



राष्ट्रीय प्रौद्योगिकी संस्थान सिलचर

National Institute of Technology Silchar

(राष्ट्रीय महत्त्व का संस्थान / An Institute of National Importance)

सिलचर / Silchar – 788 010, असम / Assam, भारत / INDIA

फोन/ Phone : (03842) 242074 फैक्स /Fax : (03842) 224797

ई-मेल/ E-mail : nalin@ee.nits.ac.in वेबसाइट/ Website : www.nits.ac.in

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TO WHOMSOEVER IT MAY CONCERN

This is to certify that the Environment Audit Report 2022-23 of Tripura University is an original internal audit work conducted by the Environment 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 Environment 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.

Prof. Nalin B. Dev Choudhury

Dean (Research & Consultancy)

Professor, Electrical Engineering Department

NIT Silchar, Assam 788010



**Environmental Audit Report
(2022-2023)**



TRIPURA UNIVERSITY
(A Central University)
SURYAMANINAGAR – 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

Forward from Vice Chancellor

In an era defined by the pressing challenges of climate change, resource depletion, and environmental degradation, institutions must transcend traditional paradigms and embrace a holistic commitment to sustainability. This ethos is the cornerstone for Tripura University's relentless pursuit of green, energy, and environmental excellence.

The fourth Green, Energy, and Environmental Audit Report for 2022-23 is a testament to the University's unwavering dedication to harmonizing growth with environmental stewardship. As our planet grapples with the far-reaching consequences of unchecked resource exploitation, the actions of educational institutions become increasingly pivotal in shaping a sustainable future.

This audit report meticulously examines Tripura University's practices through the lens of global environmental imperatives. It delves into the intricacies of energy consumption, environmental management, and green initiatives, presenting a comprehensive analysis that scrutinizes the present and charts a course for a more sustainable tomorrow.

At a time when the world faces escalating climate challenges and biodiversity loss, institutions of higher learning bear a significant responsibility. This report, crafted by the diligent efforts of the Green Audit Committee, is not merely a document; it is a compass guiding the University towards ecologically responsible practices and policies.

The urgency to act cannot be overstated. Through this audit, Tripura University takes a conscientious step forward in mitigating its environmental footprint. The recommendations herein are strategic imperatives for the University and echo the global call for decisive action to preserve our planet's delicate ecological balance.

As we navigate the complexities of the 21st century, let this report manifest our commitment to a sustainable future. May it inspire not only introspection but concerted action. Tripura University's journey towards a green, energy-efficient, and environmentally conscious campus is a beacon of hope, illustrating that positive change is necessary and achievable.

Let this report serve as a clarion call for the academic community, urging us all to become custodians of the Earth and champions of a resilient, sustainable global future.

(Prof. Ganga Prasad Prasain)

Acknowledgement

In alignment with our steadfast dedication to environmental stewardship and sustainability, Tripura University has consistently spearheaded numerous initiatives, encompassing environmental campaigns, workshops, and extension programs. Our overarching objective remains to drive positive societal change on both national and global fronts. Recognizing the paramount importance of conducting an environmental audit for the sustainable development of our esteemed institution, Tripura University remains committed to excellence, seeking to enhance environmental quality while preserving the pristine ecosystem of our campus—a commitment aimed at securing a promising legacy for future generations of students and residents.

This comprehensive report, covering the period 2022 - 2023, signifies our fourth formal effort to meticulously document the outcomes of our investigative work and provide an exhaustive analysis of all pertinent aspects of the Environmental Audit process. Aligned with the climate neutrality objectives set by the Government of India, Tripura University aspires to play a pivotal role in mitigating global ecological crisis. To achieve this, we have adopted a holistic approach, including the establishment of an Environmental Audit Committee comprising faculty members with specialized expertise in this field. This committee has diligently collected critical environmental data within our campus while facilitating on-site solutions to address environmental challenges.

The primary aim of the Environmental Audit Committee is to identify prevailing and emerging environmental concerns, involving a comprehensive examination of our environmental management practices and their impact on our campus environment. This report is the result 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 in this report are designed to establish a robust foundation for the 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 aim to collectively confront the challenges that lie ahead. In this collaborative pursuit, this report serves as a vital resource to guide 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, 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 the Member Secretary, TSPCB, and his team for providing essential campus data.

We also extend our sincere appreciation to Prof. Nalin Behari Dev Choudhury from the Department of Electrical Engineering at NIT, Silchar, for his invaluable role as the External Expert for the Environmental Audit 2022-23. 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, 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 in the academic year 2022-23

Prof. Badal K Datta
Chairman

**Tripura University Environmental Audit Committee
2022-2023**

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. Nalin Behari Dev Choudhury, Department of Electrical Engineering, NIT, Silchar.

Convener

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

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Introduction

The conduct of environmental audits assumes importance due to the escalating urgency of environmental concerns and an ever-growing need for sustainable practices. This Environmental Audit Report represents a thorough assessment of the environmental dimensions, operational methodologies, and potential avenues for improvement within the campus of Tripura University. With the predominant 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, and prevailing operational procedures, 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. 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 offer 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 was established as a State University on 2nd October 1987, emerging from the renowned Calcutta University. Designated as one of the 56 Central Universities in India, Tripura University was instituted on 2nd July 2007 through a parliamentary act to establish a teaching and affiliate institution in the state. Nestled in a lush, semi-urban stretch 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 of Tripura, it originated from the past CUPGC. Situated in the North Eastern part of India, the university has been committed to achieving academic excellence. Notably, the university has made significant strides, enhancing its infrastructure and literary landscape.

Presently, the university offers diverse programs in Science, Arts and Commerce. Its academic portfolio comprises 60 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 arts, commerce, science and technology fields.

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

The university boasts 44 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 various sports and socio-cultural activities, including film screenings, musical performances, art festivals, debates, university fairs, sports tournaments, and wellness walks.

The campus encompasses lakes, woodlands, hills, flower gardens, and fruit orchards, creating a tranquil, scenic landscape. 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 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 contributes significantly to the nation's prosperity and plays a pivotal role in bolstering our Gross Domestic Product (GDP). Guided by our unwavering commitment to catalyzing 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 Honourable Prime Minister Shri Narendra Modi, the emphasis on sustainable practices permeates 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 steadfastly commit 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, we are dedicated to overseeing the environmental efficiency of its research and educational endeavours through the diligent efforts of the Environmental Audit Committee.

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. We seek to highlight strengths and areas warranting improvement through meticulous gap analysis. 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 assess the university's environmental practices and resource utilization comprehensively. This systematic approach encompassed the following key elements:

Preliminary Assessment:

- ❖ **Gathering Pertinent Information:** The process commenced with collecting 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.

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 followed 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 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:

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

Through a systematic application of this holistic environmental audit methodology, Tripura University understood its environmental practices and their impact. The outcomes pinpointed opportunities for resource conservation and 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 involving the systematic recording and evaluation of various critical aspects of the campus environment. This comprehensive approach encompassed several key components 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 university campus's land use and land cover (LULC). 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 water sources, 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. The questionnaire set and the resulting data collected from this approach is attached in APPENDIX-I and APPENDIX-II respectively.

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 is valuable for informed decision-making, resource conservation, and pursuing a greener and more environmentally responsible future.

POST AUDIT STAGE

Completing 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 from the audit into concrete actions that will propel the campus toward 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 audit findings into a sustainable perspective shift. By wholeheartedly embracing these insights, the university charts a course toward 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 emerge, 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.

The Post-Audit Phase is a call to action, a commitment to evolve and adapt to pursue a more sustainable tomorrow. It is a testament to Tripura University's leadership in fostering positive change within its academic goals and its profound responsibility towards the environment. As the university strides into this exciting phase, it carries the hope and promise of a brighter, greener, and more environmentally aware future.

Land use and land cover

Set against an undulating backdrop, the heart of the 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 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 show that the campus spans an area of 97 acres. The main campus covers 75 acres within this expanse, 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 roads, housing guesthouses/hostels, residential quarters, and the Botanical garden and Forest Park. Yet, concerns arise from silting the wetland and its embrace by dense grass and aquatic weeds in pockets.

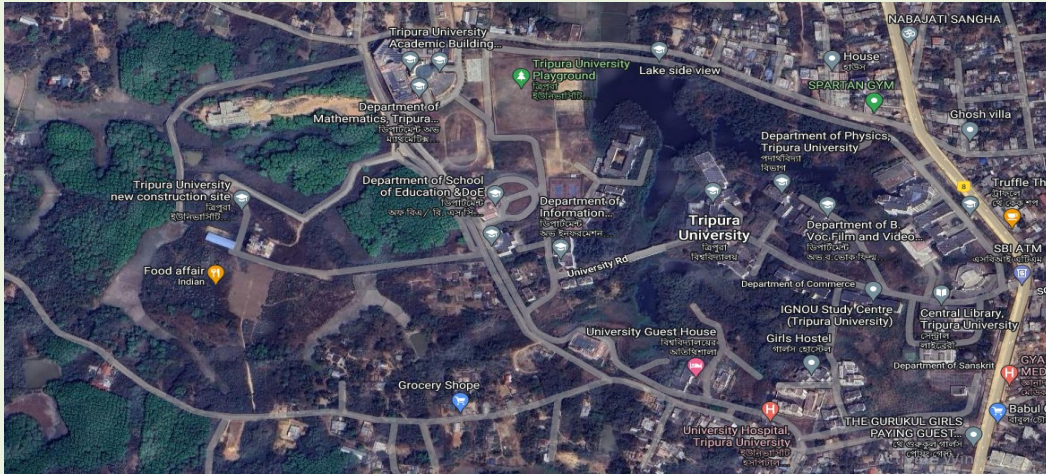


Fig 1: Map of Tripura University campus



Fig 2: Hostels and Academic Building 12 near the lake and plantation area



Fig 3: Sports field near students and scholars hostel

Approximately 38.74 acres (~39.94% of the total area) are built-up sites, 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.

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. Rampant and unsustainable utilization of water resources has brought forth the twin challenges of contamination and depletion. Groundwater and water held within lakes, ponds, and streams face 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 is a comprehensive tool to gauge water resources' quality, availability, and utilization. Its scope encompasses the assessment of these attributes and an evaluation of the facilities in place and methodologies adopted to rejuvenate and harness water resources. Through systematic review, 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 is 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, contributing to a sustainable and ecologically conscious future.

Water Usage and Management

Water Consumption

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 university residents and the academic and administrative departments (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 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.

Rainwater Harvesting

Tripura University is graced with a natural marvel, a substantial water body nestled within its premises. This sprawling lake adds to the campus's aesthetic charm and 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. A sluice gate has been strategically positioned to sustain a consistent water level, complemented by a semi-permanent structure. These interventions are pivotal, guaranteeing a stable water level in the lake. Furthermore, this vast water body is 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. The institution signifies its commitment to responsible environmental stewardship through innovative approaches such as rainwater harvesting and greywater reuse.

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

A natural lake extends about 15 acres of land within the university's premises (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. It also supports the local community's agricultural field along with recharging the ground water table. The lake water also serves the purpose of irrigating the orchards maintained on the campus, like sweet lemon, banana, guava, etc., during the pre-monsoon periods.

Water Source and Treatment

Tripura University meets its water demands by utilizing 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 potable. The transformation is remarkable, as untreated water harbours substantial sediments, salts, and other harmful substances rendering it unsuitable for direct use.



Fig 4: Sluice gate for sustaining and controlling flow/water level of the University Lake



Fig 5: Water treatment facility

Groundwater Management

Groundwater management practices at Tripura University epitomize the institution's dedicated efforts towards sustainable environmental stewardship, a crucial facet of its comprehensive environmental audit. Understanding the pivotal role of groundwater in maintaining ecological balance, the university has implemented a series of meticulous measures to ensure responsible usage and conservation.

One key strategy involves rainwater harvesting systems strategically placed across the campus. These systems effectively capture and channel rainwater into recharge structures, replenishing the groundwater table. The institution has also invested in permeable pavements, allowing rainwater to infiltrate the soil and contribute to natural aquifer recharge.

In addition, the university has embraced efficient irrigation practices, that optimize water usage in landscaping and agricultural areas. This not only conserves groundwater but also enhances water-use efficiency. Moreover, regular monitoring of groundwater is conducted to assess the impact of various campus activities on the aquifer.

The incorporation of native vegetation in landscaping further contributes to groundwater management by reducing water demand and promoting natural groundwater recharge. Through these concerted efforts, Tripura University actively safeguards its groundwater resources, ensuring a sustainable and resilient water management system for the campus ecosystem.

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:** Water tanks overflowing have been encountered intermittently. This issue signifies wastage and 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.
- ❖ **Sedimentation of 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 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 pursuing sustainable and responsible water management, Tripura University envisions a future of 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 is 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:** Installing automated sensors to prevent water tank overflow serves a dual purpose: preventing wastage and streamlining water distribution.
- ❖ **Adopting Automated Taps:** Adopting 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.

Soil Conservation

Soil conservation measures implemented at Tripura University exemplify the institution's commitment to sustainable environmental practices. Recognizing the paramount importance of preserving soil health, the university has undertaken a multifaceted approach to soil conservation as part of its comprehensive environmental audit.

The adoption of agroforestry practices stands out as a pivotal strategy, integrating trees and shrubs into the agricultural landscape. This not only prevents soil erosion but also enhances soil fertility through nutrient cycling. The implementation of contour plowing across the campus has proven instrumental in mitigating runoff and minimizing soil disturbance, thereby preserving the topsoil structure.

Furthermore, the university has embraced cover cropping techniques to safeguard against soil erosion during periods of non-cultivation. Cover crops act as a protective blanket, reducing surface runoff and enhancing water infiltration, contributing to overall soil moisture conservation. The institution has also prioritized the use of organic farming practices, promoting the application of organic manures and compost to improve soil structure and fertility.

These soil conservation endeavors not only align with the institution's environmental consciousness but also contribute significantly to the overarching goal of creating a sustainable and resilient 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 of improper waste handling. The multifaceted nature of waste, encompassing diverse categories, necessitates a holistic approach to its management.

Assessing Waste Categories: A Prerequisite for Effective Management

Solid waste, a byproduct of human activity, is categorized into three classes: biodegradable, non-biodegradable, and hazardous. Biodegradable waste encompasses organic materials like food waste, canteen disposables, and toilet waste. Non-biodegradable waste contains 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 meticulously managing hazardous waste. A proactive stance in handling materials posing potential health and environmental threats 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.

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

Disposal: Waste disposal 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.

Sustainable Waste Management

The waste disposal audit functions appraise existing waste management policies while charting a pathway toward transformation. Ultimately, the audit serves as a proactive endeavor to mitigate waste-related challenges, safeguard the environment, and elevate the university campus's overall health and sustainability.

Status of Solid Waste Generation

Solid Waste Generation Dynamics:

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 waste generation, 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 waste transfer from these smaller bins to larger containers, effecting a seamless waste management process.

Coordinated Waste Transport

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

Quantifying the Waste Footprint:

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.

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 of such significant waste generation.

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 prioritizing resource optimization, waste minimization, and sustainable practices. Sustainable waste management takes center stage in the collective journey towards an environmentally conscious campus, fostering a harmonious coexistence between the academic domain and nature.

Solid Waste Management

Solid waste management is a poignant focal point where all stakeholders converge within sustainable practices. Here, collective awareness finds resonance, and each entity within the university ecosystem orchestrates its role in the solid waste management symphony, guided by convenience, requisites, and resource accessibility.



Fig 6: Waste collection points within campus and collection by AMC truck and personnel

Practices

Solid waste management weaves together diverse stakeholders, enacting their distinctive practices. Though unique to each sector, these practices 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.

Departmental management

Across the 44 academic departments of the university, a collective of 180 indoor dustbins exists for the cause of waste disposal. Each department, on average, hosts around five of these dustbins. However, an intriguing observation emerges – the absence of a dedicated waste segregation mechanism within these academic bastions.

Systematic Segregation

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 vital step of segregation remains to be fully realized.



Fig 7: Assorted bins for waste segregation at some locations in the campus

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 unique approaches, converges toward a shared goal – sustainable waste management. Harnessing the momentum of awareness and collaboration, the university community can journey toward a more responsible, systematic, and

effective waste management paradigm.

Sustainable Vision

As the university community unites its collective vision, a sustainable panorama emerges. With each stakeholder segment contributing its essence, a harmonious coexistence between academia and environmental stewardship is noticed.

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	

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. Diving into waste management, an array of distinctive practices comes to light. The teacher 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

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

Municipal Partnership and Composting

A synergistic partnership with the Agartala Municipal Corporation (AMC) is central to campus waste management. 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 –segregation and landfilling for some, while composting becomes the destiny for the rest.

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 curtail the ecological footprint further.

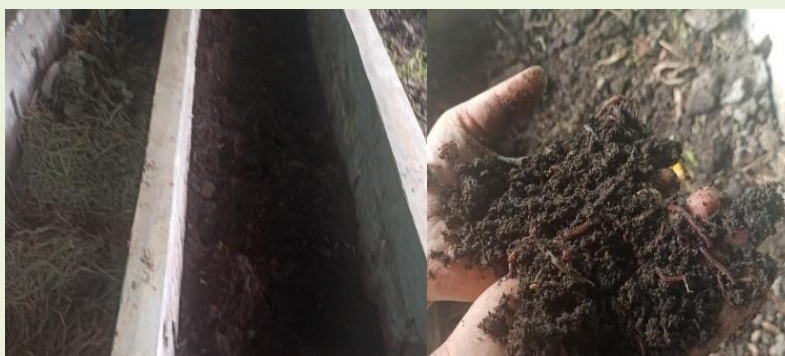


Fig 8: Different organic wastes used for vermi-composting

Vermicomposting:

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.

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 pre-composted substrates, infused with earthworms, flourish within specially designed cemented tanks, culminating in the birth of nutrient-rich vermicompost.

The vermicompost is used in flower 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. Solid waste management is 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.

Liquid waste management:

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 ecological harmony. With a holistic perspective, the University seeks to orchestrate responsible liquid waste practices.

Liquid waste paints a comprehensive mosaic from diverse campus vitality nodes. 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 liquid waste spectrum bifurcates into two distinct categories:

1. **Sewage Waste:** 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, managing sewage waste is paramount.

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

2. Laboratory, Residential Washing, and Canteen Effluents: The second category comprises laboratory liquids, residential washing effluents, and canteen discharges. These effluents are an amalgam of academic pursuit, habitation, and nourishment and collectively contribute to the campus's liquid waste.

Disposal

Embracing the sustainability ethos, 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 is directed through drainage channels to ameliorate the ground's water table.

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 vision aligns with creating a holistic infrastructure that nurtures liquid waste in an environmentally harmonious manner.

As liquid waste intertwines with the campus's journey toward sustainability, the commitment to stewardship remains unwavering. The university's aspirations echo establishing 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 planet's pulse.

Biomedical waste management

As the campus engages in pioneering research, the responsible management of biomedical waste emerges as a critical note in its eco-conscious symphony. Within the confines of academic pursuit, certain faculties engage in animal research. While limited in scale, this avenue 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.

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 toward responsible disposal.

Collaboration with Agartala Municipal Corporation

The University put on the mantle of responsibility upon reaching an adequate threshold of collected waste. 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 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. These seemingly trivial details are a testament to the campus's overarching commitment to sustainability, ethics, and the harmonious coexistence of research and environmental consciousness.

E-waste management

Within the pulsating heart of Tripura University's academic landscape, a silent symphony of technology plays out – a harmony of innovation, learning, and progress. In its quest for sustainable progress, the campus pioneers responsible stewardship of electronic remnants.

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 portrays academia's evolving landscape, where the relics of progress reside.

In this digital waste symposium, the e-waste together takes center stage. This collectively 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.

E-waste: Reuse, Recycle, Dispose

Tripura University champions an efficient mechanism for e-waste resolution. The ethos 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.

Buy-back Option

As technology unfurls its wings toward 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 embracing newness is balanced by the prudent management of its technological past.

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

Within the waste management, the 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.

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 is a conscientious steward, embracing its responsibility.

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 yielding 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.

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

Disposal Uncertainties

While knowledge serves as the compass, disposal often remains a terrain of uncertainties. Tripura University's Green Audit Committee conducted a survey revealing 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 were trapped in unfamiliarity.

Challenges

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 of hazardous waste, followed by household and office cleaners, pesticides, and wood preservatives – each slipping into disposal channels in measured quantities.

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 progress and potential, setting the stage for conscientious action.

- ❖ **Harmonizing Biomedical Waste Disposal:** Biomedical waste emerges as a focal point in the laboratories' humming heartbeats. The audit highlights 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 the campus's vitality and the environment's well-being.
- ❖ **Towards a Plastic-Free Haven:** Tripura University is carving its own path in a plastic-dominated world. 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 vermicomposting, a step towards sustainable transformation. Yet, the observation notes a gap between the aspiration and the full realization of vermicomposting potential. The soil's voice longs for more organic sustenance.

Recommendations and Suggestions

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

- ❖ **Championing Biodegradable Alternatives:** The realm of biodegradable alternatives stands ready to be endorsed. This recommendation becomes a call to action, a shift towards materials that breathe harmoniously with nature.
- ❖ **Nurturing Vermicomposting Potential:** The landscape of vermicomposting holds untapped potential, promising to meet the campus's organic cravings. By nurturing this potential,

Tripura University can promote the soil and its aspirations.

- ❖ **Guiding Liquid Hazardous Waste:** The 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:** The recommendation suggests embracing a centralized paper recycling system, weaving the campus into a narrative where paper's life cycles are reversed.
- ❖ **Igniting the Incinerator Option:** An incinerator awaits ignition in the campus's tapestry. This recommendation envisions the installation of an incinerator for proper waste disposal that breathes a cleaner future.

The Green Audit's observations and recommendations intertwine, shaping a transformation narrative. 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

Water Quality Monitoring

To assess the university's drinking water quality, a sample 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 Tripura State Pollution Control Board laboratory 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 (μ S/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	Spéarophiolometric

*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 briefly summarized in Table 7. This analytical endeavour accurately represents 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)
Raw Water	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
Drinking water	Resin cum RO-UV purifier (Model Kent MineralRO)	25-30	6.8-7	0.8-1.2	0.01-0.2	2.9869	0.8096	35-44
Raw Feed Water	Feed underground water	52	6.2-6.5	10-22	0.4-0.7	-	-	-
Treated Water	Iron Removal Plant cumoxidation and mixing chamber	59	6.3-6.6	0.8-3	-	-	-	-

Water Quality of Tripura University Lake

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.

An exhaustive comparison was drawn between its physico-chemical attributes and the established benchmarks to gauge the water quality's robustness. 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 Dissolved Oxygen (DO) concentration exceeded desirable limits, warranting vigilant attention. Intriguingly, the parameters pivotal for pisciculture, including free carbon dioxide, DO, and ammonia, surpassed ideal values. This significant dichotomy 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 academic exploration and 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.

Air quality assessment

In pursuing a sustainable and healthy campus environment, Tripura University conducted a comprehensive assessment of air quality within its premises. This endeavour focused on monitoring

three critical parameters: Particulate Matter (PM₁₀), Sulphur Dioxide (SO₂), and Nitrogen Dioxide (NO₂), each offering valuable insights into the quality of the air that the university community breathes.

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 °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 ₂	5.68 \pm 0.41	5.5 \pm 0.72	7.7 \pm 0.57	-	-	5
9	Total CO ₂	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 ²⁺ hardness	89.75 \pm 2.01	104.5 \pm 2.69	116.25 \pm 2.51	75	75	75-150
14	Mg ²⁺ 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

Particulate Matter (PM₁₀): PM₁₀, 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, mainly emissions from motor vehicles and industries.

An air quality monitoring station was strategically positioned atop the Laboratory of Chemistry building to ensure accurate measurement. It was chosen for its accessibility, security, and reliable power supply with Tripura State Pollution Control Board (TSPCB) services. 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_{2.5} sampler (manufactured by M/s Environtech Instruments Pvt. Ltd., New Delhi) was employed to measure PM_{2.5}, PM₁₀, NO₂, and SO₂.

The findings revealed that the concentration of PM₁₀ within the Tripura University campus stood at 63.2 $\mu\text{g}/\text{m}^3$, while PM_{2.5} measured at 44.80 $\mu\text{g}/\text{m}^3$ (as presented in Table 9). Notably, both figures were below the permissible limits outlined by the Central Pollution Control Board (CPCB). Ambient Air Quality Standards are 100 $\mu\text{g}/\text{m}^3$ and 60 $\mu\text{g}/\text{m}^3$ for PM₁₀ and PM_{2.5}, respectively. These results suggest that the quality of air in regards to particulate matters needs to be checked to prevent from deterioration. The major sources of PM₁₀ and PM_{2.5} within the campus likely include dust and

exhausts from vehicular traffic, construction activities, and burning.

Sulphur Dioxide (SO₂): SO₂ is a significant concern, serving as an indicator for gaseous sulphur oxides (SO_x). On the University Campus, the concentration of SO₂ was found to be a mere 4.39 µg/m³ (as indicated in Table 9), significantly below the CPCB permissible limit of 80 µg/m³ signifying that the university campus is not plagued by SO₂ pollution. The lush vegetation within the campus also plays a role in absorbing SO₂, contributing to the healthy air quality.

Nitrogen Dioxide (NO₂): NO₂, the primary form of NO_x in the atmosphere, is produced by various human activities. It is an air pollutant and contributes to forming ozone (O₃) and acid rain. In the University campus, the concentration of NO₂ was measured at 15.80 µg/m³ (as reported in Table 9), significantly lower than the CPCB ambient air quality permissible limit of 80 µg/m³.

The results presented in Table 9 provide compelling evidence that the PM_{2.5}, PM₁₀, SO₂, and NO₂ levels 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 developing a noteworthy example of responsible environmental management.

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

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

Vehicular movements

While conducting an environmental audit of our university campus, an in-depth analysis of vehicular movements was undertaken to assess the environmental impact 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, including those visiting the campus's bank and post office, frequented the TU Campus during typical days each month. Notably, 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 environmental audit findings 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, more eco-conscious community.

Promoting Environment Friendly Transportation

Tripura University, recognizing the integral role of transportation in environmental sustainability, has implemented a robust strategy to promote eco-friendly commuting as part of its environmental audit initiatives. The institution is committed to reducing its carbon footprint and mitigating the environmental impact associated with transportation.

To encourage sustainable commuting, the university has prioritized the development of cycling infrastructure and pedestrian-friendly pathways. Dedicated well-maintained walkways contribute not only to reduced vehicular emissions but also to a healthier campus environment. Tripura University as a part of its initiative encourages the use of bicycle which further incentivizes the adoption of sustainable modes of transport among students and staff.

Moreover, Tripura University actively promotes the use of electric vehicles (EVs) within the campus. The university administration also supports awareness campaigns emphasizing the environmental benefits of using electric vehicles, fostering a culture of responsible commuting.

Additionally, the institution encourages the use of public transportation and carpooling among the campus community. Incorporating environment-friendly transportation measures into its environmental audit underscores Tripura University's commitment to creating a sustainable and eco-conscious campus environment.

Recommendations for Sustainable Transportation: To address these concerns and promote sustainable transportation practices within the campus, the following suggestions 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.
- ❖ **Environment-friendly transportation:** Initiatives to enhance accessibility to public transit options and the creation of designated carpooling zones contribute to minimizing individual carbon footprints associated with daily commuting.
- ❖ **Monitoring and Reporting:** Regularly monitor and report 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 considered a pollutant. There are two significant settings where noise mainly occurs: community and industrial. Community noise, also called environmental noise, is defined as the noise emitted from all sources except industrial sources. Regarding community noise, the WHO guidelines recommend less than 30 dB(A) in bedrooms at night, which is essential for good quality sleep. Again, it should be less than 35 dB(A) in classrooms, vital 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, sound pressure.

Sound level is the sound pressure level in decibels (dB) and is 20 times the logarithm to the base ten ratio of a weighted sound pressure to the reference sound pressure. This is expressed as force per unit area in Newton per square metre (N/m²) or in Pascal (Pa).

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

A steady Sound pressure Level would have given the same total energy as the actual fluctuating time over the given period of 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 conducted to assess the equivalent noise level (L_{eq}) around the university campus both in the day and night time. Sound Level Meters (SLM) SL-4001 were used to monitor noise levels. During monitoring, the noise levels were observed at least for 30 minutes at each location. 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 the day and night.

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

Sl. No.	Location	Measured Noise Level at Day Time L_{eq} dB(A)	Standard at Day Time for Sensitive Zone L_{eq} dB(A)	Measured Noise level at Day Time L_{eq} dB(A)	Standard at Night Time for Sensitive Zone L_{eq} dB(A)
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 in Table 10, it was observed that the ambient noise levels in four locations are well within the prescribed standard limit during day and night. The exceeding of maximum permissible limits in these areas can be attributed to the noise emerging from vehicular movements and traffic along the National Highway/other roads along the University campus. Although within permissible limits, the noise levels were a bit high in the administrative areas and main gate because of the congregation of a large number of stakeholders for official works along with the large no. of vehicular movement in and out of the building area. In all the sampling stations, the L_{eq} levels were within permissible limits. Due to the reduced population on the campus, the community noise levels at most locations are within the allowable levels.

However, it is essential 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 L_{eq} levels are high outside the atmosphere of the classrooms, they should be below the WHO recommended value of 35 dB(A), which is suitable for a classroom teaching-learning environment.

Observations

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

Suggestions and Recommendations

- ❖ Encourage using 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 the highway.
- ❖ Govt. authorities are requested to monitor loudspeakers and noise-producing sources within a 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 2022-2023 to evaluate the institution's environmentally conscious practices and produce a comprehensive audit report.

The environmental auditing process commenced by evaluating the institution's waste management protocols and water consumption practices. 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, students, and other stakeholders were gathered through inquiries to gain insights into usage habits. Data was collected through on-site visits and direct measurements in different sectors, such as water and waste. Standard environmental monitoring protocols were employed to gauge the ambient quality of the campus environment. The amassed data were meticulously collated and analyzed to formulate this comprehensive environmental audit report for Tripura University.

The present survey revealed 97 acres of land, of which 75 acres existed as a part of the main campus and an additional 22 acres was added to the total area during 2015. Water auditing was conducted to evaluate raw water intake facilities and determine the facilities for water treatment and reuse. The potable water quality is within the standard limits. The daily use of the water during 2022-2023 was approx. 431000 L per day. TU does not have a reusable water treatment facility for wastewater generated from Academic buildings, administrative buildings, libraries, residential quarters, guest houses, hostels, laboratories, canteen, etc., and thus requires attention. The stakeholders 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 per the direction of the competent authority on a broader scale as and when required. Tripura University is blessed with a large natural water body measuring inside its premises. Naturally, this large lake serves the primary purpose of rainwater harvesting. Rainwater harvesting systems could be improved so that every building has a facility to reuse water.

The waste collection and disposal were reviewed, and the best way to combat the problems was suggested. On average, various stakeholders generate about 428 Kg of different types of solid waste per week respectively. Investigations revealed that 44 Academic Departments of the University have a total of 180 numbers of indoor dustbins installed for solid-waste disposals. On average, each of these departments has a provision of about 5 dustbins. On average, the teacher's quarters maintain one personal dustbin for solid-waste disposals and a pit for the dumping of organic wastes. 40% of the Academic Departments and 50% of residential quarters support separate disposal systems for dry and wet waste. For all the academic departments, administrative offices, residential quarters/hostels/guest house, and canteens, 90 % of the accumulated solid waste, excluding the ones that 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, forming a best practice on the campus.

During the audit, it was noticed among the faculty members of Tripura University by the Audit Committee that the majority of the stakeholders (> 90%) were confident about their understanding of hazardous waste and their obligation to dispose of materials. Hazardous wastes generated in minimal quantity require transportation from the university property to an approved treatment facility. There is no collection and management of waste across the campus. Still, improvements in the overall liquid waste are required to manage the handling and transportation of the generated waste to a treatment facility on the campus. The laboratory liquid is sent to the soak pit, and other liquid wastes are mainly

drained to improve the ground level of water. The university does not have any sewage treatment plant yet. Tripura University has a very efficient mechanism to dispose of E-wastes generated from various sources. All these wastes are put to optimal use. All such equipment which cannot be reused or recycled is being disposed of through authorized vendors. A Buy-Back option is preferred instead of a new procurement 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). Hazardous wastes generated in minimal quantity requires transportation off from the university property

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 values of PM_{10} , $PM_{2.5}$, SO_2 , and NO_2 ; 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 a 24-hour schedule in three shifts (8 hours) at the monitoring station. The sampling procedures for measurement of $PM_{2.5}$, PM_{10} , NO_2 , and SO_2 were made according to the internationally accepted standard technique. The Particulate matter PM_{10} was observed to be $63.2 \mu\text{g}/\text{m}^3$ and $PM_{2.5}$ was observed to be $44.80 \mu\text{g}/\text{m}^3$ on the Tripura University campus, which is lower than the permissible limits of CPCB Ambient Air Quality Standards of $100 \mu\text{g}/\text{m}^3$ and $60 \mu\text{g}/\text{m}^3$, respectively. In the University Campus, the primary source of PM_{10} and $PM_{2.5}$ might be the dust from Vehicular traffic, construction, and burning. In the University Campus, the SO_2 concentration was $4.39 \mu\text{g}/\text{m}^3$. This is much below the CPCB permissible limit of $80 \mu\text{g}/\text{m}^3$.

Moreover, the good luxuriant vegetation on the university campus also contributes a lot to the absorption of SO_2 by plants. In the University campus, the NO_2 was $15.8 \mu\text{g}/\text{m}^3$. This is much below the CPCB ambient air Quality permissible limit of $80 \mu\text{g}/\text{m}^3$. It was estimated that, on an average, around 400 nos. of two-wheelers and 110 nos of four-wheeler vehicles (including vehicles coming to the Bank & Post Office) visited TU Campus on 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, including 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 conducted to assess the equivalent noise level (L_{eq}) around the Tripura University campus both in the daytime and nighttime. The noise levels were high in the administrative areas and entrance gates because of obvious reasons of the congregation of many stakeholders for official works along with the large no. of vehicular movement in and out of the building area. In most other sampling stations, the L_{eq} levels were within permissible limits. Due to the reduced population on the campus, the community noise levels at most locations are within the allowable levels.

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

Finally, it can be concluded that the Environment Audit Report-2022-23 will help assist the eco-friendly approach to the sustainable development of the Tripura University Campus. The observations, suggestions, and recommendations specified in every section will guide the university authority in formulating suitable policy for the university to improve the quality of the environment within the Tripura University campus by defining its goal such that the concerted efforts can bring about an impact at the global level.

Appendix-I**Green/Energy/Environmental Audit Questionnaire - Tripura University****Stakeholder Survey**

Instructions: Please provide accurate and detailed information to aid in the Green/Energy/Environmental Audit Report's data collection and analysis. Your responses are crucial in assessing the university's environmental practices and sustainability efforts.

Section 1: Stakeholder Survey

Please specify if you are a:

Teaching Staff	
Non-Teaching Staff	
Student	
Other (please specify)	

Section 2: General Awareness

- a) Whether TU/Department has conducted any awareness/responsibility programme among the staff/student members:

Yes		No		Maybe	
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- b) Whether all the departments/teachers/non-teaching members/students are aware about the need of the environmental protection and audit:

Yes		No		Maybe	
-----	--	----	--	-------	--

- c) Whether TU has involved the students as volunteers in green activities/ programme:

Yes		No	
-----	--	----	--

- d) Whether TU has conducted any workshop/seminar/lecture on environmental awareness programme inside and/or outside the campus:

Yes		No		Maybe	
-----	--	----	--	-------	--

Section 3: Water Consumption, Usage and Management

- a) Whether TU has an efficient and hygiene water storage facility/ structure/ mechanism to minimize the loss of water during storage:

Yes		No	
-----	--	----	--

- b) Whether TU is using water filter with RO, Aqua Guard and/or large water filter with cooler at strategic locations in the departments/ Central library/ other centres within the campus:

Yes		No	
-----	--	----	--

- c) Whether TU has its own mechanism and/ or technical personnel to repair water leakage/ carry out routine inspection:

Yes		No		Don't know	
-----	--	----	--	------------	--

d) Whether rainwater harvesting units are installed in TU Campus:

Yes No Maybe Don't know

e) Whether TU has developed/ is developing a system for reuse and recycle of water:

Yes No Don't know

f) Whether there is any of necessity for assessing the Water Quality Index (parameters: pH, EC, TDS, Turbidity, metal contaminants- Iron, Arsenic, etc.) of water used in hostel, lab, office, canteen, tap water:

Yes No Maybe Don't know

g) Whether TU has adequate/ sufficient drainage system:

Yes No

h) Do you have any knowledge of the university's water availability and usage patterns?

Yes No

i) If your response to the above question is 'Yes' please provide any details you are aware of regarding water usage and conservation efforts:

Section 4: Energy Conservation Strategies and practices

a) Whether TU has any provision/choice of renewable and carbon-neutral electricity options:

Yes No Maybe

b) Whether TU is planning / has installed solar panels for harnessing solar energy:

Yes No Maybe

c) Whether TU has efficient water heating system:

Yes No Maybe Don't know

d) Whether you are concerned in turning off electrical appliances when not in use either in institutional and/ or commercial and/ or residential area:

Yes No

e) Whether there is monitoring system to switch off the power mains when not in use:

Yes No Don't know

f) Whether the users follow the appropriate and measurable targets for a reduction of energy, such as, computer, printers, lab equipment when not in use

Yes No Maybe Don't know

g) Whether there any options for equipment's running on standby mode:

Yes	No	Maybe	Don't know
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h) Whether TU has taken initiative to purchase efficient and environmentally sound appliances in order to fulfill the green budget:

Yes	No	Maybe	Don't know
-----	----	-------	------------

i) Whether TU has its own mechanism in repairing of electrical fault:

Yes	No	Maybe	Don't know
-----	----	-------	------------

j) Whether the class rooms are with sufficient illumination in day time and ventilation

Yes	No
-----	----

k) How many (%) e-notice generated by the college for academic/administrative purposes in a month?

l) Whether TU has organized lectures on energy conservation in order to give awareness to the students:

Yes	No	Maybe
-----	----	-------

m) How frequently do you use appliances/equipment within the university premises?

Daily	Rarely	Few times a week	Few times a month
-------	--------	------------------	-------------------

Other: _____

n) Can you provide general characteristics of the appliances/equipment you use regularly? (eg., lighting, computers, printers, etc.)

o) Whether the architectural design for TU is based upon use of natural lighting & ventilation, to save extra power for bulbs and fans:

Yes	No
-----	----

p) Whether florescent bulbs are replaced with CFL bulbs/LEDs:

Yes	No	Don't know
-----	----	------------

q) Are you aware of any conservation strategies or practices implemented within Tripura University?

Yes	No
-----	----

r) If your response to the above question is 'Yes', could you briefly describe these strategies or practices?

s) Whether TU has any common car sharing/car pool among the students and faculty:

Yes	No	Maybe	Don't know
-----	----	-------	------------

t) Mode of commute to TU:

Public	<input type="checkbox"/>	Private	<input type="checkbox"/>	Walking	<input type="checkbox"/>
--------	--------------------------	---------	--------------------------	---------	--------------------------

u) If you use private vehicle to commute please specify the type of vehicle:

4 Wheeler with CNG	<input type="checkbox"/>	4 Wheeler without CNG	<input type="checkbox"/>
2 Wheeler	<input type="checkbox"/>	Bicycle	<input type="checkbox"/>

Section 5: Waste Management and Sustainability

a) How familiar are you with the waste disposal practices followed within the university?

Very Familiar	<input type="checkbox"/>	Somewhat Familiar	<input type="checkbox"/>	Not Familiar	<input type="checkbox"/>
---------------	--------------------------	-------------------	--------------------------	--------------	--------------------------

b) Is there any method of segregation of waste materials?

Yes	<input type="checkbox"/>	No	<input type="checkbox"/>	Maybe	<input type="checkbox"/>	Don't know	<input type="checkbox"/>
-----	--------------------------	----	--------------------------	-------	--------------------------	------------	--------------------------

c) Have you observed any waste reduction or recycling initiatives on campus?

Yes	<input type="checkbox"/>	No	<input type="checkbox"/>
-----	--------------------------	----	--------------------------

d) Whether TU has arranged any workshop/seminar/conference for awareness of the students/staff for specific arrangements for recyclable wastes:

Yes	<input type="checkbox"/>	No	<input type="checkbox"/>	Maybe	<input type="checkbox"/>	Don't know	<input type="checkbox"/>
-----	--------------------------	----	--------------------------	-------	--------------------------	------------	--------------------------

e) Whether TU follow specific disposal method for solid or liquid waste in specific manner:

Yes	<input type="checkbox"/>	No	<input type="checkbox"/>	Maybe	<input type="checkbox"/>	Don't know	<input type="checkbox"/>
-----	--------------------------	----	--------------------------	-------	--------------------------	------------	--------------------------

f) Whether the recycling/collection facilities are provided by the Agartala Municipality Council and/or private suppliers (recyclables including glass, white plastic bottle, printer cartridges, cardboard, furniture, plastics, thermocol, waste papers, electrical goods & appliances, electronic gadgets, instruments, equipment, packing materials):

Yes	<input type="checkbox"/>	No	<input type="checkbox"/>	Maybe	<input type="checkbox"/>	Don't know	<input type="checkbox"/>
-----	--------------------------	----	--------------------------	-------	--------------------------	------------	--------------------------

g) Whether TU has any composting ground/ waste collection from every household or any collection unit, etc.:

Yes	<input type="checkbox"/>	No	<input type="checkbox"/>	Don't know	<input type="checkbox"/>
-----	--------------------------	----	--------------------------	------------	--------------------------

h) Is there any mechanism of treatment/uses of domestic influent in the college campus (if so,

Yes	<input type="checkbox"/>	No	<input type="checkbox"/>	Don't know	<input type="checkbox"/>
-----	--------------------------	----	--------------------------	------------	--------------------------

i) If the response to the above question is 'Yes' what is the capacity of treatment plant/composting etc.?

j) Is there any incidents of burning of plastics containing garbage within the campus for necessary reduction?

Yes	<input type="checkbox"/>	No	<input type="checkbox"/>	Maybe	<input type="checkbox"/>	Don't know	<input type="checkbox"/>
-----	--------------------------	----	--------------------------	-------	--------------------------	------------	--------------------------

k) Whether the cleaning products used by the TU staff are eco-friendly and under the COSHH (Control of Substances Hazard to Health) regulations:

Yes	<input type="checkbox"/>	No	<input type="checkbox"/>	Don't know	<input type="checkbox"/>
-----	--------------------------	----	--------------------------	------------	--------------------------

l) Whether TU is using fertilizers, pesticides for any purposes

Yes	<input type="checkbox"/>	No	<input type="checkbox"/>	Don't know	<input type="checkbox"/>
-----	--------------------------	----	--------------------------	------------	--------------------------

m) If your response to the above is 'Yes', please specify amount used per month and places of uses:

E-WASTE MANAGEMENT

n) Is there any means of disposal of unused computers, printers and electronic wastes through authorized agents?

Yes	<input type="checkbox"/>	No	<input type="checkbox"/>	Maybe	<input type="checkbox"/>	Don't know	<input type="checkbox"/>
-----	--------------------------	----	--------------------------	-------	--------------------------	------------	--------------------------

Section 6: Biodiversity and Land Use

a) Is there any garden inside/outside the campus under TU custody?

Yes	<input type="checkbox"/>	No	<input type="checkbox"/>
-----	--------------------------	----	--------------------------

b) Whether the garden is watered by using drip/sprinkler irrigation system:

Yes	<input type="checkbox"/>	No	<input type="checkbox"/>	Maybe	<input type="checkbox"/>	Don't know	<input type="checkbox"/>
-----	--------------------------	----	--------------------------	-------	--------------------------	------------	--------------------------

c) Have you come across migratory birds and wild animals in the TU campus?

Yes	<input type="checkbox"/>	No	<input type="checkbox"/>
-----	--------------------------	----	--------------------------

d) Have you come across stray animals (dogs, cats) in the TU campus?

Yes	<input type="checkbox"/>	No	<input type="checkbox"/>
-----	--------------------------	----	--------------------------

e) Have you noticed any efforts to preserve or enhance biodiversity within the university campus?

Yes	<input type="checkbox"/>	No	<input type="checkbox"/>	Maybe	<input type="checkbox"/>	Don't know	<input type="checkbox"/>
-----	--------------------------	----	--------------------------	-------	--------------------------	------------	--------------------------

f) If the response to the above question is 'Yes', please provide any information about those efforts?

g) Is there any mechanism of review or periodical monitoring of tree species?

Yes	<input type="checkbox"/>	No	<input type="checkbox"/>	Don't know	<input type="checkbox"/>
-----	--------------------------	----	--------------------------	------------	--------------------------

h) Whether TU has taken any programme for plantation of some fruit trees which can attract birds, bees etc.:

Yes	<input type="checkbox"/>	No	<input type="checkbox"/>	Don't know	<input type="checkbox"/>
-----	--------------------------	----	--------------------------	------------	--------------------------

Section 7: Environmental Quality Assessment

a) Have you observed any changes in the ambient environmental quality within the university campus?

Yes

No

b) If your response to the above question is 'Yes', please describe the changes you've observed:

Section 8: Conservation Strategies and Practices

a) Are you aware of any conservation strategies or practices implemented within Tripura University?

Yes

No

b) If your response to the above question is 'Yes', please briefly describe these strategies or practices?

Thank you for taking the time to complete this questionnaire. Your input are invaluable in shaping the Green/ Energy/Environmental Audit Report and contributing to Tripura University's commitment to environmental sustainability.

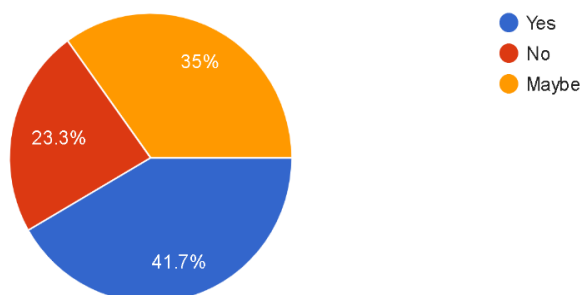
Appendix-II

This section contains responses obtained as a result of the questionnaire survey conducted on the stakeholders. Tripura University is at the forefront of developing into a model environmentally sustainable campus with efforts from relevant departments and also all the concerned stakeholders. Several sensitization programs are conducted at the departmental and university level as well as outreach-outside campus programs for general awareness. The university perseveres to promote judicious use of resources, proper disposal of residues and waste, maintaining the cleanliness of campus and making an environmental pollution free campus that can enhance the overall growth and development of the academic atmosphere of all the stakeholders. The questionnaire consists of several questions that seek to understand the impact of the efforts being felt by the stakeholders. The survey revealed that more ventures are needed for mass awareness, acceptance and participation to steer the paradigm shift towards an epitome of environmental stewardship among the universities in the country. The questionnaire is divided into sections and is presented as follows:

General Awareness

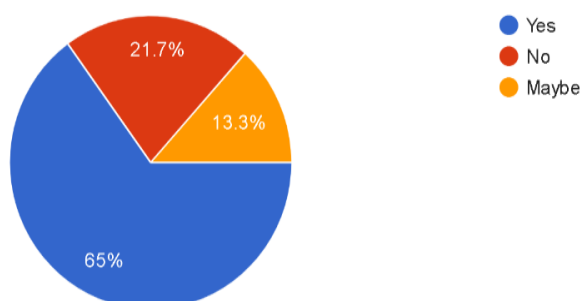
a) Whether TU/ department has conducted any awareness/ sensitization programme among the staff/ student members:

60 responses



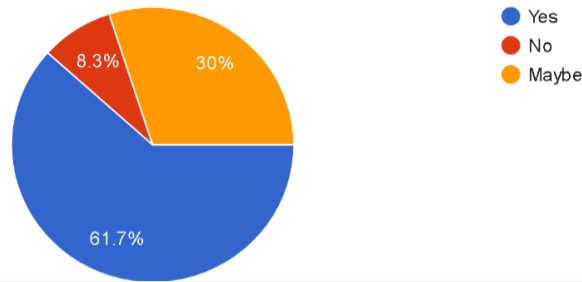
b) Whether all the departments/ teachers/ non-teaching members/ students are aware about the need of the environmental protection and audit:

60 responses



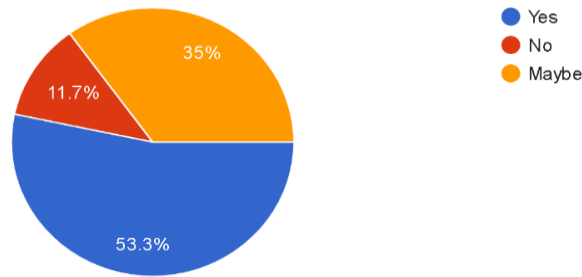
c) Whether TU has involved the students as volunteers in green activities/ programmes:

60 responses



d) Whether TU has conducted any workshop/ seminar/ lecture on environmental awareness programme inside and/or outside the campus for society/ people outside the university:

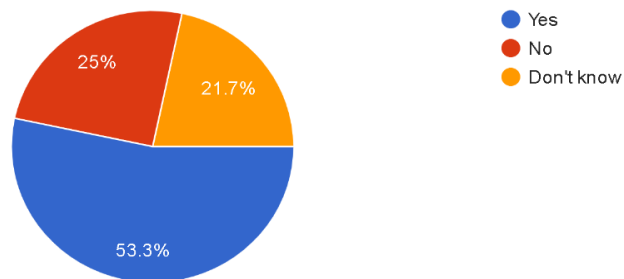
60 responses



Water Consumption, Usage and Management

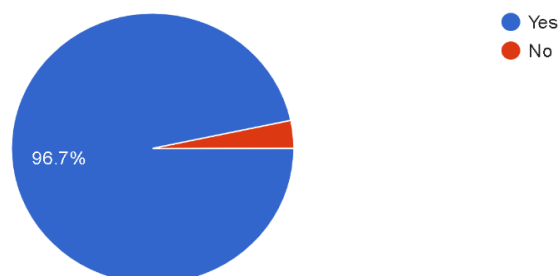
a) Whether TU has an efficient and hygienic water storage facility/ structure/ mechanism to minimize the loss of water during storage:

60 responses



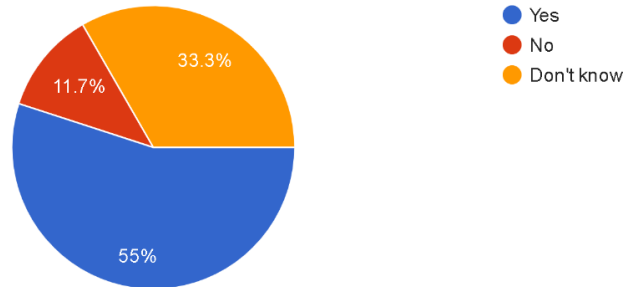
b) Whether TU has installed/ is using water filter with RO, Aqua Guard and/ or large water filter with cooler at strategic locations such as in the departm.../ Central library/ other centres within the campus:

60 responses



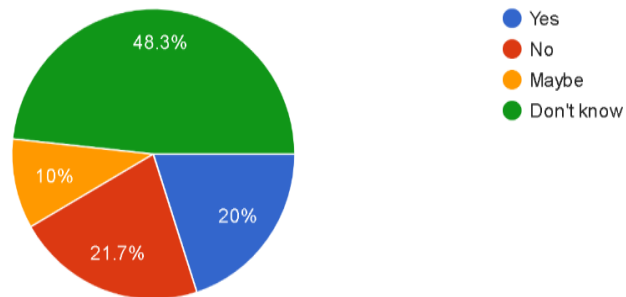
c) Whether TU has its own mechanism and/ or technical personnel to repair water leakage/ carry out routine inspection:

60 responses



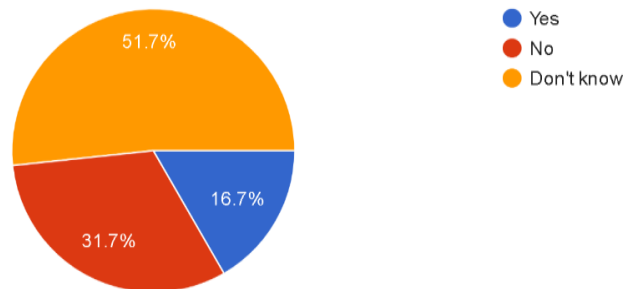
d) Whether rainwater harvesting units are installed in TU Campus:

60 responses



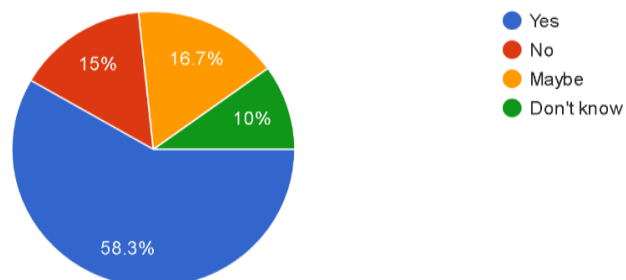
e) Whether TU has developed/ is developing a system for reuse and recycle of water:

60 responses



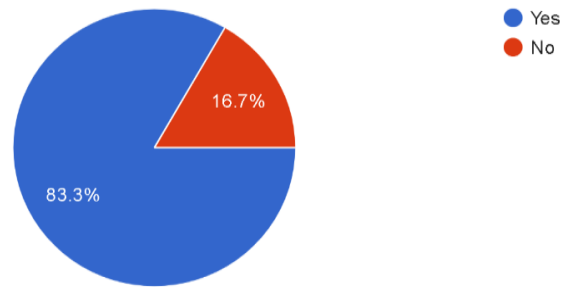
f) Whether there is any necessity for assessing the Water Quality Index (parameters: pH, EC, TDS, Turbidity, metal contaminants - Iron, Arsenic, etc.) o...at includes hostels, lab, office, canteen, tap water:

60 responses



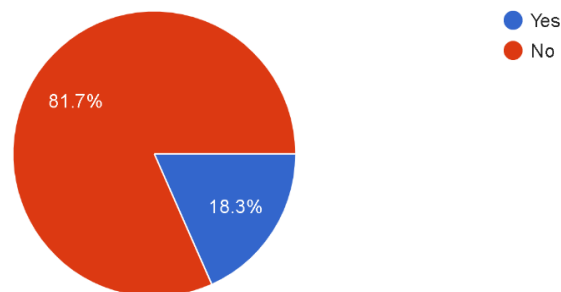
g) Whether TU has adequate/ sufficient drainage system:

60 responses



h) Do you have any knowledge of the university's water availability and usage patterns?

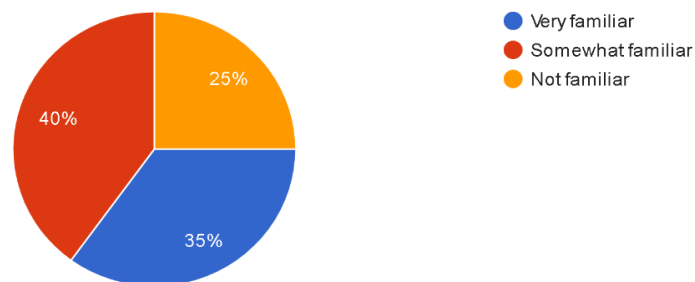
60 responses



Waste Management and Sustainability

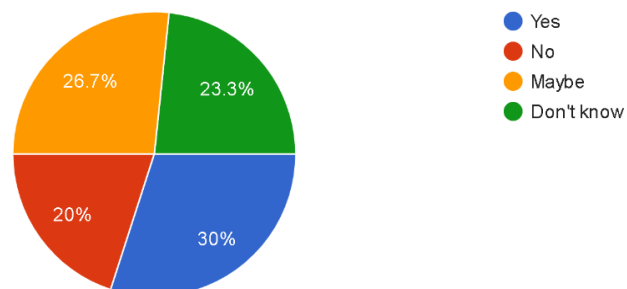
a) How familiar are you with the waste disposal practices followed within TU campus?

60 responses



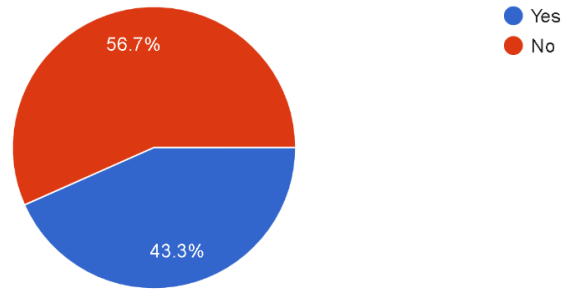
b) Is there any method of segregation of waste materials?

60 responses



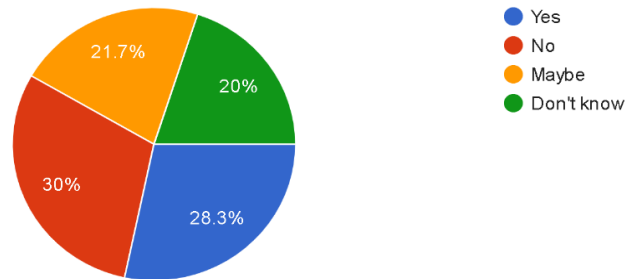
c) Have you observed any waste reduction or recycling initiatives on campus?

60 responses



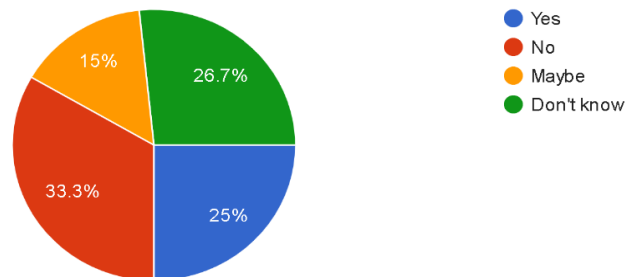
d) Whether TU has arranged any workshop/ seminar/ conference for awareness the students/ staff for specific arrangements for recyclable wastes:

60 responses



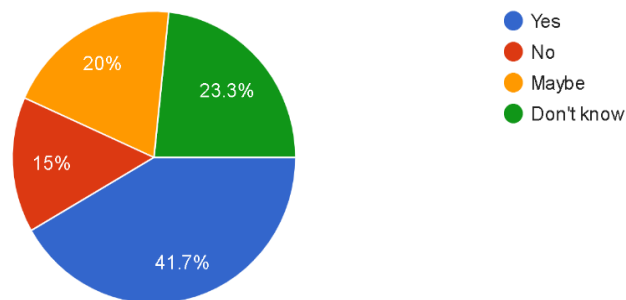
e) Whether TU follow specific disposal method for solid or liquid waste in specific manner:

60 responses



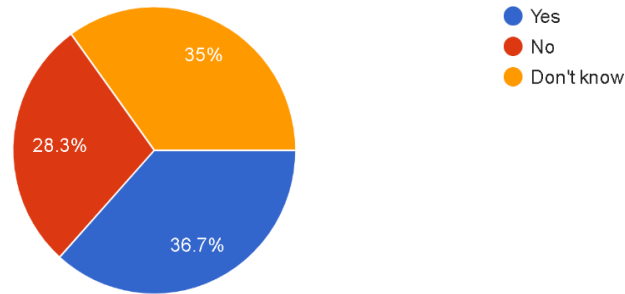
f) Whether the recycling/ collection facilities are provided by the Agartala Municipality Council and/or private individuals/ organizations (recyclab...dgets, instruments, equipment, packing materials):

60 responses



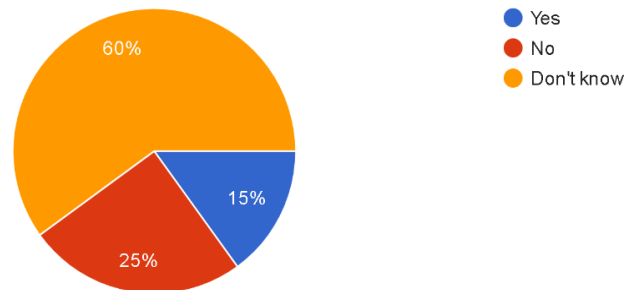
g) Whether TU has any composting ground/ waste collection from every household or any collection unit, etc.:

60 responses



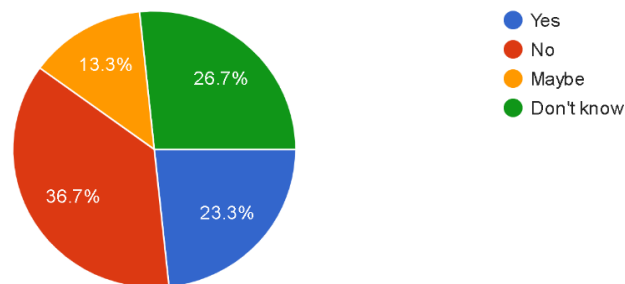
h) Is there any mechanism for treatment/ secondary uses of domestic effluent in the TU campus?

60 responses



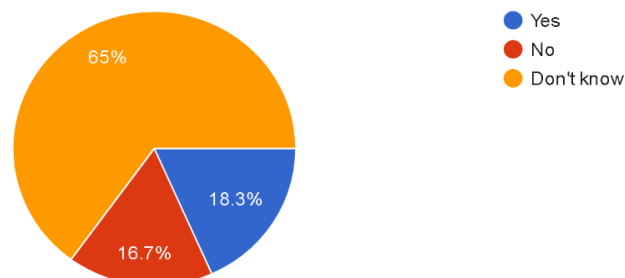
j) Is there any incidents of burning of plastics containing garbage within the campus for necessary reduction?

60 responses



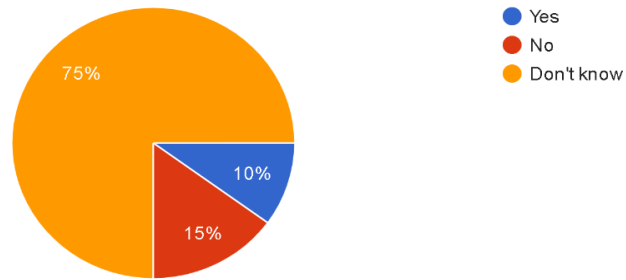
k) Whether the cleaning products used by the college staff are eco-friendly and under the COSHH (Control of Substances Hazard to Health) regulations:

60 responses



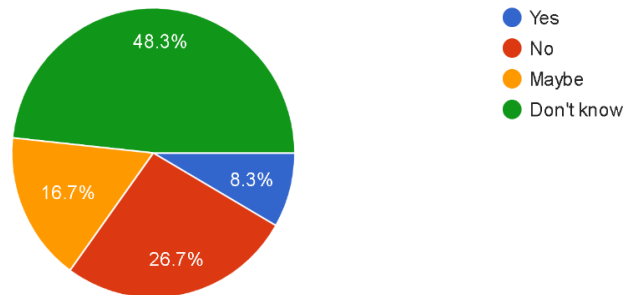
l) Whether TU is using fertilizers, pesticides for any purposes:

60 responses



E-waste Management n) Is there any means of disposal of unused computers, printers and electronic wastes through authorized agents?

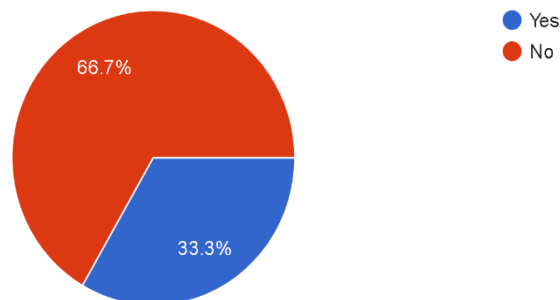
60 responses



Environmental Quality Assessment

a) Have you observed any changes in the ambient environmental quality within the university campus?

60 responses





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TRIPURA | INDIA**