



**राष्ट्रीय प्रौद्योगिकी संस्थान, अगरतला**  
**NATIONAL INSTITUTE OF TECHNOLOGY, AGARTALA**  
**BARJALA, AGARTALA - 799 046**  
**Civil Engineering Department**

**Dr. Umesh Mishra,**  
**Professor**

**02-11-2023**

**REF: F.TU/REG/IQAC/AUDIT/06/2023 Dated 10.08.2023**

**TO WHOMSOEVER IT MAY CONCERN**

This is to certify that the first ever Environmental Audit Report 2021-22 of Tripura University is an original internal audit work conducted by the Environmental Audit Committee to monitor the environmental management practices adopted in the University which is in line with the terms of the International Standards of Internal Auditing.

After going through the report, it is obvious that adequate and appropriate audit procedures were followed for Environmental Quality Audit, Water Audit and Waste Disposal Audit and the gathered evidences support the conclusions reached and contained in this report.

The suggestions and recommendations prescribed and the conclusions derived are quite genuine and within the achievable limits, and I understand that Tripura University is competent to fulfill those to meet the Sustainable Development Goals.

I recommend and firmly believe that this report meets the requirement prescribed for development of a Green Campus.

**(Dr. Umesh Mishra)**

PROFESSOR  
Civil Engineering  
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# **ENVIRONMENTAL AUDIT REPORT**

## **2021-2022**



**TRIPURA UNIVERSITY**  
**Suryamaninagar | TRIPURA (W)- 799022 | TRIPURA |**  
**INDIA**



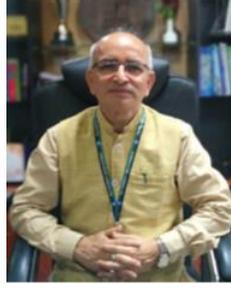


प्रो. गंगा प्रसाद प्रसाई  
कुलपति

**Prof. Ganga Prasad Prasain**  
Vice-Chancellor

त्रिपुरा विश्वविद्यालय  
(केन्द्रीय विश्वविद्यालय)  
सूर्यमणिनगर-799022, त्रिपुरा, भारत

**Tripura University**  
(A Central University)  
Suryamaninagar-799022, Tripura, India



### Foreword from Vice Chancellor

I have great pleasure to introduce the Green/Energy/Environmental Audit report-2021-22, a milestone achievement that underscores our unwavering dedication to environmental stewardship. This report signifies a momentous step forward as we, as an institute, take stock of our ecological impact and chart a course towards a more sustainable future.

In an era defined by the convergence of global challenges and shared responsibilities, this report embodies our commitment to transparency, accountability, and progress. It is a reflection of our institute's ongoing journey to align our practices with the principles of sustainability, echoing the sentiment that knowledge and awareness are pivotal agents of change.

The Green/Energy/Environmental Audit report-2021-22 encapsulates the meticulous efforts of our Green/Energy/Environmental Audit Committee which constitute a team of researchers and sustainability experts who have meticulously delved into our institution's operations. Their insights, derived from rigorous assessment and careful evaluation, offer a panoramic view of our environmental footprint - the good, the better, and the areas warranting improvement.

With a deep sense of responsibility and optimism we present this report to our stakeholders. We recognize that our actions today lay the foundation for the world we bequeath to future generations. The report's findings beckon us to embrace innovation, challenge conventions, and forge a path that reconciles our aspirations with the planet's health.

I extend my heartfelt appreciation to every individual who has contributed to the creation of this report. Your dedication to advancing sustainability is a testament to the spirit of collaboration and shared purpose that defines our institute.

May this Audit report (s) serve as a compass guiding us towards more eco-conscious practices, fostering a culture of environmental awareness and inspiring collective action. Let us seize this moment to galvanize change, secure in the knowledge that every positive step we take today reverberates for years to come.

Together, we embark on a transformative journey, driven by the profound belief that by nurturing nature, we nurture ourselves.

(Prof. Ganga Prasad Prasain)

## Acknowledgement

In line with our unwavering commitment to environmental stewardship and sustainability, Tripura University has consistently taken the lead in organizing a multitude of initiatives, including environmental campaigns, workshops, and extension programs. Our goal has always been to catalyze positive societal change on both national and global scales. We recognize the paramount importance of conducting an environmental audit to ensure the sustainable development and advancement of our esteemed institution. Tripura University remains steadfast in its pursuit of excellence and is dedicated to enhancing environmental quality while preserving the pristine ecosystem of our campus, thus securing a promising legacy for future generations of students and campus residents.

This comprehensive report, which encompasses the period 2021-2022, marks our third formal endeavour to meticulously document the outcomes of our investigative work and provide an exhaustive analysis of all pertinent aspects of the Environmental Audit process. In alignment with the climate neutrality objectives set by the Government of India, Tripura University aspires to play a pivotal role in averting global ecological crises. To accomplish this, we have embraced a holistic approach, including the establishment of an Environmental Audit Committee comprising faculty members with specialized expertise in this field. This committee has been diligently collecting critical environmental data within our campus while facilitating on-site solutions to address environmental challenges.

The principal aim of the Environmental Audit Committee is to identify prevailing and emerging environmental concerns, entailing a comprehensive examination of our environmental management practices and their impact on our campus environment. This report is the culmination of a collective effort, driven by each dedicated member of the Tripura University Environmental Audit Committee and its stakeholders. Through exhaustive assessments of environmental parameters, combined with meticulous data collection and analysis, the committee has identified immediate and pressing threats within our campus environment. The recommendations and suggestions contained in this report are designed to establish a robust foundation for continuous enhancement of our environmental standards.

This report underscores the significance of engaging all stakeholders in our endeavour. By championing a bottom-up approach, we aspire to collectively confront the challenges that lie ahead. In this collaborative pursuit, this report serves as a vital resource to steer meaningful action and foster a lasting culture of environmental responsibility.

We extend our heartfelt gratitude for the invaluable encouragement and administrative support provided by Prof. Ganga Prasad Prasain, Hon'ble Vice Chancellor of Tripura University, throughout this study. His guidance has been our guiding light, and on behalf of the Environmental Audit Committee-2021-2022, we express our profound appreciation for his benevolent support. Our gratitude extends to all teaching and non-teaching staff, as well as the Deans and Heads of Departments at Tripura University, for their generous assistance in gathering data for this report.

Special recognition is due to Member Secretary, TSPCB and his team for providing essential campus data.

We also extend our sincere appreciation to Prof. Umesh Mishra from the Department of Civil Engineering at NIT, Agartala, for his invaluable role as the External Expert for the Environmental Audit 2021-22. His expertise and insights greatly enriched the audit process, and his dedication significantly contributed to the depth and quality of our findings.

A heartfelt acknowledgment is reserved for all committee members who played an integral role in the creation of this report. In particular, we extend special thanks to Dr. Thiru Selvan, the convener of the Tripura University Environmental Audit Committee -2021-22, for his unwavering commitment to compiling this report.

It is our sincere belief that the collective efforts of the current Environmental Audit Committee will significantly benefit Tripura University. We earnestly hope that embracing the management plan outlined in this report becomes a shared responsibility among all stakeholders of the university, as we strive to diminish our environmental footprint. Together, we can ensure a sustainable and environmentally conscious future for Tripura University.

Prof. Badal K Datta  
Chairman

**Tripura University Environmental Audit Committee  
2021-2022**

**Chairman**

Prof. B. K. Datta, Dean, Faculty of Science, Tripura University

**Members**

Prof. R.K. Nath, HoD, Dept. of Chemistry, Tripura University

Prof. Y.V. Krishnaiah, Dept. of Geography & D.M., Tripura University

Dr. B.K. Sharma, Dept. of Microbiology, Tripura University

Dr. S.S. Singh, Dept. of Zoology, Tripura University

Mr. N. Tripura, Electrical Engineer, Tripura University

Mr. Rajesh Banik, Civil Engineer, Tripura University

Mr. Krishna Das, Executive Engineer, Tripura University

Campus In-charge, Tripura University

**External Expert**

Prof. Umesh Mishra, Department of Civil Engineering, NIT, Agartala.

**Convener**

Dr. Thiru Selvan, Dept. Forestry and Biodiversity, Tripura University

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**Introduction**

In an era defined by the escalating urgency of environmental concerns and an ever-growing need for sustainable practices, the importance of conducting comprehensive environmental audits has never been more pronounced. This Environmental Audit Report represents a thorough assessment of the environmental dimensions, operational methodologies, and potential avenues for improvement within the precincts of Tripura University. With the overarching aim of advancing environmental efficiency, reducing operational costs, and minimizing the institution's ecological footprint, this report encapsulates a meticulous scrutiny conducted within the campus of Tripura University.

In the global quest for sustainable progress, organizations are increasingly recognizing the pivotal role of environmental responsibility in achieving both economic and ecological objectives. This Environmental Audit Report serves as a valuable instrument for identifying conservation opportunities, prioritizing corrective actions, and delineating a strategic roadmap for the adoption of eco-conscious practices. By furnishing a comprehensive overview of the current environmental landscape, prevailing operational procedures, and equipment efficiency, this report empowers Tripura University with actionable insights to make well-informed decisions.

The analysis presented within this report is the culmination of collaborative efforts between our dedicated Environmental Audit Committee members and the personnel of Tripura University, whose invaluable contributions and access to essential data were pivotal. Employing a combination of on-site assessments and meticulous data compilation, we have strived to uncover a comprehensive perspective on resource utilization and potential areas for enhancement.

The structure of this report is designed to provide a clear depiction of the present environmental scenario, followed by an in-depth exploration of conservation measures tailored to the unique needs and aspirations of Tripura University. Our findings are organized to encompass cost-effective and cost-neutral opportunities, moderate investment prospects, and strategic recommendations for the long term. These recommendations will enable Tripura University to make prudent decisions in alignment with its operational goals.

In the pursuit of a future defined by sustainability and ecological efficiency, this Environmental Audit Report stands as a cornerstone, offering a comprehensive understanding of resource consumption patterns and a roadmap for achieving tangible improvements. By embracing the insights, it provides, Tripura University takes a significant step towards reducing resource wastage, optimizing resource allocation, and contributing to a greener and more prosperous tomorrow.

It's noteworthy that environmental auditing aligns with Criterion 7 of NAAC (National Assessment and Accreditation Council), an autonomous organization in India responsible for categorizing institutions as Grade A, B, or C based on the scores assigned during the accreditation process. This underscores the institutional commitment of Tripura University towards holistic excellence, including environmental responsibility, as a key component of its journey toward academic and operational excellence.

**About Tripura University**

Tripura University, established as a State University on October 2nd, 1987, emerged from the renowned Calcutta University. Situated in the North Eastern region of India, the university has been committed to achieving academic excellence. Nestled in a lush, semi-urban expanse of 75 acres along the National Highway at Suryamaninagar (23°45'40"N; 91°15'58"E), approximately 9 kilometers south of Agartala, the capital city, it originated from the former CUPGC.

Designated as one of the 49 Central Universities in India, Tripura University was founded on July 2nd, 2007, through a parliamentary act with the purpose of establishing a teaching and affiliating

institution in the state. Notably, the university has made significant strides, enhancing both its infrastructure and academic landscape.

Presently, the university offers a diverse array of programs through its Science, Arts, and Commerce Faculty. Its academic portfolio comprises a total of 57 programs, encompassing Undergraduate, Postgraduate Diploma, and other Postgraduate Programs. Additionally, the university provides Ph.D. programs in 38 subjects. With an annual enrollment exceeding 4000 students, the campus serves as a hub of education and exploration. Moreover, Tripura University fosters pioneering research initiatives spanning various fields of arts, commerce, science and technology.

Despite its geographical remoteness and communication challenges, the university remains dedicated to competing nationally in academic accomplishments, research breakthroughs, innovation, and successful placements. This commitment is aptly reflected in its commendable NAAC Assessments and NIRF rankings.

The university boasts 46 well-equipped departments, each furnished with state-of-the-art classrooms, laboratories, continuous internet access, a computer center, library, free Wi-Fi campus-wide, sports facilities, an open-air theater, health services, banking amenities, a cafeteria, post office, food court, hostels, and a guest house. Its esteemed faculty is not only dynamic but also compassionate and approachable. Alongside regular academic sessions, the university promotes a variety of sports and socio-cultural activities, including film screenings, musical performances, art festivals, debates, university fairs, sports tournaments, and wellness walks.

Set against a backdrop of scenic beauty, the campus encompasses lakes, woodlands, hills, flower gardens, and fruit orchards, creating a tranquil environment. The abundance of trees, the fragrance of flora, the chorus of birds, fluttering butterflies, and local wildlife collectively provide a refreshing contrast to academic demands, nurturing and rejuvenating the minds of its student community.

### **Environmental Audit at Tripura University**

In an era where governments worldwide prioritize policies aimed at enhancing labour productivity and economic growth by investing in human capital development, Tripura University stands as a beacon of commitment to these ideals. We recognize that our dedication to knowledge and skill enhancement not only contributes significantly to the nation's prosperity but also plays a pivotal role in bolstering our Gross Domestic Product (GDP). Guided by our unwavering commitment to catalysing transformative change, Tripura University has exerted substantial efforts to elevate educational standards and contribute to the nation's progress.

As we continue to advance our cutting-edge research initiatives across diverse fields, the university's growth is inevitably accompanied by an increase in energy consumption and the associated environmental implications. In harmony with the vision set forth by the Government of India, under the guidance of the esteemed Prime Minister Shri Narendra Modi Ji, the emphasis on sustainable practices permeates across all sectors. This alignment seamlessly resonates with the mission established by the University Grants Commission (UGC), which mandates an "Environmental Consciousness" criterion (Criterion VII) for assessing educational institutions.

In the contemporary era of sustainable development, Tripura University has embraced the principles of responsible resource utilization and environmental stewardship, recognizing that environmental efficiency is an integral facet of campus management. Environmental auditing, a systematic evaluation of practices to gauge their efficiency, detect inefficiencies, and explore avenues for optimization, is our approach to curtail our environmental impact and contribute to broader ecological objectives.

We are steadfast in our commitment to responsible resource management and aspire to set an example in sustainable academic practices. In alignment with the sustainability mandates set forth by the

Government of India, Tripura University is dedicated to overseeing the environmental efficiency of its research and educational endeavours through the diligent efforts of the Environmental Audit Committee.

### **Policy Objectives of the Tripura University Environmental Audit**

**Identification of Strengths and Enhancement Opportunities:** Our policy aims to conduct a comprehensive environmental audit, evaluating sustainable practices within administrative, academic, and research domains. Through meticulous gap analysis, we seek to highlight strengths and areas warranting improvement. Subsequently, actionable strategies will be outlined to advance our sustainability objectives.

**Cultivation of Environmental Awareness:** We are committed to nurturing a culture of environmental consciousness throughout our campus. By involving all stakeholders, including students, faculty, staff, and administration, our goal is to inspire responsible and optimized utilization of available resources, thereby mitigating our ecological footprint.

**Proactive Environmental Governance:** Our policy underscores the significance of proactive environmental governance. By gathering foundational data on critical environmental parameters, we aim to identify potential concerns in advance and address them pre-emptively. This approach ensures a sustainable and ecologically harmonious campus environment.

Through these policy objectives, Tripura University underscores its commitment to efficient resource utilization, environmental awareness, and proactive mitigation of environmental concerns through the implementation of environmental audits.

To achieve these goals, the Environmental Audit Committee of Tripura University is dedicated to:

- ❖ Identifying prevailing and emerging environmental concerns.
- ❖ Overseeing environmental management practices.
- ❖ Evaluating existing practices that could influence resource consumption.
- ❖ Promoting awareness among the university's stakeholders.
- ❖ Compiling an Environmental Audit Report detailing eco-conscious practices adopted by various departments, support services, and administrative entities.

With these initiatives, Tripura University embarks on a journey toward a greener, more sustainable future, aligned with the global call for responsible environmental stewardship.

### **Environmental Audit Methodology**

The Environmental Audit conducted at Tripura University was executed through a meticulous methodology designed to comprehensively assess the university's environmental practices and resource utilization. This systematic approach encompassed the following key elements:

#### **Preliminary Assessment:**

- ❖ **Gathering Pertinent Information:** The process commenced with the collection of crucial data concerning environmental practices, trends in resource consumption, and relevant campus-specific information.
- ❖ **Identifying Key Impact Areas:** Key areas with significant environmental impact were identified, including waste management, water usage, emissions, and other pertinent factors. This step laid the foundation for focused assessments.

**Onsite Data Collection:**

- ❖ Site Visits: Environmental auditors conducted on-site visits to various buildings and facilities within the campus to assess real-time environmental practices and resource utilization.
- ❖ Water Quality Analysis: Standard protocols were employed to conduct water quality analysis, ensuring the assessment of water-related environmental parameters.
- ❖ Air Quality Analysis: Air quality analyses of the university campus were performed following established protocols, providing insights into air pollution and its sources.
- ❖ Noise Level Measurements: Sound level measurements were undertaken using specialized equipment at selected sampling stations, both during the day and night, to evaluate noise pollution levels within the campus.
- ❖ Data Collection: Comprehensive data, encompassing resource specifications, operational routines, and consumption patterns across various systems, was diligently collected.

**Enquiries and Stakeholder Interviews:**

- ❖ Engaging with Stakeholders: Interviews and discussions were conducted with relevant stakeholders, including facility managers, maintenance staff, and campus occupants.
- ❖ Insights and Perspectives: These interactions provided valuable insights into operational routines, waste management practices, and potential avenues for resource conservation. Stakeholder perspectives were integral to the audit process.

**Resource Use Analysis:**

- ❖ Data Analysis: Collected data was subjected to rigorous analysis to calculate resource consumption across different areas and systems.
- ❖ Identifying Trends: The analysis aimed to identify trends, patterns, and deviations in resource usage that required attention and remediation.

**Waste Management Analysis:**

- ❖ Evaluating Waste Practices: Waste management practices, including waste segregation, disposal methods, and recycling efforts, underwent comprehensive evaluation.
- ❖ Proposing Strategies: Based on the analysis, recommendations were formulated to enhance waste reduction, recycling, and overall waste management practices, thereby reducing the university's environmental impact.

**Report Compilation:**

- ❖ Synthesizing Findings: The culmination of this comprehensive audit process involved synthesizing the findings, recommendations, and analyses into a comprehensive environmental audit report.

Through the systematic application of this holistic environmental audit methodology, Tripura University gained a nuanced understanding of its environmental practices and their impact. The outcomes not only pinpointed opportunities for resource conservation but also laid the groundwork for a more sustainable, eco-conscious, and environmentally responsible campus. This methodology underscores the commitment of Tripura University to fostering a greener future while contributing to

broader ecological objectives.

## AUDIT STAGE

The initiation of the Environmental Audit at Tripura University was marked by a meticulous process that involved the systematic recording and evaluation of various critical aspects related to the campus environment. This comprehensive approach encompassed several key components, all aimed at providing a holistic understanding of the university's environmental impact and resource utilization.

**Land Use and Land Cover Assessment:** The audit commenced by meticulously recording the land use and land cover (LULC) within the university campus. This assessment helped identify areas designated for different purposes, offering insights into how land resources were allocated and utilized.

**Water Availability and Usage Analysis:** Comprehensive data on water availability and usage were gathered, shedding light on the sources of water, consumption patterns, and water management practices within the campus.

**Waste Generation and Management Practices:** An extensive examination of waste generation and management practices was conducted. This included assessing waste types, disposal methods, recycling efforts, and overall waste management strategies adopted by the university.

**Environmental Parameters Recording:** Environmental parameters, critical for understanding the campus ecosystem, were meticulously recorded. These parameters encompassed a wide range of factors, from air quality to noise levels, helping to gauge the environmental conditions prevailing within the campus.

**Facilities Assessment:** The audit team recorded detailed information about the various facilities and infrastructure across the Tripura University campus. This assessment included an evaluation of the facilities' environmental impacts and resource consumption.

**Stakeholder Engagement:** To obtain a comprehensive perspective on resource usage and environmental practices, structured questionnaires were used to interview staff, students, and other stakeholders. These questionnaires solicited information regarding appliance usage, frequency, and general characteristics, thus providing valuable insights into consumption patterns.

**Data Collection Methods:** Data collection was a multi-faceted process, involving both on-site visits and questionnaire-based surveys across various sectors, including water, energy, and waste. This approach ensured the gathering of comprehensive and accurate data.

**Ambient Environmental Quality Monitoring:** To gauge the environmental status within the university campus, ambient quality assessments were conducted using standardized protocols. This involved monitoring air quality, noise levels, and other environmental parameters to ascertain the campus's environmental health.

**Data Collation and Analysis:** The data collected from these diverse sources were systematically collated and rigorously analysed. This process aimed to identify trends, patterns, and areas that required attention or improvement.

The culmination of this exhaustive data collection and analysis process is the Environmental Audit Report of Tripura University. This report encapsulates a wealth of information, insights, and recommendations derived from the audit, offering a comprehensive view of the university's environmental practices and their impact.

Through this audit, Tripura University demonstrates its commitment to responsible resource

management, environmental stewardship, and a dedication to fostering a more sustainable and ecologically conscious campus. The report serves as a valuable tool for informed decision-making, resource conservation, and the pursuit of a greener and more environmentally responsible future.

## **POST AUDIT STAGE**

The successful completion of the Environmental Audit at Tripura University marks the beginning of a transformative stage - the Post-Audit Phase. This phase holds paramount importance as it translates the valuable insights obtained from the audit into concrete actions that will propel the campus towards a future characterized by heightened sustainability. Within this phase, the campus's distinctive land use and land cover practices take centre stage, revealing an intriguing narrative of its environmental footprint.

The Post-Audit Phase embodies Tripura University's unwavering commitment to translating the findings of the audit into a sustainable shift in perspective. By wholeheartedly embracing these insights, the university charts a course towards a harmonious coexistence of campus development and ecological mindfulness. In doing so, Tripura University ensures a lasting legacy marked by enlightenment, innovation, and a profound commitment to environmental stewardship.

This phase is where ideas, strategies, and initiatives come to life, taking root in the fertile ground of sustainability. It is a time for innovation, collaboration, and collective action as the university community joins hands to implement changes that will reduce its environmental impact, enhance resource efficiency, and contribute to a greener, more sustainable future.

With a steadfast focus on practical actions, the Post-Audit Phase underscores Tripura University's dedication to making tangible and lasting changes. These changes extend beyond campus boundaries, setting an example for responsible environmental management and inspiring others to follow suit. It is a phase where the vision of a sustainable and eco-conscious campus becomes a reality, and the journey towards heightened sustainability begins in earnest.

In essence, the Post-Audit Phase is a call to action, a commitment to evolve and adapt in the pursuit of a more sustainable tomorrow. It is a testament to Tripura University's role as a leader in fostering positive change, not only within its academic pursuits but also in its profound responsibility towards the environment. As the university strides forward into this exciting phase, it carries with it the hope and promise of a brighter, greener, and more environmentally aware future.

## **Land use and land cover**

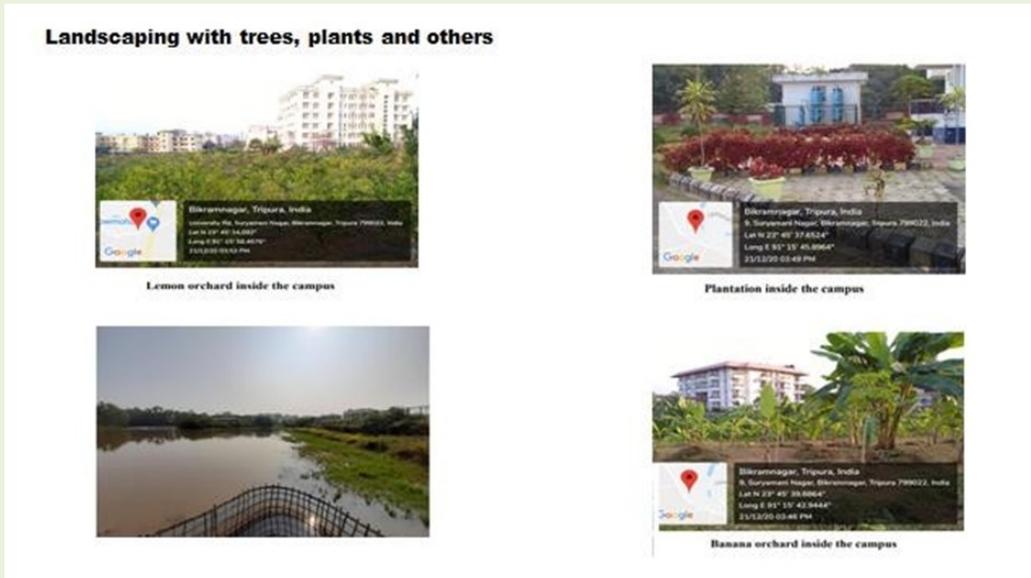
### **Preserving Ecosystem Diversity and Wetlands**

Set against an undulating backdrop, the heart of Tripura University campus cradles a serene wetland, a shimmering gem that gracefully cascades toward the southeastern boundary. Nourished by rainwater, this aquatic haven flourishes year-round, offering sanctuary to an array of aquatic flora and fauna. The enchanting tableau of scattered trees weaves a vibrant tapestry for a diverse spectrum of life forms. Artful integration of Academic Departments, residential quarters, and hostels within this landscape reflects a thoughtfully orchestrated urban equilibrium.

Insights from the recent study unveil a campus spanning 97 acres. Within this expanse, the main campus covers 75 acres, augmented by an additional 22 acres since 2015. Orchards, wetlands, Botanical garden and Forest Park, and playgrounds collectively embrace 29.07 acres (29.97%; Fig. 1). Orchestrated plantations adorn internal thoroughfares, enclaves housing guesthouses/hostels, residential quarters, and the Botanical garden and Forest Park. Yet, concerns arise from the silting of the wetland and its embrace by dense grass and aquatic weeds in pockets.

**Balancing the Constructed and the Ecological**

Approximately 38.74 acres (~39.94% of the total area) stand as built domains, encompassing residential quarters, hostels, academic departments, and administrative hubs. Given the scarcity of elevated land, a trend of encroaching upon the wetland for new constructions has emerged. Recent architectural endeavours gravitate toward multistoried structures, a testament to the university's vertical expansion vision. Interwoven road networks bridge buildings, traversing an estimated 2.82 acres, while expansive playgrounds extend across nearly 6.43 acres.



**Landscaping with trees, plants and others**



Lemon orchard inside the campus



Plantation inside the campus



Banana orchard inside the campus

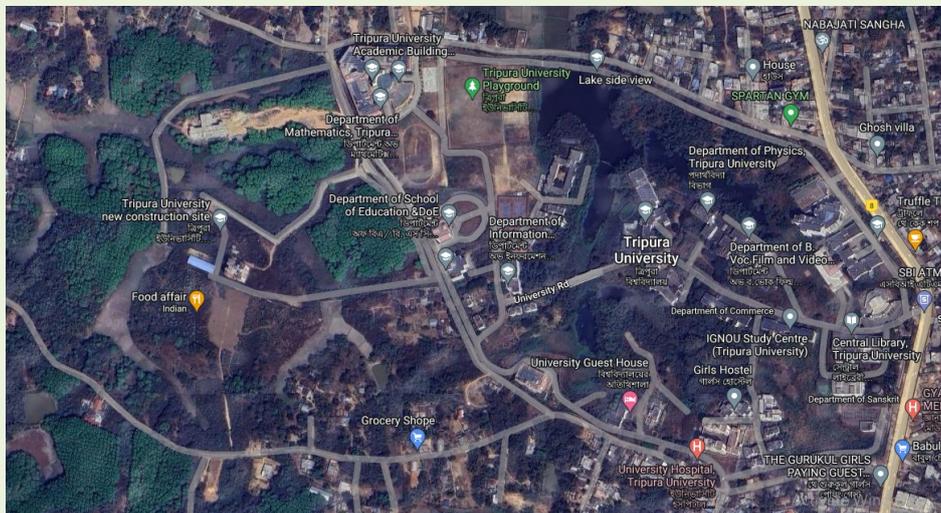


Fig 1: The Map of Tripura University campus

Table 1: Land use categories in Tripura University Campus

Sl. No.	Land Use Category	Area (in approx. Acres)
1	Botanical Garden and Forest Park	3.75
2	Wetland (Lake area)	7.95
3	Play ground	6.43
4	Orchards	10.94
5	Road	2.82

6	Foot Path	0.21
7	Pump Station	0.20
8	Protection Wall	0.02
9	Drain	0.46
10	Retaining Wall	0.02
11	Culvert	0.02
12	Building Under Construction	1.03
13	Overhead Tank	0.009
14	Car Parking	1.48
15	Garage	0.15
16	Building	29.17
17	Transformer	0.104
18	Generator	0.05
19	Security House	0.012
20	Water Pump	0.04
21	Septic Tank	0.88
22	Jungle Area	5.51
23	Tin Shed	0.06
24	Power Sub Station	0.25
25	Toilet	0.49
26	Garden	0.25
27	Statue	0.001

### Water Audit

Water, the lifeblood of our planet, is an indispensable natural resource that sustains all living organisms. Its availability is intricately tied to climatic patterns and geographical features. The significance of water is undeniable, as it serves as the foundation for life itself. However, despite its natural abundance, readily accessible and potable water is a luxury not freely bestowed upon human populations. Through conscientious practices, efforts have been made to conserve and make water available for human consumption. Alas, rampant and unsustainable utilization of water resources has brought forth the twin challenges of contamination and depletion. Groundwater, as well as water held within lakes, ponds, and streams, faces imminent peril due to these anthropogenic pressures.

The escalating threats to water resources underscore the urgency of their conservation, protection, and management. In the face of mounting concerns, the need to ensure the sustainable availability and utilization of water within the campus of Tripura University becomes paramount. A concerted approach to water management is essential to prevent further deterioration of these vital resources.

Water auditing serves as a comprehensive tool to gauge the quality, availability, and utilization of water resources. Its scope encompasses not only the assessment of these attributes but also an evaluation of the facilities in place and methodologies adopted to rejuvenate and harness water resources. Through systematic assessment, water auditing aims to maintain the integrity of water sources, averting their degradation and ensuring their continued vitality.

As the campus of Tripura University engages in a Water Audit, it reaffirms its commitment to responsible water stewardship. The audit stands as a testament to the university's dedication to protecting and enhancing water resources within its purview. By conducting this audit, the institution takes a crucial step toward safeguarding these invaluable assets, thereby contributing to a sustainable and ecologically conscious future.

***Water Usage and Management: A Pragmatic Approach***

***Water Consumption: A Daily Necessity***

Within the confines of Tripura University's vibrant campus, water plays an indispensable role in meeting the daily needs of its occupants. A staggering 431,000 liters of water are drawn from its sources each day, serving the needs of both university residents and the academic and administrative departments alike (Table 2). This consistent and substantial demand underlines the importance of prudent water management.

***A Sustainable Paradigm: Reuse and Recycle***

In a commendable display of sustainable practices, stakeholders residing within the university's residential quarters embrace the concept of reusing greywater. This greywater, derived from various domestic activities, finds new life in nurturing gardening and cultivating vegetable fields. Additionally, water recycling initiatives operate under the auspices of authoritative guidance, activated as needed. Such initiatives contribute to the holistic goal of preserving water resources and minimizing wastage, thereby aligning with the university's green agenda.

***Nature's Bounty: The Gift of Rainwater Harvesting***

Tripura University is graced with a natural marvel, a substantial water body nestled within its premises. This sprawling lake not only adds to the campus's aesthetic charm but also serves as a vital reservoir for rainwater harvesting. During the monsoons, the rooftops of the campus buildings channel rainwater directly into the lake through an intricate network of rainwater outlets and reinforced concrete drains. This ingenuity ensures the continuous replenishment of the groundwater table throughout the year, bolstering its levels. To sustain a consistent water level, a sluice gate has been strategically positioned, complemented by a semi-permanent structure. These interventions are pivotal, guaranteeing a stable water level in the lake. Furthermore, this vast water body serves as a natural wellspring for recharging the groundwater and diligently supplying ample water through the university's pumping systems.

As Tripura University embraces sustainable water practices, it not only meets its immediate water needs but also champions the preservation of this precious resource for future generations. Through innovative approaches such as rainwater harvesting and greywater reuse, the institution signifies its commitment to responsible environmental stewardship.

Table 2: Source and uses of water in the TU campus

Source of water		
Sl. No	Parameters	Information
1	No of Wells	2
2	No of the motors used	2
3	Horsepower- motor	20 HP x 2
4	Depth of well- Total	76 m x 2
5	Capacity of Tank-Total	150000 L
6	Iron Removal Plant	02x 10000; 02x5000
Quantity of water used in different sections of the Campus		
	Sections	Water use (L/day)
7	Hostel	135000
8	Resident quarter	54000
9	Administrative block	8000
10	Construction work	Self-Arrangement
11	Canteen	4000
12	Urinals and Toilets	80000

13	Departments	63000
14	Gardens	50000
15	Laboratories	20000
16	Drinking	12000
17	Leakage	5000
18	Main purposes of water use in the campus	Drinking and cooking purpose Toilets and wash areas Laboratory use Gardening Construction
19	Nos. of water tap excluding households/ residential quarters)	1250 Nos
20	Water cooler and drinking water filtration facility (excluding households/ residential quarters)	68 Nos
21	Nos. of urinal and toilets (excluding households/ residential quarters)	113
22	Nos. of waterless /bio-toilets	Nil
23	Any water wastage/why?	Yes, leakage from pipes and tanks, leaving of taps open at times
24	Water usage for gardening	50000 Ltr
25	Wastewater sources	leakage from pipes and tanks, Overflowing of tanks from residential qtrs., Toilets, laboratories, hostels
26	Use of wastewater	Nil
27	The fate of wastewater from labs	Discharged into soak pit in case of contamination and natural discharge
28	Any wastewater treatment for lab water	No
29	Whether any green chemistry method practiced in Labs	No
30	Rainwater harvesting	Rain water harvesting is maintained by the water body within the premises which also helps in maintaining the ground water level and there is no reusable rain water which is harvested

### Water Conservation facility

A natural lake extends about 15 acres of land within the premises of the university (locally called Lunga land). This lake recharges the rain water collected from the entire campus and forms the reservoir for fish farming throughout the year. Additionally it also supports agricultural field of the local community along with recharging the ground water table. The lake water also serves the purpose of irrigating the orchards maintained in the campus like sweet lemon, banana, guava, etc. during the pre-monsoon periods.



### *Water Source and Treatment*

Tripura University meets its water demands through the utilization of two underground tube wells. This water, retrieved via motor-driven mechanisms, undergoes a meticulous purification process within an iron removal plant cum oxidation and mixing chamber. This sophisticated treatment regime renders the water not only consumable but also portable. The transformation is remarkable, as untreated water harbors substantial sediments, rendering it unsuitable for direct use.

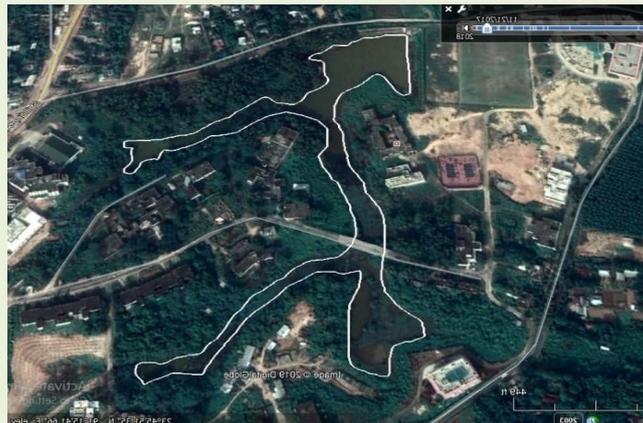


Fig. 2. Map showing the Tripura university lake

### **Observations**

A thorough evaluation of Tripura University's water management practices has unveiled noteworthy observations that demand earnest consideration. Notable observations encompass various dimensions of water usage, infrastructure, and maintenance, delineating areas that necessitate intervention:

- ❖ **Absence of Reusable Water Treatment Facility:** Notably absent is a dedicated facility for treating wastewater emanating from diverse sources, including academic and administrative

buildings, the library, residential quarters, guest houses, hostels, laboratories, and the canteen. The lack of this facility inhibits efficient recycling and reuse of water, amplifying the strain on fresh water resources.

- ❖ **Overflowing Overhead Water Tanks:** Instances of water tanks overflowing have been encountered intermittently. This issue not only signifies wastage but also underscores the need for better monitoring and control mechanisms to ensure optimal utilization.
- ❖ **Inadequate Water Consumption Monitoring:** Effective water resource management is impeded by the absence of systematic consumption monitoring systems across the campus. The lack of accurate records undermines the formulation of targeted conservation strategies.
- ❖ **Sediment Accumulation in the Lake:** The picturesque lake area, while providing an aesthetic charm, grapples with sediment accumulation, particularly during rainfall. This phenomenon jeopardizes both water quality and the ecosystem's equilibrium.
- ❖ **Uncontrolled Water Discharge from Buildings:** Water generated within various buildings is presently discharged into the lake without proper treatment or containment measures, potentially leading to ecological imbalances.

### **Suggestions and Recommendations**

In the pursuit of sustainable and responsible water management, Tripura University envisions a future marked by prudent conservation and innovative solutions. With a focus on achieving these goals, the following recommendations are presented:

- ❖ **Enhancing Rainwater Harvesting Systems:** The augmentation of rainwater harvesting systems emerges as a priority. A concerted effort to equip each building with efficient rainwater harvesting mechanisms would foster water reuse and replenishment.
- ❖ **Igniting Water Conservation Drives:** A comprehensive water conservation initiative is advocated, leveraging the participation of all stakeholders. Collective efforts to reduce water consumption through awareness campaigns and conscious practices would yield significant outcomes.
- ❖ **Implementing Automated Overflow Prevention:** The installation of automated sensors to prevent water tank overflow serves a dual purpose: preventing wastage and streamlining water distribution.
- ❖ **Adopting Automated Taps:** The adoption of automated taps aligns with modern technological advancements. By regulating water flow, these taps mitigate unnecessary consumption, contributing to a culture of efficiency.
- ❖ **Establishing a Sewage Treatment Plant (STP):** Introducing a Sewage Treatment Plant on the campus holds substantial potential. This facility could effectively treat wastewater, offering a sustainable source for toilet flushing and irrigation purposes.

Tripura University's journey towards responsible water management rests on the foundation of these insights and recommendations. As the institution moves forward, a commitment to effective conservation practices and prudent resource utilization will pave the way for a greener, more sustainable campus ecosystem.

## Waste disposal audit

### *Evaluating Waste Disposal Practices*

The waste disposal audit unravels the intricate web of waste management practices within the university campus, aiming to mitigate the adverse ecological and health implications associated with improper waste handling. The multifaceted nature of waste, encompassing diverse categories, necessitates a holistic approach towards its management.

### *Assessing Waste Categories: A Prerequisite for Effective Management*

Solid waste, a byproduct of human activity, is categorized into three distinct classes: biodegradable, non-biodegradable, and hazardous waste. Biodegradable waste encompasses organic materials like food waste and canteen disposables, along with toilet waste. Non-biodegradable waste encompasses commonplace items such as plastic, tins, and glass bottles, often discarded in households and educational institutions. The most critical category, hazardous waste, encompasses materials with potential health or environmental threats, including corrosive chemicals, acids, and flammable substances.

### *Environmental Implications of Inadequate Waste Management*

The management trajectory of waste is intrinsically linked to the environment and public health. Incorrect storage, collection, and disposal can incite environmental degradation, engendering unsightly litter in communities and precipitating health concerns. The repercussions extend further, infiltrating soil and water sources with harmful contaminants. Combustion of waste contributes to the release of greenhouse gases, exacerbating global climate change.

### *Catalyzing Sustainable Practices*

A cornerstone of sustainable waste management rests upon the principle of minimization. The audit recognizes the urgency of implementing prudent practices, propelling the following recommendations:

**Hazardous Waste Vigilance:** Special emphasis is placed on the meticulous management of hazardous waste. A proactive stance in handling materials posing potential threats to health and the environment is paramount.

**Biodegradable Waste Valorization:** Transforming biodegradable waste into a resource holds immense potential. Technologies like anaerobic digestion can harness energy from these materials, while composting can yield valuable organic fertilizers.

**Championing Non-Biodegradable Waste Recycling:** The repurposing of non-biodegradable waste through recycling and reuse is pivotal. This approach curtails the environmental burden posed by these materials.

**Scientific Disposal over Unscientific Practices:** The disposal of waste should adhere to scientific guidelines, avoiding practices like pit dumping or burning. Such improper disposal methods can contaminate soil and water resources, perpetuating environmental harm.

### *Holistic Vision for Sustainable Waste Management*

The waste disposal audit functions as a critical lens, appraising existing waste management policies while charting a pathway towards transformation. An imperative fusion of conscientious practices, sustainable technologies, and informed policies is prescribed. Ultimately, the audit serves as a

proactive endeavor to mitigate waste-related challenges, safeguarding the environment, and elevating the overall health and sustainability of the university campus.

### **Status of Solid Waste Generation in the campus**

#### ***Solid Waste Generation Dynamics: A Comprehensive Insight***

The intricate web of solid waste generation within the university campus unveils an essential facet of the institution's environmental impact. Every corner of Tripura University, encompassing academic departments and administrative domains, contributes to the generation of waste, necessitating a meticulous evaluation of the prevailing practices.

#### ***Microcosmic Waste Handling: Departmental Initiatives***

Solid waste generation permeates every department and administrative office, spawning the creation of waste in diverse forms. Small waste bins stationed within departments become repositories for generated waste. Subsequently, the diligent housekeeping personnel orchestrate the transfer of waste from these smaller bins to larger receptacles, effecting a seamless waste management process.

#### ***Culmination in Collection: Coordinated Waste Transport***

A cohesive network of waste bins strategically positioned throughout buildings expedites the waste collection process. The vigilant housekeeping staffs diligently congregate the waste from these distributed bins, ensuring a hygienic and organized transition. Ultimately, the collected waste is channeled into larger waste bins, poised for collection by the Agartala Municipal Corporation's waste disposal vehicle.

#### ***Quantifying the Waste Footprint: An Empirical Glimpse***

Quantifying the extent of solid waste generation reveals the university's ecological footprint. A comprehensive assessment illustrates the distribution of waste generation across various segments of the campus. Notably, hostels and faculty accommodations, including teacher flats and quarters, emerge as the prominent contributors to the accumulated solid waste.

#### ***Empirical Insight into Weekly Waste Generation***

As substantiated by empirical data presented in Table 3, the diverse stakeholders of the university collectively generate an average of 428 kg of distinct solid waste variants per week. This robust accumulation underscores the significance of devising sustainable waste management strategies to curtail the ecological implications associated with such significant waste generation.

#### ***Navigating Toward Sustainable Waste Management***

The assessment of solid waste generation underscores the critical need for holistic waste management strategies within the university campus. With departments, administrative units, hostels, and faculty residences all playing their part in this ecological equation, collaborative efforts are essential to minimize waste generation and optimize its management. The quantification of waste underscores the importance of tailored strategies, which prioritize resource optimization, waste minimization, and sustainable practices. In the collective journey towards an environmentally conscious campus, sustainable waste management takes center stage, fostering a harmonious coexistence between the academic domain and nature.

## **Solid Waste Management**

### ***Holistic Solid Waste Management: A Symbiotic Endeavor***

Within the realm of sustainable practices, the management of solid waste serves as a poignant focal point where all stakeholders converge. It is here that collective awareness finds resonance, and each entity within the university ecosystem orchestrates their individual role in the solid waste management symphony, guided by convenience, requisites, and resource accessibility.

### ***Tailored Practices, Unified Objective***

Intriguingly, the multifaceted tapestry of solid waste management weaves together diverse stakeholders, each enacting their own distinctive set of practices. These practices, though unique to each sector, coalesce around the overarching pursuit of sustainable waste management. Departments, administrative units, and other constituents undertake a purposeful approach to waste management, encapsulating a holistic commitment to environmental stewardship.

### ***Venturing into Departmental Realms***

Venturing into the labyrinthine corridors of academia, one uncovers a remarkable endeavour. Across the 45 academic departments of the university, a collective of 180 indoor dustbins stand as silent sentinels to the cause of waste disposal. Each department, on average, hosts around five of these vigilant dustbins. However, an intriguing observation emerges – the absence of a dedicated waste segregation mechanism within these academic bastions.

### ***A Call for Systematic Segregation***

Within this landscape, a clarion call arises for the implementation of systematic waste segregation practices. The journey from the academic sphere to the waste bin necessitates a crucial intermediate step: categorization. While the intent to manage waste responsibly is apparent, the crucial step of segregation remains to be fully realized.

### ***Pathways to Enhanced Solid Waste Management***

Navigating the path toward enhanced solid waste management, it becomes evident that a collective effort is indispensable. The mosaic of stakeholders, each with their unique approaches, converges toward a shared goal – sustainable waste management. Harnessing the momentum of awareness and collaboration, the university community can embark on a journey toward a more responsible, systematic, and effective waste management paradigm.

### ***A Sustainable Vision Unveiled***

As the university community unites its collective vision, a sustainable panorama emerges. It's a vista where waste management isn't merely a pragmatic necessity, but a reflection of shared values. With each stakeholder segment contributing its essence, a harmonious coexistence between academia and environmental stewardship is forged, casting a resplendent glow upon the institution's green audit journey.



Fig. 3: Waste bins and the collection of waste in TU campus



Fig.4: Waste collection centres of AMC in TU campus

Table 3: Solid waste generated on the campus per Week

Stakeholders	Types of solid waste	Average waste generated /week (Kg)	% of waste
Academic Department	Paper waste	42.0	9.81
	Plastic waste	08.0	1.87
	Organic Waste	35.0	8.18
	E-waste	02.0	0.47
Administrative Office	Paper waste	20.0	4.67
	Plastic waste	03.0	0.70
	Organic Waste	12.0	2.80
	E-waste	01.0	0.23
Residential Quarter/Hostels/ GuestHouse	Paper waste	50.0	11.68
	Plastic waste	25.0	5.84
	Organic Waste	200.0	46.73
	E-waste	01.0	0.23
Canteens	Paper waste	05.0	1.17
	Plastic waste	04.0	0.93
	Organic Waste	20.0	4.67
	E-waste	0.0	0.00
TOTAL		428 Kg /week	

***Sustainable Solid Waste Management: Nurturing Nature's Balance***

Within the tapestry of sustainable practices, the University campus has embraced an evolving ethos of solid waste management, ushering in a harmonious coexistence between academia and environmental stewardship. A holistic approach finds resonance in the diverse practices adopted by various stakeholder segments, each weaving their unique contributions toward a shared goal – a greener, cleaner future.

***Distinctive Segregation Efforts***

Diving into the realm of waste management, an array of distinctive practices comes to light. The teacher's quarters stand as exemplars, maintaining individual personal dustbins for solid waste disposal and dedicated pits for organic waste. Remarkably, 40% of Academic Departments and 50% of residential quarters have embraced separate disposal systems for dry and wet waste, portraying a commitment to responsible waste management.

***Segmented Sorting Initiatives***

A nuanced practice emerges, one where biodegradable waste is segregated from its non-biodegradable counterparts. The realms of teacher's quarters, Guest House, and 20% of Academic Departments serve as bastions of this sorting endeavor, while hostels are yet to fully embrace this differentiation.

***Municipal Partnership and Composting***

A synergistic partnership with the Agartala Municipal Corporation (AMC) is central to the campus's waste management narrative. A staggering 90% of accumulated solid waste, excluding pit-dumped waste, is diligently collected by AMC every two days. This waste undergoes a transformative journey – a process of segregation and landfilling for some, while composting becomes the destiny for the rest.

***Championing Responsible Waste Recycling***

While the centralized system underpins effective waste management, an avenue remains untrodden – recycling. Currently dormant, the promise of recycling awaits activation, offering a realm of possibilities to further curtail the ecological footprint.

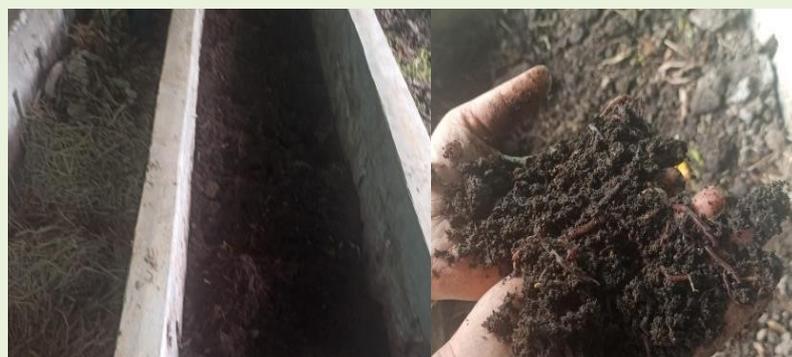


Fig. 5: Different organic wastes used for vermi-composting

### *Vermicomposting: Nature's Eloquent Solution*

In this narrative, vermicomposting emerges as a beacon of innovation and sustainability. Spearheaded by the expertise of The then Prof. Priyasankar Chaudhuri from the Department of Zoology, the university embraced this technology wholeheartedly. Organic waste, including leaves, terrestrial weeds, and kitchen scraps, undergoes a metamorphosis under the diligent care of earthworms.

### *Earthworms as Catalysts of Change*

These earthworms, the *Perionyx excavatus* species, tirelessly transform the organic waste into vermicompost, nutrient-rich organic manure. This process, spanning a mere 45 days, exemplifies nature's efficiency and regenerative power. The precomposted substrates, infused with earthworms, flourish within specially designed cemented tanks, culminating in the birth of nutrient-rich vermicompost.

### *Fertile Harvest: A Gift to Gardens*

From the vermicomposting unit's basement, the fruits of this labour are ushered into flower gardens and Musambi gardens, nurturing sustainable agriculture. The campus comes full circle, as the vermicompost breathes life into the very spaces that foster its inception, contributing to the harmonious rhythm of nature.

### *A Testament to Green Ingenuity*

In the vivid tapestry of green audit endeavors, the journey of solid waste management stands as a testament to the campus's commitment to sustainable practices. As waste is transformed into nourishment, the university's nurturing spirit extends to the environment, weaving a legacy that resonates with ecological balance and responsible coexistence.

Table 4: Nutrient characteristics of different organic wastes

Parameters	C	BC	AC	MC	KW
pH	7.42	6.75	6.3	7.63	10.0
Electrical conductivity ( $\mu\text{Mho cm}^{-1}$ )	580.66	720.00	570.00	990.00	-
Organic Carbon (%)	17.14	19.52	19.83	20.37	36.8
Total Nitrogen (%)	1.26	1.52	1.82	3.08	3.49
Av. Phosphorus ( $\text{mg } 100\text{g}^{-1}$ )	147.39	48.97	26.15	163.71	0.89 % (Total P)
Av. Potassium ( $\text{mg } 100\text{g}^{-1}$ )	1000.00	937.33	1087.00	5962.00	2.18 % (Total K)

\*C = Cow dung, BC = Bamboo - cow dung, AC = Acacia - cow dung, MC = Mikania - cowdung, KW = Kitchen waste

Table 5: Plant nutrients in vermicompost (after 45 days) derived from organic wastes of University Campus

Parameters	C	BC	AC	MC	KW
pH	6.85	7.06	6.9	6.71	7.59
Electrical conductivity ( $\mu\text{Mho cm}^{-1}$ )	594.33	870.00	680.66	1387.00	-
Organic Carbon (%)	11.20	17.90	14.92	17.49	10.48
Total Nitrogen (%)	1.96	2.23	2.16	3.83	1.67
Av. Phosphorus ( $\text{mg } 100\text{g}^{-1}$ )	275.04	130.96	86.88	300.96	1.09% (Total P)
Av. Potassium ( $\text{mg } 100\text{g}^{-1}$ )	1175.00	1420.00	1589.00	7321.33	0.85% (Total K)

\*C = Cow dung, BC = Bamboo - cow dung, AC = Acacia - cow dung, MC = Mikania - cowdung, KW = Kitchen waste

**Liquid waste management:***Navigating Liquid Waste Management: A Sustainable Odyssey*

Within the symphony of sustainability, liquid waste management emerges as a pivotal crescendo in the University's green audit narrative. As the campus engages in scientific exploration, nourishment, and habitation, liquid waste from various sources shapes the ecological harmony. With a holistic perspective, the University seeks to orchestrate responsible liquid waste practices.

*Fluid Origins and Diversity*

Originating from diverse nodes of campus vitality, liquid waste paints a comprehensive mosaic. The conduits of liquid waste originate from the dynamic interplay of Science laboratories, Hostels, Residential quarters, and the bustling canteen. These intricate streams collectively weave a tapestry of environmental responsibility.

*Classifying Liquid Waste*

The University's liquid waste spectrum bifurcates into two distinct categories, each with its own nuances:

1. Sewage Waste: In the first category, sewage waste finds its place. This waste embodies the residues of everyday life, necessitating a meticulous approach to containment and treatment. As a crucial aspect of the campus's sustainability fabric, the management of sewage waste assumes paramount importance.
2. Laboratory, Residential Washing, and Canteen Effluents: The second category comprises laboratory liquids, residential washing effluents, and canteen discharges. An amalgam of academic pursuit, habitation, and nourishment, these effluents collectively contribute to the campus's liquid waste matrix.

*Responsible Disposal Pathways*

Embracing the ethos of sustainability, the campus navigates responsible disposal pathways for liquid waste. Laboratory liquids gracefully find their way to soak pits, ensuring an eco-conscious approach to disposal. Other liquid waste, with the intention of ameliorating the ground's water table, is directed through drainage channels.

*Towards a Sustainable Horizon*

Despite the commendable strides in responsible liquid waste management, the University acknowledges the need for comprehensive solutions. Presently devoid of a dedicated sewage treatment plant, the campus's vision is aligned with the creation of a holistic infrastructure that nurtures liquid waste in an environmentally harmonious manner.

As liquid waste intertwines with the campus's journey towards sustainability, the commitment to stewardship remains unwavering. The University's aspirations echo the establishment of a framework that preserves, rejuvenates, and nurtures liquid waste with the same zeal that it approaches academia and research. In the fluidic embrace of sustainable practices, the campus envisions a greener future, harmonizing with the pulse of the planet.

## **Biomedical waste management**

### ***Navigating Biomedical Waste: A Responsible Journey***

In the tapestry of sustainability, the canvas of biomedical waste management unfurls as an intricate thread, meticulously woven into Tripura University's green audit narrative. As the campus engages in pioneering research, the responsible management of biomedical waste emerges as a key note in its eco-conscious symphony.

### ***Unveiling Biomedical Waste***

Within the confines of the academic pursuit, certain faculties engage in research involving animals. This avenue, while limited in scale, births a trace of biomedical waste – a byproduct of progress. The insignificance of this waste volume underscores the University's commitment to ethical research practices.

### ***A Transitory Dwelling***

In reverence to ethical and responsible waste management, the University treads a cautious path. The carcasses of these research animals find a transitory dwelling, stored within the icy grasp of -20°C temperatures. This interim refuge aligns with the University's commitment to maintaining the dignity of these beings and preserving them for their eventual journey towards responsible disposal.

### ***Collaboration with Agartala Municipal Corporation***

Upon reaching an adequate threshold of collected waste, the University dons the mantle of responsibility. Handing over this biomedical waste baton to the Agartala Municipal Corporation ushers in the final act of this responsible journey. In this seamless handoff, the campus aligns with the broader civic ecosystem, ensuring that even this minor residue of research finds its rightful place in the realm of waste management.

### ***Responsible Stewardship: Ethical Progress***

In the pursuit of academic excellence, Tripura University reiterates its dedication to responsible stewardship. While the volume of biomedical waste remains minute, the conscientious manner in which it is handled reflects the ethos of ethical progress. The University's commitment extends beyond research boundaries, culminating in an environmentally conscious partnership with the community.

As the curtains draw on the chapter of biomedical waste, Tripura University's green audit story resounds with the echoes of responsibility. In these seemingly trivial details lies a testament to the campus's overarching commitment to sustainability, ethics, and the harmonious coexistence of research and environmental consciousness.

## **E-waste management**

### ***E-waste Odyssey: Guiding Technology's Afterlife***

Within the pulsating heart of Tripura University's academic landscape, a silent symphony of technology plays out – a harmony of innovation, learning, and progress. Yet, within this rhythm, the University is attuned to the echo of a different cadence – that of e-waste management. In its quest for sustainable progress, the campus pioneers responsible stewardship of electronic remnants.

### ***Mapping the E-waste Terrain***

The digital tapestry that embellishes Tripura University's educational journey is interwoven with electronic wastes. These technological castaways originate from various precincts – computer laboratories, electronic labs, Physics Labs, Chemistry Lab, Biotech Labs, Academic and Administrative Offices. This intricate amalgam of e-waste paints a portrait of academia's evolving landscape, where the vestiges of progress reside.

### ***E-waste Ensemble***

In this digital symposium of waste, the ensemble of e-waste takes center stage. This ensemble comprises items that have reached the crossroads of their operational life – out-of-order equipment, obsolete lab instruments, circuitry, desktops, laptops, accessories, printers, cables, cartridges, and more. As technology journeys onward, these companions of the past find themselves cast aside, yearning for a fitting afterlife.

### ***The E-waste Echelon: Reuse, Recycle, Dispose***

Tripura University champions an efficient mechanism for e-waste's resolution. The ethos here embraces three key avenues – reuse, recycling, and responsible disposal. Wastes that still bear a spark of utility are given a second life, avoiding premature consignment to oblivion. Yet, for those beyond rejuvenation, the University collaborates with authorized vendors for their conscientious disposal. This partnership ensures that e-waste's voyage is navigated with a commitment to environmental consciousness.

### ***Choosing Wisely: The Buy-back Option***

As technology unfurls its wings towards constant evolution, the University stands at a crossroads – to acquire anew or to embrace the buy-back option for technology's metamorphosis. In a world where newness beckons, Tripura University champions a path of wisdom. The campus's choice echoes an ethos of sustainability, where the embrace of newness is balanced by the prudent management of its technological past.

### ***A Harmonious Technology Choreography***

In the dance of technology's rapid evolution, Tripura University orchestrates a harmonious choreography that resonates with e-waste's melody. As laboratories hum with scientific pursuits and offices pulsate with administrative rhythms, the campus acknowledges its responsibility towards the electronic companions that have served their purpose. Through the tapestry of e-waste management, the University contributes its notes to the symphony of sustainable progress.

## **Hazardous Waste**

### ***Navigating Hazardous Waste: A Journey of Responsibility***

Within the intricate tapestry of waste management, the thread of hazardous waste requires a discerning hand and an informed mind. Tripura University, nestled in the embrace of knowledge, confronts the nuances of hazardous waste management with a blend of understanding and action.

### ***Regulatory Pathways and Unique Challenges***

In the realm of hazardous waste, the Ministry of Environment, Forest and Climate Change, Government of India, presides as the custodian of regulations. The Hazardous Waste (Management and Handling) Rules, 1989, evolved into the more comprehensive "Hazardous waste (Management, Handling, and Trans-boundary Movement) Rules, 2008." Amid this regulatory landscape, Tripura

University stands as a conscientious steward, embracing its responsibility.

### ***Unique Context of Hazardous Waste at the University***

Within the University's academic embrace, hazardous waste assumes a diverse identity. While some departments generate substantial quantities, others align with the classification of conditionally exempt small quantity generators. This category encompasses those generating less than 100 grams of hazardous waste per month. Amid this diversity, awareness and compliance intertwine – some stakeholders may not fully grasp their obligations under these regulations.

### ***Weaving Knowledge into Action: Understanding Hazards***

The crux of effective hazardous waste management lies in understanding potential hazards. Within the campus's academic alcoves and laboratories, knowledge is key. Stakeholders are entrusted with disseminating information on hazardous materials – their reactivity and potential health implications. This conscious dissemination knits a fabric of informed action.

### ***Navigating the Maze: Disposal Uncertainties***

While knowledge serves as the compass, disposal often remains a terrain of uncertainties. Tripura University's Green Audit Committee embarked on a survey that revealed an intricate web of understanding and uncertainty among respondents. A majority displayed an understanding of hazardous waste, yet uncertainty clouded the path of its disposal. Green initiatives designed to manage hazardous waste found themselves ensnared in a shroud of unfamiliarity.

### ***Challenges and a Call for Progress***

As the University's academic clock ticks, hazardous waste's clockwork presents challenges. The blend of variety and small quantities underscores the complexity. The data echoes a tale where household batteries emerge as the most frequently disposed hazardous waste, followed by household and office cleaners, pesticides, and wood preservatives – each slipping into disposal channels in measured quantities.

### ***A Quest for Sustainable Resolution***

Yet, within this journey of challenges, a quest for resolution emerges. Tripura University's embrace of hazardous waste management pivots on responsible handling and transportation to approved treatment facilities. While challenges pepper this path – financial needs for external handling and on-site coordination, the diversity of waste types, and small quantities – the University stands firm, acknowledging its role in this orchestration.

### ***Orchestrating a Harmonious Campus***

As the University's corridors witness the ebb and flow of knowledge, hazardous waste becomes an adjunct to this symphony. The resonance of understanding, the clarion call of awareness, and the rhythm of responsible management harmonize into a tapestry where hazardous waste finds its rightful place. Amid laboratories and academic buildings, Tripura University leads a quest that resonates with responsibility, knowledge, and sustainable progress.

### **Observation**

Amid the sprawling expanse of Tripura University's campus, the Green Audit has unveiled valuable insights that map the trajectory of sustainability. These observations resonate with both progress and potential, setting the stage for conscientious action.

- ❖ **Harmonizing Biomedical Waste Disposal:** In the laboratories' humming heartbeats, biomedical waste emerges as a focal point. The audit shines a light on the need for a more streamlined disposal system. This revelation calls for a symphony where every biomedical waste molecule finds its rightful place in the grand orchestration of waste management.
- ❖ **Nurturing Liquid Hazardous Waste:** As the campus pulsates with academic fervor, liquid hazardous waste seeks a more appropriate disposal path. This observation taps into the essence of responsibility, urging the adoption of practices that safeguard both the campus's vitality and the environment's well-being.
- ❖ **Towards a Plastic-Free Haven:** In a world dominated by plastic, Tripura University is carving its own path. Initiatives have been germinating to weave the campus into a plastic-free haven. This step, though commendable, beckons for collective effort and awareness, a joint endeavor to birth a plastic-free legacy.
- ❖ **Vermi-Composting: Growing Towards Fulfillment:** The campus's green ambitions embrace vermi-composting, a step towards sustainable transformation. Yet, the observation notes a gap between the aspiration and the full realization of vermi-composting's potential. The soil's voice yearns for more organic sustenance.

### Recommendations and Suggestions

From these observations, recommendations bloom like buds, promising a verdant future.

- ❖ **Championing Biodegradable Alternatives:** The heart of sustainability beats within the choice of materials. The realm of biodegradable alternatives stands ready to be championed. This recommendation becomes a call to action, a shift towards materials that breathe in harmony with nature.
- ❖ **Nurturing Vermi-Composting Potential:** The landscape of vermi-composting holds untapped potential, promising to meet the campus's organic cravings. By nurturing this potential, Tripura University can nurture both the soil and its aspirations.
- ❖ **Guiding Liquid Hazardous Waste:** The laboratories' pursuits paint the canvas of discovery, but liquid hazardous waste requires a guided journey beyond campus confines. The recommendation echoes the need for a well-mapped route to off-campus disposal facilities.
- ❖ **Unveiling Paper Recycling's Potential:** Among the rustling pages of academia lies a story of paper. The recommendation suggests embracing a centralized system of paper recycling, weaving the campus into a narrative where paper's life cycles are revered.
- ❖ **Igniting the Incinerator Option:** In the campus's tapestry, an incinerator awaits ignition. This recommendation envisions the installation of an incinerator, a guardian of proper waste disposal that breathes a cleaner future.

The Green Audit's observations and recommendations intertwine, shaping a narrative of transformation. Each observation, a compass pointing north, and each recommendation, a beacon lighting the way. As Tripura University embarks on this journey, the seeds of change are sown, fostering a legacy where sustainability blooms in every corner of the campus.



**Environmental quality audit**

**Evaluating Water Quality: Ensuring Purity and Potability**

**WATER QUALITY MONITORING**

In order to assess the drinking water quality of the university, one drinking water sample from the university was collected in a pre-cleaned one litre polythene bottle for the analysis of different physical & chemical parameters. The analysis was carried out in the laboratory of Tripura State Pollution Control Board using the standard methods given in APHA (American Public Health Association), 2012. The analytical results of the collected water samples are shown in Table 6.

Table: 6: Analytical Result of Drinking Water Sample Collected from Tripura University.

Parameter	Sample data	Standard (BIS, 2012)		Method of measurement
pH	6.68	6.5-8.5	6.5-8.5	pH Meter
Conductivity (µS/cm)	107			Conductivity Meter
TDS (mg/L)	54	500	2000	Gravimetric
Turbidity (NTU)	2.84	5	1	Turbidity Meter
Chlorine (mg/L)	11.4	250	1000	Argentometric
Total Hardness (mg/L)	80.2	200	600	EDTA- Titrimetric
Iron (mg/L)	0.08	0.3	0.3	Spectrophotometric
Magnesium (mg/L)	7.2	30	100	Calculation
Calcium (mg/L)	11.8	75	200	EDTA- Titrimetric
Arsenic (mg/L)	BDL	0.01	0.05	Spéarophilometric

\*BDL= below detectable limit

### *Comprehensive Quality Analysis*

To ensure the adherence of the water to stringent quality standards, a comprehensive assessment of its parameters is imperative. Water samples drawn from various sources within the campus were subjected to thorough analysis. The resultant data, encapsulating quality parameters, findings, and insights, have been succinctly summarized in Table 7. This analytical endeavour provides an accurate representation of the water's quality, thereby ensuring its fitness for consumption and diverse uses.

Tripura University's commitment to ensuring the purity of its water resources is vividly reflected in this stringent quality assessment. By subjecting its water to rigorous scrutiny, the institution safeguards the health and well-being of its occupants while upholding the tenets of responsible environmental management.

Table 7: Water quality analysis report of the water samples obtained from different sources within TU campus

Type of Sample	Water Source/ point of use purifier used	TDS (ppm)	pH Range	Turbidity (NTU)	Iron (ppm)	Calcium (ppm)	Magnesium (ppm)	COD (ppm)
<b>Raw Water</b>	Tap water	50-96	6.5-9	1.2-5.3	0.05-4.5	6.2-8.1	1.2-1.9	55-65
<b>Drinking water</b>	Resin cum RO-UVpurifier (Model Kent MineralRO)	25-30	6.8-7	0.8-1.2	0.01-0.2	2.9869	0.8096	35-44
<b>Raw Feed Water</b>	Feed underground water	52	6.2-6.5	10-22	0.4-0.7	-	-	-
<b>Treated Water</b>	Iron Removal Plant cumoxidation and mixing chamber	59	6.3-6.6	0.8-3	-	-	-	-

### *Assessing Tripura University Lake Water Quality*

#### *Inquisitive Exploration*

Delving into the ecological intricacies of Tripura University's sprawling lake, a meticulous inquiry into its seasonal water quality was spearheaded by a Master's study from the Department of Forestry and Biodiversity (Prajapati, 2019). The exploration, showcased the institution's commitment to fostering knowledge and understanding of its natural resources.

To gauge the water quality's robustness, an exhaustive comparison was drawn between its physico-chemical attributes and the established benchmarks. These benchmarks were defined by the Bureau of Indian Standards (BIS), the World Health Organization (WHO) for drinking water quality, and the pisciculture standard delineated by ICAR-RC-NEH region. The meticulous comparison, encapsulated within Table 8, yielded insightful revelations.

The observations unveiled a nuanced narrative: nearly all assessed parameters aligned favourably with the standard drinking water quality criteria. However, the concentration of Dissolved Oxygen (DO) and Calcium hardness exceeded desirable limits, warranting vigilant attention. Intriguingly, the parameters pivotal for pisciculture, including free carbon dioxide, DO, Total Hardness (TH), and ammonia, surpassed ideal values. This dichotomy is significant as it hints at a potential risk of heightened fish mortality rates.

### Indices of Water Quality

Through systematic analysis, the Water Quality Index for the site was established at 79.95, positioning it within the range of 50 to 100. This placement signifies a positive indication of good water quality. Concurrently, the Palmer's Algal Pollution index unveiled a value of 12, indicating moderate pollution within the lake's ecosystem. According to this index, values between 0-10 signal minimal organic pollution, while 10-15 signifies moderate pollution. The moderate pollution discerned within Tripura University Lake is primarily attributed to sediment accumulation.

As the institution peers into the dynamic realm of water quality, it manifests a deep-rooted dedication to not only academic exploration but also the preservation of its natural assets. By unraveling the complex interplay of parameters and indices, Tripura University demonstrates its commitment to responsible stewardship of its ecological heritage.

Table 8: Seasonal Water quality of Tripura University lake

Sl. No.	Parameters	Monsoon Mean $\pm$ SE	Seasons		Drinking		Fish
			Winter Mean $\pm$ SE	Summer Mean $\pm$ SE	BIS	WHO	ICAR
1	Temp $^{\circ}$ C	31.45 $\pm$ 0.11	19.05 $\pm$ 0.45	33.4 $\pm$ 0.21	-	-	-
2	EC (mhos/cm)	1.62 $\pm$ 0.02	1.42 $\pm$ 0.01	1.16 $\pm$ 0.02	-	-	-
3	Total suspended solid	20.38 $\pm$ 1.07	27.63 $\pm$ 1.80	29.25 $\pm$ 1.66	75	$\leq$ 30	-
4	Total Dissolved Solids	215.75 $\pm$ 1.33	304.12 $\pm$ 1.76	319.13 $\pm$ 2.43	500	500	-
5	pH	7.58 $\pm$ 0.04	7.78 $\pm$ 0.06	6.91 $\pm$ 0.01	6.5-9.2	6.5-8.5	6.7-9.5
6	Total Alkalinity (mg/l)	148.43 $\pm$ 2.50	101.67 $\pm$ 2.34	167.57 $\pm$ 3.05	200	120	50-300
7	Chloride	56.80 $\pm$ 2.37	88.75 $\pm$ 2.17	128.98 $\pm$ 2.97	250	250	-
8	Free CO <sub>2</sub>	5.68 $\pm$ 0.41	5.5 $\pm$ 0.72	7.7 $\pm$ 0.57	-	-	5
9	Total CO <sub>2</sub>	112.31 $\pm$ 0.55	218.10 $\pm$ 2.24	136.30 $\pm$ 2.35			
10	Dissolved Oxygen	9.02 $\pm$ 0.58	9.22 $\pm$ 0.84	9.12 $\pm$ 0.54	4.0	4.0-6.0	4
11	BOD	0.63 $\pm$ 0.18	2.83 $\pm$ 0.41	4.08 $\pm$ 0.39	-	20-30	<10
12	Total hardness (mg/l)	162.5 $\pm$ 2.5	165.25 $\pm$ 1.81	177 $\pm$ 1.69	300	500	30-180
13	Ca <sup>2+</sup> hardness	89.75 $\pm$ 2.01	104.5 $\pm$ 2.69	116.25 $\pm$ 2.51	75	75	75-150
14	Mg <sup>2+</sup> hardness	72.75 $\pm$ 2.41	60.75 $\pm$ 2.78	72.5 $\pm$ 2.87	30	150	-
15	Ammonia	0.98 $\pm$ 0.14	0.91 $\pm$ 0.10	1.05 $\pm$ 0.22	0.5	1.5	0.1

Note: - BIS: Bureau of Indian Standards, WHO: World Health Organization, Reference: IS 10500: 2012, WHO 2004, ICAR-RC-NEH

### Air quality assessment

In the pursuit of a sustainable and healthy campus environment, Tripura University embarked on a comprehensive assessment of air quality within its premises. This endeavour focused on monitoring three critical parameters: Particulate Matter (PM<sub>10</sub>), Sulphur Dioxide (SO<sub>2</sub>), and Nitrogen Dioxide (NO<sub>2</sub>), each offering valuable insights into the quality of the air that the university community breathes.

Particulate Matter (PM<sub>10</sub>): PM<sub>10</sub>, consisting of solid or liquid particles with diameters of 10 micrometers or less, encompasses a range of airborne elements, including smoke, dust, soot, salts, acids, and metals. These particles can originate directly or form indirectly through chemical reactions in the atmosphere, particularly from emissions of motor vehicles and industries.

To ensure accurate measurement, an air quality monitoring station was strategically positioned atop the Laboratory of Chemistry building, chosen for its accessibility, security, and reliable power supply with the services of Tripura State Pollution Control Board (TSPCB). The monitoring was conducted round-the-clock in three shifts, each lasting eight hours. International standard techniques employing Respirable Dust Sampler (RDS) with gaseous sampling attachments and PM<sub>2.5</sub> sampler (manufactured by M/s Environtech Instruments Pvt. Ltd., New Delhi) was employed to measure PM<sub>2.5</sub>, PM<sub>10</sub>, NO<sub>2</sub>, and SO<sub>2</sub>.

The findings revealed that the concentration of PM<sub>10</sub> within the Tripura University campus stood at 63.2 µg/m<sup>3</sup>, while PM<sub>2.5</sub> measured at 44.80 µg/m<sup>3</sup> (as presented in Table 9). Importantly, both figures were below the permissible limits outlined by the Central Pollution Control Board (CPCB) Ambient Air Quality Standards, which are 100 µg/m<sup>3</sup> and 60 µg/m<sup>3</sup> for PM<sub>10</sub> and PM<sub>2.5</sub>, respectively. These results suggest that the major sources of PM<sub>10</sub> and PM<sub>2.5</sub> within the campus likely include dust from vehicular traffic, construction activities, and burning.

**Sulphur Dioxide (SO<sub>2</sub>):** SO<sub>2</sub> is a significant concern, serving as an indicator for gaseous sulphur oxides (SO<sub>x</sub>). In the University Campus, the concentration of SO<sub>2</sub> was found to be a mere 4.39 µg/m<sup>3</sup> (as indicated in Table 9), significantly below the CPCB permissible limit of 80 µg/m<sup>3</sup>. This signifies that the university campus is not plagued by SO<sub>2</sub> pollution. The lush vegetation within the campus also plays a role in absorbing SO<sub>2</sub>, contributing to the healthy air quality.

**Nitrogen Dioxide (NO<sub>2</sub>):** NO<sub>2</sub>, the primary form of NO<sub>x</sub> in the atmosphere, is produced by various human activities. It is not only an air pollutant by itself but also contributes to the formation of ozone (O<sub>3</sub>) and acid rain. In the University campus, the concentration of NO<sub>2</sub> was measured at 15.80 µg/m<sup>3</sup> (as reported in Table 9), significantly lower than the CPCB ambient air quality permissible limit of 80 µg/m<sup>3</sup>.

The results presented in Table 9 provide compelling evidence that the levels of PM<sub>2.5</sub>, PM<sub>10</sub>, SO<sub>2</sub>, and NO<sub>2</sub> within the Tripura University campus fall well within the prescribed standards set by the CPCB. This underscores the university's commitment to maintaining a healthy and sustainable campus environment, promoting the well-being of its community members, and setting a noteworthy example in responsible environmental management.

Table 9: Status of ambient air quality in the campus of Tripura University

Pollutants	Time weighted Average	S-1	Standards (CPCB, 2009)	Method Used
Particulate matter (PM <sub>10</sub> ) µg/m <sup>3</sup>	24 Hours	63.2	100	Gravimetric
Particulate Matter (PM <sub>2.5</sub> ) µg/m <sup>3</sup>	24 Hours	44.80	60	Gravimetric
Sulphur Dioxide (SO <sub>2</sub> ) µg/m <sup>3</sup>	24 Hours	4.39	80	Improved West and Geake
Nitrogen Dioxide (NO <sub>2</sub> ) µg/m <sup>3</sup>	24 Hours	15.8	80	Jacob & Hochheiser

### Vehicular movements

In the course of conducting an environmental audit of our university campus, an in-depth analysis of vehicular movements was undertaken to assess the impact on the environment and formulate recommendations for sustainable transportation practices. This report encapsulates the findings and suggestions resulting from the evaluation.

**Quantifying Vehicular Movements:** Our investigation revealed that, on average, approximately 450 two-wheelers and 150 four-wheeler vehicles, which also include those visiting the campus's bank and post office, frequented the TU Campus during typical days each month. Importantly, this calculation excludes vehicles owned by campus residents, focusing solely on external traffic.

**Parking Facilities:** The University currently provides two designated parking areas to accommodate these vehicles efficiently. However, it was observed that approximately 30 percent of these vehicles visit the campus only briefly, suggesting the potential for optimizing parking and reducing the environmental impact associated with idling and short-term stays.

**Environmental Implications:** The continuous influx of vehicles into the campus has several environmental implications that necessitate attention and mitigation:

- ❖ **Air Quality:** The emissions from both two-wheelers and four-wheelers contribute to air pollution, which can adversely affect the health and well-being of campus residents and local communities.
- ❖ **Traffic Congestion:** The high volume of vehicular movements can lead to traffic congestion within and around the campus, resulting in inefficient transportation and increased greenhouse gas emissions.
- ❖ **Noise Pollution:** The noise generated by vehicles can disrupt the campus environment, impacting the overall quality of life for students, faculty, and staff.
- ❖ **Parking Space Utilization:** The inefficient utilization of parking spaces can lead to haphazard parking, reducing the aesthetics of the campus and potentially causing safety hazards.

The findings of the environmental audit underscore the need for a holistic approach to managing vehicular movements within the university campus. By adopting sustainable transportation practices and implementing the recommended measures, the campus can minimize its environmental footprint while fostering a healthier and more eco-conscious community.

**Recommendations for Sustainable Transportation:** To address these concerns and promote sustainable transportation practices within the campus, the following recommendations are put forth:

- ❖ **Promote Alternatives:** Encourage the use of alternative modes of transportation, such as bicycles, walking, and carpooling, among students, faculty, and staff.
- ❖ **Improve Public Transport:** Collaborate with local authorities to enhance public transportation options to and from the campus, making it a convenient choice for the community.
- ❖ **Implement Parking Policies:** Institute policies that prioritize long-term parking for campus residents and short-term parking for visitors. Implement measures like time limits and parking fees to discourage extended stays.
- ❖ **Green Transportation Incentives:** Introduce incentives for eco-friendly vehicles, such as electric cars and scooters; including designated parking areas and charging stations.
- ❖ **Education and Awareness:** Conduct awareness campaigns to educate the campus community about the environmental impact of vehicular emissions and the benefits of sustainable transportation choices.
- ❖ **Monitoring and Reporting:** Regularly monitor and report on progress in reducing vehicular emissions and enhancing sustainable transportation options to ensure accountability.

**Ambient Noise Levels**

Under the Air (Prevention and Control of Pollution) Act, 1981, noise is regarded as a pollutant. There are two major settings where noise mostly occurs; these are - community noise and industrial noise. Community noise is also called environmental noise and is defined as the noise emitted from all the sources except the noise from the industrial sources. As far as community noise is concerned the WHO guidelines recommend less than 30 dB(A) in bedrooms during the night which is essential for good quality sleep. Again, it should be less than 35 dB(A) in classrooms which is important for good teaching and learning conditions.

The ‘root mean square’ quantity of a sound wave is known as r.m.s excess pressure or more commonly as sound pressure.

Sound level is the sound pressure level in decibels (dB) and is 20 times the logarithm to the base ten of the ratio of a weighted sound pressure to the reference sound pressure. This is expressed as force per unit area either in Newton per square metre (N/m<sup>2</sup>) or in Pascal (Pa).

“A-weighted” means making graded adjustments in the intensities of the sound of various frequencies for the purpose of noise measurement so that the sound pressure level measured by an instrument reflects the actual response of the human ear to the sound measured.

Steady Sound pressure Level which over the given period of time would have given the same total energy as the actual fluctuating time. Thus  $L_{eq}$  is the r.m.s sound pressure level taking the measurement duration as the averaging time. It is calculated as follows:

$$L_{eq} = 10 \log \left( \sum_{i=1}^n f_i 10^{L_i/10} \right)$$

- $f_i$  = Fraction of time for which the consent SPL persists
- $L_i$  = Sound Intensity Level
- $L_{min}$  = Minimum Noise Level during the period of measurement
- $L_{max}$  = Maximum Noise Level during the period of measurement.

The ambient noise monitoring data at different locations of Tripura University Campus are shown in Table 10.

The study was carried out to assess the equivalent noise level ( $L_{eq}$ ) around the university campus both in the day time and night time. Sound Level Meters (SLM) SL-4001 was used for monitoring of noise levels. The noise levels were monitored at least for 30 minutes at each location during monitoring. The noise monitoring was carried out at the 4 (four) locations inside the university campus covering the Entrance gate, Administrative block, Library building and Chemistry department during day time and night time.

Table 10: Noise Levels in dB (A) at different locations within T.U. Campus

Sl. No.	Location	Measured Noise Level at Day Time Leq dB(A)	Standard at Day Time for Sensitive Zone Leq dB(A)	Measured Noise level at Day Time Leq dB(A)	Standard at Night Time for Sensitive Zone Leq dB(A)
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1	Main Gate (Entrance)	48.6	50	39.8	40
2	Near Library Building	46.1	50	39.1	40
3	Near Administrative Building	48.1	50	39.2	40
4	Near Chemistry Department	45.2	50	34.8	40

From the data obtained Table 10, it was observed that the ambient noise levels in four locations are well within the prescribed standard limit during day and night time. The exceeding of maximum permissible limits in these areas can be attributed to the noise emerging from vehicular movements and traffic-related noises along the National Highway/other roads along with the University campus. The noise levels although within permissible limits were bit high in the administrative areas and main gate because of obvious reasons of the congregation of a large number of stakeholders for official works along with large no. of vehicular movement in and out of the building area. In all the sampling stations, the Leq levels were within permissible limits. Due to the reduced population on the campus, the community noise levels at most locations are within the permissible levels.

However, it is important to note that the average noise level, considering all sampling stations within the campus, was lower than the maximum permissible limit of 50db(A) as recommended by the CPCB for all the location. Although the Leq levels are high outside the atmosphere of the classrooms, it should be below the WHO recommended value of 35 dB(A) which is suitable for classroom teaching-learning environment.

### Observations

- ❖ It is estimated that > 60 percent of campus dwellers walk within the campus.
- ❖ Noise is a disturbing factor on campus, particularly along the national highway, and within the campus during all India Examinations and Admission periods.

### Suggestions and Recommendations

- ❖ Encourage the use of alternative modes of transportation, such as bicycles, walking, and carpooling, among students, faculty, and staff
- ❖ Collaborate with local authorities to enhance public transportation
- ❖ Introduce incentives for eco-friendly vehicles
- ❖ The vehicular account should be maintained for the campus dwellers and staff members.
- ❖ Noise attenuation has to be done by planting vegetation around buildings and along Highway.
- ❖ Govt. authorities are requested to monitor the use of loudspeaker and noise producing sources within the 100m radius outside the University campus in compliance with prescribed rules.

## Summary

Environmental auditing is the process of assessing and determining the extent to which the practices of an institution align with eco-friendly and sustainable principles. In this context, Tripura University conducted its Environmental Audit for the year 2021-2022 with the central objective of evaluating the institution's environmentally conscious practices and producing a comprehensive audit report.

The process of environmental auditing commenced by evaluating the institution's waste management protocols, water consumption practices, among others. The audit team systematically assessed various facilities within the university campus, measuring elements like water usage and identifying associated consumption patterns and their environmental impacts. Inputs from staff and students were gathered through inquiries to gain insights into usage habits. Data collection was achieved through on-site visits and direct measurements in different sectors such as water and waste. To gauge the ambient quality of the campus environment, standard protocols for environmental monitoring were employed. The amassed data were meticulously collated and analyzed to formulate this comprehensive environmental audit report for Tripura University.

The present survey revealed a total of 97 acres of land of which of which 75 acres existed as a part of the main campus and an additional area of 22 acres was added to the total area during 2015. Water auditing was conducted for the evaluation of facilities of raw water intake and determining the facilities for water treatment and reuse. The potable water quality is within the standard limits. The daily use of the water during 2021-2022 was approx. 431000 L per day. TU does not have a reusable water treatment facility for wastewater generated from Academic buildings, administrative buildings, library, residential quarters, guest houses, hostels, laboratories, canteen, etc. and thus require attention. The stake holders of the residential quarters of Tripura University specially re-use the grey water which is obtained from the various domestic activities for gardening and vegetable fields etc. Also, water recycling is done as per the direction of the competent authority in broader scale as and when required. Tripura University is blessed with a natural large water body measuring inside its premises. Naturally, this large lake serves the main purpose of rain water harvesting. Rainwater harvesting systems could be improved so that there is a facility available in every building for reusing of water.

The waste collection and disposal were reviewed and the best way to combat the problems was suggested. On an average, various stakeholders generate about 428 Kg of different types of solid waste per week respectively. Investigations revealed that 45 Academic Departments of the University have a total of 180 numbers of indoor dustbins installed for solid-waste disposals. On an average, each of these departments has a provision of about 5 dustbins. The teacher's quarters maintain on an average one personal dustbin for solid-wastes disposals and a pit for the dumping of organic wastes. 40% of the Academic Departments and 50% of residential quarters maintain separate disposal systems for dry and wet waste. For all the academic departments, administrative office, residential quarter/hostels/guest house and canteens 90 % of the accumulated solid waste excluding the ones which are dumped in the pits is lifted by Agartala Municipal Corporation (AMC) every two days, which is then segregated and land filled while for the rest is composted. While the centralized system of solid-waste management involves timely and periodic lifting of the disposed of wastes by the Agartala Municipal Corporation, it is laudable that proper waste management including composting initiatives has been adopted. The organic wastes filled in the pits are subjected to composting which forms a best practice in the campus.

During the audit it was noticed among the faculty members of Tripura University by the Audit Committee, that majority of the stakeholders (> 90%) were confident about their understanding of hazardous waste and their obligation in disposing of materials. It is evident that hazardous wastes which though is generated in very small quantity requires transportation off the university property, to an approved treatment facility. It is evident that there is no collection and management of waste across the campus, but improvements in the overall liquid waste is required to manage the handling and

transportation of the generated waste to a treatment facility off the campus. The laboratory liquid is sent to soak pit and other liquid wastes are mainly drained to improve the ground level of water. University do not have any sewage treatment plant yet. Tripura University has very efficient mechanism to dispose E wastes generated from various sources. All these wastes are put to optimal use. All such equipment's which cannot be reused or recycled is being disposed off through authorized vendors. Instead of a new procurement Buy-Back option is preferred for technology upgradation. Most departments do not generate large quantities of hazardous waste and can be classified as conditionally exempt small quantity generators (generators of less than 100 grams of hazardous waste per month). It is evident that hazardous wastes which though is generated in very small quantity requires transportation off the university property, to an approved treatment facility.

From the water quality data, it has been concluded that, all the analyzed parameters of the drinking water at Tripura University Campus are within the prescribed standards limit of CPCB (Central Pollution Control Board). The observed value of PM-10, PM-2.5, SO<sub>2</sub>, and NO<sub>2</sub>; of air inside the Tripura University Campus are within the prescribed standard limit of CPCB (Central Pollution Control Board, 2009). The air quality monitoring was conducted for 24-hour schedule in three shifts (8 hourly duration) at the monitoring station. The sampling procedures for measurement of PM<sub>2.5</sub>, PM<sub>10</sub>, NO<sub>2</sub> and SO<sub>2</sub> were made according to the internationally accepted standard technique. The Particulate matter PM<sub>10</sub> was observed to be 63.2 µg/m<sup>3</sup> and PM<sub>2.5</sub> was observed to be 44.80 µg/m<sup>3</sup> in the Tripura university campus which is lower than the permissible limits of CPCB Ambient Air Quality Standards of 100 µg/m<sup>3</sup> and 60 µg/m<sup>3</sup>, respectively. In the University Campus, the major source of PM<sub>10</sub> and PM<sub>2.5</sub> might be the dust from Vehicular traffic, construction, and burning. In the University Campus, the SO<sub>2</sub> concentration was observed to be 4.39 µg/m<sup>3</sup>. This is much below the CPCB permissible limit of 80 µg/m<sup>3</sup>. Moreover, the good luxuriant vegetation which is present in the university campus also contributes a lot to the absorption of SO<sub>2</sub> by plants. In the University campus, the NO<sub>2</sub> was observed to be 15.8 µg/m<sup>3</sup>. This is much below the CPCB ambient air Quality permissible limit of 80 µg/m<sup>3</sup>. It was estimated that on an average around 400 nos. of two wheelers and 110 nos of four-wheeler vehicles (including vehicles coming to Bank & Post Office) visited TU Campus in general days per month excluding the vehicles of campus dwellers.

Our investigation revealed that, on average, approximately 450 two-wheelers and 150 four-wheeler vehicles, which also include those visiting the campus's bank and post office, frequented the TU Campus during typical days each month. It was observed that the ambient noise levels in four locations inside the university campus covering the Entrance gate, Administrative block, Library building and Chemistry department are well within the prescribed standard limit during day and night time. The status of noise level value obtained at day time and night time it was found that the noise levels of all the locations were within the prescribed limit. The noise level monitoring was carried out to assess the equivalent noise level (L<sub>eq</sub>) around the Tripura University campus both in the day time and night time. The noise levels were high in the administrative areas and entrance gate because of obvious reasons of the congregation of a large number of stakeholders for official works along with large no. of vehicular movement in and out of the building area. In most of the other sampling stations, the Leq levels were within permissible limits. Due to the reduced population on the campus, the community noise levels at most locations are within the permissible levels.

The Environmental Monitoring inside the campus of Tripura University revealed that the Environmental status in respect of water, air and noise of the university is decent and the campus is free from any kind of major pollutants.

Finally, it can be concluded that the Environment Audit Report-2021-22 will help in assisting the process of an ecofriendly approach to the sustainable development of the Tripura University Campus. The observation, suggestions and recommendations specified at every section will guide the university authority in formulating suitable policy for the university so as to improve the quality of environment within the Tripura university campus by defining its goal such that the concerted efforts can bring about an impact at the global level.



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