



GuruJal

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An initiative of Abhipsa Foundation

Case Study

India's First Water Neutral Campus BSF Campus, Bhondsi, Gurugram





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An initiative of **Abhipsa Foundation**

“Every Drop Used. Every Drop Valued.”

At the BSF Bhondsi Campus, GuruJal is creating a model for water-neutral campuses by integrating wastewater reuse, rainwater harvesting, groundwater recharge and nature-based solutions—moving from water consumption towards water stewardship.

Brookfield
Properties

Xebia
CREATING DIGITAL LEADERS

 **PEPSICO**

 **nagarro**

I. EXECUTIVE SUMMARY AND BASELINE CONTEXT

Located along NH248A in the Sohna Block of Gurugram District, the 216-acre 95 BN Border Security Force (BSF) Campus houses over 4,500 residents and key operational facilities. Facing severe regional groundwater depletion, defunct sewage infrastructure, and erosion from monsoon runoff, the campus undertook a multi-stakeholder transformation led by GuruJal (Abhipsa Foundation) in partnership with corporate partners Xebia IT Architects, PepsiCo India, Brookfield Properties, and WeForWater. By integrating Nature-Based Solutions (NbS) - including Decentralised Wastewater Treatment Systems (DEWATS), twin pond rejuvenations, gully plugs, detention basins, and rooftop rainwater harvesting - the campus transitioned into a water-neutral defence facility.



Figure 1: 95 Battalion BSF Campus Bhondsi, Gurugram

II. BASELINE ENVIRONMENTAL PROFILE AND THE NEED FOR INTERVENTION

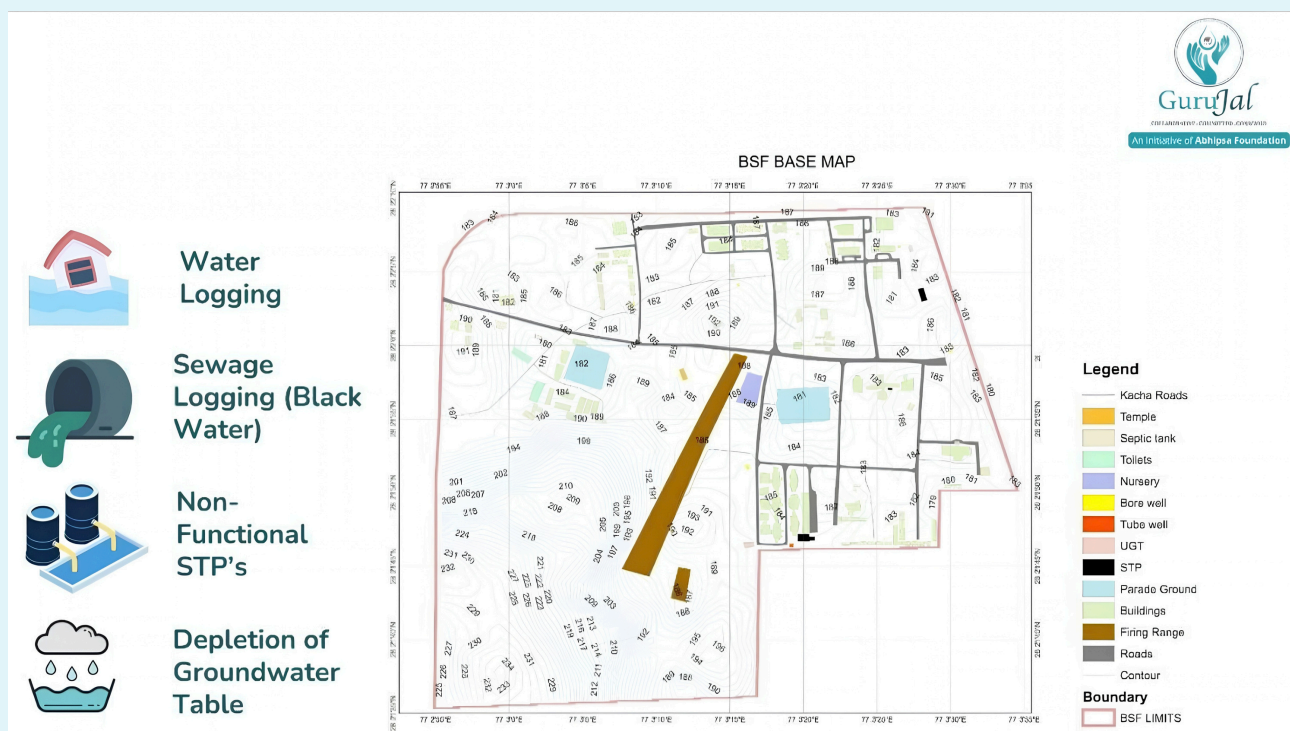
1. Geographic & Regional Context

The 95 BN Border Security Force (BSF) Campus is situated along NH248A in the Sohna Block of Gurugram District, Haryana (Coordinates: 28.365767°N, 77.050195°E). Spanning **216 acres** at the foothills of the Aravalli range, the campus accommodates over **4,500 residents** alongside operational barracks, training grounds, a hospital, and administrative infrastructure. Across Haryana, groundwater levels drop by 0.5 to 1.0 meter annually due to over-extraction, placing southern districts like Gurugram under severe hydrological strain.

2. Core Environmental & Infrastructure Challenges

Prior to the intervention, the campus faced four interconnected water management crises:

- Severe Groundwater Depletion: The campus depended entirely on deep borewells and tubewells for domestic supply. Static water tables dropped to depths between 36.1 and 45 meters below ground level (m.bgl).
- Persistent Sewage & Water Logging: Untreated blackwater and greywater from the Mahila Barrack, Sub-ordinate Mess, and Dhobi Ghat overflowed into unmanaged open depressions, creating stagnant, unhygienic pools.
- Defunct Treatment Facilities: Existing mechanical Sewage Treatment Plants (STPs) were non-functional, leaving raw effluents untreated.
- Aravalli Runoff & Topsoil Erosion: High-velocity monsoon torrents descending from the adjacent Aravalli ridges gouged deep natural gullies, stripping fertile topsoil and risking structural damage downstream.



III. METHODOLOGY AND SUSTAINABLE MASTER PLAN ARCHITECTURE

1. Data-Driven Methodology & Assessment

To transition the 216-acre BSF Bhondsi Campus toward complete water neutrality, GuruJal (Abhipsa Foundation) executed a structured, four-stage diagnostic framework. Rather than applying generic concrete infrastructure, all interventions were grounded in data-driven assessments

- Drone Topographical Mapping: High-resolution drone aerial surveys were conducted to map the 216-acre campus, establish elevation contours, and trace natural drainage paths originating from the Aravalli ridge.
- Hydrological Audits: Assessing daily water consumption patterns across barracks, residential quarters, the hospital, and mess facilities to establish the campus water balance.
- Baseline Soil & Ecological Audits: Soil permeability tests, water quality sampling (BOD, COD, TDS), and mapping existing native vegetation and micro-fauna.

2. The Master Plan Architecture

- The Multi-Barrier NbS Framework: Replacing high-energy concrete infrastructure with decentralized, low-CAPEX nature-based interventions.

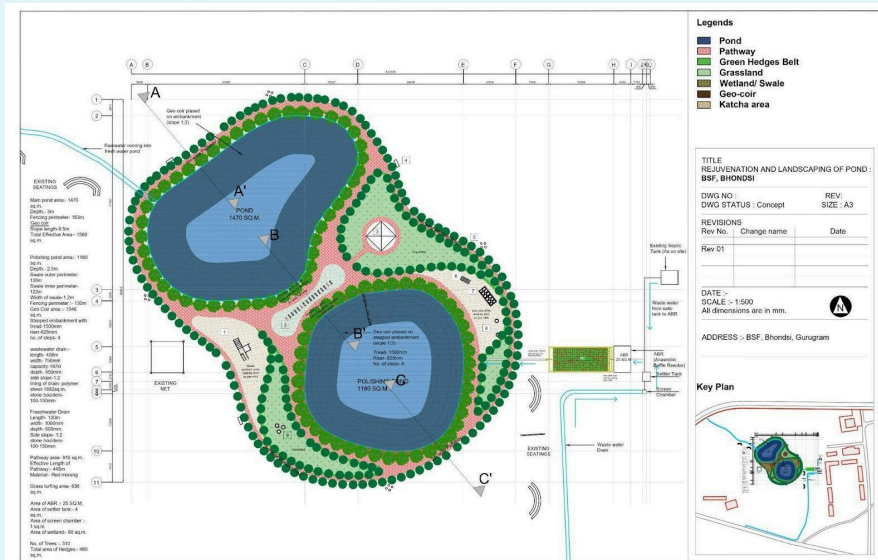
 Consolidated Intervention & Methodology Matrix

DIAGNOSE → INTERVENE	PHYSICAL SCOPE	PARTNER	WATER & ENVIRONMENTAL IMPACT	
STP Deficiency Audit → Admin Pond DEWATS	50 KLD DEWATS + Admin Pond	Brookfield CSR		Replaces defunct STP Zero-energy recycled water reuse
Drone Contour Survey → Aravalli Gully Plugs	2 stone check structures	PepsiCo CSR		390 kL holding capacity 64.25% increase in soil moisture
Drainage & Runoff Survey → Detention Ponds	2 interconnected basins (265 kL)	PepsiCo CSR		87.31% increase in soil moisture 2.44 MLY flood mitigation
Infrastructure Audit → Rooftop RWH	3 RWH units (30 KL capacity)	PepsiCo CSR		Up to 1.91 MLY rainwater captured & recharged to deep aquifers
Ecological Profiling → Bioswales + Plantation	324.2 m² bioswales + 1,000+ plants	GuruJal / BSF		Native carbon sink 1–2°C local microclimate cooling

IV. WASTEWATER TREATMENT AND ECO-POND REJUVENATION

1. Xebia CSR Project: Twin Pond Rejuvenation and 50 KLD DEWATS

Restoration of two ponds: one receiving wastewater from the Mahila Barrack and the other rain-fed.



1.1 The Baseline Problem

Before the intervention, the area was severely degraded and posed significant environmental and health risks:

- Dual Unmanaged Depressions: Two degraded earthen basins—one seasonally dry, the other choked with untreated wastewater.
- Raw Sewage & Greywater Pooling: Unchecked overflow from barracks, mess, and Dhobi Ghat created stagnant, unhygienic pools.
- Severe Groundwater Stress: Heavy borewell reliance dropped static water tables to ~45 mbgl with zero artificial recharge.
- Soil Erosion & Slope Instability: Monsoon runoff scoured uncompacted embankment slopes, causing continuous bank collapse.



Figure: Wastewater sludge across the site

1.2 THE NATURE- BASED SOLUTION

To address these challenges with minimal energy-intensive infrastructure, a Nature-Based Solutions (NbS) approach was implemented.

1.2.1 Civil Earthworks & Slope Fortification

- Pond Profiling & Dredging: Removed invasive vegetation and accumulated sludge, reshaping the two depressions into a functional dual-pond system.
- Geo-Coir Erosion Control: Installed 700 GSM Geo-Coir matting, anchored with bamboo stakes, to stabilize pond embankments and reduce rainfall-induced erosion.



Figure : Development of Pond Area

1.2.2 50 KLD Nature-Based Wastewater Treatment Plant (DEWATS):

A zero-electricity, zero-chemical 50 KLD DEWATS treats incoming wastewater before it reaches the ponds:

- Screen Chamber: Removes coarse debris.
- Settler Tank: Settles suspended solids.
- Anaerobic Baffled Reactor (ABR): Uses anaerobic bacteria to break down organic pollutants.
- Constructed Wetland: Gravel-based wetland with Red Canna, Phragmites and Typha for natural filtration and nutrient removal.
- Bio-Swales & Dual Ponds: Vegetated channels further polish treated water before it enters the Polishing and Main Ponds.



Figure : Constructed Wetland Development

1.3 Circular Economy & Botanical Shield

- Military & Plastic Waste Diverted: Discarded BSF helmets were painted and converted into hanging bird feeders. Waste vehicle tyres were transformed into frog sculptures and playground seating, while single-use plastic bottles were upcycled into garden art installations.



Figure : Landscaping elements made up of waste material



Figure : Restored Double Structured Pond

1.4 Quantified Impact

**18,250 KL/YEAR WASTEWATER TREATED • 9.1 MILLION LITRES/YEAR
GROUNDWATER POTENTIAL • 0.4 M RISE OBSERVED IN ~1 MONTH**

2. Brookfield Properties Pvt. Ltd. Pond Development

2.1 The Baseline Problem:

- Groundwater Depletion: Heavy dependence on 11 borewells led to 4 drying up and 7 yielding highly mineralised water.
- Sewage Overflow: A dysfunctional 50 KLD STP caused untreated sewage overflow, open cesspools and unhygienic conditions.
- Stormwater Runoff: Poor drainage caused severe waterlogging and prevented rainwater from contributing to groundwater recharge.



Figure: Sewage Overflow from Manhole



Figure: Defunct Sewage Treatment Plant

2.2 Intervention Details — Technical Solutions & Execution

- Site Demarcation: Demarcated a 0.5-acre site near the Administrative Block.
- Pond Rejuvenation: Created an 836 sq.m pond, 3 m deep, with Geo-Coir matting for slope stabilization.
- 50 KLD DEWATS: Installed a decentralized treatment system using an ABR and 200 sq.m constructed wetlands for natural wastewater treatment.
- Water Channelization: Routed sewage through treatment units into the pond and channelized rainwater runoff for recharge.



Figure: Anaerobic Baffled Reactor with vegetated gravel wetlands

Ecological Recovery and Monitoring :



The intervention transformed a 0.5-acre degraded sewage site into a vibrant eco-park, with 41 trees, 190 shrubs, 220 sq.m of hedges, and lotus plantations supporting aquatic life and algae control. The site is **estimated to offset 3,500 kg CO₂ over 10 years**. For accountability, 1 Automatic Digital Water Level Recorder tracks groundwater recovery toward the **9.1 million litres/year recharge target**, supported by 3–6 monthly water quality audits. Long-term maintenance is strengthened through capacity-building sessions for BSF Jawans.

3. PepsiCo CSR Watershed & Water Conservation Project

3.1 Baseline Problem Statement

- Runoff & Soil Erosion: High-velocity monsoon runoff from the Aravallis caused severe gully erosion, topsoil loss, and structural damage.
- Waterlogging & Poor Infiltration: Poor drainage and low soil permeability led to waterlogging and limited natural recharge during heavy rains.
- Aquifer Depletion: High groundwater dependence highlighted the need to divert surface runoff for deep aquifer recharge.



3.2 Intervention Details & Technical Specifications

WATER RETENTION, RECHARGE & MONITORING INTERVENTIONS

A combination of decentralised, nature-based solutions to capture, retain and recharge rainwater across the campus landscape.

Intervention	Design / Configuration	Area / Catchment	Capacity	Key Function / Outcome
01 GULLY PLUGS	Two gully plugs were constructed across natural gullies using stone, brick, cement pitching, and Hume pipes.	16,532 sq. m Watershed area	390 kL Holding capacity (total)	• Slows down runoff • Traps sediment • Reduces soil erosion • Promotes groundwater recharge
02 DETENTION PONDS	Two interconnected detention ponds were developed with vegetated swales, gentle slopes, and stone pitching.	13,000 sq. m Catchment area	265 kL per pond 530 kL total Capacity	• Retains stormwater temporarily • Enables filtration and controlled percolation • Reduces peak runoff • Supports groundwater recharge
03 ROOFTOP RAINWATER HARVESTING	Rainwater harvesting systems were installed across two buildings, comprising three collection units. Collection networks and natural gravel-sand filtration systems were installed.	233 sq. m Rooftop area (three units)	18 kL/day Design capacity	• Captures rainwater from rooftops • Filters through natural gravel-sand media • Recharges deeper aquifers through injection wells
04 MONITORING & ECOLOGICAL ENHANCEMENT	One Automatic Water Level Recorder (AWLR)/piezometer was installed for real-time groundwater monitoring. Native and pollinator-friendly species were planted around pond perimeters.	- Not applicable	- Not applicable	• Enables real-time monitoring of groundwater levels • Enhances biodiversity with native and pollinator-friendly planting around pond perimeters



Figure: Detention Pond



Figure: Gully Plug for Soil & Water Conservation

The plugs break the speed of the water coming down the hill. Instead of racing across the campus, the water slows, spreads out, and has time to soak into the ground. Soil that used to wash away now settles behind the stones. Downstream roads and buildings are protected, and the low ground no longer stays flooded after heavy rain.

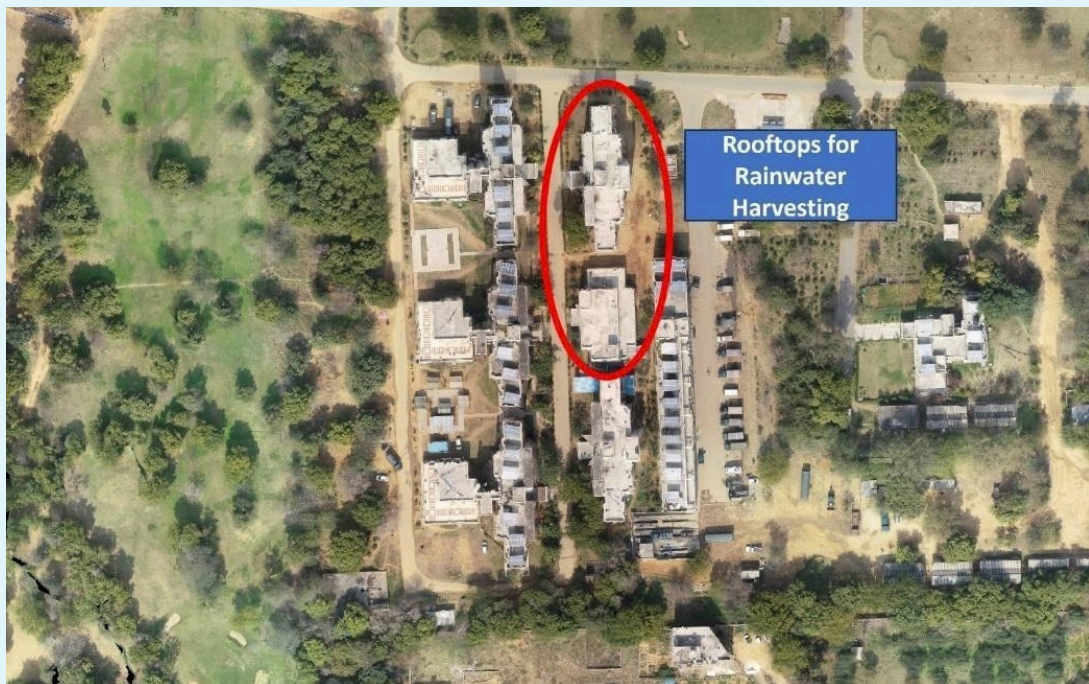


Figure: Selected sites for Rainwater harvesting

The rooftop rainwater harvesting technique was successfully implemented to collect rainwater and channel it through pipes into drains equipped with natural filtration media. Two buildings were identified for harvesting rainwater and recharging groundwater

3.3 Quantified Impact

390 kL holding capacity · 16,532 m² watershed area · 64.25% soil-moisture increase · 620 kL/year recharge potential · 2.956 ML/year stormwater mitigation

4. Xebia CSR, Pond Development Project

4.1 The Baseline Problem

- Septic Tank Overflow: Leaking and overflowing septic tanks caused uncontrolled wastewater discharge and land pollution.
- Stormwater & Flooding: Aravalli runoff led to severe waterlogging while wasting potential rainwater recharge.
- Site Degradation: The site had become an unhygienic wastewater dump, posing health risks and contributing to aquifer depletion.



Figure: Dry and Degraded Ponds



Figure: Septic tanks were leaking and overflowing

4.2 Nature-Based Solution (NbS) & Technical Interventions

- **50 KLD Nature-Based Wastewater Treatment Plant**
 - Pre-Treatment: Collection sump with screening and refurbished settler tanks.
 - Anaerobic Treatment: Underground biodigester/ABR for natural sludge digestion.
 - Constructed Wetland: Gravel-based root-zone wetland for natural filtration.
 - Multi-Stage Treatment: Effluent passes through polishing and spillover ponds and bioswales before entering the main pond.
- **Pond Rejuvenation & Civil Infrastructure**
 - Pond: Developed a 0.65-acre (904 sq.m) pond with 2.2 m depth and 5.79 million litre capacity.
 - Erosion Control: Geo-Coir matting installed along embankments to stabilize slopes naturally.
- **Eco-Park Development & Softscaping**
 - Water Conditioning: Lotus plantations introduced to help control algae and support aquatic health.
 - Green Cover: Native trees, shrubs and hedges planted across the site.
 - Site Amenities: Added stone-paved walkways, fencing, gazebo and seating areas.



Figure: Bioswale



Figure: Storm water discharge

4.3 Quantified Impact



27,000+ KL/YEAR WASTEWATER TREATED • 9.58 MILLION LITRES/YEAR GROUNDWATER RECHARGE • 225 KL MONSOON RUNOFF HARVESTED • 40 MBGL BASELINE GROUNDWATER LEVEL

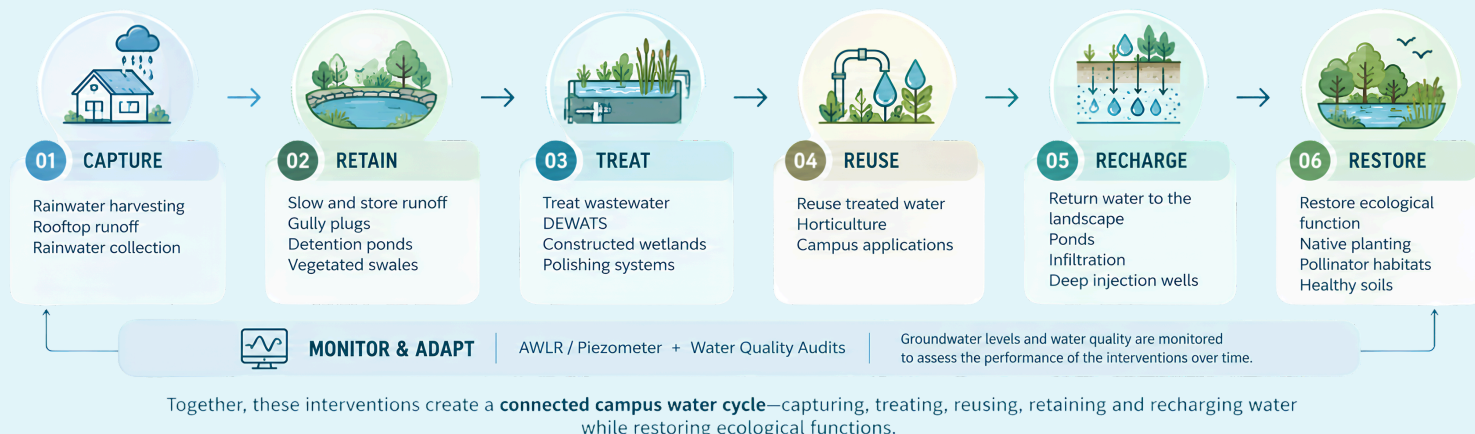
V. CONCLUSION

Achieving Campus Water Neutrality through Integrated Water Management (IWM)

The transformation of the 216-acre BSF Bhondsi Campus from a water-stressed, sewage-logged facility into a water-neutral campus demonstrates the power of Integrated Water Management (IWM). Rather than treating wastewater disposal, flood mitigation, and water supply as isolated problems, the campus adopted an interconnected, closed-loop approach

- Loop 1: Wastewater to Reusable Resource (DEWATS & NbS)
- Loop 2: Stormwater Mitigation to Aquifer Replenishment
- Loop 3: Ecological Restoration & Social Cohesion

HOW THE IMPACT WAS CREATED



Combined Annual Water & ecology Impact

25.26 million liters/year

Groundwater recharge potential

63.9 million liters/year

Wastewater treated & reused

5.4 million liters/year

Stormwater managed

Upto 87%

Increase in soil moisture

Key Lessons & Replicable Model

1. Public-Private-Community Partnership (PPCP): The BSF Bhondsi experience demonstrates the value of collaboration between GuruJal, BSF and corporate CSR partners, combining institutional ownership, technical expertise and funding.
2. Nature-Based, Low-CAPEX Solutions: Decentralised interventions such as DEWATS, constructed wetlands, ponds, gully plugs and rainwater harvesting address water challenges while working with the site's natural hydrology.
3. Data-Driven Planning & Monitoring: Hydrological assessments, soil studies, water-quality monitoring and AWLR/piezometers support evidence-based planning and tracking of intervention performance.
4. Institutional Ownership: Capacity-building and involvement of BSF personnel support long-term operation, maintenance and stewardship.
5. Site-Specific Design: The model demonstrates that campus water solutions should be designed around local water flows, groundwater conditions, wastewater generation, soil characteristics and ecological context rather than applied as a standard template.

The transformation of the BSF Bhondsi Campus demonstrates how water security in fragile ecosystems can be strengthened through integrated, nature-based approaches rather than reliance on energy-intensive infrastructure. By applying an Integrated Water Management (IWM) framework supported by Nature-Based Solutions, the campus has integrated wastewater treatment and reuse, stormwater management, groundwater recharge and ecological restoration. This collaborative approach offers a replicable model for military cantonments, institutional campuses and other water-stressed regions across India.



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