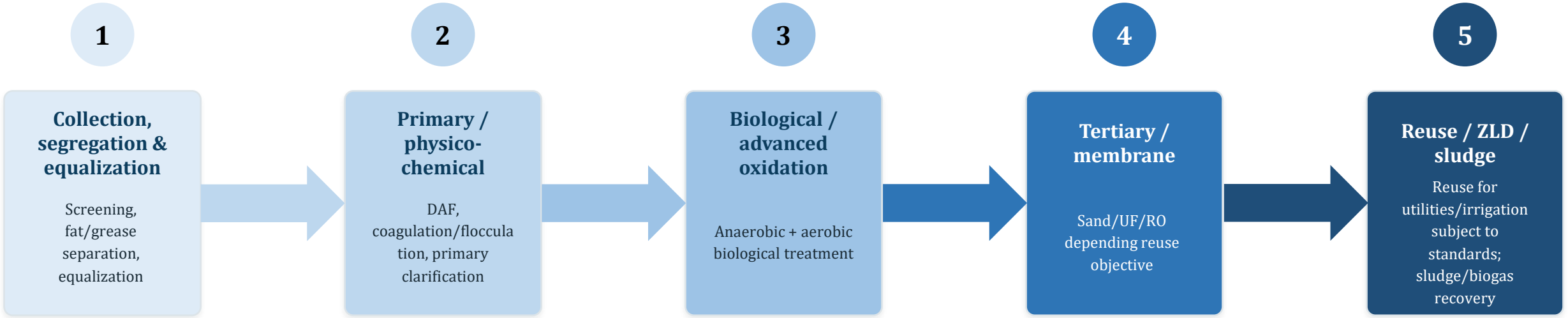


Key Market Highlights

- ✓ Water & Wastewater treatment capacity is expected to increase from 160 MLD in FY26 to 210 MLD by FY35, registering ~3% CAGR.
- ✓ The wastewater treatment market value is projected to USD 0.22 Bn in FY26 to USD 0.45 Bn by FY35, at ~8% CAGR.

Sources: BDB Analysis based on NITI Aayog & CPCB Reports

Food: Production Process & Waste Generation Stages/Characteristics/Equipment's/Current Practices & Major Suppliers



Typical wastewater characteristics / pollutants

- High BOD/COD
- Suspended solids
- Carbohydrates
- Proteins
- Fats/oils
- Nutrients; generally biodegradable

Major equipment / machines

- Screens, DAF
- Fat separator
- UASB/EGSB
- MBBR/ASP/SBR
- Clarifier
- Filtration

Current Indian working practice / evidence

- Biological treatment is generally economically attractive because of high biodegradability; anaerobic systems allow biogas recovery

Representative major suppliers

- WABAG
- Thermax
- Ion Exchange
- Veolia
- SUEZ

Sources: BDB Analysis based on NITI Aayog & CPCB Reports

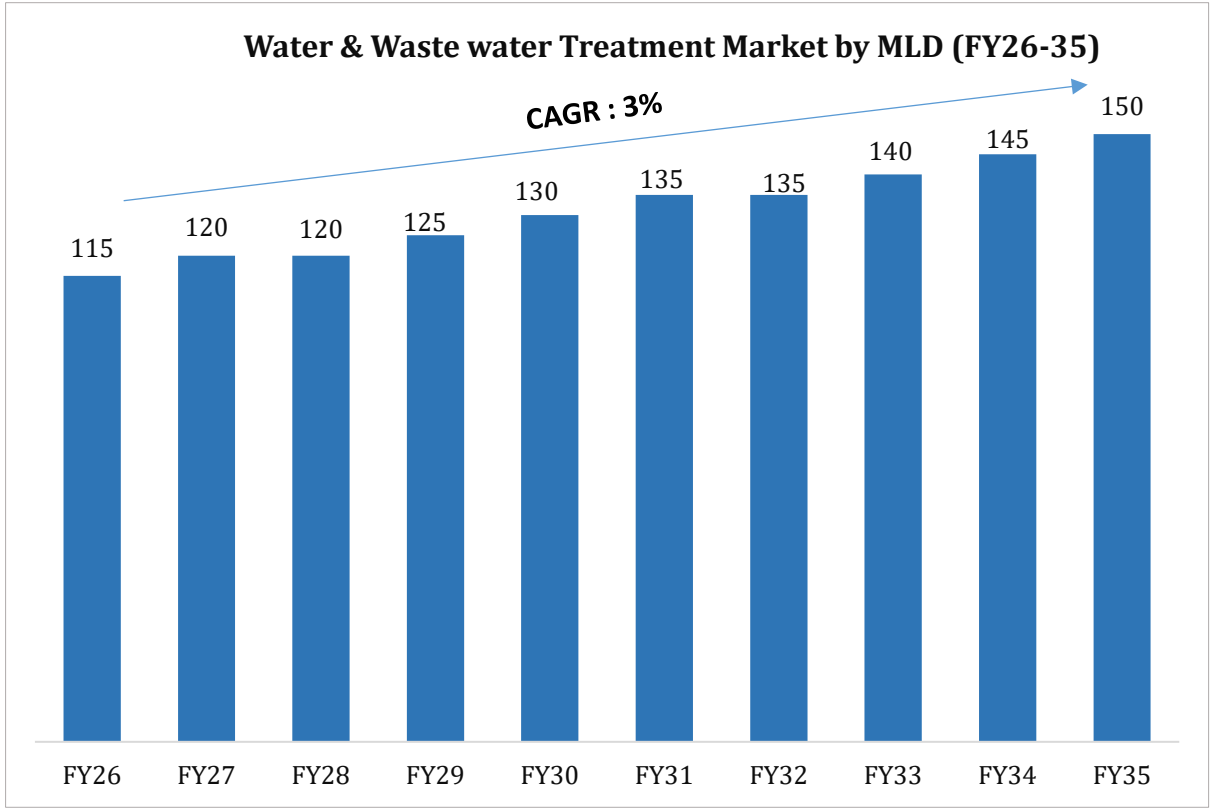
Food: Government Policies/Regulations/Initiatives

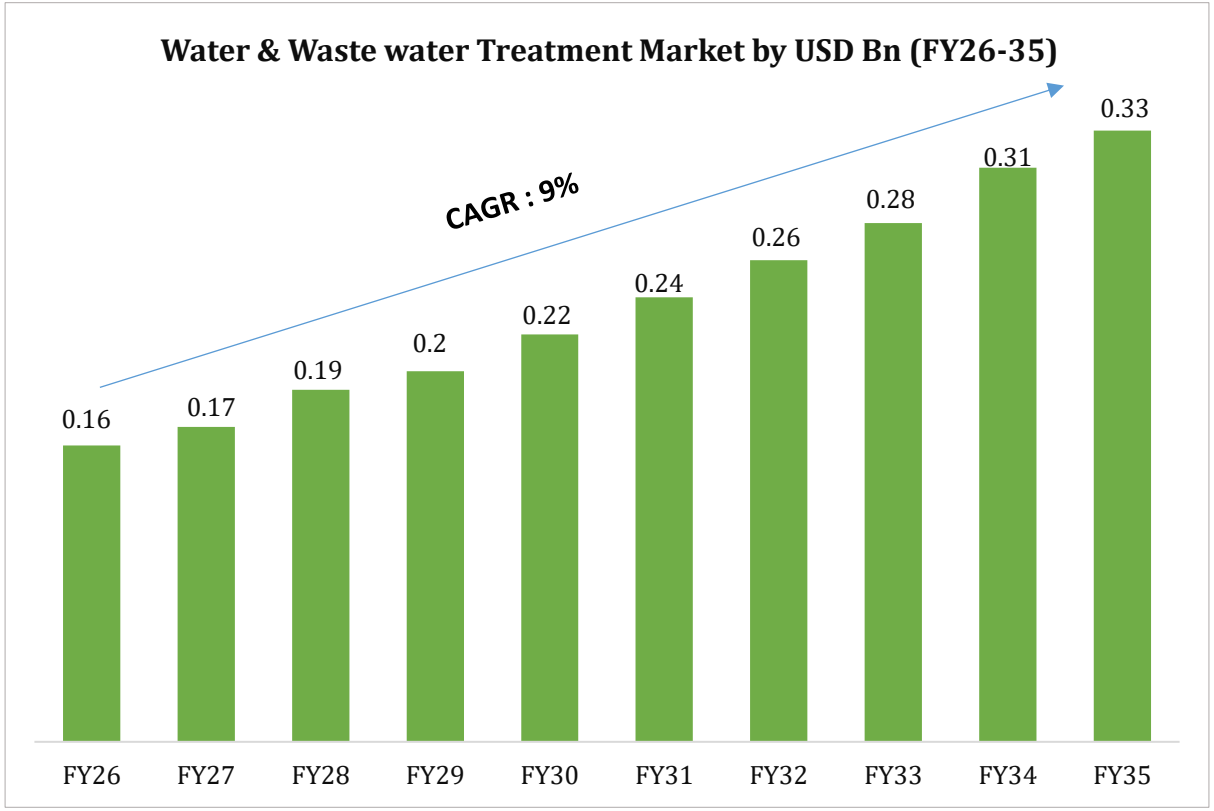
Policy / Regulation	Details
Water (Prevention & Control of Pollution) Act, 1974	Requires ETP and consent for organic wastewater discharge.
Environment (Protection) Act, 1986	Provides overarching environmental standards applicable to food-processing plants.
Environment (Protection) Rules, 1986	General/sector-specific standards determine final discharge quality.
CPCB industry-specific standards	Mainly general/sector-specific food-industry requirements.
OCEMS	Applicable to qualifying large/high-pollution units.
ZLD requirements / Consent conditions	Usually reuse-focused rather than universal ZLD.
CETP model	Limited/moderate; larger plants generally use captive ETPs.
National Framework on Safe Reuse of Treated Water, 2022	Promotes treated-water reuse in utilities/non-product applications.
Draft Liquid Waste Management Rules, 2024	Encourages improved treatment and reuse.
NITI Net Zero Scenario	Important: organic wastewater creates potential for anaerobic treatment and methane recovery.
State PCB requirements / CTO conditions	High: CTO determines ETP and discharge/reuse conditions.

Sources: BDB Analysis based on NITI Aayog & CPCB Reports

4.3.2
Beverage Industry

Beverages: Water & Wastewater Treatment Market



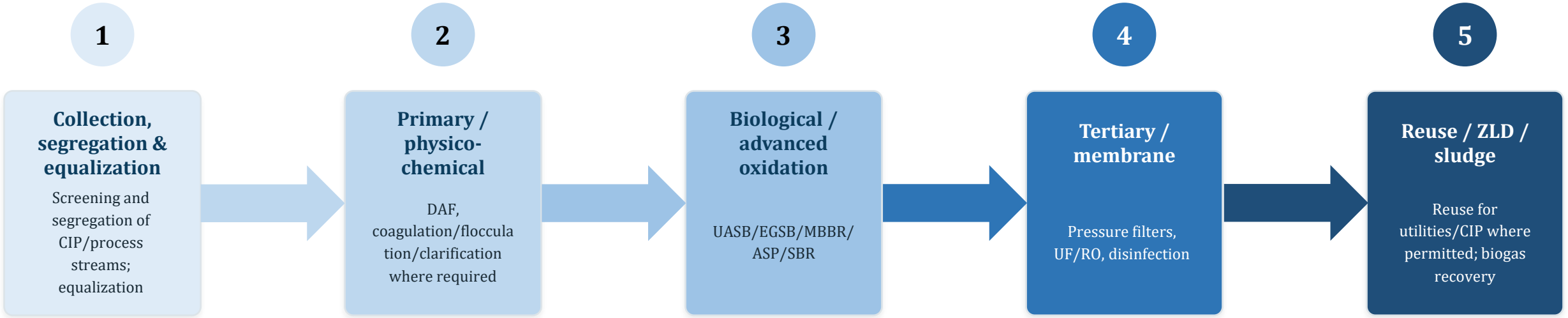


Key Market Highlights

- ✓ Water & Wastewater treatment capacity is expected to increase from 115 MLD in FY26 to 150 MLD by FY35, registering ~3% CAGR.
- ✓ The wastewater treatment market value is projected to USD 0.16 Bn in FY26 to USD 0.33 Bn by FY35, at ~9% CAGR.

Sources: BDB Analysis based on NITI Aayog & CPCB Reports

Beverages: Production Process & Waste Generation
Stages/Characteristics/Equipment's/Current Practices & Major Suppliers



Typical wastewater characteristics / pollutants

- High BOD/COD
- Sugars
- alcohol depending on product
- cleaning chemicals
- suspended solids
- variable pH

Major equipment / machines

- Screens, DAF
- Equalization
- UASB/EGSB
- MBBR/SBR
- clarifier, RO

Current Indian working practice / evidence

- Combination of anaerobic + aerobic treatment is common for high-organic loads; reuse is becoming more important

Representative major suppliers

- WABAG
- Thermax
- Ion Exchange
- Veolia

Sources: BDB Analysis based on NITI Aayog & CPCB Reports

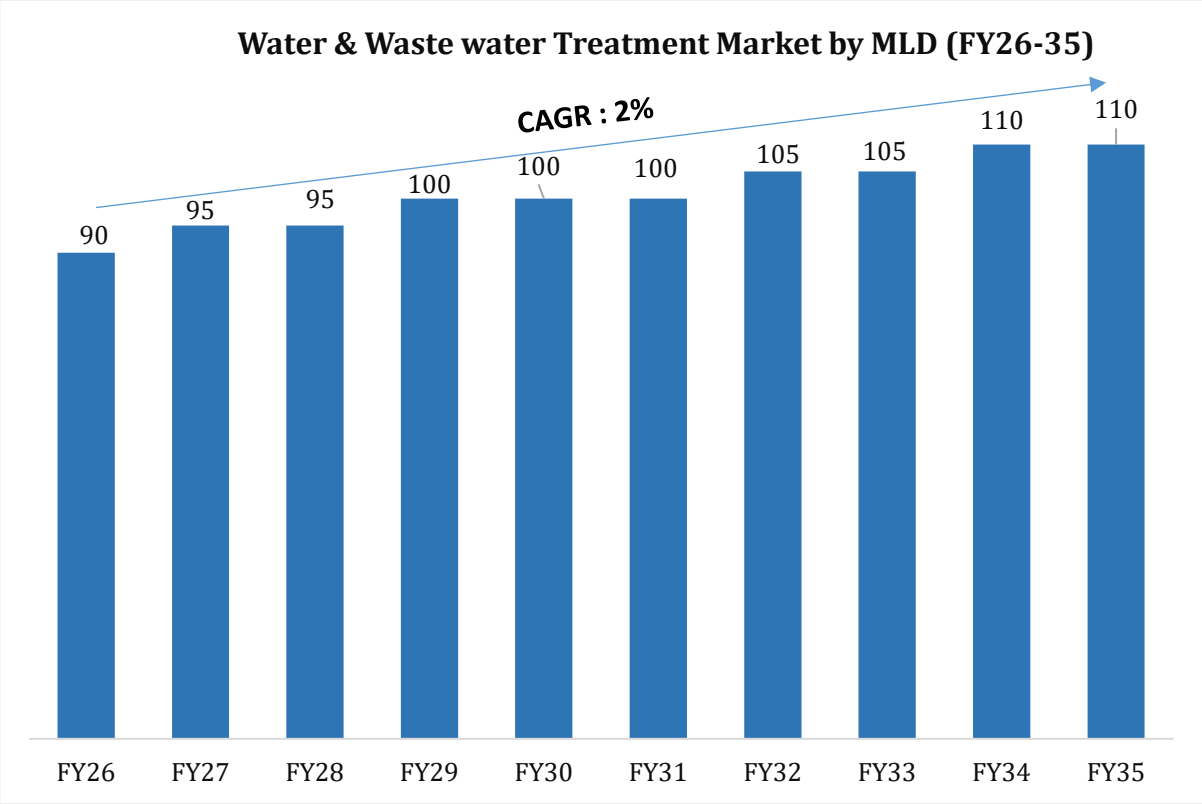
Beverages: Government Policies/Regulations/Initiatives

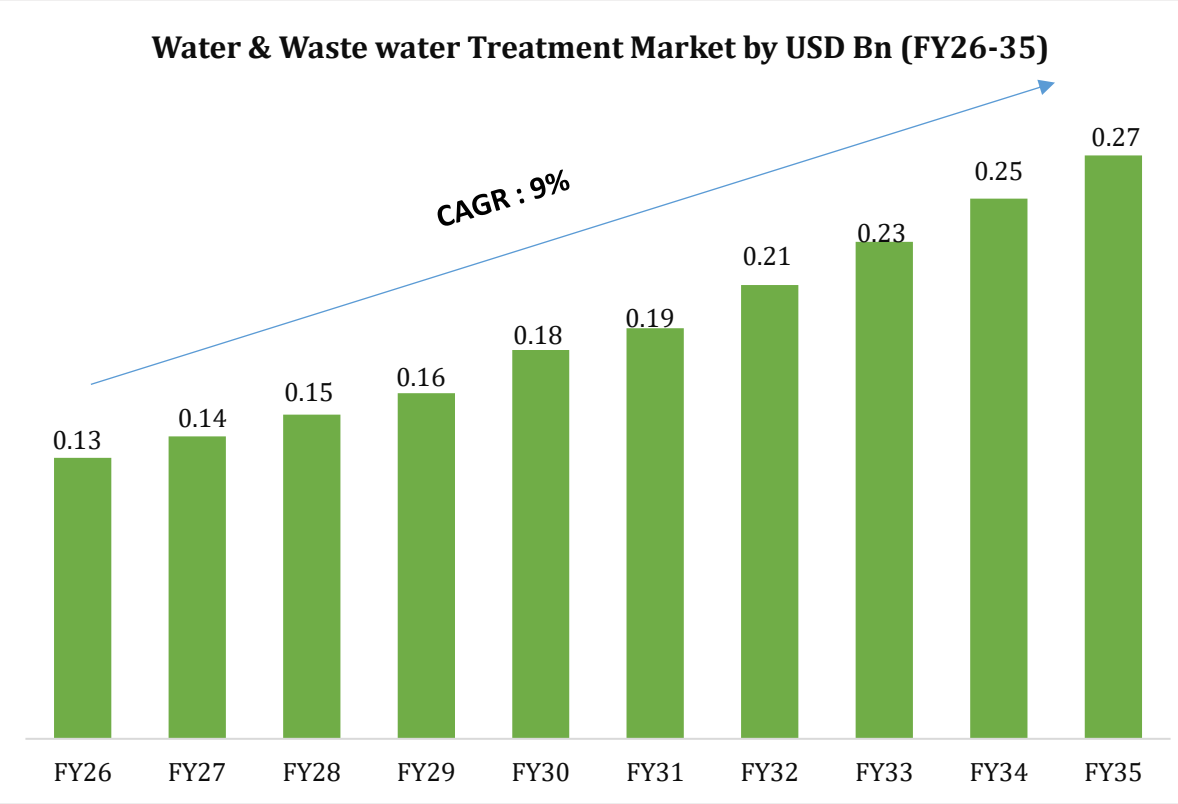
Policy / Regulation	Details
Water (Prevention & Control of Pollution) Act, 1974	Requires treatment of high-organic/CIP wastewater before discharge.
Environment (Protection) Act, 1986	Applies through fermentation/brewery-related effluent standards.
Environment (Protection) Rules, 1986	Fermentation industry standards apply to breweries/maltries/distilleries. (Central Pollution Control Board)
CPCB industry-specific standards	Fermentation/brewery wastewater standards.
OCEMS	Applicable to qualifying fermentation/brewery units.
ZLD requirements / Consent conditions	Primarily water recovery/reuse rather than universal ZLD.
CETP model	Limited/moderate; cluster model possible.
National Framework on Safe Reuse of Treated Water, 2022	Supports reuse for utilities/CIP-related applications subject to quality requirements.
Draft Liquid Waste Management Rules, 2024	Encourages systematic wastewater management/reuse.
NITI Net Zero Scenario	Supports anaerobic treatment/energy recovery where applicable.
State PCB requirements / CTO conditions	High: CTO determines wastewater treatment and discharge route.

Sources: BDB Analysis based on NITI Aayog & CPCB Reports

4.3.3
Dairy Industry

Dairy: Water & Wastewater Treatment Market



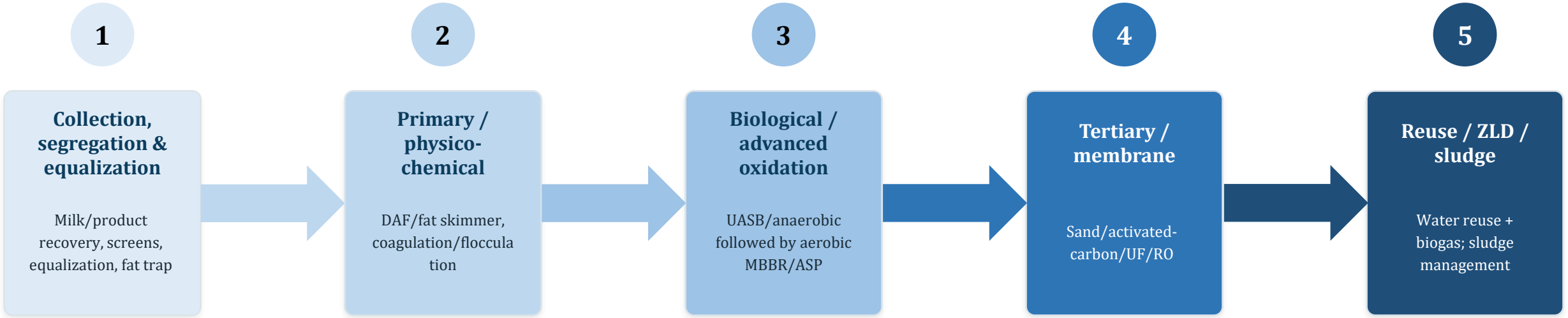


Key Market Highlights

- ✓ Water & Wastewater treatment capacity is expected to increase from 90 MLD in FY26 to 110 MLD by FY35, registering ~2% CAGR.
- ✓ The wastewater treatment market value is projected to USD 0.13 Bn in FY26 to USD 0.27 Bn by FY35, at ~9% CAGR.

Sources: BDB Analysis based on NITI Aayog & CPCB Reports

Dairy: Production Process & Waste Generation Stages/Characteristics/Equipment's/Current Practices & Major Suppliers



Typical wastewater characteristics / pollutants

- Milk fats, proteins
- Lactose
- high BOD/COD
- TSS
- nutrients; pH typically variable due to CIP

Major equipment / machines

- Fat skimmer
- DAF
- Equalization
- UASB
- MBBR/ASP
- Clarifier
- tertiary filtration

Current Indian working practice / evidence

- Government inspection records show ETPs using fat skimmer + equalization + UASB + aeration + clarifier. (CPCB)

Representative major suppliers

- WABAG
- Thermax
- Ion Exchange
- Veolia
- SUEX

Sources: BDB Analysis based on NITI Aayog & CPCB Reports

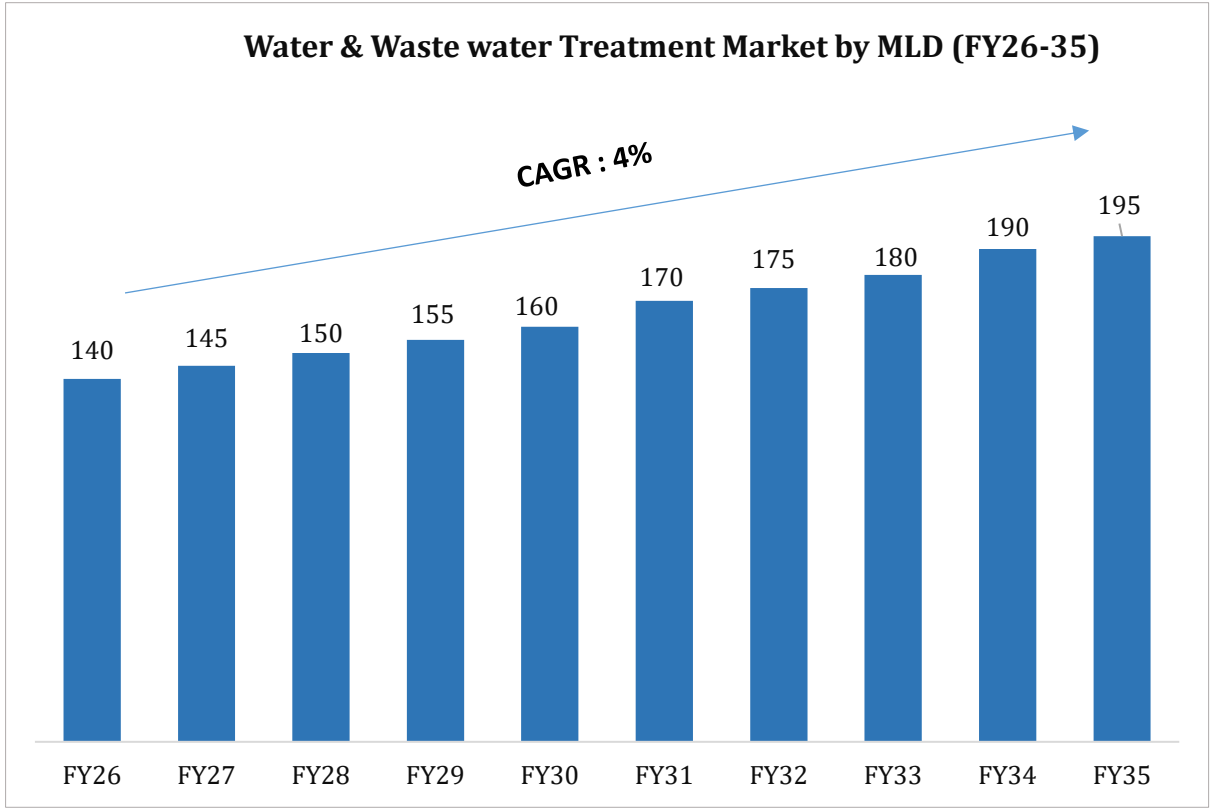
Dairy: Government Policies/Regulations/Initiatives

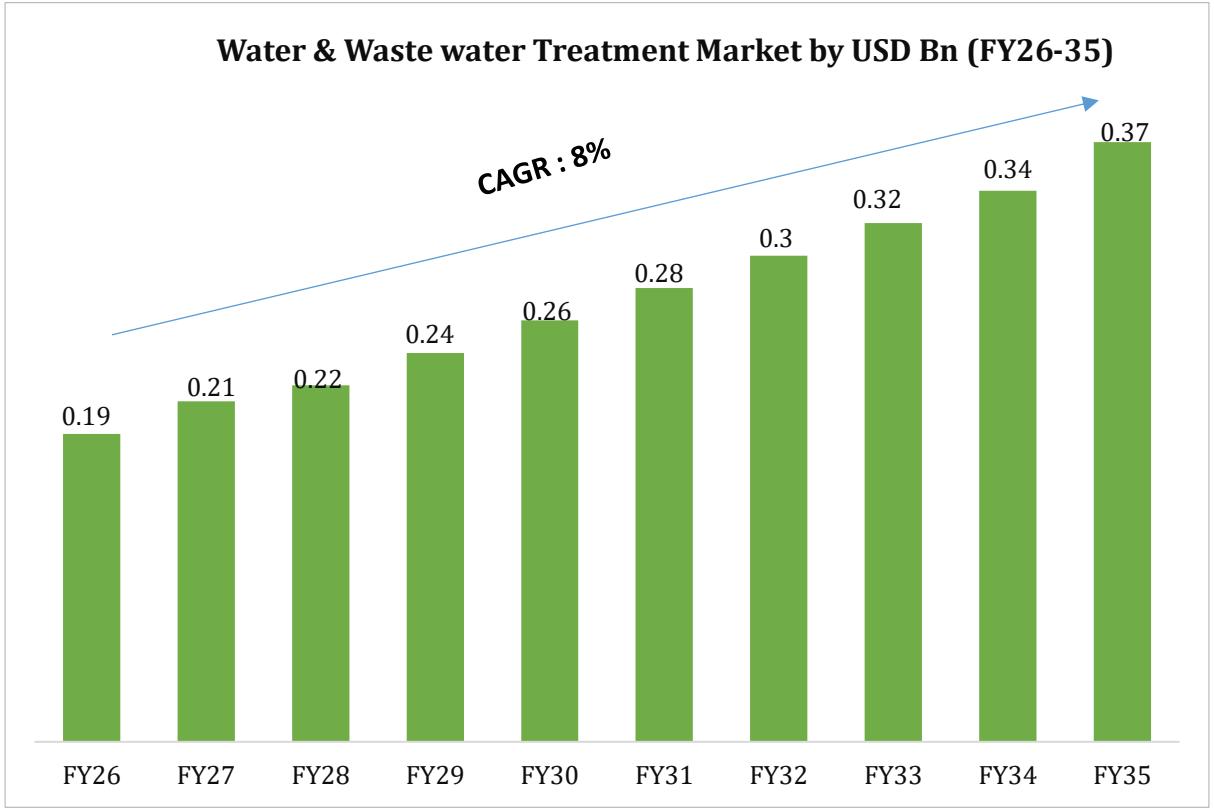
Policy / Regulation	Details
Water (Prevention & Control of Pollution) Act, 1974	Requires ETP for high-BOD/COD dairy effluent.
Environment (Protection) Act, 1986	Provides framework for prescribed discharge standards.
Environment (Protection) Rules, 1986	Discharge standards drive biological treatment and polishing.
CPCB industry-specific standards	CPCB requirements for dairy effluent/monitoring.
OCEMS	Applicable to qualifying large dairy units.
ZLD requirements / Consent conditions	Increasing reuse/biogas recovery, but ZLD is not generally universal.
CETP model	Moderate; large dairy plants typically have captive ETPs.
National Framework on Safe Reuse of Treated Water, 2022	Encourages reuse for non-potable plant applications.
Draft Liquid Waste Management Rules, 2024	Supports improved wastewater collection, treatment and resource recovery.
NITI Net Zero Scenario	Very High: NITI specifically identifies dairy and proposes improved anaerobic treatment/methane recovery. (NITI Aayog)
State PCB requirements / CTO conditions	High: plant-specific consent determines ETP standards.

Sources: BDB Analysis based on NITI Aayog & CPCB Reports

4.3.4
Sugar Industry

Sugar: Water & Wastewater Treatment Market





Key Market Highlights

- ✓ Water & Wastewater treatment capacity is expected to increase from 140 MLD in FY26 to 195 MLD by FY35, registering ~4% CAGR.
- ✓ The wastewater treatment market value is projected to USD 0.19 Bn in FY26 to USD 0.37 Bn by FY35, at ~8% CAGR.

Sources: BDB Analysis based on NITI Aayog & CPCB Reports

Sugar: Production Process & Waste Generation Stages/Characteristics/Equipment's/Current Practices & Major Suppliers

1 **Collection, segregation & equalization**

Segregate high-COD streams, condensate, cooling water; oil/grease removal

2 **Primary / physico-chemical**

Mechanical oil/grease skimmer, equalization, clarification

3 **Biological / advanced oxidation**

Anaerobic followed by aerobic/extended aeration

4 **Tertiary / membrane**

Microfiltration/bag/ cartridge/ceramic filtration; CPU for boiler condensate

5 **Reuse / ZLD / sludge**

Reuse/recycle; ZLD where required; biogas/sludge

Typical wastewater characteristics / pollutants

- High BOD/COD
- suspended solids
- oil/grease
- organic matter
- variable pH; high-strength streams can exceed COD 2,000–2,500 mg/L

Major equipment / machines

- Oil/grease skimmer
- Equalization
- anaerobic digester/filter
- Aeration
- Clarifier
- microfiltration/CPU

Current Indian working practice / evidence

- CPCB's 2025/26 sugar charter specifically calls for mechanical oil/grease skimmers, two-stage anaerobic + aerobic treatment, tertiary microfiltration and CPUs for high-pressure boilers

Representative major suppliers

- WABAG
- Thermax
- Ion Exchange
- Veolia

Sources: BDB Analysis based on NITI Aayog & CPCB Reports

Sugar: Government Policies/Regulations/Initiatives

Policy / Regulation	Details
Water (Prevention & Control of Pollution) Act, 1974	Requires treatment and controlled discharge of sugar-mill effluent.
Environment (Protection) Act, 1986	Supports sector-specific sugar effluent standards.
Environment (Protection) Rules, 1986	CPCB sugar standards drive ETP performance and final effluent quality.
CPCB industry-specific standards	Direct: CPCB Sugar Charter specifies treatment and discharge requirements.
OCEMS	Applicable to qualifying sugar units/CETPs.
ZLD requirements / Consent conditions	Reuse/recycling increasingly important; ZLD depends on site/consent.
CETP model	Moderate; large sugar mills generally operate captive ETPs.
National Framework on Safe Reuse of Treated Water, 2022	Encourages reuse in process/utilities and reduces freshwater demand.
Draft Liquid Waste Management Rules, 2024	Supports improved industrial wastewater management.
NITI Net Zero Scenario	High: sugar wastewater has high organic load and potential for anaerobic treatment/biogas recovery. (NITI Aayog)
State PCB requirements / CTO conditions	High: state conditions can impose stricter discharge/reuse requirements.

Sources: BDB Analysis based on NITI Aayog & CPCB Reports

Wastewater Treatment Technologies

Three Sub-Sectors, Three Distinct Profiles

- ✓ Dairy: milk receiving through product-specific lines (cheese, butter, ice cream), interrupted regularly by clean-in-place cycles that can knock over downstream biological treatment if equalization isn't sized properly.
- ✓ Sugar/distillery: cane crushing, juice extraction, clarification, evaporation and crystallization - spent wash comes out specifically at the distillation stage. Beverage/brewing: fermentation, filtration, packaging, with yeast and grain residues needing pre-treatment.

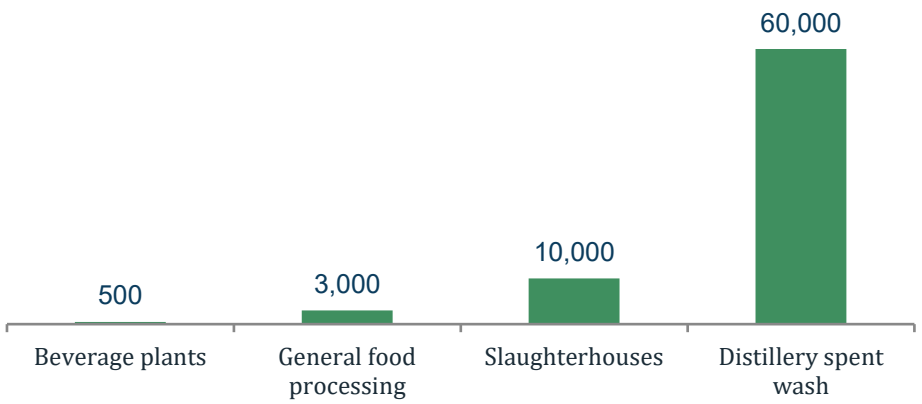
One Treatment Design Does Not Fit This Category

- ✓ BOD swings wildly by sub-segment (chart, next page). High organic load favors anaerobic treatment - UASB digesters or anaerobic membrane bioreactors - for biogas recovery, usually paired with an aerobic polishing stage (MBBR or SBR) to hit final discharge limits.

DAF Is Close to Universal; Cost Benchmarks

- ✓ Removing fats, oils and grease through dissolved air flotation (DAF) is close to a universal requirement across dairy, meat-processing, and beverage effluent.
- ✓ For context: a 25 KLD small dairy/bakery unit without DAF runs roughly USD 10,600-19,100 in India; a 50 KLD dairy with DAF runs USD 21,200-37,100 - the range any Japanese equipment supplier would be pricing against.

BOD by Sub-Segment (mg/L) - Log-Scale Difference



Distillery Spent Wash vs. Beverage Wastewater

- Distillery spent wash is around 100 times more concentrated than typical beverage-plant wastewater.
- This is why CPCB treats distillery spent wash as a separate regulatory category.
- Therefore, any treatment technology or service positioned for the broader "food & beverage" sector should clearly specify which type and concentration of wastewater it is actually designed to handle.

Sources: BDB Analysis based on reports and information from SUSBIO, IDRO Group, MDPI (dairy wastewater characteristics).

Waste Characteristics & Treatment/Recycling Needs & Major Companies, Key Projects & Equipment Adoption Trends

Biogas Recovery: Compliance Requirement and Energy Offset

Anaerobic digestion is both a compliance requirement and a real energy-cost offset. Respirometric studies have shown methane content over 60% for dairy and sugar-industry wastewater specifically.

Valorizing By-Products Instead of Landfilling

By-products like bagasse and press mud from sugar, or whey solids from dairy, are increasingly valorized rather than landfilled - opening the door to combined waste-to-value offerings, not just pure effluent treatment.

Sludge Handling & Odor Control: the Sore Points

These are the persistent sore points Indian ETP contractors keep flagging, and an area where more capable technology is genuinely underused.

Company / Entity	Role
SUSBIO	ETP design and build for food & beverage clients, from small Maharashtra dairy cooperatives to large Karnataka beverage plants
Chokhavatia Associates	End-to-end wastewater treatment (MBBR, SBR, UASB, ZLD) for dairy, brewery, meat-processing, and beverage clients
IDRO Group	DAF and biological treatment technology for slaughterhouse, dairy, winemaking, and confectionery effluent
Regional sugar mill cooperatives (UP, Maharashtra, Karnataka)	Primary demand base for spent-wash biomethanation and ZLD systems

Sources: BDB Analysis based on reports and information from Science.gov (biogas fermentation study), Chokhavatia Associates.

Cluster Overview: Kolhapur, Muzaffarnagar, Anand & Baddi

Sugar Industry

Kolhapur, Maharashtra: EIEL secured a USD 42.3 million project from MIDC to upgrade CETPs to Zero Liquid Discharge across three cooperative industrial estates (Ichalkaranji, Hatkanangale, Yadrav), part of a broader Panchganga River pollution-abatement program. 24-month build, plus ongoing O&M.

Muzaffarnagar (UP): Triveni Engineering sugar mills (Ramkola, Rampur), which have faced court cases over alleged environmental violations; UPPCB inspects monthly rather than quarterly.

Dairy Industry

Anand: headquarters of Amul (GCMMF) - 2025 revenue ~USD 9.52 billion, 3.6 million member milk producers, building a new 20 lakh-LLPD milk plant in Saurashtra.

Food Industry

Baddi-Barotiwala-Nalagarh (BBN), Himachal Pradesh: Declared a severely polluted area by CPCB in 2006; a 25 MLD CETP built at Kenduwal village (2005-06) treats load from food industry along with mixed load from, paper, detergent, and pharmaceutical units in one shared facility.

Sources: BDB Analysis based on reports and information from newsonprojects.com, The Wire (Science), Wikipedia (Amul), PMC (BBN CETP study).

4.4
Metal Processing, Surface Treatment, Automotive, Electronics & Battery

Market Overview & Major Cluster Regions

Dense Clusters Feeding Multiple Manufacturing Sectors

Electroplating and metal-finishing units cluster densely around Pune, Delhi-NCR, and Bengaluru, feeding automotive (fasteners, chrome trim), aerospace (anodized aluminium), electronics (circuit boards, connectors, EMI shielding), and general consumer-goods manufacturing.

A Six-Decade-Old Industry, Still Growing

Automotive is one of India's largest manufacturing sectors on its own, each stage contributing a different effluent stream. India's electroplating industry actually goes back to 1976 (Mumbai's first semi-automatic facility) and has grown more or less continuously since the early 1960s.

Regulations & Current Monitoring Practices

Case-Specific Consent, Not a Blanket Rule

Electroplating is one of the most tightly regulated metal-finishing processes in India: cyanide complexes, heavy metals, and wide pH swings mean the SPCB sets case-specific Consent to Operate conditions rather than a blanket rule.

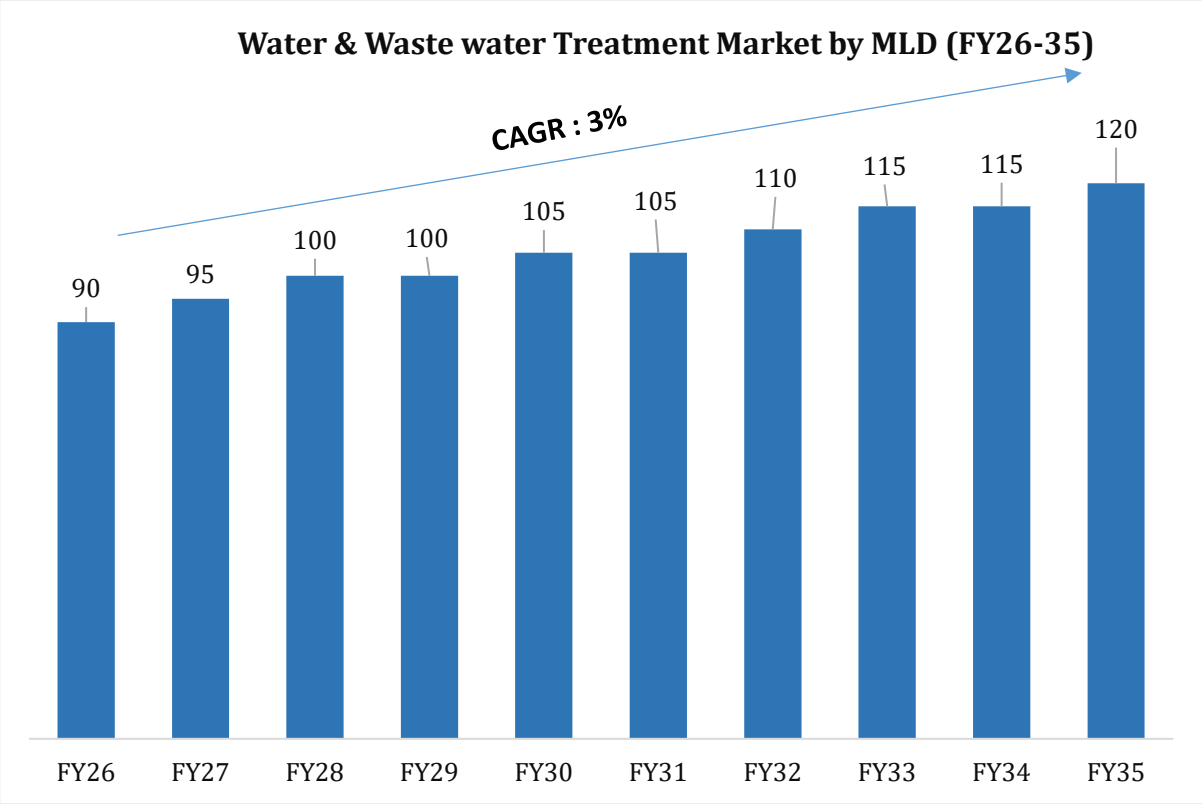
~29% of Waste Is Hazardous

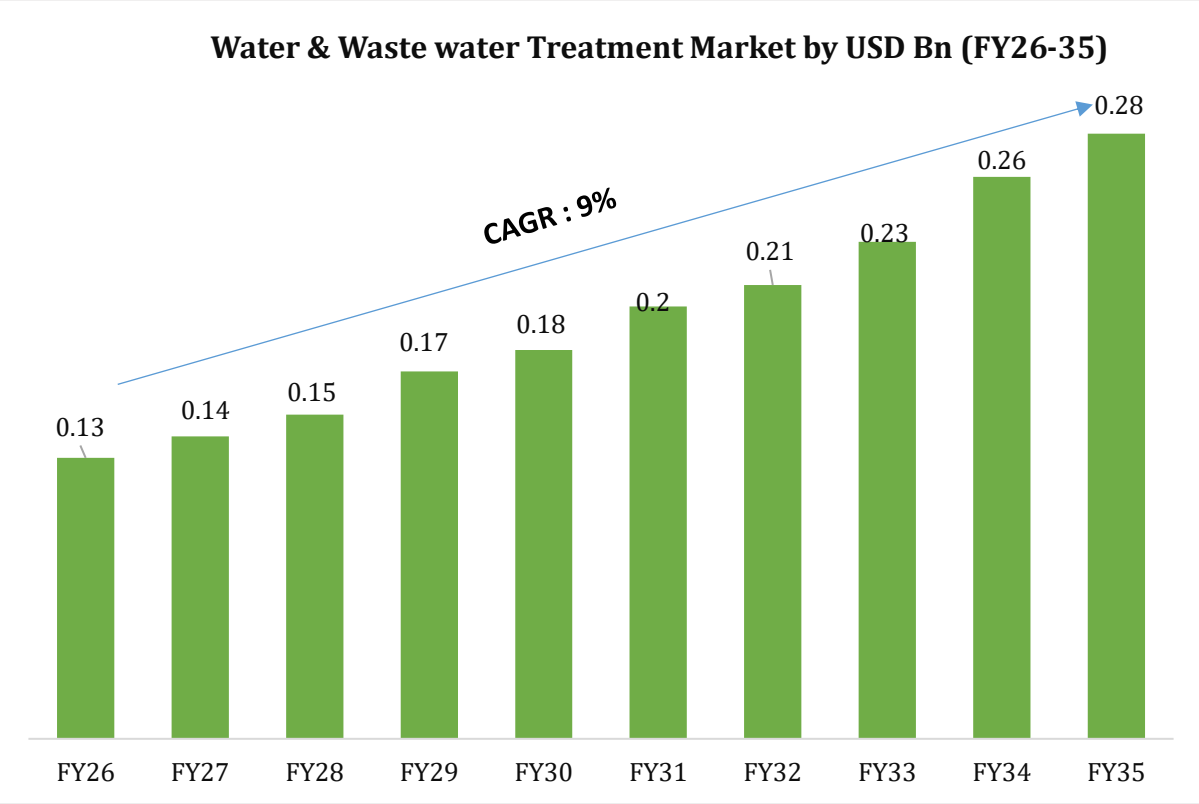
Industry technical literature puts roughly 29% of electroplating-industry waste in the hazardous category, driving strict handling and disposal obligations on top of standard effluent rules. Battery manufacturing/assembly (distinct from recycling) falls under standard hazardous-industry effluent rules due to lead, lithium-compound, and solvent content.

Sources: BDB Analysis based on reports and information from Kelvin Water Treatment, Enter Climate, theaspd.com (COINDS reference).

4.4.1
Metal Processing Industry

Metal: Water & Wastewater Treatment Market



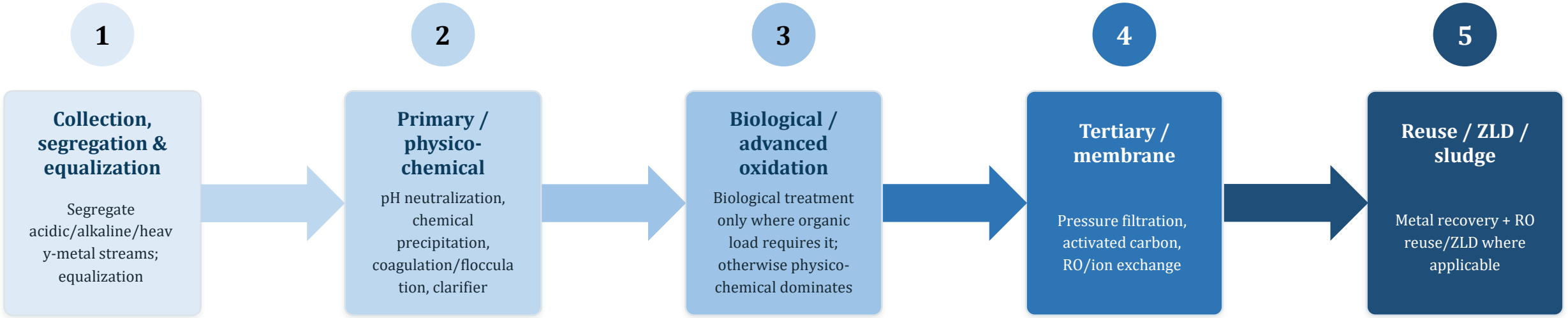


Key Market Highlights

- ✓ Water & Wastewater treatment capacity is expected to increase from 90 MLD in FY26 to 120 MLD by FY35, registering ~3% CAGR.
- ✓ The wastewater treatment market value is projected to USD 0.13 Bn in FY26 to USD 0.28 Bn by FY35, at ~9% CAGR.

Sources: BDB Analysis based on MPCB & CPCB Reports

Metal: Production Process & Waste Generation Stages/Characteristics/Equipment's/Current Practices & Major Suppliers



Typical wastewater characteristics / pollutants

- TSS, metals such as Cr, Ni, Zn, Cu, Pb, Fe; acids/alkalis, cyanide/fluoride depending process

Major equipment / machines

- Neutralisation tanks
- chemical dosing
- Precipitation
- Clarifier
- filter press,
- cartridge/multimedia filters, RO

Current Indian working practice / evidence

- CETPs increasingly monitor metal-specific parameters and reuse treated effluent.
- CPCB inspection data show reuse in steel CETP applications

Representative major suppliers

- WABAG
- Thermax
- Ion Exchange
- Veolia

Sources: BDB Analysis based on MPCB & CPCB Reports

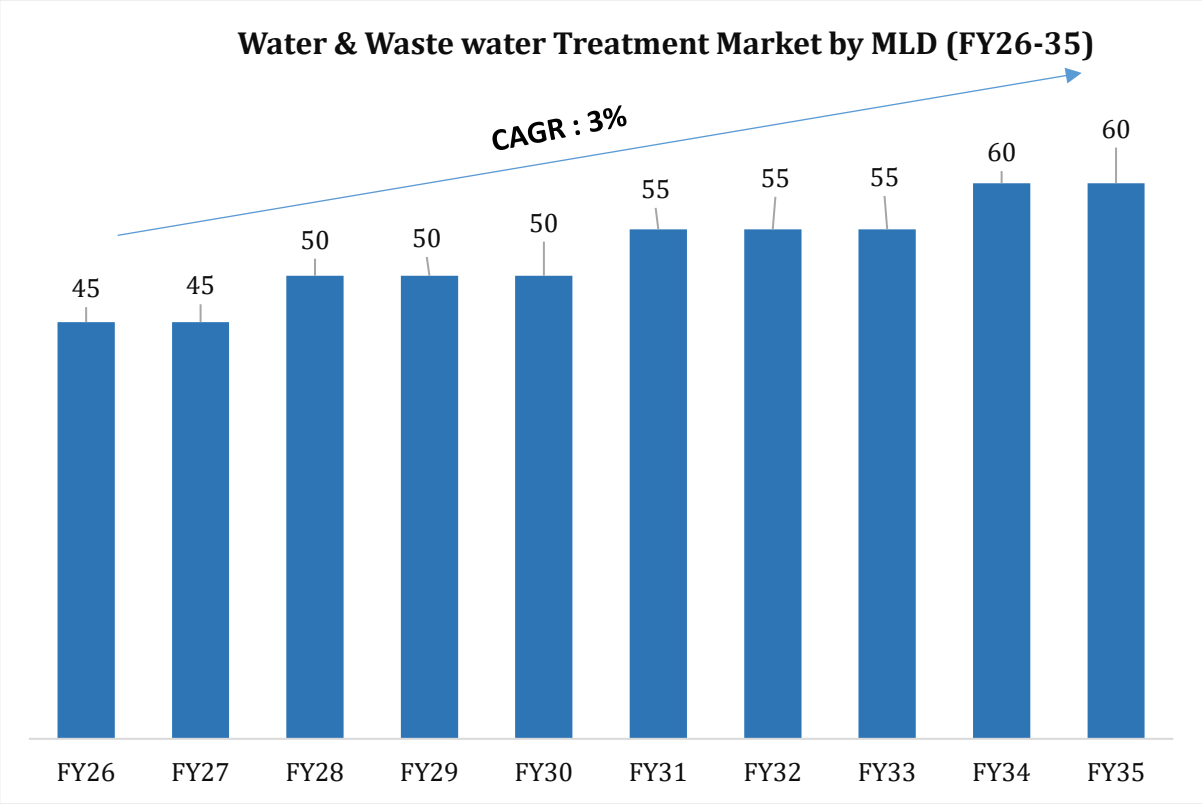
Metal: Government Policies/Regulations/Initiatives

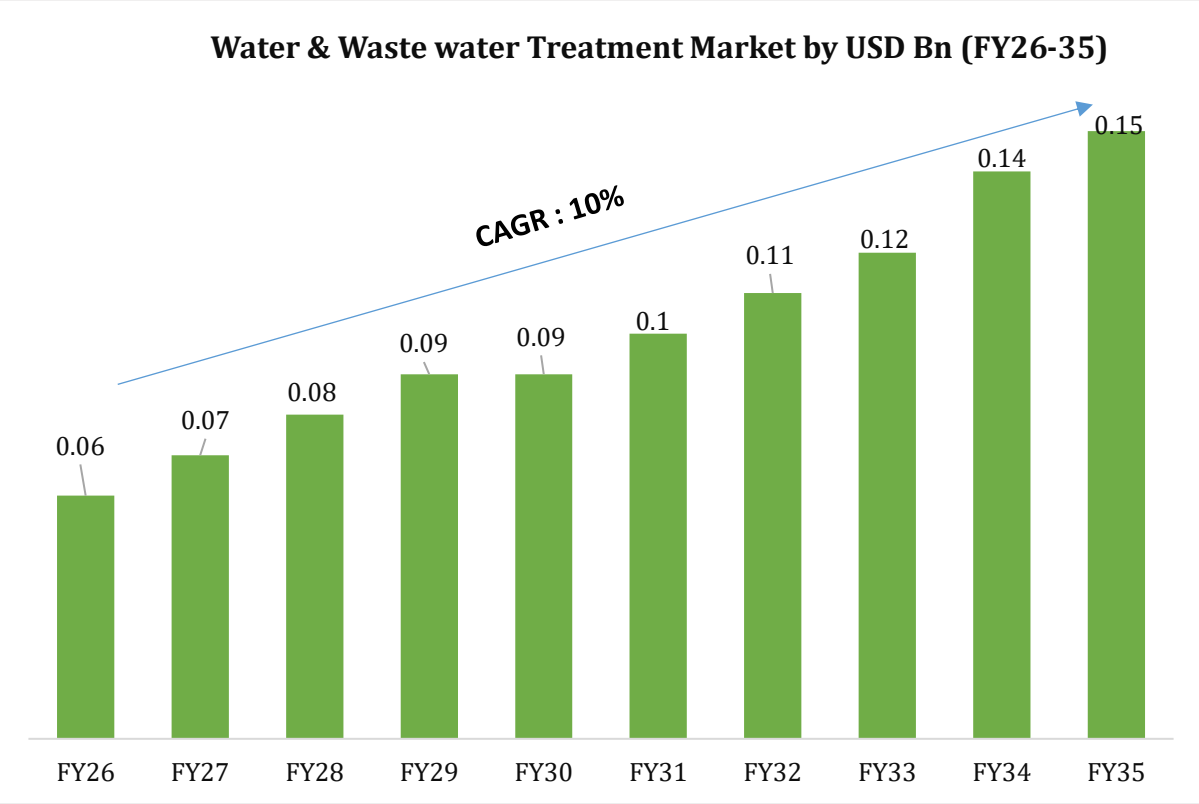
Policy / Regulation	Details
Water (Prevention & Control of Pollution) Act, 1974	Requires treatment of metal-bearing wastewater before discharge.
Environment (Protection) Act, 1986	Provides framework for metal/steel-related effluent standards.
Environment (Protection) Rules, 1986	General/sector-specific standards govern treated metal-bearing effluent.
CPCB industry-specific standards	Relevant to steel/metal-processing wastewater depending on process.
OCEMS	Important for large steel/metal plants and CETPs.
ZLD requirements / Consent conditions	Applied selectively for high-TDS/high-metal wastewater.
CETP model	Important in industrial/engineering clusters.
National Framework on Safe Reuse of Treated Water, 2022	Supports reuse in cooling/process operations.
Draft Liquid Waste Management Rules, 2024	Encourages better management of industrial liquid waste and sludge.
NITI Net Zero Scenario	Promotes energy-efficient wastewater management.
State PCB requirements / CTO conditions	High: state PCB determines metal-specific treatment and monitoring.

Sources: BDB Analysis based on MPCB & CPCB Reports

4.4.2
Surface Treatment Industry

Surface Treatment: Water & Wastewater Treatment Market



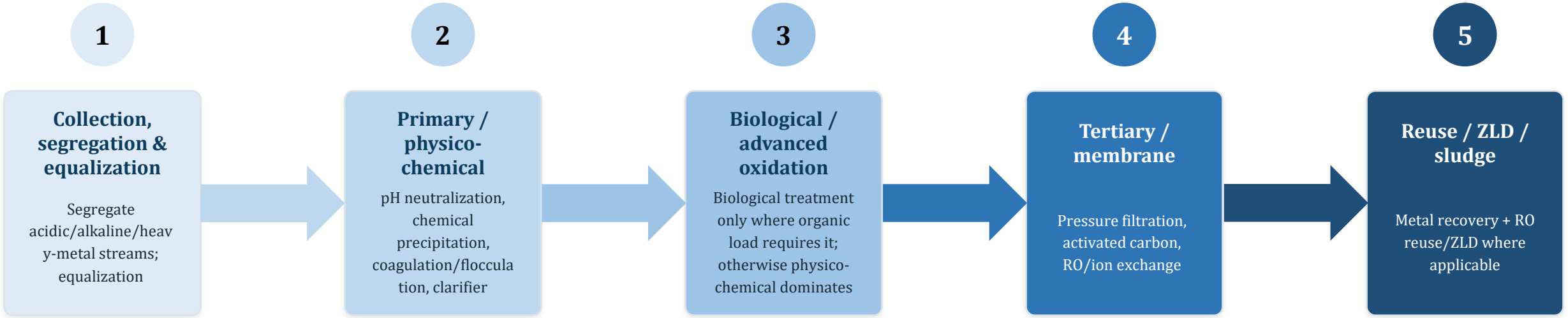


Key Market Highlights

- ✓ Water & Wastewater treatment capacity is expected to increase from 45 MLD in FY26 to 60 MLD by FY35, registering ~3% CAGR.
- ✓ The wastewater treatment market value is projected to USD 0.06 Bn in FY26 to USD 0.15 Bn by FY35, at ~10% CAGR.

Sources: BDB Analysis based on MPCB & CPCB Reports

Surface Treatment: Production Process & Waste Generation Stages/Characteristics/Equipment's/Current Practices & Major Suppliers



Typical wastewater characteristics / pollutants

- Cr(VI), total chromium
- Nickel
- Zinc, copper, cyanide, acids/alkalis
- TSS

Major equipment / machines

- Chrome reduction
- cyanide oxidation,
- Neutralization
- chemical precipitation clarifier
- Filter press
- RO/ion exchange

Current Indian working practice / evidence

- Karnataka's Peenya action plan requires impervious flooring, above-ground tanks, leak testing, scrubbers, water/effluent records and primary treatment before CETP

Representative major suppliers

- WABAG
- Thermax
- Ion Exchange

Sources: BDB Analysis based on MPCB & CPCB Reports

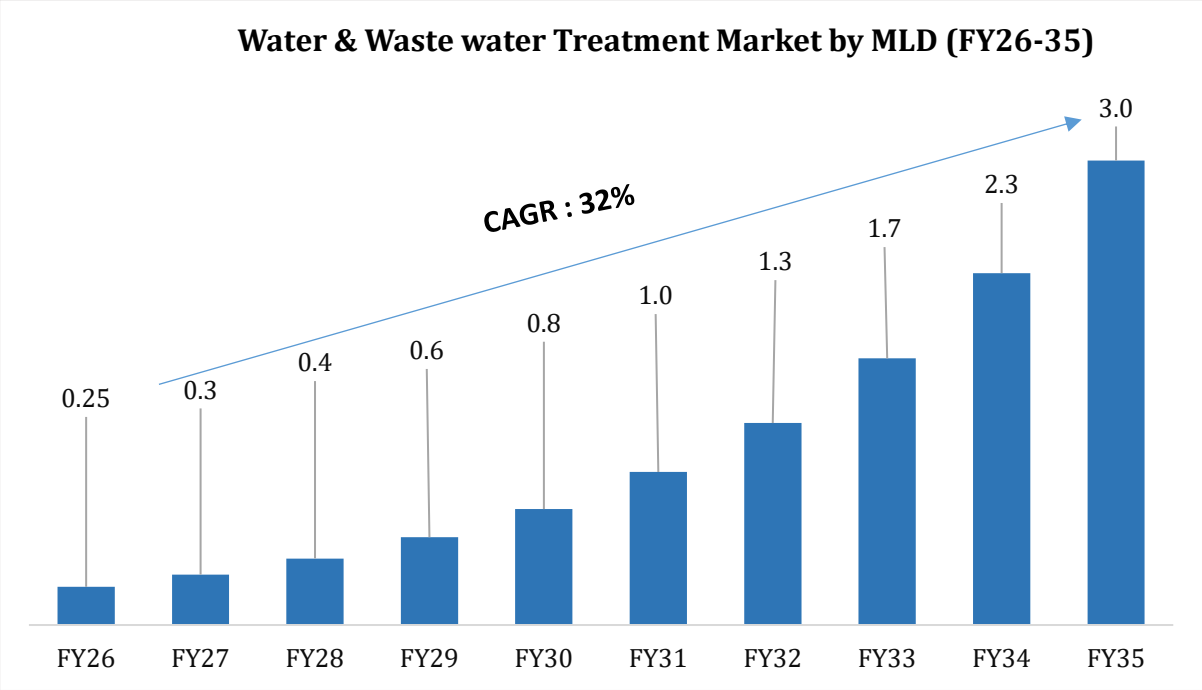
Surface Treatment: Government Policies/Regulations/Initiatives

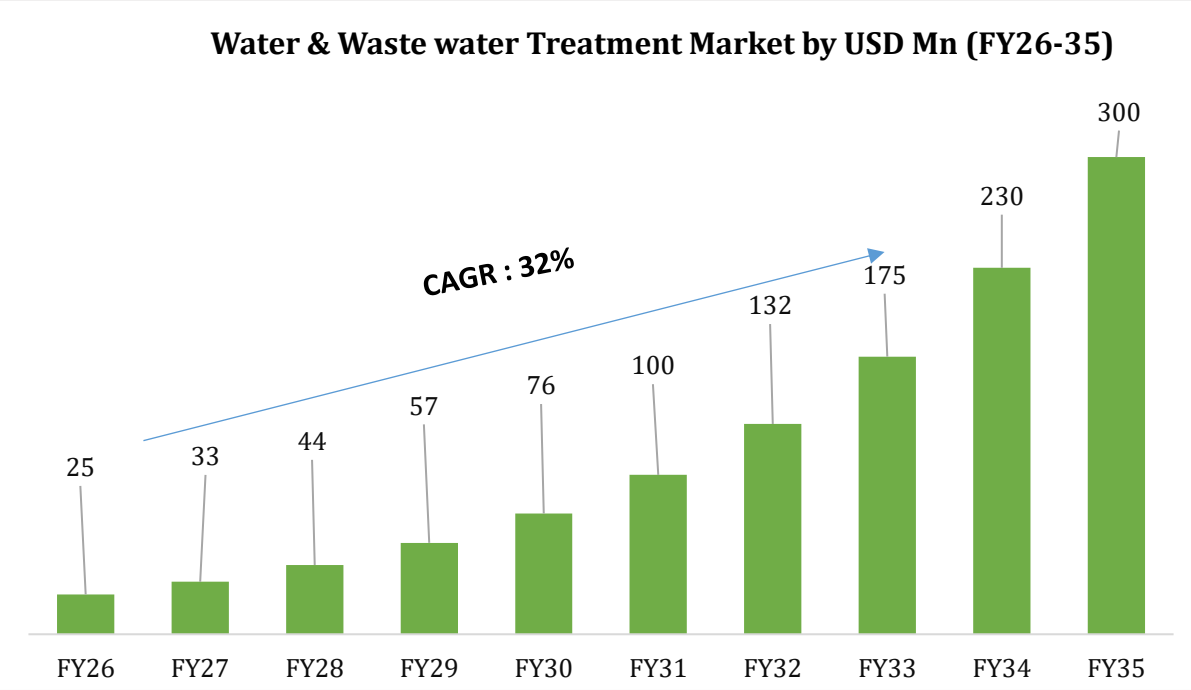
Policy / Regulation	Details
Water (Prevention & Control of Pollution) Act, 1974	Critical: regulates acid, alkali, cyanide, chromium and heavy-metal effluent.
Environment (Protection) Act, 1986	Provides legal basis for electroplating effluent standards.
Environment (Protection) Rules, 1986	Electroplating standards prescribe limits for cyanide, Cr, Ni, Zn, Cu, Pb and total metals. (Central Pollution Control Board)
CPCB industry-specific standards	Direct: electroplating wastewater standards.
OCEMS	High: useful for continuous monitoring of treated heavy-metal effluent/CETPs.
ZLD requirements / Consent conditions	High where process wastewater must be recycled and metal-bearing discharge minimised.
CETP model	Very High: electroplating clusters benefit from common physico-chemical treatment.
National Framework on Safe Reuse of Treated Water, 2022	Supports rinse-water recycling and closed-loop treatment.
Draft Liquid Waste Management Rules, 2024	Supports stronger control of hazardous/metal-bearing liquid streams.
NITI Net Zero Scenario	Promotes resource-efficient treatment and lower treatment emissions.
State PCB requirements / CTO conditions	Very High: state PCB/CETP consent determines treatment of cyanide/chromium/heavy metals.

Sources: BDB Analysis based on MPCB & CPCB Reports

4.4.3
Battery Industry

Battery Recycling : Water & Wastewater Treatment Market





Key Market Highlights

- **Large Lead-Acid Battery Base:** Established automotive, industrial and UPS battery volumes provide a steady near-term demand for wastewater treatment and lead recovery.
- **Rapid Li-Ion Recycling Growth:** EV adoption is driving rising Li-ion recycling volumes and more complex metal-rich wastewater, creating demand for advanced treatment solutions.
- **Shift to Metal Recovery:** Recyclers are moving from “treat and dispose” to “recover and reuse”, creating opportunities for electrochemical, membrane and selective-recovery technologies.
- **Stronger Compliance & Formalisation:** EPR requirements and tighter environmental standards are driving investment in modern, compliant and monitored ETP systems.
- **Water Reuse & Circular Economy:** Growing focus on water efficiency is creating demand for water recycling, ZLD and closed-loop systems, increasing the value of wastewater-treatment solutions.

Sources: BDB Analysis based on MPCB & CPCB Reports and NITI aayog report

Lead-Acid Battery Recycling & Wastewater Treatment Opportunity in India followed by Lithium-ion Battery types

1. Established and Increasingly Formalised Recycling Ecosystem

India has a well-established network of authorised lead-acid battery and lead-waste recyclers. The latest CPCB list identifies 672 registered recyclers, with an authorised recycling capacity of approximately 3.53 million tonnes per year. Major recycling activity is concentrated in Rajasthan, Maharashtra, Tamil Nadu, Telangana, Gujarat, Karnataka, Haryana and West Bengal.

Market opportunity: The concentration of recyclers in established industrial clusters creates a focused market for industrial wastewater treatment, ETP upgrades, water-reuse systems, ZLD solutions and related pollution-control technologies.

2. EPR is Driving a Shift Towards Organised and Traceable Recycling

The Battery Waste Management Rules, 2022 introduced an Extended Producer Responsibility (EPR) framework, making producers responsible for ensuring the collection, recycling or refurbishment of waste batteries. The framework has subsequently been strengthened through amendments in 2023, 2024 and 2025.

Market opportunity: The increasing formalisation of battery recycling is expected to drive greater demand for regulatory-compliant effluent treatment, monitoring and environmental-management systems, particularly among registered recycling facilities.

3. Battery Recycling Generates Specialised Industrial Wastewater

Lead-acid battery recycling can generate wastewater from activities such as battery breaking and washing, wet separation, acid handling, equipment cleaning and associated process operations. The CPCB framework also emphasises appropriate process controls and monitoring, including wastewater and lead-content assessment.

Market opportunity: Unlike conventional domestic wastewater, these streams may require treatment for lead and other heavy metals, suspended solids, variable pH and contaminated sludge. This creates opportunities for specialised industrial wastewater-treatment technologies rather than conventional STP solutions.

4. Environmental Compliance Extends Beyond Wastewater

Compliance requirements for lead-recycling facilities cover multiple environmental parameters, including wastewater, air emissions, ambient air, soil and groundwater, with particular attention to potential lead contamination. CPCB guidance also addresses occupational exposure and worker health monitoring.

Market opportunity: This creates scope for integrated environmental solutions combining ETPs, water recycling and reuse, sludge management, pollution monitoring and compliance-support systems rather than standalone wastewater-treatment equipment.

5. Opportunity is Shifting from Effluent Treatment to Water Recovery and Reuse

For larger and more organised recyclers, the opportunity is increasingly moving beyond “treat and discharge” towards “treat, recover and reuse.” Treated process water can potentially be recycled for suitable applications within the plant, reducing freshwater consumption and wastewater discharge.

Market opportunity: Technology providers that can offer water recovery, process-water reuse and high-quality effluent treatment, alongside heavy-metal removal, can address both regulatory compliance and operating-cost reduction. This creates a stronger value proposition than conventional ETP solutions alone.

Sources: BDB Analysis based on reports and information from MoEFCC, CPCB

Production Process & Waste Generation Stages/Characteristics & Required Treatment Technologies

Technical Challenge

- ✓ Heavy metals (chromium, nickel, copper, zinc, cadmium), cyanide complexes, and extreme pH in both directions define this effluent.

Electrocoagulation Research and Results

- ✓ Recent electrocoagulation research has demonstrated up to 99.7% Pb, 98.5% Cd and 98.9% Cu removal under controlled laboratory conditions, while Indian research is simultaneously advancing biological, adsorption and electrochemical approaches for battery-recycling wastewater. This creates a strong applied-R&D opportunity for Japanese expertise in electrochemical systems, advanced materials and process scale-up to partner with Indian academic and industrial groups.

Recovery Over Removal

- ✓ Integrated treatment systems can combine ion exchange, chemical precipitation and membrane technologies, along with cyanide destruction, to ensure effective wastewater treatment and metal recovery.
- ✓ Recovery of chromium, nickel and copper for reuse in plating operations can reduce fresh raw-material requirements, lower operating costs and create a clear commercial benefit.

Sources: BDB Analysis based on reports and information from Kelvin Water Treatment, USPTO patent literature (metal-finishing process descriptions).

Geographic concentration of the CPCB Registered Battery recyclers

State	CPCB Registered recyclers (Nos)	Authorised capacity (MTPA)
Rajasthan	121	440,722
Maharashtra	94	350,871
Tamil Nadu	27	452,023
Karnataka	32	419,056
Gujarat	41	381,210
Telangana	32	314,001
Haryana	58	274,864
West Bengal	61	135,612
Andhra Pradesh	17	251,728
Madhya Pradesh	56	126,921

Opportunity Areas -

- **Existing Lead-Acid Recyclers → ETP Modernisation & Water Reuse**
  - Heavy-metal removal: Existing ETPs need upgrading to reliably remove lead (Pb), antimony (Sb), arsenic (As), copper (Cu) and suspended lead particles from acidic wastewater.
  - Sludge & water reduction: Technologies such as chemical precipitation, electrocoagulation, filtration and membrane polishing can reduce hazardous sludge generation and enable treated-water reuse within the recycling process.
- **New Greenfield Lead-Recycling Plants → Advanced ETP + Resource Recovery**
  - Integrated treatment: New plants can design wastewater management from the outset, combining acid recovery/neutralisation, desulphurisation, heavy-metal removal and sludge dewatering rather than adding treatment after commissioning.
  - ZLD & metal recovery: RO/MEE/ZLD, selective precipitation or electrochemical recovery can reduce liquid discharge while recovering lead and other valuable materials, supporting a closed-loop water and material-recovery model.
- **Emerging Li-Ion Recyclers → Complex Chemical Wastewater Treatment**
  - Hydrometallurgical wastewater: Li-ion recycling generates acidic/alkaline, high-TDS wastewater containing Li, Ni, Co, Mn, Cu and other dissolved metals, requiring more selective treatment than conventional lead-acid ETPs.
  - Selective recovery + membranes: Ion exchange, solvent extraction, adsorption, nanofiltration/RO and electrochemical recovery can selectively recover valuable metals while producing reusable process water and reducing ZLD costs.

Sources: BDB Analysis based on reports and information from CPCB

India's Battery Recycling Landscape – Key Industry Players

India's battery-recycling industry is evolving from conventional material recovery to more integrated and technology-driven circular recycling. This transition is creating increasing demand for advanced ETPs, metal recovery, water reuse and ZLD solutions.

Amara Raja – Integrated Lead-Acid Recycling

- ✓ Location: Chittoor/Tirupati, Andhra Pradesh & Cheyyar, Tamil Nadu
- ✓ Scale: ~150,000 TPA planned lead recycling + ~7,000 TPA plastic recycling.
- ✓ Process: Automated battery breaking → acid/lead/plastic separation → smelting & refining → desulphurisation.
- ✓ Wastewater opportunity: Acid handling, Pb/heavy-metal removal, sludge management and water reuse.
- ✓ Circular model: Recovered lead is reintegrated into battery manufacturing, strengthening the closed-loop model.

Attero – Advanced Li-Ion Recycling

- ✓ Location: Roorkee, Uttarakhand
- ✓ Focus: EV and Li-ion battery recycling using mechanical + hydrometallurgical processes.
- ✓ Recovery: Lithium, cobalt, nickel, manganese and other valuable materials.
- ✓ Wastewater opportunity: High-TDS and metal-rich wastewater, requiring selective recovery, membranes and advanced treatment.
- ✓ Technology potential: Metal recovery + membrane treatment + electrochemical treatment + ZLD/water reuse.

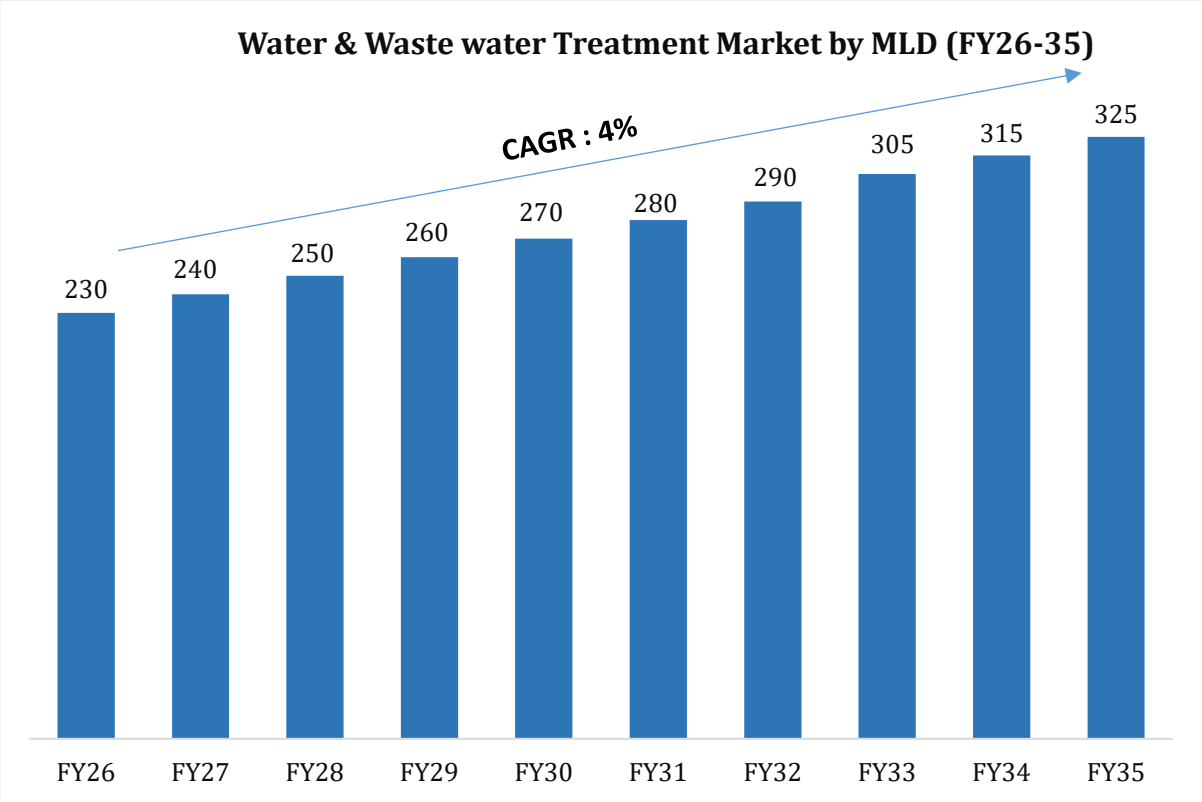
Exide / Chloride Metals – Established Lead Recycling

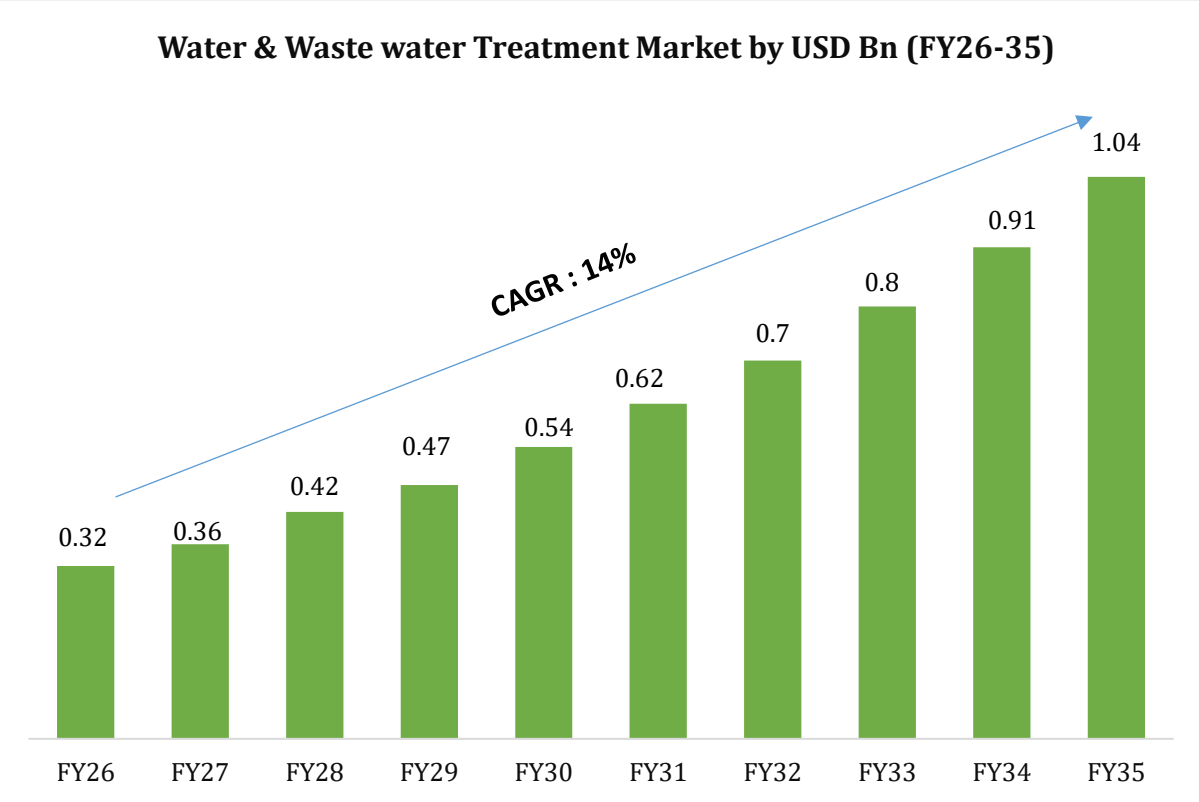
- ✓ Locations: Malur – Karnataka | Supa – Maharashtra | Haldia – West Bengal
- ✓ Scale: Large established lead-acid recycling network integrated with battery manufacturing.
- ✓ Process: Battery breaking → lead separation → secondary smelting/rotary furnace → refining → lead alloys.
- ✓ Wastewater opportunity: Acidic wastewater, lead-bearing solids, sulphates and heavy metals require ETP treatment and sludge management.
- ✓ Upgrade potential: Existing large plants offer opportunities for ETP modernisation, improved metal removal and water recycling.

Sources: BDB Analysis

05
Land-Based Aquaculture Business
(Focus Area Application)

Land-based Aquaculture (Focus Area Application): Water & Wastewater Treatment Market





Key Market Highlights

- ✓ Water & Wastewater treatment capacity is expected to increase from 230 MLD in FY26 to 325 MLD by FY35, registering ~4% CAGR.
- ✓ The wastewater treatment market value is projected to USD 0.32 Bn in FY26 to USD 1.04 Bn by FY35, at ~14% CAGR.

Sources: BDB Analysis based on Press Information Bureau Reports

Land-based Aquaculture (Focus Area Application): Production Process & Waste Generation Stages/Characteristics/Equipment's/Current Practices & Major Suppliers

1 **Collection, segregation & equalization**

Solids capture, screening, sludge separation; flow balancing

2 **Primary / physico-chemical**

Drum filter, settling/clarification , foam fractionation

3 **Biological / advanced oxidation**

Nitrification + denitrification biofilters; moving-bed biofilm

4 **Tertiary / membrane**

UV/ozone, fine filtration, oxygenation

5 **Reuse / ZLD / sludge**

High water recirculation/RAS; sludge composting/agricultural use where appropriate

Typical wastewater characteristics / pollutants

- TSS, uneaten feed
- faecal solids
- Ammonia
- Nitrite
- Nitrate
- Phosphate
- organic load
- pathogens

Major equipment / machines

- Drum filter
- settling tank
- protein skimmer
- biofilter/MBBR
- Denitrification reactor
- UV/ozone, oxygenator

Current Indian working practice / evidence

- India is moving toward RAS and biofloc for intensive production.
- ICAR has demonstrated indigenous RAS and biofloc systems

Representative major suppliers

- Specialized RAS suppliers
- ICAR technology licensees
- Aquaculture-system integrators

Sources: BDB Analysis based on Press Information Bureau Reports

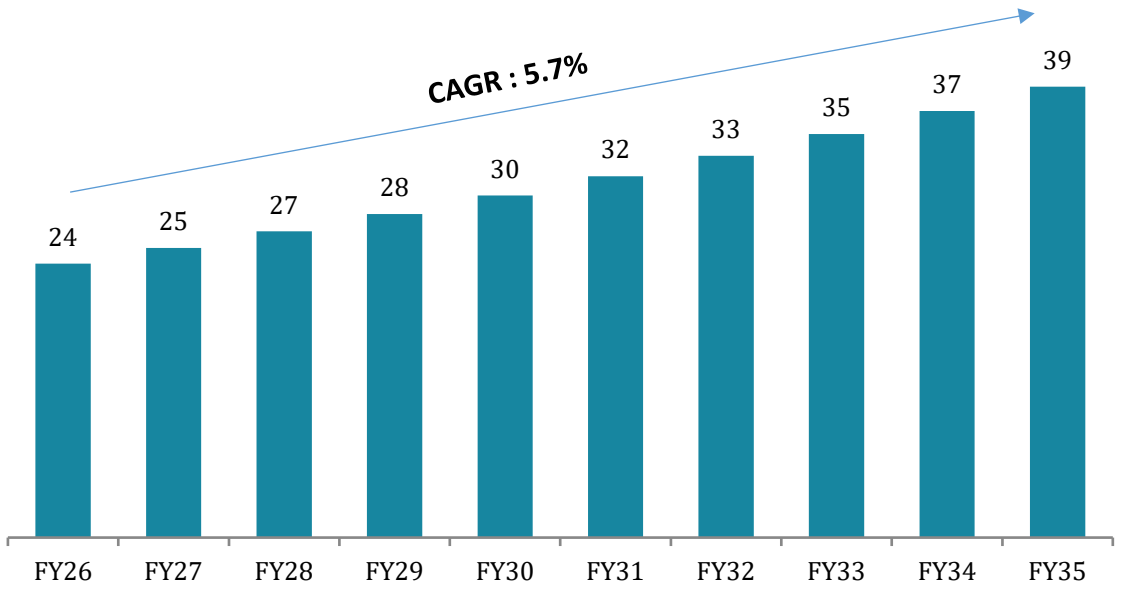
Land-based Aquaculture (Focus Area Application): Government Policies/Regulations/Initiatives

Policy / Regulation	Details
Water (Prevention & Control of Pollution) Act, 1974	Applies to aquaculture effluent where discharge can cause water pollution; treatment/reuse controls depend on the discharge setup.
Environment (Protection) Act, 1986	Provides broader environmental protection framework; sector-specific requirements depend on aquaculture operation/discharge.
Environment (Protection) Rules, 1986	Applicable where aquaculture discharge falls under regulated pollution-control requirements.
CPCB industry-specific standards	More dependent on fisheries/aquaculture regulations and state requirements than CPCB industrial standards.
OCEMS	Generally less central than conventional industrial OCEMS; monitoring depends on scale and discharge conditions.
ZLD requirements / Consent conditions	Recirculation/reuse is generally more relevant than conventional industrial ZLD.
CETP model	Not normally a conventional CETP market; RAS/on-farm treatment is more relevant.
National Framework on Safe Reuse of Treated Water, 2022	Very High: aligns strongly with RAS and water-recirculation systems.
Draft Liquid Waste Management Rules, 2024	Potentially relevant to structured wastewater/resource management as the sector develops.
NITI Net Zero Scenario	Encourages low-energy recirculation and resource-efficient systems.
State PCB requirements / CTO conditions	State fisheries/environment authorities can determine discharge/reuse conditions depending on facility and location.

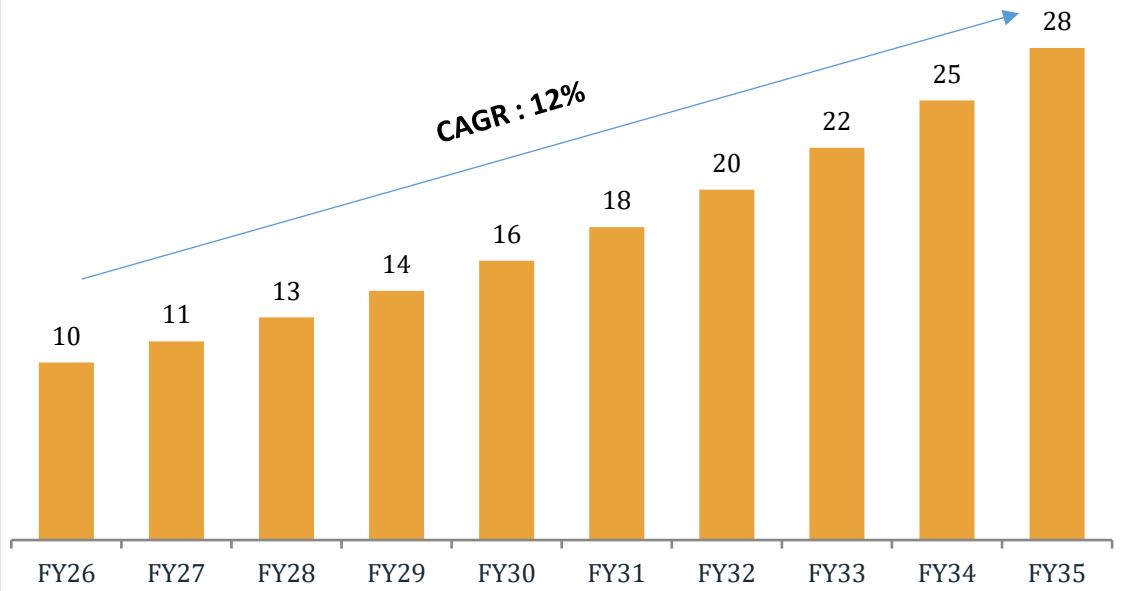
Sources: BDB Analysis based on Press Information Bureau Reports

Land-Based Aquaculture Market Size & Shrimp Market Overview

Total Market FY26 – 35 (USD Bn)



Shrimp Segment Market FY26 – 35 (USD Bn)

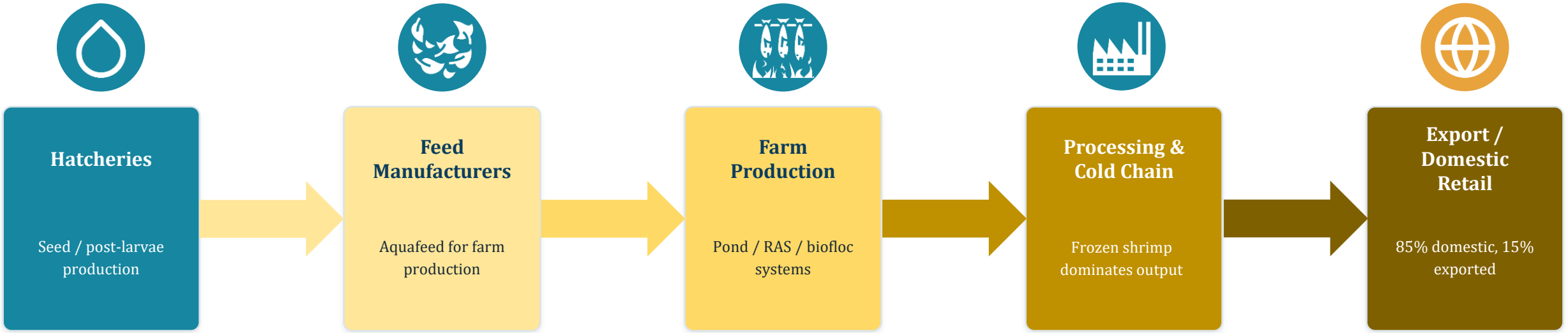


- ✓ India aquaculture market (2026): ~USD 24 Bn, growing with 5.70% CAGR toward ~USD 39 Bn by 2035 (EMR).
- ✓ Production volume: 15.5 million tons in 2026, projected 30.9 Mt by 2035.
- ✓ West Godavari/Bhimavaram is the epicenter: 83% of registered farmers already receive subsidies. Power is a real cost driver - a one-acre pond needs ~10 HP continuous aeration (~7,700 units/month); AP's subsidized agri power rate (USD 0.017/unit vs. standard USD 0.039/unit) is a material input-cost lever

- ✓ Shrimp farming segment (2026): ~USD 10 Bn, 12% CAGR toward ~USD 28 Bn by 2035.
- ✓ Andhra Pradesh alone produces ~64 lakh tons of aqua products/year and accounts for ~75% of India's total shrimp exports, spread across East/West Godavari, Krishna, Guntur, and Nellore districts - roughly 2 lakh hectares, 10 lakh+ families directly/indirectly supported.
- ✓ Freshwater carp and cold-water fisheries in the North; shrimp and marine aquaculture in the South (Andhra Pradesh leads, first to adopt RAS and automated feeding); freshwater/inland systems in the East; brackish-water farming in the West. Strongest equipment demand: Andhra Pradesh, Tamil Nadu, Odisha, West Bengal, Gujarat. India is the world's #2 producer of farmed fish.

Sources: BDB Analysis

Overview : Value Chain & Key Players



85% Stays Domestic - Frozen Shrimp Leads Exports

- ✓ About 85% of India's aquaculture production stays domestic, with 15% exported.
- ✓ Frozen shrimp dominates exports at roughly 65% of the total, and exports have averaged USD 7-8 billion a year over 2019-2025 - updated by FY2025-26 actuals on the next slide.
- ✓ Per-capita consumption has nearly doubled in a few years, from ~6 kg/person annually before COVID to ~11 kg now - a genuine structural shift in demand, separate from anything happening in export markets.

Company	Role in Value Chain
Avanti Feeds Limited	India's largest aquafeed producer (JV with Thai Union Frozen Products); shrimp/fish feed plus processing and exports
Godrej Agrovet Limited	Diversified agri-conglomerate; balanced aquafeed for freshwater and marine species
Growel Feeds / CP Aquaculture / The Waterbase Ltd	Leading fish and shrimp feed manufacturers
Cargill Aqua Nutrition / Skretting India	Premium and large-scale aquafeed suppliers, often shortlisted for scale contracts
Aquaconnect (AI/IoT platform)	AI-powered farm advisory (FarmMOJO), reported to lift farmer income 5-10% via productivity gains

Sources: BDB Analysis based on reports and information from MPEDA, IMARC Group, Secondary Research

Overview : Seafood Exports (FY25 – 26) & Technical Needs, Challenges

USD 8.3-8.5 Bn in FY2025-26

- ✓ India's seafood exports reached a record 19.7 lakh metric tonnes worth ~USD 8.28-8.46 Bn in FY2025-26, per MPEDA.
- ✓ Frozen shrimp remained the primary driver: ~USD 5.5-5.6 Bn, 66.5% of total dollar earnings - despite a ~15-20% volume/value decline in shipments to the US specifically, linked to reciprocal tariffs.

Market Diversification Underway

- ✓ The US remains the top market (2,56,128 MT) followed by China, the EU, Southeast Asia, Japan, and the Middle East.
- ✓ The government is actively pursuing FTA talks and market diversification given US tariff pressure - a live consideration for any Japan-facing supply relationship

Water Quality Is the Central Technical Challenge

- ✓ RAS and bio floc are subsidized precisely because water-quality failure - ammonia buildup, low dissolved oxygen, pathogen load - is the leading cause of production loss.
- ✓ Real-time sensors, automated feeding, and IoT-based farm management remain rare outside large integrated players.

Sources: BDB Analysis based on reports and information from MPEDA (via PIB, Business Standard, Millennium Post - 2026 reporting).

Land-Based Aquaculture: The Market is Moving from Farming to Controlled Production

The opportunity is shifting from "fish farming" to "controlled food production" — where water management, automation, biosecurity, energy efficiency and data become critical operating capabilities.

- Land-based aquaculture is emerging as farmers and investors seek greater control over production, water, biosecurity and economics.
- Climate variability is an important catalyst, but the deeper driver is the need to make aquaculture more predictable, scalable and resource-efficient.

The structural drivers shaping the market -

- **Water efficiency -** Reduce water consumption, improve recycling and minimise dependence on water exchange.
- **Climate & environmental risk -** Reduce exposure to temperature, rainfall, flooding and salinity fluctuations.
- **Disease & biosecurity -** Create controlled production environments with better disease prevention and monitoring.
- **Higher production density -** Produce more output from limited land through intensive and controlled systems.
- **Regulatory pressure -** Growing focus on farm registration, effluent management, biosecurity and environmental performance.
- **Production consistency -** Improve control over water quality, feeding, temperature and operating conditions to support more predictable yields.
- **Market proximity -** Enable production closer to urban and premium markets, potentially reducing logistics and cold-chain requirements.
- **Technology adoption & policy support -** Government programmes are actively supporting RAS, Biofloc and other technology-based aquaculture systems. PMMSY currently reports 12,081 RAS units and 4,205 Biofloc units under supported activities.

Sources: BDB Analysis

Shrimp Farming: Risk Reduction is Creating the Technology Opportunity

- India has strong shrimp farming potential, but profitability remains exposed to disease, water quality, feed costs, energy costs and market-price fluctuations.
- Regulatory and environmental requirements are increasing, with CAA requiring farm registration and guidelines for SPF shrimp, disease surveillance and environmental compliance.
- CAA also specifies wastewater management and treatment requirements, increasing the need for effective effluent and water-quality management.
- The opportunity is not limited to RAS adoption; the greater need is to reduce production risks, improve survival rates and increase farm-level productivity.
- This creates opportunities for water-quality monitoring, biosecurity, efficient aeration, automation, water recycling and effluent-treatment technologies.

Key challenge	Technology opportunity
Disease outbreaks & biosecurity risk	Biosecurity systems, disinfection and disease monitoring
EHP / WSSV and other disease risks	Early-warning systems, diagnostics and controlled water management
Fluctuating water quality	Real-time monitoring of DO, pH, salinity, temperature, ammonia and ORP
High dissolved-oxygen requirement	Energy-efficient aeration and automated DO-based control
High feed costs	Precision / automated feeding and feed-conversion optimisation
Skilled labour dependency	Automation, remote monitoring and alarm systems
Water exchange requirements	Water-recycling and controlled / low-water-exchange systems
Effluent management	Effluent treatment, sludge management and water reuse
Export-quality & traceability requirements	Digital farm records, traceability and compliance systems
Price volatility	Productivity improvement and more consistent production

Sources: BDB Analysis based on reports and information from Coastal Aquaculture Authority (CAA); ICAR-CIBA; Department of Fisheries.

Beyond Shrimp: Premium Species Could Improve Land-Based Economics

Beyond Shrimp: India is moving towards species diversification, creating opportunities for premium freshwater and marine aquaculture supported by RAS, biofloc, cage culture and advanced water-management technologies.

Growth Drivers — Beyond Shrimp

- Government is actively promoting species diversification to reduce dependence on shrimp and expand India's aquaculture base across freshwater, brackishwater and marine species.
- Higher-value fish species offer opportunities for better farm economics through premium pricing, differentiated products and year-round controlled production.
- Advances in hatchery, seed production, RAS, cage culture and biofloc technologies are making intensive farming of non-shrimp species increasingly feasible.
- Domestic demand for quality and consistent seafood is creating opportunities for commercially farmed premium fish, particularly near urban and high-value consumer markets.
- PMMSY is moving towards cluster-based development, with dedicated clusters for species such as tilapia, pangasius, scampi, murrel, pearl spot and brackishwater aquaculture.

Freshwater / River & Inland Species — Emerging Opportunities

- **Tilapia** – Increasingly attractive for intensive and controlled farming due to established culture technology, strong domestic demand and suitability for biofloc/RAS systems.
- **Pangasius** – Established commercial freshwater species with potential for further organised, cluster-based production; PMMSY has identified a dedicated Pangasius cluster in Siddharthnagar, Uttar Pradesh.
- **Scampi (Giant Freshwater Prawn)** – Higher-value freshwater species with renewed government/ICAR focus; improved genetic strains and production technologies are supporting its revival.
- **Murrel / Snakehead** – High-value freshwater species with growing interest in intensive culture; PMMSY has identified a Murrel cluster in Mancherial, Telangana.
- **Pearl Spot and other regional premium species** – Offer opportunities for differentiated, locally preferred fish and controlled production; Kerala has been identified as a Pearl Spot cluster.

Marine / Brackishwater Species — Premium Opportunity

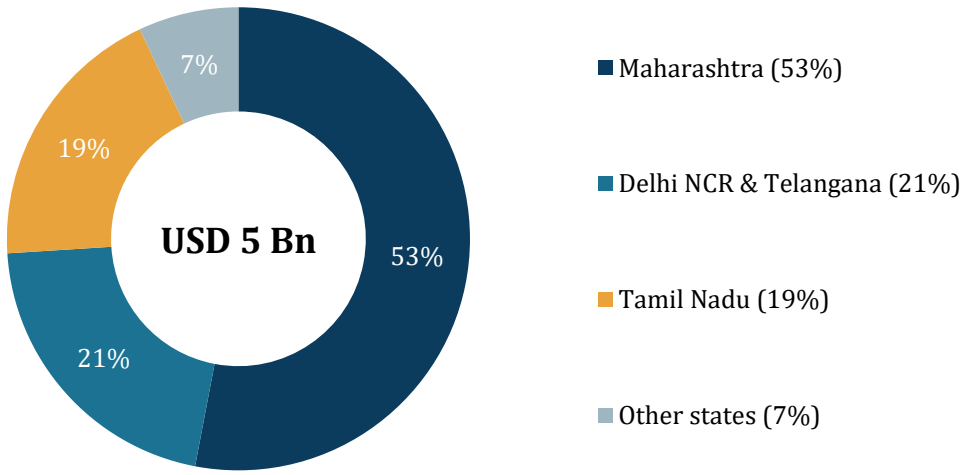
- **Asian Seabass / Barramundi** – One of the strongest candidates for premium aquaculture, supported by established Indian hatchery and farming technologies and attractive domestic demand.
- **Pompano** – High-value marine fish with established Indian seed-production technology and potential for **cage and intensive farming**.
- **Grouper / Snapper / Seabream** – Premium species with strong market potential; recent ICAR advances in grouper seed production can support expansion of marine aquaculture.
- **Cobia** – High-value, fast-growing marine species with Indian breeding/seed-production capability and potential for sea-cage culture.
- **Pearl Spot / Milkfish and other brackishwater finfish** – Offer opportunities to diversify coastal farming beyond shrimp and make better use of brackishwater resources.

Sources: BDB Analysis based on reports and information from Department of Fisheries/PMMSY; ICAR; ICAR-CIFA; ICAR-CIBA; ICAR-CMFRI.

06
Ongoing Projects, Competitive Landscape & Opportunities

Active Project Details

State-wise Project Details (FY26)



Project Name	Location	Agency	Model	Value (USD Mn)
7 Mega STPs Package	Mumbai, MH	BMC	EPC / HAM	2,048
Perur 400 MLD Desalination	Chennai, TN	CMWSSB	Public	515
31 Citywide STPs (1,570 MLD)	Hyderabad, TS	HMWSSB	PPP (HAM)	466
Cooum River Restoration	Chennai, TN	CRRT	State Govt	461
27 Decentralized STPs	Delhi NCR	DJB	Public	361
Mula-Mutha River Cleanup	Pune, MH	PMC / JICA	JICA Loan	141

Note:

- ✓ The USD 5.0 billion tracked pipeline, around USD 3.8 billion (76%) is currently under active implementation, while USD 1.2 billion (24%) is at the announced or pre-execution stage.
- ✓ Maharashtra – USD 2.65 billion: Major BMC sewage treatment plant (STP) projects in Mumbai and JICA-funded river restoration initiatives.
- ✓ Tamil Nadu – USD 0.95 billion: Large-scale seawater desalination plants and river-cleanup projects.
- ✓ Delhi NCR & Telangana – USD 1.05 billion: Yamuna Action Plan, DJB decentralized STPs, and citywide STP projects in Hyderabad.
- ✓ All six benchmark projects are part of municipal water and wastewater infrastructure and use EPC, PPP/HAM, and JICA-funded procurement models. These are also the key procurement structures relevant to industrial CETP retrofit projects discussed in this report.

Sources: BDB Analysis based on reports and information from State PWD/Jal Nigam project trackers, JICA project documentation.

Competitive Landscape & Opportunity Area

Company	Position
Larsen & Toubro (L&T)	Market leader in turnkey EPC for mega municipal schemes, citywide STPs, and intake pipelines
VA Tech Wabag	Pure-play global water MNC; FY26 revenue USD 427.7 Mn (+21% YoY), order book USD 1.82 Bn – up from USD 1.60 Bn in Dec'25
Ion Exchange (India) Ltd	Integrated player strong in industrial ETP, resin manufacturing, and high-margin O&M
Megha Engineering (MEIL)	Large-scale infrastructure and water-project EPC across multiple states
Tata Projects	Diversified EPC arm with water/wastewater infrastructure capability
Enviro Infra Engineering (EIEL)	CETP/STP-focused EPC contractor active in MSME industrial clusters
ALEP Management / Kelvin Water Treatment	Specialist ETP design for electroplating and automotive effluent
SUSBIO / Chokhavatia Associates	Food, beverage, and dairy-sector ETP specialists
Thermax Ltd. / SPML Infra / Triveni Engineering	Diversified industrial water & energy players, active across multiple verticals in this report

Opportunity Area	Details
Pharma & API - antibiotic-residue treatment/monitoring	A well-documented, unresolved discharge problem; both advanced oxidation and precision monitoring are underserved. 2025-26 update: BDP infrastructure now actually progressing.
Metal/Surface Treatment - heavy-metal recovery & recycling	Active Indian academic research (electrocoagulation), but limited commercial technology transfer from Japan so far
Land-Based Aquaculture - RAS & water-quality monitoring	A near-direct match for Shiga's Lake Biwa restoration heritage, with strong government subsidy support and record FY26 export performance
Chemical/Dye - CETP-scale solvent recovery & sludge minimization	The cluster (CETP) model suits a shared-infrastructure partnership better than single-client sales
Food/Beverage/Dairy/Sugar - biogas & FOG-handling technology	Real energy-recovery upside, but the basic biological treatment layer is already commoditized

Sources: BDB Analysis

Glossary

AMRUT 2.0	Atal Mission for Rejuvenation and Urban Transformation 2.0
AOP	Advanced Oxidation Process
API	Active Pharmaceutical Ingredient
ASP	Activated Sludge Process
ATFD	Agitated Thin Film Dryer
B2B	Business-to-Business
B2C	Business-to-Consumer
B2G	Business-to-Government
BDP	Bulk Drug Park
Biofloc	Biofloc Technology
BOD	Biochemical Oxygen Demand
CAA	Coastal Aquaculture Authority
CAGR	Compound Annual Growth Rate
CAPEX	Capital Expenditure
CETP	Common Effluent Treatment Plant
CIP	Clean-in-Place
COD	Chemical Oxygen Demand
CPCB	Central Pollution Control Board
CPI	Corrugated Plate Interceptor
CTE	Consent to Establish
CTO	Consent to Operate
DAF	Dissolved Air Flotation
DO	Dissolved Oxygen
EGSB	Expanded Granular Sludge Bed
EHP	Enterocytozoon hepatopenaei
EPC	Engineering, Procurement and Construction
EPR	Extended Producer Responsibility
ETP	Effluent Treatment Plant
FCR	Feed Conversion Ratio
FDI	Foreign Direct Investment
FOG	Fats, Oils and Grease
FY	Financial Year
FY26E	FY2025-26 Estimated
FY35P	FY2034-35 Projected
GDP	Gross Domestic Product
GFCF	Gross Fixed Capital Formation
GIDC	Gujarat Industrial Development Corporation
GPCB	Gujarat Pollution Control Board
ICAR	Indian Council of Agricultural Research
CIBA	Central Institute of Brackishwater Aquaculture
CMFRI	Central Marine Fisheries Research Institute
IoT	Internet of Things
Jal Shakti	Ministry of Jal Shakti
JICA	Japan International Cooperation Agency
JJM	Jal Jeevan Mission
KLD	Kilolitres per Day
MBBR	Moving Bed Biofilm Reactor
MBR	Membrane Bioreactor
MEE	Multiple Effect Evaporator
MEE	Multiple Effect Evaporator
MLD	Million Litres per Day
MoEFCC	Ministry of Environment, Forest and Climate Change
MPCB	Maharashtra Pollution Control Board
MPEDA	Marine Products Export Development Authority
MPN	Most Probable Number
MSME	Micro, Small and Medium Enterprise
N/A	Not Applicable / Not Available
NCR	National Capital Region
NF	Nanofiltration
NITI Aayog	National Institution for Transforming India
NMCG	National Mission for Clean Ganga
O&M	Operations and Maintenance
OCEMS	Online Continuous Effluent Monitoring System
OPEX	Operating Expenditure
ORP	Oxidation-Reduction Potential
PCB	Pollution Control Board
pH	Potential of Hydrogen
PIB	Press Information Bureau
PMMSY	Pradhan Mantri Matsya Sampada Yojana
R&D	Research and Development
RAS	Recirculating Aquaculture System
RO	Reverse Osmosis
ROI	Return on Investment
SBR	Sequencing Batch Reactor
SPCB	State Pollution Control Board
SPF	Specific Pathogen Free
STP	Sewage Treatment Plant
TDS	Total Dissolved Solids
TNPCB	Tamil Nadu Pollution Control Board
TSS	Total Suspended Solids
UASB	Upflow Anaerobic Sludge Blanket
UF	Ultrafiltration
UPPCB	Uttar Pradesh Pollution Control Board
USPTO	United States Patent and Trademark Office
WSSV	White Spot Syndrome Virus
ZLD	Zero Liquid Discharge

Thank You

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