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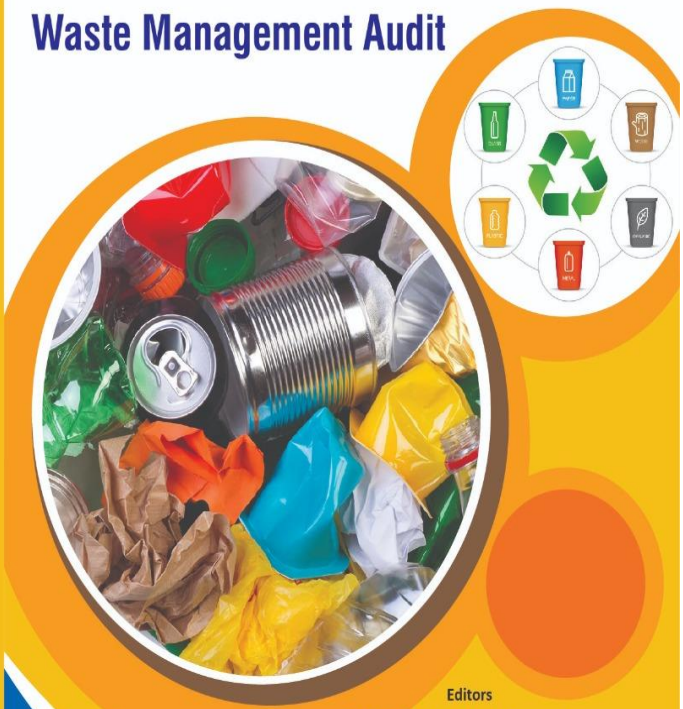

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PREFACE

Waste Management and Soil and Water audit is the quantitative and qualitative data to track soil, water and waste and to gain actionable insights to improve the operational performance. It is used to maintain the clean and hygenic environment that leads to the stakeholders. It provides a solution at 360˚ view of a surrounding campus and makes it easy for Owners / Managers/ Environmentalists to collaborate, measure, control, and reduce environmental impacts. Finally it leads to enhancing the quality of life for human beings, animals and plants.

Waste Management Audits such as Bio – medical waste management, E- Waste Management, Plastic Waste Management and soil and water audit are a well-developed process of extracting information about an Institution and Organization that provides a realistic assessment of how the Institutions and Organizations take steps towards protecting the environment. In order to save the ecofriendly atmosphere of an Institution and Organization, well-developed environmental objectives and targets should be undertaken to reduce the harmful effects to a greater extent. These audits can minimize the environmental pollution in the campus remarkably which in turn reduce the global warming effect as a whole. As per the Government law, the waste management legislations should be followed by all the Institutions and Organizations and make sure that their activities should not destroy the environment.

Nature Science Foundation (NSF), Coimbatore, Tamil Nadu, India is functioning energetically to conduct different awareness programmes and implement various schemes to Schools, Colleges and Universities across India towards the noble cause of environmental protection and nature conservation. The main motto of the NSF is “Save the Nature to save the Future” and “Go Green to save the Planet”. NSF is a Non-Governmental ISO 9001:2015 certified organization under the Nature Science Foundation. Public Charitable Trust managed by a Board of Trustees. It is a non-profitable Foundation registered under the Societies Registration Act 1975 (TN Act 27 of 1975).

The authors have taken enormous efforts to prepare this ‘Environment Management Audit Manual’ in a big way. Treatment of the subject matter has been very simple, clear and comprehensive. The authors followed lucid language with a maximum number of illustrations and photographs for easy understanding of the subject contents by the Readers. This manual will be definitely useful for the Lead Auditors those who are conducting audits on Environment Management perspectives. I express my sincere appreciation to all the authors in bringing out such a useful manual and took efforts in getting Copyright and publishing this Manual through a reputed publisher through proper channels.

CHAIRMAN
NATURE SCIENCE FOUNDATION
COIMBATORE, TAMIL NADU, INDIA

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Waste Management audit is a process to ensure that the waste are segregated and disposed safely without any harm to the environment and the living beings. Similar to that of Soil and Water audits is a type of assessment to ensure that the Institution and Organization campus is periodically checking the water and soil samples to ensure its quality level.

We attempted to prepare a comprehensive manual on 'Waste Management Audits' which covers Waste Management, Bio – medical waste management, plastic waste management and soil and water audit to Lead Auditors those who are conducting audits on Environment Management perspectives. Moreover, the authors did not claim that this is our own original ideas and concepts. It is merely an outcome of the compilation of different Waste Management System audit processes and collected more information from waste management legislations. It gives us an immense pleasure to thank Nature Science Foundation, Coimbatore, Tamil Nadu, India for offering an opportunity to write a comprehensive manual on 'Waste Management Audits' which is copyrighted and published through proper channels.

Words are inadequate to express my sincere thanks to Chairman, Vice-Chairman, Secretary, Joint Secretary, Treasurer, **Dr. P.V. Sreenivasan**, Director, Dr. Sreekala K Nair, Director (R&D), **Dr. D. Vinoth Kumar**, Joint Director, **Ms. V. Sri Santhya,** Assistant Director, **Ms. T. Joys Ememmal**, Programme Officer, **Ms. M. Nithya**, Programme officer, **Ms. E. Sivaranjani**, Programme Officer, **Ms. R. S. Thulaja**, Programme Officer and **Ms. S. Vishnu Swetha**, Programme Assistant for their constant encouragement and support in writing this manual very successfully.

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Thanks are also due to the Publishers for taking pains in bringing out the book very successfully. Reader's perceptive, constructive suggestions and critical comments will be highly appreciated, if any.

Dr. S. Rajalakshmi
Dr. Amzad Basha Kolar
Dr. G. A. Asif Jamal

CONTENTS

1. WASTE MANAGEMENT AUDIT

1.1. Introduction

Due to the increasing population and subsequent urbanization, production and consumption processes have increased because of which waste generation has increased rapidly in India. As a result of industrialization and the shifting of people from rural to urban areas in search of jobs, there has been an increase in the urban population of which waste generation has also increased tremendously. Industrialization has brought both positive as well as negative impacts on the world. Solid waste generation and its improper management is one of the negative consequences of industrialization. Unscientifically, disposal of solid waste in open dumps and landfills creates problems for public health and the environment. Hence, safe disposal with effective waste management is necessary. Waste management is concerned with how solid waste can be transformed and turned into a useful resource. Currently, India's population is around 1.40 billion or 140 crores, which is showing an increase of 0.91 billion during 2011. In 2011, India's population was 1.21 billion (UIDAI, 2020). As per an estimate, a total of 1,30,000 to 1,50,000 metric tonnes (MT) of municipal solid waste is being generated in India every day. That means around 330-550 grammes of waste is generated per urban inhabitant per day. In this way, it adds up to roughly 50 million MT per year and if it is calculated considering the current rates, this will increase to ~125 million MT per year by 2031 (Biswas and Parida 2021).

Solid waste is a mixture of biodegradable, non-biodegradable, recyclable and inert waste generated primarily from residential, commercial, industrial and institutional sources. As per a recently published study, around 62 million tonnes of waste are currently being generated in our country. which may increase by up to 165 million tonnes by 2030 (Tewari, 2021). Of the total generated solid waste, 75-80% of the municipal waste gets collected and only 22–28% of this waste is processed and treated (PIB GoI, 2016). So, the rest of the waste (approx. 72–78%) is left untreated and dumped in open areas which is leading to environmental and health hazards. Therefore, it is necessary that every household, including business owners all around the world, adopt solid waste management.

1.2. What is waste?

Waste is a discarded substance that cannot be used further by the primary user or that is no longer used for its intended purpose. Generally, waste, commonly known as garbage, is generated due to human activities from domestic activities, commercial activities, construction activities, or industrial activities. All non-biodegradable parts of these waste products which are added to the environment are often highly resilient and remain for very long periods of time in the environment without decomposition.

1.3. Categories of Waste

There are broadly two categories of wastes, viz., biodegradable and non-biodegradable waste. Biodegradable wastes, also known as wet waste, are the waste types that are mainly of plant and animal origins and include domestic waste such as food waste generated from the kitchen, garden waste or green waste, paper waste, and biodegradable plastic waste. These wastes are decomposed by the microbes over time depending on the material and can be composted to obtain manure. Human waste, sewage, and slaughterhouse waste also come under biodegradable waste. Generally, the biodegradable portion is mainly due to food and garden waste.

Non-biodegradable waste is also called dry waste. It cannot be degraded by microorganisms, so they remain on the earth as it is for thousands of years. Hence, they are the major pollutants. It includes glass, plastics, newspaper, etc. Though it cannot be decomposed, it can be recycled and reused. It is a heterogeneous mixture consisting of paper, plastic, cloth, metal, glass, earth, construction and demolition materials, organic matter, household waste, sanitation residue and waste from streets, etc. Hence, apart from biodegradable and non-biodegradable waste, a few other categories are there.

All the five broad categories of waste are as follows:

- **Biodegradable waste:** food and kitchen waste, green waste, paper (can also be recycled).
- **Non-biodegradable/ recyclable material:** paper, glass, bottles, cans, metals, certain plastics, etc.
- **Inert waste:** construction and demolition waste, dirt, rocks, and debris.
- **Composite wastes:** waste clothing, Tetra Packs, waste plastics such as toys.
- **Domestic hazardous waste and toxic waste**: It is also called household hazardous waste. They are: medication, e-waste, paints, chemicals, light bulbs, fluorescent tubes, spray cans, fertilizer and pesticide containers, batteries, shoe polish, etc.

1.4. Types of Waste

There are types of waste that are described as follows:

1.4.1. Municipal Solid Waste: Municipal solid waste (MSW), commonly known as garbage, is collected by the municipality and/or disposed off at the municipal waste disposal site. Based on the sources of waste generation, it is further categorised into residential, commercial, institutional and municipal services. Municipal solid waste (MSW) consists of the items that are used in our daily lives and then thrown away. These products include food items, packaging materials, newspapers, clothes, containers, bottles, batteries, and durable goods like furniture, etc., generated by households, offices, hotels, shops, schools, and other institutions. The major components are paper (27%), food waste (14.6%), yard trimmings (13.5%), plastic (12.8%), rags, metal (9.1%), rubber, leather, and textiles (9%), wood (6.2%), and glass (4.2%) (USEPA, 2013). Some fractions of demolition and construction debris, hazardous waste materials such as used electric light bulbs, batteries, automotive parts, and a very small quantity of biomedical waste such as discarded medicines and used syringes are often found in collected municipal solid waste. Once collected, they are sorted and treated for recycling and reuse before their final disposal.

1.4.2. Biomedical waste: Biomedical waste or hospital waste is the waste created by healthcare activities such as diagnosis, treatment, immunization or any kind of research activity or in the production or testing of biologicals. It contains hazardous materials such as needles and syringes, chemicals, pharmaceuticals, medical devices and radioactive materials and infectious materials such as unwanted microbiological cultures and stocks, bandages and soiled dressings, body parts, other human or animal tissues, diagnostic samples, discarded blood, etc.

1.4.3. Plastic waste: Plastic wastes are the discarded products made of plastic, such as packaging material, carry bags, pouches, etc., whose life is over and are of no use as prescribed in the Plastic Waste Management Rules, 2016. They are recyclable materials. It is necessary to manage plastic waste properly because the accumulation of plastic discarded objects causes adverse effects on wildlife, the marine environment and human beings.

Plastic waste can be easily seen everywhere on land and in oceans, lakes, rivers, ice and air which causes damage to humans and the whole environment.

1.4.4. Electronic waste: Electronic waste also known as "E-waste," refers to unwanted or useless electronic or electrical products that are non-working, broken, rejected, or have reached the end of their useful life. Some examples of electronic waste are computers, cell phones, tablets, televisions, photocopiers, fax machines, etc. They are dangerous in nature due to toxic chemicals they release and can harm the environment. Although they can be refurbished, reused or recycled.

1.4.5. Bio-waste: Bio-waste is biodegradable waste which consists of mainly organic waste. It includes green waste generated from paper waste, gardens and parks, food and kitchen waste from households, restaurants and food processing waste from food processing plants. In the landfill directives, it is defined as ‘waste capable of undergoing anaerobic or aerobic decomposition, such as food and garden waste, and paper and cardboard. Bio-waste is a fuel resource that may be used to produce heat and electricity.

1.4.6. Construction and demolition waste: C&D waste comprising of building materials, construction debris and rubble generated during the redevelopment, construction, repair and demolition of any civil structure. Though it is kept as a separate category, some of the fraction of C&D waste is also found in municipal solid waste. Earlier, the waste was disposed of at the disposal facilities. But nowadays, in some cities, C&D waste treatment facilities are available. C&D waste contains high proportion of recyclable materials which are used to make construction materials. There may be some hazardous substances in C&D waste and those should be disposed of separately.

1.4.7. Industrial waste: Industrial waste is generated as a result of industrial processes. They are categorized mainly as hazardous waste and non-hazardous waste. Though industrial waste is not considered as municipal solid waste and is not mixed with it, in some places, non-hazardous waste is disposed of with municipal waste. In this case, the industries arrange for waste transportation to the disposal site and may be responsible for disposal fees. According to the legislation and current practises, the municipality should explicitly define its responsibility for industrial waste management. This would assist in the quantity and classification of hazardous and non-hazardous industrial wastes, as well as municipal and non-municipal wastes.

1.5. Solid Waste Management

Different kinds of waste have various environmental impacts. Improper or unscientific disposal of solid waste causes health hazards, disease, water contamination, air pollution, and bad aesthetics, etc. Solid Waste Management refers to the management of solid waste generation, collection, storage, transfer, transport, processing and disposal in accordance with the best principles of public health, economics, engineering, conservation, aesthetics and other environmental issues (Fig. 1). It provides solutions for reuse and recycling items to save resources. Solid waste management includes the processes and actions required to manage waste from its generation to final disposal which is collected from different sources and disposed off properly. The scope of waste management includes all administrative, financial, legal, planning and engineering tasks associated with the solutions to problems of the solid waste challenges that the community's residents have imposed on it (Tchobanaglous, *et al.*, 1997).

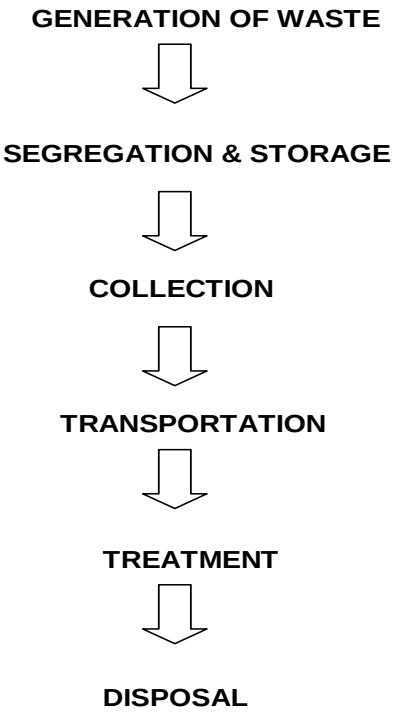


Figure 1. General process of Waste Management

1.6. Segregation and Storage of MSW

SW is usually collected and stored at source and then segregated into biodegradable waste and non-biodegradable waste. The non-biodegradable waste is thereafter segregated into recyclables, non-recyclables and hazardous waste. After segregation, waste is stored in waste bins.

	
Colour Coded Bins in Urban Areas	**Colour Coded Bins in Rural Areas**

1.6.1. Collection

Collection of waste takes place on a daily basis in all departments. The common areas are swept and the waste is transported to the collection centres.

1.6.2. Transportation

From the collection centres, waste is transported to the treatment or disposal/ landfill site. Tractor-trailers, tricycles, etc. are mainly used for the transportation of this waste.

1.6.3. Treatment

There are two main mechanisms of waste treatment being adopted in India. These include composting (aerobic composting and vermicomposting) and waste-to-energy (WTE) (incineration and pelletisation).

1.6.4. Disposal on Dumping/ Landfill Sites

A landfill or a "dump site," is a site where waste materials are disposed off. Historically, landfills have been one of the most common methods of waste management and remain so in many places around the world. Landfills are the waste disposal sites used by numerous producers as well as internal waste disposal facilities (where a producer of waste disposes of its own waste at the place of production). Many landfills are also used for other waste management purposes, such as temporary storage, consolidation and transfer or in most cases, permanent disposal. Landfill sites can be classified into various categories, like sanitary landfills, hazardous waste landfills, inert waste landfills, dumps, and bioreactor landfills.

1.7. Waste Management Legislations

1.7.1. Waste management Legislations

Due to the rapid industrialization and development in the country, the generation of waste has increased manifolds. Sometimes this waste is not regulated and managed properly which creates various environmental as well as health issues. Hence, to ensure development and sustainability go together, it is necessary that waste be properly treated and disposed of. In India, the Ministry of Environment, Forests and Climate Change (MoEFCC) is the governing body which works with the Central Pollution Control Board (CPCB) and other State Pollution Control Boards (SPCBs). There are several policies, acts and rules are available for the purpose of waste regulation which help in waste management.

These policies, acts and rules aim to reduce the generation of waste, encourage waste recycling and eliminate unregulated waste disposal into the environment which might affect the ecosystem or human beings.

1.7.2. The National Environment Policy

The National Environment Policy, 2006 laid emphasis on disposal, recycling and treatment of waste.

1.7.3. The Environmental Protection Act

The Environment Protection Act was enforced in 1986 in India for the protection and improvement of the environment. The act aims to support and promote the management, protection, enhancement and wise use of the environment, recognising the following parameters: preventing, mitigating and remediating environmental impacts is important in making decisions and taking actions.

The rules framed under the Act mandate industrial units and corporates to act in a responsible manner to protect the environment, ensure the location and functioning of industries and deal with waste generation in a responsible manner. Various rules are notified to govern areas like waste prevention, minimization, reuse and recycling of municipal solid waste, industrial, agricultural and hazardous waste.

This Act confers powers on the Central Government to regulate all forms of waste. It is one of the primary legislatures to protect the environment and regulate waste. Some of the important provisions of this Act are as follows:

1. Section 7 of this Act places a principal prohibition on harming the environment by stating that no person carrying out any activity should emit or discharge environmental pollutants in excess of the prescribed standards.
2. Section 9 of the Act states that if any event takes place which harms the environment through any foreseen or unforeseen event, the person responsible for the harm is duty bound to prevent or alleviate the pollutant discharged as a result of such event. The person is also obliged to inform the proper authorities about any event that may harm the environment.
***Polluter Pays Principle**– Section 9(3) of the Act embodies the "Polluter Pays Principle" which states that any expense which has been incurred to restore the environment to its natural state shall be paid by the person who is responsible for such degradation. This concept of continuing punishment is very important.
1.The Act also contains provisions which remove the corporate veil. In the event that any environmental offence is committed by a company with the connivance or consent of any director, manager, secretary or any other officer of the company, they'll be held personally liable for committing offences in the name of the company.
2. Environmental Protection Rules, 1986 were formulated by the government under the power conferred to them by the Environmental Protection Act. Through these powers, the government has the authority to give specific directions without changing the principle Act.

1.7.4 Sold Waste Management Rules, 2016

The Ministry of Environment, Forest and Climate Change, Government of India has revamped the Municipal Solid Wastes (Management and Handling) Rules 2000 and notified the new Solid Waste Management Rules, 2016 on April 8, 2016. Every urban local body (from Mega City to Panchayat level), outgrowths in urban agglomerations, census towns as declared by the Registrar General and Census Commissioner of India, notified areas, notified industrial townships, areas under the control of Indian Railways, airports, airbases, defence establishments, special economic zones (SEZs), state and central government organizations, places of pilgrimage, religious and historical significance as may be notified by the respective authorities household, event organizers, street vendors, RWAs & Market Associations, gated communities having more than an area of 5000 sq.m., hotels & restaurants, etc.

In the rules, the duties of waste generators and authorities are described. It is the duty of each waste generator to segregate waste category wise (bio-degradable, non-biodegradable, and domestic hazardous wastes) and store waste separately in suitable bins and hand it over to municipal workers or authorised waste collectors. Construction and demolition waste, sanitary waste and garden waste should be stored properly and disposed of as per the guidelines. No waste generator shall dump, burn or bury solid waste generated outside his premises on streets, public open spaces, or in drains or bodies of water. All waste generators are required to pay a user fee. No one shall organise an event or gathering of more than one hundred people in any unlicensed location without notifying the local body at least three working days in advance – they are responsible for waste segregation. Within one year of the date of notification of these rules, all resident welfare and market associations, all gated communities and institutions with more than 5,000 sq.m of area and all hotels and restaurants must segregate waste in partnership with the local body, treat waste by composting or bio-methanation and hand over recyclables to authorised recyclers.

1.7.5 Hazardous and Other wastes (Management and Transboundary Movement) Rules, 2016

The Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016 were published to ensure the safe generation, processing, treatment, packaging,

storage, transportation, use reprocessing, collection, conversion and offering for sale, destruction, and disposal of hazardous waste.

The HWM Rules, 2016 ensure resource recovery and disposal of hazardous waste in an environmentally sound manner. Unlike HWM rules 2008, rules 2016 also talk about other wastes which means Waste tyres, paper waste, metal scrap, used electronic items, and other materials are recognised as recyclable and reusable. These resources support industrial activities while also reducing the country's reliance on its natural resources. HWM rules for 2016 include 6 chapters, 8 schedules and 12 forms. These rules are not applicable to wastewater, exhaust gases, radioactive wastes, biomedical wastes or municipal solid wastes. HWM Rules define

- Responsibility of the occupier for hazardous waste management
- Responsibility of the State Government
- The import and export of hazardous and non-hazardous wastes
- The process of their treatment, storage and disposal
- process of packaging, labelling and transportation

1.7.6 The Plastic Waste Rules, 2016

The Plastic Waste Management Rules, 2016 were notified on March 18, 2016 in the Official Gazette by the Ministry of Environment, Forests and Climate Change, under sections 6, 8 and 25 of the Environment Protection Act. The rules are aimed

- To push waste minimization,
- It enables and ensures source segregation and recycling,
- Encourage waste pickers, recyclers, and waste processors to participate in the collection of plastic waste fractions from households or any other source of its generation or intermediate material recovery facility.
- To adopt the polluter's pay principle for the sustainability of the waste management system
- To ensure effective plastic waste management so as to minimise the threat posed to the environment.

Plastic waste rules, 2016 have been made applicable to every waste generator, local body, gram panchayat (rural regions), manufacturer, producer, and importer. The rules are not applicable to Special Economic Zones (SEZs) or export-oriented units. PW rules include 1 schedule, 17 rules, and 6 forms. In the rules, the responsibilities of every producer and generator are described. Principal responsibilities include:

- To ensure that recyclable plastic waste fractions are separated, collected, stored, transported and channelled to authorised recyclers
- To ensure that recyclable plastic waste fractions are channelled to recyclers
- Ensuring that no damage is caused to the environment during this process.
- Creating awareness among all stakeholders about their responsibilities
- Ensuring that plastic waste is not burnt openly.

1.7.7. Bio-Medical Waste Rules, 2016

There may be several risks, such as disease or infection due to untreated bio-medical waste, risk of disease due to use of expired medicines, and risks to domestic and stray animals from improper bio-medical waste management. Biomedical waste management rules ensure the proper disposal and management of biomedical waste. The Bio-Medical Waste Management Rules, 2016 apply to all the wastes generated during the diagnosis, treatment, or immunisation of human beings, animals, research activities pertaining thereto, or in the production or testing of biological products, or in health camps and the categories

mentioned in Schedule-I of the rules. Rules are aimed at ensuring the safe disposal of bio-medical waste. The BMW Rules 2016 have the main features of the Bio-medical Waste (Management & Handling) Rules, 1998 as well as several new provisions. The new rules contain 4 schedules, 18 rules and 5 forms. These regulations apply to all units that generate bio-medical waste, including hospitals, nursing homes, clinics, dispensaries, Ayush hospitals, pathological laboratories, blood banks, veterinary institutions, animal houses, research or educational institutions, health camps, medical or surgical camps, vaccination camps, blood donation camps, school first aid rooms, forensic laboratories, research labs, and so on. Each occupier of a bio-medical waste generating unit needs to obtain an authorization from the concerned State Pollution Control Board (SPCB). The bio-medical waste management process involves:

- ✓ Bio-medical waste should be separated at the point of generation.
- ✓ Highly infectious and laboratory waste should be pre-treated.
- ✓ Colour-coded containers/bags/bins should be used for collection and storage of segregated waste.
- ✓ Wastes are transported from the source to a central storage area and stored there and treated.
- ✓ Finally, waste is disposed of through the Central Bio- Medical Waste Treatment Facility.

1.7.8. E-Waste Management Rules, 2016

The E-Waste (Management) Rules were notified on March 23rd, 2016 and came into effect on October 1st, 2016 by the Union government to update existing waste management norms in India. The E-waste management rules 2016 are applicable to every producer, consumer or bulk consumer, collection centre, dismantler and recycler of e-waste involved in the manufacture, sale, purchase and processing of electrical and electronic equipment or components listed in Schedule I including their components, consumables, parts and spares which make the product operational. The rules have obligated various stakeholders to perform important duties under the rules so as to ensure proper and effective management and disposal of e-waste.

Schedule I of the EWM Rules 2016 has two categories of electrical and electronic equipment, namely:

- ✓ Computers, main frames, minicomputers, notebooks, notepads, laptops, personal computers, printers including cartridges, copying machines, electronic typewriters, telephones, mobiles, cordless telephones and answering machines.
- ✓ Consumer electricals and electronics like TVs, washing machines, refrigerators, air conditioners, including other mercury-containing lamps.

Some of the important feature of EWM rules 2016 are:

- ✓ The EWM rules 2016 have extended the applicability to manufacturers, dealers, refurbishers, etc.
- ✓ Used lead acid batteries and radioactive waste are excluded from EWM 2016
- ✓ Micro enterprises have specifically been excluded from the purview of applicability of the EWM Rules, 2016.
- ✓ Another main feature of these rules is Extended Producer Responsibility (EPR), which is the responsibility of every producer of electrical and electronic equipment (EEE) for the channelization of e-waste to an authorised dismantler or recycler to ensure environmentally sound management of such waste. EPR authorisation is mandatory and all the producers, including importers, e-retailers, on-line sellers and e-bay of EEE covered in the E-Waste (Management) Rules have to obtain the same.

1.7.9. Batteries (Management and Handling) Rules

As batteries include dangerous and corrosive compounds such as mercury, lead, cadmium, sulphuric acid, lthium perchlorate and others batteries management and handling rules were developed to ensure that they were properly disposed off. Every manufacturer, importer, re-conditioner, assembler, dealer, recycler, auctioneer, consumer, and bulk consumer who is involved in the manufacture, processing, sale, purchase, and usage of batteries or components is subject to the rules.

- By the 30th of June and 31st of December of each year, the manufacturer, importer, assembler, and re-conditioner must submit to the SPCB a half-yearly return of their sales and buy-backs in Form-I.
- Both the importer and the recycler must register.

1.7.10. Construction and Demolition Waste Management Rules, 2016

The construction and demolition (C&D) waste management guidelines were implemented to encourage the use of C&D waste as well as segregation, recovery, reuse, and recycling at the source of origin. The rules apply to all waste generated during the construction, remodelling, repair or demolition of any civil structure by any individual, organisation or authority that generates construction and demolition waste, such as construction debris, etc.

Main compliances under the C&D waste management rules are as follows:

- The State Pollution Control Board or Pollution Control Committee must be notified of the authorization for the construction of a site for storage and processing, recycling facilities or construction and demolition waste on Form I.
- If an accident occurs during the processing, treatment or disposal of construction and demolition waste, the local authority's official in charge of the facility or the facility's operator must notify the local authority on Form-V.

1.8. Waste Management Audit

1.8.1. Waste Management Audit

A waste audit, also known as a waste composition analysis, is a physical and systematic analysis of all the waste available at a waste generating unit. The detailed survey and analysis are conducted by the auditor to get a detailed understanding of waste generation, waste composition and waste categorization which helps in understanding the problems and identifying the potential opportunities. A waste audit also helps ascertain the cost incurred for waste disposal and how it can be reduced through reusing or recycling the waste.

A waste audit is proposed and carried out to ensure that waste management techniques are implemented and followed in a sustainable manner in organisations, institutions and the industrial sector. The audit process includes the preparation and completion of a questionnaire, a physical investigation of the campus, observation and study of documents, key person interviews, data analysis, measurements and recommendations. During the waste management audit, the following points are addressed: waste generation, storage of waste and waste disposal. An auditor helps to identify the waste generation by going through the waste containers, sorting waste items, making observations, recording, and analysing the data. A waste audit includes the following tasks:

- Establish baseline data.
- Identifying and quantifying waste streams.
- Examine waste flow paths.
- To identify opportunities for waste diversion and source reduction.

- Evaluate the performance of present waste management systems.
- Identify strategies to improve their efficacy.
- Obtain detailed waste generation data.

1.8.2. Significance of Waste Audit

A waste audit can help the organisation be better equipped to dispose of the garbage it produces on a daily basis in an effective and responsible manner. By carrying out a waste audit, it can be ascertained what kind of waste is being generated and how much of each type of waste is generated. Sorting and weighing of the waste materials gives a clear picture of the types and quantity of waste materials. Once the type and quantity of waste material being generated every day is known through a waste audit, a more efficient waste management plan can be designed for the organisation, so that proper initiative can be taken for the reuse and recycling of the waste materials.

A waste audit also provides insight into how effective the organization's current waste management system is; what the problems, ambiguities, and breakdowns are, and what changes and adjustments can be made to make it better and more efficient.
Conducting a waste audit in organisations or waste-generating units is important because it serves as a key to the identification, assessment and quality improvement processes and helps to achieve the desired outcomes such as cost reduction, compliance and increased sustainability.

1.8.3. Objectives of Waste Audit

The objectives of the audit will determine the waste types, characteristics and physical locations to be audited. The main objectives of audit objectives are:

- To determine the composition and quantity of waste being generated.
- To encourage the reuse and recycling of materials to minimise the waste thrown away in trash.
- To ensure the proper waste management practises are being implemented and followed.
- To measure the effectiveness of existing waste management systems.
- To identify opportunities for improving waste management systems and strategies.
- To collect baseline data for measuring the effectiveness of waste minimization strategies.
- To ensure that the waste arising from work is handled, stored, collected, transported and disposed of in an environmentally acceptable manner.

1.8.4. Benefits of Waste Audit

Conducting waste audits can help minimise an organization's negative environmental impact so that the most suitable waste disposal alternative can be selected. Here are a few ways a waste audit might help an organisation or institute make innovative changes:
1. The waste audit provides all the information on storage, collection, disposal and transportation of waste. This data helps to determine the effectiveness of the operation of the organisation. It gives an idea about what is working or not working with the existing waste and recycling management program. Hence, it enables organisations to figure out the most effective and sustainable waste management policy. This allows you to make the necessary changes to increase and maximise your operating efficiency. If an auditor finds during the auditing process that more recyclables are being thrown away in the trash, in that case, corrective action can be taken by fine-tuning the recycling programme or educating employees about recycling and repurposing of waste.

2. Through a waste audit, the progress and success of operations can be measured by setting a baseline and creating benchmarks year after year. Suppose the percentage of recyclables is around 20%, in a follow-up waste audit in a year which recorded content in waste has dropped to 15% it means that the waste management procedures are successful. Targets can be set for monitoring the progress and effectiveness of the waste and recycling programmes can be measured.
3. Waste audits are an important way to save money by minimising waste generation, increasing reuse and recycling and sending the least amount of waste to the trash. Waste hauling can also be reduced if it is properly managed. Some hidden revenue may even be generated from the generated recyclable waste and composting.
4. Through a waste audit, data can be checked and verified against the data provided by the hauler and thereby one will get more accurate data. In this way, it helps to cut the hauling costs and save money by paying unnecessary fees levied due to incorrect data.
5. With accurate waste data, strategies can be put in place to reduce the volume and/or frequency of solid waste disposal and hauling costs.
6. The waste audit helps to meet the standard requirements as they are part of the various certification systems like LEED, IGBC, GRIHA and GEMS etc.
7. There are certain guidelines and rules under the legal setup for every business who disposes of waste. Every business can get the actual data by conducting a waste audit wherein a comparison of the current operations and regulatory requirements is made. Therefore, expensive fines can be avoided.
8. It gives calmness and peace of mind when you know that your organisation is meeting legal disposal requirements.
9. Waste audits help to determine the waste category and estimate waste quantity and further design a more efficient waste disposal programme for reuse and recycling of waste that diverts useful material from the landfill. It helps to reduce air and water pollution which helps curb global warming and conserve natural resources.
10. Through waste audit, an organisation gets the recognition of being an eco-friendly organisation because of the adoption of an eco-friendly management system. This helps to attract customers in the future.

1.8.5. Checklist for Waste Audit

The checklists for the conduct of a waste audit have been included with different parameters on waste collection, storage, and disposal. An adequate number of colour coded dustbins as per guidelines (Red, Yellow, Blue and Black & Green Bins) should be made available on the campus for various waste collection, segregation and disposal activites. A waste disposal record register, as well as puncture-proof containers for sharps and blue bags should be kept and made available on campus.

In hospitals, labs and pharmaceutical industries, mutilators such as needle/syringe cutters and calibrated weighing machines for biomedical waste collection should be made available. Personal protective equipment such as gloves, caps, masks, aprons, gumboots, and so on should be readily available on campus in accordance with campus policies. Around 1% fresh sodium hypochlorite or bleaching powder solution should be made available as per guidelines in hospitals, labs, and pharmaceutical industries. In addition, the Mercury Spill Management Kit, Post Exposure Prophylaxis Kit and Blood Spill Management Kit should be made available in hospitals, labs, and pharmaceutical industries. There should be proof of a licenced company's' signed MoU with the organisation for waste collection as per the Govt. regulation available at waste generating unit. Norms must be followed by the organisation as per the Central and State Government Pollution Control Board. Different forms, formats, annual reports, etc. should be made available for waste collection and mode of transportation. A trained, dedicated and skilled individual for waste

management should be present at the waste generating unit. The waste must be segregated at the site of generation. If the waste is not segregated, then the reason should be known. It should be ensured that infectious and non-infectious waste should not be mixed at the source of generation in hospitals, labs and the pharmaceutical industry.

To determine the E-wastes, wood wastes, construction wastes, plastic wastes, hazardous wastes and biomedical wastes should not be mixed at the source of generation. Bins, containers, and bags and their transportation means should be monitored. Details on the personal protective equipment like masks and gloves used while collecting the waste from the site of deposition should be made available. Proper details of the adoption of E-waste management and plastic waste management in the campus are to be checked.

In order to determine the quality practises undertaken by any organisation or waste generating unit and to recommend more convenient strategies to eradicate contaminants coming from the waste, waste auditors follow a set of predetermined checklists. For organisations like educational institutions and industries, the following are the checklists:

I. Qualitative Measurement of Waste Management

S.No.	Requirements and checklists of the audit	Conformity		
		Yes	No	Remarks
1.	Adequate number of Dust Bins as per Guidelines (Red, Yellow, Blue, and Black & Green Bins) are made available in the campus for various wastes, collection, segregation and disposal.			
2.	Record Register for waste disposal and Puncture proof Containers for Sharps / Blue Bags are made available in the campus			
3.	Mutilators (Needle / syringe cutters) and calibrated weighing machines for biomedical wastes collection*			
4.	Personal protected materials like Gloves, Caps, Masks, Aprons & Gum boots etc. used are adequately made available as per the Guidelines in the campus.			
5.	Around 1% fresh Sodium hypochlorite or Bleaching Powder solution is made available as per guidelines*			
6.	Mercury Spill Management, kit, Post Exposure Prophylaxis Kit and Blood spill Management kit are available*			
7.	Proof of Licensed Companies signed MoU with the Organization for wastes collection as per the Govt. regulation			
8.	Norms are being followed by the Organization as per the Central and State Government Pollution Control Board			
9.	Different Forms, Formats, Annual Report, etc. are available for waste collection and mode of transportation			
10.	Availability of a trained dedicated with skilled personals for waste management.			
11.	Is the waste segregated at the site of generation? If not, where are they segregated?			
12.	Is the infectious waste and non infectious waste mixed at the source of generation?*			
13.	Is e-wastes, wood wastes, construction wastes, plastic wastes, hazardous wastes and biomedical wastes mixed at the source of generation?			

14.	Is the waste covered in covered bins? and Is the bins filled up to more than ¾ th level ?			
15.	Is the bins cleaned with soap and disinfectant regularly and bins are overfilled? And is the stored waste kept beyond 48-72 hrs?*			
16.	Is the waste transported in closed containers or open bags? and Are the waste collection bins/Trolleys/wheel barrow used for transporting wastes?			
17.	Is the personal protective gears like mask and gloves used while collecting the wastes from the site of deposition?			
18.	Whether the concept of E-Waste management is followed in the campus?			
19.	Has a Management Representative, E-Waste Specialist, Laboratory Staff been assigned?			
20.	Whether E-Waste management practices included in the purchase policy of electronic items?			
21.	Whether an authorised refurbrisher appointed to manage the E-waste			
22.	Are the E-Waste refurbished and used again in the Institution?			
23.	Whether the importance waste and their implications on environmental and personal hygiene through awareness programmes are conducted for stakeholders?			
24.	Signing MoU with Government and NGOs ensure proper handling of waste materials			
25.	Whether construction and wood wastes are subjected to reuse them in the same organization campus?			
26.	Whether plastic wastes are burnt inside the campus? Any air pollution due to plastic materials burning takes place ?			
27.	Projects and dissertation works, scholarly publication on various wastes and their management carried out by staff members and students			
28.	Whether hazardous wastes are properly discarded in which acids, solvents and salts are disposed after diluting with water and poured after buried in the soil			
29.	Have programmes for the achievement of plastic free area objectives and targets been established and implemented as on today? Any display board is made in the campus?			
30.	Are recycling of plastic polymers promoted in the campus among the stakeholders?			
31.	Wood waste are collected and recycled properly and they used for fuel and degradation / green manuring purposes?			
32.	Residual wastes are properly disposed in the campus after burring the soil with proper dilution with water			

*Applicable for Hospitals/Labs/Pharmaceutical Industrial sectors

II. Quantitative Measurements

S.No	Name of the Electrical items / Equipment / Instruments	E waste code by NSF	Quantity
1.	Mainframe	ITEW	
2.	Internet connectivity Accessories	ITEW	
3.	Personal computer	ITEW	
4.	Laptop	ITEW	
5.	Dot matrix Printer	ITEW	
	Laser Printer	ITEW	
	Ink jet printer	ITEW	
6.	Cartridge	ITEW	
7.	Xerox machine	ITEW	
	Scanner	ITEW	
	Fax machine	ITEW	
8.	Telephones	ITEW	
9.	Cellar phones	ITEW	
10.	Television	CEEW	
11.	Solar panel	CEEW	
12.	Water heater	CEEW	
	Solar water heater	CEEW	
13.	Split AC	CEEW	
	Window AC	CEEW	
	Centralized AC	CEEW	
	Air Cooler	CEEW	
14.	Tube light	CEEW	
	Fluorescent lamps	CEEW	
	Halogen lamp	CEEW	
	Sodium Vapour lamp	CEEW	
	CFL	CEEW	
	LED tube lights	CEEW	
	LED Focusing lights	CEEW	
15.	Ceiling Fan	CEEW	
	Pedestal Fan	CEEW	
	Table Fan	CEEW	
	Portable Fan	CEEW	
16.	Lead acid batteries	CEHW	
17.	Lithium Ion Battery	CEHW	
18.	Cable and wires	CEEW	
19.	Inverter with UPS	CEEW	
20.	Switch board	CEEW	
21.	Solar panel	CEEW	
22.	LCD projector	CEEW	
23.	Refrigerator	CEEW	
24.	Water doctor	CEEW	
25.	RO water plant	CEEW	
26.	Generator	CEEW	
27.	Pump	CEEW	
28.	Motors	CEEW	

29.	Compressor	CEEW	
30.	Vacuum Cleaner	CEEW	
31.	Ventilator	CEEW	
32.	Insect trap	CEEW	
33.	Podium containing Mike, Speakers, Amplifiers, Radio, Camera, Sensors, etc.	CEEW	
34.	**Civil Engineering Equipment / Machines** Compressing testing machine, Universal testing machine, Total Station, Theodolites, Flexure testing machine, Torsion testing & Izod impact testing machines, Hardness testing machine, Beam deflection test apparatus, Centrifugal Pump, Gear Pump, Submersible pump, Reciprocating Pump, Pelton Wheel turbine, Francis turbines / Kaplon turbine, Turbidity meter, pH meter, Conductivity meter, Jar test apparatus, BOD incubator, COD digester, Direct shear apparatus, Triaxial shear apparatus,	LEEW	
35	**Equipment, Instruments and Machineries related to Life Sciences and Biological Sciences including Biotechnology, Nanotechnology, Food Technology, etc.** Electronic Balances, pH Meter, Hot-air-Oven, Microwave Oven, Laminar Air Flow, Autoclave, Microscopes, , Rotatory Evaporators, Centrifuges, Electrophoretic apparatus, Chromatography devices, Grinders, Mixers, Deep Freezers, BOD Incubator, COD Digester, Extraction apparatus, Incubators, CO2 incubator, Heating Mantle, Vacuum pump, Vortex mixer, Magnetic stirrer**,** Gel rocker, Sonicator, Growth Chambers, Air curtains, Aerators, Spectrophotometers, Calorimeters, Turbidity meter, Colony Counter Water bath, Dry bath, Thermocycler, Gene gun, Gel Documentation System, Transilluminator, Ice maker, ELISA Reader & Washer, Aquarium, Zebrafish / animal house facility, Mechanical & Orbital Shakers, Cyclo	LEEW	

	mixer, Lyophilizer, Incinerators, Ammeter, Flame Photometer, Fluorimeter, Fermentors, Reactors, Particle size Analyzer, XRD, FTIR, Muffle Furnace		
36	**Chemical Sciences and Engineering Equipment / Machines** Distillation Units, Packed bed distillation, Roll crusher, Jaw crusher, Sieve analysis machine, Shell and tube heat exchangers, Plate and frame filter press, Fume hood, Nephelometer, Membrane Filtration Apparatus, Jar test apparatus	LEEW	
37	**Electrical, Electronics and Communication Engineering Equipment / Machines** DC Shut motor, DC Series motor, DC Compound motor, DC Shunt motor, DC Compound generator, DC series generator, Single phase & Three phase transformers, Single phase & Three phase auto transformers, Loading rheostat, single phase & Three phase, Inductive & Capacitive load, Power electronics trainer kits, Three phase squirrel cage induction motor, Single phase & Three phase induction motor, Three phase slip ring induction motor, AC generator, Stabilizers, Synchronizer, Half and Fully controlled converters, Buck, Boost and buck-boost converters, Single phase and Three phase inverters, Synchros, CRO, DSO, CRO, Microprocessor trainer kits, Microcontroller trainer kits, Arudino trainer kits, Digital electronics trainer kits, Flip-flops, Counters, Half adder, Full adder circuits,	LEEW	
38	**Mechanical Engineering Equipment / Machines** Lathe machine, Milling machine, Drilling machine, Slotting machine, Shaping machine, Cylindrical, Grinding, Coordinate Measuring, Universal testing devices, Thermal Conductor, Air Compressor, Single Cylinder 4 Stroke Diesel Engine, CNC Turning Centre, Kaplan, turbine,	LEEW	

	Pelton wheel turbine, Francis turbine, Venturimeter, Orifice meter, Nephelometer, CAD & CAM machines, Tensile strength apparatus, Younggus modules apparatus, XRD machines,		
39	**Textile Technology Equipment / Machines** Ring spinning, Rotor spinning, Weaving machine, Ruti C loom, Circular Knitting machine, Curing chamber, Wash Fastness Tester, Streamer, Washing machine, Dryer,	LEEW	

***ITEW- Information technology E waste**

*****Applicable for Hospitals/Labs/Pharmaceutical Industrial sectors

******CEEW- Consumer Electronic E waste

***CEHW- Consumer Electronic Hazardous waste

**** A minimum of 50% criteria should be attained

*****LEEW- Laboratory Equipment E waste

- *Take feedback from doctors for quality on services for continual improvements.*
- *Provide necessary training to the hospital staff handling waste at the health care Units.*
- *Supply bar-coded biodegradable bags to track the necessary information and keep it in records.*

Source: NSF

1.9. Waste Management Audit Procedure

1.9.1. Waste Management Audit Procedure

A waste audit is performed to calculate the type and amount of waste generated by an organization. It also measures how much waste is recycled vs. thrown out. Thereafter, recycling, reduction and diversion goals are set and a management plan is formulated and implemented. Any size organization can perform a waste audit. A waste audit involves three stages: i. Pre-audit, ii. Audit and iii. Post Audit (Fig. 2).

1.9.2. Pre-audit

At the pre-audit stage, a meeting is conducted to strengthen the audit's scope and objectives and to discuss the possibilities associated with the audit. An audit team is formed at this stage. In the pre-audit meeting, all the participants get the opportunity to meet together, collect available information and discuss the concerns that help them study before arriving on the site. The audit protocol and audit plan are also handed over to all the members.

1.9.3. Audit

At this stage, the audit team starts working according to the outline scope of the audit as set in the pre-audit stage. All the waste generation and recyclable data statistics are collected to establish the audit baseline. The best ways of presenting data are evaluated. It includes the following activities:

1. review of documents and records such as admission registers, water charge remittance, furniture registers, laboratory equipment registers, purchase registers, audited statements, and office registers.

2. Interviews or discussion with the staff associated with waste handling, waste management, and other stakeholders
3. Site inspection and data collection

1.9.4. Post-audit

At this stage, the audit team will list the solid waste management problems identified as a result of the audit. A solid waste management plan will be prepared. Strategies are to be selected to address these problems. Auditors determine an action plan and record it on the action plan sheet and provide it to the management of the organisation.

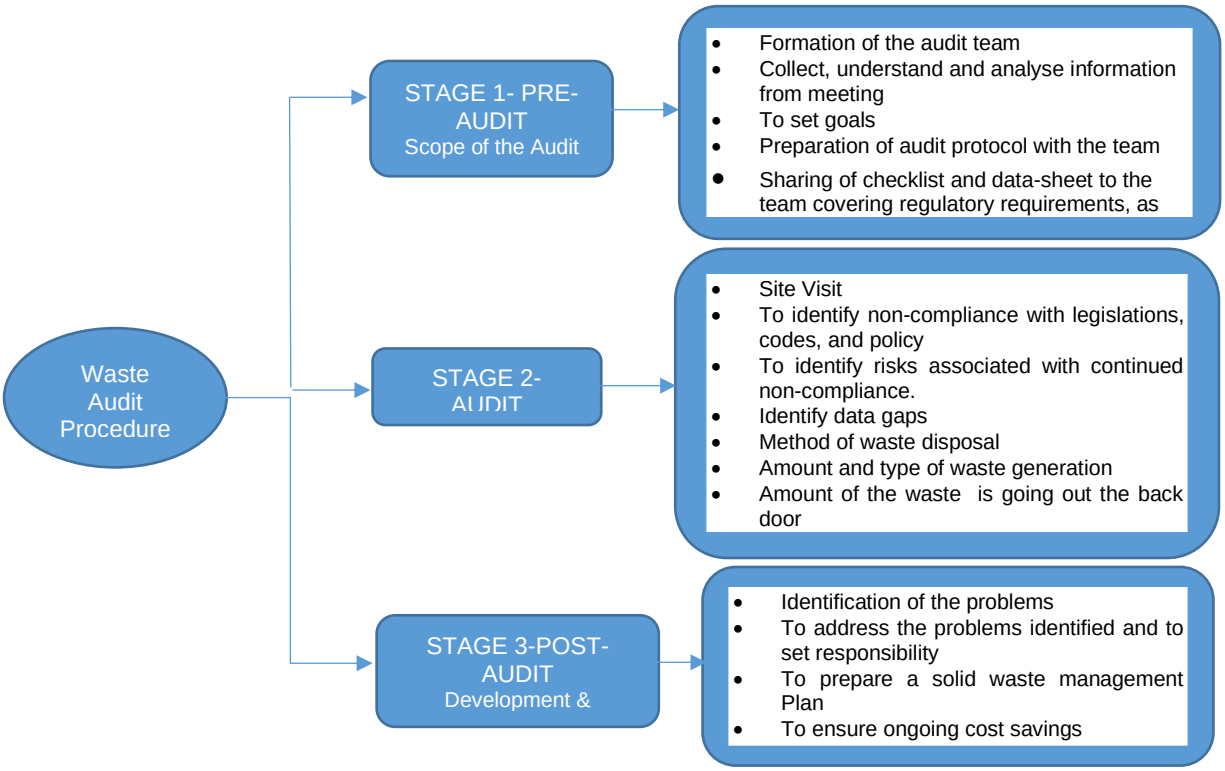


Fig 2. Waste Management Audit Procedure

1.9.5. Steps to Conduct Waste Audit

Before the start of an audit, a lot of prior and ongoing preparations are required. Steps involved in a waste audit are as follows:

Step 1: Plan audit objective

The first step of the waste audit is to understand why there is a need for a waste audit. Is it only to know how much waste is being generated or how much recycling is being done or is our current management plan in order or to devise better waste management strategies to bring profit out of separated waste material? For a better economic and environmental outcome, all participants and coordinators in the waste audit programme should have a specific goal and comprehensive knowledge of it.

Step 2: Gathering the team and setting a date

To get the best results from the audit, involve representatives from each department of the organisation because every department is responsible for its contribution to the waste generation. Or include a third-party audit team. Next, fix a date for the audit when there is no special event or holiday so that most of the staff will be available in the organisation.

Step 3: Determine the waste categories

Before the start of the audit, make a list of the most common waste types generated by the organisation. The most common waste audit categories are given as under:

- Paper & Cardboard
- Glass
- Metals
- Plastic bottles
- Other plastic
- Textiles
- Organic material (Food waste, Garden waste, Agricultural waste, Slaughterhouse waste, etc.,)
- Aluminium cans
- Materials packaging
- Signage
- Display materials
- Construction & demolition waste
- Hazardous wastes (Paint, Hazardous materials, Biomedical, Batteries, Oil filters and Remainder/composite waste)
- Electrical and electronic equipment
- Tyres
- Furniture
- Ceramics

Step 4: Gather the required Equipment

After choosing the dates and potential participants of the audit, the following equipment and tools are to be stocked so that the team can work properly and safely.

- An open area for sorting the trash.
- A bathroom scale for weighing each category.
- A sieve to separate the small pieces with a gauge of around 1 cm.
- Labelled boxes for sorting each waste category.
- 5 shovels, 5 rakes, and 2 hand brooms.
- Litter pickers (plastic or metal grabbers) to pick and sort the waste if needed.
- Tongs for each volunteer (optional).
- Clipboards for recording your findings.
- 2 wheelbarrows to collect waste from tractors and trailers.
- Trash bags for re-bagging your waste after the audit.
- 1 large first-aid kit including an eye bath.
- Large containers for disposing of waste

Step 5: Arrange facilities for the staff

While sorting the waste, it is very important to involve the trained staff wearing protective aprons and protective gear. The following facilities for staff should be made available at the site:

- Drinking water for staff
- Personal protective equipment (PPEs) such as latex or non-latex rubber gloves, rubber boots, goggles, disposable face masks, aprons, water facilities with soap and disinfectant for each volunteer.

Step 6: Sorting the waste into category

Waste generated in the institute or industry is sorted out daily based on the type of waste. The main categories for sorting waste are:

- Organic or compostable waste: food waste, garden waste, dry leaves, grass clippings
- Recyclable waste/Solid rubbish: Plastics, glass, cardboard, textiles, electronics, metal ceramics etc.
- Hazardous waste: chemically reactive substances, flammable substance, corrosive substances
- E-waste
- Batteries
- Biomedical waste
- Liquid waste- organic liquids, waste detergents, polluted water

On the final day of the audit, all the waste and recycling materials must be collected from the whole building. All the waste is to be weighed to get a baseline for how much is thrown away weekly (or as per the audit duration). All the recyclables are also weighed to establish how much waste is being recycled weekly (or as per the audit duration). Waste is to be sorted into different containers as per their categories and must be labelled properly. If the waste is to be analysed department wise, then department wise waste must be collected in different containers and labelled accordingly. The waste source needs to be mentioned in the data sheet. It will give an idea of the accurate estimation and the most waste-generating department in the organisation. An average percentage is to be calculated for every waste. It is necessary to sort and weigh every item found in the audit process.

Waste Audit Data Sheet

Date of Audit _____

S. No.	Items	Weight (kg)	Percentage	Source of Origin	Mode of Disposal
1.	• Food waste				
2.	• Garden waste including dry leaves, grass clippings				
3.	• Other organic waste				
4.	• Total Organic waste				
5.	Plastics waste				
6.	Glass waste				
7.	Paper & cardboard				
8.	Textiles waste				
9.	Electronics				
10.	Metallic waste				
11.	Ceramics waste				
12.	Biomedical waste				
13.	C&D waste				
14.	Hazardous waste				

15.	Lead Acid Batteries				
16.	Lithium Ion Batteries				
17.	Other				
	Total				

Total weight of waste being thrown away each day: _____ kg.
Total weight of items that can be diverted each day: _____ kg.
Total Weight of Compostable Items each day: _____ (kg)
Total Weight of Recyclable Items each day: _____ (kg)
Waste going to landfill after first audit: _____ kg.
Waste going to landfill after basic diversion: _____ kg.
Waste going to landfill after additional waste-reduction action: _____ kg.

Steps 7: Examine audit results and findings

After taking all weights, this data can be used for a waste stream analysis.

1) Calculate and record the waste diversion rate using this process:

- Divide the weight of recyclables by the combined weight of all the waste (trash + recyclables).
- Multiply the result by 100.

If a composting unit is installed on the premises and waste is being composted.

- Divide the weight of compostable waste by the combined weight of all the waste (trash + compostable).
- Multiply the result by 100.
- This gives you the percentage of waste you divert from the landfill each week.

2) Observe the weights recorded for individual waste categories.

- Which categories are the highest?
- Did the highest categories differ between departments?
- Did you find any recyclables mixed in with the trash?
- Were there categories you didn't realize you had?

Based on the audit results, total waste generated per year, waste generated per person per day, or waste generated per person per year can be calculated.

Waste projections

Total population	
Number of garbage dumps	
Number of toilets	
Total waste generated (kg/day)	
Total waste generated (Tonne/day)	
Total waste generated (Tonnes/year) approx. 40 weeks	
Waste generated per person (kg/person/year)	
Waste generated per person (kg/person/day)	
Waste generated per person (gm/person/day)	

1.9.6. Cost Estimation

1. Current waste disposal costs Rs._____/month Rs._____/year _____/kg
2. Current recycling costs Rs._____/month Rs._____/year _____/kg

3. Estimated weight that can be diverted from garbage going to landfill ___ year (includes items that can be recycled and composted)
4. Amount saved through reduced disposal costs Rs._____/year
5. Revenue generated by selling soil made by composting Rs._____/year
6. Financial benefit of waste reduction programs (4 + 5) Rs._____/year

Step 8: Audit report preparation

Once the waste audit is completed, based on the audit findings and comparative data of each category and the sources, an audit report is prepared. This report will help to determine the biodegradable, compostable, and recyclable resources out of the trash that has been misused all this time. Based on this data, an action plan is prepared by identifying the waste diversion opportunities and quantifying waste streams. The current waste management system can be improved with the help of a waste audit better than ever.

1.9.7.Steps after Waste Auditing

After completion of the waste audit and waste stream analysis, the auditor should consider the following points:

- It should be double-checked that the dumpster size and frequency of pickup are still adequate for meeting needs. If waste output changes are observed, a different size or number of pickups may be more cost-effective.
- If a recycler should be involved, if no recycling services have been engaged until now, more focus should be on recycling more goods.
- Set waste recycling as a personal goal to increase the recycling rate.
- Recycling instructions or guidelines should be made and distributed among the employees to achieve this goal.
- Set a goal to decrease waste in the most important categories.
- Identify the steps necessary to achieve that goal and communicate them to the team (for example, to save paper, e.g., switch to online bill payment).
- Identify the objects that can be reused, e.g., repairing devices rather than purchasing new ones and reuse of packaging materials.
- It is also necessary to make a schedule for achieving your recycling and waste reduction objectives. A timeline for the achievement of the desired waste reduction can be set for one or two years.
- The next waste audit should be planned at that time to verify if the objectives were reached.

1.10. Action Plan for Waste Reduction

Preparing one's own waste reduction action plan allows one to rethink procedures to produce less waste or redesign processes and hence boost efficiency.

Step 1: Review the site waste audit report and ensure 3R's actions are being followed.

Review site Waste Audit Report and gather information about the 3R's (reduction, reuse and recycling) actions that are currently in place, such as waste reduction strategies, quantity of current waste reduction, reuse, recycling, disposal and analysis of operating costs after following 3R's.

Step 2: Using the 3Rs, identify major waste reduction opportunities.

Examining the materials that make up a substantial part of the waste produced is a key aspect in identifying 3R's potential for waste reduction. Consider the cost of waste disposal, the potential for source separation, the potential to reduce, reuse or recycle, the complexity of handling and current and potential regulatory requirements.

Step 3: Determine Waste Reduction Priorities After identifying areas for potential waste reduction

Possible impacts of other priorities on the 3R's should be investigated and at least the following items should be considered when developing a waste reduction action plan. Review the costs and benefits of each waste reduction opportunity. Be aware of anticipated landfill closures, increased tipping fees or other factors that may affect the disposal of waste and ensure the availability of on-site storage space and storage space with adequate fire safety.

Step 4: Figure Out Why Waste Is Produced?

When evaluating waste reduction possibilities, you should start by asking yourself, "Why is this material being used?" These kinds of questions may be inspiring. Some proposed questions are:

Answers to these questions may reveal possibilities for reducing, reusing or recycling the waste, such as:

1. Where waste can be eliminated in the operations by reducing the use of specific materials or procedures.
2. Where other materials that can be reused or recycled.
3. Where it is possible to utilise disposable materials.
4. Where one can buy less material. For example, consider bulk purchasing instead of individually packed items can save the amount and reduce less packing materials.
5. Materials that have been previously recycled can be utilised.
6. Where one can one put controls in place to limit waste production during the operations?

Step 5: Identify Waste Reduction, Reuse and Recycling Opportunities

This section discusses some of the most prevalent 3Rs opportunities. Although the concepts are often simple and can lead to more significant initiatives. The following are some opportunities to improve the management of waste products:

Reduce Waste

Employees at any facility may already be employing a variety of waste-reduction techniques. Some disposable products may have already been replaced with reusable products in the facility. Use fewer disposable number of supplies, equipment and focus on strengthening purchasing rules in administrative departments to reduce the amount of incoming packaging.

Minimize Paper Usage

Avoiding the waste of paper by implementing double-sided printing and photocopies. E-mail memos and reports to staff or clients instead of providing hard copies. Encourage staff to save digital copies of documents instead of printing them. Remove names from mailing lists if magazines or catalogues are no longer needed.

Bulk Purchasing

To get volume discounts, look into buying in bulk. Bulk purchases frequently come with less packaging than items purchased individually.

Disposable/ Reusable/Eco-friendly Packaging

Request loose products rather than individually packed ones when purchasing supplies.

Instead of using disposable tape dispensers, use permanent tape dispensers. Request that the package be "taken back" by the vendor or it should be reusable or eco-friendly.

Cafeteria Waste

Single-serve condiment containers should be avoided. Customers who bring their own coffee/travel mug should receive a discount. To cut down on waste, go over the menus again, focusing on portion sizes. Start a "litter less lunch" campaign to encourage employee or students to bring lunches in reusable containers. Napkin dispensers might help to avoid using too many napkins.

Washrooms

Replace disposable hand towel dispensers with hand dryers where possible.

Manufacturing Technology

Wherever possible, adopt newer production technologies that reduce material usage. Due to older technology, make sure that process start-up and/or cut-off tolerances aren't exorbitant. To avoid waste, improve process controls.

Reuse Equipment

Reusable things can be donated or sold. Charitable organisations are typically interested in equipment and supplies that are no longer needed.

Donate Left Over or Unused Food

Donations of consumable fresh foods and out-of-date packaged foods are welcomed by many food banks. To determine if you can assist in this way, contact your local social organisations.

Recycle Waste

Many recyclable materials, such as corrugated cardboard, office paper, newspaper, glass, aluminium, steel, plastic products, and food waste have markets. As the markets grow, more items may be added to recycling list.

Use of Recyclable Materials

Look for ways to include recycled materials in the daily routine. The success of recycling is dependent on stable material markets. You can also contribute to the environment by buying products containing recycled materials.

Internal Recycling

Recycle the used materials wherever feasible, introduce processes to support internal recycling of waste materials and use the recycled products.

Employee Training on Source Separation

Make sure that segregation of different types of waste materials at source. All personnel should be trained in source-separation techniques and given enough well-labelled containers and storage facilities to collect recyclable material.

Organic Waste

Examine the options for composting. Look into composting organic materials like food waste, leaves and yard trash and paper towels with private operators or by the local government.

Internet or Business Directory

Find recycling companies in the surrounding area by using a local business directory or by searching on the internet.

Box 1: Follow 3Rs: Reduce , Reuse and Recycle

Reduce

Buy less and use less.

- Purchase recycled papers.
- Use softcopy instead of hard copy
- Purchase environmentally friendly office supplies.
- Choose to purchase items with less packaging.
- Double-side printing and photocopying.
- Use one-sided printed paper instead of throwing in trash.
- Set printer to print double sided as a default setting.
- Print notices on half-sheets.
- Use emails instead of faxes.
- Post newsletters online.
- Avoid printing out emails.
- Host paper-free meetings by setting the agenda on the board.
- Use fewer paper towels in the washroom or replace them with electric hand dryer.
- Use refillable soap dispenser in washroom
- Encourage waste-free lunches.
- Reduce the use of tetra-packs by using refillable containers.
- In the dining area replace the paper napkins with the cloth napkins.
- Purchase condiments, sweeteners, salt and pepper in bulk.
- Use dispensers instead of individually packaged servings.

Reuse

- Replace disposable items with reusable items and learn to share or donate to avoid the landfill.
- Reuse the other side of used paper.
- Use reusable coffee cups and water bottles.
- Stock cafeteria with reusable or biodegradable plates, cups and cutlery.
- Donate uneaten lunch items to a "share a lunch" program.
- Donate used computers, eyeglasses, cell phones, clothes, textbooks and other items.
- Host a clothing swap/sale/collection.
- Host a schoolyard/garage sale-type fundraiser

Recycle

- Divert garbage by recycling items such as paper, glass, plastics, cans, tetra packs and cardboard.
- Recycle special items such as batteries, electronics, cell phones and computers.
- Compost organic waste.
- Limit contamination of recycled items by ensuring they are clean.
- Recycle ink and toner products.
- Ensure correct disposal methods are used for chemicals.

Step 6: Evaluate Impact of Material Purchasing Practices on Waste Reduction

Material purchasing procedures involve a lot of waste reduction possibilities. Actions to change the materials used to manufacture your products or provide your services may involve discussions with suppliers. Replacing non-recyclable materials with reusable or recyclable materials gives economic benefits and greater waste diversion.

Step 7: Achievable Waste Reduction Action Plan

A waste reduction action plan is a compilation of the identified waste reduction opportunities and the actions intended to be taken in reducing waste. At this stage, realistic waste reduction targets should be set. It is also important that the work plan is achievable. Excessive over-targeting could have negative effects on employee attitudes and confidence in future work plans. The work plan focuses on the wastes for which reduction measures, actions and objectives have been specified. The format enables to identify activities on specific waste materials as well as the total amount of waste reduced, reused and recycled.

1.11. Conclusion

Waste management audit is carried out to provide an indication on how the environmental organization system is working towards the noble cause of environmental protection and nature conservation. To conclude the waste management audit report, the College is an eco-friendly campus and providing very good amicable atmosphere to the stakeholders.

2. BIOMEDICAL WASTE AUDIT

2.1 Introduction

Generally, people think that hospitals and other healthcare facilities are only to treat ill-health persons and generate biomedical waste. But the majority of people are unaware that they also produce a significant amount of biomedical waste which can be contagious and harm both people and the environment. Health care waste is a specific waste category that is generated by healthcare facilities such as hospitals, laboratories, physician and dental clinics, research institutes, surgery centers, nursing homes, veterinary practices and personal health care facilities. Due to the advancements in scientific technologies, the quantity and type of bio-medical waste is increasing day by day. In the absence of improper treatment, bio-medical waste may pose a health hazard to healthcare workers and may also cause a threat to the environment.

The Central Pollution Control Board (CPCB) reported a total of 3,52,014 HCFs in India including 1,13,186 bedded and 2,37,938 non-bedded in its annual report on Biomedical Waste Management published in 2020. There are a total of 208 common biomedical waste treatment facilities in India and around 2,44,282 HCFs handover their bio-medical waste to CBWTFs where it is treated and disposed of properly. In addition to this, 17,206 medical facilities have established private bio-medical waste treatment and disposal systems. Out of total 656 tonnes of produced bio-medical waste per day, only about 590 tonnes were processed and disposed off. The rest 66 tonnes of waste produced each day may be dumped far away in large graves. There are possibilities that bio-medical waste could harm public health, hence it is required that such facilities must follow guidelines framed by the government so that the public can be protected who may possibly encounter it. The Ministry of Environment, Forestry, and Climate Change (MoEF) is the primary regulatory agency that oversees many areas of biomedical waste.

The rules and regulations for managing biomedical waste must be followed by everyone who generates, gathers, stores, transports, processes, discards or otherwise manages biomedical waste. Because of its infectivity and toxicity, biomedical waste may constitute a health risk and is capable of spreading infectious diseases in humans or animals and is thus considered hazardous. It may be the source of a number of serious illnesses, including hepatitis and AIDS which are known to have transmitted via biomedical waste. Other prevalent diseases spread by poor waste management include whooping cough, tetanus, diarrhoea, pneumonia, tuberculosis and other communicable diseases.

2.2 What is Biomedical Waste

According to the Bio-medical Waste Management Rules, 2016, "Any waste which is generated during the diagnosis, treatment or immunisation of human beings or animals or in research activities pertaining thereto or in the production or testing of biologicals or in health camps and including categories mentioned in Schedule I" is considered bio-medical waste.

Any biological and non-biological waste that has been disposed off and is not intended for further use is considered hospital trash. Hazardous waste that is very pathogen-rich and has the potential to spread diseases is referred to as infectious waste. For instance, laboratory-produced infectious agent cultures and stocks, medical waste and trash produced by infectious people.

2.3 Classification of Biomedical Waste

It is common knowledge that many sorts of harmful and infectious compounds are produced during various types of healthcare activity which may cause harm to patients and personnel who are exposed to these wastes. Keeping this in view, the World Health Organization (WHO) has given the following simplified classification for the biomedical waste handling and management in hospitals (Fig.1):

a) General or non-hazardous waste

b) Bio hazardous waste

1) Non-infectious waste

- Cytotoxic waste
- Chemical waste
- Radioactive waste
- Pharmaceutical waste

2) Infectious waste

- Sharps
- Pathological waste

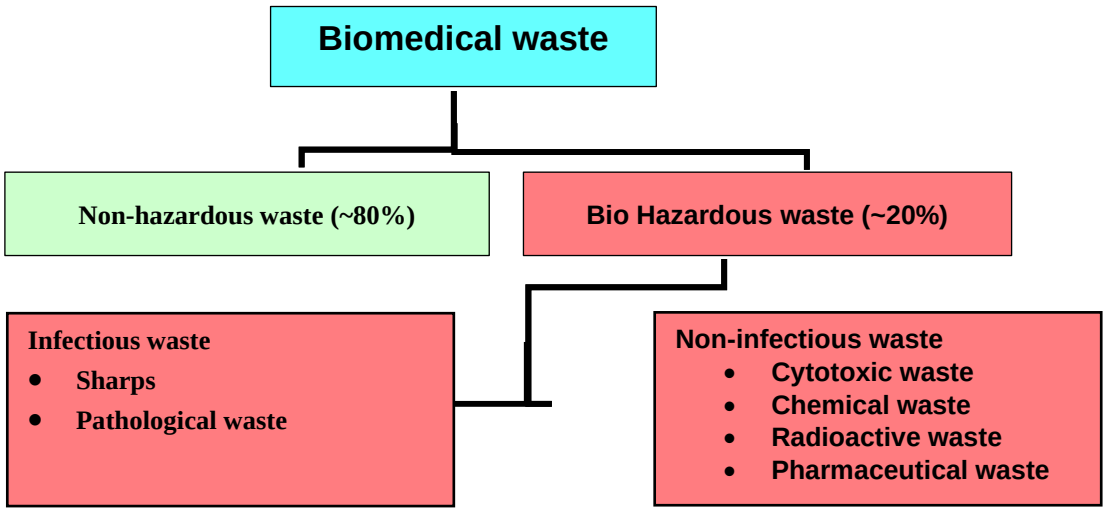


Figure 1. Broad categorization of Biomedical Waste

According to the report published by MoEF, GoI (2009-10), 80% of biomedical waste is actually non-hazardous or non-infectious waste and is called general waste which can be managed as municipal solid waste if segregated properly. However, the remaining 20% is infectious or biohazardous and needs to be treated in dedicated facilities. This 20% biohazardous waste includes around 15% infectious (pathological wastes and the remaining 5% non-infectious (pressurised containers, incineration ash, pharma and other types of wastes). It may contain certain toxic chemicals such as cholоromethane

Categorization of biomedical waste is given in Schedule I of the BMW Rules, 2016. These categories are given in Table 1.

Table 1. Biomedical waste Categorization.

Category	Types of Wastes	
Yellow	a) Human Anatomical Waste	Human tissues, organs, body parts and foetus below the viability period (as per the Medical Termination of Pregnancy Act 1971, amended from time to time).
	b) Animal Anatomical Waste	Experimental animal carcasses, body parts, organs, tissues, including the waste generated from animals used in experiments or testing in veterinary hospitals or colleges or animal houses.
	c) Soiled Waste	Items contaminated with blood, body fluids like dressings, plaster casts, cotton swabs and bags containing residual or discarded blood and blood components.
	d) Expired or Discarded Medicines	Pharmaceutical waste like antibiotics, cytotoxic drugs including all items contaminated with cytotoxic drugs along with glass or plastic ampoules, vials etc
	e) Chemical Waste	Chemicals used in production of biological and used or discarded disinfectants.
	f) Chemical Liquid Waste	Liquid waste generated due to use of chemicals in production of biological and used or discarded disinfectants, Silver X-ray film developing liquid, discarded Formalin, infected secretions, aspirated body fluids, liquid from laboratories and floor washings, cleaning, house-keeping and disinfecting activities etc.
	g) Discarded linen, mattresses, beddings contaminated with blood or body fluid.	Discarded linen, mattresses, beddings contaminated with blood or body fluid.
	h) Microbiology, Biotechnology and other clinical laboratory waste	Blood bags, Laboratory cultures, stocks or specimens of microorganisms, live or attenuated vaccines, human and animal cell cultures used in research, industrial laboratories, production of biological, residual toxins, dishes and devices used for cultures.
Red	Contaminated Waste (Recyclable)	Wastes generated from disposable items such as tubing, bottles,

		intravenous tubes and sets, catheters, urine bags, syringes (without needles and fixed needle syringes) and vaccutainers with their needles cut) and gloves.
White (Translucent)	Waste sharps including Metals	Needles, syringes with fixed needles, needles from needle tip cutter or burner, scalpels, blades, or any other contaminated sharp object that may cause puncture and cuts. This includes both used, discarded and contaminated metal sharps
Blue	Glassware	Broken or discarded and contaminated glass including medicine vials and ampoules except those contaminated with cytotoxic wastes.
	Metallic Body Implants	Metallic Body Implants

2.4 Composition of Waste

Health care waste only makes up around 1 to 1.5 percent of the total municipal solid waste produced in a city, of which about 15 percent is deemed contagious, as estimated by Sikka (2010). According to a study of NEERI, 1997 as cited by Jayaswal and Saha (2010), paper (15%), rags (15%), plastic (10%), glass (4%), infectious waste (1.5%) and general garbage (53.5%) are the most common materials found in hospital waste produced in India (Figure 2).

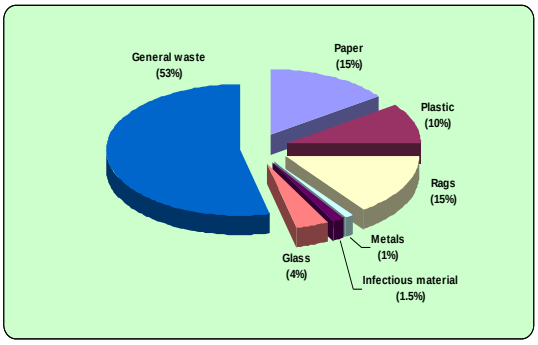


Figure 2: Percent Composition of Hospital Waste

As per another study conducted by Patil and Shekdar (2001), a hospital generates mainly infectious waste such as bandages, linen, etc., (30-35%), plastic (7-10%), glass (3-5%), disposable syringes (0.3-0.5%) and general waste (40-45%) as depicted in Table 2.

Table 2. Composition of Hospital Waste in India

S. No.	Material	Approximate Percentage
1	Infectious waste	30-35%
2	Plastics	7-10%
3	Glass	3-5%
4	Disposable syringes	0.3-0.5%
5	General waste	40-45%

Source: *Patil and Shekdar (2001).*

The most of the infectious waste is made up of dressings, cotton gauze, mutilated human parts, placentas, and abandoned dialysis kits composed of plastic and aluminium. In addition to chemicals and solvents needed for analysis, laboratory waste also includes pathogenic materials. No matter how much bio-medical waste there is, it always considered to be bad for the neighbourhood. This needs to be handled right away and disposed off properly. Hazardous diseases frequently focus on wasted blood and blood products. Silver bromide (Fixon), glutaraldehyde, hydroquinone, and potassium hydroxide are among the chemical contaminants found in the waste stream from X-ray machines. Infectious substances and methanol are frequently found in the waste stream after the sterilisation of syringes. The amount of bio-medical waste produced by healthcare facilities is influenced by a variety of factors, including waste management techniques, the type of facility, occupancy, specialisation, percentage of reusable items in use, infrastructure and resource availability and others (Mandal and Dutta, 2009).

2.5 Sources of Biomedical waste

2.5.1 Major sources

- Hospitals (government/private)
- Dispensaries/ nursing homes/clinics.
- Medical research institute/ medical colleges.
- Primary health care centres.
- Veterinary colleges and animal research centres.
- Paramedic services.
- Blood banks.
- Mortuaries/autopsy centres.
- Institutions of Biotechnology.
- Manufacturing units.

2.5.2. Minor Sources

- Physicians clinics.
- Dental clinics.
- Vaccination centres.
- Blood donation camps.
- Acupuncturists/cosmetic clinics /psychiatric clinics.
- Animal houses/slaughter houses.
- Institutions for disabled persons
- Funeral services.

2.6 Management of Biomedical Waste

Medical facilities are essential to save lives, but the waste generated from these units due to bio-medical activities cannot be ignored. In fact, the management of bio-medical waste has become a significant problem for everyone, including the environment and healthcare professionals as well as the general population. Health care professionals, waste collectors, and other members of the public may be exposed to improperly managed bio-medical waste, which could result in a number of health issues and pose a serious risk to the environment. All individuals involved in health care activities, as well as those who support and fund them, have a social obligation to manage biomedical waste in a safe and sustainable manner. Adequate bio-medical waste management is required to protect public safety, health, and the environment. Hence, such waste must be given specific treatment and management before it is finally disposed of.

Bio-medical waste management entails a majority of engineering tasks such as collection, transportation, treatment, and waste disposal. Every healthcare establishment is required to collect waste and deliver it to a common bio-medical waste treatment facility for final processing and disposal.

2.6.1. Need of Bio-medical Waste Management

Inadequate management of the bio-medical waste produced in healthcare facilities, clinics, laboratories, and medical institutions may pose direct health hazards to those who come into contact with it, as well as to the environment and the workers who handle it. There are several scenarios in which anyone may come into contact with biomedical waste and become infected, necessitating proper management:
Sometimes, injuries may happen to hospital staff and waste handlers on coming into contact with sharps present in the waste that may lead to infection.

- Hazardous chemicals and drugs may cause harm to those who handle waste.
- Patients admitted to hospitals may get nosocomial infections or healthcare-associated infections (HAI) to improper waste management and poor infection control practices.
- There may be some chances that discarded drugs may be repackaged and sold to unwary customers.
- Outside the hospital, there is an infection risk for people who handle waste and foragers as well as the general public living near by the hospitals.
- Unsuitable incineration emissions and ash may create a problem of air, water and soil contamination.

To reduce the risk of contamination for waste handlers, scavengers and people living close to hospitals, biological waste must be supervised. Bio-medical waste must therefore be managed to safeguard the environment and the general public's health.

2.6.2. Advantages of Bio-medical Waste Management

Planning the management of bio-medical waste and reconditioning for each kind of waste produced in healthcare facilities is a critical activity because it contributes significantly to global cleanliness, public health, resource preservation and ecosystem sustainability. In the health care units, about 80% of waste is general or non-hazardous waste from which some items can be recycled. This curbs the consumption of natural resources and the waste quantity going to a landfill. Hospitals and other healthcare facilities produce bio-medical waste which is collected, segregated, treated and then disposed off. Here are some advantages of proper bio-medical waste management:

- It makes the environment cleaner and healthier.
- It also minimises the health risks to the health care staff and waste handlers like the incidence of infections of critical diseases like HIV/AIDS, sepsis, hepatitis, tuberculosis and other diseases spread by infectious medical equipment.
- It also reduces the incidence of hospital-acquired infections.
- It reduces the chances of infections and subsequent deaths that may cause due to reused and repacked disposables.
- It helps to stop the illegal trading of used syringes, injection needles and medical tools.
- Less chances of hazards to public and occupational health.
- Accurate biomedical waste management also lowers the expenses of waste management and infection control in the hospital.
- Efficient waste treatment and disposal might help earn revenue.

2.6.3. Process of Management of Biomedical Waste

Handling, segregation, mutilation, disinfection, storage, transportation and final disposal should all be addressed with a cradle-to-grave approach which involves the implementation of standard operating procedures. These steps must be taken in order to dispose of biomedical waste in every facility in a safe and effective manner (Acharya and Singh, 2000).

2.6.4. Handling and Segregation of Bio-medical Wastes

Biomedical waste needs to be handled carefully. The fundamental to minimising and successfully managing medical waste at-source is waste segregation as per the waste categorization (Table 1). The most efficient way to distinguish between the various categories of biomedical waste is to sort it into color-coded plastic bags or containers in line with Schedule I of the BMWM Rules 2016 as indicated in Table 3 and Figure 3.

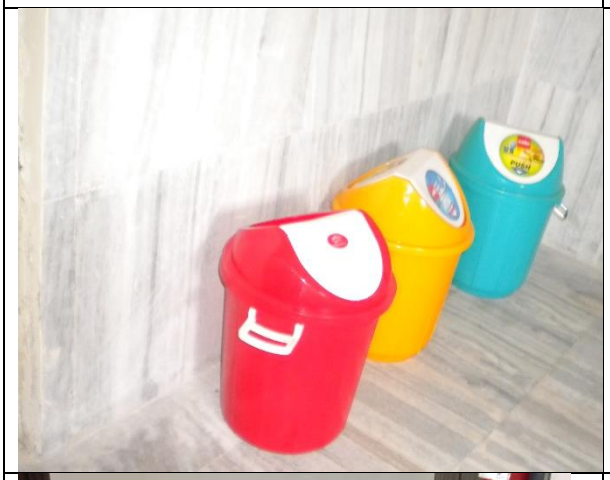
Table 3. Segregation, treatment and disposal of BMW as per Schedule I of Biomedical Waste Management Rules, 2016

Bags/Bins	**Waste categories** (Details given in Table 1)	**Type of Bag or Container to be used**	**Treatment**
Yellow	(a) Human Anatomical Waste (b) Animal Anatomical Waste (c) Soiled Waste	Yellow coloured non-chlorinated plastic bags	Incineration or plasma pyrolysis or deep burial
	(d) Expired or Discarded Medicines	Yellow coloured non-chlorinated plastic bags or containers	All other discarded medicines shall be either sent back to manufacturer or disposed by incineration.
	(e) Chemical Waste	Yellow coloured containers or non-chlorinated plastic bags	Incineration or plasma pyrolysis or Encapsulation in hazardous waste treatment, storage and disposal facility.
	(f) Chemical Liquid Waste	Separate collection system leading to effluent treatment system	Pre-treatment before mixing to other wastewater and discharge conforming the norms as given in Schedule III.
	(g) Discarded linen, mattresses, beddings contaminated with blood or body fluid.	Non-chlorinated yellow plastic bags or suitable packing material	Non- chlorinated chemical disinfection followed by incineration or Plasma Pyrolysis or for energy recovery.

	(h) Microbiology, Biotechnology and other clinical laboratory waste	Autoclave safe plastic bags or containers	Sterilize with non-chlorinated chemicals on-site thereafter incineration
Red	Contaminated Waste (Recyclable)	Red coloured non-chlorinated plastic bags or containers	Autoclaving or Micro Waving followed by Shredding or mutilation or combination of sterilization and shredding.
White (Translucent)	Waste sharps including Metals	Puncture proof, Leak proof, tamper proof containers	Autoclaving or Dry Heat Sterilization followed by shredding or mutilation or encapsulation in metal container or cement concrete; combination of shredding cum autoclaving and sent for final disposal
Blue	a) Glassware b) Metallic Body Implants	Cardboard boxes with blue colored marking	Disinfection by washing with detergent and sodium hypochlorite treatment or through autoclaving or microwaving or hydroclaving and then sent for recycling.

Figure 3. Waste collection Colour coded bins for biomedical waste management in various HCEs


Bio-Medical Waste

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बायो मेडिकल वेस्ट का वितरण
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प्लास्टिक वेस्ट
संक्रमित वेस्ट
नोकदार वेस्ट
साधारण वेस्ट
SRMS
SHRI RAM MURTI SMARAK
INSTITUTE OF MEDICAL SCIENCES, BAREILLY


काँच/धातु का वेस्ट
BIOHAZARD
SoClean
SHARP WASTE ONLY



2.6.5. Mutilation

For disposable needles and other sharp waste, it is advised that mutilation be properly followed. Sharp waste such as mutilated needles should be kept in containers that cannot be punctured.

2.6.6. Disinfection

To disinfect the mutilated wastes, the use of a 1% hypochlorite solution or another chemical reagent is required. It is necessary to ensure that chemical treatment ensures disinfection.

2.6.7. Storage and transportation

A separate space, room, or building that can accommodate the volume of garbage generated and the frequency of waste collection should be used to store the waste which should be placed in bags or containers. The following are the procedures and recommendations for the storage area:

- Biomedical waste should not be stored for longer than 48 hours (between generation and treatment). To guarantee that the waste does not endanger human health or the environment and the authorised person must perform the actions outlined in the Biomedical Waste Management Rules, 2016, and seek authorization from the designated authority if this is not possible.
- Lead shielding should be used to safeguard radioactive waste when it is stored in containers to prevent dispersion. Waste that will be held during radioactive decay should be labelled with the kind of radionuclide, the date and the details of the required storage conditions.
- Cytotoxic waste needs to be stored in a secure location, apart from other biomedical waste.
- The storage facility should have an impervious, hard-standing floor with adequate drainage and a suitable water supply for cleaning and disinfection.
- Staff in charge of garbage processing should have easy access to the storage space.
- The business should be able to be locked to prevent unauthorised people from entering.

- Waste collection vehicles must have easy access.
- The storage area must be shielded from the sun and inaccessible to animals, flies, mosquitoes, rodents and raptors.
- Ample lighting and minimum ventilation are required.
- The storage facility shouldn't be situated next to fresh food markets or areas where food is prepared. Instead, it should be conveniently located next to a supply of cleaning supplies, protective clothing and waste bags or containers

2.6.8. On-site transport

Biological waste is carried from the hospital or other facility in wheeled carts, bins or trolleys that are exclusively used for that task and meet the requirements listed below:

- Loading and unloading must be easy.
- Any protruding edges should not be there to avoid damage to garbage bags or containers during waste loading and unloading.
- Vehicles should be easy handling and must be disinfected regularly with an appropriate disinfectant.
- Garbage-bags must be sealed and intact at the end of transportation process.

2.6.9. Off-site transportation

Medical waste transferred from hospitals to CBWTF for processing entails

- *Regulation and control system:* The waste regulatory authority should have the transportation company's registration information or be aware of it. Facilities that handle and dispose of biomedical waste need have a permission from a body that regulates waste before they can do so.
- *Specific packaging needs for off-site delivery:* The bags or containers must be suitable for the contents, i.e., for sharps, they must be puncture-proof and chemically resistant.
- *Container labelling:* The containers must be labelled in accordance with Schedule IV (Box 1).
- *Routing:* Biomedical waste should be delivered using the shortest route possible which should be arranged ahead of time.

2.6.10. Processing of biomedical waste

According to the standard procedures outlined in Schedule II of the BMW Rules 2016, the bio-medical wastes are primarily treated by incineration, autoclaving, microwaving, deep burial, chemical disinfection and heat sterilisation. According to the Rules, human anatomical waste, animal anatomical waste, soiled waste and chemical waste can be handled and disposed of through plasma pyrolysis, deep burial, or burning. As long as deep burial of biomedical waste is only permitted in rural or distant places without access to a facility for treating common biomedical waste.

2.6.11. Incineration

There are two chambers (primary and secondary) in waste incinerator. The primary chamber's temperature must be 800^{o}C, 50 ^{o}C, while that of secondary chamber must be 1050^{o}C, 50 ^{o}C. To control environmental pollution, the incinerator must have adequate pollution control devices. CPVC plastic should not be burned in order to prevent the production of dioxins and furans. Within two years of the notice of the BMW Rules 2016, the existing incinerators must adhere to the operational and emission norms. Additionally, existing incinerators must adhere to the 0.1ngTEQ/Nm3 dioxin and furan norms within two

years after the start of these regulations. To achieve a total organic carbon content in the bottom ashes and slag of less than 3 percent or a loss on ignition of less than 5 percent of the dry weight, incinerators (combustion chambers) must be regulated for temperature, retention time, and turbulence.

2.6.12. Autoclaving/Microwaving

The non-incinerable BMW that can be autoclaved or microwaved etc. There are two different types of waste autoclaves: vacuum and gravity flow. Non-incinerable waste is typically treated in a vacuum-type autoclave. For treatment of BMW in a gravity flow autoclave, the necessary temperatures, pressures, and times are 121 ^{0}C, 15 psi, 135 ^{0}C, 31 psi, or 149^{0}C, 52 psi and 30 minutes. For treatment of BMW in a vacuum autoclave, the needed temperature, pressure, and time are 121 ^{o}C, 15 psi, and 45 minutes, or 135 ^{o}C, 31 psi and 30 minutes.

2.6.13. Deep Burial

A two-meter-deep ditch must be constructed. Garbage should be placed in the pit's lower half followed by a 50 cm layer of lime and finally the remaining soil. Making ensuring that animals cannot enter cemeteries is essential. Animals can be kept out using wire mesh coverings or galvanised iron. It is usually done in remote areas where no CBWTF is available.

2.6.14. Chemical disinfectant and Dry Heat Sterilization

Some microorganisms are killed by chemical treatment systems using chemical disinfectants.

Dry heat sterilisation is used to destroy germs in used sharps with a sterilising interval of 90 minutes, and is carried out at a temperature of not less than 185^{0}C for at least 150 minutes in each cycle. An automatic recording system should be in place to monitor operating parameters. These are the treatment and disposal methods currently being used for biomedical waste. However, currently, BMW produced at most HCFs/HCEs is treated in the Common Biomedical Waste Treatment Facility.

2.7. Common Facility for Final Disposal of Infectious BMW

Despite knowing the rules, hospitals, private practitioners and emergency care centres lack the time and resources to properly dispose of biomedical waste. Self-contained on-site treatment methods may be desired and useful for large healthcare facilities. It won't be financially or operationally viable for smaller institutions. Color-coded bags, daily infectious waste collection, secure garbage transport to an off-site treatment facility, and technology-assisted final disposal using appropriate system. Figure 4 depicts the entire biomedical waste treatment process at CBWTF.

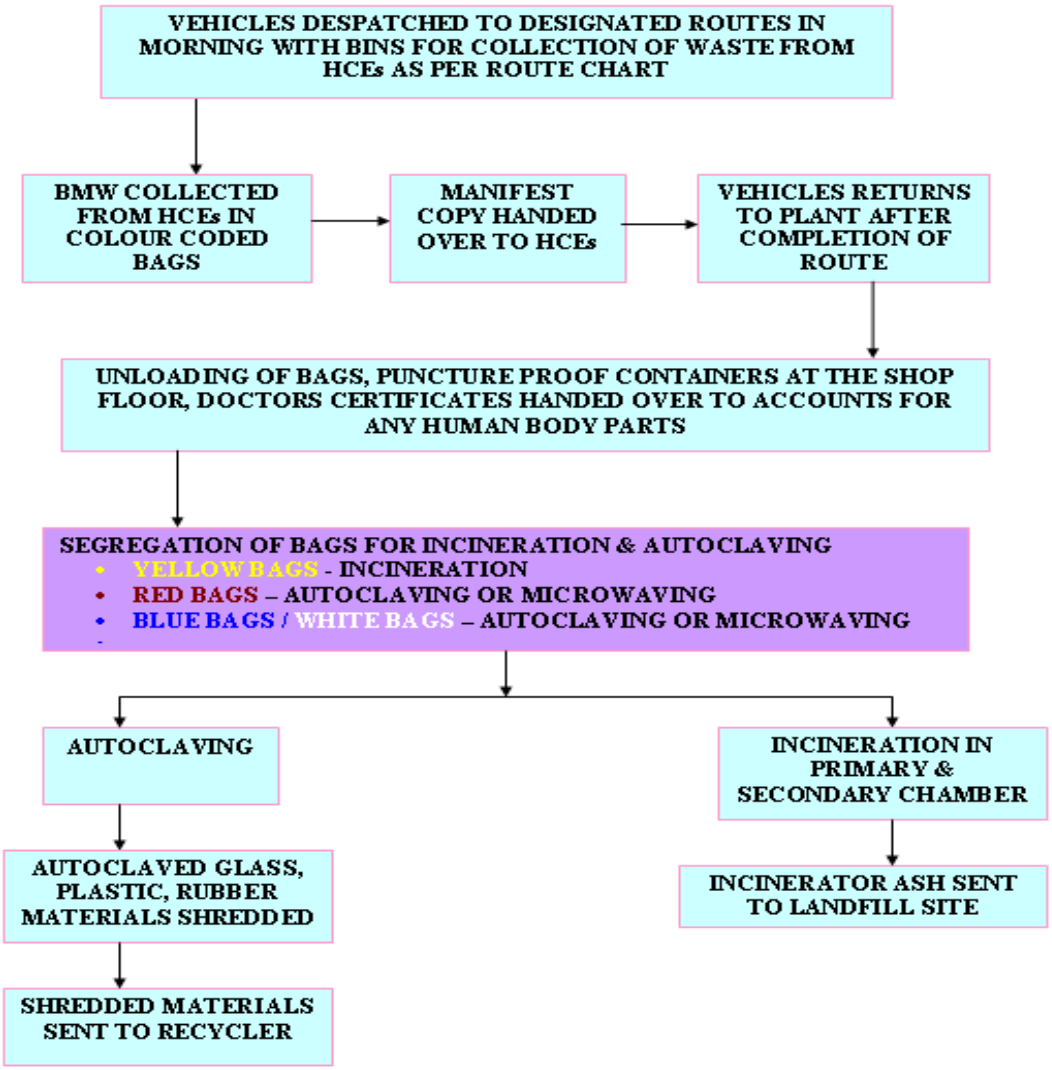


Figure 4. Flow chart showing the process of biomedical waste management in CBWTF.

2.7.1. Disposal of Biomedical Wastes in Sanitary and Secured Landfills

As per the manual of MoUD, GOI's (2000) on "Municipal Solid Waste Management," sanitary and secure landfilling is required in the following circumstances:

• For autoclaved/ hydroclaved/ microwaved waste - Sanitary landfill
• For disposal of incineration ash- Sanitary landfill
• For disposal of sharps- Secure landfill or within the hospital's boundaries by constructing a concrete lined pit.
•Disposal of healthcare wastes in a secure landfill until adequate management facilities are available.

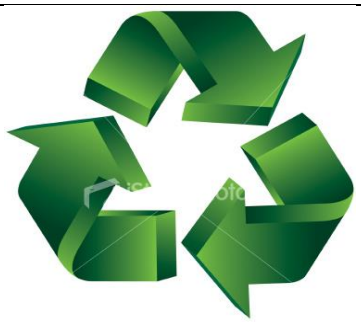
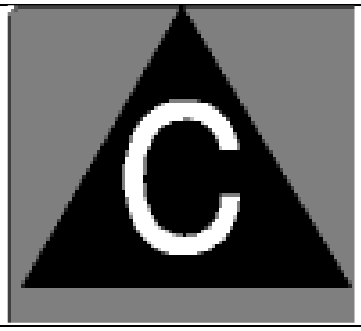
Box 1. Practices for safe handling of Biomedical Waste

All healthcare facilities including those in the public and commercial sectors must adhere rigidly to the recommended segregation at source of bio-medical waste.

1. Avoid touching the BMW with bare hands. After handling waste, hands should be thoroughly cleansed with soap.
2. The first and most crucial stage in waste reduction and effective waste collection, transportation, treatment and disposal is waste segregation.

3. Ensure that the waste segregation process is properly monitored that appropriate color-coded bags are used for garbage collection and that waste is stored in a common storage room to prevent infection.
4. Sharp waste should be handled with care and collected in puncture-resistant containers.
5. Syringe cutters and needle crushers should be used to dispose of used needles and syringes at the source. Never recap used syringes; the majority of needle prick injuries occur as a result of recapping.
6. Autoclaving should be used to disinfect waste which is highly contagious. The Biohazard symbol should be placed on infectious waste bags and containers, and cytotoxic waste should be gathered in containers that are leak-proof and properly marked as such. Recycling-friendly waste should be clearly labelled.

Common symbols used for Bio-medical waste

		
Bio Hazard	**Recycling**	**Cytotoxic material**

7. Before delivering any disposable plastic to the seller, it must be crushed. I-V fluid bottles, saline bottles, catheters and tubes and any disposable items other than discarded sharps must all be punctured before being sent for treatment.
8. Personal Protective Equipment (PPE) that is damaged or contaminated must be changed on a regular basis. When managing BMW garbage, always wear good quality gloves, masks, shoes, an apron and other protective gear. Cutting gloves, bottles and infusion sets requires the use of curved scissors.
9. Products made of plastic, rubber and filthy linen must be disinfected with sodium hypochlorite at the place of manufacture for at least an hour. Every change ought to begin with a fresh solution.
10. Employees must either knot the neck of the waste bag or seal it to prepare it for on-site collection when it is three quarters full.
11. The kerbside storage area needs to be hard-standing, impervious and with good drainage system. It need to make accessing the waste collection van easier.
12. Wheeled carts, containers or trolleys with wheels that are not being used for anything else should be used to transport biomedical waste throughout the hospital. Every day, the carts need to be cleaned. The off-site transportation vehicle should be properly labelled with the details of the operator such as name and address.
13. Biomedical waste can be handled using technologies like incineration, autoclave, microwave, hydroclave at the end of the procedure.
14. Specific higher-risk personnel who handle biological waste may receive tetanus and serum hepatitis immunizations. Nurses and other members of the health-care unit handling BMW will be held responsible for adequate segregation and storage. BMW's management should be periodically supervised by higher authorities. Sweepers will pick health care waste after segregation and place it in coloured plastic bags with their necks tightly tied. They will then move it to the healthcare unit's central intermediate storage room which will be placed in a convenient area. In the case of laboratories and

clinics, the section in charge will be held accountable for oversight and strict implementation in their respective areas.

15. To fulfil the stipulated requirement, the facility must plan for treatment of liquid bio-medical waste/leachate such as chemical disinfection, prior to discharge to an outside drain.

2.8. Biomedical waste Management

2.8.1. Biomedical waste Management rules, 2016

If not properly disposed of and combined with municipal garbage, health care waste or medical waste generated by healthcare facilities can be extremely harmful, making the entire waste stream hazardous. Improperly treated bio-medical waste also has the potential to spread diseases. In the absence of adequate and appropriate biomedical waste handling, environmental and human health may be seriously threatened (Singh and Sarma, 1996). Due to the advancement in medical technologies, drugs, and disposables, the burden on waste management and handling systems has increased manifolds. This waste must be managed in order to meet environmental, sanitary and legal requirements.

Considering the gravity of the problem associated with biomedical waste management, the Ministry of Environment and Forests (MoEF), GoI, announced the Bio-medical Waste Management (Management and Handling) Rules, 1998 in July 1998 through a Gazette notification (S.O. 630€) dated 20.7.1998. Thereafter, the Bio-medical Waste (Management and Handling) Rules, 1998, have been amended thrice, first on 6th March 2000, second time on June 2, 2000 and later on a third amendment on September 17th, 2003. Later, through a Gazette notification (GSR 343(E)) dated 28.03.2016, the Central Government replaces the Bio-medical Waste Management (Management and Handling) Rules, 1998 with the Biomedical Waste Management Rules, 2016. The primary goals of the regulations are to guarantee proper biomedical waste collection, segregation, transportation, scientific treatment and disposal.

These rules apply to everyone who creates, collects, receives, stores, transports, treats, disposes off or handles biomedical waste including those who work in any kind of health care establishments such as hospitals, nursing homes, clinics, laboratories, veterinary hospitals, etc.

Radioactive wastes, hazardous wastes, hazardous chemicals, lead acid batteries, elecctronic waste, municipal solid waste, hazardous microorganisms, and genetically modified cells are not covered under the Biomedical Waste Rules 2016.

These regulations require all "occupiers" or those with control over the establishment or its premises, to take all practical steps to make certain that waste created is managed in a way that safeguards both the environment and human well-being.

Box 2. Salient features of Bio-Medical Waste Management Rules, 2016

1. BMW rules are applicable to all kind of healthcare establishments which are generating medical waste.
2. Eliminate gloves, blood bags, and CPVC plastic bags within two years
3. On-site sterilization of laboratory waste, pathology waste, blood samples and blood bags in accordance with WHO or NACO guidelines
4. It is required to regularly vaccinate all of its healthcare professionals and to provide training to all of them

5. Create a bar-code system for disposal of biomedical waste bags and containers.
6. Submission of yearly report on its website within two-years.
7. Describe significant mishaps.
8. The current legislation imposes stricter norms for incinerators in an effort to prevent environmental pollution.
9. Within two years, existing incinerators must adhere to the requirements for secondary chamber retention time as well as Dioxin and Furans.
10. To improve the source-level segregation of waste, bio-medical waste has been divided into four categories rather than the previous ten.
11. The authorization process has been streamlined. There is a utomatic approval for hospitals with beds. For bedded HCFs, the authorization's duration corresponded with that of the consent orders. Non-Bedded HCF Authorization once.
12. In case a common waste treatment facility is accessible at a distance of 75 kilometres, installation of an on-site treatment and disposal facility will not be allowed to any occupier.
13. The administrator of a common facility for the treatment and disposal of biomedical waste must make sure that the HCFs' biomedical waste is collected on regularly and to help the HCFs with their training.

Therefore, it is necessary for hospitals, nursing homes, clinics, dispensaries, animal houses, pathological labs, etc., to take the necessary actions to handle their bio-medical waste in accordance with the rules, wherein bio-medical waste classification, colour coding, etc., have been defined in various Schedules (Box 1). However, not every institution needs to have a separate waste treatment facility. The regulations also allow for the treatment of waste to be done in any other facilities, including public ones. But it is the occupier's duty to see that the waste is dealt with within 48 hours.

Box 3. Summary of Schedules in BMW Rule

There are four schedules provided in the Biomedical Waste Management Rule, 2016. Summary of contents of these Schedules are:

Schedule	**Contents**
I	Categorization of Biological wastes
II	Standards of treatment and disposal of biomedical waste
III	Prescribed authority and the corresponding duties
IV	Label of containers, bags and transportation of Bio-Medical waste

2.9. Biomedical Waste Audit

A crucial component of any healthcare facility is the management of biomedical waste. Bio-medical wastes are produced on account of medical activity like medical diagnosis of patient, therapy, treatments and management. Every member of the healthcare team must possess the necessary training, experience, ability to mentor others and handling abilities for the collection and treatment of waste. The environment, the general population, and the health care workers are all at risk from the waste produced by hospitals and other healthcare facilities. Biomedical waste handling, treatment, and disposal is a growing concern that is being faced by health care facilities.

It is a well-known fact that the total biomedical waste contains only 15-20% hazardous waste, including 10-15% is infectious and 5–10% is non-infectious waste. So, around 80-85% of waste can be disposed of as municipal solid waste. Still, the rest 15-20%

of biomedical waste, which includes infectious and non-infectious parts, needs adequate management, as if it remains ill-treated and poorly managed, it may cause several health hazards and also contaminate the environment. The entire stream could become toxic if a very small amount of unprocessed bio-medical waste is combined with municipal trash. By following the BMW Rules 2016, total medical waste generation can be reduced and managed efficiently. And, a bio-medical waste audit helps to supervise the whole process of management of biomedical waste including segregation, handling and dumping practices. Biomedical waste audits act as a useful waste management tool for healthcare providers, allowing them to assess the effectiveness of their waste management systems and procedures across all of their generation sites.

2.10. Significance of Biomedical waste audit

It is critical for an organisation to understand what kind of waste is produced, as well as how much. Are the waste management practises followed by organisations adequate? Does the organisation comply with the rules and guidelines of the government? A waste audit gives an answer to all these questions. It helps the organisation avoid heavy fines and a bad reputation.

2.11. Objectives of the Bio-medical waste audit

The main objectives of the bio-medical waste management audit are:

- Quantification of medical waste generation.
- To quantify the recyclable waste.
- To estimate the waste being thrown away.
- To segregate biomedical waste as per the category and colour-coded bins.
- To determine the adequacy of existing bio-medical waste management practices.
- Waste management practices within the health care facility.
- Handling and disposal mechanisms installed.
- The objective was to understand how efficiently our biomedical waste management rules and standard procedures were being followed.
- Identification of gap areas.

2.12. Benefits of Biomedical Waste Audit

A bio-medical waste audit helps in the following ways:

- In the bio-medical waste audit, existing volumes and categories of waste are evaluated.
- Waste audits facilitate improved bio-medical waste segregation practices.
- It helps to identify the opportunities for waste minimization.
- It helps to identify the opportunities for potential cost savings.
- A cost estimation for existing bio-medical waste management practises has been done.
- A waste audit helps keep compliance with regulation and waste minimization goals set by the central and local governments.
- It reduces the risk of fines that may be caused due to non-compliance.
- It aids in the identification of the need for awareness programmes and employee training.
- Waste audits are aimed at reducing the amount of waste that ends up in landfills, as well as reducing dangers such as sharp injuries among healthcare workers and CO_2 emissions.
- helps in the protection of the environment.

2.13 Biomedical Waste Audit Methodology

2.13.1 Biomedical Waste Audit Methodology - Outline

Biomedical waste audits are prospective studies that involve daily audits by the biomedical waste management audit team including some of the representatives from the organisation whose audit is being done. Problematic areas were identified and corrective action was planned following discussion within the biomedical waste team. Each day during the whole audit period, the audit team visits the designated areas in the health care facility. The audit team records all the observations in accordance with the biomedical waste audit checklist, especially designed to collect data from the identified generation sites on a daily basis. The biomedical waste management committee discussed the audit report at the end of each month and forwarded it to the medical superintendent for any necessary action.

2.14. Where should a biomedical waste audit be performed?

Bio-medical waste audits are performed in all types of healthcare facilities, including small, medium and large waste generators. Major biomedical waste generators are veterinary clinics, hospitals, doctors' offices, outpatient clinics, urgent care centres, pathological laboratories, medical research institutes, etc., which require bio-medical waste audits.

2.14.1 Biomedical Waste Audit Checklist

The checklists for the conduct of a waste audit have been included with different parameters on waste collection, storage, and disposal. An adequate number of colour coded dustbins as per guidelines (Red, Yellow, White and Blue bins) should be made available on the campus for various waste collection, segregation and disposal activities. A waste disposal record register, as well as puncture-proof containers for sharps and blue bags should be kept and made available on campus.

In hospitals, labs and pharmaceutical industries, mutilators such as needle/syringe cutters and calibrated weighing machines for biomedical waste collection should be made available. In compliance with campus policies, personal safety gear such as aprons, gloves, caps, masks, gumboots, etc. should be easily accessible on campus. Around 1 per cent sodium hypochlorite or bleaching powder solution should be made available as per guidelines in hospitals, labs, and pharmaceutical industries. In addition, the Mercury Spill Management Kit, Post Exposure Prophylaxis Kit and Blood Spill Management Kit should be made available in hospitals, labs and pharmaceutical industries. There should be proof of a licenced company’s signed MoU with the organisation for waste collection as per the Govt. regulation available at the waste generating unit. Norms must be followed by the organisation as per the Central and State Government Pollution Control Board. Different forms, formats, annual reports, etc. should be made available for waste collection and mode of transportation. A trained, dedicated and skilled individual for waste management should be present at the waste generating unit. Segregation of waste must be done at source. If it is not segregated at source, then the reason should be known. It should be ensured that intermixing of infectious and non-infectious waste must not be done at generation sources in hospitals, labs and the pharmaceutical industry.

To determine the E-wastes, wood wastes, construction wastes, plastic wastes, hazardous wastes and biomedical wastes should not be mixed at source. Waste bins, bags and containers and their transportation means should be monitored. Details on the PPEs like gloves and masks used while collecting the waste from the site of deposition should be

made available. The proper details of the campus's adoption of E-waste management and plastic waste management must be checked. In order to determine the quality practises undertaken by any organisation or waste generating unit and to recommend more convenient strategies to eradicate contaminants coming from the waste, waste auditors follow a set of predetermined checklists. For organisations like educational institutions and industries the following are the checklists:

Biomedical Waste Audit				
Name of Organisation				
Date				
Venue				
Audit Checklist				
1.	Name of the hospital/health-care unit/ Pathological Laboratory/ Research institute etc.			
2.	Address/Location			
3.	Contact Person (with phones Fax, e-mail)			
4.	Month/Year of Establishment			
5.	Month/Year of approval/ authorization. Give details.			
6.	Compliance status of HCF's	Complying with norm	Not complying with norms	Total show cause notices/ Direction under EPA were issued
7.	Type of HCF (Government /Private)			
8.	Total No. of beds			
9.	Tentative No. of Out patients			
10.	Area of the biomedical unit (in acres)			
11.	Actual (Average) generation of biomedical Waste (kgs/day)			
12.	Colour coding		Waste Category	Total quantity of BMW generated (in kg/day) by the hospital as per colour coding
	Yellow			
	Red			
	White			
	Blue			
13.	Details of biomedical waste treatment methods being followed in the HCF			

14.	Are these treatment method sufficient?	
15.	Type of equipment used (include photos)	
16.	Mode of collection & transportation of waste (include photos).	
	• Details of machinery used to collect and sort biomedical waste.	
	• Information about the machinery used to transport biomedical waste across the facility.	
	• Whether waste collected in a container labelled bins as prescribed by the rules?	
	• Does the individual who collects BMW keep a register with them?	
	• Whether the person who collects BMW using PPEs?	
	• Is there any leakage while loading/ unloading, etc.?	
	• Is the contact details such as name, address, phone number, and other information displayed on the vehicle along with the symbol?	
17.	Does the HCF is in an agreement with CBWTF?	
18.	Does the CBWTF operator gather trash every day or every other day? Is the 48-hour requirement compiled?	
19.	Charges of collection, transportation and treatment by CBWTF	
20.	Staff involvement in collection and segregation operation at HCF (No. of persons)	
	• Management/Administration	
	• Equipment operations	
	• Transportation of BMW	
	• Sanitation and others	
21.	Treatment equipment installed at HCF	
	• Incineration (capacity, make, air pollution control devices, etc.)	

	• Capacity of autoclave/microwave/ hydroclave and make.		
	• Capacity and make of shredder.		
	• Details of sharp pit/ encapsulation washing facility.		
	• Observation on vehicle/ container washing facility.		
22.	Details of treatment procedure (include flow chart)		
23.	Status of infrastructure (Yes/No)		
	• The equipment room for waste treatment.		
	• Main room for garbage storage.		
	• A room for treated waste storage.		
	• Administrative room.		
	• Incinerable/Deep burial		
	• Autoclaving/Microwave		
	• Availability of onsite ETP for treatment of Liquid wastes		
	• Others please specify		
24.	Total quantity of BMW (in kg/day) on site that the hospital treated and disposed of		
25.	Facility Available	Total capacity	Quantity of treated in kg/day
	• Incineration		
	• Deep burial		
	• Autoclaving		
	• Microwaving		
	• Shredding		
	• Disinfections by chemical treatment		
	• Disposal into municipal landfill		
	• Discharge of liquid waste into drains after chemical treatment		
	• Recycling(sold to recyclers)		
26.	Are adequate number of sign boards available in HCF		
27.	Are proper lighting arrangements in waste storage area.		
28.	Odour problem remedial		
29.	Emergency services and firefighting equipment.		

30.	Procedures for pest/insect management, etc..	
31.	Protection equipment for those who handle waste.	
32.	Disposal of end products (treated waste) (include photos)	
	• Plastic wastes after treatment.	
	• Treated sharps.	
	• Incineration ash.	
	• Other treated solid wastes.	
33.	Record keeping details	
34.	Monitoring details	
	• The frequency of testing of ETP effluent discharge and the name of the laboratory for autoclave, microwave, hydroclave, and incinerator (specify approved or not). Provide information on compliance or non-compliance.	
	• How frequently sites are inspected?	
	• Emission from incinerator stacks (parameters stipulated in the Rules, temperature and residence time, etc.)	
	• The characteristics of incineration ash to determine if it qualifies as hazardous waste under the HWM Rules.	
	• Validation/efficacy test of autoclave/microwave/ hydroclave.	
35.	Problems faced by units	
36.	Future programmes for process Modification, upgradation.	
37.	Any other observations.	
Signature		

2.14.2 Waste Audit Procedure

A waste audit is performed to calculate the type and amount of waste generated by an organization. It also counts the quantity of waste that is recycled versus that is thrown out. Thereafter, recycling, reduction and diversion goals are set and a management plan is formulated and implemented. Any size organisation can perform a waste audit. A waste audit involves following three stages:

2.14.3. Pre-audit

At the pre-audit stage, an event is conducted to strengthen the audit's scope and objectives and to discuss the possibilities associated with the audit. An audit team is formed at this stage. The pre-audit meeting gives all participants the chance to get together, gather

information and talk about issues that will assist them prepare for the site visit. The audit plan and protocol are also distributed to each participant.

2.14.4.Audit

At this stage, the audit team starts working according to the outline scope of the audit as set in the pre-audit stage. All the waste generation and recyclable data statistics are collected to establish the audit baseline. The best ways of presenting data are evaluated. It includes the following activities:

- Review of documents and records such as admission registers, water charge remittance, furniture registers, laboratory equipment registers, purchase registers, audited statements, and office registers.
- Interviews or discussion with the staff associated with waste handling, waste management, and other stakeholders
- Site inspection and data collection

2.14.5. Post-audit

At this stage, the audit team will list the solid waste management problems identified as a result of the audit. A solid waste management plan will be prepared. Strategies are to be selected to address these problems. Auditors determine an action plan and record it on the action plan sheet and provide it to the management of the organisation.

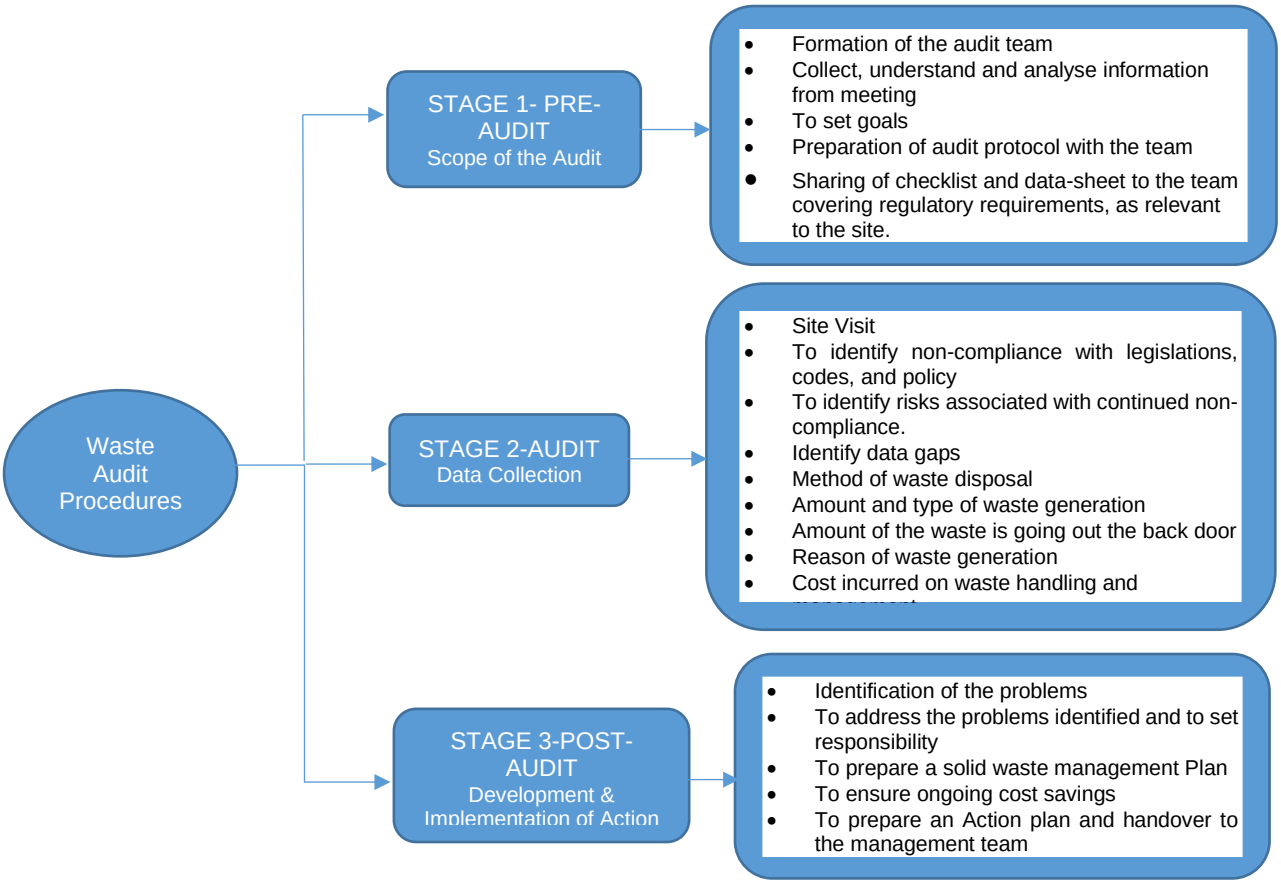


Figure 5. Waste Audit Procedure

2.15. Steps to Conduct Biomedical Waste Audit

A successful Bio-medical waste audit takes a lot of prior and ongoing preparations. Steps involved with a waste audit are as follows:

Step 1: Set objectives of Audit

The first step of the waste audit is to understand why there is a need for a waste audit. Is it only to know how much waste is being generated or how much recycling is being done, or is our current management plan in order or to devise better waste management strategies to bring profit out of your waste material? For a better economic and environmental outcome, all participants and coordinators in the waste auditing process should have a clear purpose and thorough understanding.

Step 2: Assemblage of team and setting up a date

To get the best results from the audit, involve representatives from each department of the organization because every department is responsible for its contribution to the waste generation. Or include a third-party audit team. Next, fix a date for the audit when there is no special event or holiday so that most of the staff will be in the organization.

Step 3: Determine the waste categories

Before the start of the audit, list the most prevalent waste forms generated by the organisation. The most common waste audit categories are given as under:

- Discarded medicines
- infectious waste
- Pathological waste

- Sharps
- Anatomical waste
- Hazardous wastes (Paint, Hazardous materials such as chemicals, x-ray films Batteries, Oil filters and Remainder/composite waste)
- Electrical and electronic equipment (Transparencies, used print cartridges, toner cartridges, printer ribbons, computers and other electronics etc.)
- Paper & Cardboard
- Newspaper
- Boxboard
- Glass
- Plastic bottles
- Other plastic
- Steel cans
- Aluminium cans
- Other metallic material
- Wood/furniture
- Textiles
- Organic material (Food waste, Garden waste etc.)
- Materials packaging
- Tyres
- Ceramics
- C&D waste

Step 4: Gather the required Equipment

After choosing the dates and potential participants of the audit, the following equipment and tools are to be stocked so that the team can work properly and safely.

- An outdoor space for waste sorting.
- A scale to weigh each category separately.
- A sieve with a gauge of about 1 cm to separate the little bits.
- Labelled boxes for sorting each waste category.
- 2 hand brooms, 5 rakes, and 5 shovels.
- Litter pickers, which can be used to pick up trash and sort it if necessary.
- Tweezers for every volunteer (optional).
- Clipboards to record your findings.
- 2 wheel-barrows to collect waste from tractors and trailers.
- Trash bags for re-bagging of waste after the audit.
- One sizable first-aid kit with an eye wash.
- Large containers for disposing of waste

Step 5: Arrange facilities for the staff

While sorting the waste, it is very important to involve the trained staff wearing protective aprons, and protective gear. The following facilities should be made available on site:

- Drinking water for staff
- Personal protective equipment (PPEs) such as latex or non-latex rubber gloves, rubber boots, goggles, disposable face masks, aprons, water facilities with soap and disinfectant for each volunteer.

Step 6: Site Survey of the Health Care Facility

During the audit process, the audit team will need to do the following tasks:

- Record Observations

The audit team will record the general observations such as the appropriate color-coded bins, bins/container placement, appropriate categorization of waste thrown in the bins, proper signage, bio-medical waste management practices and compliance or non-compliance by the staff.

Data in invoices, manifests, haulers, contracts and purchasing must be checked.

- Interview

Auditors also interview and discuss with the HCF staff about their knowledge of waste procedures, waste practices, training received and their concerns like department-wise data collection, incomplete data or lack of transparent billing and recommendations for improvements.

Step 7: Location to Visit during the Bio-medical Waste Audit

- BMW storage areas
- Infectious waste storage
- Recycling areas
- Material Management including purchasing, storeroom(s)
- Facilities/maintenance
- Hazardous waste storage areas
- Surgical Services area
- Patient Care Floors
- ICU/CCU areas
- Radiology
- Laboratory
- Pharmacy/ medical
- Kitchen/food service areas including pantry, canteen, food court, dining room, waste collection areas
- Administrative Area

Step 8: Documents to be checked

- Medical waste management policy of health care unit
- National or local medical waste processing standards
- Facility safety procedures
- Earlier audit reports
- Accident or incident reports
- Logs for off-site final disposal
- Service contract, if outsourcing collection and/or treatment
- Service contract, if housekeeping is contracted out
- Service contract, if outsourcing garbage handling
- Log record of training of employees
- SOPs for waste management and maintenance
- Laboratory SOPs
- SOPs for retaining and storing garbage

Step 9: Sorting of the waste by category

Waste generated in the HCF is sorted out daily based on the type of waste. The main categories for sorting waste are:

a)General or non-hazardous waste

b)Biohazardous waste

1) Non-infectious waste
- Pharmaceutical waste
- Chemical waste
- Radioactive waste
- Cytotoxic waste

2) Infectious waste
- Pathological waste
- Sharps

On the final day of the audit, all the waste and recycling materials must be collected from the whole building. During the audit, the following points will be considered for baseline data:
- Identification of waste types generated.
- Identification of quantities of waste generated.
- Identification of the responsible department for each waste stream category
- Identification of existing practises for recycling, reusing, and reduction of waste.
- Identification of current waste disposal costs.
- Understanding of the opportunities for waste minimization and cost savings.

The following questions are answered in the audit:
- What are the container sizes installed in the HCF?
- Does the HCF have any in-house waste treatment equipment?
- How much does the facility pay the CBWTF per kilogramme of bio-medical waste?
- What is the waste collection frequency?

Before the start of the weighing process, proper PPEs should be utilized. To collect the baseline audit data, all the waste is to be weighed by volume and by weight or percentage composition, once every 24 hours (or as given in the Table 4) throughout the audit duration. Quantitative and qualitative data is to be recorded. Photographs need to be taken. All the recyclables are also weighed to establish how much waste is being recycled weekly (or as per the audit duration). Waste is to be sorted into different containers as per their categories and must be labelled properly. If the waste is to be analysed department wise, then department wise waste must be collected in different containers and labelled accordingly. The waste source needs to be mentioned in the data sheet. It will give an idea of the accurate estimation and the most waste-generating department in the organisation. An average percentage is to be calculated for every waste. It is necessary to sort and weigh every item found in the audit process.

Table 4. Department-wise Waste Survey Collection Frequency

Department	Frequency of Data Collection
Each ward	Every shift
Each OT	Every surgery or operation
OPD	Every shift
ICU	-do-
Emergency unit	-do-
Dialysis unit	Every procedure
Radiation unit	Every procedure
Path lab and Biochemical lab	Every shift
Pharmaceutical unit	Everyday

Pantry	Two times a day, after each meal
Administrative unit and central store	Everyday
Surrounding premises and lawn	-do-

Source: CPHEEO Manual

Data Sheet

Bio-medical Waste Audit Data Sheet				
Date of Audit				
Ward/ Out Patient Department/ Other Department:				
Waste category	**Total weight of each waste category (in kg)**	**Weekly total (kg)**	**Daily average (kg/day)**	**Remarks**
Infectious				
Gloves/ Masks				
Bandages/dressings				
Sharps				
Syringes				
Other infectious				
Pathological waste				
Anatomical waste				
Non-infectious				
Chemical waste				
Pharmaceutical/ Discarded medicines				
Cytotoxic waste				
Radioactive waste				
General Waste				
Paper/ cardboard/ Boxboard				
Newspaper				
Plastic				
Glass				
Steel cans				
Aluminium cans				
Metal				
Rubber				
Wood/furniture				
Textile				
Food Waste				
Garden waste				
Electrical & electronic waste				
C&D Waste				
Daily total (kg)				

No. of clients per day				
Kg per person per day				

(A) Total weight of waste being handed over to CBWTF each day: _____ kg.
(B) Total weight of waste being thrown away each day: _____ kg.
(C) Total Weight of Recyclable Items each day: _____ (kg)
(D) Total Weight of Compostable Items each day: _____ (kg)
(E) The total daily weight of the items (A) + (B) + (C) that can be redirected is _____ kg.
(F) After the initial audit, _____ kg of waste was sent to a landfill.
(G) After basic diversion, (G) _____ kg of waste is sent to a landfill.
(H) Waste entering the dump following further waste-reduction measures: _____ kg

(a) + (b) + (c) gives the amount of waste that generated to keep out of the landfill on a weekly basis.

Steps 10: Analyse audit results and findings

This data can be utilised for analysis of generated waste after taking into account all weights.

1) Use the following formula to determine and record the waste diversion rate:

- Bio-hazardous waste

Divide the weight of bio-hazardous waste (infectious and non-infectious waste) delivered to CBWTF
Multiply the result by 100.

- Recyclable Waste

Divide the aggregate weight of all the waste by the weight of recyclables. (trash plus recyclables).
Multiply the result by 100.

- Compostable waste

If a composting unit is installed on the premises and waste is being composted.
Divide the weight of compostable waste by the combined weight of all the waste (trash + compostable).
Multiply the result by 100.

2) Pay attention and note down the weights listed for each type of waste;

- Which was the largest weight category
- Were there variations in the top categories between departments?
- Were any recyclables found among the waste?
- Did you have any categories that you weren't aware of?

Based on the audit results, total waste generated annually and waste generated / person / day or waste generated / year or waste generated / person can be calculated.

Waste projections

Total number of beds	
Numbers of meals prepared /day	
Number of garbage dumps	
Total waste generated (kg/day)	
Total waste generated (Tonne/day)	
Total waste generated (Tonnes/year) approx. 40 weeks	

Waste generation/ person/day	

Cost Estimation

Worksheet for Cost-Benefit Analysis

1. Expenses of present waste disposal (paying to CBWTF) #_____Per kg Rs.____Per year Rs.____Per month

2. Currently, recycling costs #_____Per kg Rs.____Per year Rs.____Per month

3. The weight that can be calculated to be saved from going to the landfill in the given year (includes items that can be recycled and composted) #___Per year

4. Savings from lower disposal costs: Rs. _____Per year

5. Income from selling composted soil: Rs._____ per year

6. Financial gain of waste minimization scheme (S. No. 4 + S. No. 5) Rs.____Per year

7. Cost of Adopting waste minimization programs Rs._____/year

8. Total expense or gain of waste minimization scheme (S. No.6 – S. No.7) Rs._____Per year

Step 11: Audit report preparation

Once the waste audit is completed, based on the audit findings and comparative data of each category and the sources, an audit report is prepared. This report will assist in identifying the recyclable, compostable and biodegradable materials among the waste that has been discarded for so long. By quantifying waste streams and finding waste diversion options based on this data, an action plan is created. The current waste management system being practised in the organisation can be improved more than ever with the help of the trash audit results.

2.16. Steps after Waste Auditing

After completion of the waste audit and waste stream analysis, the auditor should consider the following points:

- It should be double-checked that the dumpster size and frequency of pickup are still adequate for meeting needs. If waste output changes are observed, a different size or number of pickups might be economical.
- If a recycler should be involved, if no recycling services have been engaged until now, More focus should be on recycling more goods.
- Set waste recycling as a personal goal to increase the recycling rate.
- Recycling instructions or guidelines should be made and distributed among the employees to achieve this goal.
- Set a goal to decrease waste in the most important categories.
- Identify the steps necessary to achieve that goal and communicate them to the team (for example, to save paper, e.g., switch to online bill payment).
- Identify the objects that can be reused, e.g., repairing devices rather than purchasing new ones and reuse of packaging materials.
- It is also necessary to make a schedule for achieving your recycling and waste reduction objectives. A timeline for the achievement of the desired waste reduction can be set for one or two years.

- The next waste audit should be planned at that time to verify if the objectives were reached.

2.17. Action Plan

2.17.1. Action Plan for Waste Reduction

Preparing an own waste reduction action plan allows one to rethink procedures to produce less waste or redesign processes and hence boost efficiency.

Step 1: Check the compliance of the government's policies and guidelines

Improve the knowledge about BMW rules to enable better compliance with waste management practises. It is also required to check the compliance of the government policies and guidelines.

Step 2: Create a strategy for managing waste

Developing a plan for managing waste helps to set goals to manage bio-medical waste properly. Share the goals with the staff so that they be achieved.

Step 3: Review the site waste audit report and make sure 3R's actions are being followed.

Review the site Waste Audit Report to learn more about the 3R's practises that are presently being implemented, including waste reduction methods, the amount of waste that is currently being minimized, reused, recycled, and thrown away, as well as an analysis of operational costs following the 3R's.

Step 4: Determine Major Waste Reduction opportunities

An important step in determining the waste reduction potential of the 3Rs is to look at the components that constitute a significant portion of the waste created. Take into account the price of disposing of trash, the possibility of source segregation, the potential for reducing, reusing, or recycling, the difficulty of processing, and any present or future regulatory needs.

Step 5: Establish Priorities for Waste Reduction After identifying areas for potential waste reduction

Possible impacts of other priorities on 3Rs should be investigated, and at least the following items should be considered when developing a waste reduction action plan:
Review each option for waste reduction's costs and benefits. Make sure there is enough on-site storage areas with proper fire safety, and be informed of any impending landfill closures, tipping tax increases, or other issues that may affect the disposal of waste.

Step 6: Figure Out Why Waste Is Produced?

When evaluating waste reduction possibilities, you should start by asking yourself, "Why is this material being used?" These kinds of questions may be inspiring. Responses to these queries may tell possibilities for waste reduction, reuse and recycling of waste. Some of the expected question are:

- Where waste can be eliminated in your operations by reducing the use of specific materials or procedures.
- Where other materials that can be reused or recycled can be used.
- Where it is possible to utilise disposable materials.
- Where you can buy less material. For example, consider bulk purchasing instead of individually packed items.

- Materials that have been previously recycled can be utilised.
- Where can you put controls in place to limit waste production during your operations?

Step 7: Identify Waste Reduction, Reuse, and Recycling Opportunities

This section discusses some of the most prevalent 3Rs opportunities. Although the concepts are often simple and can lead to more significant initiatives.

The following are some opportunities to improve the management of waste products:

2.18. Reduce Waste

Employees at your facility may already be employing a variety of waste-reduction techniques. Some disposable products may have already been replaced with reusable products in your facility. Use fewer disposable supplies and equipment that you use. Focus on strengthening purchasing rules in administrative departments to reduce the amount of incoming packaging.

1.Minimize Paper Usage

Using xerox and double-sided printing to reduce paper waste. Instead of distributing printouts of memos and documents to employees or clientele, email them. Encourage employees to store electronic versions of papers rather than printing them. If subscriptions to publications or catalogues are no longer required, remove them.

2.Bulk Purchasing

To get volume discounts, look into buying in bulk. Bulk purchases frequently come with less packaging than items purchased individually.

3.Disposable/ Reusable/Eco-friendly Packaging

Request loose products rather than individually packed ones when purchasing supplies.

Instead of using disposable tape dispensers, use permanent tape dispensers.

Request that the package be "taken back" by the vendor or it should be reusable or eco-friendly.

4.Cafeteria Waste

Single-serve condiment containers should be avoided. Discounts to the customers may be given those who bring their cups. To cut down on waste, go over the menus again, focusing on portion sizes. Start a "litter less lunch" campaign to encourage employee or students to bring lunches in reusable containers. Napkin dispensers might help you avoid using too many napkins.

5.Washrooms

Replace disposable napkin dispensers with hand driers where possible.

6.Manufacturing Technology

Where possible, adopt current production methods that minimise the use of materials. Due to older technology, make sure that process's initiation and/or termination tolerances aren't exorbitant. To avoid waste, improve process controls.

7.Reuse Equipment

Reusable things can be donated or sold. Charitable organisations are typically interested in equipment and supplies that are no longer needed.

8.Donate Left Over or Unused Food

Donations of consumable fresh foods and out-of-date packaged foods are welcomed by many food banks. To determine if you can assist in this way, contact your local social organisations.

9.Recycle Waste

There are markets for a variety of recyclables, including cardboard containers, office paper, newspaper, glass, aluminium, steel, items, and food leftovers. As the markets grow, more items may be added to your recycling list.

10.Use of Recyclable Materials

Investigate ways to use recycled materials into your products. The success of recycling is dependent on stable material markets. You can also contribute to the environment by buying products containing recycled materials.

11.Internal Recycling

Components of your own products must be recycled internally as much as possible.

12.Employee Training on Source Separation

Make sure you segregate the different types of waste materials at source. All personnel should be trained in source-separation techniques and given enough well-labelled containers and storage facilities to collect recyclable material.

13.Organic Waste

Examine your options for composting. Look into composting organic materials like food leftover/scrap, leaves and lawn trash, and napkins with private operators or your local government.

14. Internet or Business Directory

Use a local business directory or a search engine to locate recycling businesses in your region.

Box 4: Follow 3Rs: Reduce , Reuse and Recycle
Reduce • Buy less and use less. • Purchase recycled papers. • Use softcopy instead of hard copy • Purchase eco-friendly stationary supply for office. • Buy products with minimum packaging. • Printing and photocopying on both sides. • Use one-sided printed paper instead of throwing in trash. • Make duplex printing the preferred option for your printer. • Use half-sheets for printing notices. • Send emails rather than faxes. • Online newsletter posting. • Refrain from printing emails. • Post the meeting agenda on the notice-board to hold paperless meetings. • Replace paper napkins with electric hand dryer. • Use refillable soap dispenser in restroom

- Promote zero-waste meals.
- Use reusable bottles to cut down on the use of tetra-packs.
- In the dining area replace the paper napkins with the cloth napkins.
- Buy grocery items in large quantity at a time to avoid packaging material.
- Use dispensers rather than portions that are separately packed.

Reuse

- To avoid filling up landfills, swap out throwaway things for reusable ones and learn to share or contribute.
- Use the paper's back side again.
- Make use of reusable glasses and cups.
- Provide reusable or biodegradable dishes, glasses, and cutlery in the cafeteria.
- Contribute leftover lunches to a "sharing a lunch" initiative.
- Donate used textbooks, clothing, mobile phones, electronics, and other stuff.
- Hold a clothing exchange or auction.

Note: It is prohibited to re-use needles or syringes.

Recycle

- Reduce waste by recycling materials including cardboard, paper, glass, plastic, cans, and tetra-packs.
- Recycle any unique stuff you may have, like batteries and electronic gadgets etc..
- Composting of organic waste
- Make sure that recycled materials are clean to reduce contamination.
- Recycle your toner and ink products.
- Ensure that chemicals are disposed of properly.

Step 8: Determine How Material Buying Procedures Affect Waste Reduction

There are several opportunities to reduce waste when buying materials. Changing the materials used to create the goods or deliver the services can need talking to the suppliers. Economic gains and increased waste diversion result from replacing non-recyclable products with reusable or recyclable ones.

Step 9: Attainable Waste Minimization Implementation Plan

A waste minimisation implementation plan is a compendium of the prospects for waste reduction that have been discovered as well as the steps that will be done to reduce trash. Practical waste minimisation goals should be established at this time. The working strategy must also be really feasible. The attitudes of employees and their confidence in upcoming work plans may be negatively impacted by excessive over-targeting. The wastes for which reduction actions, goals, and measures have been set forth are the main emphasis of the work plan. The approach makes it possible for us to track issues pertaining to certain waste types as well as the overall amount of garbage that is minimized, reused, and recycled.

2.19. Conclusion

Conducting of Biomedical waste management audit will ensure the safety practice and hygienic to all the living being. Segregation and disposal of Biomedical waste must be taken in account in all the premises.

3. E-WASTE MANAGEMENT AUDIT

3.1 Introduction

The amount of e-waste generated by the widespread use of primary items like computers and mobile phones increased as the economy progressed. The administration recognises the importance of improving the country's information technology capabilities. In addition, various organisations use a range of approaches to promote e-literacy among the general public. It is a survey of a facility's regular waste stream. E-waste management is the process of collecting e-waste, recovering and recycling material using safe procedures and disposing of e-waste using appropriate approaches to minimise negative environmental impacts. It is a term used to describe abandoned electrical or electronic devices. It includes used electronics destined for refurbishment, reuse, resale, salvage recycling through material recovery, or disposal. This includes both working and broken items that are discarded or transferred to a recycling centre. The information and communication revolution radically altered the way organise our lives, economies, industries, and institutions in the twentieth century. Simultaneously, this has resulted in a slew of issues, including a vast volume of hazardous garbage and other waste generated by electric devices. It is a severe difficulty for modern society, and it necessitates concerted efforts to solve it in order to achieve long-term growth. It is any electrical or electronic equipment that has been destroyed.

Any item classified as electronic waste has a lifetime profile that varies depending on the type of electrical or electronic device. The information in the lifetime profile comprises the dangerous quantity present in abandoned objects, the economic worth, and the impact on the environment and people’s health if they are not recycled properly. In developing countries, electronic waste is deconstructed and sorted by hand, as opposed to industrialised countries which use advanced machinery and provide personal protective equipment (PPE) for individuals who risk their lives extracting various materials from electronic waste.

The quick innovation, the development of technical advances and the high rate of obsolescence in the electronics industry all contribute to the creation of electronic trash. This has resulted in one of the world's fastest-growing waste streams which includes end-of-life electrical and electronic equipment products such as refrigerators, washing machines, laptops, printers, televisions, mobile phones, IPods and other items, many of which include dangerous elements. It is made up of ferrous and non-ferrous metals, polymers, glass and wood, among other things. Iron and steel are provided in 50% plastics, 21% non-ferrous and 13% mercury, arsenic and lead. It's an assessment of a facility's normal waste stream. E - waste auditors pick through bags of trash, collect data, and analyse it. The E-waste auditors go through bags of waste, sort items, record and analyze the data. In doing this, auditors identify what is being thrown away, what is being recycled or diverted through other means and the amounts of each type by weight or volume.This development has been aided by strong increases in exports, consumption and investment.

3.2 Role of Educational Institutions in India

In 1995, India got introduced to two revolutionary technologies – mobile telephone services and the internet. It boomed the use of Information and Communications Technology (ICT) in almost every sector of life including education. Schools, colleges and universities widely started using the ICT for administration, training and learning processes. In India, the per capita PC ownership between 1993 and 2000 has grown by 604% as against the world average of 181% during the same period (Sinha-Khetriwal et

al., 2005). Government of India's National Mission of Education through ICT launched in February 2009 allocated 5.02 billion of rupees for ICT provisions in educational institutes. University Grants Commission (UGC) of India and also introduced various grants and schemes for upgrading computer systems, building digital libraries, starting online courses and developing intranets for university automation. As a result, almost every educational institute including schools had started using computers, printers and scanners along with the traditional electronic devices like television and radios.

About 20.72 millions students and 817 thousands faculty were enrolled in the higher education system of India during March 2011 (MHRD, 2012). A large fraction of this student- teacher base has their personal electronic devices in the forms of computers, laptops, tablets, cell phones, pen drives, CDs, printers, etc. Driven by rapid technological changes and a buoyant economy, today's latest equipments may be PCs, laptops or cell phones become obsolete in no time. The life span of computers has dropped from six years in 1997 to just two years in 2005 and mobile phones have a life span of even less than two years. These unwanted electronic devices becomes e-waste. The amount of generated e-waste per year is growing rapidly and it is estimated that India will see 500% hike in e-waste from old computers from 2007 levels by 2020 (UNEP, 2010).

As per Rode's (2012) study of e-waste management in Mumbai metropolitan region, Indian educational institutes contribute to generation of e-waste largely followed by industries and hospitals. As per OECD's (2014) latest report on 'Trends Shaping Education 2014', education plays a crucial role in raising awareness of environmental challenges and shaping the attitudes and behaviours that can make a difference. Higher education institutes can generate human capital on environmental issues in their region, act as a source of expertise, inspire through good practice on campus and add to existing knowledge through research (Mora et al., 2006). It is interesting to know the role of higher education institutes about awareness and management of e-waste which damages the environment drastically. The chapter analyses e-waste awareness in Indian educational institutes and their efforts of e-waste management.

3.3. Aims and Objectives of an E-waste audit

3.3.1. Aim and Objectives of the E-Waste Management audit

1. To dispose of unneeded electronic devices quantity of e-waste goods or things has significantly expanded.
2. To approve the procedures in order to reduce pollution the computers, air conditioners, mobile phones, televisions, fax machines and other commonly used electronic devices should all be properly disposed.
3. To contains some e-waste valuable covers or materials that may be recycled or reused of e-waste management.
4. To reduce, reuse, and recycle under this strategy, manufacturers are assigned significant responsibility for the treatment and disposal of their products.
5. To assure electronic trash may include potentially dangerous chemicals that need to be disposed of with care to protect the environment.

3.4. Impact of recycling e-waste

After analysing the aims of e-waste management, discuss the effect and various prospects for e-waste management in India. Glass, metals and plastic are among the recyclable components that are included in almost all electronic wastes, but because unsuitable disposal procedures and techniques were used, these materials could not be

recycled for other use. The hazardous components of electronic trash may cause havoc on the human body if it is disassembled and treated in a hasty way.

When garbage is disposed off, procedures such component disassembly, wet chemical processing, and incineration are utilised which expose workers directly to dangerous chemicals and cause them to breathe them in. Gloves and face masks are not frequently utilised and workers frequently lack the training and expertise necessary to do their duties effectively. Additionally, hand hazardous metal extraction introduces harmful substances into the person's bloodstream in the process.

The health risks vary from brain issues to liver and kidney damage. The earth, air, and water are all contaminated by recycling e-waste debris. During the recycling process, hazardous substances that have no commercial or economic value can be discarded. Such hazardous substances leak into an underground aquifer, lowering the quality of the area's groundwater and making it unsuitable for drinking and agricultural use. Lead, arsenic, mercury, cadmium, and PCBs render the soil poisonous and unsuitable for agricultural use when electrical debris is buried in landfills. The surface soil of India's four major metropolises, New Delhi, Chennai, Mumbai, and Kolkata where electronic garbage is handled by the informal sectors, has been shown to have growing quantities of PCBs, furans, BPA, heavy metals, etc.

3.5 Effects of E-Waste on the Environment and Safety

When the benefits of recycling electronic waste are considered it is imperative to know the effects of this waste on the environment and the safety of living things. Impact of electronic wastes on environment are

1. Most electronics contain toxic elements such as lead, nickel, zinc, and chromium.
2. The release of toxic elements to the environment causes health problems to humans when they encounter them, either by touch or oral in take.
3. Improper disposal of this waste by burning causes a release of toxic gases in to the atmosphere, damaging the atmospheric layers.
4. E-waste disposed of in landfills seeps into the groundwater, causing problems for both land and sea animals.
5. A lot of fish that die from unnatural causes contain some of these toxic substances in their system.
6. Development of neurological, reproductive and other biological problems for human beings that inhale, apply or ingest any substance with e-waste items.
7. E-waste has rendered some geographical areas toxic for human beings and other animals because of the sole purpose of being used as dumping sites.
8. High levels of e-waste toxic substances in the soil kill plants and reduce agricultural harvest. Without a robust agricultural industry, both human beings and animals suffer from a lack of food.
9. Atmospheric changes due to toxic gases lead to climatic changes such as global warming.
10. Even as the e-waste problem keeps growing, the recycling industry has also grown significantly.
11. Identify different areas globally dedicated to e-waste recycling and providing jobs to hundreds of thousands of people worldwide.
12. A country like China handles almost 70% of the world’s e-waste recycling needs. Otherwise, without proper recycling, much of this waste ends up in scrap metal dealers’ hands.

13. Not only does it make the environment better, but communities are also protected from health hazards that come from these wastes.

3.6 Benefits of recycling electronic waste audit and identifying problems

1. Reduced Mining of virgin resources

Most electronic components contain minerals and metallic elements that must be mined from different mining fields across the world. The continuous mining of resources is fast, leading to their depletion and affecting the environment negatively. Recycling electronic components like circuit boards, there is an impressive amount of these elements like tin, gold, palladium, copper and silver recovered from natural resources. For instance, harvesting tin from electronic components reduces a significant percentage of tin mined from natural resources. It has been estimated that 40-800 times more gold and 30-40 times more copper can be recovered from 1 ton of circuit boards than from mining 1 ton of ore.

2. Provides an environmentally friendly source of resources to manufacturers

On purchase of a new electronic device, the metallic and plastic compositions are entered to a work place from a resource somewhere. When the old ones are discarded, the negative impact is two times higher to metallic and plastic resources must be dug up and the waste hurts the environment. Instead, practicing safe recycling of unwanted electronics means that can reduce save the environment from being over-exploited and you also keep it safe from unnecessary e-waste. Since e-waste does not readily decompose, dumping these metallic elements instead of reusing them only adds to bio-hazards to the environment and human beings. Proper e-waste recycling means that manufacturers have an environmental friendly source of metallic and plastic materials to produce new devices. For example, hard drives can be processed into aluminium ingot for use by automotive manufacturers. As a result it can be achieved get to reduce the depletion of natural resources and reduce unnecessary e-waste dumping on the environment.

3. Prevent usage of landfills

Landfills are serious environmental hazards and impact all living things, humans, plants, and animals alike. When individual fail to recycle electronic waste from the house or commercial buildings properly, this waste ends up in the hands of informal waste operators who dump the same in landfills. In due course, the metallic, plastic and toxic materials in this e-waste start leaching through the landfills' and enter into nearby water quantum of sources. The more e-waste is not recycled correctly, the greater space at the need to have landfills for disposal. One of the benefits of recycling electronic waste is reducing landfills that have hazardous effects on the environment, especially water bodies. When the e-waste handed over to certified recyclers, it can be assumed that proper care is taken to reuse the e-waste and recycled.

4. Protect Water Bodies from Toxic Waste Poisoning

Landfills release toxic chemicals into the groundwater and this finds its way to nearby wells and freshwater bodies. The people and animals that use the contaminated water start getting sick from chemical poisoning. E-waste recycling prevents a fair amount of these toxic elements from leaching into bodies of water and ensures the water is kept fresh and safe. Keeping water bodies clean is one of the benefits of recycling electronic waste.

5. Save Land and Energy

Primary productions of metals from mining ores consume a considerable amount of energy and land. Digging and drilling holes underground and leaving these places as

wasteland harms the environment. One should agree with that land with gaping holes and pits is not a pleasant sight. Also, some of these holes only end up destabilizing surrounding grounds whenever there are heavy rains. Electronic recycling can help curb continuous mining and helps global environmentalists save energy and to avoid land wastage. Energy is a resource that cannot be afford to misuse and saving it is a way of thanking mother nature for the precious gift and is one of the benefits of recycling electronic waste.

6. E-waste recycling helps reduce air pollution

Among the benefits of recycling electronic waste is the ability to reduce air pollution from toxic gases. One can do their part in ensuring that poisonous gases are not released into the air as the living organisms need to breathe by ensuring the old and no-longer-in-use electronic devices are correctly recycled rather than being burnt directly. Perhaps we have noted that from the effects of e-waste to the environment, high temperatures on the components cause them to release poisonous gases into the air which are harmful to living things. For example, for 1 ton of gold or platinum, about 10000 tons of Carbon dioxide is emitted. Electronic recycling cuts a significant percentage of toxic gas emissions and, as a result, protects the air from pollution.

7. Electronic Recycling Promotes the Integrity of Agricultural Soil

E-waste recycling not only prevents release of toxic chemicals that leaching into the soil and making it poisonous in turn affect the plant growth; it besides prevents the release of poisonous gases, it controls dust through mining to surrounding agricultural fields. A large percentage of the world's population relies on agriculture as a livelihood source and ensuring the fields are fertile and safe to grow plants is essential to promoting overall human wellbeing. As one of the benefits of recycling electronic waste, promoting the integrity of soil, promotes agriculture and the growth of natural green resources for plants, animals and human beings. A greener environment leads to cleaner air and safer home for all.

8. Reduce health hazards on the environment

Localities are hubs for waste disposal have issues of residents experiencing health problems such as skin disease arising from improper e-waste disposal. When the environment is ailing, inhabitants will ail too. Proper e-waste recycling helps protect the environment from hazardous and toxic substances that can hurt people who use these natural resources. We can avoid environmental hazards from leaching metals, poisonous gases, and dust from mining and burning waste by safe recycling of e-waste.

9. Promote fisheries resources

E-waste is a complex composition of different toxins that when dumped in landfills, leach into water bodies and kill fishes and other water animals. There is a significant amount of lead, copper, mercury, cadmium and other deadly material that permeates the streams and rivers and kills water life in the end. Mercury, for example, is a neurotoxin that can kill in mere minutes. Recent studies from scientists have shown that dead fishes found in deposits on sea and waterbed contain high mercury levels determined to come from human activities around water bodies. E-waste recycling helps reduce water poisoning and jeep it fresh for water animals and plants. As a result, e-waste recycling help preserve the freshwater ecosystem for plants, animals and even people who depend on them as livelihood sources.

10. Availability of more resources in recycling

As more electronic waste is handed over to these recyclers, they can deliver readily available resources. Whenever the peoples dispose of electronics that we deem obsolete, these give rise to more purified resources than starting from scratch through mining and refining. A good example is the amount of copper and gold that you find from 1 ton of electronic devices than 1 ton of ore. The process of cleaning and reusing this to make other components is easier on the environment and produces more than digging through miles and miles of the ground; it is one of the benefits of recycling electronic waste. The metals gathered from electronic waste components only require smelting into ingots and are then ready to use. Most of the electronic devices that are considered waste can be reused with a few upgrades if you think of it.

11. **Minimize illegal recycling / recovery operations**

- Environmentally safe & sound Recycling by channelizing e-waste to registered e-waste recyclers
- Extended responsibilities to producers to manage a system of e-waste collection/take back and channelizing to a registered dismantler/recycler.
- Responsibilities to urban local bodies for orphan products and for waste found mixed with MSW
- To create an e-waste collection channelization system
- Reduce hazardous substances in electrical and electronic components

3.7 Essentials for E-Waste Disposal audit

Many of the common items we use every day contain potentially hazardous materials that must be disposed of properly. And it is illegal in many states to dispose of them in household or office garbage. A list of e-waste items that are banned from the trash by the state of California which is applicable to every nations.

- Fluorescent lamps and tubes
- Batteries
- Computer and television monitors
- Electronic devices including computers, printers, VCRs, cell phones, telephones, radios, and microwave ovens
- Electrical switches and relays
- Thermostats that contain mercury
- Pilot light sensors
- Mercury gauges
- Mercury-added novelties such as greeting cards that play music, athletic shoes with flashing lights in soles made before 1997 and mercury maze games

For most of us, however, the most common electronic items that eventually end up as e-waste are computers (both desktop and laptop models), tablets, smartphones and batteries. And, aside from dead batteries, all of these items are either reusable or recyclable when it's time to get rid of them.

3.8 Essential disposal steps for these e-waste items

- If needed, identify software you want to use on your new computer.
- Take down license key information
- Un-register the software from the old computer
- Locate install files and back them up so you have them available on your new computer.

- Back up your files to another location so that you can either copy files to your new computer.
- Backup your data to an external hard drive or save your data to a flash drive.
- Erase all data from your computer.
- Don't try to destroy your hard drive by drilling holes, degaussing, smashing it. It's dangerous and ineffective.
- Don't sell or dispose of your computer without having the hard drive wiped professionally, if need be.
- Make sure to remove or disconnect all cables, devices and media from the computer.

3.8.1. Steps for Mobile Device Disposal

1. Back up the data from your phone. If you're trading it in for a new phone this is usually done at the time of purchase.
2. Remove the SIM card and any SD cards. Consult your manual or ask your wireless provider for help, if needed.
3. Once removed, your SIM or SD cards should be stored in a secure place.
4. Complete a factory reset on your phone. A factory reset clears your old phone of all data and returns it to its original condition.
5. Call Junk King for proper disposal of your e-waste, if needed.

3.8.2. CRT (Cathode Ray Tube) Disposal Tips

1. Don't put the CRT TV or monitor on the curb as it can be damaged and create a hazard.
2. Don't put the CRT TV or monitor in the trash as it is illegal and hazardous.
3. Do call Junk King to pick up your CRT TV or monitor for reuse or recycling.

3.8.3. Personalized Recommendations for E-Waste Disposal

Rubbish/Junk waste is provides an efficient, safe and eco-friendly e-waste disposal service to make the whole process easy for everyone. Once, we experienced e-waste removal team will haul off peoples old electronics and without damaging your home on the way out. If needed, we will do all the heavy lifting - no need to carry items like old stereos and TVs out to the curb. Finally, we will make sure that your e-waste is disposed of at a proper recycling facility so that it doesn't do any harm to our ecosystem. We simply point and we'll haul our old electronic rubbish into our junk removal trucks, with no hidden fees.

3.9. Environmental Audit Committee (EAC) report on electronic waste released

3.9.1. Detailed recommendations to take action

As such, the EAC report urges Government to take action through a number of detailed recommendations which include:

- 'As a matter of urgency', online retailers and marketplaces have the same take-back responsibilities that physical retailers will have in 2021/2022.
- The setting of ambitious and long-term targets for collection, reuse and recycling of e-waste and that this action is undertaken to a 'very high standard'.
- The document notes the exceptional pressure high streets have experienced this year and that exempting e-retailers will deepen entrenched competitive disadvantages.
- Furthermore, the report underlines the need for online market places to fully conform to compliance laws and pay the same producer responsibility fees as other suppliers of electronic goods.

- The report urges Government to ban products manufactured with purposefully short life-times, via planned obsolescence.
- Moreover, it recommends mandatory labelling that states the expected lifetime and reparability index of all electronic products
- It calls for assurances from manufacturers that their products can be easily dismantled and subsequently recycled at waste sites.
- The detail recommends this be done through incentivisation and 'potentially through an extended producer responsibility system'.

3.10. Benefits of the e-waste management Audit

1. It protects the environment

- Recycling e-waste can keep a range of harmful materials out of the environment.
- Lighting, including fluorescent tubes and lamps that contains toxic mercury that can leach into waterways when it is thrown into landfill.
- However, when lighting is recycled, the mercury is recovered and safely used again in products like dental amalgam.
- The same goes for batteries, which can feature lead, mercury and cadmium.
- For example, when a lead-acid battery is recycled, the plastic parts and toxic lead are recycled, while the sulphuric acid is neutralised and then converted into sodium sulphate to make fertiliser and detergent.

2. It reduces business costs

- E-waste recycling is not only good for Mother Nature; it can also be good for a business' bottom line.
- Most state and territory governments have now incentivised e-waste recycling by hiking the cost of dumping or outright banning it.
- There are also some non-tangible dividends of recycling to consider, such as lowering the future costs of non-renewable materials and boosting staff morale and retention.

3. It supports non-renewable recycling

- The growing demand for electronic devices and appliances means a range of metals and other non-renewable resources need to be mined and processed.
- However, many of the materials used to make smartphones, appliances and other e-waste can be re-used again.
- These resources include steel, aluminium, copper and gold — not to mention large amounts of plastic that can be turned into new products.
- Recycling e-waste puts these materials back to work after you're done with your device, while dumping e-waste in landfill means more resources need to be dug up to make your next laptop.

4. It shows your eco-friendly credentials

- Employees increasingly want to work for businesses that do their part for the environment and the community.
- Recycling is a simple and tangible way to demonstrate your organisation's commitment to social and environmental values and reinforces those principles to the employees.
- Ecocycle provides recycling certificates that illustrate the achievements, and also outline how the business is performing against the present green goals

5. It's super easy to recycle e-waste

- Recycling e-waste has never been easier.
- There are a range of places and businesses where one can drop off an old phone, TV or other household appliances.

6. Determine the effectiveness of the operations

- A waste audit can explain that what is working or not working with your current waste and recycling management program.
- It can uncover breakdowns, expose wasteful problems or confirm successes.
- This enables to make necessary adjustments to improve and maximize the operational efficiency.
- For example, if the audit reveals that a huge percentage of recyclables are ending up in the trash, one can take corrective steps, either by refining the recycling program or through recycling education.
- The results can also impact the purchasing decisions, for example, by prompting to look for suppliers with take-back programs or reduced packaging.
- Waste audits can unlock missing revenue streams and potential savings. By reducing what is going into the trash, one may also be able to reduce your waste hauling fees, which are increasing all the time. The recyclables might even have value on the market.
- One global consumer products brand discovered breakdowns in their program that resulted in a lot of waste. Not only did the waste audit uncover a sizable revenue stream for them, it also revealed potential savings of up to 33% of their annual waste hauling costs. Without conducting an audit, the company's program could have continued to be underutilized, resulting in needless waste and years of lost savings.
- Another company that decided to implement an organics program after a waste audit revealed that a large percentage of their trash was made up of food scraps. As a result, their waste load is now 25% lighter.
- A client decided to eliminate disposable coffee cups after a waste audit revealed that nearly 30% of their waste volume was made up of these cups.

7) Measure success

- A waste audit can help set a baseline and create benchmarks year after year so one can set targets and gauge the progress and effectiveness of waste and recycling programs.
- One large financial institution began a series of recycling training sessions after a waste audit revealed that 22% of their trash consisted of recyclables.
- A follow-up waste audit a year later showed that the amount of recyclables in their waste stream had dropped to 15%, meeting their sustainability goals for improvement
- The audit results were also a morale booster for their employees who were delighted to learn that their efforts were making a measurable difference.

8) Verify/get more accurate data

- Waste audits can help verify data provided by the hauler which is important for operations and billing. Incorrect data can lead to unnecessary fees.
- Accurate data is also key to conducting a waste removal RFP when it is time to renegotiate contracts.

9) Meet certification standards

- Waste audits are part of the requirements for various certification standards like LEED. For example, a review of 100% of the ongoing waste stream is necessary to comply with the requirements of LEED for Existing Buildings Operations & Maintenance 2009 or higher.

11) Fulfill requirements for certain regulatory compliance and reporting purposes

- If the source may need data from audits to complete reporting to put in regulatory compliance, or one may require the information for your CSR or GRI reporting needs.

3.11. Conclusion

E-waste recycling is necessary but it should be conducted in a safe and standardized manner. The acceptable risk thresholds for hazardous, secondary e-waste substances should not be different for developing and developed countries. E-waste poses a huge risk to humans, animals, and the environment. The presence of heavy metals and highly toxic substances such as mercury, lead, beryllium, and cadmium pose a significant threat to the environment even in minute quantities. Consumers are the key to better management of e-waste.

4. PLASTIC WASTE MANAGEMENT AUDIT

4.1. Introduction

Plastic can take a very long time to decompose, even though it is a vital material for our economy and offers many advantages to modern living. It takes up valuable landfill space, pollutes the environment and has a negative impact on our oceans. Additionally, it alludes to the enormous amount of plastic debris that isn't recycled and ends up in landfills or in less developed countries, untamed dump sites. This is high times use less plastic and learn more about plastic recycling if individuals, want to address the problem of plastic waste and pollution on our planet.

Plastic can have detrimental effects on both human health and the environment at every stage of its life cycle including resource extraction, production, usage and disposal. Lack of medical protective equipment at the height of the COVID-19 pandemic is one indication of how overly relying on disposable plastics affects the robustness of our healthcare systems in addition to having negative effects on the environment. Although we continue to produce and consume more plastic, since the bulk of plastic materials takes centuries to disintegrate, all of the plastic that has been dumped in landfills. That plastic has to go someplace and it's typically either carelessly discarded on land or rivers in developing countries, before ending up in the ocean, endangering marine life.

The truth is that it is unable to control the amount of plastic already present on the globe or the rate at which it is being generated. For our planet, to have a safe and healthy future, othe attitudes and behaviours regarding plastic need to shift. Plastic garbage is frequently disposed of properly and delivered to facilities to be collected, recycled, or recovered, especially in more industrialized nations. However, the majority of the plastic garbage produced in underdeveloped nations is dumped into rivers and streams or left in open and uncontrolled dump sites. Releasing plastics into the environment is having a huge negative impact on the environment since recycling standards in developing nations are inferior to those used in the developed world.

4.2.Role of Educational Institutions in India

We believe that the best way to address plastic pollution is for companies to stop producing so much plastic in the first place. That’s why we are mobilizing volunteers around the world with brand audits to hold companies accountable for their role in manufacturing the plastic pollution crisis and catalyze systemic change. By combining people power with data evidence, brand audits are the Break Free from Plastic movement’s tool for pressuring companies to: REVEAL their total plastic footprint, REDUCE the amount of plastic they produce, REDESIGN their packaging for refill and reuse.

India banned manufacture, import, stocking, distribution, sale and use of identified single use plastic items which have low utility and high littering potential, all across the country from July 1, 2022. While it is an important material for our economy, providing multiple benefits to modern day living, plastic can take thousands of years to biodegrade. It takes up valuable space in landfill sites and is polluting the natural environment, having a significant impact on our oceans. Recyclable plastic waste should be channelized to registered plastic waste recyclers. Local bodies should encourage the use of plastic for road construction. Thermoplastic waste shall be processed and disposed of as per the guidelines issued from time to time by the central pollution control board. India recycles 94.17% of waste plastics through mechanical recycling while 0.93% is chemical or feedstock

recycling and 5% for energy recovery and alternative uses such as making roads, boards, and tiles.

India is generating about 3.5 million tonnes of plastic waste annually and the per capita plastic waste generation has almost doubled over the last five years. "Plastic pollution adversely affects our ecosystems and is also linked to air pollution," In financial year 2019, Maharashtra generated the largest amount of plastic waste in India, at 410,000 metric tons. In comparison, the north-eastern states such as Sikkim, Mizoram, and Tripura contributed the least to plastic waste generation. The NGO analysed data from the Central Pollution Control Board (CPCB) and found the country generated 25,940 tonnes of plastic waste every day. According to the report, Kolkata and Chennai occupy the second and third spot among metropolitan cities for daily plastic waste generation.

4.3. Aims and Objectives of Plastic Waste Audit

1. To determine composition and quantities of waste being generated.
2. To measure effectiveness of existing waste management systems.
3. To identify opportunities for improving waste management systems and strategies.
4. To collect baseline data for measuring the effectiveness of waste minimization strategies
5. To collect and make sense of information that plastic which is made from natural resources, can have positive and negative effects on the environment.
6. Create a socio-technical model for taking plastic waste management from informal to formal economy
7. To check the correctness of the financial statements that the organisation provides
8. To design, evaluate and refine a solution for reducing the amount of plastic waste generate.

4.4. Importance of Plastic Waste Audit

The audit procedure is used to determine the kind and volume of trash produced by a company. The information gathered from the audit will show what kind of waste the firm produces and how it manages that waste. Through these audits, we want to put the spotlight on corporations who have been responsible for the manufacturing, distribution, and proliferation of non-recyclable and single-use plastic packaging that ends up in landfills, oceans and waterways. The activity aims to gather important data to call for innovations in product packaging and delivery systems to ensure that plastic waste is drastically reduced and that nothing ends up in our oceans, landfills and other disposal facilities.

India produces a whopping 62 million tonnes of waste every year. A staggering 43 million tonnes of solid waste is collected annually, out of which only 11.9 million or 22-28% is treated, while about 31 million tonnes of waste is left untreated and dumped in landfill sites. The waste and particularly plastic menace for Indian cities is compounded because of the poor state of solid waste management and the inadequate infrastructure for sewerage and storm water drainage.

India’s Plastics Waste Management Rules 2016 emphasises the phase-out of non-recyclable multi-layered plastics by March 2018 and requires manufacturers, producers, and users of non-recyclable packaging to either pay municipalities for the cost of managing such waste or arrange to take it back and manage its disposal themselves. While there have been attempts by local governments to ban plastic bags and single-use plastic in various cities of India, the move has received backlash from the plastic industry. The Plastic Waste Management Rules were amended to benefit businesses manufacturing and using plastic especially Fast Moving Consumer Goods (FMCG) companies. The current amendment

gives plastic producers a scope to argue that their products can be put to some other use, if not recycled. This type of plastic was supposed to be banned by March 2018, but it is nowhere near a phase-out.

4.5. Impact of Plastic Waste Audit

- Reduce waste that needs collecting and reduce transport pollution.
- Engage with family members or employees on their waste, helping them to share specific behaviours they can change.

4.6. Benefits of the Plastic Auditing

Compared to most other materials, plastic is more affordable, lighter, and adaptable. It is perfect for electrical wiring and electronics because of its thermal and insulating qualities. Our homes are much more energy-efficient and cost-effective to heat and cool when plastics are used as insulation.

4.6.1. Plastic Standard, Independent auditing and Validation

- The Plastic Waste Reduction Standard lays out the rules and requirements which all projects must follow in order to be certified.
- All Plastic Program projects are subject to desk and field audits by both qualified independent third parties
- To ensure all the staffs that standards are met and methodologies are properly applied.
- Auditors known as validation/verification bodies (VVBs) are tasked with assessing projects against the Plastic Program rules and the requirements of the applied methodology.

4.6.2. Compliance to plastic waste rules

1. Actions were not being taken by District Collectors/District Magistrates for the enforcement of the rules and it was difficult to verify whether vendors were using carry bags or containers made of recycled plastic for storing, carrying, dispensing or packaging of foodstuffs.
2. It was difficult to verify in audit whether recycling was being done according to specifications of Bureau of Indian Standards (BIS).
3. Inspections consisted of evaluating whether the authorization holder was compliant with their discharge permit and for select sites, the HWR on a section-by-section basis.
4. The response of a notice of compliance is only issued if none of the assessed sections are found to be out of compliance.
5. If a single non-compliance was found during an inspection, the minimum compliance response was an advisory, regardless of how many sections were compliant or how minor the noncompliance.

4.7. Advantages of plastic waste audit

1. Reduces greenhouse gas emissions which contribute towards climate change.
2. Reduces the amount of waste that needs to be recycled or in developing countries, sent to landfills/incinerators.
3. Saves money, since reusable items work out cheaper than constantly purchasing more plastic.
4. It may also help to avoid environmental harm.

5. The Environmental Protection Regulation Act 2019 indicates that waste handlers must submit waste tracking information when transporting regulated waste or waste residues. This is why it's crucial to use a professional waste disposal service.

4.8. Recommendations

1. Segregation should be given greater emphasis by means of publicity and awareness campaigns and holding regular meetings with housing associations and NGOs.
2. State governments could make waste segregation mandatory and the municipalities could be authorised to levy fines if segregated waste is not made available to the municipalities for collection.
3. Waste processing should be made mandatory in each municipality.
4. CPCB could help each municipality in identifying the waste processing technology best suited to the needs of the municipality.
5. Sufficient funding should be provided by MoEF/MoUD to set up waste processing infrastructure in each municipality.
6. All municipalities should take steps to improve the existing dumpsites to make them more sanitary and aesthetic.
7. Dumpsites in residential areas and near water sources/water bodies should be closed down and periodic monitoring of dumpsites for contamination of environment should take place.
8. Plastics were also regarded as a major source of pollution to the environment.
9. Recycled Plastics Manufacture and Usage Rules were notified in 1999 with an amendment in 2003 entrusting the District Commissioner/ District Magistrate of each district and PCB with the responsibility of managing plastic waste.
10. MoEF and the states may consider introducing effective strategies for the reduction and recycling of household waste like deposit refund schemes, promoting the use of jute bags rather than plastic bags, waste exchanges, etc., for reduction of waste at source.

4.9. Conclusion

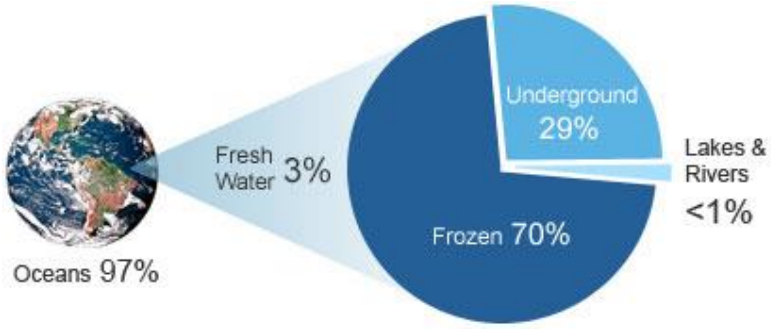
Monitoring of the plastic waste rules was careless and ineffective. In the absence of effective monitoring, violation of rules would escape detection. Violation of rules would also result in contamination of the environment, besides posing risks to human health.

5. SOIL AND WATER AUDIT

5.1. Background

Mankind is now facing grave problems like environmental degradation, depletion of natural resources and the emerging global warming besides climate change impacts, which are besides widely discussed at the global and regional levels. Life exists in our planet earth only because of nature's life supporting systems. Hence protection and conservation of environment is cardinal to the sustenance of life on earth. Soil and water are vital natural resources for human survival. The growing population in the world and increasing demand are placing tremendous pressure on these resources, which results in fast depletion of these resources in many countries posing serious problems to agriculture sustainability, livelihood opportunities and vulnerable communities.

Soil and water are inequitable natural resources of India and at global level. Soil are naturally occurring loose covering on the earth's surface. Weathering altered the rock particles of soil into mixtures of mineral and organic constituents (Bridges, 1997). Soil is rich in microorganisms such as bacteria, fungi, actinomycetes, algae, protozoa and nematodes. The microorganism of the soil helps in enzymatic degradation of organic matter, energy storage and conversion of nutrients in the available forms (Jenkinson and Ladd, 1991). The chemical and physical property of soil makes it a rich medium for the plant growth. Water the other natural resource constituting with 97% of salt water and 3% in fresh water (Alley *et al*., 1999). The use of water is inevitable in our daily needs. Water is used in agriculture, industrial, household, recreational and environmental activities. The natural source of fresh water are surface water and ground water. Ground water is used as primary source of domestic drinking water. Artificial sources of fresh water are treated wastewater and desalinated seawater.



Soil and water are natural resources of the organization that has to be structured, planned and developed from the point of entry to end users the stakeholders in such a way with contamination free soil and water, sustainable use of land and water and suitable measures for their conservation. Soil and water Audit is a tool to improve the quality of the land and water to provide a healthy environment for the stakeholder directly and indirectly of the campus. It creates awareness on environmental ethics, resolves environmental issues and offers solutions to various social and economic needs (APHA, 2017). It strengthens the concept of "Jal Jeevan Mission" and "Sustainable Land Management" among stakeholders of India for the protection of natural ecosystems for future prospects.

Soil and water audit procedures includes the definition of Soil and Water audit, methodology on how to conduct Soil and Water audit at Educational Institutions and Industrial sectors as per the checklist of Environment Management Systems and

International Standards on ISO 14001:2015, Jal Jeevan Mission, Swachh Bharath Scheme under Clean India Mission to understand the principles and importance of various audits in the context of the organization and risk assessment at 360˚ views (Gnanamangai *et al.*, 2021). Soil and water audit helps the educational institutions/ industries to maintain eco-friendly environment, assures personal hygiene to various stakeholders and supports the nation; on the whole for the noble cause of environmental protection and nature conservation which in turn enhances the quality of life of all living beings (Arora, 2017).

Most of the soil in India are well drained, deep, fairly loamy, slightly acidic to alkaline and lime-free soils and they are ideal for variety of plant cultivation (Arora and Sekhon, 2015). The Indian soils are mainly derived from gneissic rock containing large amount of mica with good behaviour of water holding capacity with abundance of micro and macro elements. Some of the soils are characterized by clay loam type, classified as latosols with good organic matter contents along with sufficient amount of nitrogen, potassium and phosphorous contents all tea soils are distinctly acidic, rich in nitrogen content and (Mishra, 2020).

5.2. Role of Educational Institutions in India

Educational institutions are playing important role in a nation's growth and development which starts from maintenance of green campus without harming the environment. A clean and healthy environment in an Organization determine effective learning skills and offers a conducive learning environment to the students. Educational institutions are insisted by both Central and State Governments to offer eco-friendly atmosphere to the stakeholders. In addition, all the Educational institutions are asked to save the environment for future generations and to resolve the environmental problems (accumulating solid wastes and wastewaters/effluents and their careless disposal, enormous utility of plastics, uneconomical consumption of water, irresponsible in water harvesting and storage procedures, etc.) through Environmental Education. Implementing Swachh Bharath Abhiyan Scheme launched by the Indian Government thro' the Educational institutions plays a major role in terms of giving neat and clean environment to tribal, rural and urban people across the country besides the regular and conventional activities carried out by NSS, NCC/Student Force, Nature club, Eco club, Science club, Fine Arts club, Flora and Fauna club, Youth Red cross unit, etc. Seminar, Conference, Workshop, training and awareness programmes on Biodiversity conservation education, environmental awareness programmes, etc. may be conducted periodically by the Management and Administrative people of an Organization to the stakeholders.

Soil and Water audit in the campus is a systematic method whereby an organization's environmental performance is checked against its environmental strategies and compliances of the Government guidelines. This audit process is definitely useful for the Educational institutions to maintain the campus neatly and can give pure atmosphere to the students and staff members including Management people. It is like an official examination of the environmental effects on an organization's campus as per the Government guidelines. The audit report may be useful to improve the organization's campus significantly by following the recommendations and suggestions given in the report. The green campus audit processes are being undertaken by World / Indian Green Building Council (IGBC), Green Building Code and Green Ratings Systems (GBCRS), Green Rating for Integrated Habitat Assessment (GRIHA), Consideration of Indian Industry GreenCo Rating System (CII-GreenCo) and Associated Chambers of Commerce and Industry of India (ASSOCHAM) along with ISO EMS 14001:2015 criteria and the concept of Swachh Bharath Abhiyan under Clean India Mission.

5.3. Environment Friendly Campus to maintain soil health and water quality

As stated earlier, Organization is liable to provide an eco-friendly atmosphere along with good drinking water facility to all the stakeholders (students and staff members). Manuring the cultivated plants/grown within the campus may applied with organic manure, cow dung, farmyard manure and vermicompost instead of using chemical fertilizers. All non-compostable and single-use disposable plastic items, plastic utensils, plastic straws and stirrers should be avoided. Demonstration/awareness programme on establishing plastic-free environment and utility of organic alternatives for all incoming and current students, staff and faculty should be organised. Reduction of use of papers alternated with e-services, e-circulars, etc. and proper disposal of wastes, recycling and suitable waste management system should be considered to establish environment friendly campus.

5.4. Aims and Objectives of Soil and Water Audit

- To maintain periodic records on physico-chemical and biological parameters of soil and water in the organization campus.
- To maintain contamination free with safe soil and water for the stakeholders which in turn useful for maintaining the environment and personal hygiene.
- To identify and provide baseline information to assess threat and risk to the ecosystem with respect to safe soil and water due to Organization development.
- To recognise and resolve different environmental threats of the Organization without creating any soil and water pollution.
- To ensure proper utilization of resources available in the surrounding areas towards future prosperity of the humanity as bioresources like water and soil are considered to be very important.
- To fix a couple of norms for disposal of all varieties of wastes for pollution free soil and water as per the Green and Environment Policy.
- To assess the proper utilization of water from the entry to the consumers and discharge the wastewater as per the guidelines of Central and State Government Pollution Boards.

5.5. Importance of Soil and Water Auditing

The Management of the Organization (Auditee) should be exposed their inherent commitment towards making healthy environment through the Soil and Water auditing and ready to encourage/follow all types of activities to enhancement the quality of soil and water. They should promote activities such as conduct of environment awareness programmes, sprinkler system for irrigation system for effective water management and to maintain soil moisture, rainwater harvesting to restore the groundwater, use of biofertilizers and avoidance of chemical fertilizers and agrochemicals to enhance the soil quality, etc., prior to and after the soil and water auditing. The administrative authorities should formulate ‘Jal Jeevan mission’ and “Sustainable Land management” principles based on technical report of Soil and Water auditing. A clean and healthy environment will enhance an effective teaching/learning process and creates a favorable learning green environment to the scholars. They should create the awareness on the importance of sustainability of soil and water through environmental education among the student members and research scholars. Soil and water Audit is the most effective, ecological approach to manage environmental complications.

Soil and Water audit may be beneficial to the campus in improving the activities of sustainable land and water which in turn useful to save the planet for future generation. Soil and Water audit is a kind of professional care and a simple indigenized system about

the environment monitoring in terms quality enhancement of soil and water which is a duty of each and every individual who are the part of economical, financial, social and environmental factors. It is necessary to conduct soil and water audit frequently at least once in three years in campus because students and staff members should aware of the soil and water audit and its beneficial effects in order to save planet by means of 'Jal Jeevan mission' and "Sustainable Land Management" which in turn support the institution to set environmental models ('icon') for the community. Soil and water audit is a professional and useful measure for an Organization to determine how and where they are retaining the campus eco-friendly manner. It can also be used to implement the alleviation measures at win-win situation for the stakeholders and the planet. It provides an opportunity to the stakeholders for the development of ownership, personal and social responsibility.

5.5.1. Benefits of the Soil and Water Auditing

There are several benefits on conduct of water and soil audit by the Organization which may be definitely useful to improve the campus significantly based on the audit report. It covers both qualitative and quantitative measurements including physical, biochemical and microbiological observations of the presence of streams and springs, number of bore wells, open wells, water channels, etc., in the campus. It has to be checked for decrease in green cover and any key alteration in the soil species as indicators of soil contamination. Installation of water saving devices like automatic system and water meter and efforts taken towards water leakage, leak detection and repair, water pumping works towards water conservation are playing important role.

Vermicomposting or any similar process may be carried out inside the campus to preserve soil health. The various Clubs, Forums, Cells, Associations and Student / Staff Chapters such as Eco club, Nature club, Science club, Fine Arts club, Flora and Fauna club, Youth Red Cross, NCC/Student Force and NSS bodies may be involved in providing awareness programmes to educate stakeholders on the importance of sustainable water and land use.

5.5.2. The following are the major benefits of the water and soil auditing

Soil and water audit is a proven technology for providing pure atmosphere without any soil and water pollution and supplying safe drinking water to the stakeholders worldwide since long time. UV light as a biological and chemical technology methods is most effective method to give safe water to the stakeholders which does not create any new chemical by products, does not change the flavour or odour of the water and also does not remove any beneficial minerals. Its effectiveness depends upon many factors and it is very important to design the water purifier scientifically so as to deliver the safe and purified water. Turbidity, particulate matter, and natural organic matter are the most significant water quality parameters having the greatest effect on biological disinfection capability. Water temperature and pH have an insignificant effect on water quality and disinfection capability by increasing levels of turbidity, particulate matter and natural organic matter absorb more unwanted materials present in the water. There is concern of adverse health effects to the consumer as a result of mercury exposure from UV lamp breakage during operation including reverse osmosis system of water purification. It is very convenient, instant and easy to operate is some of other important advantages.

Water borne disease has been a concern to human being; ever since its discovery and the most appropriate treatment process adopted is microbial disinfection. Disinfection is necessary to destroy pathogenic (disease causing) bacteria and other harmful microorganisms that are present in water due to contamination. Over several years, water

heating (hot water) and ultraviolet (UV) disinfection as biological technology have been followed as a viable technology for drinking water disinfection. Biological disinfection systems inactivate protozoa, fungi, bacteria and viruses. Through all-embracing research and meticulous field experiences, biological disinfection has proven to be safe, reliable, and inexpensive and accepted this as a world ide technology for drinking water disinfection. The following benefits are taken into account while soil and water audit is undertaken at an organization as one of the best practices followed.

- ✓ Internal audit procedure for soil and water analysis will be implemented periodically in the organisation.
- ✓ Analysis of soil profile in terms of testing various soil parameters should be carried out in the campus.
- ✓ Soil fertility analysis in terms of enumerating various beneficial and harmful microorganisms preferred in the campus
- ✓ Analysis of soil organic matter, ratio of gravel, clay and sand particles, water holding capacity and above the ground biomass.
- ✓ Observation of any streams /springs present inside the campus may subjected to test and record of any decline in water quality and quantity in recent times.
- ✓ Observation of any decrease in green cover area in the campus along with key alteration in the soil species.
- ✓ Finding out any change in the water use /land use pattern followed in recent times due to either the vertical growth or the horizontal development of the organization.
- ✓ Observation of soil erosion, acidification, contaminations, land scape management and associated issues inside the campus.
- ✓ number of bore wells, open wells, water reservoirs & channels, water supply, check dam, etc., are sufficient in the campus.
- ✓ Finding out any water logging problem arise inside the campus during the heavy rainfall to document water saving opportunities and measures taken by the management.
- ✓ Observation of any loss of soil and water biodiversity inside the campus including awareness programmes on soil and water conservation.
- ✓ Formulation of sustainability goals for sustainable land use and rain harvesting system in the campus.
- ✓ Number of taps and faucets, toilets, showers, rest rooms, etc. in sufficient numbers in the campus coinciding with the human population.
- ✓ Efforts taken towards water leakage, leak detection & repairs, water pumping works towards water conservation.
- ✓ Availability of sprinkler and drip systems for irrigation methods for effective water management including Installation of water saving devices like automatic system, water meter, etc.
- ✓ Sewage treatment plant availability and its uses including gardening fir efficient irrigation and lawn care practices, water wise landscaping, etc.
- ✓ Organizing programmes to educate stakeholders on the importance of sustainable land use and water conservation through Cells, Clubs, Forums, Chapters, Associations and etc.
- ✓ Investment carried out for sustainable land use and its conservation including Action plan devised to restore the degraded land. Campus comes under seismic zone and protective zone under Government Acts and Statues.
- ✓ Vermicomposting, green manures, cow dung manures or any similar process carried out inside the campus for soil health preservation.

- ✓ Detection of Escherichia coli, Coliform bacteria and Faecal Coliform in water samples collected from different places in the campus.

5.6. Water Audit

Water is a precious natural resource facing shortage of availability all over the world. A water audit is an on-site survey and assessment of water-using hardware, fixtures, equipment, landscaping and management practices to determine the efficiency of water use and to develop recommendations for improving water-use efficiency (Newcomb, 2008). In simple words, a water audit is a systematic review of a site that identifies the quantities and characteristics of all the water uses. The site may vary from a public water utility, facility (institutional or commercial properties like malls, office, schools etc.) or a household. The overall objective of conducting a water audit is to identify opportunities to make system or building water use more efficient. Since water uses vary greatly from one type of business or institution to another and from site to site, therefore water audit is crucial to determine quantity, nature and quality of water consumption. Water audit for a water utility refers to tracking, assessing and validating all components of flow from the site of withdrawal or treatment through the water distribution system and into the consumer's properties. On the other hand, water audit of an office building would review direction and quantity of water used for domestic, cooling/heating, sanitary and landscaping processes. Whereas, a domestic water use audit examines the major areas in which a facility uses water, including human consumption, personal hygiene & sanitation, washing, cleaning, laundry, gardening, etc.

It may be noted that the National Mission on Water Conservation with the campaign '*Jal Shakti Abhiyan*' initiated by the Government of India, appeals all citizens to collectively address the problem of water shortage by conserving every drop of water and suggested for conducting water audit for all sectors on water use.

General guidelines for Water Audit & Water Conservation, 2005 envisages that water audit is a full analysis of water processed by a utility. It is an effective management tool for minimizing losses, optimizing various uses and thus enabling considerable conservation of water. Water audit improves the knowledge and documentation of the distribution system, problem and risk areas and a better understanding of what are happening to the water after it leaves the source point.

The water audit is a well-established method for identifying both productive and wasteful usage of water. A water-saving plan can be designed if one understands where water is consumed and lost. Detecting and fixing leaks saves a significant amount of water while also eliminating the need to find additional water sources to satisfy rising demand. As a consequence, a water audit may produce desired outcomes by detecting and resolving water issues, as well as making water utility financially sustainable. The ultimate objective of a water audit should be to identify and execute water-saving programmes.

5.6.1. Objectives

- ✓ To list out the water resources of the Campus
- ✓ To find out the pattern and quantity of water usage in the Campus
- ✓ To trace the quantity of water wastage in the Campus
- ✓ To assess the quality of available water
- ✓ To suggest remedial measures and water conservation practices

Simply water audit is to evaluate water use and management practices of the institution and identify interventions for improved water use efficiency. Water audit will help to reduce water consumption for different sections in the institution and identify and quantify the areas of excessive water usage and water losses, suggest ways and means for reduction in water use and losses.

5.6.2. Scope of Work

1. To develop a water circuit flow diagram for the entire institution showing locations of reservoir tanks, pumps, water use sections etc.
2. Collection & compilation of basic data of pumps such as ratings, rated details, operating hours of pumps, reservoirs/tanks capacities, etc.
3. Measurement of flow rates at major operating pumps and water use locations
4. Preparation of overall water balance diagram of the institution.
5. Study of existing water distribution system & estimation of associated losses including estimation of water seepage losses from water storage tanks.
6. To suggest water use reduction, reuse & recycling for water conservation with cost benefit analysis and the required investment.
7. To calculate specific water consumption of institution and possible benchmarks for water use within the institute.

5.7. Methodology

The water audit for any educational institutions included both primary and secondary data collection for various identified water uses. Primary data collection included the following components

1. Questionnaire survey for various water usage activities.
2. Questionnaire survey will be conducted among the water users.
3. Flow rate calculation from the taps flow rates and number of all water using fixtures/ equipment was also undertaken.

The methodology will be followed to carry out water audit is described step by step as follows:

Step 1: Walk through survey

This walk-through survey of the facility is to understand the locations of various water supply sources, schematic layout of water supply pipeline networks, intake raw water and process water use, etc., following activities will be covered:

- ✓ Understanding of existing water sourcing, storage and distribution facility
- ✓ Assessing the water demand and water consumption areas/processes within the facility
- ✓ Preparation of detailed water circuit diagram based on water supply network

Step 2: Secondary data collection through discussion with officials and other members of the institute

This entails collection of secondary data information covering aspects related to layout of the institute and different unit processes, source(s) of water, the supply schematics and available instrumentation along with technical details related to supply (such as capacity of pumps); water supply network diagrams and operational capacities, etc.

Step 3: Data analysis and preparation of detailed water audit report

- ✓ Documentation of collected & analyzed water balancing and measurement details; analysis if secondary data and field survey and measurements
- ✓ Determine key opportunities for water use reduction, reuse & recycle with paybacks

- ✓ Listing of opportunities identified for water conservation based on with cost benefit analysis of each identified option
- ✓ Recommendations to maximize water savings and minimize/eliminate water losses

5.8. Water Quality

Water is one of the most important substances on earth. All plants and animals must have water to survive. If there was no water there would be no life on earth. We use clean water to drink, grow crops for food, operate factories, fisheries and other recreational activities. Water is vitally important to every aspect of our lives. Monitoring the quality of water will help protect our water bodies from pollution.

Water quality can be defined as the chemical, physical, biological and radiological characteristics of water and it is a measure of the condition of water relative to the requirements of one or more biotic species and or to any human need or purpose. It is most frequently used by reference to a set of standards against which compliance, generally achieved through treatment of the water can be assessed. The most common standards used to assess water quality relate to health of ecosystems, safety of human contact, and drinking water. Bureau of Indian Standard, World Health Organization (WHO) and Indian Standards (IS) are the most commonly using standards of water.

Water pollution is become one of the most serious environmental problems now a days. Water pollution is caused by a variety of human activities such as industrial, agricultural and domestic and by natural means such as soil erosion, leaching of minerals from rocks and decaying of organic matter. Water pollution mainly divided into two.

Point Source Pollution- water pollution that can be traced to a specific origin discharge via pipes, sewage and ditches

Non-point Source Pollution- Pollutants that enter bodies of water over large areas rather than being concentrated at a single point of entry diffuse, but its cumulative effect is very large. Ex: runoff from agricultural fields or parking lots.

Rivers, lakes, seas, oceans, estuaries and ground water sources may be polluted by point or non-point sources. When pollutants are discharged from a specific location such as a drain pipe carrying industrial effluents discharged directly into water body it represents point source pollution. In contrast non-point sources include discharge of pollutants from diffused sources or from a larger area such as runoff from agricultural fields, grazing lands, construction sites, abandoned mines and pits, roads and streets. Enter of all these pollutants ultimately change the chemical, physical and biological characteristic of water and results the quality of the water undesirable for human consumption. The water quality analysis is mainly based on physical factor, chemical factor and biological factor.

- ➢ Physical Factors/physical parameter- including temperature pH, colour, conductivity, odour, taste, turbidity, suspended solids, dissolved solids, etc
- ➢ Chemical Factors/ chemical parameters- including hardness, fluoride, calcium, alkalinity, magnesium, nitrate, chloride, phosphate, sulphate, BOD, COD, phenols, oil & grease, pesticides, nitrate
- ➢ Biological Factors /biological parameters- including total coliform, faecal coliform, MPN, etc.,

5.9. Methods for Sample Preparation

Summary of Special Sampling and Handling Requirements

Determination	**Container**	**Minimum sample size**	**Preservation**	**Maximum storage period**	
				Recommended	Regulatory
pH	Plastic, polyethylene/ polypropylene cane, glass bottle	50 ml	Analyze immediately	0.25 hrs.	0.25 hrs.
Conductivity	Plastic, polyethylene/ polypropylene cane, glass bottle	100 ml	Analyze immediately	0.25 hrs	0.25hrs
Acidity	Plastic, polyethylene/ polypropylene cane, glass bottle	100 ml	Refrigerate	24 hrs	14days
Alkalinity	Plastic, polyethylene/polypropylene cane, glass bottle	200 ml			
Chloride	Plastic, polyethylene/polypropylene cane, glass bottle	50 ml	None required		28 days
Hardness	Plastic, polyethylene/polypropylene cane, glass bottle	100 ml	Add HNO_3 or H_2SO_4 to pH<2	6 months	6 months
BOD	Glass BOD bottle	300 ml	Analyse immediately titration may delayed after acidification	0.25 h 8 h	0.25h 8h
COD	Plastic, polyethylene/polypropylene cane, glass bottle	100 ml	Analyze as soon as possible, or add H_2SO_4 to pH<2;	7 days	28 days

Nitrate	Plastic, polyethylene/polypropylene cane, glass bottle	200 ml	Add H_2SO_4 to pH<2, refrigerate	1-2d	28d
Phosphate	Plastic, polyethylene/polypropylene cane, glass bottle	100 ml	dissolved phosphate filter immediately refrigerate	48h	

5.10. Water quality analysis

5.10.1.Temperature

Temperature plays an important role in water chemistry. Increase in temperature badly affects the dissolved oxygen concentration in water. Also other effects of temperature are rate of plant growth, rate of photosynthesis, metabolic rate of organisms, sensitivity of organisms and amount of dissolved gas in water. When water temperature decreases DO saturation increases. Water temperature is often measured with a thermometer. A thermometer has a liquid inside that expands as the temperature increases. Temperature is measured as degrees on a standard scale, such as Fahrenheit or Celsius.

Instrument- Mercury Thermometer.

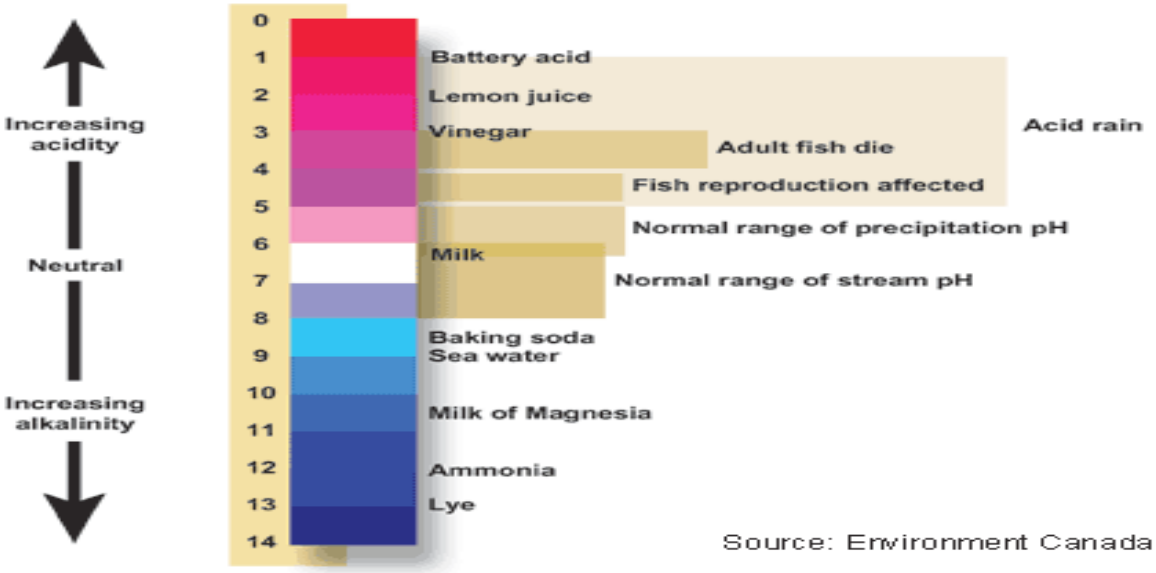
5.10.2. pH

pH or hydrogen ion activity is one of the most important and frequently used tests in water chemistry. The pH of a solution is measured as negative logarithm of hydrogen ion concentration. At a given temperature, the intensity of the acidic or basic character of a solution is indicated by pH or hydrogen ion concentration. pH values from 0 to 7 are diminishing acidic, 7 to 14 increasingly alkaline and 7 is neutral.

Method - APHA, 4500-H+ B Standard methods for the examination of water and waste water, 22nd edition.

5.10.3. Instrument- pH meter Systronic Company 361 (µ Controller Based pH system with Electrode & Temp. Probe Type: 361 and Potable Pocket sized tester (Model-PCSTestr 35)

The basic principle of electronic pH measurement is the determination of hydrogen ion activity by potentiometric measurement using standard hydrogen electrode and a reference electrode. The electromotive force (emf) produced varies linearly with pH. Thus the plot of pH verses electrode potential will be a straight line with a negative slope. The measured instrument is also calibrated potentiometrically with an indicating glass electrode and using standard buffer such as pH 4, 7 and 9.2 having assigned pH.



5.10.4. pH chart and pH with different mediums

Impacts of pH in aquatic organisms are, extremely basic water results in ammonia converting to toxic form and the toxicity of ammonia depends on temperature and pH. Aquatic species are not the only ones affected by pH. While humans have a higher tolerance for pH levels (drinkable levels range from 4-11 with minimal gastrointestinal irritation), there are still concerns. pH values greater than 11 can cause skin and eye irritations, as does a pH below 4. A pH value below 2.5 will cause irreversible damage to skin and organ linings. Lower pH levels increase the risk of mobilized toxic metals that can be absorbed, even by humans, and levels above 8.0 cannot be effectively disinfected with chlorine, causing other indirect risks. In addition, pH levels outside of 6.5-9.5 can damage and corrode pipes and other systems, further increasing heavy metal toxicity.

5.10.5 Conductivity

Conductivity is the measure of the ability of aqueous solution to carry electric current and varies both with numbers and types of ions in the solutions which in turn is related to the concentration of ionized substance in water. This ability is directly related to the concentration of ions in the water. These conductive ions come from dissolved salts and inorganic materials such as alkalis, chlorides, sulfides and carbonate compounds. Conductivity is measured in micromhos/centimeter or micro Siemens /centimeter. The higher unit milli Siemens/ cm.1mS/cm=10µS/cm

Method- APHA, 2510-B, Standard Methods for the examination of water and waste water, 22nd Edition.

Instrument Used-Conductivity meter Systronic308 and portable meter by Eutech

The basic principle is the conductance of a solution is measured between two spatially fixed inert electrodes. The conductance of a solution is directly proportional to the surface area of the electrode and inversely proportional to the distance between the two electrodes. Thus conductance, CαA/1 or C=KxA/1. Where K is a constant called specific conductance or conductivity; 'A' and 'I' are area and length of the electrode respectively. The instrument is calibrated with 0.01molar KCl.

Conductivity is a measurement used to determine a number of applications related to water quality. These are as follows:

- ✓ determining mineralization: this is commonly called total dissolved solids. Total dissolved solids information is used to determine the overall ionic effect in a water source. Certain physiological effects on plants and animals are often affected by the number of available ions in the water.
- ✓ noting variation or changes in natural water and wastewaters quickly;
- ✓ estimating the sample size necessary for other chemical analyses; and
- ✓ determining amounts of chemical reagents or treatment chemicals to be added to a water sample.

5.11. Total Dissolved Solids

Dissolved solids" refer to any minerals, salts, metals, cations or anions dissolved in water. Total dissolved solids (TDS) comprise inorganic salts (principally calcium, magnesium, potassium, sodium, bicarbonates, chlorides and sulfates) and some small amounts of organic matter that are dissolved in water.

Method- Standard Methods for the Examination of Water and Wastewater; APHA2540 C, 22nd Edition, 2012 (Gravimetric method & Potable Pocket-sized tester (Model-PCSTestr 35)

Sample filtration for gravimetric method

It is a measure of inorganic load present in an effluent. Since saline water has high TDS, intrusion of the same may result in high TDS in water body. Discharge of effluent with high TDS may aggravate pollution of natural water system.

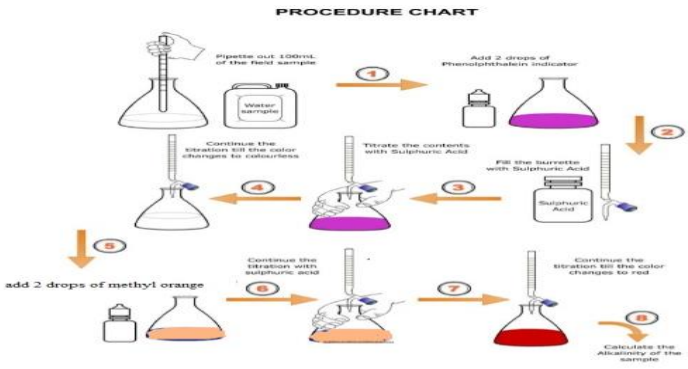
Elevated dissolved solids can cause "mineral tastes" in drinking water. Corrosion or encrustation of metallic surfaces by waters high in dissolved solids causes problems with industrial equipment and boilers as well as domestic plumbing, hot water heaters, toilet flushing mechanisms, faucets and washing machines and dishwashers.

Indirect effects of excess dissolved solids are primarily the elimination of desirable food plants and habitat-forming plant species. Agricultural uses of water for livestock watering are limited by excessive dissolved solids and high dissolved solids can be a problem in water used for irrigation.

5.11.1. Alkalinity

The alkalinity of natural or treated water is the capacity of some of its components to accept protons. Examples of such ions are hydroxyl, carbonates, bicarbonates, phosphates, etc., The equivalent amount of acid needed to neutralize these ions is called Total Alkalinity. Expressed in $CaCO_3$ in mg/L.

Method- Standard Methods for the Examination of Water and Wastewater; APHA, 22nd Edition.

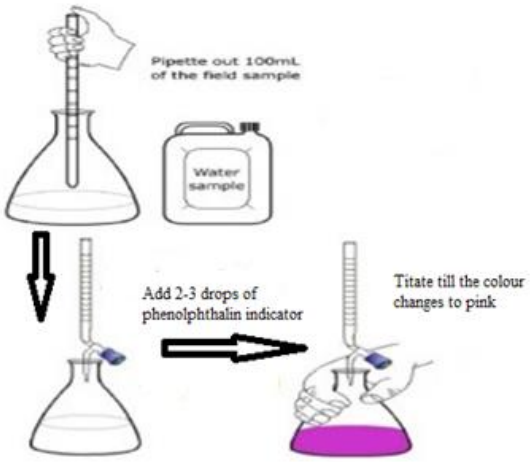


Alkalinity of sample can be estimated by titrating with standard sulphuric acid (0.02N) at room temperature using phenolphthalein and methyl orange indicator. Titration to decolourisation of phenolphthalein indicator will indicate complete neutralization of OH- and ½ of CO_3--, while sharp change from yellow to orange of methyl orange indicator will indicate total alkalinity (complete neutralisation of OH-, CO_3--, HCO_3-).

5.11.1. Acidity

Acidity of water is quantitative capacity to react with strong base to a designated pH. Acids contribute corrosiveness and influence chemical reaction rates, chemical speciation and biological process. The measurement also reflect a change in quality of source of water. The value may vary significantly with the end point pH used in the determination strong mineral acids, weak acid such a carbonic, acetic and hydadyzing such as iron or aluminium sulfates may contributes to the measured acidity according to the method of determination.

Method- Standard Methods for the Examination of Water and Wastewater; APHA 2310 B, 22nd Edition.



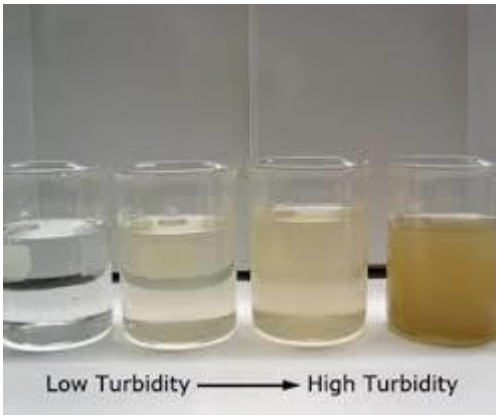
The principle behind the analysis is the hydrogen ions present in a sample as a result of dissociation or hydrolysis of solutes react with additions of standard alkali. Acidity is thus depends on the end point pH or indicator used. A known volume of sample is titrated against standard NaOH solution. The addition of a suitable indicator usually phenolphthalein changing its colour from colourless to development of pink colour.

5.11.2. Turbidity

Turbidity measures the clarity of the water. Turbidity in water caused by suspended and colloidal matter like clay, silts, finely divided organic matter, planktons and other microscopic organism. Suspensions of particles in water interfere with passage of light and causes transmission or absorption of light which is termed as Turbidity or by its effect on the scattering of light which is termed as Nephlometery. Turbidity is measured in Nephelometric Turbidity Units (ntu).

Method- Standard Methods for the Examination of Water and Wastewater; APHA-2130-B, 22nd Edition, 2012.

Instrument-Digital Nephelo turbidity meter 132



The working principle of Nephelometer is based on the light scattered by the sample and comparing the intensity of the light scattered by a standard reference suspension under the same condition. The higher the intensity of scattered light, the higher turbidity. Impacts of high turbidity levels are sediment can block out light needed for vegetation, suspended particles may absorb heat and thus increase water temperature, sediment can bury fish eggs and benthic invertebrates.

5.11.3. Hardness

Water hardness is a traditional measure of the capacity of water to precipitate soap. Hardness of water is not a specific constituent but is a variable and complex mixture of cations and anions. Total hardness is defined as the sum of the calcium and magnesium concentration, both expressed as $CaCO_3$, in mg/L. The degree of hardness of drinking water has been classified in terms of the equivalent $CaCO_3$ concentration as follows:

Soft 0-60 mg/L

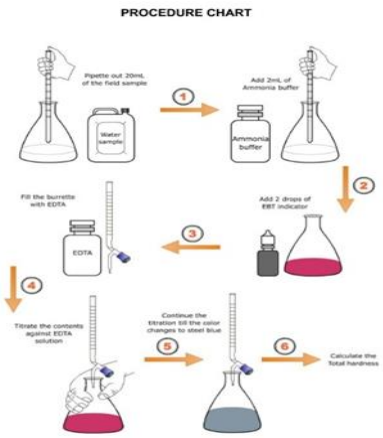
Medium 60-120 mg/L

Hard 120-180 mg/L

Very hard >180 mg/L

Although hardness is caused by cation, it may also be discussed in terms of carbonate (temporary) and non-carbonate (permanent) hardness. Carbonate hardness refers to the amount of carbonates and bicarbonates in the solution that can be removed or precipitated by boiling. This type of hardness is responsible for the deposition of scale in hot water pipes and kettles. When total hardness is numerically greater than that of total alkalinity expressed as $CaCO_3$, the amount of hardness equivalent to alkalinity is called carbonate hardness1. When the hardness is numerically equal to less than total alkalinity, all hardness is carbonate hardness. The amount of hardness in excess of total alkalinity expressed as $CaCO_3$ is non-carbonate hardness. Non-carbonate hardness is caused by the association of the hardness-causing cation with sulphate, chloride or nitrate and is referred to as “permanent hardness”. This type of hardness cannot be removed by boiling.

Method- Standard Methods for the Examination of Water and Wastewater; APHA2340 C, 22nd Edition, 2012 (EDTA titration method).



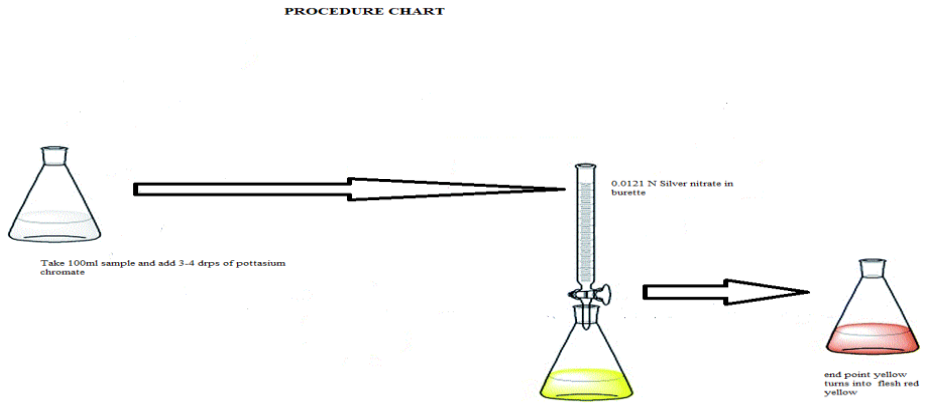
The fundamental principle of EDTA titration is Ethylenediaminetetracetic acid (EDTA) and its sodium salts form a soluble chelated complex with certain metal ions. Calcium and magnesium ions develop wine red colour with Eriochrome black T in aqueous solution at pH 10.0 ± 0.1. When EDTA is added as a titrant, Calcium and magnesium divalent ions get complexed resulting in sharp change from wine red to blue which indicates end-point of the titration. Magnesium ion must be present to yield satisfactory point of the titration. Hence, a small amount of complexometically neutral magnesium salt of EDTA is added to the buffer. The sharpness of the end point increases with increasing pH. However, the specified pH of 10.0 ± 0.1 is a satisfactory compromise. At a higher pH i.e. at about 12.0 Mg++ ions precipitate and only Ca++ ions remain in solution. At this pH murexide (ammonium purpurate) indicator forms a pink colour with Ca++. When EDTA is added Ca++ gets complexed resulting in a change from pink to purple which indicates end point of the reaction.

5.11.4. Chloride

Chloride in the form of chloride ion, is one of the major anions in water and waste water. The salty taste produced by chloride concentration is variable and dependent on the chemical composition of water. Some water containing 250 mg Cl/L may have a detectable salty taste if the cation is sodium. On other hands the typical salty taste may absent in water containing as much as 1000 mg Cl/L, when the predominant cations are calcium and magnesium.

Method- Standard Methods for the Examination of Water and Wastewater; APHA4500-O B, C, 22nd Edition, 2012. (The argentometric method titration method)

In a neutral or slightly alkaline solution, potassium chromate can indicate the end point of the silver nitrate titration of chloride. Silver chloride is precipitated quantitatively before red silver chromate is formed is the principle of chloride titration. Water with high concentration of chloride adversely affect damage plant growth, giving drinking water unpleasant taste and overtime sodium chloride high corrosively will damage plumbing, appliances and water heater.



5.11.4.1. Dissolved Oxygen (DO)

Dissolved Oxygen is the amount of gaseous oxygen (O_2) dissolved in the water. Oxygen enters the water by direct absorption from the atmosphere by rapid movement or waves and tumbling action saturating water with oxygen through aeration and as a waste product of plant photosynthesis. The amount of oxygen dissolved in water depends on the temperature and concentration of solute present in it. Water temperature and the volume of moving water can affect dissolved oxygen levels.

Method- Standard Methods for the Examination of Water and Wastewater; APHA 4500-O B,C, 22nd Edition, 2012. (The Winkler method with azide modification). The basic

principle of winker's method is the oxygen present in sample rapidly oxidises the dispersed divalent manganous hydroxide to its higher valency, which is precipitated as a brown hydrated oxide after the addition of NaOH/KOH and NaI/Kl. Upon acidification, manganese reverts to divalent state and liberates iodine from NaI/Kl equivalent to the original DO content. The liberated iodine is titrated against sodium thiosulfate ($Na_2S_2O_3$) using starch as an indicator.

5.11.4.2. D.O. Sample bottle after adding D.O reagents

Waters with consistently high D.O. are considered healthy and stable aquatic systems is a positive sign whereas absence of D.O. is a sign of severe pollution and very difficult to survive aquatic organisms. Dumping of organic wastes and other thermal pollutants adversely reduced the D.O. level in water bodies. A healthy waterbody contains a D.O. concentration of 8 mg/l. A water body with less than 4 mg/l D.O. indicates pollution of that water body.

5.11.5. Biochemical Oxygen Demand

The Biochemical Oxygen Demand (BOD) is an empirical standardized laboratory test which measures oxygen requirement for aerobic oxidation of decomposable organic matter and certain inorganic materials in water, polluted waters and wastewater under controlled conditions of temperature and incubation period. The quantity of oxygen required for above oxidation processes is a measure of the test. The test is applied for fresh water sources (rivers, lakes), wastewater (domestic, industrial), polluted receiving water bodies, marine water (estuaries, coastal water) and also for finding out the level of pollution, assimilative capacity of water body and also performance of waste treatment plants.

Method- Standard Methods for the Examination of Water and Wastewater; APHA-5210 B, 22nd Edition, 2012. (The Winkler method with azide modification).

5.11.6. BOD incubator

The method consists of filling with sample to overflowing, in an airtight bottle of specified size and incubating it at temperature of 20^{o}C for 5 days. Dissolved oxygen is measured initial and final incubation and the BOD is computed from the difference between initial and final D.O. The method is modified by BIS to suit the Indian conditions ie., at 27 ^{o}C and an incubation period of 3 days. Because the initial D.O. is determined immediately after the dilution is made, all oxygen uptakes including that occurring during the first 15 minutes is included in the BOD measurement.

5.11.7. Chemical Oxygen Demand

Chemical Oxygen Demand (COD) test determines the oxygen requirement equivalent of organic matter that is susceptible to oxidation with the help of a strong chemical oxidant. It is an important, rapidly measured parameters as a means of measuring organic strength for streams and polluted water bodies. The test can be related empirically to BOD, organic carbon or organic matter in samples from a specific source taking into account its limitations. The test is useful in studying performance evaluation of wastewater treatment plants and monitoring relatively polluted water bodies. COD determination has advantage over BOD determination. COD results can be obtained in 3-4 hrs as compared to 3-5 days required for BOD test. Further, the test is relatively easy, precise and is unaffected by interferences as in the BOD test. The intrinsic limitation of the test lies in its inability to differentiate between the biologically oxidisable and biologically inert material and to find out the system rate constant of aerobic biological stabilization.

Method- Standard Methods for the Examination of Water and Wastewater; APHA-5210 B, 22nd Edition, 2012(Open reflux method).

The open reflux method is suitable for a wide range of wastes with a large sample size. The dichromate reflux method is preferred over procedures using other oxidants (e.g. potassium permanganate) because of its superior oxidizing ability, applicability to a wide variety of samples and ease of manipulation. Oxidation of most organic compounds is up to 95-100% of the theoretical value. The organic matter gets oxidised completely by potassium dichromate ($K_2Cr_2O_7$) with silver sulphate as catalyst in the presence of concentrated H_2SO_4 to produce CO_2 and H_2O. The excess $K_2Cr_2O_7$ remaining after the reaction is titrated with ferrous ammonium sulphate [Fe $(NH_4)^2(SO_4)^2$]. The dichromate consumed gives the oxygen (O_2) required for oxidation of the organic matter.

Fatty acids, straight chain aliphatic compounds, aromatic hydrocarbons, chlorides, nitrite and iron interfere in the estimation. The interference caused by chloride can be eliminated by the addition of mercuric sulphate to the sample prior to the addition of other reagents. About 1.0 g of mercuric sulphate is adequate to complex 100mg chloride ions in the sample in the form of poorly ionized soluble mercuric chloride complex. Addition of Ag_2SO_4 to concentrated H_2SO_4 as a catalyst stimulates the oxidation of straight chain aliphatic and aromatic compounds. Nitrite nitrogen exerts a COD of 1.14 mg/mg NO_2-N. Sulphamic acid at the rate of 10mg/mg NO_2-N may be added to $K_2Cr_2O_7$ solution to avoid interference caused by NO_2-N. Aromatic hydrocarbons and pyridine are not oxidised under any circumstances. Volatile organic compounds will react in proportion to their contact with the oxidant. For complete oxidation of organic matter, it is necessary to take volumes

of sulphuric acid and sample plus potassium dichromate in 3:2:1 ratio. However, to maintain the ratio, the volumes and strength of oxidant/sample may suitable be varied.

5.11.8. Nitrate

Nitrate is the most highly oxidised form of nitrogenous compounds commonly present in natural waters. Significant sources of nitrate are chemical fertilizers, decayed vegetable and animal matter, domestic effluents, sewage sludge disposal to land, industrial discharge, leachates from refuse dumps and atmospheric washout. Depending on the situation, these sources can contaminate streams, rivers, lakes and ground water. Unpolluted natural water contains minute amounts of nitrate. Excessive concentration in drinking water is considered hazardous for infants because of its reduction to nitrite in intestinal track causing methemoglobinaemia. In surface water, nitrate is a nutrient taken up by plants and converted into cell protein. The growth stimulation of plants, especially of algae may cause objectionable eutrophication.

Method- Standard Methods for the Examination of Water and Wastewater; APHA-4500 NO_3^-, 22nd Edition, 2012(Brucine method).

Colorimetric method is followed for the analysis of nitrate. When a water sample containing nitrate ion is treated with Brucine in sulfuric acid, a yellow solution results.

Spectrophotometer

The concentration of nitrate nitrogen may be calculated based upon the absorbance of the solution at 410 nm in spectrophotometer.

5.11.9. Phosphate

Phosphorous occurs in natural waters and in wastewater almost solely in the form of various types of phosphates. These forms are commonly classified into orthophosphates and total phosphates. These may occur in the soluble form, in particles of detritus or in the bodies of aquatic organisms. The various forms of phosphates find their way into wastewater, effluents and polluted water from a variety of sources. Larger quantities of the same compounds may be added when the water is used for laundering or other cleaning, since these materials are major constituents of many commercial cleaning preparations. Orthophosphates applied to agricultural or residential cultivated land as fertilizers are carried into surface waters with storm runoff and to a lesser extent with melting snow. Organic phosphates are formed primarily by biological processes. They are contributed to sewage by body wastes and food residues. Presence of phosphates in water and wastewater

analysis has a great significance. Phosphate in small concentration are used in water supplies to reduce scale formation, to increase carrying capacity of mains, to avoid corrosion in water mains, to remove iron and manganese in micro quantities and in coagulation especially in acid conditions. The presence of phosphate in large quantities in fresh waters indicates pollution through sewage and industrial wastes. It promotes growth of nuisance causing micro-organisms. Though phosphate possesses problems in surface waters, its presence is necessary for biological degradation of wastewaters. Phosphorus is an essential nutrient for the growth of organisms and helps for the primary productivity of a body of water.

Method- Standard Methods for the Examination of Water and Wastewater; APHA-4500-P, 22nd Edition, 2012 (Stannous chloride method).

Colorimetric method is used for the quantification of phosphate in water. The basic principle of stannous chloride method, acidic condition, orthophosphate reacts with ammonium molybdate to form molybdophosphoric acid. It is further reduced to molybdenum blue by adding reducing agent such as stannous chloride or ascorbic acid. The blue colour developed after addition of ammonium molybdate is measured at 690 or 880 nm within 10-12 minutes after development of colour by using blank. The concentration is calculated from the standard graph. The intensity of the blue coloured complex is measured which is directly proportional to the concentration of phosphate present in the sample.

5.11.10. Sodium and Potassium

Sodium ranks sixth among the elements in order of abundance and is present in most natural water. The levels may vary from less than 1 mg Na/L to more than 500 mg Na/L. Relatively high concentrations may be found in brines and hard water softened by the sodium exchange process. The ratio of sodium to total cations is important in agriculture and human pathology. Soil permeability can be harmed by a high sodium ratio. Persons affected with certain diseases require water with low sodium concentration. A limiting concentration of 2 to 3 mg/L is recommended in feed water destined for high-pressure boilers. When necessary, sodium can be removed by the hydrogen-exchange process or by distillation. Sodium compounds are used in many applications, including caustic soda, fertilizers and water treatment chemicals.

Potassium ranks seventh among the elements in order of abundance, yet its concentration in most drinking water seldom reaches 100mg/L. Potassium is an essential element in both plant and human nutrition and occurs in groundwater as a result of mineral dissolution.

Instrument- Flame emission photometric method direct-reading.

The flame photometer calibrated using different standards of sodium and potassium. After calibration the samples aspirate through the flame photometer.

Bacteriological analysis

Pollution Indicator Bacteria

The microbial examination is used worldwide to monitor and control the quality and safety of various types of waters. Microbiological examination of water samples is usually undertaken to ensure the water is safe to drink or bathe in. As many potential pathogens could be associated with water and their concentration may be very low, it is thus impractical to screen samples for all possible pathogens. Instead, various indicator organisms have been used as surrogate markers of risk.

The presence of coliform organisms in water has been attributed to influxes of allochthonous bacteria from waste discharges and surface water drainage. The proportion of faecal coliforms (FC) comprising the total coliform (TC) population or the total viable bacterial population can be used as an index of pollution from sanitary wastes of human or other animal origin. These organisms are considered as ideal indicator organisms as they meet the following criteria.

- It should be a member of the intestinal micro flora of warm-blooded animals.
- It should be present when pathogens are present and absent in uncontaminated water.
- It should be present in greater number than the pathogens.
- It should be equally resistant as the pathogens to environmental insults.
- It should not multiply in the environment.
- It should be detectable by means of easy, rapid and inexpensive methods.
- The indicator organisms should be non-pathogenic.

5.11.11.Total coliforms (TC)

The coliform or total coliform group includes all of the aerobic and facultative anaerobic, Gram negative, non-spore forming rod shaped bacteria that ferment lactose in 24-48 hours. This group includes the genera *Escherichia coli, Citrobacter, Enterobacter* and *Klebsiella*. From the health point of view, the coliform test has been the most important test used to analyse the quality of water. The total coliform test remains the primary indicator of bacteriological quality of potable water, distribution system water and public water supplies because a broader measure of pollution is desired for these waters.

5.11.12. Faecal coliforms (FC)

Faecal coliform is a sub group of total coliform and is defined as Gram negative, non-spore forming rods that ferment lactose in 24 $\pm$ 2 hours at 44.5 $\pm$ 0.2^{o}C with the production of gas in multiple tube procedure. The major species in this group is E. coli, a species indicative of faecal pollution and the possible presence of enteric pathogens. The presence of these organisms particularly *E. coli*, indicates the possible presence of other disease causing bacteria. The rational behind this procedure is that *E. coli* is always present in sewage in higher concentration whereas pathogens are present in variable numbers. Thus there is a greater probability that *E. coli* will be present in water contaminated with raw sewage at any time than those pathogenic organisms detected. Thus it is assumed that if *E. coli* is present, other enteric pathogens are also present, if they are absent, disease - producing organisms are probably also absent.

5.11.13. Faecal streptococci (FS)

The faecal streptococci will be used to describe the Streptococci, which indicate the sanitary quality of water and waste water. This groups include, *Streptococcus equines*, *Streptococcus bovis*, etc., Since they commonly inhabit the intestinal tract of human and warm blooded animals, they are used to detect the faecal contamination of water. In combination with data of coliform bacteria, faecal streptococci are used in sanitary evaluation as a supplement to faecal coliform when more precise determination of source of contamination is necessary (FC/FS) ratio. From the data it was reasoned that ratios greater than 4:4 were indicative of pollution derived from domestic wastes composed of man's body waste. Ratios less than 0.7 suggested that contamination originated from livestock and poultry wastes or from storm water runoff. Because of limited survival time outside the animal intestinal tract their presence indicates very recent contamination from farm animals.

5.11.14. Sample collection

The samples were aseptically collected in sterile plastic bottles from ruttners water sampler. Samples were transported to the laboratory in an ice box.

5.11.15. Total Heterotrophic Bacterial count

Water samples were serially diluted aseptically up to 10¬-2 using sterile distilled water after taking 1ml of the sample into 9 ml of sterile distilled water in a test tube. Aliquots of 0.2 ml samples from each dilution were spread plated in triplicate on R2A medium for the enumeration of total aerobic heterotrophic bacteria which is expressed as total viable count (TVC). The plates were then incubated at 30ºC for 48-72 hours. After incubation, plates with 30 to 300 colony forming units (CFU) were selected for counting and isolation of bacterial cultures.

5.12.Analysis of Faecal Coliform (MPN method)

The most probable number (MPN) load of faecal coliform bacteria was determined by three-tube dilution method using EC broth as medium. 10 ml, 1ml and 0.1 ml of water samples were inoculated into respective dilution tubes containing inverted Durham's tubes. 10 ml samples were inoculated into 10 ml double strength EC broth; 1 ml and 0.1 ml samples were inoculated into single strength EC broth of 10 ml each. Inoculated tubes were incubated at 44.5ºC for 24 hours and observed for growth and gas production. Tubes showed growth and gas production were recorded as FC positive and used for calculating the MPN index. The density of faecal coliform was expressed with most probable number (MPN) per 100 ml of water.

5.13. Analysis of Faecal Streptococci (MPN method)

The most probable number (MPN) load of Faecal streptococci bacteria was determined by three-tube dilution method using Azide Dextrose Broth (ADB) as medium. 10 ml, 1ml and 0.1 ml of water samples were inoculated into respective dilution tubes. 10 ml samples were inoculated into 10 ml double strength ADB; 1 ml and 0.1 ml samples were inoculated into single strength ADB of 10 ml each. Inoculated tubes were incubated at 37ºC for 24 hours and observed for turbidity in the medium. Tubes showed turbidity in medium were recorded as FS positive and used for calculating the MPN index. The density of Faecal. streptococci was expressed with most probable number (MPN) per 100 ml of water.

5.14. Water management practices in the educational institutions

- ❖ Rainwater Harvesting
- ❖ Drainage system
- ❖ Water treatment system
- ❖ Orientation and public participation
- ❖ Sewage treatment plant

6. Soil Audit

Soil is a living system representing a finite resource vital to life and forms a thin layer of minerals and organic matter on the earth's surface. It is the complex mixtures of minerals, organic compounds and living organisms that interact continuously in response to natural and imposed biological, chemical and physical forces. Soil develops slowly from various parent materials and is modified by time, climate, macro and microorganisms, vegetation and topography (Asadi *et al.*, 2008). Healthy soils provide clean air and water, bountiful crops and forests, diverse wildlife, and beautiful landscapes. The soil does all this by performing five essential functions like regulating water, sustaining animal and plant life, filtering potential pollutants, cycling nutrients and supporting structures (Asadi *et al.*, 2008). Soils are the natural bodies in which the plants are growing and provide the starting point for successful agriculture. Rapid increase in human population has increased the stress on natural resources, including the soil. Degradation of soil adversely affects the agricultural production and other interrelated natural resources. Soil pollution leads to surface water and groundwater contamination. Most soils are capable to some degree of adsorbing and detoxifying many pollutants to harmless levels through chemical and biochemical processes.

6.1. Importance of Soil

Soil is a vital resource for human survival in that it is the medium in which most plants grow, it cleans and stores water, detoxifies pollutants, and plays a key role in the regulation of the Earth's temperature. Soil is also the habitat of a multitude of soil organisms necessary for the cycling of elements and for keeping a healthy environment for human beings (Blum, 2007).

Soils are a critical enabling resource for human well-being, as they are important for the production of a wide range of products and ecosystem services. Soils are essential for the production of food, textiles and pharmaceuticals. Both for plant growth and water supply, soil absorbs stores, alters, purifies, and releases water. Soil interacts with the environment by absorbing and emitting gases (eg: CO_2, methane, water vapour and dust). Soils contain the largest amount of organic carbon on the planet (over double the organic carbon stored in vegetation). Soils control carbon, oxygen, and nutrient cycles in plants (N, P, K, Ca, Mg and so on).

6.2. Soil Health

The capacity of soil to function as a vital living system within land use constraints is defined as soil health and quality. This function, which keeps soil biological productivity up, also keeps the environment and human health in good shape. Warkentin and Fletcher (1997) reviewed that the development of soil health approaches as well as the content of soil health and soil quality information and its application to reduce negative impacts on agricultural productivity and long-term sustainability. Soil quality is linked to soil function, whereas soil health portrays the soil as a finite, non-renewable and dynamic living resource. The notion of soil health, which encompasses interactions between plant inputs and soil in creating a healthy environment. Nutrient imbalances in soil, excess in fertilization, soil

pollution, and soil loss processes, all of which are becoming more wide spread in developing countries, have negative effects on soil health and quality.

6.3. Soil quality

Soil quality is a concept being developed to characterize the usefulness and health of the soils which depends entirely on the components like soil minerals, organic matter, air, water, and living organisms. This property can change due to human impact on the soil. As soil plays a dominant role in maintaining the ecological balance, it is necessary to maintain the soil quality including soil fertility, potential productivity, resource sustainability and environmental quality (Shepard *et al*., 1977). In an agricultural context, soil quality is managed to maximize production without adverse environmental impact, while in a natural ecosystem soil quality is observed as a baseline value or set of values against which further change in the system may be compared.

Soil quality is defined as "*the capacity of a soil to function within ecosystem boundaries to sustain biological productivity, maintain environmental quality and promote plant and animal health*" (Doran and Parkin, 1994). Soil functions derive from the physical, chemical, and biological processes that take place within the soil as a result of the soil attributes. The soil functions as proposed by Karlen *et al.* (1997) are as follows:

⇒ Sustaining biological activity, diversity, and productivity;

⇒ Regulating and partitioning water and solute flow;

⇒ Filtering, buffering, degrading, immobilizing and detoxifying organic and inorganic materials including industrial and municipal by-products and atmospheric deposition;

⇒ Storing and cycling nutrients and other elements within the earth's biosphere and providing support of socioeconomic structures and protection for archeological treasures associated with human habitation.

The ability of a particular type of soil to function within natural or managed ecosystem boundaries in order to maintain or increase plant and animal productivity. Improve the quality of water and air and promote human health as well as dwelling.

Soil quality is important because healthy soil can store and process more water. Poorly drained soil will not have water. Making it impossible for the plants to develop and survive. Organic matters and substances created by living organisms, is essential for healthy, high quality soil (Wienhold *et al*., 2006). The intrinsic ability of a soil to function is its inherent soil quality. Sandy soils drains more quickly than clay soils. Roots have greater room in deep soil than in soil with bedrock near the surface. These features are immutable and difficult to modify. The intrinsic quality of soil is frequently used to compare one soils capability to those of another as well as to assess the value or suitability of soils for specific purpose (USDA, 2006). Soil quality can be physical, chemical or biological depending on the soil variables evaluated. The majority of physicochemical parameters are associated with inherent soil quality while biological and physical factors are associated with dynamic soil quality, although biological components of soil quality are frequently highlighted (Ball and De la Rosa, 2006).

6.4. Soil quality assessment

Soil quality evaluation is likely to be one of the most divisive issues in the soil science community. The objective is look at the history, current state and future possibilities of employing soil quality assessment as a tool to track the physical, chemical and biological effects of management decisions on soil and water resources. The distinction between inherent and dynamic soil quality, as well as recognized and addressed (Douglas *et al*., 2008).

The complexity of soil makes soil quality assessment impractical and worthless, according to a recurrent theme resource. They argue that rather than focusing on soil quality. Soil quality advocates claim that while soil scientist have long recognized the numerous distinctive and vital qualities and processes offered by fragile soil resources, soil are still highly undervalued outside of the agricultural community (Karlen *et al*., 2003).

Soil quality assessment focuses on dynamic characteristics to assess the long term viability of soil management strategies but it must be based on the soil parameters themselves. A soil quality indicator is a simple property of the soil that may be measured to determine its quality in relation to a certain function. To improve the ability to manage soil sustainability are need effective soil quality evaluation strategies.

6.5. Relevance of Soil quality assessments

Soil quality assessment is valuable for agricultural production. These characteristics taken together constitute a soils inherent quality. They assist in comparing and evaluating soils. Soil quality assessments are performed to determine the impact of management on the soils health. Worldwide, soil resources are degraded at an unprecedented rate due to various human activities. Human activities affect soils by influencing the pattern, amount, and intensity of surface-water runoff, erosion, and sedimentation. Many agricultural practices cause alteration of soil attributes that result in soil malfunction and ultimately, in the degradation of soil and water resources. Hence soil quality assessment is an important tool to assess the quality of soil in a particular area.

6.6. Soil Health Card (SHC)

The Government of India introduced the Soil Health Card Scheme on February 19, 2015. The government intends to provide soil cards to farmers as part of the scheme, which would include crop-specific advice. In India, the SHC scheme was launched in the hopes of encouraging the prudent use of fertilizers by limiting their indiscriminate application and so lowering input costs (Bisen and Shivaramane, 2020).

The Department of Agriculture and Co-operation, which is part of the Ministry of Agriculture and Farmers' Welfare, promotes the SHC. It is being implemented by all state and union territory government’s Departments of Agriculture.

A soil health card is used to assess the current state of soil health and to track changes in soil health that are influenced by land management over time. Soil health indicators and descriptive phrases are displayed on a SHC. Farmer’s practical experience and understanding of local natural resources is generally used as indicators. The card includes a list of indications of soil health that can be determined without the need of technical or scientific equipment. Farmers all across the world rely on soil health and fertility for long-term prosperity. The first step toward sustainable farming is to continue to utilise the best fertilizers and cropping patterns according to scientific recommendations. In terms of agriculture production, preserving long-term viability requires maximizing fertilizer use and reducing waste.

SHC is a printed report supplied to a farmer for all of his land holdings. It contains information on the state of the soil based 12 parameters: pH, EC, OC, N, P, K, S, Zn, Fe, Cu, Mn, and B. The soil health card will give fertilizer recommendations and soil changes for the farm based on all of these parameters. SHC will be made available to farmers once

every three years and it will show the status of his land's soil health for that time period. (Veeraiah *et al*., 2019).

6.7. Soil sampling

6.7.1.Principle

Soil testing is an essential component of soil resource management. Each sample collected must be a true representative of the area being sampled. Utility of the results obtained from the laboratory analysis depends on the sampling precision. Hence, collection of large number of samples is advisable so that sample of desired size can be obtained by sub-sampling. In general, sampling is done at the rate of one sample for every two hectare area. However, at-least one sample should be collected for a maximum area of five hectares.

6.7.2. Collection and preparation of soil samples

Collection of soil sample is very important and critical as only a minute fraction of the huge soil mass of the field is actually used for analysis in the laboratory. Hence the following aspects should be strictly adhered for having a truly representative soil sample.

1. The sample must properly represent the area. A field can be treated as a single sampling unit only if it is appreciably uniform in all respects. Variation in slope, colour, texture, crop growth and management should be taken in to account and separate sets of composite samples should be collected from each of such area. Recently fertilized plots, bunds, channels, marshy tracts and spots near trees, wells, compost pits/piles or other such non-representative locations must be avoided during sampling.
2. The nature of crop species especially with respect to its root penetration and rooting depth determine the depth of sampling. In case of field crops and other seasonal crops samples must be taken from a depth of 0-15 cm (generally expressed as plough layer). For deep-rooted crops like sugarcane and plantation crops and also for crops under dry farming condition, samples have to be taken from different depths depending on the rooting depth.

Materials required

1. Spade or auger
2. Scoop
3. Core sampler
4. Sampling bags
5. Plastic tray or bucket

6.7.3.Sampling equipment and documentation list

Sampling plan
Sample location map
Tape measure
Survey stakes or flags
Camera
Stainless-steel buckets or bowls
Sample containers, pre-cleaned
Logbook
Chain-of-custody forms
Plastic sheet

6.8. Representative sample collection

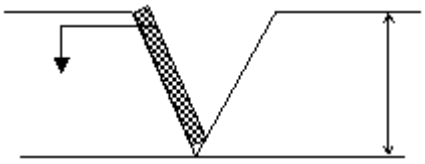
The objective of representative sampling is to ensure that a sample or group of samples adequately reflects site conditions.

6.8.1. Sampling procedure

Samples must be taken from well distributed sampling sites from a uniform sampling unit (generally at least 10-15 per acre) by means of suitable sampling tools and a composite sample may be prepared. Sample must be taken from the desired depth after removing the surface litter. The soil collected in this manner should be thoroughly mixed by hand on a clean piece of cloth, polythene sheet or thick paper and the bulk must be reduced to about 500 g of composite sample by quartering. This sample must be quickly air dried in shade at room temperature and put in cloth or polythene bags with suitable labels.

6.8.2. Soil samples are collected using the following procedure:

1. Carefully remove the top layer of soil to the desired sample depth with a pre-cleaned spade;
2. Drive the auger to a plough depth of 15 cm and draw the soil sample.
3. If auger is not available, make a 'V' shaped cut to a depth of 15 cm in the sampling spot using spade.
4. Using a pre-cleaned, stainless-steel scoop, spoon, trowel, or plastic spoon, remove and discard the thin layer of soil from the area that came into contact with the shovel;
5. Transfer the sample into an appropriate container using a stainless-steel or plastic lab spoon or equivalent. If composite samples are to be collected, place the soil sample in a stainless-steel or plastic bucket and mix thoroughly to obtain a homogeneous sample representative of the entire sampling interval. Place the soil samples into labeled containers.
6. Ensure that a sufficient sample size has been collected for the desired analysis.



6 inches (15 cm)

6.8.3.Precautions in collection and storing of samples

Care should be taken to avoid contamination of the samples. Any possibility of contact with chemicals, fertilizers or manures must be avoided. Special care must be given at the time of drawing and processing if the samples are to be tested for micronutrients. Only stainless steel/plastic tools, sieves and containers are to be used.

6.8.4. Processing of soil samples

Air dried soil sample is normally passed through 2 mm sieve and used for analysis. Before sieving the soil should be lightly crushed in wooden pestle and mortar. Plant residues, gravel and other foreign matter retained on the sieve are discarded. If the gravel content is substantial, a note may be taken of that. For certain type of analysis (Eg. organic carbon) it becomes necessary to grind the soil further so as to pass it through sieves of finer mesh size (0.5 mm).

6.9. Soil analysis

The soil analysis can be broadly classified as physical testing and chemical analysis.

6.9.1. Physical test

- ✓ **Determination of soil texture**: by rapid feel method. Soil texture is qualitatively determined by a rapid feel method which involves rubbing the moistened soil between the thumb and the fingers. If the soil is sandy, does not form a ribbon. Whereas clayey soils forms ribbon.
- ✓ **Soil pH:** Electrometric method: the pH of 1:2.5 soil water extract is measured using pH meter. It is a measure of hydrogen ion activity of soil water system and indicates whether the soil is acidic, neutral or alkaline in reaction.
- ✓ **Electrical Conductivity (EC):** Electrical conductivity in soil water system is a measure of concentration of water soluble salt in soil.

6.9.2. Chemical Test

1. Soil organic carbon (Measure of Nitrogen)

Walkely and Black Rapid Titration Method: The organic matter in the soil is oxidized by potassium dichromate, conc. sulphuric acid mixture and unreacted dichromate is back titrated with ferrous ammonium sulphate using ferroin as indicator. From the value of ferrous ammonium sulphate used the volume of potassium dichromate consumed for oxidation of organic matter can be calculated

2. Estimation of available phosphorus

Bray's method no: 1 (Bray and Kurtz, 1945): Available phosphorous content is readily determined by extracting the available phosphorous in the soil by adding bray extractant from the filtrated extract. Phosphorous is determined colorimetrically by measuring the intensity of the blue colour developed.

3. Estimation of potassium

Flame photometric method: Available potassium in the soil can be extracted using one normal neutral ammonium acetate solution and concentration in the extract can be measured using flame photometer.

4. Estimation of calcium

The same ammonium acetate extractant prepared for potassium can be used for calcium determination using flame photometer.

5. Estimation of magnesium

AAS method: Magnesium concentration in the soil can be determined with the help of atomic absorption spectrophotometer after extraction of magnesium from the soil by normal neutral ammonium acetate solution.

6. Estimation of sulphur

Turbidimetric method: Available sulphur can be extracted from the soil using calcium chloride extractant. The sulphur concentration in the extractant can be estimated by measuring the turbidity formed by adding barium chloride to the extract.

7. Estimation of iron, copper, manganese and zinc

Dilute HCL is used for extracting micro nutrients from the soil sample. The various micro nutrient concentration of the soil solution can be attained by using atomic absorption spectrophotometer by selecting appropriate hollow cathode lambs.

8. Estimation of boron

Azomethane H methods used for developing colour for the hot water soluble boron in soil sample. The intensity of yellow colour is proportional to the concentration of boron in the extract which can be measured using a spectrophotometer at a wavelength of H_2O nm.

6.10. Conclusion

The soil and water audit are an excellent tool for assessing the available water resources and consumption pattern also the soil quality of the institution. Furthermore, it offers scientific ways to promote soil and water conservation by minimizing water loss and indiscriminate consumption practices.

7. FORMAT FOR REPORT OF AUDITS

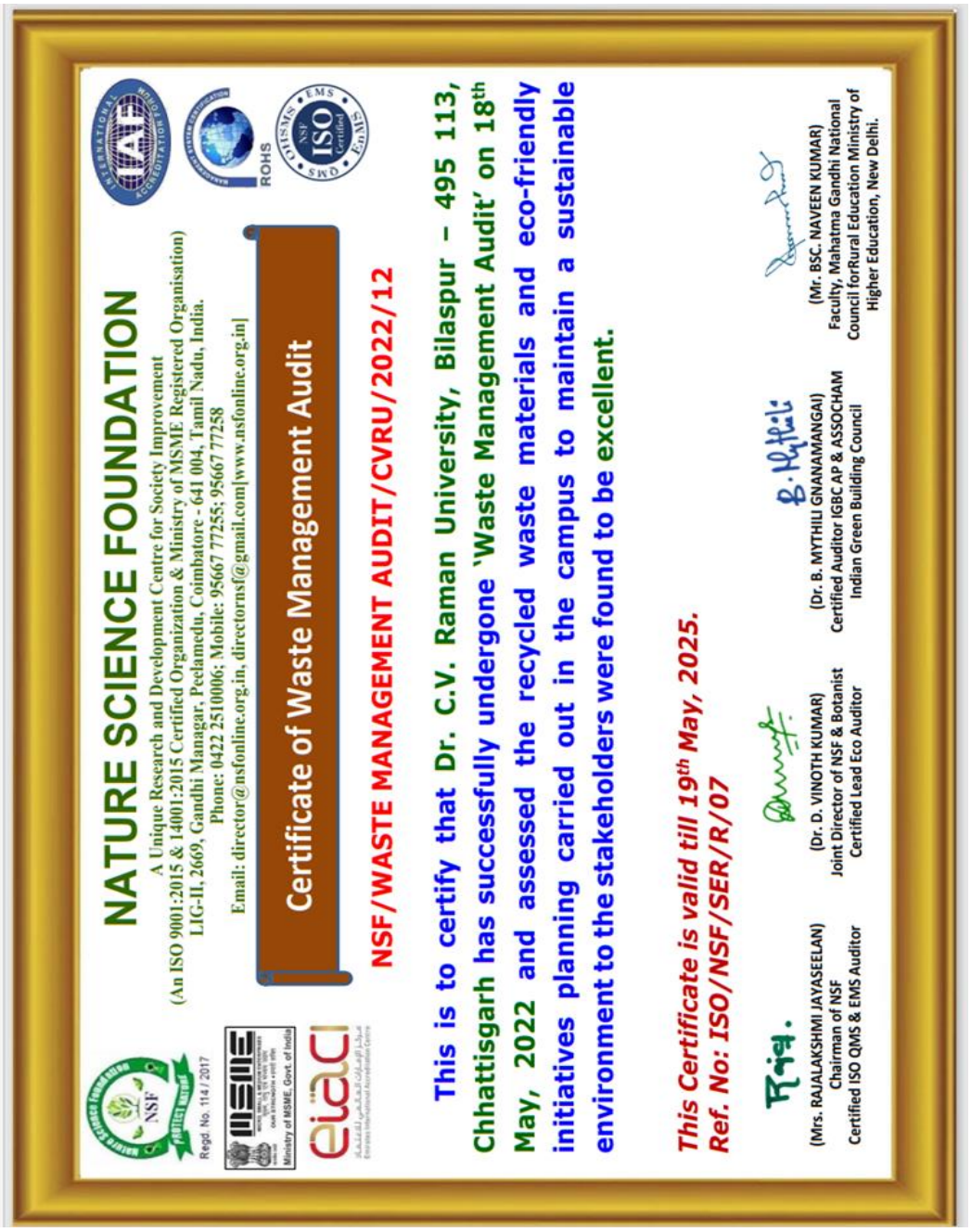
1. Introduction of the Audit
2. Definition of the proposed Audit
3. About the Organization
4. Details of Audit Team, Date of audit and Venue of audit
5. Aim and Objectives of the Auditing
6. Scope of the Audit
7. Methodology carried out in the Auditing
    a. Pre-Audit steps
    b. Onsite-Audit steps
    c. Post-audit steps
8. Assessing the strengths and weaknesses of the Auditing
    a. Internal auditing procedures
    b. Gathering audit data and evidence
    c. Recording audit findings
    d. Evaluating the audit findings
    e. Extending the Audit Process
9. Eco club activities carried out in the campus
10. Activities and Programmes carried out by the Organization
11. Suggestions, Observations and Recommendations
12. Conclusion
13. Acknowledgement
14. References

Audits and Auditors Details

a. Date and Day, Year of the Audit :
b. Name of Type of Audit :
c. Name of the ISO EMS Auditor :
d. Name of the Lead Eco Auditor :
e. Name of the Subject Expert-I :
f. Name of the Subject Expert-II :
g. Name of the Subject Expert-II :
h. Name of the IGBC AP Auditor :
i. Name of the ASSOCHAM AP Auditor :
j. Name of the BEE Energy Auditor :
k. Name of the LEED AP Auditor :
l. Name of the GRIHA CP Auditor :
m. Name of the PBRS CP Auditor :
n. Name of the FSMS :
o. Name of the Waste Management Auditor :
p. Name of the Waste Management Officer :

8. SAMPLE CERTIFICATES OF WASTE MANAGEMENT, BIO – MEDICAL WASTE MANAGEMENT, E – WASTE MANAGEMENT, PLASTIC WASTE MANAGEMENT, SOIL & WATER AUDIT

Sample Certificate of 'Waste Management Audit'



NATURE SCIENCE FOUNDATION

A Unique Research and Development Centre for Society Improvement
(An ISO 9001:2015 & 14001:2015 Certified Organization & Ministry of MSME Registered Organisation)
LIG-II, 2669, Gandhi Managar, Peelamedu, Coimbatore - 641 004, Tamil Nadu, India.
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Regd. No. 114 / 2017

Ministry of MSME, Govt. of India

Certificate of Waste Management Audit

NSF/WASTE MANAGEMENT AUDIT/CVRU/2022/12

This is to certify that Dr. C.V. Raman University, Bilaspur – 495 113, Chhattisgarh has successfully undergone 'Waste Management Audit' on 18th May, 2022 and assessed the recycled waste materials and eco-friendly initiatives planning carried out in the campus to maintain a sustainable environment to the stakeholders were found to be excellent.

This Certificate is valid till 19th May, 2025.
Ref. No: ISO/NSF/SER/R/07

(Mrs. RAJALAKSHMI JAYASEELAN)
Chairman of NSF
Certified ISO QMS & EMS Auditor

(Dr. D. VINOTH KUMAR)
Joint Director of NSF & Botanist
Certified Lead Eco Auditor

(Dr. B. MYTHILI GNANAMANGAI)
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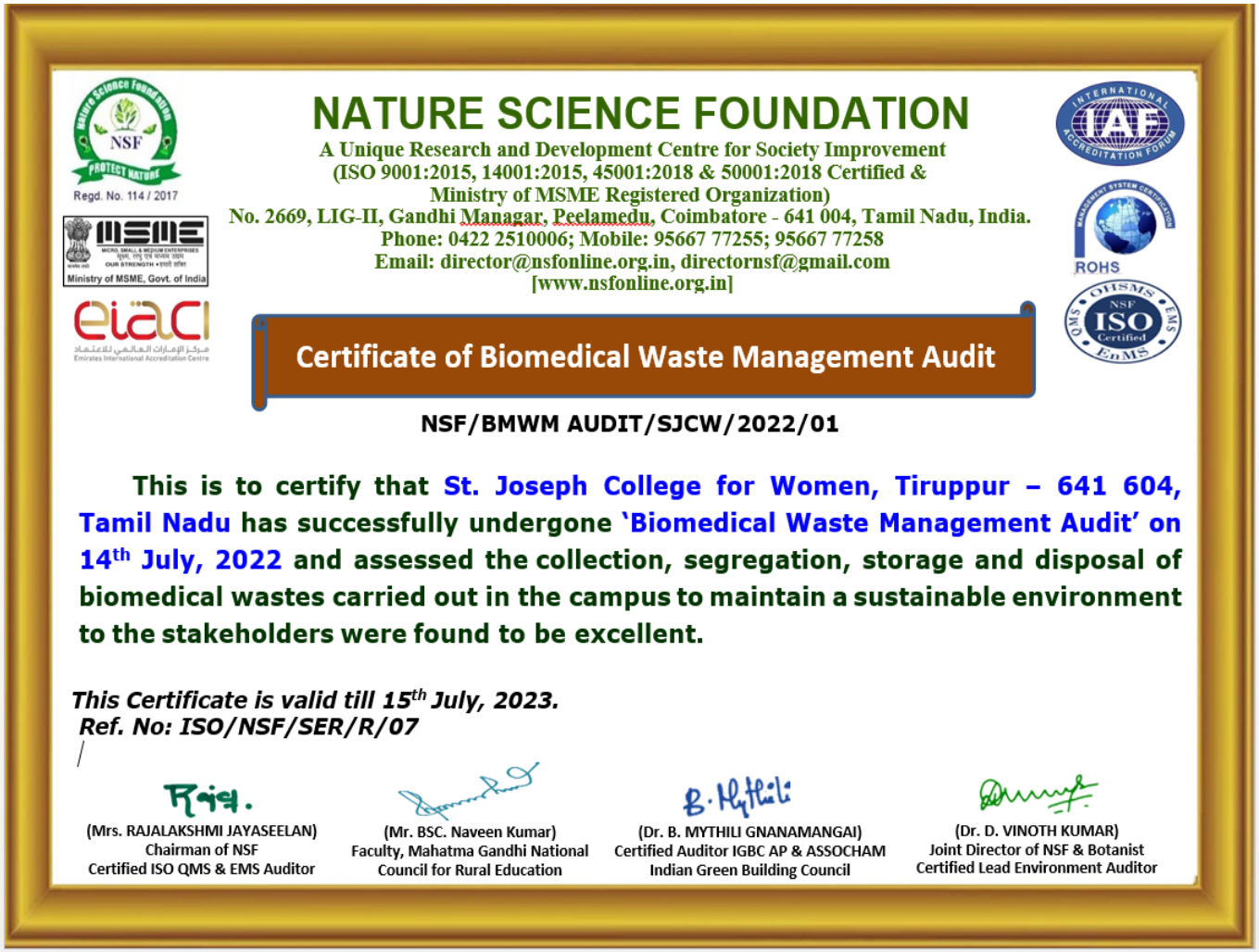
Indian Green Building Council

(Mr. BSC. NAVEEN KUMAR)
Faculty, Mahatma Gandhi National
Council forRural Education Ministry of
Higher Education, New Delhi.



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Regd. No. 114 / 2017

Ministry of MSME, Govt. of India

ROHS

Certificate of Biomedical Waste Management Audit

NSF/BMWM AUDIT/SJCW/2022/01

This is to certify that St. Joseph College for Women, Tiruppur – 641 604, Tamil Nadu has successfully undergone 'Biomedical Waste Management Audit' on 14th July, 2022 and assessed the collection, segregation, storage and disposal of biomedical wastes carried out in the campus to maintain a sustainable environment to the stakeholders were found to be excellent.

This Certificate is valid till 15th July, 2023.
Ref. No: ISO/NSF/SER/R/07

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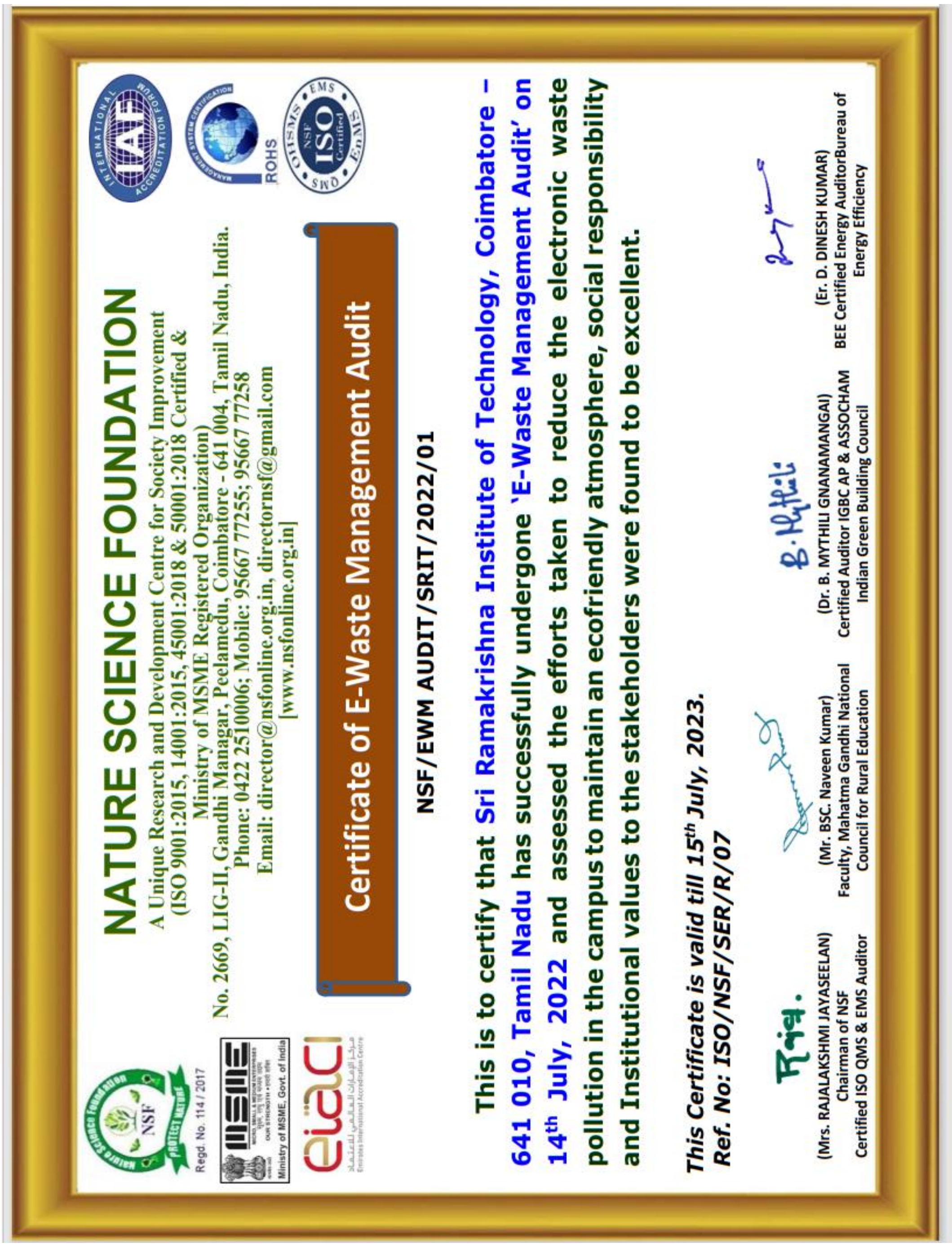
Joint Director of NSF & Botanist
Certified Lead Environment Auditor

Sample Certificate of 'E - Waste Management Audit'



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[www.nsfonline.org.in]

Certificate of E-Waste Management Audit

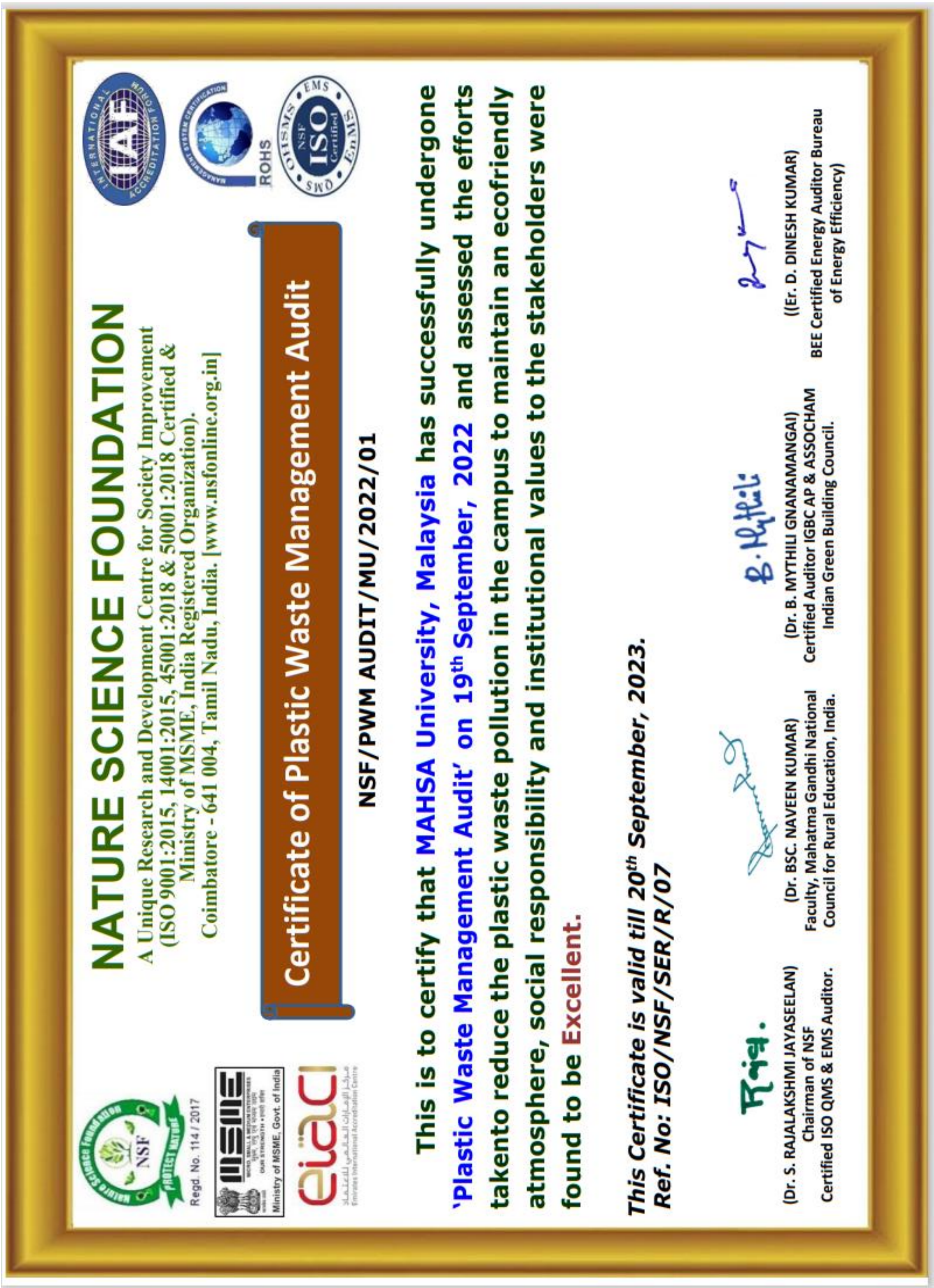
NSF/EWM AUDIT/SRIT/2022/01

This is to certify that Sri Ramakrishna Institute of Technology, Coimbatore – 641 010, Tamil Nadu has successfully undergone 'E-Waste Management Audit' on 14th July, 2022 and assessed the efforts taken to reduce the electronic waste pollution in the campus to maintain an ecofriendly atmosphere, social responsibility and Institutional values to the stakeholders were found to be excellent.

This Certificate is valid till 15th July, 2023.
Ref. No: ISO/NSF/SER/R/07

(Mrs. RAJALAKSHMI JAYASEELAN) Chairman of NSF Certified ISO QMS & EMS Auditor	(Mr. BSC. Naveen Kumar) Faculty, Mahatma Gandhi National Council for Rural Education	(Dr. B. MYTHILI GNANAMANGAI) Certified Auditor IGBC AP & ASSOCHAM Indian Green Building Council	(Er. D. DINESH KUMAR) BEE Certified Energy AuditorBureau of Energy Efficiency

Sample Certificate of 'Plastic Waste Management Audit'



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Coimbatore - 641 004, Tamil Nadu, India. [www.nsfonline.org.in]

Certificate of Plastic Waste Management Audit

NSF/PWM AUDIT/MU/2022/01

This is to certify that MAHSA University, Malaysia has successfully undergone 'Plastic Waste Management Audit' on 19th September, 2022 and assessed the efforts takento reduce the plastic waste pollution in the campus to maintain an ecofriendly atmosphere, social responsibility and institutional values to the stakeholders were found to be Excellent.

This Certificate is valid till 20th September, 2023.
Ref. No: ISO/NSF/SER/R/07

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Indian Green Building Council.

((Er. D. DINESH KUMAR)
BEE Certified Energy Auditor Bureau of Energy Efficiency)

Sample Certificate of 'Soil and Water Audit'

Regd. No. 114 / 2017

Ministry of MSME, Govt. of India

NATURE SCIENCE FOUNDATION

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Certificate of Soil and Water Audit

NSF/Soil & Water Audit/UNOM/2021/18

This is to certify that University of Madras (Chepauk, Marina, Guindy, Taramani and Chetpet Campuses), Chennai, Tamil Nadu has successfully undergone 'Hygiene Audit' on 22nd November, 2021 and assessed the soil and water sample, related to the control of pathogenic microorganisms in the soil and water carried out by the Organization were found to be excellent.

This Certificate is valid till 23rd November, 2024.
Ref. No: ISO/NSF/SER/R/07

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(Dr. D. VINOTH KUMAR)
Joint Director of NSF & Botanist
Certified Lead Environment Auditor

9. PROFILE OF NATURE SCIENCE FOUNDATION

Nature Science Foundation (NSF), Coimbatore, Tamil Nadu, India is Non-Governmental, ISO QMS (9001:2015), EMS (14001:2015), OHSMS (45001:2018) and EnMS (50001:2018) certified and Ministry of MSME registered Organization It is functioning strenuously to conduct different awareness programmes and implement various schemes to public and school / college students towards the noble cause of nature protection. Some of the programmes are also being organized for the benefit of tribal communities to create the supply chain for biodiversity conservation studies.

The main motto of the NSF is, "Save the Nature to Save the Future" and "Go Green to Save the Planet". NSF is a Non-Governmental Organization under Nature Science Foundation Public Charitable Trust managed by a board of trustees. NSF is a non-profitable foundation registered under the TN Societies registration Act 1975 (TN Act 27 of 1975) on 29th November, 2017 at Peelamedu, Coimbatore- 641 004, Tamil Nadu, India with Certificate of Registration No. 114 / 2017.

NSF has executive, advisory and supportive committee members to involve by themselves to protect the nature to save the future of living organisms and planet. A wide range of members covering vice-chancellors, principals, eminent academicians, scientists, engineers, technologists, lawyers, social workers, entrepreneurs, volunteers and staff members from academic institutions and industries and students from schools and colleges are extending their support to achieve the objectives of the NSF.

Vision:

To be the leading research and development cum extension centre for Academicians, Scientists, Technologists, Engineers, Entrepreneurs, Social Workers and Volunteers in Nature Conservation, Education and Socio-Economic Innovations for the noble cause of nature protection.

Mission:

- To promote educational and environmental awareness programmes through social activities for enhancing the quality of life.
- To conserve nature from environmental pollutants using traditional and modern technologies for sustainable land management.
- To impart and enhance the traditional knowledge of biodiversity and implement the restoration programmes in Western Ghats of southern India.
- To aim at social, economic, political and educational development of oppressed people in the undeveloped regions
- To create supply chain through tribal development and women empowerment to conduct activities for the noble cause of nature protection
- To educate the tribal community children through social service and towards the upliftment of tribes as a whole and make them as entrepreneurs.

Objectives of NSF:

- NSF is conducting awareness programmes on various contemporary topics such as protection of environment, environmental pollution, biodiversity conservation, soil conservation, water management, solid waste management, herbal plants, car

exhaust management, plastics exploitations, role of medicinal plants in human health, afforestation, restoration programme in forests, forest management, education to tribes, tribal development, women empowerment and etc. to public domain and school/college students.

- NSF is implementing various schemes for the protection of natural resources by encompassing restoration and afforestation programmes by following traditional and modern technologies.
- Biodiversity conservation is the primary aim of NSF by creating supply chain through tribes which in turn useful to protect the economically important plants and wild life animals.
- To educate the tribal community children through social service and upliftment of tribes as a whole and make them as entrepreneurs is another mile stone of the NSF. Financial support will be given to tribal communities especially tribal children for their higher studies.
- NSF is giving partial financial assistance to schools and colleges for conducting seminars, conferences, symposia and workshops with respect to nature protection studies and to promote the training and research and innovative programs amongst students and teachers.
- To create awareness about plastic materials usage and junk food consumption by spreading the knowledge and importance of healthy life among rural people.
- To provide monetary aid and other help for the relief from natural calamities like flood, tempest and earth quakes, etc.
- To raise funds from members, public, philanthropists, banks, financial sectors, academic institutions, Government and Public Institutions, societies, charitable and public trusts and multinational companies in form of subscriptions, donations, grants, loans and other contributions to attain the objects of the Trust.
- To takeover or absorb any existing charitable institutions similar to the objects of the Trust with immovable properties. The income and funds available with the trust shall solely be utilized for the achievement of the objects of the trust and it shall not be diverted for the purpose other than the achievement of the objectives of the trust and no portion of it will be utilized for payment to the Trustees/office bearers by way of profit/dividend/interest, etc.

Membership:

School, college and university students, staff members and faculties including public and employees from industrial sectors are encouraged to become a life, annual and provisional member with NSF. They can involve themselves in the noble cause of environmental protection and nature conservation. Membership cards and certificates will be given to the members which will be useful to attend NSF sponsored seminars, conferences, workshops and training programmes with 50% concession of the registration fees. Provisional members can conduct environmental awareness programmes through NSF for the benefit of public domain, rural and tribal people. Membership fees are Rs.100/- per school student, Rs.200/- per college student and Rs.500/- per staff and public as per the norms of the NSF. The application forms are made available in the NSF website.

Awards and Honours

In order to encourage the students, members of faculty, academicians, scientists, entrepreneurs and industrial experts those who are involving in environmental protection and nature conservation studies, NSF tributes the deserved meritorious candidates with various awards and honours. The awards and honours are given under following criteria:

'Best Faculty Award', 'Best Scientist Award', 'Best Entrepreneur Award', 'Best Social Worker Award', 'Best School Student Award', 'Best College Student Award', 'Best Women Faculty Award', 'Best Women Scientist Award', 'Lifetime Achievement Award', 'Fellow of NSF', 'Best School / College / University / Industry', 'Best College Principal Award', 'Best School Head master Award', 'Best School Principal Award', 'Best School teachers Award' and 'Young Scientist Award'. The application forms are made available in the NSF website.

Financial Support for Conducting Programmes on Nature Protection

Financial support will be given for conducting Conferences / Seminars / Workshops / Training Programmes / Summer & Winter camps in all disciplines and specializations covering different categories such as Engineering / Technology / Science / Arts / Law / Management / Medicine towards the noble cause of nature protection. The application should have detailed programme (such as speakers, topics/titles of papers/lectures, list of participants etc.) at least two months in advance of proposed activity for taking further action. The sanction of grants by the Foundation depends on the importance of the topic /subject of the events and its relevance to nature protection. Programmes may be conducted for school as well as college students to create awareness about nature protection. Programmes conducted for public domain and tribal development will be encouraged by giving substantial amount of funds which will be the primary aim of the Foundation. The application form for getting the financial support from the NSF to conduct the various awareness programmes is made available in the NSF website.

International Eco Club Student Chapter (IECSC)

Application form in the prescribed format available in the NSF Website to establish IECSC at Colleges and Universities forwarded by the Head of Institution will be received throughout the year. To start IECSC at Colleges and Universities, a minimum strength of 100 Students members and three Staff coordinators are mandatory. Any student of full time/part-time course (B.Sc./M.Sc., B.E./B.Tech./B.Pharm./ M.E./ M.Tech./ M.Pham. / M.Phil./Ph.D.) is eligible to become member in IECSC. IECSC can conduct Conferences, Seminars, Workshops, Student Technical Symposium, Distinguished lecture programme, Environment day celebration, Ozone day celebration, Project model exhibition, Awareness programmes on Environmental pollution, Biodiversity and Natural resources conservation and etc. with the financial support of the Foundation. Best IECSC will be rewarded with a cash award of Rs.25,000/- along with a shield and memento for their outstanding contribution based on number of programmes conducted which will be honoured during the second week of January every year on the occasion of 'NSF Annual Meet and Award Distribution Ceremony'. Student members of IECSC can get financial assistance for innovative projects every year which is scrutinized by the Subject Expert committee with a maximum amount of Rs.10000/-

Memorandum of Understandings (MoU)

NSF is signing Memorandum of Understanding (MoU) with various Colleges, Universities and Industries across the globe for conducting awareness programmes on nature conservation and environmental protection, conduct of various environmental audits, collaborative project proposal submission to national / international funding agencies, joint research paper publications in peer reviewed journals, filing patent rights and copy rights and projects on environmental protection and nature conservation, wastewater and solid waste management and tribal development & women empowerment and upliftment. The following thrust areas in which MoU can be signed.

- Programmes on Biodiversity conservation, Nature and Environmental protection
- Establishment of 'International Eco Club Student / Staff Chapters'
- Conduct of 'Extension activities' and 'Outreach programmes' for students
- Generation fund from Governmental and Non-Governmental organizations
- Offering Green audit, Eco Audit, Hygiene and Energy Audit courses
- Joint publications in peer reviewed journals and consultancy projects
- Adaptation of tribal villages and tribal children for their higher studies
- Upliftment of tribes as a whole and make them as Entrepreneurs
- Entrepreneurship awareness programme and Start-up programmes
- Conducting conferences / seminars / workshops / training programmes on biodiversity conservation and environmental protection
- Student Project Schemes and Faculty / Scientist Schemes

Green Pledge of the NSF

- Don't cut trees
- Don't use plastic bags
- Don't burn plastic materials
- Don't waste waters
- Don't destroy natural resources
- Don't eat junk foods
- Don't drink carbonated soft drinks
- Don't disturb the forests
- Don't use aerosol products (fresheners)
- Don't discharge pesticides, paints, oils in drainage etc.
- Don't use light sources during day time
- Walk early morning to inhale fresh air
- Plant more medicinal plants in the surroundings
- Reduce the use of petroleum products
- Service the automobiles regularly for energy efficiency
- Condemn old vehicles for clean environment
- Reuse the sewage water for gardens
- Maintain proper rainwater harvesting system

10. APPLICATION FORMS

NATURE SCIENCE FOUNDATION

(A Unique Research and Development Centre for Society Improvement)

[ISO QMS (9001:2015), EMS (14001:2015), OHSMS (45001:2018) & EnMS (50001:2018) Certified and Ministry of MSME Registered Organization]

No. 2669, LIG-II, Gandhi Managar, Peelamedu, Coimbatore - 641 004, Tamil Nadu, India. Website: www.nsfonline.org.in.

Phone: 0422 2510006; Mobile: 9566777255, 9566777258

Email: director@nsfonline.org.in, directornsf@gmail.com.

APPLICATION FOR WASTE MANAGEMENT AUDIT TO ACADEMIC INSTITUTIONS, HOSPITALS AND INDUSTRIAL SECTORS

Reference Number	NSF/WMA 2022-23/Orgn.Name/ Dated:
Name of the Organization & Address	
Date of Audit	
Name of the Lead and EMS Auditors	
Is it a new Audit (or) renewal process?	New audit (or) Renewal audit, tick (√) any one. If it is a Renewal audit, mention the date of last audit:
Purpose	To collect and receive the waste materials like e-wastes, wood wastes, construction wastes, plastic wastes, hazardous wastes and biomedical wastes from Academic Institutions, Hospitals / Pharmaceutical and other Industrial Sectors. To ensure proper storage of the wastes as per their classification, characterization, and mode of treatment and disposal. To analyze and decide the treatment and disposal scheme of wastes as per the guidelines of MOEF, CPCB & DPCC. To optimize the treatment and disposal cost by management practices and provide very economical services to the hospitals. To educate and make the individual health care facilities aware of sorting the wastes in a scientific manner and comply with the applicable regulations. To conduct the public awareness programmes to various stakeholders. To search for cost effective and environmental friendly

	technology for treatment of bio-medical and hazardous waste. To search for suitable materials to be used as containers for biomedical waste requiring incineration/autoclaving/ microwaving. In terms of biomedical wastes, ascertain generation of both infectious and general waste per bed per day for Sub Centres (SC), Additional Primary Health Centres (APHC) and Primary Health Centres (PHCs), Community Health Centres (CHC) and Combined Hospital (CH).	
PROCEDURE		
Procedure	**Description**	**Responsibility**
Annual plan	Each year a plan for the waste management audit is prepared by management. Waste collection and segregation, mutilation, disinfection, storage, transportation and final disposal are vital steps for safe and scientific management of wastes in any establishment. The committee should be responsible for making specific action plan for the waste management and its supervision, monitoring and implementation.	Management Representative
Walk-through Audit	Based on the checklists, the waste management audit is carried out in the form of observations in the Academic Institutions, Hospitals / Pharmaceutical and other Industrial Sectors.	Audit team
Follow-up of action	Corrective action has to be undertaken and implemented within the prescribed duration.	Campus Coordinator
Reporting and Recommendations	Submission of corrective action in the form of Report in association with the hygiene club / Student Chapters of the Institute.	Lead Auditor EMS Auditor Hygiene Auditor

l. Qualitative and quantitative measurements

S.No.	**Requirements and checklists of the audit**	**Conformity**		
		Yes	**No**	**Remarks**
1.	Adequate number of Dust Bins as per Guidelines (Red, Yellow, Blue, and Black & Green Bins) are made available in the campus for various wastes' collection, segregation and disposal.			
2.	Record Register for waste disposal and Puncture proof Containers for Sharps / Blue Bags are made available in the campus			
3.	Mutilators (Needle / syringe cutters) and calibrated weighing machines for biomedical wastes collection*			
4.	Personal protected materials like Gloves, Caps, Masks, Aprons & Gum boots etc. used are adequately made available as per the Guidelines in the campus.			
5.	Around 1% fresh Sodium hypochlorite or Bleaching Powder solution is made available as per guidelines*			
6.	Mercury Spill Management, kit, Post Exposure Prophylaxis Kit and Blood spill Management kit are available*			

7.	Proof of Licensed Companies signed MoU with the Organization for wastes collection as per the Govt. regulation			
8.	Norms are being followed by the Organization as per the Central and State Government Pollution Control Board			
9.	Different Forms, Formats, Annual Report, etc. are available for waste collection and mode of transportation			
10.	Availability of a trained dedicated with skilled personals for waste management.			
11.	Is the waste segregated at the site of generation? If not, where are they segregated?			
12.	Is the infectious waste and non infectious waste mixed at the source of generation?*			
13.	Is e-wastes, wood wastes, construction wastes, plastic wastes, hazardous wastes and biomedical wastes mixed at the source of generation?			
14.	Is the waste covered in covered bins? and Is the bins filled up to more than ¾ th level ?			
15.	Is the bins cleaned with soap and disinfectant regularly and bins are overfilled? And is the stored waste kept beyond 48-72 hrs?*			
16.	Is the waste transported in closed containers or open bags? and Are the waste collection bins/Trolleys/wheel barrow used for transporting wastes?			
17.	Is the personal protective gears like mask and gloves used while collecting the wastes from the site of deposition?			
18.	Whether the concept of E-Waste management is followed in the campus?			
19.	Has a Management Representative, E-Waste Specialist, Laboratory Staff been assigned?			
20.	Whether E-Waste management practices included in the purchase policy of electronic items?			
21.	Whether an authorised refurbrisher appointed to manage the E-Waste?			
22.	Are the E-Waste refurbished and used again in the institution?			
23.	Whether the importance of waste management and their implications on environmental and personal hygiene through awareness programmes are conducted for stakeholders?			
24.	Signing MOU with Government and NGOs ensure proper handling of waste materials			
25.	Whether construction and wood wastes are subjected to reuse them in the same organization campus?			
26.	Whether plastic wastes are burnt inside the campus? Any air pollution due to plastic materials burning takes place ?			
27.	Projects and dissertation works, scholarly publication on various wastes and their management carried out by staff members and students			
28.	Whether hazardous wastes are properly discarded in which acids, solvents and salts are disposed after diluting with water and poured after buried in the soil			

29.	Have programmes for the achievement of plastic free area objectives and targets been established and implemented as on today? Any display board is made in the campus?			
30.	Are recycling of plastic polymers promoted in the campus among the stakeholders?			
31.	Wood waste are collected and recycled properly and they used for fuel and degradation / green manuring purposes?			
32.	Residual wastes are properly disposed in the campus after burring the soil with proper dilution with water			

* Applicable for Hospitals/Labs/Pharmaceutical Industrial sectors
** A minimum of 50% criteria should be attained

- *Take feedback from doctors for quality on services for continual improvements.*
- *Provide necessary training to the hospital staff handling waste at the health care Units.*
- *Supply bar-coded biodegradable bags to track the necessary information and keep it in records.*

II. Qualitative measurements

S.No	Name of the Electrical items / Equipment / Instruments	E waste code by NSF	Quantity
1.	Mainframe	ITEW	
2.	Internet connectivity Accessories	ITEW	
3.	Personal computer	ITEW	
4.	Laptop	ITEW	
5.	Dot matrix Printer	ITEW	
	Laser Printer	ITEW	
	Ink jet printer	ITEW	
6.	Cartridge	ITEW	
7.	Xerox machine	ITEW	
	Scanner	ITEW	
	Fax machine	ITEW	
8.	Telephones	ITEW	
9.	Cellar phones	ITEW	
10.	Television	CEEW	
11.	Solar panel	CEEW	
12.	Water heater	CEEW	
	Solar water heater	CEEW	
13.	Split AC	CEEW	
	Window AC	CEEW	
	Centralized AC	CEEW	
	Air Cooler	CEEW	
14.	Tube light	CEEW	
	Fluorescent lamps	CEEW	
	Halogen lamp	CEEW	
	Sodium Vapour lamp	CEEW	
	CFL	CEEW	

	LED tube lights	CEEW	
	LED Focusing lights	CEEW	
15.	Ceiling Fan	CEEW	
	Pedestal Fan	CEEW	
	Table Fan	CEEW	
	Portable Fan	CEEW	
16.	Lead acid batteries	CEHW	
17.	Lithium Ion Battery	CEHW	
18.	Cable and wires	CEEW	
19.	Inverter with UPS	CEEW	
20.	Switch board	CEEW	
21.	Solar panel	CEEW	
22.	LCD projector	CEEW	
23.	Refrigerator	CEEW	
24.	Water doctor	CEEW	
25.	RO water plant	CEEW	
26.	Generator	CEEW	
27.	Pump	CEEW	
28.	Motors	CEEW	
29.	Compressor	CEEW	
30.	Vacuum Cleaner	CEEW	
31.	Ventilator	CEEW	
32.	Insect trap	CEEW	
33.	Podium containing Mike, Speakers, Amplifiers, Radio, Camera, Sensors, etc.	CEEW	
34.	**Civil Engineering Equipment / Machines** Compressing testing machine, Universal testing machine, Total Station, Theodolites, Flexure testing machine, Torsion testing & Izod impact testing machines, Hardness testing machine, Beam deflection test apparatus, Centrifugal Pump, Gear Pump, Submersible pump, Reciprocating Pump, Pelton Wheel turbine, Francis turbines / Kaplon turbine, Turbidity meter, pH meter, Conductivity meter, Jar test apparatus, BOD incubator, COD digester, Direct shear apparatus, Triaxial shear apparatus,	LEEW	
35	**Equipment, Instruments and Machineries related to Life Sciences and Biological Sciences including Biotechnology, Nanotechnology, Food Technology, etc.** Electronic Balances, pH Meter, Hot-air-Oven, Microwave Oven, Laminar	LEEW	

	Air Flow, Autoclave, Microscopes, , Rotatory Evaporators, Centrifuges, Electrophoretic apparatus, Chromatography devices, Grinders, Mixers, Deep Freezers, BOD Incubator, COD Digester, Extraction apparatus, Incubators, CO2 incubator, Heating Mantle, Vacuum pump, Vortex mixer, Magnetic stirrer**,** Gel rocker, Sonicator, Growth Chambers, Air curtains, Aerators, Spectrophotometers, Calorimeters, Turbidity meter, Colony Counter Water bath, Dry bath, Thermocycler, Gene gun, Gel Documentation System, Transilluminator, Ice maker, ELISA Reader & Washer, Aquarium, Zebrafish / animal house facility, Mechanical & Orbital Shakers, Cyclo mixer, Lyophilizer, Incinerators, Ammeter, Flame Photometer, Fluorimeter, Fermentors, Reactors, Particle size Analyzer, XRD, FTIR, Muffle Furnace		
36	**Chemical Sciences and Engineering Equipment / Machines** Distillation Units, Packed bed distillation, Roll crusher, Jaw crusher, Sieve analysis machine, Shell and tube heat exchangers, Plate and frame filter press, Fume hood, Nephelometer, Membrane Filtration Apparatus, Jar test apparatus	LEEW	
37	**Electrical, Electronics and Communication Engineering Equipment / Machines** DC Shut motor, DC Series motor, DC Compound motor, DC Shunt motor, DC Compound generator, DC series generator, Single phase & Three phase transformers, Single phase & Three phase auto transformers, Loading rheostat, single phase & Three phase, Inductive & Capacitive load, Power electronics trainer kits, Three phase squirrel cage induction motor, Single phase & Three phase induction motor, Three phase slip ring induction motor, AC generator, Stabilizers, Synchronizer, Half and Fully controlled converters, Buck, Boost and	LEEW	

	buck-boost converters, Single phase and Three phase inverters, Synchros, CRO, DSO, CRO, Microprocessor trainer kits, Microcontroller trainer kits, Arudino trainer kits, Digital electronics trainer kits, Flip-flops, Counters, Half adder, Full adder circuits,		
38	**Mechanical Engineering Equipment / Machines** Lathe machine, Milling machine, Drilling machine, Slotting machine, Shaping machine, Cylindrical, Grinding, Coordinate Measuring, Universal testing devices, Thermal Conductor, Air Compressor, Single Cylinder 4 Stroke Diesel Engine, CNC Turning Centre, Kaplan, turbine, Pelton wheel turbine, Francis turbine, Venturimeter, Orifice meter, Nephelometer, CAD & CAM machines, Tensile strength apparatus, Younggus modules apparatus, XRD machines,	LEEW	
39	**Textile Technology Equipment / Machines** Ring spinning, Rotor spinning, Weaving machine, Ruti C loom, Circular Knitting machine, Curing chamber, Wash Fastness Tester, Streamer, Washing machine, Dryer,	LEEW	

***ITEW- Information technology E waste**
****CEEW- Consumer Electronic E waste**
*****CEHW- Consumer Electronic Hazardous waste**
*******LEEW- Laboratory Equipment E waste**

* Applicable for Hospitals/Labs/Pharmaceutical Industrial sectors
** ** A minimum of 50% criteria should be attained

- *Take feedback from doctors for quality on services for continual improvements.*
- *Provide necessary training to the hospital staff handling waste at the health care Units.*
- *Supply bar-coded biodegradable bags to track the necessary information and keep it in records.*

Note: This Audit process and Certificates are valid for three years only from the date of Audit.

Signature of Auditing Chairman **Signature of the Lead Auditor**

NATURE SCIENCE FOUNDATION

(A Unique Research and Development Centre for Society Improvement)

[ISO QMS (9001:2015), EMS (14001:2015), OHSMS (45001:2018) & EnMS (50001:2018) Certified and Ministry of MSME Registered Organization]

No. 2669, LIG-II, Gandhi Managar, Peelamedu, Coimbatore - 641 004, Tamil Nadu, India. Website: www.nsfonline.org.in.

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Email: director@nsfonline.org.in, directornsf@gmail.com.

APPLICATION FOR BIOMEDICAL WASTES MANAGEMENT AUDIT TO HOSPITALS, EDUCATIONAL INSTITUTIONS AND INDUSTRIAL SECTORS

Reference Number	NSF/BMWMA 2022/Orgn.Name/ Dated:
Name of the Organization & Address	
Date of Audit	
Name of the Lead and EMS Auditors	
Is it a new Audit (or) renewal process?	New audit (or) Renewal audit, tick (√) any one. If it is a Renewal audit, mention the date of last audit:
Purpose	To collect and receive the biomedical waste from health care facilities. To ensure proper storage of the wastes as per their classification, characterization, and mode of treatment and disposal. To analyze and decide the treatment and disposal scheme of wastes as per the guidelines of MOEF, CPCB & DPCC. To optimize the treatment and disposal cost by management practices and provide very economical services to the hospitals. Ascertain generation of both infectious and general waste per bed per day for Sub Centres (SC), Additional Primary Health Centres (APHC) and Primary Health Centres (PHCs) and Community Health Centres (CHC). To educate and make the individual health care facilities aware of sorting the wastes in a scientific manner and comply with the applicable regulations. To conduct the public awareness program. To search for cost effective and environmental friendly technology for treatment of

	biomedical and hazardous waste. To search for suitable materials to be used as containers for biomedical waste requiring incineration / autoclaving / microwaving.	
PROCEDURE		
Procedure	**Description**	**Responsibility**
Annual plan	Each year a plan for the biomedical waste management audit is prepared by management. Waste collection and segregation, mutilation, disinfection, storage, transportation and final disposal are vital steps for safe and scientific management of bio-medical waste in any establishment. The committee should be responsible for making Hospital specific action plan for the hospital waste management and its supervision, monitoring and implementation.	Management Representative
Walk-through Audit	Based on the checklists, the biomedical waste management audit is carried out in the form of observations in the hospitals/pharmaceutical industries.	Audit team
Follow-up of action	Corrective action has to be undertaken and implemented within the prescribed duration.	Campus BMWM Coordinator
Reporting and Recommendations	Submission of corrective action in the form of Report in association with the hygiene club / Student Chapters of the Institute.	BMWM Lead Auditor EMS Auditor

ll.Qualitative and quantitative measurements

S.No.	**Requirements and checklists of the audit**	**Conformity**		
		Yes	**No**	**Remarks**
1.	Adequate number of dust bins for Biomedical wastes disposals as per the BMW Guidelines (Red, Yellow, Blue and Black) and Green bins for General wastes.			
2.	Adequate number of bags for Biomedical wastes as per the Guidelines (Red, Yellow, Blue, and Black) and Green bags for BMW General wastes.			
3.	Puncture Proof Containers for Sharps / Blue Bags kept across in the campus			
4.	Mutilators (Needle / syringe cutters) and Calibrated Weighing machines for Biomedical wastes disposal accuracy including BMW Record Register			
5.	Personal protected equipments like Gloves, Caps, Masks, Aprons & Gum boots etc. used adequately as per the BMW Guidelines.			
6.	Around 1% fresh Sodium hypochlorite or Bleaching Powder Solution as per the BMW Guidelines.			
7.	Mercury Spill Management, kit, Post Exposure Prophylaxis Kit and Blood spill Management kit are made available in the campus as per the BMW Guidelines			

8.	BMW Licenses under Central and State Government Pollution Control Board norms Biomedical waste management			
9.	Different Forms & Formats (Needle Stick Injury & Annual Report, etc.)			
10.	Availability of a trained dedicated person for BMW Management and implementation.			
11.	Availability trained and skilled BMW person for BMW Collection & Transportation.			
12.	Availability dedicated & trained infection control Nurse available			

III. Generation & Segregation, Collection and Storage, Transportation, Treatment and disposal of biomedical wastes

Generation & Segregation of Biomedical wastes				
From Wards / O.T.s / ICUs / Labs / OPDs / Blood Bank / Radiology etc. Others				
S.No.	**Details of particulars**	**Yes**	**No**	**Remarks**
1.	Is the biomedical wastes segregated at the site of generation in the campus as per the BMW Guidelines?			
2.	Is the sharp infectious wastes (needles, blades, broken glass etc) to be disposed in white / blue puncture proof Containers?			
3.	Is the non sharp infectious material: (infected plastics, syringe, dressing, gloves, masks, blood bags and urine bags) to be disposed in red plastic bins/bags?			
4..	Is anatomical infectious wastes (Placenta, body parts) to be disposed in yellow plastic b ins or bags?			
5.	Is non infectious (General) waste E.g. packing materials, cartons, fruit and vegetable pills, syringe and needle wrappers, medicine covers to be disposed in Green / Black plastic bins or bags?			
6.	Is the infectious wastes and non infectious wastes mixed at the source of generation?			
Collection and Storage Biomedical Wastes				
1.	Is the biomedical wastes covered in covered bins ?			
2.	Is the bins filled up to more than ¾ th level?			
3.	Is the bins cleaned with soap and disinfectant regularly?			
4.	Is the bins overfilled?			
5.	Is the infectious and non infectious biomedical wastes filled in same / different bins?			
6.	Is the stored biomedical wastes kept beyond 48 hrs duration?			
7.	Is collected biomedical wastes are stored properly as the BMW guidelines?			

Transportation of biomedical wastes				
1.	Is the biomedical wastes transported in closed containers without any spreading and causing any disease?			
2	Are the biomedical wastes collection bins / Trolleys / wheel barrow used for transporting waste?			
3.	Is the Pre defined route available for transportation of biomedical wastes within the health care facility?			
4.	Is the biomedical wastes transported in open container and bags?			
5.	Is the transportation done during the OPD time or any Emergency?			
Treatment and disposal of biomedical wastes				
1.	Is your biomedical wastes disinfected and mutilated before final disposal			
2.	Is the anatomical sample wastes to be deep buried /incinerated?			
3.	Are the syringes to be cut and chemically disinfected with 1% sodium hypo chloride solution at the source of generation before final disposal?			
4.	Is the infected plastics to be chemically disinfected or autoclaved, shredded and send for final disposal?			
5.	Is the General wastes to be chemically disinfected before final disposal?			
6.	Is the infectious wastes disposed before chemical disinfection and mutilation?			
7.	Can the infectious wastes and non infectious wastes be mixed at any point of time?			

IV. Management of different waste streams measures undertaken

1.	Is the sharp injury reported and is it reported within 7 hrs. If yes then please mention the count per month?			
2.	Are the protective gears like gloves used while handling and syringe?			
3.	Is the barrel and plunger detached before disinfecting the syringe?			
4.	Is the sharp waste mixed with other wastes?			
5.	Is the practice of recapping or bending of needles being done?			
6.	Is the sharp discarded in poly bags properly			
7.	Is the sharp disposed in open area in the campus?			
8.	Is the vials and ampoules disposed in sharp containers?			

9.	Is the anatomical wastes disinfected before final disposal?			
10.	Is the anatomical wastes disposed in unsecured open areas or in any water bodies?			
11.	Is the personal protective gears like mask and gloves used while handling sputum cups and slides?			
12.	Is the sputum cup or slides disinfected with 5 % hypochlorite solution for at least one hour?			
13.	Is the sputum cups finally disposed inside the premises?			
14.	Is the slides of the Sputum test disposed in sharp container?			
15.	Is the discarded blood bags punctured before disinfection in 5 % sodium hypochlorite solution for at least one hour?			
16.	Is the blood bag discarded without mutilation and disinfection for final disposal?			
17.	Is the plastic waste like IV set, bottles, syringes, latex gloves, catheters etc. cut by scissors before disinfection in 1% sodium hypochlorite solution?			
18.	Is the disposable gloves and masks reused?			
19.	Is liquid waste spillage (blood, body fluid puss or any discharge) disinfected by adding 1% hypochlorite solution before cleaning?			
20.	Is the blood spill cleaned cloth reused?			
21.	Is the mercury spill cleaned with bare hands?			
22.	Is the mercury disposed in waste bins and drains?			
23.	Is the mercury collected into bottle having some water and tightly covered with the lid?			
24.	Is the mercury droplet collected using 2 card board piece / syringe?			
25.	Is the hand washing done before and after any procedure? Eg. collecting lab sample, examination of the patient, handling blood and body fluid.			
26.	Does the hospital personnel visit the final disposal site even if outsourced or done outside the hospital?			
27.	Is the medicine and chemicals stored in same store?			
28.	Signing MOU with Government and NGOs ensure proper handling of biomedical waste materials			
29.	Residual wastes are properly disposed in the campus after burring the soil with proper dilution with water			
30.	Whether hazardous wastes are properly discarded in which acids, solvents and salts used in the clinical laboratories are disposed after diluting with water and poured after buried in the soil.			

31.	Projects and dissertation works, scholarly publication on biomedical wastes and their management carried out by staff members and students			
32.	Whether the importance biomedical wastes and their implications on environmental and personal hygiene through awareness programmes are conducted for stakeholders?			

* Applicable for Hospitals / Labs / Pharmaceutical Industrial sectors

** A minimum of 50% criteria should be attained

- *Take feedback from doctors for quality on services for continual improvements.*
- *Provide necessary training to the hospital staff handling waste at the health care Units.*
- *Supply bar-coded biodegradable bags to track the necessary information and keep it in records.*

Note: *This Audit process and Certificates are valid for three years only from the date of Audit.*

Signature of Auditing Chairman **Signature of the Lead Auditor**

Signature of the EMS Auditor
Environment Management System
(ISO 14001:2015, TUV NORD)

Signature of BMWM Auditor
Bio Medical Waste Management
(ISO Safety Standards FSMS 22000)

NATURE SCIENCE FOUNDATION

(A Unique Research and Development Centre for Society Improvement)

[ISO QMS (9001:2015), EMS (14001:2015), OHSMS (45001:2018) & EnMS (50001:2018) Certified and Ministry of MSME Registered Organization]

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APPLICATION FOR BIOMEDICAL E – WASTE MANAGEMENT AUDIT TO HOSPITALS, EDUCATIONAL INSTITUTIONS AND INDUSTRIAL SECTORS

Reference number	NSF/EWMA 2022-23/Orgn.Name/ Dated:
Name of the Organization & Address	
Date of Audit	
Name of the Lead and EMS Auditors	
Is it a new Audit (or) renewal process?	☐ New Audit ☐ Renewal Audit Last Audit Date: _ _/_ _/_ _ _ _
Purpose	To ensure that the Electronic (E) wastes collected and handled properly which will eventually reduce the E-wastes generation and pollution. In order to reduce the E-Wastes pollution and affect the environmental health, E-Wastes Management Audit may be carried out as per the Checklists. Proper recycling of E-Wastes helps to extract useful materials and reduces the hazardous wastes mixing into atmosphere. Ecofriendly youth leadership, green practices, social responsibility and Institutional values are to comprehend the relationship with the ecosystem for sustainable environment with respect to the E-Waste management practices followed.

PROCEDURE

Procedure	Description	Responsibility
Annual plan	Each year a plan for the Electronic (E) Wastes Management audit is prepared	Management Representative

	by Management / Representative and to ensure that the E-Waste Management system is implemented in the campus to reduce the environmental pollution and to conserve natural ecosystems.	
Walk-through Audit	Based on the checklists, the Electronic (E) wastes management audit is carried out in the form of observations in the campus.	Audit team
Follow-up of action	Corrective action has to be undertaken and implemented within the prescribed duration	Environmental Coordinator
Reporting and Recommendations	Submission of corrective action in the form of report in association with Eco club / Student Chapters / Forums of the Institute	Lead Auditor ISO 14001:2015 EMS Auditor

Requirements of general features

1. Total Area_____, Building constructed area_____, Open area
2. Year of establishment:
3. Total Strength of Students:_____ (No. of Boys_____ and No. of Girls_____)
4. Total Strength of Hostellers: _____ (No. of Boys_____ and No. of Girls_____)
5. Total Strength of Teaching Staff: _____ (No. of Males____and No. of Females___)
6. Total Strength of Non-Teaching Staff:___(No. of Males___and No. of Females___)
7. Total Strength of Employees: ___(No. of Males___and No. of Females___)
8. Year of previous NAAC Accreditation:_____ Grade Obtained: _____
9. Size of E-Wastes storage facility _____
10. Name of the Authorized Refurbrisher _____
11. Name of the Authorized transporter _____
12. Name of the Authorized Recycler / Dismantler_____

Check list for Audits Electronic (E) Waste Management Audit (To ensure at least 50% of the following should be attained)

* Total number of Information Technology E-Wastes need report
* Total number of Consumer Electronics E-Wastes need report
* total number of Consumer Electronics hazardous wastes need report
* Total number of Laboratory Equipment E-Wastes need report
* Establishment of E-Wastes storage facility
* Preparing an internal E-Wastes audit procedure
* Designating a representative to monitor the E-Wastes generation
* Labeling and segregation of E-Wastes based on type and toxicity
* Frequency of E-Wastes collection Record maintenance
* Education, training, workshop, camp etc.. related to E-Wastes for stakeholders
* MOU with E-Wastes transporter, refurbrisher and dismantler
* Extended producer responsibility included in the purchase policy to handle E-Wastes
* Implications of utilizing refurbished E-Wastes in purchase policy
* E-Wastes handlers equipped with suitable safety gears

* Installation of exclusive E-Wastes bin to collect E-Wastes in campus from stakeholders
* Implementation of Government and Non-Governmental Organization schemes
* E-Waste types like computers, mobile phones, sensors, electrical and electronic items
* Fridges, freezers and other cooling equipment and telecommunications equipment
* Consumer electronic devices and solar panels, solar water heaters
* TVs, LCD projectors, monitors and screens, public addressing system
* Tube lights, Flourescent bulbs, LED, CFL bulbs, ultra-violet lights and etc.
* Vending machines, HVLS fans, exhaust fans, motors, electric wires, switches
* Power generators, uninterruptible power supply (UPS), AC machines, lifts, ventilators,
* Refrigerators, oven, microwave oven, water pumps, etc
* RO Plants, water doctors and distillation units, water pumps

I. Qualitative measurement

S.No	Requirements and checklists of the audit	Conformity		
		YES	NO	NA
1.	Whether the concept of E-Waste management is followed in the campus?			
2.	Have internal E-Wastes audit procedures been developed and implemented in organisation?			
3.	Has a Management Representative, E-Wastes Specialist, Laboratory Staff been assigned?			
4.	Whether E-Waste management practices included in the purchase policy of electronic items?			
5.	Whether an authorised refurbrisher appointed to manage the E-Waste?			
6.	Are the E-Wastes refurbished and used again in the institution?			
7.	Whether any MOU signs with authorised recycler / dismantler to recycle / dismantle the E-Wastes?			
8.	Whether E-Wastes collection bins installed in the campus for collection of E-Wastes?			
9.	Whether E-Wastes are handled based on its toxicity with safety precautions?			
10.	Whether E-Wastes awareness programmes are conducted for stakeholders?			
11.	Are the E-Waste handlers provided with safety gears, wearing masks and caps as per the guidelines?			
12.	Signing MOU with Government and NGOs to ensure proper handling of E-wastes			
13.	Any initiative to reduces E-Wastes in the campus been developed and action taken?			
14.	Projects and dissertation works, scholarly publication on E-Wastes management carried out by staff members and students			
15.	Whether E-Wastes managed by extended producer responsibility model being carried out?			

16.	Whether the generated E-Wastes are segregated onsite and method of segregation and record maintenance?			
17.	Whether the E-Wastes are transported to refurbrisher and Dismantler by authorised transporters?			
18.	Implementation of Government and Non-Governmental Organizations schemes to create awareness on E-Wastes			
19.	Whether E-Vehicles are used inside the campus to reduce the E-wastes pollution?			
20.	Whether E-Wastes are collected frequently and segregated and evidence on record entry?			
21.	E-Waste drives inside and outside the campus to educate people about the electronic waste disposal.			

II. Quantitative measurements

S.No	**Name of the Electrical items / Equipment / Instruments**	**E waste code by NSF**	**Quantity**
1.	Mainframe	ITEW	
2.	Internet connectivity Accessories	ITEW	
3.	Personal computer	ITEW	
4.	Laptop	ITEW	
5.	Dot matrix Printer	ITEW	
	Laser Printer	ITEW	
	Ink jet printer	ITEW	
6.	Cartridge	ITEW	
7.	Xerox machine	ITEW	
	Scanner	ITEW	
	Fax machine	ITEW	
8.	Telephones	ITEW	
9.	Cellar phones	ITEW	
10.	Television	CEEW	
11.	Solar panel	CEEW	
12.	Water heater	CEEW	
	Solar water heater	CEEW	
13.	Split AC	CEEW	
	Window AC	CEEW	
	Centralized AC	CEEW	
	Air Cooler	CEEW	
14.	Tube light	CEEW	
	Fluorescent lamps	CEEW	
	Halogen lamp	CEEW	
	Sodium Vapour lamp	CEEW	
	CFL	CEEW	
	LED tube lights	CEEW	
	LED Focusing lights	CEEW	
15.	Ceiling Fan	CEEW	
	Pedestal Fan	CEEW	

	Table Fan	CEEW	
	Portable Fan	CEEW	
16.	Lead acid batteries	CEHW	
17.	Lithium Ion Battery	CEHW	
18.	Cable and wires	CEEW	
19.	Inverter with UPS	CEEW	
20.	Switch board	CEEW	
21.	Solar panel	CEEW	
22.	LCD projector	CEEW	
23.	Refrigerator	CEEW	
24.	Water doctor	CEEW	
25.	RO water plant	CEEW	
26.	Generator	CEEW	
27.	Pump	CEEW	
28.	Motors	CEEW	
29.	Compressor	CEEW	
30.	Vacuum Cleaner	CEEW	
31.	Ventilator	CEEW	
32.	Insect trap	CEEW	
33.	Podium containing Mike, Speakers, Amplifiers, Radio, Camera, Sensors, etc.	CEEW	
34.	**Civil Engineering Equipment / Machines** Compressing testing machine, Universal testing machine, Total Station, Theodolites, Flexure testing machine, Torsion testing & Izod impact testing machines, Hardness testing machine, Beam deflection test apparatus, Centrifugal Pump, Gear Pump, Submersible pump, Reciprocating Pump, Pelton Wheel turbine, Francis turbines / Kaplon turbine, Turbidity meter, pH meter, Conductivity meter, Jar test apparatus, BOD incubator, COD digester, Direct shear apparatus, Triaxial shear apparatus,	LEEW	
35.	**Equipment, Instruments and Machineries related to Life Sciences and Biological Sciences including Biotechnology, Nanotechnology, Food Technology, etc.** Electronic Balances, pH Meter, Hot-air-Oven, Microwave Oven, Laminar Air Flow, Autoclave, Microscopes, , Rotatory Evaporators, Centrifuges, Electrophoretic apparatus, Chromatography devices, Grinders, Mixers, Deep Freezers, BOD Incubator, COD Digester, Extraction apparatus,	LEEW	

	Incubators, CO2 incubator, Heating Mantle, Vacuum pump, Vortex mixer, Magnetic stirrer**,** Gel rocker, Sonicator, Growth Chambers, Air curtains, Aerators, Spectrophotometers, Calorimeters, Turbidity meter, Colony Counter Water bath, Dry bath, Thermocycler, Gene gun, Gel Documentation System, Transilluminator, Ice maker, ELISA Reader & Washer, Aquarium, Zebrafish / animal house facility, Mechanical & Orbital Shakers, Cyclo mixer, Lyophilizer, Incinerators, Ammeter, Flame Photometer, Fluorimeter, Fermentors, Reactors, Particle size Analyzer, XRD, FTIR, Muffle Furnace		
36.	**Chemical Sciences and Engineering Equipment / Machines** Distillation Units, Packed bed distillation, Roll crusher, Jaw crusher, Sieve analysis machine, Shell and tube heat exchangers, Plate and frame filter press, Fume hood, Nephelometer, Membrane Filtration Apparatus, Jar test apparatus	LEEW	
37.	**Electrical, Electronics and Communication Engineering Equipment / Machines** DC Shut motor, DC Series motor, DC Compound motor, DC Shunt motor, DC Compound generator, DC series generator, Single phase & Three phase transformers, Single phase & Three phase auto transformers, Loading rheostat, single phase & Three phase, Inductive & Capacitive load, Power electronics trainer kits, Three phase squirrel cage induction motor, Single phase & Three phase induction motor, Three phase slip ring induction motor, AC generator, Stabilizers, Synchronizer, Half and Fully controlled converters, Buck, Boost and buck-boost converters, Single phase and Three phase inverters, Synchros, CRO, DSO, CRO, Microprocessor trainer kits, Microcontroller trainer kits, Arudino trainer kits, Digital electronics trainer kits, Flip-flops, Counters, Half adder, Full adder circuits,	LEEW	

38.	**Mechanical Engineering Equipment / Machines** Lathe machine, Milling machine, Drilling machine, Slotting machine, Shaping machine, Cylindrical, Grinding, Coordinate Measuring, Universal testing devices, Thermal Conductor, Air Compressor, Single Cylinder 4 Stroke Diesel Engine, CNC Turning Centre, Kaplan, turbine, Pelton wheel turbine, Francis turbine, Venturimeter, Orifice meter, Nephelometer, CAD & CAM machines, Tensile strength apparatus, Younggus modules apparatus, XRD machines,	LEEW	
39.	**Textile Technology Equipment / Machines** Ring spinning, Rotor spinning, Weaving machine, Ruti C loom, Circular Knitting machine, Curing chamber, Wash Fastness Tester, Streamer, Washing machine, Dryer,	LEEW	

***ITEW- Information technology E waste**
****CEEW- Consumer Electronic E waste**
*****CEHW- Consumer Electronic Hazardous waste**
*******LEEW- Laboratory Equipment E waste**

III. E-Wastes handling Data sheet

Description	Type of Waste	Number	Weight
E-Wastes generated	ITEW		
	CEEW		
	CEHW		
	LEEW		
E-Wastes stored	ITEW		
	CEEW		
	CEHW		
	LEEW		
E-Wastes Transported	ITEW		
	CEEW		
	CEHW		
	LEEW		
E-Wastes Sent to Refurbrisher	ITEW		
	CEEW		
	CEHW		
	LEEW		
E-Wastes Sent to Dismantler	ITEW		
	CEEW		
	CEHW		

	LEEW		
E-Wastes managed by Extended producer responsibility model	ITEW		
	CEEW		
	CEHW		
	LEEW		
E-Wastes Recycled and Transported back to Institution	ITEW		
	CEEW		
	CEHW		
	LEEW		

A minimum of 50% criteria should be attained

Note: *This Audit process and Certificates are valid for three years only from the date of Audit*

Signature of the Chairman **Signature of the Lead Auditor**

Signature of the EMS Auditor **Signature of the Auditor / Experts**
Environment Management System **Certified by NSF / IGBC / LEED**

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APPLICATION FOR PLASTIC WASTE MANAGEMENT AUDIT TO EDUCATIONAL INSTITUTIONS AND INDUSTRIAL SECTORS

Reference Number	NSF/PWMA 2022/Orgn.Name/ Dated:	
Name of the Organization & Address		
Date of Audit		
Name of the Lead and EMS Auditors		
Is it a new Audit (or) renewal process?	New audit (or) Renewal audit, tick (√) any one. If it is a Renewal audit, mention the date of last audit:	
Purpose	The initiative aims to establish environment-friendly plastic waste disposal solutions. In the process it seeks to ban the use of plastic bags and plastic products, and reduce plastic littering across the state	
PROCEDURE		
Procedure	**Description**	**Responsibility**
Annual plan	Each year a plan for the plastic waste management audit is prepared by Management and to ensure that the environmental management system and ecosystem service are implemented in the campus.	Management Representative
Walk-through Audit	Based on the checklists, the plastic waste management audit is carried out in the form of observations in the campus.	Audit team

Follow-up of action	Corrective action has to be undertaken and implemented within the prescribed duration.	Plastic waste management Coordinator
Reporting and Recommendations	Submission of corrective action in the form of report in association with Eco club / Student Chapters of the Institute.	Lead Auditor ISO 14001:2015 EMS Auditor

I. Qualitative Measurements

S.No.	Requirements and checklists of the audit	Conformity		
		Yes	No	NA
1.	Have internal plastic waste management audit a procedures been developed and implemented in the Organization?			
2.	Have programmes for the achievement of plastic free area objectives and targets been established and implemented as on today?			
3.	Whether plastic waste management audit is being carried out periodically?			
4.	Whether Swachh Bharat Mission as per the Ministry of Housing and Urban affairs, New Delhi concepts followed?			
5.	Have responsibilities been assigned for programmes at each appropriate function and level?			
6.	Are objectives and targets documented towards plastic waste management audit periodically and any Register is made?			
7.	Signing of MoU with Govt. and NGOs to disseminate Plastic free campus motto and pledge			
8.	Are information like name, registered number, and thickness of the carry bags are known?			
9.	Are plastic waste in mixed waste and residual waste streams are monitored?			
10.	Are recycling of plastic polymers promoted among the stakeholders in the campus?			
10.	Details for assessment of handling, storage, transportation and disposal methods			
11.	Do you sell recycled plastics in the campus as the consultancy services?			
12.	Percentage of Organization's budget for environment sustainability efforts			
13.	Sufficient number of dust bins kept separately for plastics, metals, paper, hazardous, biowastes, E-wastes biomedical wastes and construction wastes			
14.	Record Register for waste disposal and Puncture proof Containers for Sharps / Blue Bags are made available			
15.	Proof of Licensed Companies signed MoU with the Organization for wastes collection as per the Govt. regulation			
16.	Norms are being followed by the Organization as per the Central and State Government Pollution Control Board			

17.	Is the plastic waste segregated at the site of generation? If not, where are they segregated?			
18.	Has a Management Representative, Plastic Waste management Specialist, laboratory staff been assigned?			
19.	Whether E-Waste management practices included in the purchase policy of electronic items?			
20.	Whether the importance Plastic wastes and their implications on environmental and personal hygiene through awareness programmes are conducted for stakeholders?			
21.	Whether plastic wastes are burnt inside the campus? Any air pollution due to plastic materials burning takes place ?			
22.	Have programmes for the achievement of plastic free area objectives and targets been established and implemented as on today?, Any display board is made in the campus?			
23.	Avoidance of plastic bags, disposal cups, plates, stirrers, forks, spoons, candy sticks, wrapping films, PVC banners in the campus			

2. Quantitate Measurements

S.No	Details of Particulars	Remarks	Explanation
1.	Widespread separate collection of dry recyclable materials		
2.	Widespread separate collection of biowastes and plastic wastes		
3.	Landfills/incineration bans for some materials		
4.	Toward circular economy- A zero waste programme		
5.	How many times recycled plastic are used?		
6.	Transformation of plastic into energy fuels?		

Note: *This Audit process and Certificates are valid for three years only from the date of Audit.*

Signature of the Chairman **Signature of the Lead Auditor**

Signature of the EMS Auditor
Environment Management System

Signature of the Auditors / Experts
Certified by NSF / IGBC / LEED

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APPLICATION FOR SOIL AND WATER AUDIT TO EDUCATIONAL INSTITUTIONS AND INDUSTRIAL SECTORS

Reference Number	NSF/SWA 2022/Orgn.Name/ Dated:
Name of the organisations & Address	
Date of Audit	
Name of the Lead and EMS Auditors	
Is it a new Audit or renewal Purpose?	☐ New Audit ☐ Renewal Audit Last Audit Date: _ _/_ _/_ _ _ _
Purpose	To ensure the sustainable land and water use practices followed for the preservation soil fertility and water quality parameters to ensure the green cover area of an organization and to provide safe water to the stakeholders better human health. Ecofriendly youth leadership, green practices, social responsibility and institutional values towards the water and soil conservation are to comprehend the relationship with the ecosystem for sustainable environment.

PROCEDURE

Procedure	**Description**	**Responsibility**
Annual plan	Each year a plan for the soil and water audit is prepared by the Management and to ensure that the quality of soil and water is preserved by implementing sustainable practices.	Management Representative

Walk-through Audit	Based on the checklists, the soil and water audit is carried out in the form of observations in the campus	Audit team
Follow-up of action	Corrective action has to be undertaken and implemented within the prescribed duration	Environmental Coordinator
Reporting and Recommendations	Submission of corrective action in the form of report in association with Nature Club / Eco club / Student Chapters of the Institute	Lead Auditor ISO 14001:2015 EMS Auditor

I. Requirements of general features

1. Total Area_____, Building constructed area_____, Open area
2. Year of establishment:
3. Total Strength of Students:_____ (No. of Boys_____ and No. of Girls_____)
4. Total Strength of Hostellers: _____ (No. of Boys_____ and No. of Girls_____)
5. Total Strength of Teaching Staff: _____ (No. of Males____and No. of Females___)
6. Total Strength of Non-Teaching Staff:___(No. of Males___and No. of Females___)
7. Total Strength of Employees: ___(No. of Males___and No. of Females___)
8. The ratio of open space area to total area:
14. Total number of bore wells, open wells, water reservoirs, check dam and etc.
15. Total number of streams, spring and rain harvesting system in the campus
16. Report of Physico-chemical parameters of water quality
17. Report of Drinking / Potable water, RO water, Tap water, Corporation water
18. Total number of taps and faucets, toilets, showers, rest rooms, etc.
19. Total number of laboratory sinks, wash basins at canteens, hostels, kitchens
20. Leak detection, leak repairs, water pumping works towards water conservation
21. Sprinkler system if available for irrigation system for effective water management
22. Water contamination and related issues including water logging during heavy rains
23. Installation of water saving devices like automatic system, water meter, etc.
24. Sewage Treatment Plant availability and its uses including gardening and lawn care practices
25. Water wise landscaping, gardening, efficient irrigation and lawn care practices.
26. Detection of *Escherichia coli,* Coliform bacteria and Faecal Coliform bacteria in water
27. Report of soil profile and soil fertility analysis

I. Qualitative Measurements

S.No	Requirements and checklists of the audit	Conformity		
		Yes	No	NA
1.	Have an internal audit procedure for soil analysis been at implemented in the organisation			
2.	Whether soil profile analysis carried out in the campus?			
3.	Whether soil fertility analysis preferred in the campus?			

4.	Whether soil organic matter and above the ground biomass analysed?			
5.	Whether any streams /springs presence observed inside the campus			
6.	Does any decline in water quality and water quantity observed in recent times.			
7.	Whether any decrease in green cover observed in the campus?			
8.	Whether any key alteration in the soil species observed?			
9.	Whether any change in the water use /land used pattern followed in recent times?			
10.	Does soil erosion and associated issues observe inside the campus?			
11.	Does soil acidification and associated issues observe inside the campus?			
12.	Does soil contaminations and associated issues observe inside the campus?			
13.	Number of bore wells, open wells, water reservoirs, Water supply, check dam and etc. are sufficient in the campus			
14.	Whether any water logging problem arise inside the campus ?			
15.	Whether any loss of soil and water biodiversity observed inside in the campus			
16.	Whether any programmes launched recently on soil and water conservation?			
17.	Whether any sustainability goals formulated for sustainable land use & rain harvesting system in the campus?			
18.	Number of taps and faucets, toilets, showers, rest rooms, etc. in sufficient numbers in the campus coinciding with the human population			
19.	Efforts taken towards water leakage, leak detection & repairs, water pumping works towards water conservation			
20.	Sprinkler system if available for irrigation system for effective water management			
21.	Water contamination and related issues including water logging during heavy rains			
22.	Installation of water saving devices like automatic system, water meter, etc.**			
23.	Sewage treatment plant availability and its uses including gardening fir efficient irrigation and lawn care practices, water wise landscaping, etc.			
24.	Whether vermicomposting or any similar process carried out inside the campus for soil health preservation?			

25.	Does any programmes conducted to educate stakeholders the importance of sustainable land use?			
26.	Whether any investment carried out for sustainable land use and its conservation?			
27.	Whether any action plan devised to restore the degraded land?			
28.	Whether campus comes under seismic zone and protective zone under Govt. act? **			
29.	Whether vermicomposting or any similar process carried out inside the campus for soil health preservation?			
30.	Detection of *Escherichia coli*, Coliform bacteria and Faecal Coliform in water			

II. Qualitative measurements

Table 1. Soil Profile and Soil Edaphic parameters of **the Organization Campus.**

S.No	**Description**	**Results / Observations**
I. Physical parameters of soils		
1.	pH	
2.	Electrical Conductivity (µmhos/cm)	
3.	Water holding capacity (%)	
4.	Sand: Gravel: Clay Ratio	
5.	Moisture Content (%)	
6.	Dry matter Content (%)	
II. Macro Nutrients estimations in soils		
7.	Total Organic carbon (%)	
8.	Available Nitrogen (%)	
9.	Exchangeable Potassium (mg/kg)	
10.	Available Phosphorous (mg/kg)	
III. Micro Nutrients estimations in soils		
11.	Calcium (mg/kg)	
12.	Magnesium (mg/kg)	
13.	Sodium (mg/kg)	
14.	Manganese (mg/kg)	
15.	Zinc (mg/kg)	
16.	Ferric (mg/kg)	

Table 2. Physical and chemical parameters of water samples collected at different sources of the Organization Campus.

S.No.	***Parameters***	***Tap water***	***RO water***	***Recycled Wastewater***
1.	*pH*			
2.	*Conductivity (micromhos/cm)*			
3.	*Colour (Hazen unit)*			
4.	*Colour & Odour*			
5.	*Taste*			

6.	*Total dissolved Solids**			
7.	*Hardness**			
8.	*BOD**			
9.	*COD**			
10.	*Dissolved oxygen**			
11.	*Dissolved CO_2**			
12.	Turbidity (NTU)			
13.	Alkalinity*			
14.	*Salinity**			
15.	Acidity*			
16.	Nitrate*			
17.	Chloride*			
18.	Sulphate*			
19.	Fluoride*			
20.	*Iron**			

***** *mg/l*

Table 3. Number of Microbial colonies in Soil and Water samples at different locations of the Organization Campus.

S.No.	Name of the Place	Number of Microbial colonies (cfu) *			
		Bacterial colonies	**Fungal colonies**	**Actinomycete colonies**	**Total colonies / Average**
1.	Water Sample I				
2.	Water Sample II				
3.	Water Sample III				
4.	Soil Sample I				
5.	Soil Sample II				
6.	Soil Sample III				

* Applicable for Industrial sectors ** A minimum of 50% criteria should be attained

Note: *This Audit process and Certificates are valid for three years only from the date of Audit.*

Signature of the Auditing Chairman

Signature of the Lead Auditor

Signature of the EMS Auditor

Signature of the Soil / Water Auditor Environment Management System (NABL Accredited Lab Specialist)

11.CHECK LIST FOR AUDITS

NATURE SCIENCE FOUNDATION

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Waste Management Audit (To ensure at least 50% Achievements should be reached)

- Different coloured dustbin maintenance for the disposal of degradable and non-degradable wastes; respectively.
- Personal protected materials like gloves, caps, masks, aprons & gum boots etc. used are adequately made available as per the Guidelines in the campus for personal safety.
- Different forms, formats, annual report, etc. are available for waste collection and mode of transportation for disposal.
- Proper disposal of residual wastes inside the campus as per the records.
- Regular cleaning of the dustbins with soap and disinfectant for their reuse.
- Availability of a trained dedicated with skilled personals for waste management.
- Implementation of Government schemes (Swatch Bharath), if any.
- Signing of MoU with Govt. NGO's for waste collection towards disposal.
- Reuse of construction and wood wastes including any biowastes inside the campus.
- Awareness programmes conducted towards the 'Waste management activities' inside the campus to the stakeholders.
- Projects and dissertation works, scholarly publication on various wastes and their management carried out by staff members and students.
- Segregation and disposal of infectious and non-infectious wastes (biomedical wastes) at the source of generation.
- Segregation and disposal of e-wastes, plastic wastes, chemical wastes and hazardous wastes at the source of generation.
- Personal protective gears like mask and gloves used while collecting the wastes from the site of deposition.
- Any display boards, slogans and sign boards placed inside the campus to ensure waste management practices.
- Special initiatives taken to control the pollution, E- Waste, plastic waste, wood waste, construction waste, hazardous waste, biomedical waste and etc. inside the campus.
- Education, training, workshop, camp, etc., conducted for the waste management among the students and staff members.
- Supply bar-coded biodegradable bags to track the necessary information and keep it in records.

Biomedical Waste Management Audit (To ensure at least 50% Achievements should be reached)

- • BMW Licenses under Central and State Government Pollution Control Board norms Biomedical waste management
- Personal protected equipment's like gloves, caps, masks, aprons & gum boots etc. used adequately as per the BMW Guidelines.
- Adequate number of dust bins for biomedical wastes disposals as per the BMW guidelines.
- Adequate number of bags for biomedical wastes as per the Guidelines
- Availability trained and skilled BMW person for Collection & Transportation.
- Disposal of sharp infectious waste in white / blue puncture proof Containers at the source of generation
- Disposal of non – sharp infectious waste in red plastic bins/bags at the source of generation
- Disposal of anatomical waste in yellow plastic bins or bags at the source of generation
- Segregation of infectious and non – infectious waste at the source of generation
- Using of covered dustbins inside the campus.
- Regular cleaning of the dustbin with soap and disinfectant
- Storage of bio – medical waste should not exceed more than 48 $\pm$ hrs.
- Pre-defined route available for transportation of biomedical wastes within the health care facility
- Transportation of Biomedical waste in the closed container without causing any disease to the stakeholders
- Transportation facilities during the OPD time or any emergency situation
- Projects and dissertation works, scholarly publication on biomedical wastes and their management carried out by staff members and students
- Awareness programmes conducted towards the importance of biomedical wastes and their implications on environmental and personal hygiene for stakeholders
- Mercury spill management kit, Post exposure prophylaxis kit and blood spill management kit are made available in the campus as per the BMW guidelines
- Proper treatment and disposal of Biomedical waste.
- Measures undertaken for the management of different waste streams.
- Supply bar-coded biodegradable bags to track the necessary information and keep it in records.

E -Waste Management Audit (To ensure at least 50% Achievements should be reached)

- Total number of Information Technology E-Wastes need report
- Total number of Consumer Electronics E-Wastes need report
- Total number of Consumer Electronics hazardous wastes need report
- Total number of Laboratory Equipment E-Wastes need report
- Establishment of E-Wastes storage facility
- Preparing an internal E-Wastes audit procedure
- Designating a representative to monitor the E-Wastes generation
- Labeling and segregation of E-Wastes based on type and toxicity
- Frequency of E-Wastes collection Record maintenance
- Education, training, workshop, camp etc.. related to E-Wastes for stakeholders
- MoU with E-Wastes transporter, refurbrisher and dismantler
- Extended producer responsibility included in the purchase policy to handle E-Wastes
- Implications of utilizing refurbished E-Wastes in purchase policy
- E-Wastes handlers equipped with suitable safety gears
- Installation of exclusive E-Wastes bin to collect E-Wastes in campus from stakeholders
- Implementation of Government and Non-Governmental Organization schemes
- E-Waste types like computers, mobile phones, sensors, electrical and electronic items
- Fridges, freezers and other cooling equipment and telecommunications equipment
- Consumer electronic devices and solar panels, solar water heaters
- TVs, LCD projectors, monitors and screens, public addressing system
- Tube lights, Flourescent bulbs, LED, CFL bulbs, ultra-violet lights and etc.
- Vending machines, HVLS fans, exhaust fans, motors, electric wires, switches
- Power generators, uninterruptible power supply (UPS), AC machines, lifts, ventilators,
- Refrigerators, oven, microwave oven, water pumps, etc
- RO Plants, water doctors and distillation units, water pumps

Plastic Waste Management Audit (To ensure at least 50% Achievements should be reached)

- Signing of MoU with Govt. and NGO's to ensure plastic free campus maintenance
- Functioning of Eco club, Cell, Forum, Association, etc. for students to maintain plastic free Campus
- Implementation of Government schemes (Swatch Bharath), if any
- Hazardous material disposal facility
- Management Representative if any in the campus
- Mechanism of monitoring (plastic waste in mixed waste and residual waste)
- Projects and Dissertation works carried out by the staff and students
- Recycling of plastic polymers collected from the campus
- Education, training, workshop, camp, etc., conducted to maintain the plastic free campus
- Alternative sources used to control the use of the plastics inside the campus
- Record register for waste disposal and puncture proof containers for sharps / blue bags
- Awareness programmes conducted towards the avoidance of plastic usage
- Slogans and sign boards placed inside the campus ensuring not to use plastics
- Preventive measures taken for the avoidance of plastic bags, disposal cups, plates, stirrers, forks, spoons, candy sticks, wrapping films and PVC banners in the campus
- Blue colour dustbin maintenance in and around the campus for plastic waste disposal

CHECK LIST FOR SOIL AND WATER AUDIT
(Ensure that at least 50% of the Data should be attained)

* Total number of Plants, Animals, Birds in the campus
* Average number of bacteria, fungi and actinomycetes in soils
* Soil profile and soil fertility analysis report
* Soil erosions, soil acidification, contamination and related issues
* Detection of *Escherichia coli, Coliform bacteria* and *Faecal Coliform* in water
* Detection of *Salmonella, Shigella* and *Vibrio cholerae* in drinking water samples
* Total number of bore wells, open wells, water reservoirs, check dam and etc.
* Total number of streams, spring and rain harvesting system in the campus
* Physico-chemical parameters of water quality
* Report of drinking / potable water, RO water, tap water, corporation water
* Proper inland drainage provided for water logging problem
* Steps taken for water logging during heavy rains and natural disaster
* Afforestation practices followed in recent times
* Use of biofertilizer, organic manure and vermicompost in soil health maintenance
* Internal audit system and procedure for soil and water analysis
* Education and training programmes related to soil and water audit

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