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INDIA-EU WATER PARTNERSHIP

Solution Document for the Safe Reuse of Treated Water (SRTW) in Panipat, Haryana

Prepared under the India-EU Water Partnership

Implemented by

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Co-funded by the European Union

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List of Abbreviations & Acronyms

BIS	Bureau of Indian Standards
BOD	Biochemical oxygen demand
CAPEX	Capital investment costs
CETP	Common effluent treatment plant
CGWB	Central Groundwater Board
COD	Chemical oxygen demand
CPCB	Central Pollution Control Board
CPHEEO	Central Public Health Environmental Engineering Organization
CSO	Civil society organization
DPR	Detailed project report
ECB	European Central Bank
ETP	Effluent treatment plant
FAO	Food and Agriculture Organization
Ham	Hectare meters
HID	Haryana Irrigation Department
HSIIDC	Haryana State Industrial & Infrastructure Development Corporation
HSPCB	Haryana State Pollution Control Board
HSVP	Haryana Shehri Vikas Pradhikaran
HWRA	Haryana Water Resources (Conservation, Regulation and Management) Authority
IEWP	India-EU Water Partnership
IOCL	Indian Oil Corporation Limited
IRR	Internal rate of return
MCP	Municipal Corporation of Panipat
MLD	Million Litres per Day
MoAFW	Ministry of Agriculture and Farmer's Welfare
MoEFCC	Ministry of Environment, Forest and Climate Change
MSME	Micro, Small & Medium Enterprises
NABARD	National Bank for Agriculture and Rural Development
NGO	Non-governmental organization
NGT	National Green Tribunal
NMCG	National Mission Clean Ganga
NPV	Net present value
OPEX	Operational costs
PHED	Public Health Engineering Department
PPP	Private Public Partnership
PRI	Panchayati Raj Institution
RO	Reverse Osmosis
SPCB	State Pollution Control Board
SRTW	Safe Reuse of Treated Water
STP	Sewage treatment plant
STW	Secondary treated effluent
TC	Total coliforms
TDS	Total dissolved solids
TTW	Tertiary treated effluent
UF	Ultrafiltration
ULB	Urban Local Body
UV	Ultraviolet disinfection

Executive Summary

The National Framework on Safe Reuse of Treated Water (SRTW) in India (SRTW Framework), developed by NMCG in November 2022 within the India-EU Water Partnership, guides states in creating consistent water reuse policies and projects.

This Solution Document and **the Compendium on SRTW business models** (sister document) shall serve as good practice documentation to support the National Framework on SRTW by identifying and assessing viable business models for SRTW. The Solution Document first provides a methodological approach (**Chapter 2**) that is subsequently applied to identify and evaluate potential SRTW business models in the Municipal Corporation of Panipat (MCP), Haryana.

MCP is an industrialized Class 1 Town with growing water demands from industry and agriculture that can soon no longer be met without exploring alternative water resources, such as treated used water. MCP currently has no reuse activities from its seven sewage treatment plants (STPs). With the introduction of the new freshwater and treated used water tariffs by the Haryana Water Resources (Conservation, Regulation & Management) Authority (HWRA), the production and use of treated used water can become an effective and economically attractive option to meet industrial, agricultural and urban water needs (**Chapter 3**).

Four potential reuse options were identified in MCP, all from existing STPs (**Chapter 4**). Reuse from common effluent treatment plants (CETPs) was not considered. Tertiary treatments for the secondary treated effluents from STPs are proposed for the three reuse options. Finally, four potential business models were identified and assessed for their viability, and the following recommendations are given (**Chapter 5**):

Business Model for Water Reuse in Textile Industry and Indian Oil Corporation Limited (IOCL): The business model involves the provision of secondary treated effluent from STPs operated by MCP to a private operator who will design, build and operate a tertiary treatment plant and sell tertiary treated effluent to the textile or petrochemical or refinery industries. A private operator selected on a design-build-operate (DBO) basis will treat the secondary treated effluents to the required water quality specified by the textile industries and the IOCL refinery.

This business model could apply to the following STPs:

- Secondary treated effluent from **STPs in Sewah Road I & II** (cumulative designed capacity of 60MLD), operated by MCP, is used for **reuse in the textile industries** of Sector 29.
- Secondary treated effluent from **STP in Refinery Road** (designed capacity of 15 MLD) for reuse in **IOCL** Panipat as cooling water.

In both cases, tertiary treatment using **ultra-filtration (UF)** is recommended.

The proposed business model offers two value propositions: First, reliable quality and quantity of secondary treated effluent at a fixed price of 5 ₹/m^3, as per HWRA state tariffs for treated secondary effluents, is provided from the two STPs operated by MCP to the Tertiary Treatment Plant (TTP) operator. Second, a reliable quantity and quality of water is supplied to the textile industry at a lower price than freshwater, which is 20 ₹/m^3 as per HWRA state tariffs for bulk water users, from the TTP private operator to the industries.

The business model is viable for UF-treated effluent at selling prices below 20 ₹/m^3 but not for RO-treated effluents. RO treatment requires selling prices of > 45 ₹/m^3 to achieve an internal rate of return > 0% for the private operator. Viability gap funding, as done in the Chennai industrial reuse case, could be considered if RO is to be taken up. Also, the demarcation of 'no-freshwater' zones in the industrial clusters would render tertiary treated used water a more attractive resource for industries.

Business Models for Water Reuse in Agriculture: Two business models for water reuse in agriculture are assessed – a) Water Swap and b) Auctioning of treated water. Both include the provision of secondary treated effluent from **STPs in Jattal Road I & II** (operated by MCP, cumulative designed capacity of 30 MLD) to the villages Naultha, Balaana, Palri, and Jondhan Khurd for irrigation of ca. 1,600 ha of wheat, rice, and sugarcane. Disinfection of the secondary effluents, e.g., by **ultraviolet disinfection**, is needed to meet the standards for irrigation set by the Haryana State Pollution Control Board (HSPCB) in 2020. It is assumed that MCP pays for CAPEX and OPEX of the disinfection unit and the conveyance to the irrigation canal/irrigation tank. In both models, the Haryana State Pollution Control Board (HSPCB) monitors the effluent quality from the Jattal Road I and II STPs. Further, it is recommended that additional monitoring is conducted by the Haryana Agriculture Department or local agricultural universities to ensure crop safety and farmer health by monitoring for faecal and chemical contamination. Monitoring results are to be regularly reported to MCP and the Haryana Irrigation Department (HID).

The ***Water Swap business model*** involves the exchange of secondary treated and disinfected effluent to the HID for an equal quantity of freshwater. The swapped freshwater can augment supply to existing customers or expand to new customers. The business model offers two value propositions: the first is from the Jattal Road I & II STPs operated by MCP to HID supply secondary treated water & disinfected effluent at prescribed water quality in exchange for an equal quantity of freshwater. The second value proposition is from HID to farmers – a similar quantity of water as provided earlier at the same price as prescribed by HWRA.

The ***Auctioning business model*** involves auctioning treated water to an entrepreneur or private agency supplying and pricing the secondary treated and disinfected wastewater to farmers. MCP pays for the CAPEX and OPEX for the treatment and conveyance of treated used water, and the local entrepreneur pays CAPEX for conveyance for last-mile connectivity with farmers. The proposed auction model offers two value propositions. First, from MCP-operated Jattal Road I and II STPs to local entrepreneurs, secondary treated wastewater is supplied with suitable water quality for irrigation purposes. This enables entrepreneurs to fulfil their role as suppliers of treated wastewater to farmers. Secondly, from local entrepreneurs to farmers, a reliable water supply is tailored to meet farmers' specific needs and requirements. This value proposition ensures farmers access to an adequate and consistent water supply for irrigation.

Amongst the two models, the *Water Swap* model demonstrated viability when MCP sells the re-allocated freshwater from HID at 9 ₹/m^3 and ensures that loss in transmission does not exceed 30%. If the MCP plans to sell the freshwater to domestic consumers, then the MCP will not be able to recover either capital or operating costs. *The auctioning* model is viable for MCP if it can auction the secondary treated water for the annual cost of ₹ 46 lakhs . Further, the local entrepreneur needs to sell the water to farmers at ₹ 9/m^3 while ensuring transmission losses are below 25%. However, at this price, a farmer cultivating rice for 1 acre will pay above 800 ₹/day, which is not feasible. Financially these models do not seem attractive, however, environmental and social benefits related to water reuse in agriculture (e.g. protection of freshwater sources and sustaining livelihoods) are substantial. They should be internalized in the viability assessment, e.g. by a comprehensive cost-benefit analysis.

Business Model for Water Reuse in Urban Applications: The business model includes the provision of secondary treated and disinfected effluents from Sector 6 & 19 STPs for urban development in Panipat, such as irrigation of parks and landscapes, for firefighting, and construction companies. MCP could save freshwater resources by switching to secondary treated effluents. However, those voluntary water swaps are not viable in Panipat due to scaling issues and high investment costs into the vehicle fleet (water supply by tankers).

Based on these assessments for MCP the prioritization of water reuse from STPs should be towards nearby industries or agriculture, and urban reuse can be done as a side business.

1. Introduction and Objectives

The Indian National Framework on Safe Reuse of Treated Water (SRTW) was published in November 2022 by the National Mission for Clean Ganga (NMCG), an implementation body of the National Ganga Council mandated to ensure abatement of pollution and rejuvenation of River Ganga. The National Framework on SRTW serves as a guidance document for Indian States to develop water reuse policies and legislation that are coherent across India. The framework was developed under the India-EU Water Partnership (IEWP) Action Phase 1 being coordinated by GIZ and supported by national and international water reuse experts. During IEWP Action Phase 2, the Action Plan for Safe Reuse of Treated Water has supported the implementation of the National Framework on SRTW. Therefore, a good practice documentation on the design, operation and maintenance of wastewater treatment and water reuse schemes, addressing funding and revenue options as well as social and environmental impacts, has been developed by national and international consultants.

This Solution Document is a component of the good practice documentation, which identifies and assesses viable business models for SRTW in Panipat, Haryana, India. Business models in this document are solutions for wastewater flows to deliver economic, social and environmental value through selling fit-for-purpose treated used water to customers. Solutions will entail a value proposition, target customers and customer relationships, key partners, identify activities and strategies to achieve business objectives, such as cost recovery of treatment processes and distribution.

Panipat City has been selected as a pilot study site in the Ganga River Basin as it is an industrialized water scarce region, with water demands having increased manifolds during the past decade. Alternative water resources to meet future industrialization and agricultural demands are crucial for Panipat. The municipal and industrial effluents from Panipat impact the water quality of River Yamuna, one of the main tributaries of River Ganga. Hence, Panipat has a high demand as well as potential for industrial, agricultural, urban or environmental reuse options, but is yet to develop a successful business model ensuring SRTW.

The good practice methodological approach of this Solution Document includes a pre-feasibility assessment where the supply and demand of used water by industries, agriculture, the municipality, or the environment, is mapped. Further, the stakeholders are identified through an institutional and regulatory/legal assessment, and technical assessments are conducted (Chapter 2.1) to identify potential reuse scenarios for the case study site (Chapter 2.2). In the final feasibility assessment, the identified business models are assessed, using financial, social and environmental indicators (Chapter 2.3).

The pre-feasibility assessment results of Municipal Corporation of Panipat (MCP) are described in Chapter 3 of this document. The identified reuse options and business models for Panipat are elaborated in Chapter 4.1. Technological fit-for-purpose specifications for the identified reuse options are discussed in detail in Chapter 4.2. The feasibility assessment for the business models (Chapters 5.1 – 5.3) was carried out in a staged manner integrating feedback from the key stakeholders, e.g., water re-users. The business models identified are described using a Business Model Canvas and assessed using financial, social and environmental indicators criteria (Chapter 5.4 and 5.5). Finally, recommendations for viable business models in Panipat are provided (Chapter 6).

2. Methods and materials

The Solution Document follows a good practice approach to identify and assess feasible business models for SRTW. The methodological approach consists of a pre-feasibility assessment (Chapter 2.1) to identify the potential reuse options and fit-for-purpose treatment technologies (Chapter 2.2) and a feasibility assessment (Chapter 2.3) to assess the viability of business models linked to the reuse options.

The decision tree in *Figure 1*, incorporating the good practice methodological approach, was developed and applied in Panipat, Haryana.

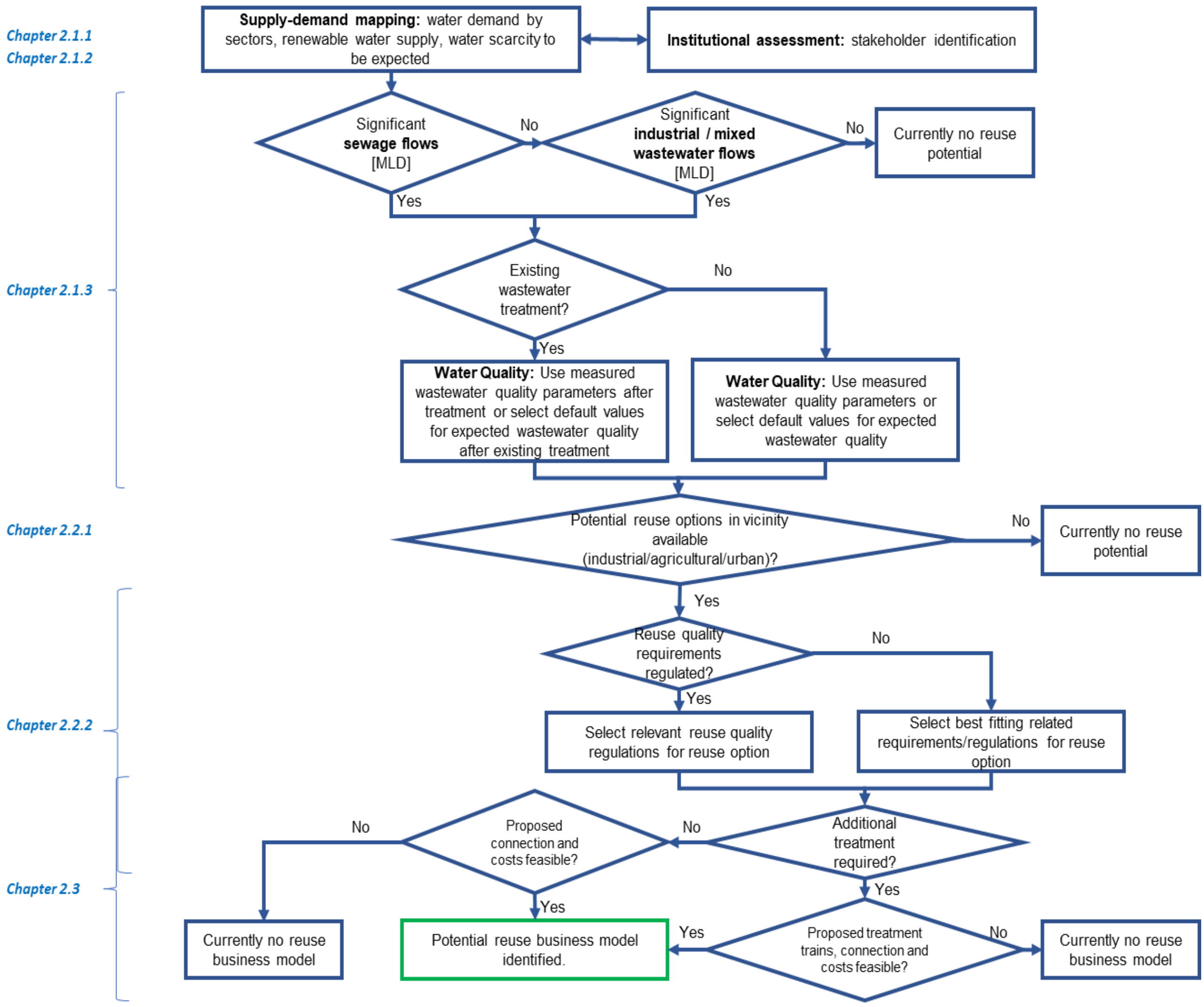


Figure 1: Decision tree to identify feasible water reuse options

2.1. Pre-feasibility Assessment

The pre-feasibility assessment aimed to identify potential reuse scenarios in a region. It brought forth a holistic view in identifying SRTW options from a water cycle perspective, considering the overall water balance and trends within the system boundaries (Chapter 2.1.1). Further, the institutional, regulatory and legal boundary conditions were evaluated (Chapter 2.1.2) as well as the existing wastewater treatment infrastructure was evaluated, using technical and financial indicators (Chapter 2.1.3).

The required data to develop these sections for the case study region Panipat were gathered through literature reviews, questionnaire surveys *(Annex 1)* and key informant interviews during field visits to the case study sites *(Annex 2)*.

2.1.1. Supply-Demand Mapping

Supply and demand mapping included the assessment of the water situation regarding the following:

- Status of water resources (rainfall, evapotranspiration, renewable internal water supply, groundwater, surface waters), and
- Water supply and demand management

Quantity and quality assessments of water resources' development over time in the case study region were assessed using available literature and governmental reports from the Central Groundwater Board (CGWB) and Haryana Water Resources (Conservation, Regulation and Management) Authority (HWRA), the Ministry of the Environment, Forest and Climate Change (MoEFCC), Central Pollution Control Board (CPCB), and Haryana State Pollution Control Board (HSPCB).

Renewable internal water resources at the case study region were approximated as the sum of internal flow (which is precipitation minus actual evapotranspiration) multiplied by the area of the case study site. External inflows and run-off were not considered.

Water supply and demand management were assessed using questionnaire data and results of key informant interviews, as well as detailed project reports (DPRs) filed for water reuse in the case study region. The questionnaires include data on freshwater tariffs paid by different sectors.

2.1.2. Institutional, Regulatory and Legal Assessment

For sustainable water reuse systems, considerable levels of coordination and clearly articulated roles, responsibilities and implementation arrangements are crucial at the Central, State, Urban Local Body (ULB) and Panchayat Raj Institution (PRI) levels. Similarly, the regulatory and operational mandate of water regulators in respect of SRTW and ownership of SRTW are to be clearly delineated.

The institutions involved in water resources management at the case study site and their inter- and intra-sectoral coordination were assessed. Existing state policies for water reuse, control and compliance mechanisms were collated. Important institutions at the state and local levels in India are as follows:

- **State level:** State Committee on SRTW; State Department of Urban Development; State Pollution Control Board (SPCB); State Department of Agriculture/Irrigation; State Department of Water Resources; State Department of Industries.
- **Urban Local Bodies (ULB):** ULBs including parastatal agencies and Special Purpose Vehicles
- ***Panchayat Raj Institutions***
- **Others:** Private Sector (technology providers, operators); water re-users (Industries, power plants, agricultural enterprises, municipalities, others); Agriculture Universities; NGOs/CSOs; Water Users Associations.

2.1.3. Technical and Financial Assessment

The existing and planned wastewater treatment infrastructure was assessed, which included numbers and locations of sewage treatment plants (STPs), common effluent treatment plants (CETPs) or effluent treatment plants (ETPs), their respective technological designs, capacities and utilisation rates, effluent qualities, conveyance and/or reuse systems in place.

For selected wastewater treatment infrastructure, the capital expenditure, operational and specific costs per m^3 of treated water and cost-recovery were identified and compared to water supply alternatives and costs.

2.2. Potential Reuse Options

For each of the existing wastewater treatment infrastructures, water reuse options were explored. First, potential reuse options were identified based on the existing water reuse plans and water demand by different sectors in the vicinity of the treatment infrastructure. Second, for the intended water reuse option, required treatment technologies/upgrading of existing treatment systems were discussed to meet the water quality standards and needs as per fit-for-purpose specifications.

2.2.1. Reuse Options

The following common non-potable water reuse options were considered based on the options identified in the National Framework on SRTW **(NMCG, 2022, p. 8)**:

- **Industrial reuse:** Process water for power plants, refineries, mills, factories and railways.
- **Agricultural reuse:** Irrigation water for agricultural fields, forestry and horticulture.
- **Urban reuse (including construction and on-site reuse within STPs):** Irrigation water for landscaping (such as parks, golf courses), indoor uses (such as toilet flushing), water for firefighting, dust control or surface cleaning of roads and constructions sites, concrete mixing and other construction processes,
- **Environmental reuse:** Environmental restoration, discharge into surface water bodies, e.g., supplying natural and artificial lakes, maintenance of wetlands and environmental flows.

Direct managed aquifer recharge was not considered as water reuse option in this document.

2.2.2. Fit-for-Purpose Treatment Technologies

'Fit-for-purpose specifications' for treated water from existing treatment technologies (see Chapter 2.1.3) were defined. Fit-for-purpose specifications are the treatment requirements to meet water quality for a particular reuse option or norms, to ensure public and environmental health or specific user needs.

The fit-for-purpose specifications were based on the minimum water quality requirements for industrial, urban and agricultural reuse purposes. Those are given e.g., in the CPHEEO Manual on sewerage and sewage treatment (**CPHEEO, 2012**; *Annex 3*) or specific state standards, such as issued by the Haryana State Pollution Control Board (Section 3.2). For environmental reuse, the minimum water quality was considered as the STP discharge standards (**NGT order, 2019**, *Annex 3*).

For **industrial reuse**, the secondary treated water from STPs or treated water from CETPs, ETPs are suitable. Tertiary treatment is commonly required to meet industry's needs. Ultra-filtration (UF) and Reverse Osmosis (RO) were considered as common tertiary treatment technologies. Characteristics, advantages and disadvantages of these two treatment processes are shown in *Table 1* **(Blandin et al., 2016; Bray et al., 2021)**.

Table 1: Characteristics of tertiary treatment technologies UF and RO

	Ultra-filtration (UF)	**Reverse Osmosis (RO)**
Designed for:	Non potable water	Desalination/brackish water, high purity applications
Pore Size:	0.01 – 0.1 µm	0.0001 – 0.01 µm
Impurities removed:	Some viruses, bacteria, suspended solids	Most viruses, organic matter and mineral salts
Impurities not removed:	Some viruses, organic matter, mineral salts	Only trace amounts
Driving force (pressure):	1 – 10 bar (low energy requirement)	10 – 100 bar (high energy requirement)
Life span membrane:	3 – 7 years	2 – 5 years
Specific considerations:	Scaling and fouling (pre-treatment required)	Scaling and fouling (pre-treatment required), Waste management: Brine

The choice for a tertiary treatment method depends on the specific characteristics of the wastewater and the desired end-use of the treated water. RO method is particularly effective for treating industrial wastewater with high salt content or dissolved solids (TDS), such as those generated by chemical, pharmaceutical, or food processing industries. The treated water can be reused for several purposes, which require high-quality water. Ultra-filtration, on the other hand, is suitable for treating industrial wastewater with high levels of suspended solids, such as those generated by textile, pulp and paper, or metal finishing industries. Provided that there is no requirement to further reduce dissolved solids, the water treated through UF can be reused for a variety of purposes that require high-quality water.

For **agricultural, urban and environmental reuse**, secondary treated water from STPs followed by disinfection was considered fit-for-purpose. Chlorination and Ultraviolet light were considered as effective disinfection processes, as shown in *Table 2* **(Collivignarelli et al., 2017, Ye et al., 2022)**.

Table 2: Characteristics of Chlorination and UV disinfection

	Chlorination	**Ultraviolet (UV)**
Impurities removed	Efficient against most bacteria, not against all viruses and protozoa	Efficient against most bacteria, viruses and protozoa
On-site operational issues and maintenance	High corrosive and toxic, high handling and safety issues	Low (fouling of tubes may requires continuous maintenance)
Life span	10 – 15 years	UV lamp: up to 1 year
Specific considerations	Formation of disinfection by-products, residuals present, cost-effective	High energy demand, high costs, unsuitable for water with high levels of suspended solids, turbidity and organic matter

The choice between UV and chlorination for disinfecting treated water for agriculture, urban and environmental use depends on various factors such as the required quality of the secondary treated effluent, the presence of specific micro-organisms and the intended use of treated water. In some cases, a combination of both UV and chlorination may be used to provide multiple barriers against microbial contamination. Overall, UV disinfection and chlorination are both effective methods for disinfecting secondary treated effluent. UV disinfection is comparatively low maintenance and can be automated but needs frequent lamp replacements and high energy demand, while chlorine disinfection requires skilled personnel to operate and comparatively needs more attention during the treatment process.

2.3. Feasibility Assessment

Based on the identified water reuse options and fit-for-purpose specifications of each STP, CETP or ETP, business models were identified and described. The roles and responsibilities of stakeholders were outlined. The business models were further assessed for their viability and social and environmental impacts, and risk and mitigation strategies related to the business models were discussed.

2.3.1. Business Models for SRTW

The business models identified were motivated by good practice examples from the EU and India. A business model is defined as **(Osterwalder and Pigneur, 2010)**:

"A business model describes how a business creates, delivers and captures value; essentially the entire solution comprising the core aspects of the business – business process (e.g. technology), target customers, produce, infrastructure, organizational structures, trading practices, operational processes and policies, and the strategies it implements to achieve its objectives (be they for cost recovery, profit maximization, social impact, etc.)".

The sustainable Business Model Canvas is used *(Table 3, Annex 4)* to visually describe elements of SRTW business models **(CASE project, 2018)**. Compared to the classical Business Model Canvas (Osterwalder, 2005), it also considers Eco-Social Costs and Benefits.

Table 3: 11 elements and leading questions of the sustainable business model CANVAS

<table>
<tr><td rowspan="2">Key Partners

Who are our key partners and key suppliers? Which key resources are we acquiring from partners and which key activities do our partners perform?</td><td>Key Activities

What key activities do our value proposition/distribution channels/customer relationships and revenue streams require?</td><td rowspan="2" colspan="2">Value Propositions

Which value do we deliver to the customer? Which customer needs are we satisfying? Or which customer problems are we helping to solve?</td><td>Customer Relationships

What type of relationships do we need to establish with our customer segments? How costly are they?</td><td rowspan="2">Customer Segments

For whom are we creating value? Who are our most important customers?</td></tr>
<tr><td>Key Resources

What key resources do our value proposition/distribution channels/customer relationships and revenue streams require?</td><td>Channels

How are we reaching our customers? Which channels are most cost-efficient?</td></tr>
<tr><td colspan="3">Cost Structure

What are the most important costs inherent in our business model? Which key resources/ key activities are most expensive?</td><td colspan="3">Revenue Streams

For what value are our customers really willing to pay? For what do they currently pay? How much does each revenue stream contribute to overall revenues?</td></tr>
<tr><td colspan="3">Social & environmental costs

What environmental and social costs is our business model generating?</td><td colspan="3">Social & environmental benefits

What environmental and social benefits is our business model generating?</td></tr>
</table>

2.3.2. Stakeholder roles and responsibilities

The roles and responsibilities of Business Model Stakeholders and their Key Partners and Customers are discussed.

2.3.3. Financial Assessment of the Business Models

The financial viability, i.e., the net present value (NPV) and internal rate of return (IRR) of each of the identified business models is calculated (*Annex 5*; MS Excel template).

The NPV allows to estimate whether or not a business will be financially profitable. The NPV is the sum of all expected cash flows over the investment's lifetime, discounted to the present value. It is calculated as:

$$NPV = \frac{Cash\,Flow_1}{(1+r)^1} + \frac{Cash\,Flow_2}{(1+r)^2} + \frac{Cash\,Flow_n}{(1+r)^n} - Initial\,Investment$$

where *Cash Flow* = the sum of money spent and money earned on the investment or project for a given period of time; *1,2, n* are the periods of time, with n being the number of time intervals; *r* = discount rate of the time period; and *initial investment* = how much must be invested upfront.

The IRR is the discount rate that makes the NPV of a business zero. It is the expected annual return on an investment, shown as a percentage of the investment. It is calculated as:

$$NPV(0) = \frac{Cash\,Flow_1}{(1+IRR)^1} + \frac{Cash\,Flow_2}{(1+IRR)^2} + \frac{Cash\,Flow_n}{(1+IRR)^n} - Initial\,Investment$$

where *NPV* is set to 0;

The key assumptions for the financial viability assessment are:

- *Financial Costs:* Capital expenditure and operating costs (CAPEX and OPEX) of the disinfection and tertiary treatment technologies and conveyance were estimated as shown in the *Table 4*.
- *Annual increase in costs* is assumed at 5%.
- *Life span of initial investment/discount rate*: Calculation of NPV and IRR is taken for a lifespan of 15 year of the CAPEX. NPV is done at discount rate of 9%/year.
- *For industrial reuse business models:* The selling price of secondary treated effluent and/or tertiary treated effluent is kept below the price paid for freshwater price by the industries.
- *For urban and agricultural reuse business models:* The selling price of secondary treated effluent and/or tertiary treated effluent is kept below the price paid for freshwater by agriculture and urban water users. The price of freshwater for domestic purpose is taken at the current pricing for metered household water connection.
- *Water Supply growth:* Annual increase in supply quantities of secondary treated water (STW) and tertiary treated effluents (TTW) is linked to the population growth rate of the case study site.
- The number of days where secondary treated effluents are supplied is assumed to be 300 days per year

Table 4: Specific CAPEX and OPEX for treatment technologies and conveyance. 1 lakh ₹ = 100,000 ₹ = 1,133 € (ECB June 2023). 1 MLD =1,000 m³/day

Item	CAPEX (₹)	OPEX (₹/MLD per year)	Reference
Reverse Osmosis	200 lakhs per MLD	13.33 lakhs (including staff)	**Greendes, SMC & SSCD (2017)**
Ultrafiltration	20 to 30 lakhs per MLD	0.6 lakhs + 1 operator at 3 lakhs	**Greendes, SMC & SSCD (2017)**
UV	4 to 5 lakhs per MLD	0.026 lakhs + 1 operator at 3 lakhs	**Tak & Kumar (2017)**
Chlorination-dechlorination	Not considered (consumable)	0.093 lakhs + 1 operator at 3 lakhs	**Tak & Kumar (2017)**
Pumping for conveyance of STW	14 lakhs per MLD	0.21 lakhs + 1 operator at 3 lakhs	**Greendes, SMC & SSCD (2017)**
Pipeline for conveyance of STW	171 lakhs per km	0.43 lakhs + 2 operator at 3 lakhs	**DPR for water reuse IOCL Panipat (unknown)**

Additional assumptions per business models are described in Chapter 5.

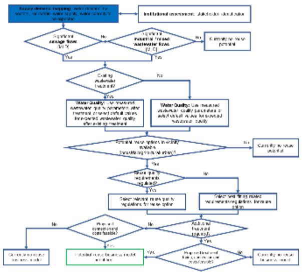
A sensitivity analysis was carried out to identify parameters that drive the business models' viability.

2.3.4. Risk and Mitigation

Business model related risks for selected stakeholders were identified and mitigation strategies related to those roles and responsibilities in the business models were discussed.

3. Pre-feasibility Assessment in Panipat, Haryana

3.1. Supply-Demand Mapping



Summary:

Renewable internal water resources in Panipat district are barely sufficient for domestic demands. They are insufficient to meet industrial and agricultural water demands, especially given the intensive rice cultivation.

Alternative water resources to meet future industrial and agricultural demands are crucial for Panipat.

With the introduction of the new freshwater tariffs by HRWA (up to 100% cost increase), and the low treated water tariffs, treated water reuse can become an economically attractive option for industries and agriculture.

3.1.1 Status of Water Resources

The Groundwater Yearbook of Haryana State 2020 – 2021 **(CGWB, 2022)** and the Groundwater information booklet Panipat District, Haryana **(CGWB, 2013)** explains, the following key facts on water resources of Panipat district.

Rainfall: The normal annual rainfall in Panipat District is **624 mm/year**. The highest rainfalls are received during the southwest monsoon (June-Sep; 521 mm; > 80% of total annual rainfall) season *(Figure 2)*. The district of Panipat witnessed a 20% decrease in total rainfall during 2019-2020, while Haryana State saw a 35% decline in total rainfall over the same time period. In Haryana, rainfall deficits between 10% and 50% have been recorded since 2013.

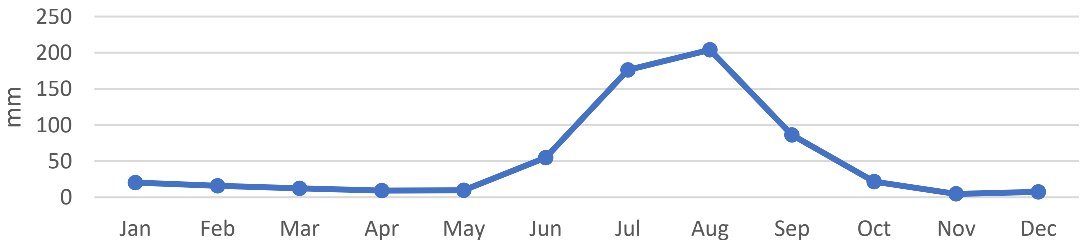


Figure 2: Month-wise normal rainfall (mm) in Panipat District

Evapotranspiration: The average evapotranspiration was **601 mm/year i**n Panipat District during 2019-2020.

Renewable internal water resources: The renewable internal water resources in Panipat District was **29.164 million m³/year (i.e., 79'900 m³/day**; **79.9 MLD);** calculated as precipitation (624 mm/year) minus actual evapotranspiration (601 mm/year) multiplied by the district area, i.e., 1,268 km². The renewable internal water resources per capita was **19.4 m^3/capita per year**, calculated with a district population of 1.5 million (projected population 2023) **(Population Census, 2023)**.

Groundwater quantity and quality: Groundwater levels in the region show variations over the years and are strongly dependent on the season (**CGWB, 2013**; *Figure 3*). According to the Central Ground Water Board, Government of India, the groundwater is overexploited in the district, with the stage of groundwater development assessed at 171%, considering the extensive agricultural activities in the area (rice and wheat cultivation, *Figure 4; Table 4*, **CGWB, 2013**).

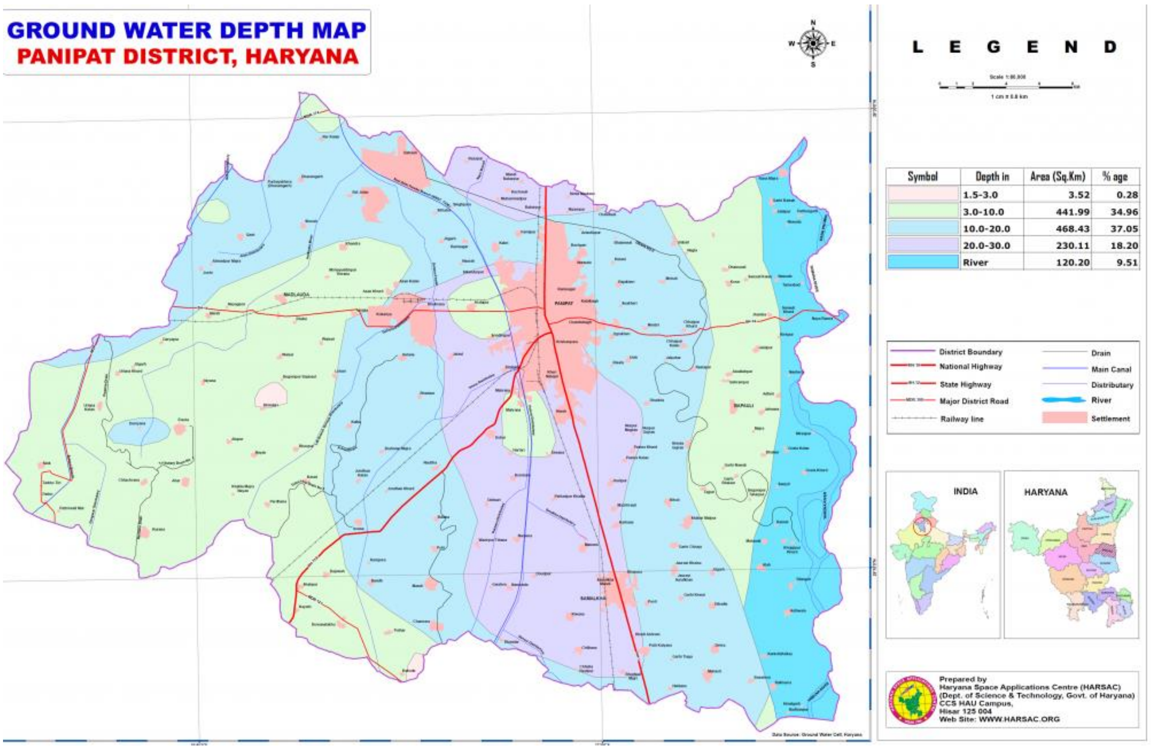


Figure 3: Groundwater levels in Panipat District (HARSAC, date unknown)

Groundwater is generally suitable for drinking purposes as parameters are within the permissible limits for drinking water (BIS: 10500). Some areas had high levels of salinity and fluoride in the groundwater. In Panipat city, groundwater was found to be polluted by nitrate, fluoride and heavy metals in some areas, and are hence unsuitable for drinking **(CGWB, 2013; HSPCB, unknown)**.

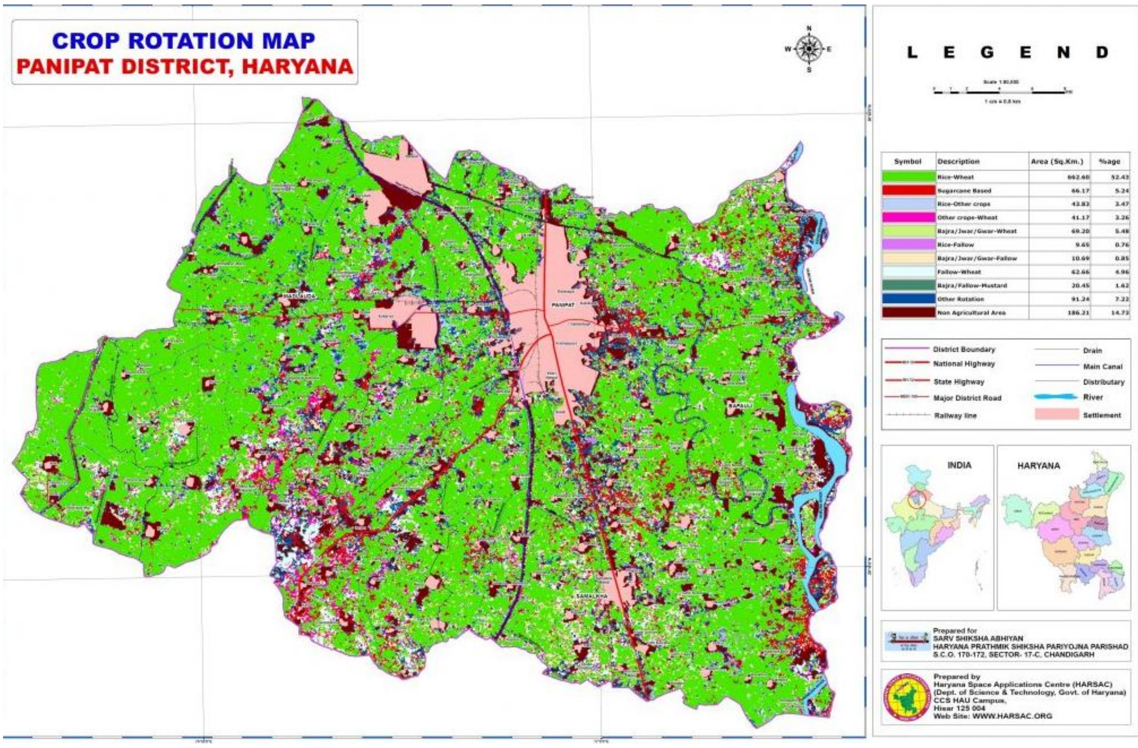


Figure 4: Land use/Land cover map Panipat District, incl. Crops grown (HARSAC, date unknown)

Surface water quantity and quality: The major water bodies in Panipat district are the Yamuna River and the Western Yamuna Canal *(Figure 5)*. The river Yamuna receives effluents from Panipat (3% of the city-wise pollution load), and therefore several stretches of the river are highly polluted **(CPCB, 2006)**.

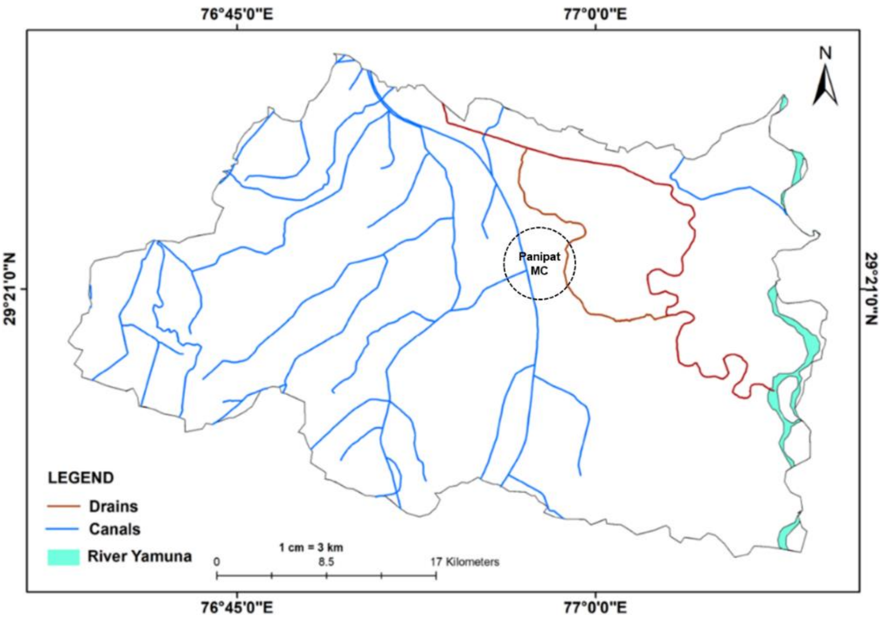


Figure 5: Schematic overview of irrigation canal systems and discharge drains close to Panipat MC (Source: Lakhvinder Kaur and Madhuri S. Rishi, 2018)

According to an analysis conducted by the Haryana State Pollution Control Board **(HSPCB, 2023)**, Panipat's drain, and river water data demonstrated a substantial amount of pollution. The Gharaunda drain, prior to entering the city of Panipat, exhibited high levels of BOD (biochemical oxygen demand), COD (chemical oxygen demand), and total coliforms (TC) with maximum levels of 80 mg/L, 200 mg/L and $5*10^4$ CFU/100mL, respectively (*Figure 6*, light blue lines). Sampling points after Panipat Municipal Corporation (*Figure 6,* yellow, blue and green lines, i.e. Drain No. 2) show an increased pollution load with levels of BOD, COD, and TC with maximum values of 300 – 500 mg/L, 1,000-1,600 mg/L and 1.5 $* 10^5 – 2.0 * 10^5$ CFU/100 mL respectively. Release of untreated sewage and industrial effluents into the drainage systems before and after Panipat is thus likely. The pollution load in Drain No. 2 is highest before meeting Yamuna (i.e. BOD of 550 mg/L, COD of 1,900 mg/L and TC of $2.5* 10^5$ CFU/100 mL, *Figure 6*, dark blue line) and thus poses severe threats to Yamuna River water quality.

3.1.2 Water Supply and Demand Management

Panipat district's internal renewable water supply is nine times higher than the current water demands *(Table 5)*. Agriculture accounts for over 71% of water consumption, followed by industry (18%) and homes (11%). Furthermore, about 30% of the water delivered is lost in transit **(HSPCB, unknown)**.

Table 5: Summary of main sectors, estimated water demand and examples.

Sector	Description	Water Source	Estimated amount [MLD]	Reference
Industry	industrial cluster (Sector 29 part 1 and 2)	Surface water (Yamuna Canal)	40	**HSPCB, unknown**
	Panipat Refinery & Petrochemical Complex / Indian Oil Corporation Limited (IOCL)	Yamuna canal	> 80	**IOCL, 2022**
Municipal	No of population (739,589 persons as of 2020) and average demand	Groundwater	Municipal supply total 100 MLD, out of which ca. 75 MLD is supplied to households (20 MLD to Industry, Non-revenue water 15 MLD)	**CGWB, 2013; MCP, 2022**
Agriculture	areas 4000 acres, crops: wheat, rice and sugarcane, Village (Number of farmers) from identified reuse cluster: Naultha (890), Balaana (384), Palri (342), and Jondhan Khurd (41)	Mainly surface water provided by canals, but also expected from drains /groundwater	510 MLD	**Rawat et al., 2018**
Total Water demand			Industries: 120 MLD Households: 75 MLD Agriculture: 510 MLD **Total: 705 MLD**	

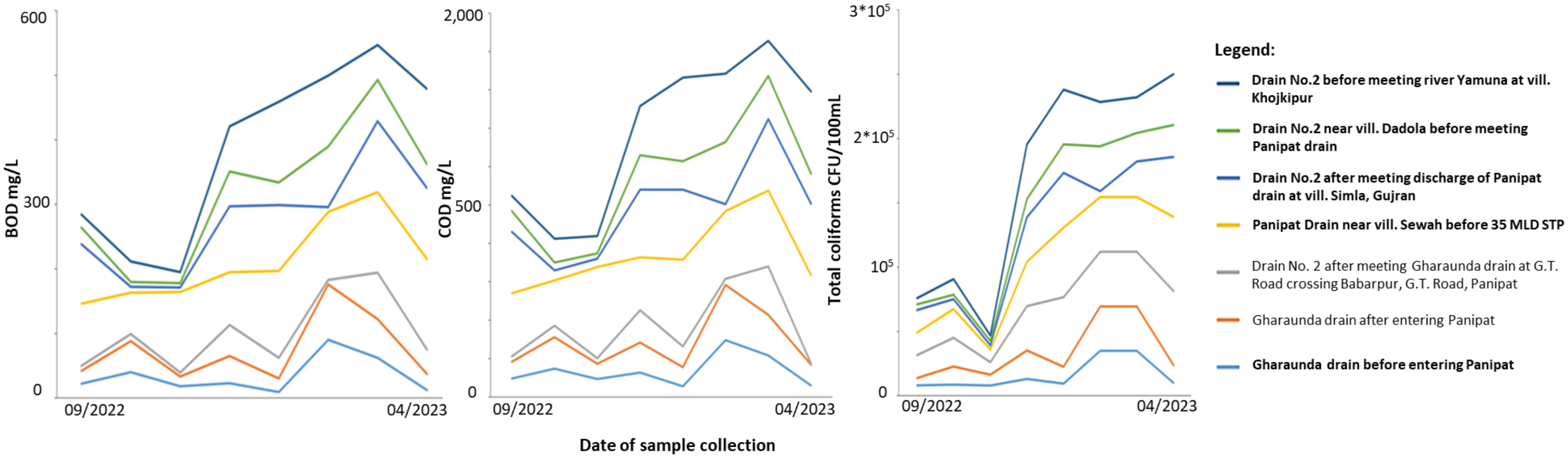


Figure 6: Water quality (BOD, COD and TC) in drain systems close to Panipat MC and before flowing into Yamuna River (HSPCB, 2023)

Industry: The Haryana Irrigation Department (HID) provides surface water from the canal for industry, while groundwater is pumped on-site at a ratio of approximately 70:30 **(SPCB/HSIIDC officials, 2022)**. The Public Health & Engineering Department (PHED) and the Haryana State Industrial & Infrastructure Development Corporation (HSIIDC) are responsible for managing it in part. The Yamuna canal feeds into a 40 million litres tank, which is subsequently distributed to the industries in Sector 29 Part 1 and 2 through a pipeline. Some individual industries have groundwater bore-wells to extract groundwater with permission from Central or State Groundwater Authorities.

There are more than 4,000 registered industrial units in Panipat located in four industrial areas. Sector 25 and Sector 29 are the large areas with 367 ha (570 units in production) and 485 ha (624 units in production), respectively **(MSME, unknown)**. Medium and Small-Enterprises are largely agro-based, or textile and home-furnishing manufacturers.

The following large-scale industrial units are found in Panipat.

Textile and home-furnishing industry: M/s. Ravera Textiles, M/s. Golden Terry Towel Pvt. Ltd., M/s. Aggarsain Spinners Ltd., M/s. Om Overseas, 80 Mile Stone

Refinery: M/s. Indian Oil Corpn. Ltd, M/s. Naptha Crackers Plant (IOC Ltd).

Food-processing & agro-based: M/s. Natural Food Products (NESTLE Ltd.) Samalkha; M/s. Aradhna Soft Drinks Co., M/s. Panipat Cooperative Sugar Mills Ltd + Distillery, M/s. S.S.A. International Samalkha

Cement: M/s. Jay Pee Cement Grinding Unit, M/s. Grasim Industries Ltd.; M/s. UltraTech. Cement Ltd.

Other: M/s. Panipat Thermal Plant, M/s. National Fertilizers Pvt. Ltd.,

Water supply charges to industries (groundwater) by HSIIDC are 18.24 ₹/m^3 for metered supply. Wastewater charges are 20% of the water supply charges, i.e., 3.64 ₹/m^3 **(MCP, 2022)**.

Bulk water supplies of surface waters by the Haryana Water Resources Authority are industry specific (as per 2018); have been revised in 2022 and are determined as follows **(HWRA, 2022a)**:

- Brick making and pisewall (rammed earth) building/water for construction work: proposed new at 30.00 ₹/m^3 (2018 rate: 15 ₹/m^3).
- Beverage and bottled water industry: proposed new at 40.00 ₹/m^3 (2018 rate: 20.00 ₹/m^3).
- Other industries, power plants and bulk users: proposed new at 20.00 ₹/m^3 (2018 rate: 10.00 ₹/m^3)
- Railways and Army (other than drinking purpose): proposed new at 15.00 ₹/m^3 (2018 rate: 7.5 ₹/m^3)
- Drinking purpose (including railway and army): proposed new at 1.00 ₹/m^3 (2018 rate: 0.25 ₹/m^3)

Drinking water supply: The Panipat District relies on groundwater for its drinking water supply, **(CGWB, 2013),** which is managed by the PHED. It maintains around 160 tube wells for drinking water supply (75 – 100 m depth). In 2013, the annual abstraction from the wells for drinking water was 2.9 million m^3 (i.e. 291 hectare meters (ham), **CGWB, 2013**).

Water supply charges for domestic connections are 1.10 ₹/m^3 for metered water supply or 120 ₹ per month for unmetered supply. The wastewater disposal charges are 25% of the water charges, i.e., 0.275 ₹/m^3 for metered supply and 30 ₹ per month for un-metered supply (MCP, 2022).

Irrigation water: Groundwater makes up about 70% of the irrigation water, 30% stems from the Western Yamuna Canal. In 2009, the allocated gross groundwater draft for irrigation was 266 MLD (i.e., 9723 ham, **CGWB, 2013**). Newer data suggest annual groundwater irrigation drafts of 510 MLD (i.e., 510,000 m^3/day; **Rawat et al., 2018**). Irrigation volumes are likely to be higher, considering the average crop irrigation needs **(FAO, 1986)**. Rice is the main kharif crop (season: June-October), whereas wheat is the main rabi crop (season: October - April). The crops are grown in rotation, with a cultivated area of 650 km^2 (i.e., 65,000 ha; > 80% land usage; *Figure 4*). Wheat has a growing period of 120 – 150 days and needs 450 – 650 mm (4500 – 6500 m^3/ha) over the total growing period. Rice has a total growing period of 90 – 150 days and needs 450 – 700 mm (4500 – 7000 m^3/ha) over the total growing period **(FAO, 1986)**.

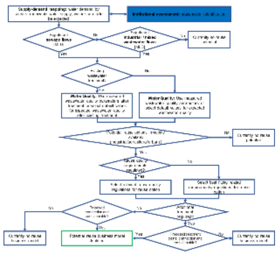
The tariffs for irrigation water (surface water) are 15 – 120 ₹/m^3 **(per crop per acre) (HWRA, 2022a)**. No new water tariffs for irrigation are proposed by HRWA to safeguard the livelihoods of farmers and food security.

HWRA has further revised the **state tariffs for treated wastewater supply** in 2022 **(HWRA, 2022b)**:

- 4 ₹/m^3 at STP site (before: 2 ₹/m^3) except agriculture
- 5 ₹/m^3 at doorstep, i.e., incl. cost of conveyance system to the consumer (before: 3 ₹/m^3) except agriculture
- Treated wastewater is supplied free of cost for use in agriculture

The new rates have been calculated, assuming a 40% cost recovery.

3.2 Institutional, Regulatory and Legal Assessment



Summary:

The Haryana Reuse of Treated Wastewater Policy 2019 will foster the uptake of SRTW in Panipat

HSCPB has revised effluent discharge standards in 2020 and proposed water reuse quality standards for irrigation, industrial reuse and groundwater recharge.

HSIIDC is a potential regulator and implementer for supplying treated water for industries in Panipat.

HSVP and MCP are responsible institutions for the Panipat state STPs/CETPs. They are potential regulators and implementers for supplying treated water for landscaping, firefighting and construction industries.

HID is a potential regulator and implementer for supplying treated water for agriculture in Panipat.

Institutional: The relevant institutions involved in management of water resources in Panipat District, their responsibilities and activities are summarised in *Table 6*.

Table 6: Relevant institutions in water management

Institution	Role and description	SRTW related activities
National Mission for Clean Ganga **(NMCG)**	Takes measures for prevention, control and abatement of pollution as well as to ensure continuous and adequate flow to rejuvenate River Ganga	NMCG integrates the efforts to clean and protect the Ganga River in a comprehensive manner. It is the key government body for the development of the national framework for SRTW. NMCG have also invested in the construction of STPs in Panipat.
Haryana State Industrial & Infrastructure Development Corporation **(HSIIDC)**	Develops basic infrastructure facilities such as water supply, external electrification, effluent disposal system and then allots industrial plots	Nodal agency of the state Government for development of industrial infrastructure including water supply, sewage, drainage infrastructure as well as provision of facilities such as STPs/CETPs.
Haryana Irrigation Department **(HID)**	Responsible for irrigation water management in the state	Government body responsible for irrigation water resource management and infrastructure such as canals. They also use their canals to provide industry water to HSIIDC. They can potentially be benefited by the availability of additional water resources for increasing irrigation capacity.
Haryana Shahari Vikas Pradhikaran **(HSVP)**	Formerly known as Haryana Urban Development Authority is the urban planning agency for Haryana	HSVP have varying roles of water supply, sewerage, storm water management, wastewater treatment and allotment of land. In Panipat, HSVP is responsible for two STPs and two CETPs.

Institution	Role and description	SRTW related activities
Central Groundwater Board **(CGWB)**	Responsible for providing scientific guidance for management, exploration, monitoring, assessment, augmentation and regulation of groundwater resources in India. They also provide permission to industries for groundwater extraction	Groundwater resources are currently under stress due to groundwater extraction, and improperly managed wastewater can deteriorate the quality of this resource. SRTW can potentially address both issues to a significant extent.
Public Health Engineering Department **(PHED)**	Responsible for piped water supply, sewerage, storm-water management, STP construction amongst others	PHED roles are quite similar to that of HSVP. In Panipat District they were responsible for STPs located in Sector 6. This responsibility recently shifted to MCP.
Central Pollution Control Board **(CPCB)**	Advises the Central Government on matters concerning prevention and control of pollution	The CPCB coordinate activities of State Pollution Control Boards to ensure prevention and abatement of pollution and can help in guiding the state on appropriate reuse standards based on the purpose of use.
Haryana State Pollution Control Board **(HSPCB)**	Monitors and regulates the water quality parameters of effluent discharged to drain (s) and imposes fine to the industries/agencies that exceed the norms	Being a regulatory body, HSPCB periodically monitors the physiochemical and biological parameters of the effluents, and. can play the role of monitoring treatment standards based on the type of end-users supplied with SRTW.
Municipal Corporation of Panipat **(MCP)**	Newly responsible for treated of municipal wastewater	MCP is responsible for managing the STPs located in sector 6.
Haryana Water Resources Authority **(HWRA)**	HWRA is mandated to achieve a sustainable water resources action plan with short term and long-term perspectives. It exercises jurisdiction in the state committing to judicious, equitable and efficient use of groundwater and surface water.	HWRA sets the tariff for treated wastewater uses as well as for bulk water uses of surface water. It provides permission for groundwater and surface water use. It mandates mining, infrastructure and industries to provide details of reuse as part of water requirements for obtaining 'no objection certificate' (NOC) for the projects.

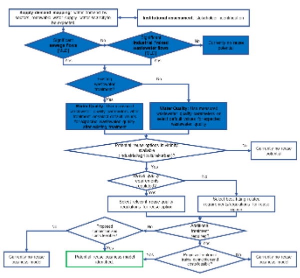
Regulatory: The State Government of Haryana has issued its Reuse of Treated Wastewater Policy in 2019 (Notification No. 5/18/2018-3PH) with the following objectives:

- *Attain a minimum coverage of 80% of the area with sewerage facilities and collection of sewage in all towns of the State.*
- *Attain a level of 100% treatment of collected sewage as per prescribed CPCB/HSPCB standards.*
- *Reuse at least 25% of the treated wastewater (TWW) by every municipality within the time frame set under the policy by every municipal body.*
    - *i. Reuse 50% of TWW by 2025*
    - *ii. Reuse 80% of TWW by 2030*
    - *iii. Similar target for villages where sewerage facility is being provided*

The State Government of Haryana introduced the integrated Water Resources Action Plan-2023-2025 under Amrit Jal Kranti which is a key step towards conserving water resources in the state. In April 2023, a state water conservation seminar was organized under Amrit Jal Kranti, in which the relevant departments of Haryana, and other national and international experts on water conservation participated. The action plan entailed the recommendations from these experts. Also, the concept of Mera Pani-Meri Virasat Yojana was implemented which is being acknowledged by other states.

Legal: HSPCB has fixed new STP effluent discharge standards in 2020 and has proposed standards for the discharge of treated sewage from STPs *(Annex 6)*.

3.3 Technical and Financial Assessment of Existing Wastewater Treatment Infrastructure



Summary:

Panipat produces 90 MLD sewage and > 35 MLD industrial wastewater.

Treatment capacity for all wastewater is available (7 STPS / 3 CETPS with 125 MLD / 45 MLD capacity), but not fully used.

Secondary treated water is compliant to the STP discharge standards, according to the latest HSPCB reports.

Industrial treated wastewater is non-compliant regarding TDS, which is a barrier to water reuse in textile industries.

Cost-recovery through wastewater charges is not achieved for sewage nor for industrial wastewater treatment.

If all sewage and industrial wastewater would be reused (125 MLD), 100% of the industrial water demand or 25% of the agricultural demand could be met.

Technical assessment: There are 6 operational STPs in Panipat City as per the latest STP Inventory **(CPCB, 2021)** and monthly progress report on Yamuna Action Plan (**HSPCB, 2022**, *Table 7*). *PNP-STP-003, Samalkha STP is outside the Panipat division boundary (Figure 7).*

Table 7: Status of STPs in Panipat District (CPCB, 2021; HSPCB, 2022). UASB = Up-flow anaerobic sludge blanket; SBR = Sequential batch reactor, MBBR = moving bed biological reactor

Location of STP	Date of Commissioning	Installed capacity (MLD)	Actual Utilization (MLD)	Technology	Use of treated sewage	Compliance status*	Dept.
PNP-STP-001, Sewah	2000	35	18	UASB	no[a]	complying	MCP
PNP-STP-004, Sewah II	2000	25	13	SBR	no[a]	complying	MCP
PNP-STP-002, Jattal Road	2000	10	7	UASB	no[a]	complying	MCP
PNP-STP-005, Jattal Road	2016	20	16	SBR	no	complying	MCP
PNP-STP-006, Sector 19	2018	30	8	SBR	no	complying	HSVP
PNP-STP-007, Sector 6	2019	0.8	0.8	SBR	no	complying	HSVP
Total capacity:		**120.8**	**62.8**				

*[a] STPs are taken up in the 'project of reuse of treated wastewater for irrigation purpose through micro-irrigation (HSPCB, 2023), * compliance status as per latest HSPCB report 2022*

Two STPs are under construction at Refinery Road (15 MLD) and Barsat Road (25 MLD). There is an additional discharge of 24.3 MLD of industrial wastewater. All 286 industries have installed ETPs, and there are three CETPs **(HSPCB, 2022)**:

- Panipat Refinery Complex CETP (2.5 MLD; under HSIIDC), status: operational and non-complying as per latest HSPCB reports.
- Sector – 29, Unit-I CETP (21 MLD, under HSVP), status: operational and complying as per most recent HSPCB reports.
- Sector – 29, Unit-II CETP (21 MLD, under HSVP), status: operational and non-complying as per most recent HSPCB reports

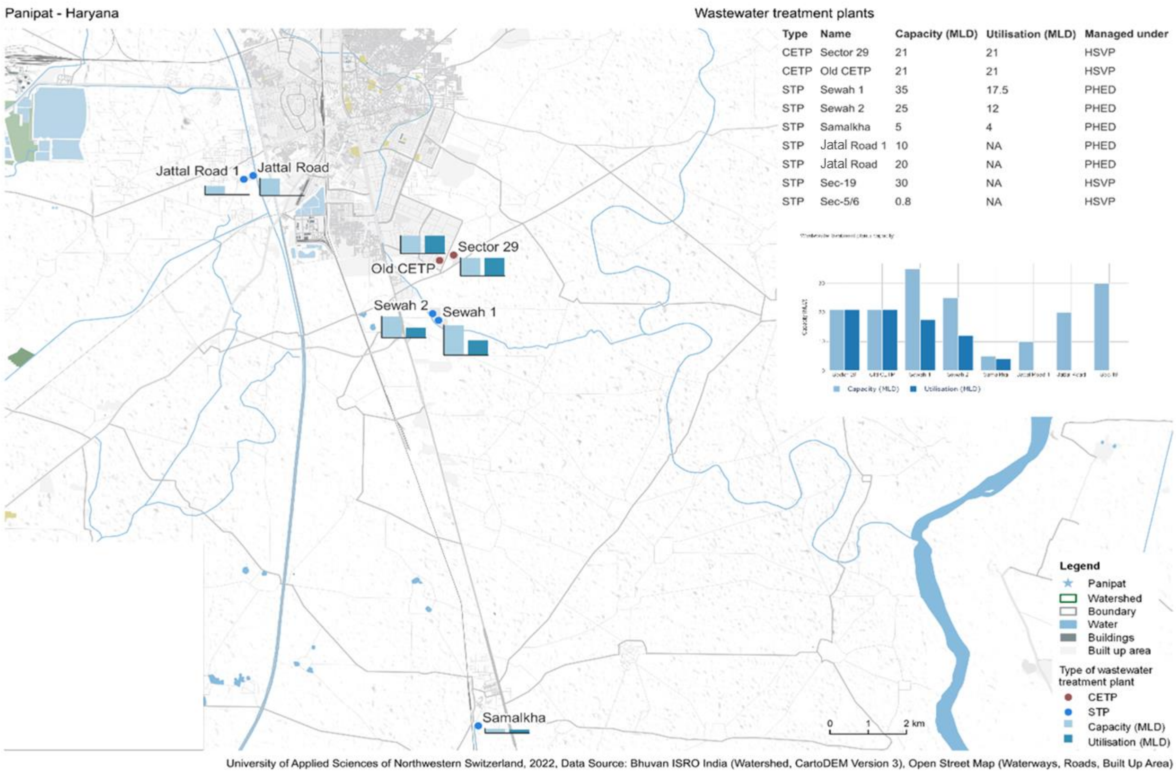


Figure 7: Overview of locations and characteristics of selected STPs and CETPs in Panipat.

It is estimated that the population of Panipat contributes about 90 MLD of domestic sewage, and industries account for 35 MLD of industrial wastewater **(HSPCB, unknown)**.

More than 90% of sewage is treated in STPs *(Table 7)*. CETPs run close to their designed capacities and the STPs are underutilized (65% used capacity; see *Table 7*). All STPs and CETPs discharge into the Panipat discharge canal, which also receives substantial amounts of untreated domestic sewage and industrial wastewater, and emanates after ca. 10 km into Yamuna River ***(Error! Reference source not found.**7)*.

The most recent reports state that all STPs were compliant with the STP effluent discharge standards (**HPSCB, 2020**, *Annex 6*). According to information shared by key informants, TDS values are in the range of 750 mg/L.

Only one CETP (Unit-I CETP) was fully complying with the CETP effluent discharge standards **(HSPCB, 2023),** as per the latest HSPCB reports. High TDS values of around 1200 – 1500 mg/L have been reported for all CETPs by key informant interviews. If CETP effluents are to be reused in textile industries, TDS removal is required because textile industries need low TDS values of around 300 mg/L.

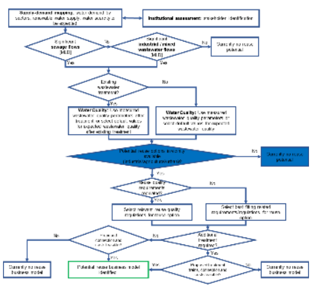
Financial assessment: The total sewage treatment costs, including CAPEX and OPEX, have been approximated for various treatment technologies in India by a consortium of seven Institutes of Technologies during the development Environment Management Plan of the Ganga River basin **(Ganga River Basin Environment Management, 2010)**. The total treatment costs, NPV in 2010, up to secondary treatment for UASB + Extended Aeration is 2.8 ₹/m^3, for SBR 2.9 ₹/m^3 and for MBBR 3.3 ₹/m^3.

The sewage treatment charges to households are only 0.275 ₹/m^3 (Chapter 3.1.2), which results in a cost recovery of < 10%.

Based on the data provided during the first stakeholder exchange *(Annex 2)*, the costs for wastewater treatment in the CETP can be estimated at more than 14 ₹/m^3 These costs seem to be not fully covered by the industrial wastewater treatment charge of 6 ₹/$m^3$for industries (**SPCB/HSIIDC officials, 2022**).

4. Potential Reuse Options in Panipat, Haryana

4.1 Reuse Options from STPs in Panipat



Summary:

The following four reuse options exist in the vicinity of 7 STPs in Panipat:

1. **Secondary treated effluent from STPs in Sewah Road I & II (cumulative designed capacity of 60MLD) for reuse in textile industries of Sector 29.**

2. **Secondary treated effluent from STP in Refinery Road (designed capacity of 15 MLD) for reuse in IOCL industry,**

3. **Secondary treated effluent from STPs in Jattal Road I & II (cumulative designed capacity of 30 MLD) for reuse in agriculture, ca 1600 ha, villages Naultha, Balaana, Palri, and Jondhan Khurd (wheat, rice, sugarcane).**

4. **Secondary treated effluent from STPs in Sector 19 and Sector 6 (cumulative designed capacity of 30.8 MLD) for urban reuse (e.g., street cleaning, park irrigation etc.) and for construction industries.**

There are currently no reuse activities from STPs. Three STPs in Panipat *(Table 8)* are considered for water reuse projects for irrigation by the Ministry of Agriculture & Farmers Welfare (MoAFW)/ National Bank for Agriculture and Rural Development (NABARD). Wastewater reuse is reported from certain ETPs for in-house industrial reuse (e.g., Panipat Refinery & Petrochemical Complex in cooling towers). A DPR has also been submitted for the development of advanced tertiary treatment at the 15 MLD STP (Refinery Road, under construction), which will supply IOCL Panipat with tertiary treated water (**DPR water reuse IOCL Panipat, unknown**).

Table 8: Water reuse options and potential in Panipat, Haryana (colour code: green= high potential; orange = medium potential; red = low potential)

Reuse options	Potential	Benefits	Challenges
In-house companies' reuse (Zero-liquid-discharge)	medium	There is efficiency and reuse potential in the industry as confirmed during the stakeholder exchanges.	Companies want to focus on their main business activities and not run ETPs (lack of capabilities to maintain quality)
Companies → Companies	medium	There could be symbiosis potential regarding water reuse within the industrial clusters	Companies want to focus on their main business activities and not run ETPs (lack of capabilities to maintain quality). Instead of individual ETPs, a CETP to manage and treat the effluent and sell it back to the industry is

Reuse options	Potential	Benefits	Challenges
			regarded by industry representatives as a preferred option.
STPs → Industry	high	Industries want an independent agency who is capable of managing the treatment of effluent and supply back the treated water to the industry. They are willing to pay for the water that they receive.	The industry representatives expressed concern that, despite having previously paid the industrial department the development fees for the industrial zone, they do not comprehend why additional charges for conveyance are also being requested of them. While cost of conveyance can be accounted for in the price of supplied treated water, it is expected that treated water is cheaper than current water supply.
CETPs → Industry	medium	See STPs → Industry	See STPs. Additional treatment steps required to assure low TDS levels.
STPs → Municipality	high	Reuse in urban greening and horticulture so as to free freshwater for drinking water purposes	Seasonal availability, logistics
CETPs → Municipality	low	Reuse in urban greening and horticulture so as to free freshwater for drinking water purposes	Seasonality, logistics, treated effluent would need additional treatment steps.
STPs → Agriculture	high	This is expected to happen out of drains uncontrolled at the moment. Very high water demands by agriculture in the area.	Currently, this water cannot be considered safe due to mixing with untreated and treated wastewater flows; financials; adequate conveyance system for secondary treated wastewater is needed.
CETPs → Agriculture	low	This is expected to happen out of drains uncontrolled (probably STP and CETP mixed effluents).	Currently this water cannot be considered safe; financials
STPS/CETPs → drains → environmental flows	medium	This is crucial to sustain aquatic ecosystems. This is expected to happen out of drains uncontrolled	Currently a lot of the canal and Yamuna River water is abstracted for irrigation; drain water cannot be considered safe for aquatic ecosystems.

This solution document considers the high potential water reuse options in Panipat. Given their compliance with secondary treated wastewater discharge standards, these are the choices for reuse from the existing Panipat STPs to industry, agricultural, and municipal entities *(Figure 8)*. As there are ongoing plans for tertiary treated wastewater from the Refinery Road STP (15 MLD, under construction), the STP is included in the reuse options for Panipat. Due to caveats about overly high TDS concentrations in the industrial effluent, water reuse from CETPs is not considered in this document.

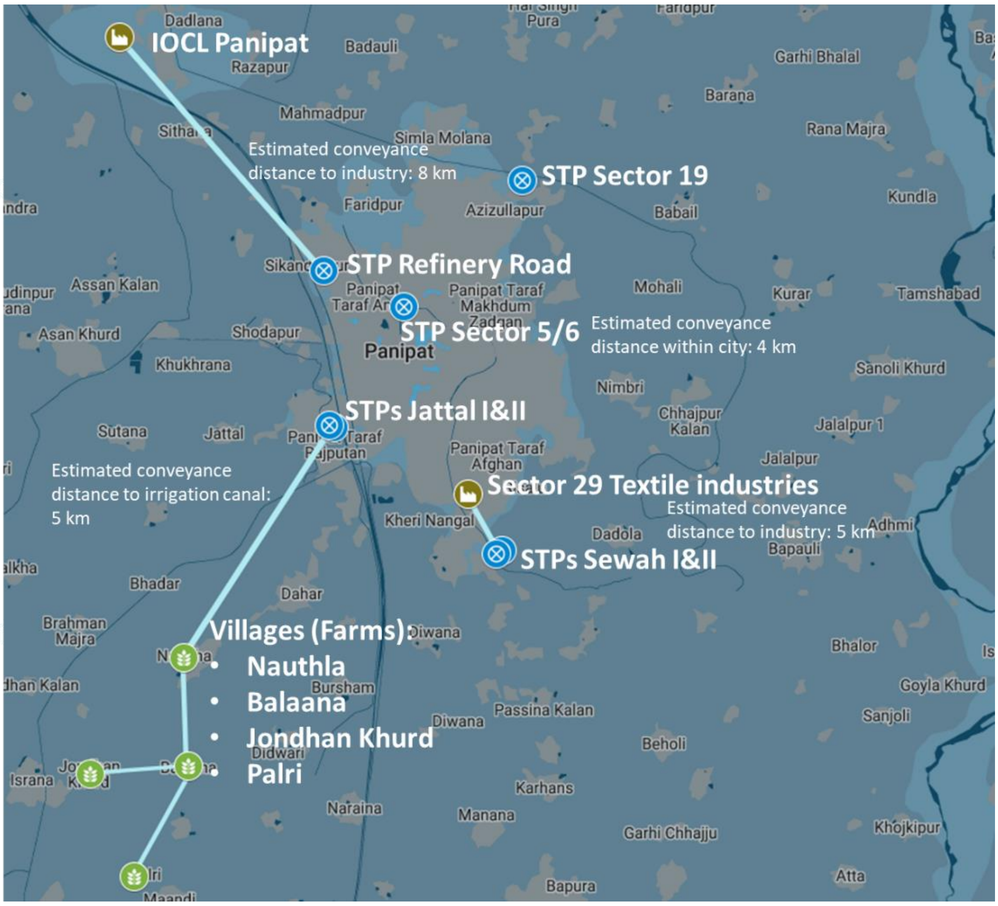
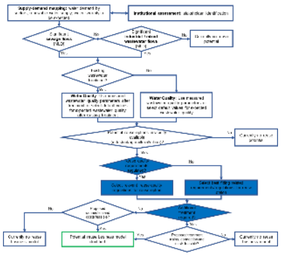


Figure 8: Water reuse options from different STPs in Panipat and estimated conveyance distances (c.f. financial assessments in chapter 5)

4.2 Fit-for-Purpose Technology Specifications



Summary:

Fit-for-purpose specifications are set in the proposed HSCPB standards for water reuse and the specific industrial needs, e.g., textile industries.

Textile industries require low TDS contents (< 300 mg/L). Secondary treated effluent from Sewah I & II STPs needs tertiary treatment via RO to remove TDS. For other industries also ultra-filtration is a tertiary treatment option.

IOCL Panipat will use secondary treated water for their cooling towers. An ultra-filtration unit is proposed as tertiary treatment of secondary effluents from Refinery Road STP.

Secondary treated effluents from Jattal I & II, Sector 5/6 and Sector 19 STPs need disinfection to achieve the HSCPB standards for irrigation and urban reuse (i.e., Faecal coliform < 100 MPN/100 mL)

The potential reuse options, their benefits and challenges are explored and assessed for Panipat in *Table 8*. For the identified reuse options, the treatment requirements are identified in *Table 9*.

Table 9: Fit-for-purpose treatment requirements of secondary treated effluents

Secondary treated effluent from	Proposed reuse option	Treatment requirements for secondary effluent
Sewah I & II	Industrial reuse for textile industries	Tertiary treatment to remove **TDS concentration**s from 750 mg/L. to 300 mg/L. Ultra-filtration cannot remove TDS. A **reverse osmosis** treatment system is required with a removal capacity for TDS of up to 99%.
Jattal Road I & II	Agriculture reuse for farmers in Nauthla, Balaana, Palri and Jondhan Kurd	The secondary effluent is compliant with the discharge standards for **Faecal coliform**, i.e., < 1000 MPN/100 mL; but does not meet the HSPCB water quality requirements of < 100 MPN/100 mL for irrigation *(Annex 6)*. An additional health protection barrier, i.e., **disinfection** through **chlorination/UV** is nevertheless highly recommended.
Sector 19 & Sector 5/6	Urban reuse for parks/landscaping and to construction companies	The secondary effluent is compliant with the discharge standards for **Faecal coliform**, i.e., < 1000 MPN/100 mL. For other non-potable reuse, such as urban reuse, Faecal coliform should be < 100 MPN/100 mL, according to HSPCB proposed water reuse standards *(Annex 6)* An additional health protection barrier, i.e., **disinfection** through **chlorination/UV** is nevertheless highly recommended.
Refinery Road	Planned industrial reuse at IOCL	Cooling water, as largely used in the petro-chemical industry, should be of sufficient good quality to minimize corrosion, scale formation and deposits of sediments. A detailed project report for water reuse in IOCL Panipat **(IOCL, unknown)** proposes an **ultra-filtration** unit for tertiary treatment.

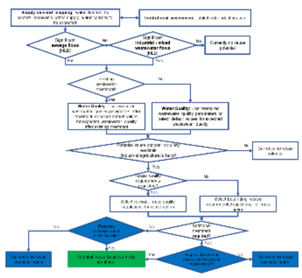
5. Feasibility Assessment for SRTW Business Models in Panipat, Haryana

Four business models for three reuse options are proposed, and their viability is assessed. Those include:

- One **business model for reuse in industries** discusses the tertiary treated water for textile industries or IOCL Panipat refinery (Chapter 5.1). This business model is inspired by the successful industrial water reuse systems in Chennai and Surat (***cf. Business Model Compendium***).

- Two **business models for agricultural reuse**, i.e., water swap and auctioning of secondary treated and disinfected effluent are described (Chapter 5.2). Those business models are reflected in the Business Model Compendium by the case studies of Alicante, Spain and Milano, Italy. In India, similar business models are found in Rajkot, India (where lake water is swapped for treated effluents for agriculture) and villages in northern Gujarat, where secondary treated effluent is auctioned annually at ₹ 5,000 – 11,000 **(Palrecha et al., 2012).** In Unjha municipality, for example, the base price for auction starts at ₹ 400,000 for 5 MLD secondary treated effluents and is allocated and contracted to the highest bidder for three years. The bidder sells secondary treated effluents to farmers at ₹/ 70 – 90 per hour supply basis, earning a profit of about ₹ 100,000 after incurring maintenance and labour costs to manage the STP.
- One **business model for urban reuse**, i.e., secondary treated and disinfected effluent for the irrigation of parks landscape, water reuse for firefighting and construction companies (Chapter 5.3) is included. The business model is displayed in the Business Model Compendium by the case study Barcelona, Spain. A similar urban reuse model (with tanker supply) is currently happening from Okhla STP in Delhi.

5.1 Business Model for Water Reuse in Textile Industry and IOCL Panipat Refinery



Summary:

The business model includes the provision of secondary treated effluent from Sewah I & II STPs (operated by MCP) to a private operator who designs, builds and operates a tertiary treatment plant and sells tertiary treated effluent to industries.

Ultra-filtration technology is financially more viable than RO technology for tertiary treatment.

Industrial reuse seems viable, and the business model is a sustainable one.

5.1.1 Business Model Description

The business model includes the provision of secondary treated effluent from STPs to a private operator who designs, builds and operates a tertiary treatment plant and sells tertiary treated effluent to industries. The respective STPs and industries are as follows:

- 60 MLD secondary treated effluent from Sewah I & II STPs → private operator of tertiary treatment plant → textile cluster in sector 29 (Phase I & II)
- 15 MLD secondary treated effluent from Refinery Road STP (under construction) → private operator of tertiary treatment plant → Panipat IOCL Refinery.

Both industries and HIISDC would invest in the required tertiary treatment facilities to achieve fit-for-purpose qualities (i.e., TDS values < 300 mg/L for textile industries). The capital and operating costs (CAPEX and OPEX) of the treatment facility is covered by the industries while the supply of secondary treated effluent and related conveyance is covered by MCP *(Figure 9)*.

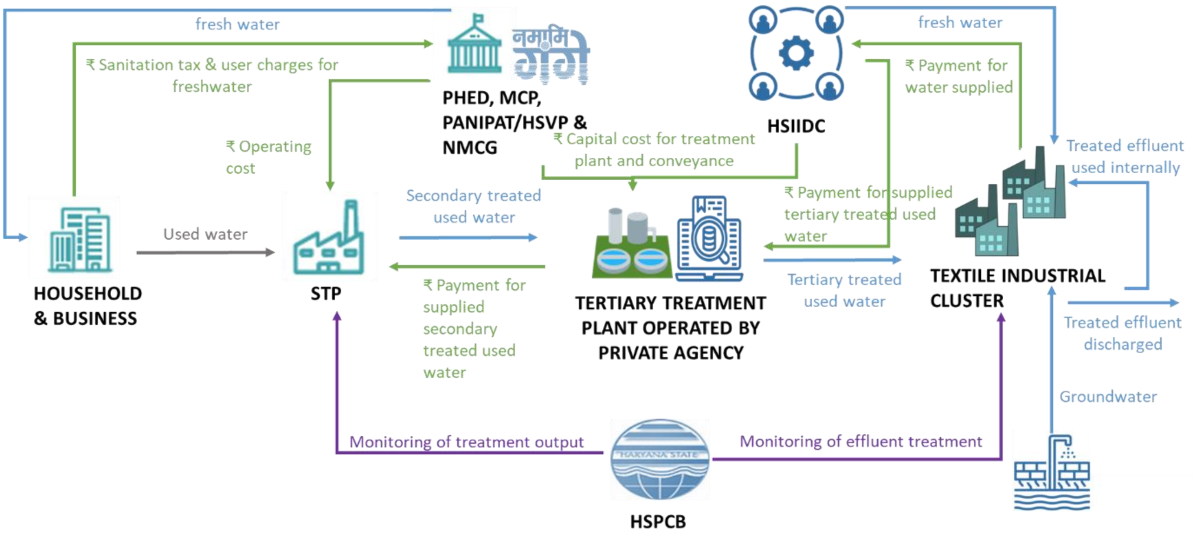


Figure 9: Business model for MCP from Sewah I & II STPs for industrial water reuse by textile cluster or IOCL in Panipat

A fixed price of 5 ₹/m³ for secondary treated effluent conveyed to the private operator is set as per the state tariffs for treated wastewater supplied by HWRA (see Section 3.1.2). A private operator needs to be selected under a DBO contract, issued by either HSIIDC, PHED, MCP, the textile industry association or IOCL Panipat. The private operator will be responsible for treating secondary treated effluents to the required water quality set by the textile industry and IOCL refinery. The private operator is paid by HSIIDC or directly by the industry based on the quantity of tertiary treated effluent supplied and the price quoted (in ₹/m³) under the DBO contract.

The proposed business model offers two types of value propositions *(Table 10)*:

- Value proposition 1: From the two STPs operated by MCP to tertiary treatment plant (TTP) operator – reliable quality and quantity of secondary treated effluent at a fixed price of ₹/m³.
- Value proposition 2: From the private operator of TTP to industries – e.g., a reliable quantity of low TDS water meeting textile industry requirement at a lower price than freshwater. The

new proposed freshwater tariffs for industries are 20 ₹/m³ (c.f. HWRA tariffs Section 3.1.2, category *other industries, p.21*)

Table 10: Business model CANVAS for reuse of tertiary treated wastewater in textile industries and IOCL Panipat

<table>
<tr>
<td rowspan="2">Key Partners
• HSIIDC
• HSPCB
• PHED
• MCP

(providing secondary treated effluent)</td>
<td>Key Activities
• Treating wastewater to secondary effluent standards
• Conveyance of STW + disinfection to TTP
• Supply of TTW to textile industries/ IOCL
• Monitoring of treatment quality</td>
<td rowspan="2">Value Propositions
• Assured quality and quantity of secondary treated effluent to tertiary treatment plant at a fixed price of 5 ₹/m³ Reliable quantity of low TDS water to the industry at price lower than freshwater, i.e., < 20 ₹/m³</td>
<td>Customer Relationships

HSIIDC/PHED/ MCP engaging industries for committing to take up assured quantity of treated used water

DBO (contract between PHED/ MCP and private operator)</td>
<td rowspan="2">Customer Segments
• Textile cluster (buying tertiary treated effluent)
• IOCL (buying tertiary treated effluent)
• Private operator (buying secondary treated effluent)</td>
</tr>
<tr>
<td>Key Resources
• Land
• Wastewater
• Financial investments in conveyance and treatment</td>
<td>Channels
• DBO contract between MCP, industries and private operator on quantity and quality of STW and TTW supplied</td>
</tr>
<tr>
<td colspan="3">Cost Structure
• CAPEX of tertiary treatment plant and treated water conveyance (secondary treated effluent to TTP; tertiary treated effluent to industries)
• OPEX of tertiary treatment plant and conveyance of secondary treated effluent to TTP</td>
<td colspan="2">Revenue Streams
• Fees from sale of secondary treated effluent to MCP and fees from sale of tertiary treated water to private operator of TTP</td>
</tr>
<tr>
<td colspan="3">Social & environmental costs
• Energy requirement to operate facility resulting in GHG emissions</td>
<td colspan="2">Social & environmental benefits
• Reduced pressure on freshwater demand from industries resulting in augmented freshwater access for domestic consumption
• Avoiding groundwater depletion
• Elimination of water availability risk for industries resulting in better sustainability for them and employment provision in the region</td>
</tr>
</table>

The business model includes two types of investments with the following potential investors:

1) Investment for the conveyance of secondary treated effluent to the TTP by a public authority (such as PHED, MCP or NMCG).

2) Investment for TTP and conveyance of tertiary treated effluent to the industries by HSIIDC/industries and the private operator winning the DBO contract (minimum 15 years). The CAPEX can be split between them on the basis of CAPEX cost recovery, which is dependent on the agreed pricing of tertiary treated effluent by the industries.

If the TTP investment viability is high, a certain percentage of the investment for secondary treated effluent conveyance could be transferred to HSIIDC/industries or the private operator.

5.1.2 Stakeholder roles and responsibilities

HSPCB is responsible for monitoring the effluent quality at the STPs and ETPs/CETPs. MCP should further monitor environmental impacts of the water reuse system, i.e., reduced pressure on groundwater draft or freshwater sources available for other sector demands. Further roles and responsibilities of stakeholders related to this business model are shown in *Table 11*.

Table 11: Stakeholder roles and responsibilities in the industrial water reuse business model in Panipat

Stakeholder	Roles and responsibilities
MCP	• Operation and maintenance of Sewah I & II STPs; treatment of sewage to secondary treated effluent standards as prescribed by HSPCB • CAPEX investment for conveyance of secondary treated effluent to TTP • Monitoring of the investment and reporting • Ensure all parties complying with their responsibilities • Conduct information, education and communication (IEC) activity in the region to create awareness on reuse of treated wastewater • Ensure that minimum quantity of municipal wastewater reaches the Sewah I & II STPs to deliver the agreed upon quantity to be delivered to the industries • Operation and maintenance of conveyance infrastructure and ensure required quantity of STW is delivered to TTP
NMCG	• Financing for the investment especially to address viability gap • Monitoring the performance of the business model
HSPCB	• Monitor the effluent qualities from Sewah I & II STPs and ETPs/CETPs at the industries
HWRA	• Monitor the pricing of freshwater and secondary treated effluent • Monitor freshwater consumption by industries post supply of secondary treated effluent
HSIIDC	• Liaising with the industries on the importance of secondary treated effluent use and get their commitment on the consumption of a fixed quantity of secondary treated effluent on a monthly basis • Assurance on supply of water to industries • CAPEX investment for TTP and conveyance • Collect fees from industries provided with tertiary treated effluent • Monitor the quality of tertiary treated effluent
Textile industry association and other industries (IOCL) targeted to be the customer for reuse	• Commitment to use tertiary treated effluent and agree on a minimum fixed quantity consumed • Meet the restrictions (if any) imposed on consumption of freshwater • CAPEX investment as required for TTP and pay fees for tertiary treated effluent • Treat own effluents generated to the prescribed standards set by HSPCB
Private operator of TTP	• Operation and maintenance of TTP and supply tertiary treated water as per quantity and quality needs of the industry • CAPEX investment as per the tender requirements and pay fees for secondary treated effluent

In the outlined business model, there is no assurance of a buyback from MCP to the private operator of the TTP. The only responsibility of MCP is to supply an assured volume and quality of secondary treated effluent at a fixed price. The following variations in the responsibilities could be considered: MCP can issue a DBO contract, including a fixed rate for the O&M costs. MCP is then completely responsible for supplying tertiary treated water to the industries and collecting fees directly from HSIIDC/industries based on the water quantity supplied.

5.1.3 Financial Assessment of the Business Model for Water Reuse in Industries

The viability analysis is conducted for MCP for the conveyance of secondary treated effluent to the TTP, and for a private operator of the TTP for selling tertiary treated effluent to the textile industries and IOCL Refinery.

Assumptions:

- *Table 12 provides* the assumed total CAPEX and OPEX for the business model.
- The distance of Sewah I & II STPs to the textile cluster is about 4 km. Both the STPs were assumed to be located at a distance of 5 km distance from the textile cluster. In the case of IOCL Refinery, the Refinery Road STP is at a distance of 8 km from IOCL.
- The current supply of secondary treated water from Sewah I / II is 31 MLD *(Table 7)* and of STP Refinery Road, it is assumed to be 10 MLD initially. An annual 2.43% increase in the secondary treated water supply is further assumed. Additionally, a water loss in transmission of 10% is anticipated.
- MCP pays the entire cost for the conveyance of secondary treated effluent to the TTP, including pumping costs. The private operator pays the entire CAPEX and OPEX for the TTP.

Table 12: Assumed CAPEX and OPEX of the industrial reuse business model. 1 lakh ₹ = 100,000 ₹ = 1,133 € (ECB June 2023).

Reuse from STPs in Sewah to Textile cluster		
Item	**CAPEX (₹)**	**Annual OPEX (₹/year)**
Pipeline	1,710 lakhs	11.3 lakhs
Pumping station	434 lakhs	10.5 lakhs
Tertiary Treatment Plant with Reverse Osmosis	12,000 lakhs	454.67 lakhs
Tertiary Treatment Plant with Ultra filtration	1,500 lakhs	42.9 lakhs
Reuse from STP in refinery road to IOCL		
Item	**CAPEX (₹)**	**Annual OPEX (₹/year))**
Pipeline	1,368 lakhs	10.4 lakhs
Pumping station	210 lakhs	5.6 lakhs
Tertiary Treatment Plant with Reverse Osmosis	3,000 lakhs	220 lakhs
Tertiary Treatment Plant with Ultra filtration	375 lakhs	13.2 lakhs

NPV & IRR: The NPV and IRR for MCP and the private operator at different selling prices of secondary (STW) and tertiary treated effluents (TTW) are given in *Tables 13 – 16* (more detailed analysis in *Annex 7*).

The MCP has to price above 3 ₹/m^3 when supplying secondary treated effluent for the textile cluster and above 7 ₹/m^3 for IOCL to recover both CAPEX and OPEX. When using reverse osmosis as tertiary treatment, the pricing of tertiary treated effluent should be more than 42 ₹/m^3 for both, the textile cluster and IOCL Refinery. For both textile cluster and IOCL, ultra-filtration is lower cost tertiary treatment option than reverse osmosis. For viability, in case of textile cluster, the price of tertiary treated effluent should be more than 9 ₹/m^3 and for IOCL it should be more than 12 ₹/m^3.

Table 13: Viability of tertiary treated effluent (via reverse osmosis) in textile industries

Price of STW Rs/KL	₹ 2	₹ 4	₹ 6	₹ 8	₹ 10	₹ 12
Price of TTW Rs/KL	₹ 15	₹ 25	₹ 35	₹ 45	₹ 55	₹ 65
NPV for MCP (in lakhs)	-₹ 763.65	₹ 653.95	₹ 2,071.54	₹ 3,489.14	₹ 4,906.73	₹ 6,324.33
IRR for MCP	2%	14%	23%	32%	40%	48%
NPV for Private entity (in lakhs)	-₹ 17,072.05	-₹ 11,401.67	-₹ 5,731.29	-₹ 60.92	₹ 5,609.46	₹ 11,279.84
IRR for Private entity	#NUM!	-24%	0%	9%	16%	23%

Table 14: Viability of tertiary treated effluent (via ultra-filtration) in industries

Price of STW Rs/KL	₹ 2	₹ 4	₹ 6	₹ 8	₹ 10	₹ 12
Price of TTW Rs/KL	₹ 10	₹ 12	₹ 15	₹ 20	₹ 25	₹ 30
NPV for MCP (in lakhs)	-₹ 763.65	₹ 653.95	₹ 2,071.54	₹ 3,489.14	₹ 4,906.73	₹ 6,324.33
IRR for MCP	2%	14%	23%	32%	40%	48%
NPV for Private entity (in lakhs)	₹ 2,521.75	₹ 2,521.75	₹ 3,230.55	₹ 5,356.94	₹ 7,483.33	₹ 9,609.73
IRR for Private entity	32%	32%	38%	55%	71%	88%

Table 15: Viability of tertiary treated effluent (via reverse osmosis) in IOCL Refinery

Price of STW Rs/KL	₹ 2	₹ 4	₹ 6	₹ 8	₹ 10	₹ 12
Price of TTW Rs/KL	₹ 15	₹ 25	₹ 35	₹ 45	₹ 55	₹ 65
NPV for MCP (in lakhs)	-₹ 1,147.67	-₹ 690.38	-₹ 233.09	₹ 224.20	₹ 681.49	₹ 1,138.78
IRR for MCP	-10%	0%	6%	11%	16%	20%
NPV for Private entity (in lakhs)	-₹ 4,646.11	-₹ 2,816.96	-₹ 987.80	₹ 841.35	₹ 2,670.50	₹ 4,499.66
IRR for Private entity	#NUM!	#NUM!	3%	14%	22%	30%

Table 16: Viability of tertiary treated effluent (via ultra-filtration) in IOCL Refinery

Price of STW Rs/KL	₹ 2	₹ 4	₹ 6	₹ 8	₹ 10	₹ 12
Price of TTW Rs/KL	₹ 8	₹ 12	₹ 15	₹ 20	₹ 25	₹ 30
NPV for MCP (in lakhs)	-₹ 1,147.67	-₹ 690.38	-₹ 233.09	₹ 224.20	₹ 681.49	₹ 1,138.78
IRR for MCP	-10%	0%	6%	11%	16%	20%
NPV for Private entity (in lakhs)	₹ 560.34	₹ 1,017.63	₹ 1,246.28	₹ 1,932.21	₹ 2,618.14	₹ 3,304.07
IRR for Private entity	30%	45%	52%	73%	95%	117%

5.1.4 Risk and Mitigation

The business model entails several risks for PHED/MCP, textile industries or IOCL Panipat and the private operator of the TTPs *(Table 17)*.

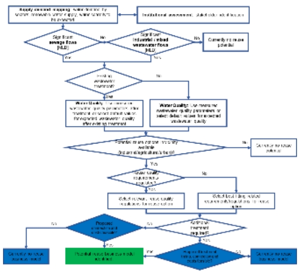
Table 17: Risks and mitigation measures identified for several stakeholders of the industrial reuse business model in Panipat

Risk	Entity (ies) prone to the risk	Mitigation measure
Industrial acceptance of secondary treated effluent	PHED/MCP and private operator of TTP	• Conduct IEC activity to create awareness on the importance of reuse of treated used water • Legally mandating reuse of treated used water by industries for a minimum required quantity or restricting consumption of freshwater
Unreliable supply of secondary treated effluent both in terms of quality and quantity	Industries & private operator of TTP	• Tri-party agreement where PHED & MCP concur on the quantity and quality of secondary treated effluent. In case of non-compliance, they need to financially compensate TTP operator and provide freshwater to industries. Similar action should be taken in the event of faulty conveyance or any other circumstances that impact quantity and quality.
Price of freshwater is too low to ensure cost recovery of TTP from sale price of tertiary treated effluent	Private operator of TTP	• The PPP agreement (DBO contract) must have appropriate safeguards to protect the profitability of the private operator of TTP, such as providing minimum guaranteed revenues, a clause needed to keep the private operator's interest in the project

5.1.5 Conclusions and recommendation

- The investment costs for the conveyance of treated used water and its operating cost should be borne by MCP. NMCG may consider providing funding to MCP for the conveyance. MCP sells secondary treated water at 4 ₹/m^3 to the private operator, who operates the tertiary treatment plant. At this price, MCP can recover the capital and operating costs of secondary used water treatment. MCP can issue a tender for the construction of conveyance under a design-build contract. Bid parameters for the tender will be on capital costs proposed per MLD.
- The use of ultrafiltration as a tertiary treatment technology for the provision of tertiary treated water is more viable than using reverse osmosis. MCP could issue a notice to the industry on the quantities and qualities of tertiary water provided based on the ultrafiltration technology. Industries may invest in tertiary treatment on their own premises based on the water quality required for their operations. If MCP wants to implement reverse osmosis as tertiary treatment plant, then viability gap funding will need to be provided to cover the capital cost of the tertiary treatment plant.
- MCP tenders the construction of a tertiary treatment plant under a design-build operate contract with 100% investment from the private sector. The bid parameters for the tender should be on the price of tertiary treated water supplied to HSIIDC. The price ranges for textile industries have to be above 9 ₹/m^3 and for IOCL it should be above 12 ₹/m^3. The upper end of the bid price has to be below freshwater price to the industries which is at 20 ₹/m^3. Annual increases in price of tertiary treated water can be set to RBI indexation.
- To render tertiary treated used water more attractive, MCP should demarcate target industrial regions as 'no freshwater zones'. Freshwater is supplied by MCP only when there is a disruption in the supply of tertiary treated water or MCP is unable to meet the quantity and quality requirements of the industry.
- To further foster uptake of SRTW, the HWRA tariffs of freshwater (2018) need to be raised and monitoring and punishment of over-/illegal abstraction enforced.

5.2 Business Models for Water Reuse in Agriculture



Summary:

The business model includes the provision of secondary treated effluent from Jattal Road I & II STPs operated by MCP to HID or a local entrepreneur who sells disinfected effluents to farmers.

Water reuse seems viable only in agriculture if CAPEX is covered by state funding.

OPEX can be covered by the sale of secondary treated effluent.

The water swap business model is viable if industries are the target customers.

Environmental and social benefits (e.g., protection of freshwater sources and sustaining livelihoods) are substantial but need to be quantified in a comprehensive cost-benefit analysis.

Two business models for agricultural reuse are presented, i.e., a water swap model and auctioning of secondary treated effluent.

5.2.1 Business Model Description: Water Swap

The idea of the water swap model is to exchange allocated freshwater, foreseen for agricultural irrigation, with secondary treated effluent. The freshwater exchanged can then be reallocated for environmental or domestic uses.

MCP provides secondary treated effluent from the Jattal Road I & II STPs to HID with an assured quantity and quality. In exchange, HID provides an equal quantity of freshwater to MCP *(Figure 10)*. With the provision of additional fresh water, MCP can either augment their existing water supplies for domestic consumption or expand its services to areas that were not covered earlier. This will result in additional revenues for MCP.

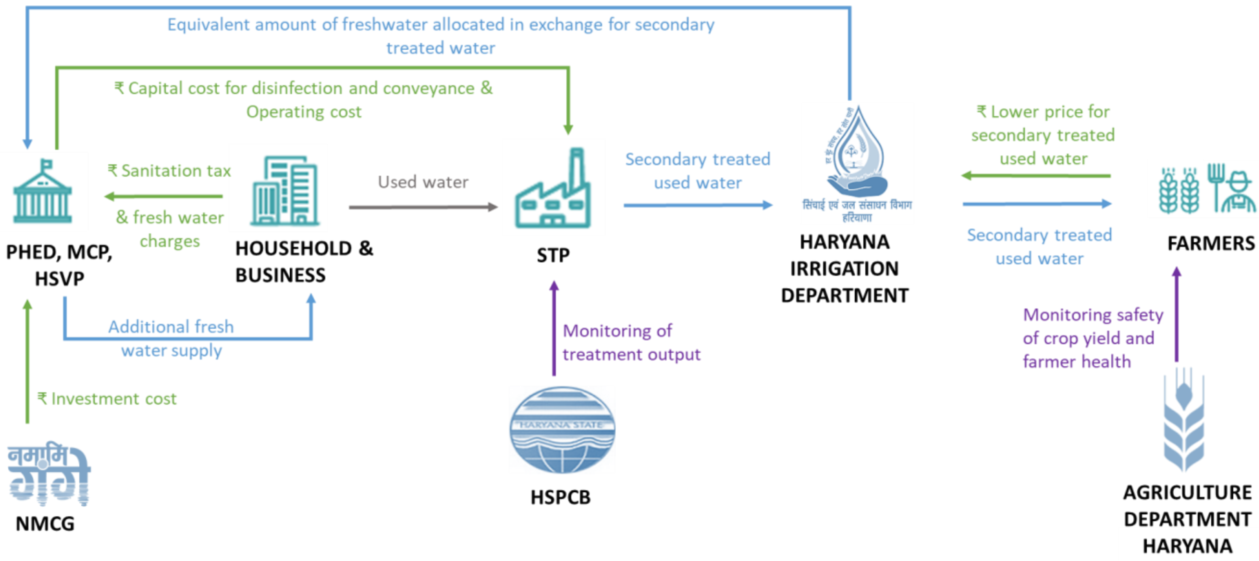


Figure 10: Business Model for Water Swap water reuse in agriculture in Panipat

MCP needs to invest in two components: a) disinfection units in Jattal Road I & II STPs to ensure removal of faecal coliform for safe reuse of treated water in agriculture, and b) conveyance of secondary treated + disinfected effluent to the nearest canal or tanks managed by HID. Additional investors, e.g., NMCG may support CAPEX investments.

The farmers use the secondary treated + disinfected effluents from the canals or tanks allocated to them as per existing arrangements with HID.

MCP is responsible for operating and maintaining the conveyance system. The role of HSPCB is to monitor the quality of secondary treated effluent towards the set effluent discharge standards. Additional monitoring by the Agriculture Department of Haryana or local agricultural universities is needed to ensure the safety of crops for human consumption and the safety of farmers' health (e.g., by monitoring faecal and chemical contamination). They should periodically report to the MCP and HID on the monitoring results.

The proposed business model offers two types of value propositions *(Table 18)*:

- Value proposition 1: From the Jattal Road I & II STPs operated by MCP to HID – secondary treated + disinfected effluent at prescribed water quality in exchange for an equal quantity of freshwater
- Value proposition 2: From HID to farmers – similar quantity of water as provided earlier at the same price as prescribed by HWRA

Table 18: Business model CANVAS for MCP for water swap of secondary treated effluent in agriculture in Panipat

<table>
<tr>
<td rowspan="2">Key Partners

• HID
• HSPCB</td>
<td colspan="2">Key Activities

• Treating wastewater to secondary effluent including disinfection
• Conveyance of secondary treated effluent to nearest canal
• Monitoring of effluent quality</td>
<td rowspan="2" colspan="2">Value Propositions

• Secondary treated + disinfected effluent to HID in exchange for freshwater
• Reliable quantity of water to the farmers supplied by HID</td>
<td colspan="2">Customer Relationships

• MCP engaging with HID to take up assured quantity of secondary treated + disinfected effluent in exchange for freshwater</td>
<td rowspan="2">Customer Segments

• Farmers</td>
</tr>
<tr>
<td colspan="2">Key Resources

• Land
• Wastewater
• CAPEX investment for conveyance and treatment</td>
<td colspan="2">Channels

• Contract between MCP and HID on water swap</td>
</tr>
<tr>
<td colspan="3">Cost Structure

• CAPEX costs for disinfection unit and conveyance of secondary treated + disinfected effluents
• OPEX costs for disinfection unit and conveyance of STW + disinfected effluents to the canal</td>
<td colspan="5">Revenue Streams

• Increased revenue to MCP from sale of augmented freshwater supplied for domestic consumption</td>
</tr>
<tr>
<td colspan="3">Social & environmental costs

• Energy requirement for disinfection and conveyance resulting in GHG emissions</td>
<td colspan="5">Social & environmental benefits

• Augmented freshwater access for domestic consumption
• Reduced groundwater depletion for agriculture</td>
</tr>
</table>

5.2.2 Business Model Description: Auctioning of Secondary Treated Effluent

In this model, PHED calls for auctioning secondary treated effluents from Jattal Road I & II STPs to local entrepreneurs/private agencies *(Figure 11)*. Farmers will purchase secondary treated effluents from the entrepreneur/private agency who wins the bid. The bidding parameter can be the price of purchase of secondary treated effluent. This model requires MCP/ MICADA (Micro Irrigation & Command Area Development Authority) to invest in a conveyance system for secondary treated effluent to the nearest storage tank that is technically and financially viable for the entrepreneur to sell to farmers and invest in disinfection units to ensure its safe reuse in agriculture. Additional investors, e.g. NMCG, may support CAPEX investments in this business model.

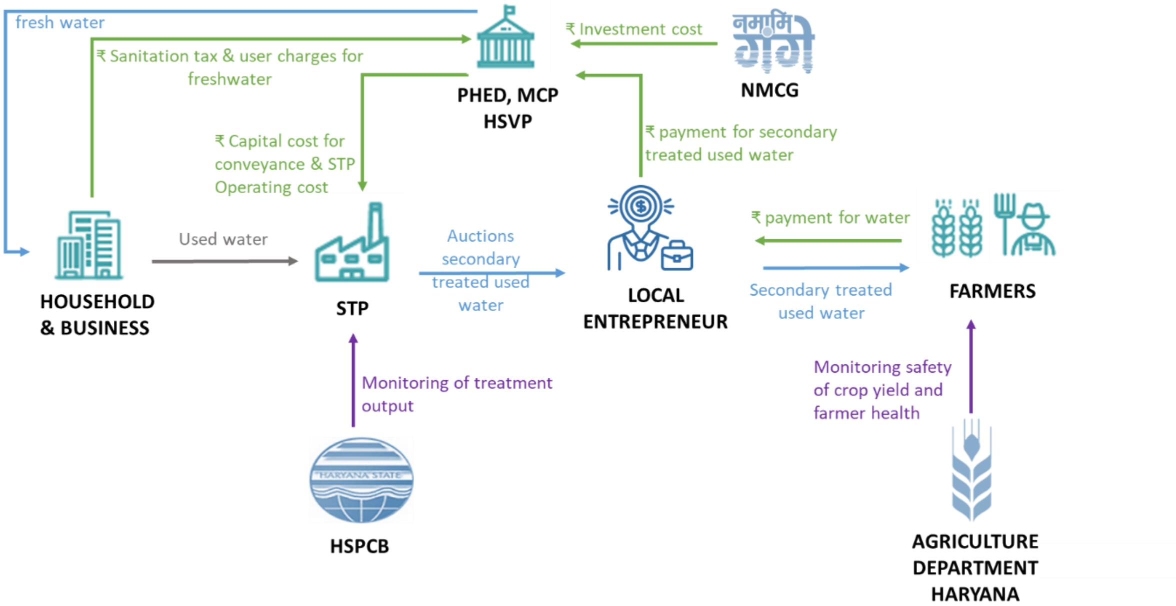


Figure 11: Business model for auctioning of secondary treated effluent for water reuse in agriculture in Panipat

The entrepreneur/private agency will supply and price secondary treated effluents to farmers. The pricing must adhere to the tariffs by HWRA (see chapter 3.1.2). The role of HSPCB is to monitor the quality of effluent from Jattal Road I & II STPs. Additional monitoring by the Agriculture Department Haryana or local agricultural universities is needed to ensure the safety of crops for human consumption and the safety of farmers' health (e.g., by monitoring faecal and chemical contamination). They should periodically report to the MCP and HID on the monitoring results.

The proposed business model offers two types of value proposition *(Table 19)*:

- Value proposition #1: From the Jattal Road I & II STPs operated by MCP to local entrepreneur – secondary treated effluents with water quality suitable for irrigation
- Value proposition #2: From local entrepreneur to farmers – reliable water supply as per the needs and requirements of the farmers

Table 19: Business model CANVAS for auctioning of secondary treated effluents for water reuse in agriculture in Panipat

<table>
<tr>
<td rowspan="2">Key Partners

• HSPCB</td>
<td>Key Activities

• Disinfection as part of wastewater treatment to create secondary effluents
• Conveyance of secondary treated + disinfected effluent to nearest canal
• Monitoring of effluent quality</td>
<td rowspan="2">Value Propositions

• Secondary treated + disinfected effluent with suitable water quality (for irrigation) to local entrepreneurs. Reliable water supply (as per the needs of farmers) supplied by local entrepreneur</td>
<td>Customer Relationships

• MCP engaging with local entrepreneur to supply secondary treated + disinfected effluent to farmers</td>
<td rowspan="2">Customer Segments

• Farmers</td>
</tr>
<tr>
<td>Key Resources

• Land
• Wastewater
• Funding for the investment in conveyance and treatment</td>
<td>Channels

• Contract MCP and local entrepreneur</td>
</tr>
<tr>
<td colspan="3">Cost Structure

• CAPEX of disinfection unit and conveyance of secondary treated + disinfected effluents
• OPEX of disinfection unit and conveyance of secondary treated + disinfected effluents to the closest point to agriculture land
• CAPEX of supplying water to farmers (by local entrepreneur)</td>
<td colspan="2">Revenue Streams

• Increased revenue to MCP from sale of secondary treated effluent
• Revenue to local entrepreneurs from supply of irrigation water to farmers</td>
</tr>
<tr>
<td colspan="3">Social & environmental costs

• Energy requirement for disinfection and conveyance resulting in GHG emissions</td>
<td colspan="2">Social & environmental benefits

• Improved crop productivity and earnings to farmers
• Reduced groundwater depletion for agriculture</td>
</tr>
</table>

5.2.3 Stakeholder roles and responsibilities

The roles and responsibilities of the key stakeholders in the identified business models for water reuse in agriculture in Panipat are given in *Table 20*.

Table 20: Stakeholder roles and responsibilities in the Business Models for water reuse in agriculture in Panipat

Stakeholder	Roles and responsibilities
MCP	• Operation and maintenance of the Jattal Road I&II STPs + disinfection unit • Operation and maintenance of conveyance infrastructure for secondary treated + disinfected effluent supply to the HID canals/tanks • CAPEX investments for disinfection unit and conveyance of secondary treated effluents • Monitoring of the investment and reporting • Ensure all parties complying with their responsibilities • Conduct IEC activity in the region to create awareness on reuse of treated wastewater • Monitoring the quantity of secondary treated + disinfected effluents is delivered to the HID canals/tanks
NMCG	• Financing for the investment especially to address the viability gap • Monitoring the performance of the business model
HSPCB	• Monitor the effluent from Jattal Road I & II STPS
HWRA	• Monitor the pricing of freshwater and STW
HID (only water swap business model)	• Monitoring the quantity of secondary treated + disinfected effluents supplied and, in exchange, supply to PHED/MCP an equal quantity of freshwater • Monitoring and managing the usage of water from canals/tanks by the farmers
Local entrepreneur (only auctioning of secondary treated effluent business model)	• Marketing the water supply to farmers • Operating the storage tank and disinfection unit to provide secondary treated + disinfected effluent to farmers
Agriculture Department Haryana &/ Local Agriculture University	• Monitoring the usage of secondary treated + disinfected effluents by farmers and assess potential health impacts • Monitoring the crop productivity and soil health where secondary treated effluent is used • Training farmers on the safe reuse of secondary treated effluents for irrigation (i.e., risk mitigation approaches as highlighted in the WHO's Sanitation Safety Planning Manual)
Farmers	• Complying with the regulations and usage of canal water as prescribed by HID • Accept 70% of secondary treated effluents as irrigation water

5.2.4 Financial Assessment of the Business Models for Water Reuse in Agriculture

Water Swap Model: The viability analysis was done for PHED/MCP for the conveyance of secondary treated + disinfected effluent from Jattal Road I & II STPs to the nearest irrigation canals/ tanks.

Auctioning of secondary treated effluent: The viability was calculated for PHED/MCP for the conveyance of secondary treated effluent from Jattal Road I & II STPs to the nearest storage tanks, and for the local entrepreneur selling disinfected irrigation water to farmers.

Assumptions:

- *Table 21* provides the assumed total CAPEX and OPEX for the business model.
- The distance between Jattal Road I & II STPs and the irrigation canal is about 5 km.
- The current supply of secondary treated water from Jattal Road I & II STP is 23 MLD *(Table 7)*. An annual 1.5% increase of the secondary treated water supply is further assumed. Additionally, a water loss in transmission of 25% is anticipated.
- *Water swap:* MCP will pay the entire CAPEX and OPEX for the disinfection unit, and the conveyance of secondary treated effluent to the irrigation canal.
- *Auctioning of secondary treated effluent:* MCP will pay the entire cost for the disinfection unit, and the conveyance of secondary treated effluent to the irrigation tank. The local entrepreneur will pay the entire CAPEX and OPEX for the conveyance from irrigation tanks to irrigation canals. It is assumed that the local entrepreneur will invest in about 5 pumps (size 5 HP) and irrigation pipes (4-inch diameter; total length 200 m). The overall CAPEX investment from the local entrepreneur is about ₹4 lakhs.

Table 21: Assumed total CAPEX and OPEX of the agricultural water reuse business models. 1 lakh ₹ = 100,000 ₹ = 1,133 € (ECB June 2023).

Item	CAPEX (₹)	Annual OPEX (₹/year[1])
Pipeline	855 lakhs	8.95 lakhs
Pumping station	322 lakhs	8.61 lakhs
Disinfection using UV	135 lakhs	4.16 lakhs

NPV & IRR for Water Swap Business model: The NPV and IRR for MCP at different freshwater prices, different conveyance distances and different water losses, are shown in *Table 22* (and *Annex 7*).

The business model is unviable at all combinations of freshwater prices, conveyance distances and transmission loss percentages *(Table 22)*. Taking maximum transmission loss at 40% and for a conveyance distance of 5 km, the price of freshwater charged should be above 10 ₹/m^3 to be financially viable. If the transmission loss is reduced to 25% and for the same conveyance distance, the business model is viable at a selling price above 8 ₹/m^3 for freshwater. This selling price for freshwater is significantly higher than the price currently charged for domestic purposes (i.e., 1.1 ₹/m^3). Hence, the target customers for the 'exchanged freshwater' should be the industries, who pay on average 20 ₹/m^3 for freshwater (2018 tariffs, Section 3.1.2).

Table 22: Viability of water swap business model for MCP

Price of freshwater (Rs/KL)	₹ 4	₹ 5	₹ 6	₹ 7	₹ 8	₹ 9
Conveyance distance (in km)	4	5	7	9	10	12
Loss in transmission	15%	20%	25%	30%	35%	40%
NPV for MCP (in lakhs)	-₹ 144.61	-₹ 115.98	-₹ 97.53	-₹ 84.61	-₹ 72.61	-₹ 70.78
IRR for MCP	#NUM!	#NUM!	#NUM!	#NUM!	-12%	-12%

NPV & IRR for Auctioning of secondary treated effluent business model: The NPV and IRR for MCP and the local entrepreneur at different auctioning prices for secondary treated effluent, the selling price of disinfected irrigation water to farmers and different transmission loss values are shown in *Table 23* (and *Annex 7*).

If the project is viable for MCP, it is unviable for the local entrepreneur, and vice versa *(Table 23)*. The project is viable for MCP if the annual auction value (paid by the local entrepreneur to MCP) for secondary treated and disinfected effluent is at ₹46 lakhs. The selling price of conveyed irrigation water from the local entrepreneurs to farmers should be above 9 ₹/m^3 while ensuring the transmission loss is below 25%. A farmer cultivating rice requires about 80,000 liters of water per day which comes to about 800 ₹/day. Farmers are unlikely to pay such a price if they have ease of access to free water.

Table 23: Viability of auctioning of secondary treated effluent business model for MCP and local entrepreneur

Price of water to farmers (Rs/KL)	₹ 4	₹ 5	₹ 6	₹ 7	₹ 8	₹ 9
Loss in transmission	15%	20%	25%	30%	35%	40%
Auction value (in lakhs)	₹ 15	₹ 25	₹ 35	₹ 45	₹ 50	₹ 55
NPV for MCP (in lakhs)	-₹ 226.79	-₹ 152.84	-₹ 78.89	-₹ 4.93	₹ 32.04	₹ 69.02
IRR for MCP	#NUM!	#NUM!	#NUM!	8%	14%	19%
NPV for Private Entity (in lakhs)	₹ 40.09	-₹ 0.60	-₹ 46.83	-₹ 98.61	-₹ 118.96	-₹ 144.85
IRR for Private Entity	113%	8%	#NUM!	#NUM!	#NUM!	#NUM!

5.2.5 Risk and mitigation

The business models for water reuse in agriculture entail several risks for MCP, HID or the local entrepreneurs and the farmers *(Table 24)*.

Table 24: Risks and mitigation measures identified for several stakeholders of the agricultural water reuse business models in Panipat

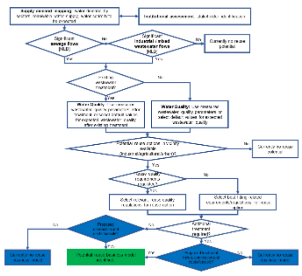
Risk	**Entity (ies) prone to the risk**	**Mitigation measure**
Acceptance of secondary treated + disinfected effluents (by farmers and HID)	MCP/PHED	• Conducting IEC activity to create awareness on importance of reuse • Directing to state policy that mandates reuse of STW in agriculture

Risk	Entity (ies) prone to the risk	Mitigation measure
Poor disinfection of secondary treated effluents resulting in impacts on farmer's health	MCP, PHED and HID	• Agreement between PHED, MCP and HID/ local entrepreneur on the quality of secondary treated effluent supplied. If non-complying, MCP & PHED need to financially compensate the local entrepreneur/ the farmers and stop the supply of secondary treated effluent.
Price of freshwater is too low to ensure cost recovery of disinfection and conveyance of secondary treated effluents	MCP and PHED	• PHED/MCP need to discuss with HWRA to increase the price of freshwater tariffs.
Pricing of secondary treated effluents to farmers by the entrepreneur can be considered as extortion	Farmers	• Price of secondary treated wastewater to farmers should be regulated by HWRA. The price should not be too low for the private entity so that its unable to make any profit.

5.2.6 Conclusions and recommendation

- The auctioning model is not viable and MCP should therefore pursue collaboration with HID for exchanging an equal quantity of freshwater with disinfected secondary treated water (water swap model). UV disinfection technology should be implemented to ensure a safe reuse of secondary treated wastewater.
- MCP should bear the investment costs for the conveyance and disinfection unit and its operating costs. MCP can recover both capital and operation costs of the conveyance and the disinfection unit if it sells the freshwater to industries as the tariff set for industries is at 20 ₹/m^3. To achieve viability, MCP needs to sell the freshwater from HID at 9 ₹/m^3 and ensure that loss in transmission does not exceed 30%. If the MCP plans to sell the freshwater to domestic consumers, then MCP will not be able to recover either capital or operating costs. The domestic price for freshwater (1.1 ₹/m^3) is too low for a viable water swap. For operational cost recovery, MCP has to sell freshwater at least at 5 ₹/m^3.
- MCP can issue a tender for the construction of the conveyance & disinfection unit under a design-build contract. Bid parameters for the tender will be on capital cost proposed per MLD.
- MCP needs to engage with the Department of Agriculture or local agricultural universities to monitor the impacts of usage of secondary treated water for irrigation. MCP should engage with corporates to co-invest under Corporate Social Responsibility and provide extra funding to an external organisation to monitor the health impacts and the safety of used water-irrigated crops for human consumption. Also, the corporates can be engaged in facilitating market uptake for the crops produced by the farmers. This would build confidence in farmers produce and for using secondary treated effluents in agriculture.

5.3 Business Model for Water Reuse in Urban Applications



Summary:

The business model includes the provision of secondary treated plus disinfected effluent from Sector 6 & 19 STPs operated by MCP to either responsible organisations for park irrigation or the construction companies.

Urban water reuse is not viable as a stand-alone business model due to scaling issues.

Urban water reuse should be recommended as additional reuse options for STPs with industrial and agricultural reuse business models

5.3.1 Business Model Description

In this business model, secondary treated effluents from Sector 6 & 19 STPs are used for urban development in Panipat, such as irrigation of parks, landscapes, for firefighting and for construction companies *(Figure 12)*.

MCP has to undertake a demand assessment for each of these end-uses. The CAPEX investment required is a disinfection unit for secondary treated effluent to ensure the safety of park visitors and neighbouring residents, employees of fire-fighting services and construction workers. CAPEX and OPEX investments for tanker supply was required. In the case of parks, landscaping and fire-fighting services, MCP was able to save freshwater resources through switching to secondary treated effluents. Thereby MCP can either augment their existing water supplies for domestic consumption or expand its services to areas that were not covered earlier. This will result in additional revenues for MCP. In the case of construction companies, regulations should be mandated that prohibit freshwater use by construction industries. MCP can supply an assured quantity and quality of secondary treated effluents to these companies at a fixed price.

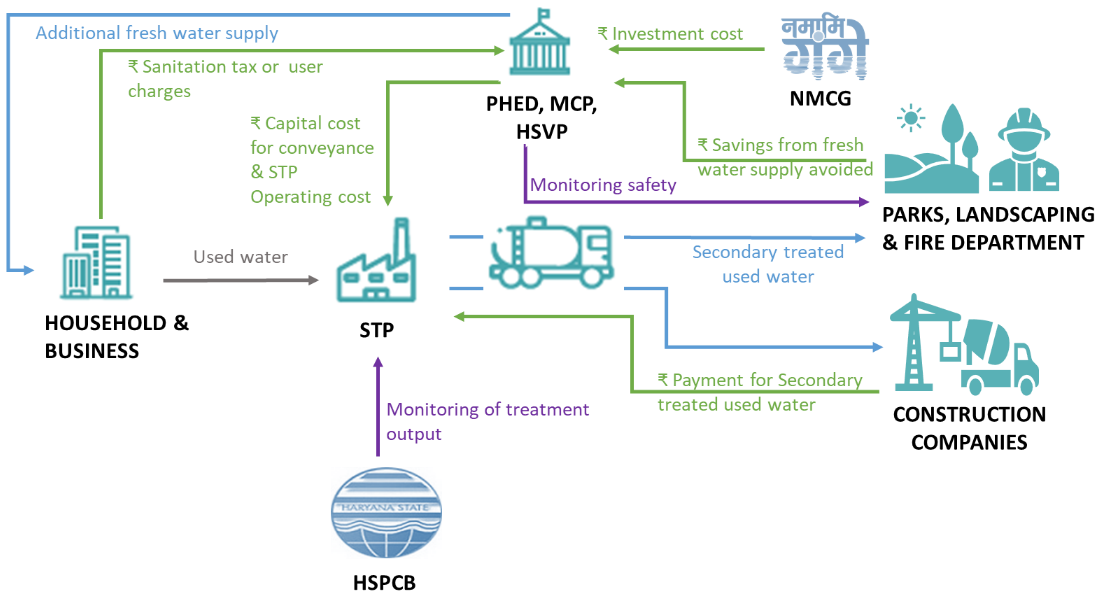


Figure 12: Business model for urban water reuse in Panipat

The proposed business model offers two types of value proposition *(Table 25)*:

- Value proposition #1: Supply of secondary treated + disinfected effluents from the Sector 6 & 9 STPs operated by MCP to parks and city landscaping for irrigation
- Value proposition #2: Supply of secondary treated + disinfected effluents from the Sector 6 & 9 STPs operated by MCP to the construction industry (reliable and low-cost water supply for construction)

Table 25: Business model CANVAS for urban water reuse in Panipat

Key Partners	Key Activities	Value Propositions	Customer Relationships	Customer Segments
• HSPCB	• Treating wastewater to secondary effluents including disinfection • Transport of secondary treated effluents to parks, landscaping and construction industry • Monitoring of effluent quality	• Availability of secondary treated + disinfected effluents for irrigation of parks and landscape • Reliable and low-cost water for construction industry	• MCP engaging with department responsible for maintaining parks and landscape • MCP engaging construction industry to use secondary treated effluents	• Department of parks and landscape • Construction industry
	Key Resources		Channels	
	• Land • Wastewater • Investments in conveyance and treatment		• Contract between MCP and construction industry	

Cost Structure	Revenue Streams
• CAPEX of disinfection unit and transport of secondary treated + disinfected effluents • OPEX of disinfection unit and secondary treated + disinfected effluents	• Additional revenue from sale of freshwater that was saved in parks and landscape irrigation • Increased revenue to MCP from sale of secondary treated + disinfected effluents to construction industry
Social & environmental costs	Social & environmental benefits
• Energy requirement for disinfection and conveyance resulting in GHG emissions	• Reduced groundwater depletion for agriculture

5.3.2 Stakeholder roles and responsibilities

The key stakeholders in this business model for urban water reuse in Panipat, and their corresponding roles and responsibilities are as described *Table 26*.

Table 26: Stakeholder roles and responsibilities in the Business Models for urban water reuse in Panipat

Stakeholder	Roles and responsibilities
MCP	• Operation and maintenance of the Sector 6 & 19 STPs and treat wastewater to secondary effluent standards, as prescribed by HSPCB including disinfection. • Operation and maintenance of trucks/tankers and ensure secondary treated + disinfected effluents are delivered to parks, landscaping and construction industry • Financing for the investment for disinfection unit and transport of secondary treated + disinfected effluents • Monitoring of the investment and reporting • Ensure all parties complying with their responsibilities • Conduct IEC activity in the region to create awareness on reuse of treated wastewater • Monitoring the quantity of secondary treated + disinfected effluents delivered for parks and landscaping
NMCG	• CAPEX investment especially to address the viability gap • Monitoring the performance of the business model
HSPCB	• Monitor the quality of effluent from Sector 6 & 19 STPs to meet the standards prescribed
HWRA	• Monitor the pricing of freshwater and secondary treated effluents
Department of parks and landscaping	• Monitoring the usage of secondary treated effluents in parks and landscaping to ensure no adverse impacts on public health and the environment • Training of staff managing parks on the safe reuse of secondary treated effluents for irrigation (i.e., risk mitigation approaches as highlighted in the WHO's Sanitation Safety Planning Manual)
Construction industry	• Commit to using secondary treated effluents for their water requirements and not using freshwater for construction

5.3.3 Financial Assessment of the Business Model for Water Reuse in Urban Applications

The financial analysis was conducted for HSVP/MCP for conveyance of secondary treated + disinfected effluents through trucks to parks, landscaping and construction sites.

Assumptions:

- The CAPEX and OPEX of the disinfection unit are 120 lakhs and 4.16 lakhs ₹, respectively.
- The investment for the trucks is dependent on the quantity of secondary treated effluents required by parks, landscaping and by construction industry. CAPEX of a water tanker of 5 m^3 is ca. 30 lakhs ₹ and the OPEX excluding fuel is about 3 lakhs ₹.
- The distance of the STPs to the reuse site is assumed to be 5 km. Assuming each of the three end uses (park, landscape, construction) requires 500 m^3/day of water, the number of trucks required will be 50, if 6 daily trips are made by each truck. The CAPEX for investing in 50 trucks would be 15 crores ₹. Annual OPEX, including fuel would be about 10 lakhs ₹.

The detailed financials are shown in *Annex 7*. The revenue for HSVP/MCP from the sale of the saved freshwater, through the switching to secondary treated effluents for park and landscape irrigation, is calculated at 4 ₹/m^3 and the sale of secondary treated + disinfected effluents to the construction industry is calculated at 9 ₹/m^3. The business model is unviable at these prices. While HSVP can recover OPEX, to recover CAPEX, the price of freshwater and secondary treated effluents should be > 51 ₹/m^3.

5.3.4 Risk and Mitigation

The business models for urban water reuse entail several risks for MCP, Department of parks and landscaping, and the construction industry *(Table 27)*.

Table 27: Risks and mitigation measures identified for several stakeholders of the urban water reuse business models in Panipat

Risk	Entity (ies) prone to the risk	Mitigation measure
Acceptance of secondary treated effluents by the construction industry	MCP/ PHED	• Conducting IEC activity to create awareness on the importance of water reuse • Directing to state policy that mandates reuse of secondary treated effluents for construction
Poor disinfection of secondary treated effluents resulting in occupational health impacts	Department of parks and landscaping and Construction industry	• If the quality of STW supplied is not disinfected adequately, MCP/PHED need to stop the secondary treated effluent supply and financially compensate construction industry • Workers in the department of parks affected should be financially compensated
Price of freshwater is too low to ensure cost recovery of disinfection and transport of secondary treated effluents	MCP/PHED	• PHED/MCP needs to discuss with HWRA to increase the price of freshwater tariffs

5.3.5 Conclusions and recommendation

On a standalone basis, urban reuse is not viable. The prioritization of water reuse from STPs should be towards industry or agriculture. Urban reuse can be done as side business on a small scale with 2 to 3 trucks to transport water for urban purposes, such as irrigation of green areas, street cleaning, firefighting or construction. Treated water that is not sold to industry or agriculture should be utilized for urban reuse purposes.

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Annex

Annex 1: Questionnaires

A.1 Quantity of water supply

1	Total Quantity of water supplied to the city (in MLD)			
2	Quantity of water supplied to households (in MLD)			
3	Quantity of water supplied to institutions (in MLD)			
4	Quantity of water supplied to industries (in MLD)			
5	Quantity of water supplied to parks and landscaping (in MLD)			
6	Quantity of Non-Revenue Water (in MLD)			
7	Ward wise water distribution and status to households - please fill below table			
	*Ward no**	*Total area of the ward (in square meters)*	*Number of households in the ward*	*Number of households with piped water supply*
8	For households that do not have piped water supply, please fill the below table			
	*Ward no**	*Number of households without piped water supply*	*Source of water supply (water tanker, tubewell, handpump etc.)*	*Quantity supplied (in KLD)*

A.2 Water supply charges

1	Average Water supply fees charged to households - piped water supply (INR per month or INR/m3)		Water supplied through (name of agency)
2	Average Water supply fees charged to households - other water supply (INR/month)		Water supplied through (name of agency)
3	Average Water supply fees charged to industries - piped water supply (INR/m3)		Water supplied through (name of agency)
4	Average Water supply fees charged to industries - other water supply (INR/m3)		Water supplied through (name of agency)

B Wastewater Treatment

B.1 Wastewater generation and conveyance

1	Quantity of domestic wastewater generated (in MLD)			
2	Total number of households connected to sewer			
3	Total number of industries connected to sewer			
4	Ward wise break up on sewer connectivity			
	*Ward no**	*Number of households connected to sewer*	*Quantity of wastewater generated (in MLD)*	
5	For households that do not have sewer connected, please fill the below table			
	*Ward no**	*Number of households without sewer connection*	*How is wastewater disposed? (open drains + septic tank, water bodies or other (mention details))*	*Quantity produced (in KLD)*
6	If sewage flows in the drain, is it intercepted? (Yes or No)			
7	If it is Yes, please share the quantity of sewage intercepted from drains (in MLD)			

B.2 Wastewater treatment

1	Total number of STPs commissioned in the city	
2	Total capacity of all the STPs commissioned in the city (in MLD)	
3	Please fill below table for details on each STP and CETP commissioned	
a)	Name of the STP or CETP*	
b)	Geo coordinates of the STP or CETP	
c)	Design Capacity of the STP or CETP (in MLD)	
d)	Quantity of wastewater flowing into STP or CETP (in MLD)	

e)	Ward numbers connected to the STP or CETP	
f)	Technology process (mention each process module)	
g)	Inlet water quality (BOD, COD & TSS and other)	
h)	Treated water quality (BOD, COD & TSS and other)	
i)	How is treated wastewater disposed? (drains, river, others (mention details))	
j)	Geo coordinates of the disposal location	
k)	Capital cost (in INR)	
l)	Operating Cost (in INR)	
m)	Energy consumed (in kWh/day)	
n)	Is the STP or CETP operations contracted (Yes or No)	
o)	If yes to STP or CETP operations contracted, name and contact details of the private entity	

B.3 Wastewater treatment charges

1	Average Wastewater collection and treatment fees charged to households (INR per month or INR/m3)
2	Average Wastewater collection and treatment fees charged to industries (INR/m3)

C. Potential users of TUW

C.1 Industries

Please fill below table	
a.	Type of industry
b.	Geo location of the industry cluster
c.	Typical size of the industry in terms of production
d.	Average quantity of water consumed for that size (in MLD)
e.	Source of water supply (municipal, borewell, both)
f.	Cost incurred for municipal water in INR per KL (if applicable)
g.	Cost incurred for borewell water INR per KL (if applicable)
h.	Is the demand for water constant throughout the year? (Yes or No)
i.	If no to constant demand for water, what are the peak demand months
j.	Is there any concern amongst industry about using treated wastewater? (Yes or No)
k.	If Yes on concern to use treated wastewater, give details
l.	If No on concern to use treated wastewater, give price willing to pay for treated wastewater (INR/KL)
m.	Quality of wastewater required (list parameters and required values)

C.2 Power Plant

Please fill below table	
a.	Name of power plant
b.	Geo location of the power plant
c.	Size of power plant (in MW)
d.	Quantity of water consumed
e.	Source of water supply (municipal, borewell, both)
f.	Cost incurred for municipal water in INR per KL (if applicable)
g.	Cost incurred for borewell water INR per KL (if applicable)
h.	Is there any concern amongst industry about using treated wastewater? (Yes or No)
i.	Is Yes on concern to use treated wastewater, give details
j.	If No on concern to use treated wastewater, give price willing to pay for treated wastewater (INR/KL)
k.	Quality of wastewater required (list parameters and required values)

C.3 Construction Industry

Please fill below table	
a.	Name of construction firm*
b.	Quantity of water consumed based on floor area of construction (in KL)
c.	Source of water supply (municipal, borewell, both)
d.	Cost incurred for municipal water in INR per KL (if applicable)
e.	Cost incurred for borewell water INR per KL (if applicable
f.	Geo location of regions where new construction will come up in the future
g.	Is there any concern amongst industry about using treated wastewater? (Yes or No)
h.	If Yes on concern to use treated wastewater, give details
i.	If No on concern to use treated wastewater, give price willing to pay for treated wastewater (INR/KL)
j.	Quality of wastewater required (list parameters and required values)

**Please interview at least 3 to 4 construction firms*

C.4 Agriculture

Please fill below table	
a.	Geo location of agriculture cluster around Panipat*
b.	Area of the geo location cluster identified (in sq km)
c.	Types of crops cultivated in that geo location cluster
d.	Number of farmers in the identified location
e.	Typical land area per farmer (in acres)
f.	Number of cropping cycles
g.	Average quantity of water required per acre

h.	Source of water supply (city wastewater, borewell, both)
i.	If the source of water supply is city wastewater, any health issues seen amongst the farmers? (Yes or No)
j.	If yes to health concern seen in farmers, list type of health issues
k.	Cost incurred for irrigation (INR per harvest)
l.	Is there any concern amongst farmers about using treated wastewater? (Yes or No)
m.	If Yes on concern to use treated wastewater, give details
n.	If No on concern to use treated wastewater, give price willing to pay for treated wastewater (INR/KL)
o.	If farmers are doing less than 3 crop cycles or not able to irrigate entire land area, would they harvest additional crop or expand land area?

**Please note that we will preferably need all the downstream agriculture cluster location and its details. At least we should identify minimum of 3 to 4 such clusters*

Annex 2: Key informants and field visits

Sl. No.	Date	Name and Designation of the Key Persons	Location in Panipat
1.	04.05.2022	• Dr Pravin Kumar, Director Technical, NMCG • Mr Kamaljeet Singh, RO, SPCB • Mr Kuldeep Singh, SPCB • Mr Rajbir Singh, HSIIDC • Mr Sanjay Harane, Solidaridad	HSVP (21 MLD CETP, Sewah)
2.	04.05.2022	• Mr Arpit, Municipal Corporation Panipat and Team.	MCP (25 MLD STP, Sewah)
3.	04.05.2022	• Mr Bhim Rana, President, Panipat Industrial Dyeing Association also affiliated with Haryana Environmental Management Society, • Mr Bhupender Chug, Golden Group of Industries, • Mr Sanjay Harane, Solidaridad	Hotel Geeta Sarovar Portico, Panipat
4.	05.05.2022	• Mr Dharmendra Kumar, Senior Manager (Health, Safety and Environment), Panipat Refinery & Petrochemical Complex, Indian Oil Corporation Limited (IOCL) • Mr Pritam Singh, President, Panipat Industrial Association • Mr Naresh Gupta from Raghav Wollen Mills near Nimbri Chowk, Bapoli Rd, Panipat • Mr Kamal Singh, Regional Officer, HSPCB • Mr Rajbir Singh, HSIIDC	Stakeholder exchange at Hotel Geeta Sarovar Portico, Panipat
5.	05.05.2022	• Mr Sukhdeep Singh, Chief Engineer, Kapoor Industrial Estate.	Kapoor Industries Limited Machhrouli, Panipat, Haryana
6.	05.05.2022	• Mr Ramesh Singh, Riviera Home Furnishings Pvt. Ltd. Panipat, Haryana)	Riviera Home Furnishings Pvt. Ltd. Panipat, Haryana

7.	27.09.2022	• Mr Sharma, Sub-divisional Officer (SDO), PHED, Panipat • Mr Arpit, Municipal Corporation (MC) • Mr Satvir Singh (PHED)	Public Health Engineering Department (PHED) office, Panipat
8.	27.09.2022	• Parveen Kumar, Junior Engineer, MICADA • Rajat Kumar, Junior Engineer, MICADA	Micro Irrigation & Command Area Development Authority (MICADA), Irrigation Department, Panipat
9.	23.11.2022	• Mr. Ajay Chhoker, Junior Engineer, MCP • Mr Jiten Chhoker, Assistant Junior Engineer, MCP	Municipal Corporation of Panipat (MCP) office, Panipat
10	23.11.2022	• Mr Pardeep Singh, AEE, HSPCB, Panipat • Mr Kamaljeet Singh, Regional Officer, HSPCB, Panipat	HSPCB Office at Panipat
11	23.11.2022	• Mr Lalit Dumyan, XEN, Construction, Irrigation Department, Panipat • Mr. Saravjeet Bhetoya, Sub-Divisional Officer	Irrigation Department, Panipat

Annex 3: Minimum water quality standards

Table 6: Recommended norms of treated sewage quality for different uses according to CPHEEO, 2012. All units in mg/L unless specified. (Source: Schellenberg et al., 2020)

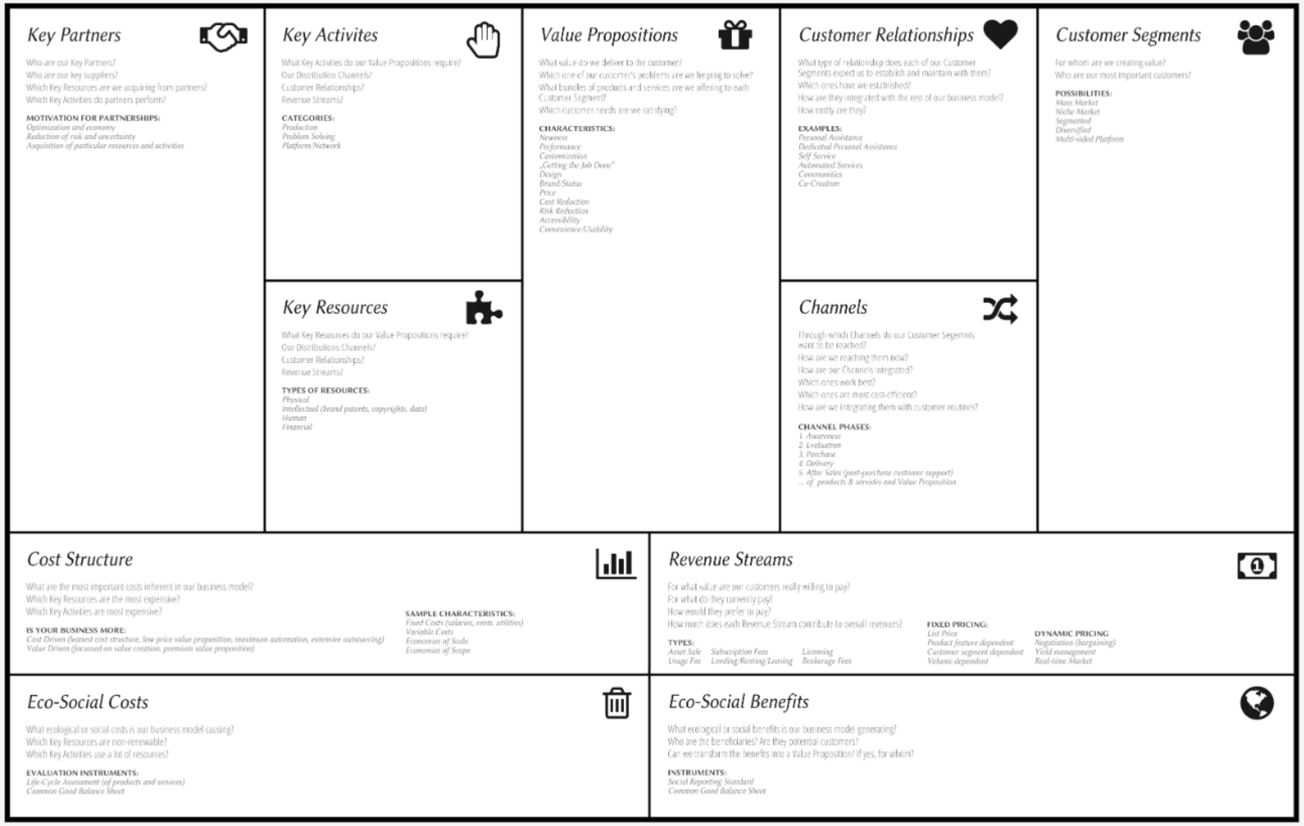
Parameter	Toilet flushing	Fire protection	Vehicle exterior washing	Non-contact impound-ments	Landscaping, horticulture & agriculture			
					horticulture, golf courses	Crops		
						Non-edible crops	Edible crops	
							Raw	Cooked
Turbidity (NTU)	<2	<2	<2	<2	<2	AA	<2	AA
SS	nil	nil	nil	nil	nil	30	nil	30
TDS				2100				
pH				6.5 to 8.3				
Temp. (°C)				Ambient				
Oil and Grease	10	nil	nil	nil	10	10	nil	nil
Minimum Residual Chlorine	1	1	1	0.5	1	nil	nil	nil
Total Kjeldal Nitrogen	10	10	10	10	10	10	10	10
BOD	10	10	10	10	10	20	10	20
COD	AA	AA	AA	AA	AA	30	AA	30
Dissolved Phosphorus as P	1	1	1	1	2	5	2	5
Nitrate	10	10	10	5	10	10	10	10
Fecal Coliform/ 100 ml	nil	nil	nil	nil	nil	230	nil	230
Helminthic eggs/liter	AA^{m}	AA	AA	AA	AA	<1	<1	<1
Color	Colorless	Colorless	Colorless	Colorless	Colorless	AA	Colorless	Colorless
Odor				Aseptic (Not septic and no foul odor)				

AA = as arising when other parameters are satisfied

Typical water quality requirement for industrial reuse *(Source: Chapter 7, Part A of the CPHEEO 2012 Manual on sewerage and sewage treatment)*

Constituent mg/L	Boiler feed	Pulp and paper	Textile	Petroleum and coal	Cooling water
Calcium	0.01 – 0.4	20	-	75	100
Iron	0.05 – 1.0	0.3 – 1.0	0.1-0.3	1	
Manganese	0.01 – 0.3	0.05 – 0.5	0.1– 0.05	-	
Alkalinity as CaCO3	40 – 350	100	-	125	
Chloride	-	200 – 1,000	-	300	100
TDS	200 – 700	-	100	1000	
Hardness as $CaCO_3$	0.07 – 350	100	25	350	
Ammonium-N	0.1	-	-	-	1-3
Phosphate-P	-	-	-	-	0.6
Silica	0.7 – 30	50	-	-	20
Colour (Hazen)	-	10-30	5	-	-

Annex 4: The Sustainable Business Model Canvas



Annex 5: Financial viability assessment template

Full excel file is available here:

Panipat financial analysis of reuse business models_v2.xlsx

Annex 6: HSPCB STP effluent discharge standards

HSPCB STP effluent discharge standards (2020) and proposed reuse water quality standard (HSPCB, 2022)

Parameters	Current HSPCB discharge standards for STP (2020)	Proposed discharge standards for		
		Irrigation	Industrial processes, construction activities and other non-potable usage	Groundwater recharge through lakes, ponds, water storage area, natural or artificial depression
pH	5.5 – 9.0	6.5 – 8.5	6.5 – 8.5	6.5 – 8.5
BOD (mg/L)	10	10[**]	10	<10
COD (mg/L)	50	50[**]	50	<50
FOG (mg/L)		0	0	0
TSS (mg/L)	20	20	10	<10
TDS (mg/L		1500	750	<500
Chloride (mg/L)		100	100	100
HCO3 (mg/L)		300	300	300
Sulphate (mg/L)		200	200	200
Fluoride (mg/L)		1	1	1
Total nitrogen (mg/L)	10	20	20	20
Ammoniacal nitrogen (mg/L)		5	5	5
Nitrate Nitrogen (mg/L)		10	10	10
Total phosphorous (mg/L)	1[*]	5	5	5
Phosphate (P dissolved) (mg/L)		1	1	1
Sulphide (mg/L)		0.01	0.01	0.01
Phenolic compound (mg/L)		0.002	0.002	0.002
Sodium (mg/L)		100	100	75
Magnesium (mg/L)		60	60	30
Calcium (mg/L)		100	100	75
Ionic detergents (MBAS) (mg/L)		< 1	< 1	0.2
Residual Chlorine (mg/L)		0.2	0.2	0.2
Total Alkalinity as CaCO3 (mg/L)		200	200	200
Total Hardness (mg/L)		200	200	200
Faecal Coliform (MPN/100 mL)	< 100	<100	<100	<100
E.coli (MPN/100 mL)		0	0	0
Intestinal helminth eggs (ocysts/100 mL)		0	0	0
Sodium Adsorption Ratio (SAR) (meq/L)		<10	<10	<3.0
Residual Sodium Carbonate (RSC) (meq/L)		<2.5	<2.5	<1.5

Electrical Conductivity (EC) (S/m)	<2000	<1200	<750
Boron (mg/L)	1	1	0.5
Cu (mg/L)	0.2	0.2	0.05
Fe (mg/L)	5.0	5.0	0.3
Mn (mg/L)	0.2	0.2	0.1
Cr (mg/L)	0.1	0.1	0.05
Ni (mg/L)	0.2	0.2	0.02
Pb (mg/L)	0.01	0.01	0.01
As (mg/L)	0.01	0.01	0.01
Cd (mg/L)	0.01	0.01	0.003
Co (mg/L)	0.05	0.05	0.05
Li (mg/L)	2.5	2.5	2.5
Zn (mg/L)	2.0	2.0	2.0
Hg (mg/L)	0.001	0.001	0.001
Al (mg/L)	1.0	1.0	0.03
Be (mg/L)	0.1	0.1	0.1
CN (mg/L)	0	0	0
Mo (mg/L)	0.01	0.01	0.01
Se (mg/L)	0.02	0.02	0.02
V (mg/L)	0.1	0.1	0.1
Ba (mg/L)	1.0	1.0	0.7
Ag (mg/L)	0.1	0.1	0.1

* *If discharged to ponds and lakes,* ***if TWW is exclusively used for irrigation purposes BOD of 30* mg/L *and COD of 150* mg/L *is permissible*

Annex 7: Viability assessment

P&L for Municipal Commission of Panipat for STW reuse in textile industry

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
Quantity of STW sold (in MLD)	31	31.75	32.52	33.32	34.12	34.95	35.80	36.67	37.56	38.48	39.41	40.37	41.35	42.36	43.39
Revenue from sale of STW to TTP	334.80	342.94	351.27	359.80	368.55	377.50	386.68	396.07	405.70	415.56	425.65	436.00	446.59	457.44	468.56
Operating cost of conveyance	21.76	22.85	23.99	25.19	26.45	27.78	29.17	30.62	32.15	33.76	35.45	37.22	39.08	41.04	43.09
Profit (Loss)	**313.04**	**320.08**	**327.27**	**334.61**	**342.09**	**349.73**	**357.51**	**365.45**	**373.54**	**381.79**	**390.20**	**398.77**	**407.51**	**416.41**	**425.47**

Sale price of STW is set at Rs 4 per KL

NPV at 9% hurdle rate is Rs 653.95 lakhs and IRR is 14%

Private entity using TTRO to treat STW for reuse in textile industry

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
Revenue from sale of TTW to industries	3515.40	3600.82	3688.32	3777.95	3869.75	3963.79	4060.11	4158.77	4259.83	4363.34	4469.37	4577.98	4689.22	4803.17	4919.89
Price paid for STW	334.80	342.94	351.27	359.80	368.55	377.50	386.68	396.07	405.70	415.56	425.65	436.00	446.59	457.44	468.56
Operating cost of TTP	454.67	477.40	501.27	526.33	552.65	580.28	609.30	639.76	671.75	705.34	740.60	777.63	816.52	857.34	900.21
Financing cost of TTP	1460.54	1460.54	1460.54	1460.54	1460.54	1460.54	1460.54	1460.54	1460.54	1460.54	1460.54	1460.54	1460.54	1460.54	1460.54
Profit (Loss)	**1265.39**	**1319.94**	**1375.24**	**1431.27**	**1488.01**	**1545.46**	**1603.59**	**1662.39**	**1721.84**	**1781.90**	**1842.57**	**1903.80**	**1965.57**	**2027.84**	**2090.57**

Sale price of TTW is set at Rs 42 per KL and sale price of STW is set at Rs 4 per KL

NPV at 9% hurdle rate is Rs 647.88 lakhs and IRR is 10%

P&L for Private entity using TTUF to treat STW for reuse in textile industry

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
Revenue from sale of TTW to industries	753.30	771.61	790.36	809.56	829.23	849.38	870.02	891.17	912.82	935.00	957.72	981.00	1004.83	1029.25	1054.26
Price paid for STW	334.80	342.94	351.27	359.80	368.55	377.50	386.68	396.07	405.70	415.56	425.65	436.00	446.59	457.44	468.56
Operating cost of TTP	42.90	45.05	47.30	49.66	52.15	54.75	57.49	60.36	63.38	66.55	69.88	73.37	77.04	80.89	84.94
Financing cost of TTP	182.57	182.57	182.57	182.57	182.57	182.57	182.57	182.57	182.57	182.57	182.57	182.57	182.57	182.57	182.57
Profit (Loss)	**193.03**	**201.06**	**209.22**	**217.53**	**225.97**	**234.56**	**243.29**	**252.16**	**261.17**	**270.33**	**279.62**	**289.06**	**298.63**	**308.34**	**318.19**

Sale price of TTW is set at Rs 9 per KL and sale price of STW is set at Rs 4 per KL

NPV at 9% hurdle rate is Rs 396.36 lakhs and IRR is 13%

P&L for Municipal Commission of Panipat for STW reuse in IOCL

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
Quantity of STW sold (in MLD)	10.00	10.24	10.49	10.75	11.01	11.28	11.55	11.83	12.12	12.41	12.71	13.02	13.34	13.66	14.00
Revenue from sale of STW to TTP	216.00	221.25	226.63	232.13	237.77	243.55	249.47	255.53	261.74	268.10	274.62	281.29	288.12	295.13	302.30
Operating cost of conveyance	15.97	16.77	17.61	18.49	19.41	20.38	21.40	22.47	23.60	24.78	26.02	27.32	28.68	30.12	31.62
Profit (Loss)	**200.03**	**204.48**	**209.02**	**213.64**	**218.36**	**223.17**	**228.07**	**233.06**	**238.14**	**243.32**	**248.60**	**253.97**	**259.44**	**265.01**	**270.67**

Sale price of STW is set at Rs 8 per KL

NPV at 9% hurdle rate is Rs 224.2 lakhs and IRR is 11%

P&L for Private entity using TTRO to treat STW for reuse in IOCL

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
Revenue from sale of TTW to industries	1134.00	1161.56	1189.78	1218.69	1248.31	1278.64	1309.71	1341.54	1374.14	1407.53	1441.73	1476.77	1512.65	1549.41	1587.06
Price paid for STW	216.00	221.25	226.63	232.13	237.77	243.55	249.47	255.53	261.74	268.10	274.62	281.29	288.12	295.13	302.30
Operating cost of TTP	220.00	231.00	242.55	254.68	267.41	280.78	294.82	309.56	325.04	341.29	358.36	376.27	395.09	414.84	435.58
Financing cost of TTP	365.14	365.14	365.14	365.14	365.14	365.14	365.14	365.14	365.14	365.14	365.14	365.14	365.14	365.14	365.14
Profit (Loss)	**332.86**	**344.17**	**355.47**	**366.75**	**377.99**	**389.17**	**400.29**	**411.31**	**422.22**	**433.00**	**443.62**	**454.07**	**464.30**	**474.31**	**484.04**

Sale price of TTW is set at Rs 42 per KL and sale price of STW is set at Rs 8 per KL

NPV at 9% hurdle rate is Rs 155.42 lakhs and IRR is 10%

P&L for Private entity using TTUF to treat STW for reuse in IOCL

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
Revenue from sale of TTW to industries	324.00	331.87	339.94	348.20	356.66	365.33	374.20	383.30	392.61	402.15	411.92	421.93	432.19	442.69	453.45
Price paid for STW	216.00	221.25	226.63	232.13	237.77	243.55	249.47	255.53	261.74	268.10	274.62	281.29	288.12	295.13	302.30
Operating cost of TTP	13.20	13.86	14.55	15.28	16.04	16.85	17.69	18.57	19.50	20.48	21.50	22.58	23.71	24.89	26.14
Financing cost of TTP	45.64	45.64	45.64	45.64	45.64	45.64	45.64	45.64	45.64	45.64	45.64	45.64	45.64	45.64	45.64
Profit (Loss)	**49.16**	**51.12**	**53.12**	**55.14**	**57.20**	**59.29**	**61.40**	**63.55**	**65.73**	**67.93**	**70.16**	**72.43**	**74.71**	**77.03**	**79.37**

Sale price of TTW is set at Rs 12 per KL and sale price of STW is set at Rs 8 per KL

NPV at 9% hurdle rate is Rs 103.05 lakhs and IRR is 13%

P&L for Municipal Commission of Panipat from freshwater swap for STW use in agriculture

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
Quantity of STW sold (in MLD)	23	23.35	23.70	24.05	24.41	24.78	25.15	25.53	25.91	26.30	26.69	27.09	27.50	27.91	28.33
Revenue from sale of freshwater	46.58	47.27	47.98	48.70	49.43	50.17	50.93	51.69	52.47	53.25	54.05	54.86	55.69	56.52	57.37
Operating cost of disinfecting	4.16	4.37	4.58	4.81	5.05	5.31	5.57	5.85	6.14	6.45	6.77	7.11	7.47	7.84	8.23
Operating cost of conveyance	17.56	18.44	19.36	20.33	21.35	22.42	23.54	24.71	25.95	27.25	28.61	30.04	31.54	33.12	34.78
Profit (Loss)	**24.85**	**24.47**	**24.03**	**23.56**	**23.03**	**22.45**	**21.82**	**21.13**	**20.37**	**19.56**	**18.67**	**17.71**	**16.68**	**15.56**	**14.36**

Sale price of freshwater swapped is set at Rs 9 per KL, with conveyance distance at 5 km and 25% transmission loss

NPV at 9% hurdle rate is Rs 36.46 lakhs and IRR is 14%

P&L for Municipal Commission of Panipat from auction of STW for use in agriculture

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
Quantity of STW sold (in MLD)	23	23.35	23.70	24.05	24.41	24.78	25.15	25.53	25.91	26.30	26.69	27.09	27.50	27.91	28.33
Revenue from sale of freshwater	46.00	46.00	46.00	46.00	46.00	46.00	46.00	46.00	46.00	46.00	46.00	46.00	46.00	46.00	46.00
Operating cost of disinfecting	4.16	4.37	4.58	4.81	5.05	5.31	5.57	5.85	6.14	6.45	6.77	7.11	7.47	7.84	8.23
Operating cost of conveyance	17.56	18.44	19.36	20.33	21.35	22.42	23.54	24.71	25.95	27.25	28.61	30.04	31.54	33.12	34.78
Profit (Loss)	**24.28**	**23.19**	**22.05**	**20.85**	**19.60**	**18.28**	**16.89**	**15.43**	**13.91**	**12.30**	**10.62**	**8.85**	**6.99**	**5.04**	**2.99**

Auction price at Rs 46 lakhs per year and with conveyance distance at 5 km

NPV at 9% hurdle rate is Rs 2.46 lakhs and IRR is 9%

P&L for Private entity from auction of STW for use in agriculture

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
Revenue from sale of water to farmers	51.75	52.53	53.31	54.11	54.93	55.75	56.59	57.43	58.30	59.17	60.06	60.96	61.87	62.80	63.74
Price paid for STW	46.00	46.00	46.00	46.00	46.00	46.00	46.00	46.00	46.00	46.00	46.00	46.00	46.00	46.00	46.00
Operating cost of water supply	3.00	3.15	3.31	3.47	3.65	3.83	4.02	4.22	4.43	4.65	4.89	5.13	5.39	5.66	5.94
Financing cost of TTP	1.20	1.20	1.20	1.20	1.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Profit (Loss)	**1.55**	**2.17**	**2.80**	**3.44**	**4.08**	**5.92**	**6.57**	**7.21**	**7.86**	**8.52**	**9.17**	**9.83**	**10.49**	**11.14**	**11.80**

Auction price at Rs 44 lakhs per year, sale of freshwater to farmers at Rs 10 per KL and transmission loss at 25%

NPV at 9% hurdle rate is Rs 38.12 lakhs and IRR is 66%

P&L for HSVP from sale of STW for urban use

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
Revenue															
Sale of freshwater saved in parks	10.80	10.80	10.80	10.80	10.80	10.80	10.80	10.80	10.80	10.80	10.80	10.80	10.80	10.80	10.80
Sale of STW to construction industry	13.50	13.50	13.50	13.50	13.50	13.50	13.50	13.50	13.50	13.50	13.50	13.50	13.50	13.50	13.50
Expense															
Operating cost of disinfecting	4.16	4.37	4.58	4.81	5.05	5.31	5.57	5.85	6.14	6.45	6.77	7.11	7.47	7.84	8.23
Operating cost of conveyance of STW	10.05	10.55	11.08	11.63	12.22	12.83	13.47	14.14	14.85	15.59	16.37	17.19	18.05	18.95	19.90
Profit (Loss)	**10.09**	**9.38**	**8.64**	**7.85**	**7.03**	**6.17**	**5.26**	**4.31**	**3.31**	**2.26**	**1.16**	**0.00**	**-1.22**	**-2.49**	**-3.83**

Price of freshwater at Rs 4 per KL and price of at Rs 9 per KL

NPV at 9% hurdle rate is -Rs 1,446.42 lakhs and cannot calculate IRR

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