

Topic

**Environmental audit and analysis
of an institutional campus.**

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Overview

“Environmental audit or Green Audit is a process of systematic identification, quantification, recording, reporting and analysis of components of environmental diversity of various establishments.”

- It aims to analyse environmental practices within and outside of the concerned sites, which will have an impact on the eco-friendly ambience.
- Green audit can be a useful tool for a college to determine how and where they are using the most energy or water or resources; the college can then consider how to implement changes and make savings.
- It can also be used to determine the type and volume of waste, which can be used for a recycling project or to improve waste minimization plan.
- It can create health consciousness and promote environmental awareness, values and ethics. It provides staff and students better understanding of Green impact on campus.

Need of environmental audit

On this background, it becomes imperative to adopt the system of the “Green Campus” for the Institutes which will lead to sustainable development and at the same time reduces a sizable amount of atmospheric carbon dioxide from the environment.

Scope of environmental audit

Green Audit is the most efficient and ecological way to manage environmental problems. It is a kind of professional care which is the responsibility of each individual who are the part of economical, financial, social, environmental factor.

Benefits of the Green Auditing

- More efficient resource management.
- To provide basis for improved sustainability.
- To create a green campus.
- To create plastic free campus and evolve health consciousness among the stakeholders.
- Point out the prevailing and forthcoming complications.
- Authenticate conformity with the implemented laws.
- Empower the organizations to frame a better environmental performance.
- Enhance the alertness for environmental guidelines and duties.
- Financial savings through a reduction in resource use
- Development of ownership, personal and social responsibility for the College and its environment
Enhancement of college profile
- Developing an environmental ethic and value systems in youngsters.
- Green auditing should become a valuable tool in the management and monitoring of environmental and sustainable development programs of the college.

synopsis

Aim-

To perform an environmental audit of educational campus.

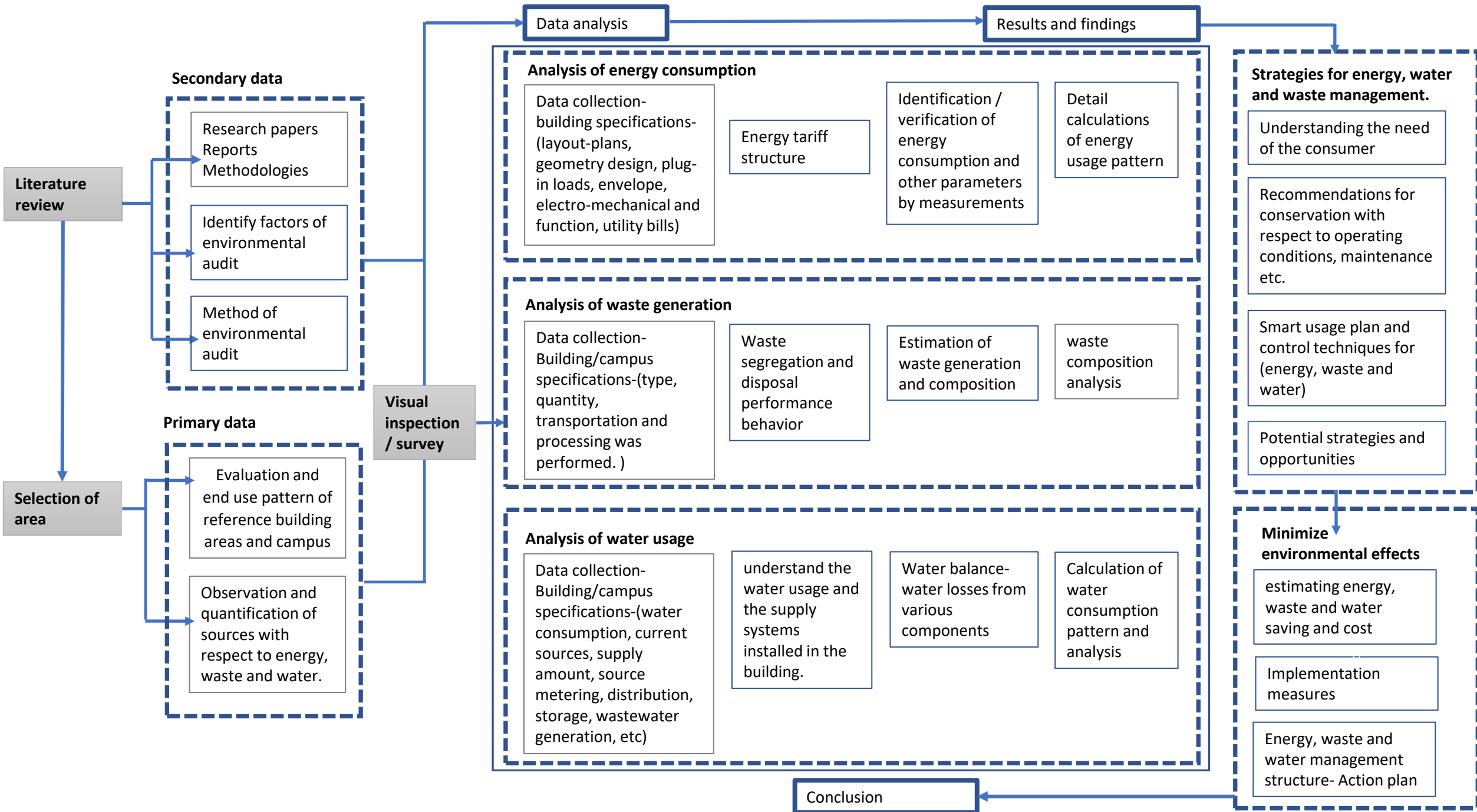
Objectives-

1. To identify sources of energy consumption, water usage and waste generation.
2. To analyze energy consumption, water usage and waste generation.
3. To suggest strategies for energy optimization, water and waste management and minimize environmental effects.

Scope-

Scope is to conduct an environmental audit with respect to energy, waste and water and does not considering other environmental parameters like biodiversity etc.

Methodology



Literature review:

Research parameters:

Environmental audit of an institutional campus

Performance behavior of environmental audit

Study layout of audit in terms of energy, water and waste.

Audit methods for institutional campus

Environmental audit analysis in terms of energy, waste and water.

Strategies for energy, water and waste management.

Research papers:

1. Environmental audit of Jesus and Mary College, Chanakyapuri.
2. Energy auditing in the college campus.
3. Implementation of a Methodology to Perform an Energy Audit with Academic Purpose.
4. Estimation of Energy Savings Potential in Higher Education Buildings Supported by Energy Performance Benchmarking: A Case Study
5. Environmental audit of Baba ghulam shah badshah university, Rajouri.
6. Greening of a campus through waste management initiatives Experience from a higher education institution in Thailand.
7. Green Auditing of Bharata Mata College, Thrikkakara.
8. Water Audit For Centre for Science and Environment.

Research papers:

1. Environmental audit of Jesus and Mary College, Chanakyapuri.

The study mainly focuses on the Green Campus, Waste Management, Water Management, Air Pollution, Energy Management & Carbon Footprint etc. being implemented by the College Management.

2. Energy auditing in the college campus.

The purpose of this study is to minimize energy costs / waste without affecting production & quality and to minimize environmental effects.

3. Implementation of a Methodology to Perform an Energy Audit with Academic Purpose.

The research sought to create a methodology to apply a standard energy audit for academic purposes to determine in a building sustainability standards.

4. Estimation of Energy Savings Potential in Higher Education Buildings Supported by Energy Performance Benchmarking: A Case Study

The objective of this paper is describe an approach for assessing the energy performance of a portfolio of buildings to provide building managers with a simplified tool for estimating an order of the magnitude of the potential energy savings.

5. Environmental audit of Baba ghulam shah badshah university, Rajouri.

To create a baseline data of good practices and provide strategies and action plans towards improving environmental quality of university for future purpose.

6. Greening of a campus through waste management initiatives Experience from a higher education institution in Thailand.

This paper is mainly focus on to describe the effects of 3R (reduce, reuse and recycle) waste management initiatives on a campus community and Practical implications for enhancing sustainable waste management are discussed in this paper.

7. Green Auditing of Bharata Mata College, Thrikkakara.

To prepare its students for fulfilling careers by enabling them to realize their full potential and by inculcating in them the spirit of intellectual enquiry, independent thinking, self- reliance, leadership, cooperation, expression of cultural talents and social service.

8. Water Audit For Centre for Science and Environment.

This paper provides convincing overview of the water use trends, effectiveness of conservation measures and potential cost and water savings.

Overall analysis-

All these papers majorly discuss on environmental audit for an institutional campus in terms of Waste Management, Water Management, Air Pollution, Energy Management & Carbon Footprint etc.

Some common objectives are:

1. Establishing a baseline of existing environmental conditions with focus on natural and physical environment.
2. Understanding the current practices of sustainability with regard to the use of water and energy, generation of wastes, purchase of goods, transportation, etc.
3. Awareness generation among students concerning real issues of environment and its sustainability.
4. Promotion of environmental awareness through participatory auditing process.
5. To provide strategies and action plans towards improving environmental quality for future.

Gap identification:

- There are no detail studies which majorly focusing on environmental audit of an equipment's which performed in building for an educational purposes.
- Need to analyze detail consumption layout and performance behavior pattern of an equipment's which are used in institutional campuses with respect to energy, waste and water management.

Environmental audit of an educational campus-

About campus:

Green audit is a potential tool which is used effectively by an educational institution for resource usage identification and optimization.

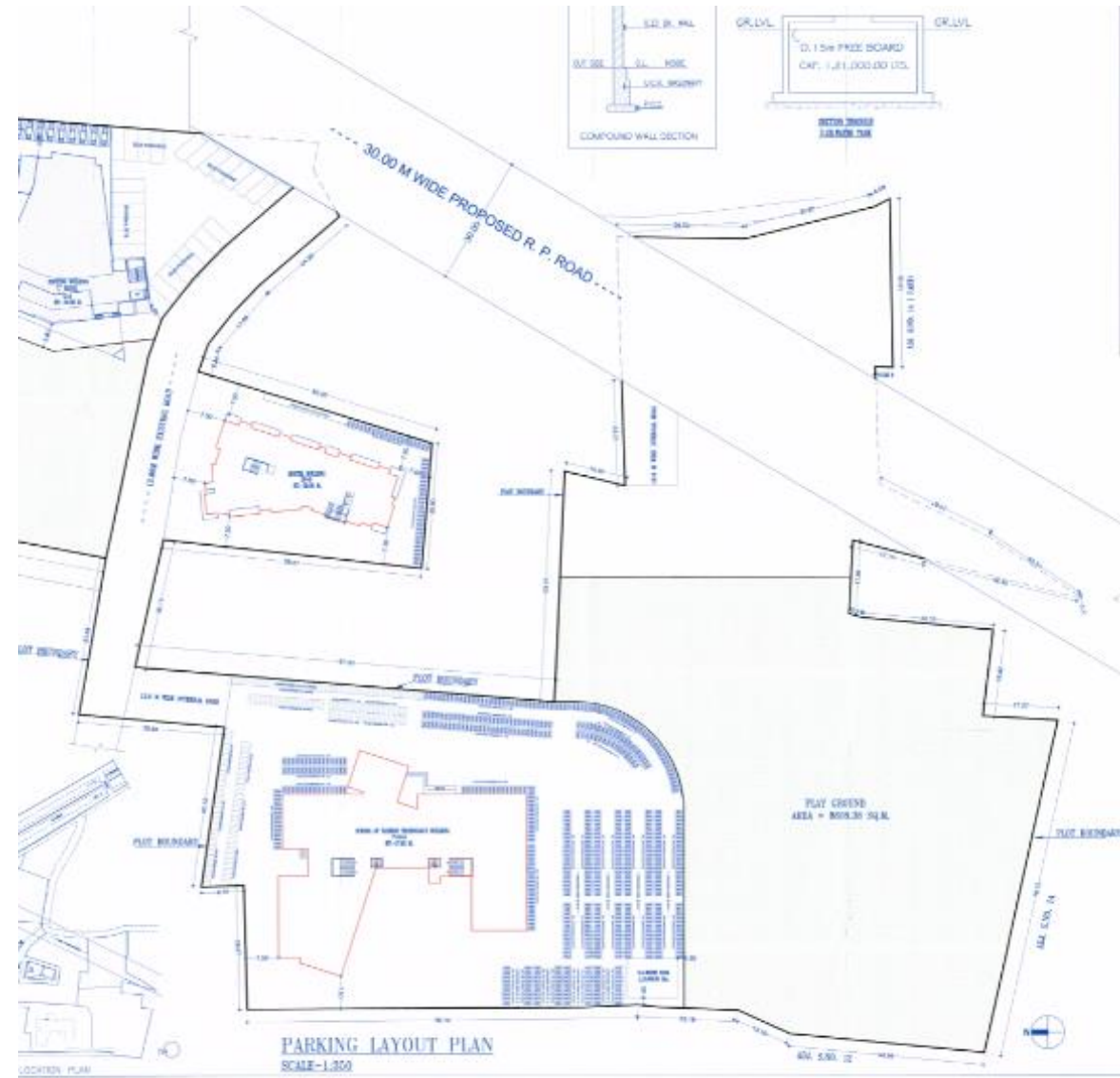
'Green auditing is the process of identifying and determining whether institutions practices are eco-friendly and sustainable'.

MKSSS's School Of Fashion Technology, Pune is a premier institute imparting Fashion education since 1998. School Of Fashion Technology has been working from past many years to impart quality education and career to its students in the areas of-

- Fashion Design Technology
- Production design
- Merchandising
- Communication
- Textile Design and Sustainable Fashion.



**Ground coverage of the building-
1634.72sq.m
Height of building-17.85m
Total built-up area- 6556.92sq.m**



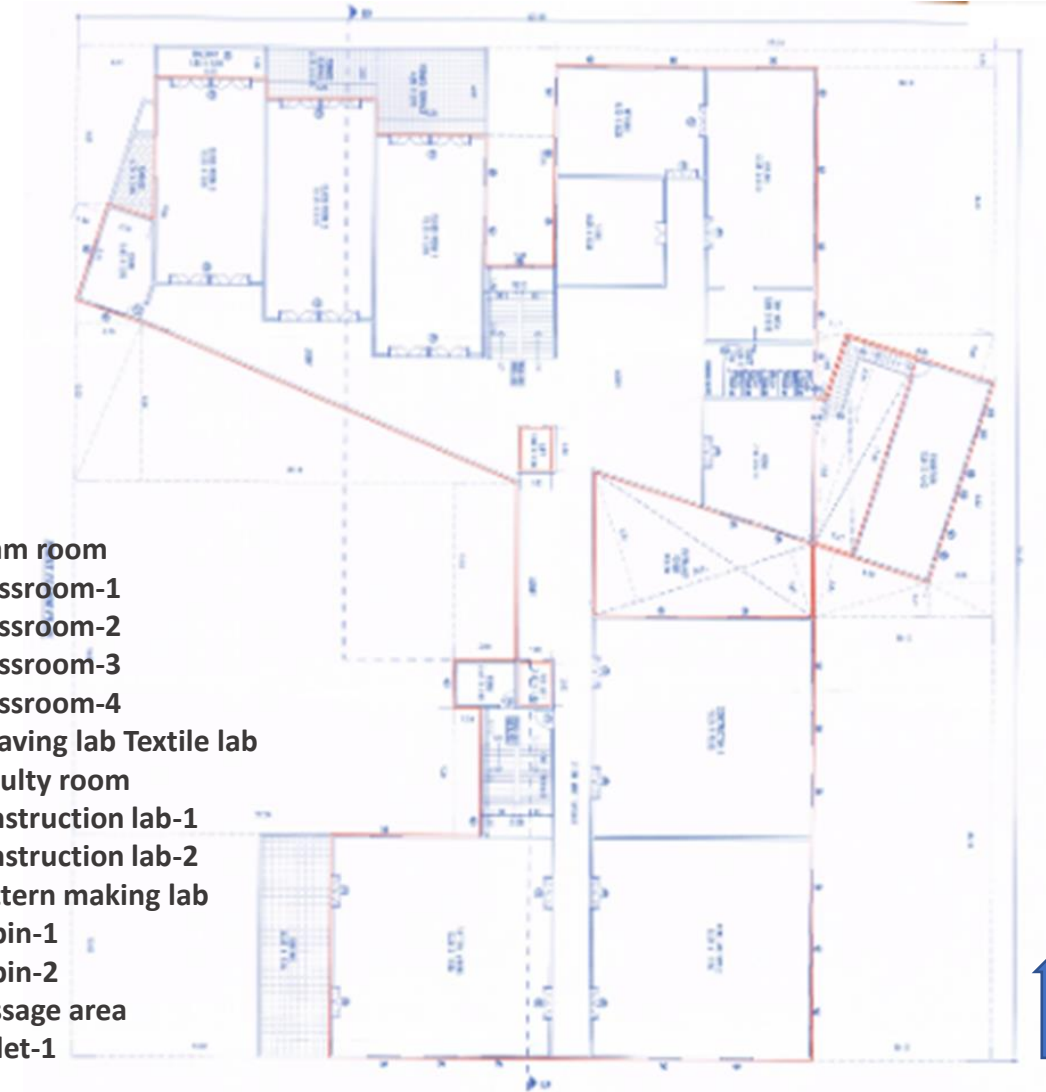
Site plan

Floor plans of an institute building-



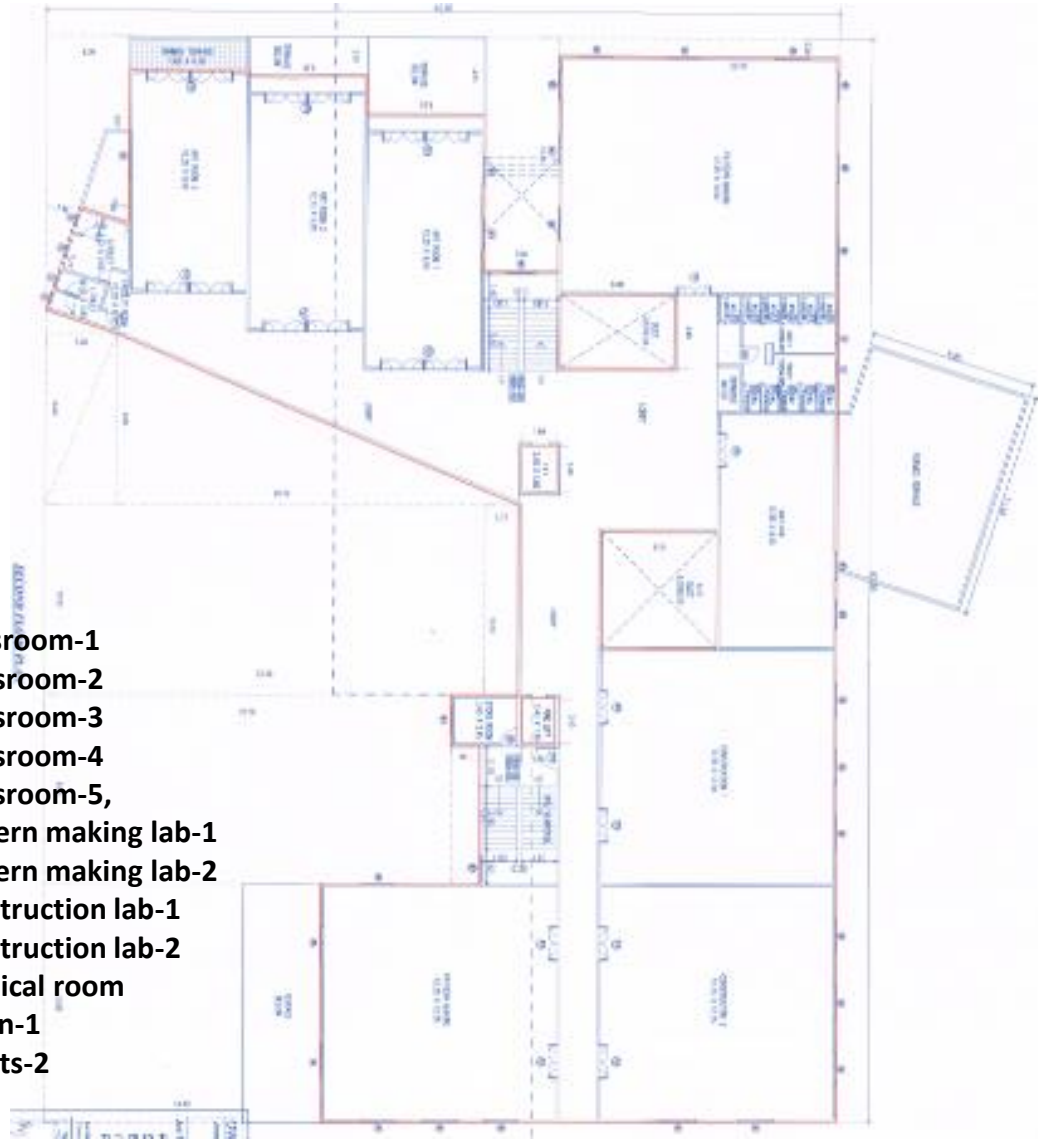
Ground floor plan

1. Admin area
2. Accounts section
3. Exam department
4. H.O.D cabin
5. Principal cabin
6. Staff cabin
7. Meeting room
8. Pantry,
9. Exhibition hall
10. Library area
11. Classroom-1
12. Classroom-2
13. Studio area
14. 6-toilets



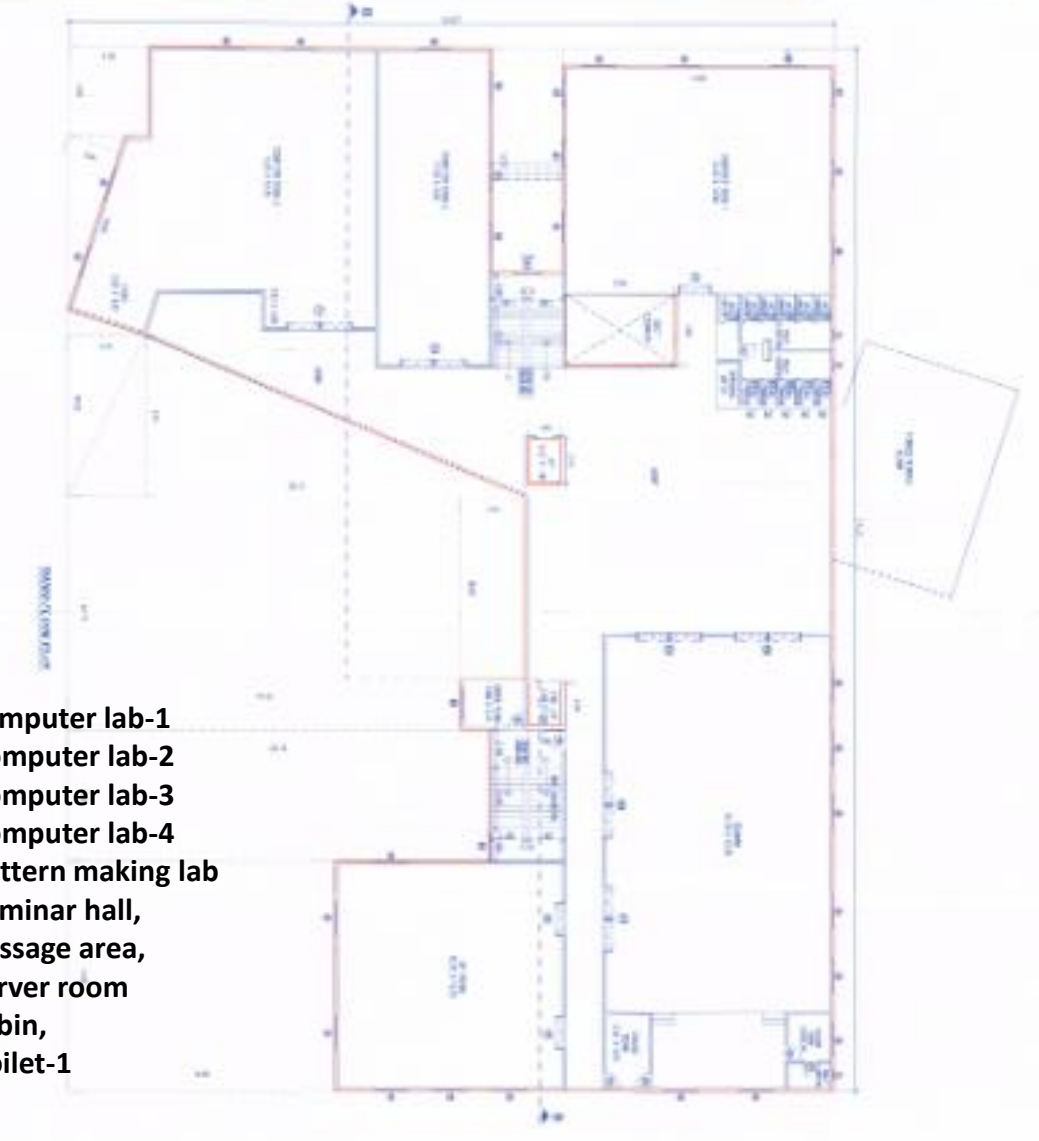
First floor plan

1. Exam room
2. Classroom-1
3. Classroom-2
4. Classroom-3
5. Classroom-4
6. weaving lab Textile lab
7. Faculty room
8. construction lab-1
9. construction lab-2
10. pattern making lab
11. Cabin-1
12. Cabin-2
13. Passage area
14. Toilet-1



Second floor plan

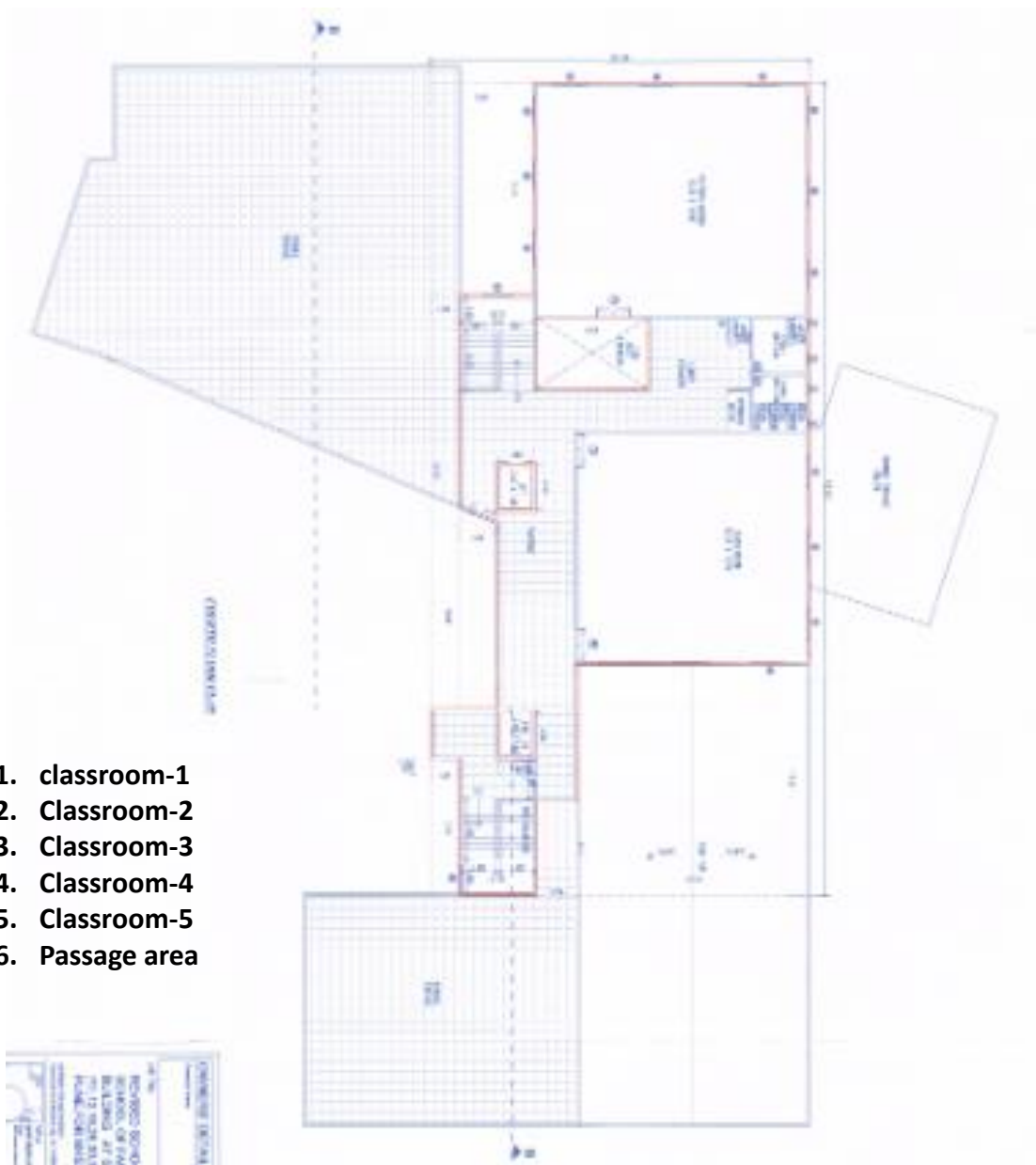
1. classroom-1
2. Classroom-2
3. Classroom-3
4. Classroom-4
5. Classroom-5,
6. pattern making lab-1
7. pattern making lab-2
8. construction lab-1
9. construction lab-2
10. Medical room
11. Cabin-1
12. toilets-2



Third floor plan

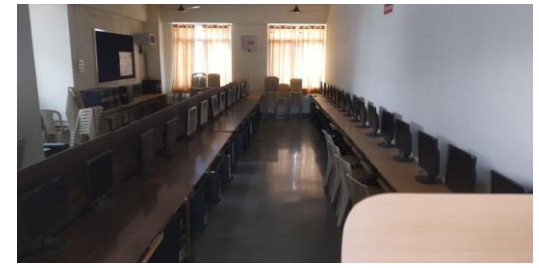
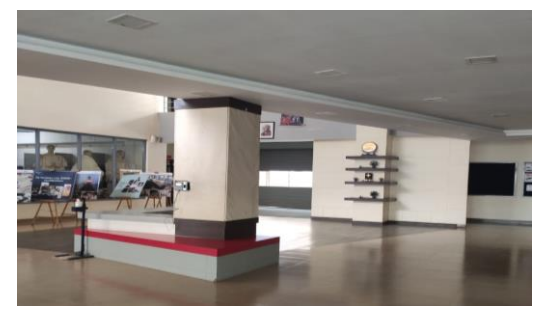
1. computer lab-1
2. Computer lab-2
3. Computer lab-3
4. Computer lab-4
5. pattern making lab
6. Seminar hall,
7. Passage area,
8. server room
9. cabin,
10. toilet-1





1. classroom-1
2. Classroom-2
3. Classroom-3
4. Classroom-4
5. Classroom-5
6. Passage area

Fourth floor plan



Environmental Audit of an institutional campus

Energy audit

Section-1	Section-2	Section-3	Section-4	Section-5
<p>Layout of institute building</p> <ul style="list-style-type: none"> • About institute- 1. No.of core branches 2. No. of students and faculty per branch 3. category of electrical load- layout in lighting, motor other equipment's like computers printers etc. 4. Total area covered by the all departments. 5. Building orientation with respect to surrounding. 	<p>Electrical distribution network system</p> <ul style="list-style-type: none"> • About institute- 1. Transformer range of institute. 2. Transformer system/distribution in campus 3. Control panel load. 4. DG set load. 5. voltage supplied to each department in college. 	<p>Energy audit methodology</p> <ul style="list-style-type: none"> • Data Collection- 1. Relevant data like electricity bills for the year 2018-20. 2. List of lighting load, fan, computer and air conditioner for each department. 3. Voltage, Current and Power are measured at each feeder. • Data Analysis- 1. The areas for implementation and energy conservation opportunities are identified. • Action Taken- 1. Identify different areas energy consumption. 2. Involved the implementation strategies based on measurement of actual energy consumption. 	<p>Survey of loads</p> <ul style="list-style-type: none"> • Number of quantity of connected load per area- 1. Lighting 2. Fan 3. AC 4. Computer etc. • Type of fixtures-e.g. fluorescent lights, LED etc. • KW rating of connected load • Total energy consumption usage. • To analyze Sunlight pattern during day time so continuous lighting is required or not during working hours. • Complete lighting load in terms of Kwh • Energy Consumption pattern of each equipment in kwh • Analysis of major role in consumption- 1. calculate the mitigation of major role of equipment load in order to reduce the wasteful energy consumption and reduce the electricity bills of college. 	<p>Energy saving technology e.g. for lighting pattern</p> <p>Energy saving technology for lightning load by wasteful energy consumption is happened.</p> <ul style="list-style-type: none"> • By identifying extra lights- • By considering standards: To calculate number of tube lights, by considering number of required lumens for given area. • By replacing of lightings- Replace existing lights by less wattage lights or by efficient lighting type. • Comparison of consumption pattern of electricity • Saving in energy bill • Implementation measures

Environmental Audit of an institutional campus

Waste audit

Section-1	Section-2	Section-3	Section-4	Section-5
<p>Waste segregation and disposal performance behavior-</p> <ul style="list-style-type: none"> • About campus- <ol style="list-style-type: none"> 1. No.of waste production activities. 2. Type of waste generation from different activities. 3. Amount of waste generation as per source area. 4. Bin location as per area. 5. Current waste segregation method/process 6. How frequently the waste is collected 	<p>Identified waste related issues-</p> <ul style="list-style-type: none"> • About campus- <ol style="list-style-type: none"> 1. Examine the perceptions, attitudes and beliefs of the campus staff and students towards the management of waste in campus area. 2. Identify maximum waste production activity 3. Problems created due to that waste. 4. How current waste problem is handling to overcome issues. 5. Identify most prominent area related with issue 6. Type of people facing this problem from campus 	<p>waste audit methodology- Understand how waste is managed at campus-</p> <ul style="list-style-type: none"> • Data collection- <ol style="list-style-type: none"> 1. Identification of waste generation sources. 2. Type and quantity of waste generation with respect to areas. 3. Understand waste composition and waste flow pattern. 4. Estimation of total waste generation. <ul style="list-style-type: none"> • Data analysis- <ol style="list-style-type: none"> 1. Analysis of waste composition. <ul style="list-style-type: none"> • Action taken- <ol style="list-style-type: none"> 1. Potential strategies for waste management 2. Implementation and awareness and monitoring of actions by action plan. 	<p>Waste composition analysis-</p> <ul style="list-style-type: none"> • Waste flow pattern and estimation <ol style="list-style-type: none"> 1. Composition of mix waste from institute areas- <ul style="list-style-type: none"> • By Hand sorting – Dry waste <input type="checkbox"/> Recyclable waste- e.g. Recyclable waste buyer <input type="checkbox"/> Non-recyclable waste 2. Composition of organic waste from cafeteria- <ul style="list-style-type: none"> • By proper segregation process • E.g. Used for animal feeding 3. Campus waste transfer station 4. Transport to final dump site by Municipality <ul style="list-style-type: none"> • Total Estimation of waste composition. 	<p>Potential strategies for waste management-</p> <ul style="list-style-type: none"> • Elements of swm- By proper waste handling, sorting, recycling, storage collection, processing, transformation disposal methods and by minimization of waste. • Understanding the differentiated composition of waste facilitates. • awareness and monitoring of actions by action plan. • Implementation measures

Environmental Audit of an institutional campus

Water audit

Section-1	Section-2	Section-3	Section-4	Section-5
<p>water usage and supply systems installed in campus-</p> <ul style="list-style-type: none"> • About campus- <ol style="list-style-type: none"> 1. various water uses during the day and the source of water. 2. water consumption per day 3. Supply amount of water per day 4. source metering 5. water distribution system 6. Specification of storage tanks. 7. Type of water fixtures 8. wastewater generation per day. 9. Identify the leakage and losses 	<p>Water supply system-</p> <ul style="list-style-type: none"> • Underground storage tank capacity in lit • No. of overhead tanks and capacity • Distribution of overhead tanks with areas • Water required for different activities - fire fighting, canteen, toilet areas, drinking water, gardening etc. • Water harvesting tank capacity. 	<p>water audit methodology-</p> <p>Understand water usage at campus-</p> <ol style="list-style-type: none"> 1. Identification of water sources. 2. Water supply requirement per day 3. Water consumption per day as per activities. 4. Water balance- real losses from sources. 5. Estimation of waste water. <ul style="list-style-type: none"> • Data analysis- <ol style="list-style-type: none"> 1. Analysis of water consumption. <ul style="list-style-type: none"> • Action taken- <ol style="list-style-type: none"> 1. Potential strategies for water management 2. Implementation and awareness and monitoring of actions by action plan. 	<p>Water consumption analysis-</p> <ul style="list-style-type: none"> • Water flow pattern and estimation <ol style="list-style-type: none"> 1. Consumption of water from building/campus area- for drinking, toilets usage, canteen etc. <ul style="list-style-type: none"> <input type="checkbox"/> Waste water treatment <input type="checkbox"/> Estimation of waste water and percentage of reuse water for specific activities. <ol style="list-style-type: none"> 2. Detail calculation of usage of rainwater Harvesting system. 2. Analysis of waster overall water distribution system. <ol style="list-style-type: none"> 4. Total Estimation of water consumption, water saving. 	<p>Potential strategies for water savings:</p> <p>By proper water handling- efficient fixtures, recycling and reuse of water, storage collection, methods to minimization of water usage.</p> <ul style="list-style-type: none"> • Saving in water consumption • awareness and monitoring of actions by action plan. • Implementation measures

Data Analysis

Energy Audit Analysis

1. Major use of the energy in building is at:

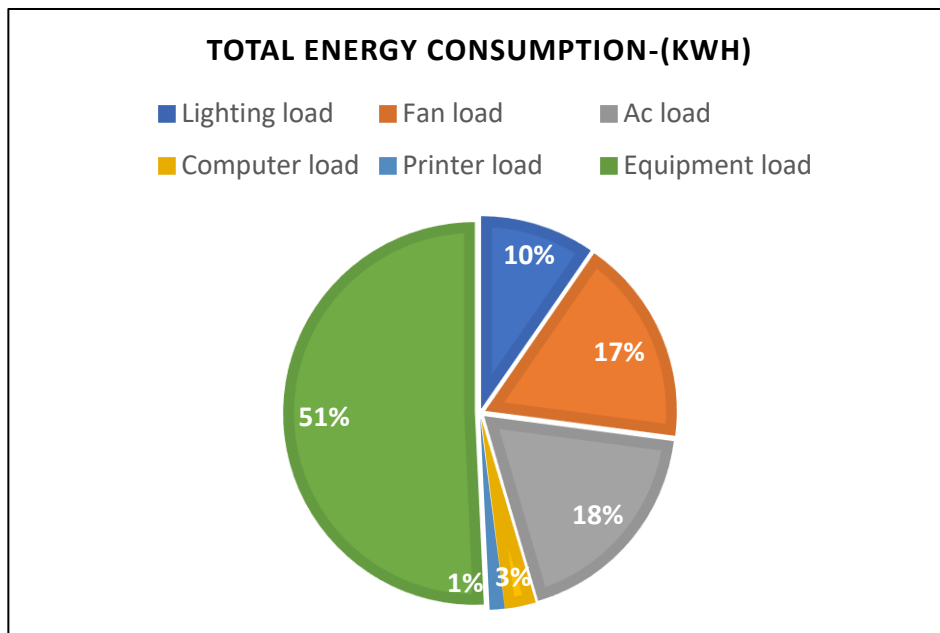
construction labs, computer labs, classrooms and admin area.

2. Electric appliances used in college are:

lighting elements, fans, ac's, computers and LCD projectors, shilai machines, iron machines, water coolers.

3. Major energy consumption by equipment's in building:

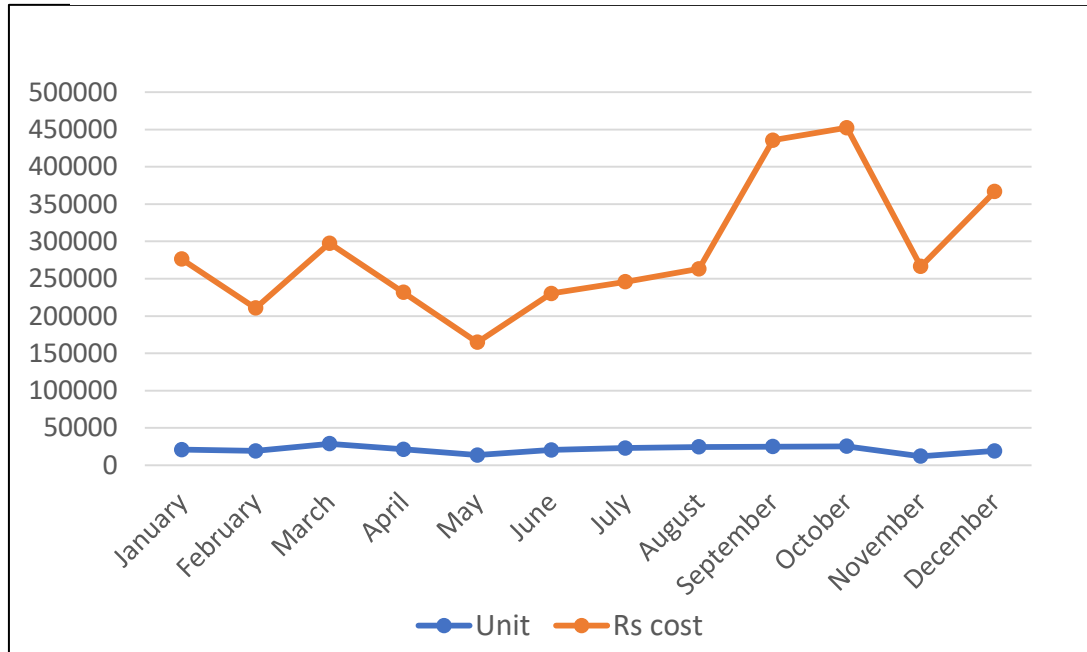
Air conditioners, water coolers, freezer, oven, projectors, shilai machines, iron machines and fusing machines, water motors.



Electrical appliances	Energy consumption in Kwh per day
Lighting load	68.64
Fan load	124.22
Ac load	145
Computer load	18.56
Printer load	8.5
Equipment load	425.53

Analysis of electricity bills (January 2018-December2018):

Electricity Consumption from January 2018- December 2018

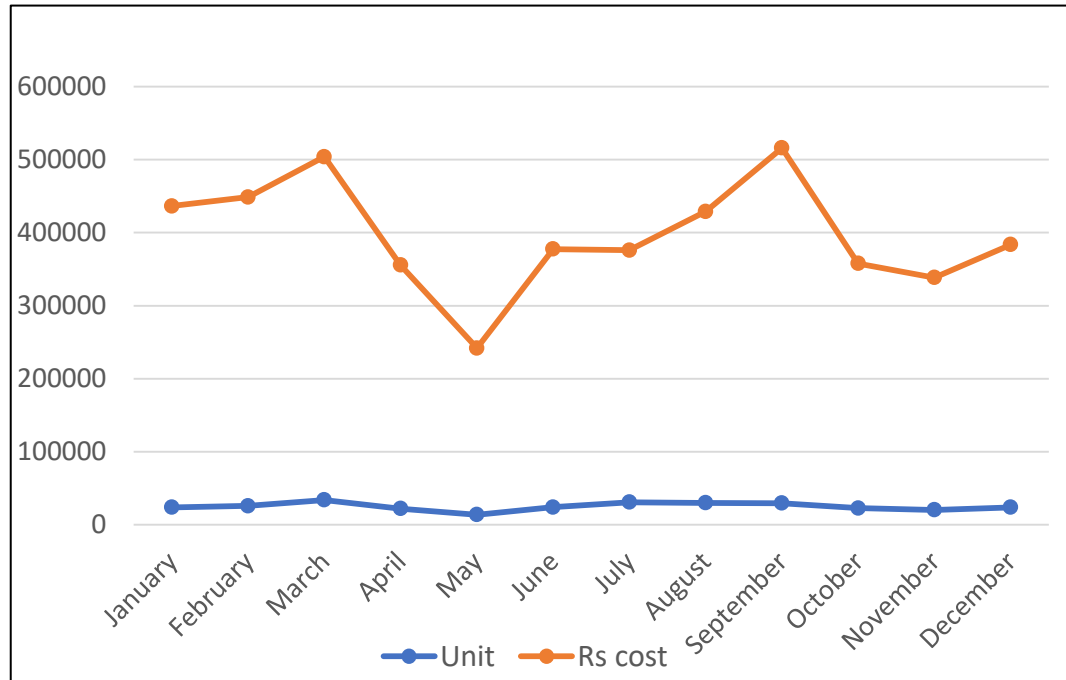


Sr.No	Bill Month	Units Rate	Units (Kwh/month)	Bill Amount (Rs.)	Bill Demand (KVA)
1	JAN 2018	9.10	20,795	2,76,384.17	127
2	FEB 2018	9.10	19,160	2,10,679.90	127
3	MAR 2018	9.10	28,740	2,97,422.16	127
4	APR 2018	9.07	21,305	2,31,612.91	127
5	MAY 2018	9.07	13,675	1,64,675.41	127
6	JUN 2018	9.07	20,545	2,30,175.48	127
7	JUL 2018	9.07	23,035	2,45,759.56	127
8	AUG 2018	9.07	24,585	2,63,136.26	127
9	SEP 2018	9.65	24,965	4,35,662.59	127
10	OCT 2018	9.65	25,285	4,52,275	127
11	NOV 2018	9.65	12,025	2,66,406.51	127
12	DEC 2018	9.65	19,160	3,66,792.01	127

The electricity consumption drops to minimal during vacation period that is in month of May and November i.e. 13,675 and 12,025 units (Kwh) and high in month of September i.e. 24,965 units (Kwh) because of more usage of equipment's.

Analysis of electricity bills (January 2019-December2019):

Electricity Consumption from January 2019- December 2019

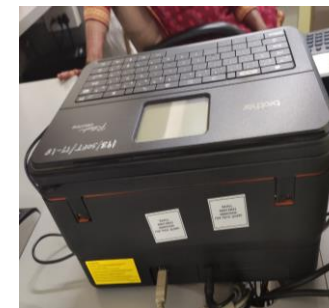


Sr.No	Bill Month	Units Rate	Units (Kwh/month)	Bill Amount (Rs.)	Bill Demand (KVA)
13	JAN 2019	9.65	23,805	4,36,458.82	127
14	FEB 2019	9.65	25,830	4,48,662.13	127
15	MAR 2019	9.65	34,020	5,03,974.53	127
16	APR 2019	9.7	22,185	3,55,595.76	127
17	MAY 2019	9.7	13,695	2,41,874.53	127
18	JUN 2019	9.7	24,025	3,77,610.30	127
19	JUL 2019	9.7	30,790	3,75,932.75	127
20	AUG 2019	9.7	30,095	4,28,977.92	127
21	SEP 2019	9.7	29,520	5,15,932.63	127
22	OCT 2019	9.70	22,825	3,57,755.2	127
23	NOV 2019	9.7	20,324	3,38,506.28	127
24	DEC 2019	09.70	23,743	3,83,732.47	127

The electricity consumption drops to minimal during vacation period that is in month of May and November i.e. 13,695 and 20,324 units (Kwh) and high in month of September i.e. 29,520 units (Kwh) because of more usage of equipment's.

Some good practices follows in terms of energy-

1. Use of star rating electric appliances i.e. refrigerator, water coolers, projectors, printers etc.
2. Maximum use of energy efficient lightings i.e. LED lights, energy efficient fans, minimum no. of CFL bulbs which are replacing with LED light.
3. Star rated shilai machines, relatively less energy consuming Juki machine for clothing lab.
4. The College building has two lifts, the front lift is operational for the entire day and the rear back lift is operational till 1.00 pm. (Lifts are used only for going up at maximum times.)
5. The management has sought star rated sewing machines as part of their commitment for energy saving practices.
6. Also, they are giving central control system for lights and fans as per phases at distribution panel boards of each floor.



Energy consumption of institute by manual method-

Calculations for energy performance index-

Energy consumption per day including all equipment's = 790.45 Kwh/day

Energy consumption per month including all equipment's i.e. (20 days from month)

= 790.45 X 20 = 15,809 Kwh/month.

Therefore, total energy consumption per year = 15,809 X 12 = 1,89,708 Kwh/year.

As per consumption, electricity bill by considering 9.07-unit rate

= 1,89,708 X 9.07 = 17,20,651.56 Rs/year.

Energy performance ratio (EPR) =

= Total energy consumption of building over a year/ Total built up area.

= 1,89,708/6556.92 = **28.93 Kwh/sq.m/year.**

EPI Ratio = EPI of proposed building/ EPI of standard building

= 28.93/150 = **0.192 Kwh/sq.m/year.**

(Maximum EPI ratio for an institutional building as per ECBC is 1)

As per ECBC, EPI for an institutional building for warm and humid climate is **150Kwh/sq.m/year.**

Energy performance index (EPI) of institute building is minimum as compare to benchmark.

Waste Audit Analysis

Dry waste-

1. Paper waste-

- Paperless work by maximum use of messages and mails for communication.
- Reuse paper by printing in both side and by using at the time of lunch.

2. Fabric waste-

- This waste is used for green fashion competitions or activities for fabric waste.
- Activities like making of quilling crafts, fabric bags, dairy covers, mask making etc.

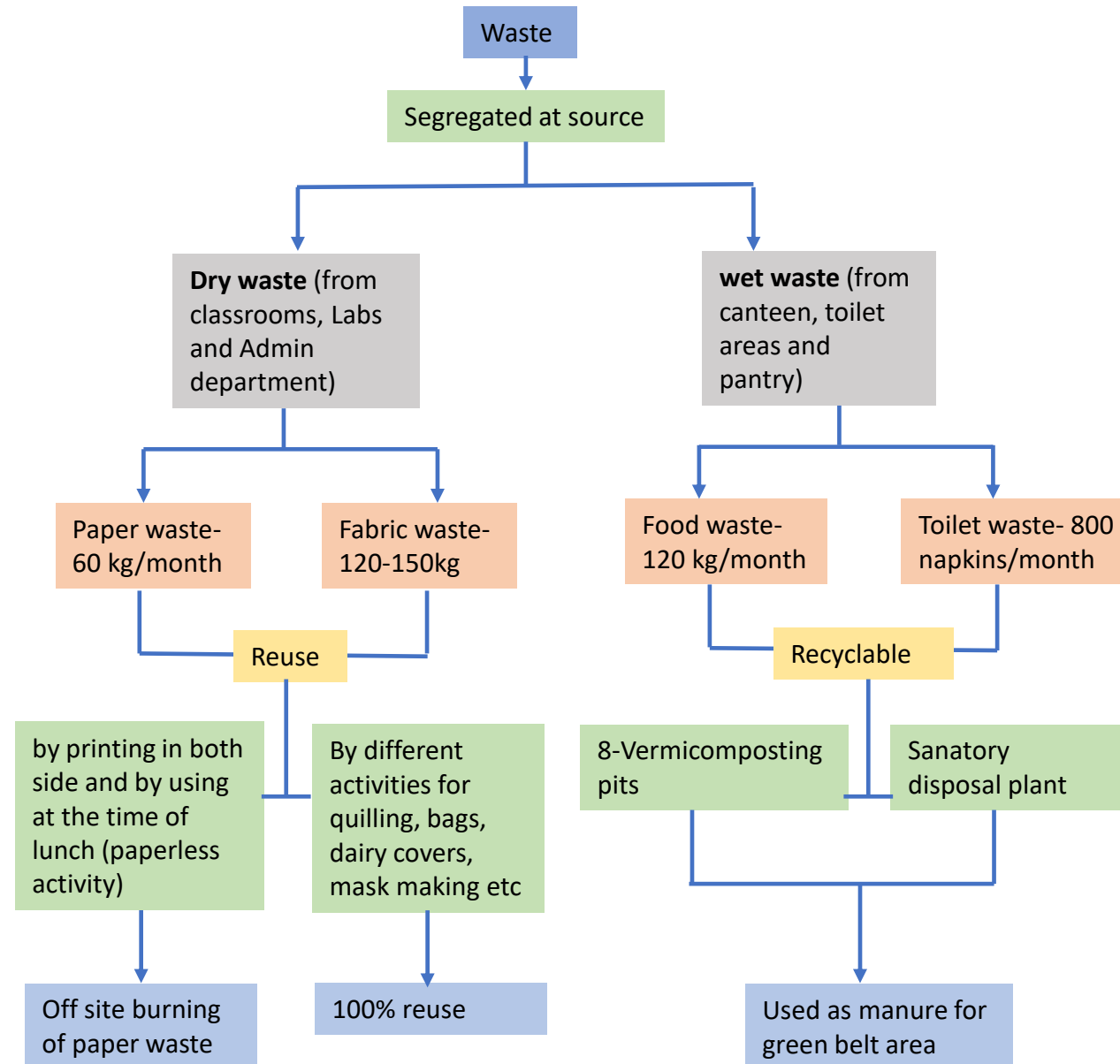
Wet waste-

1. Food waste-

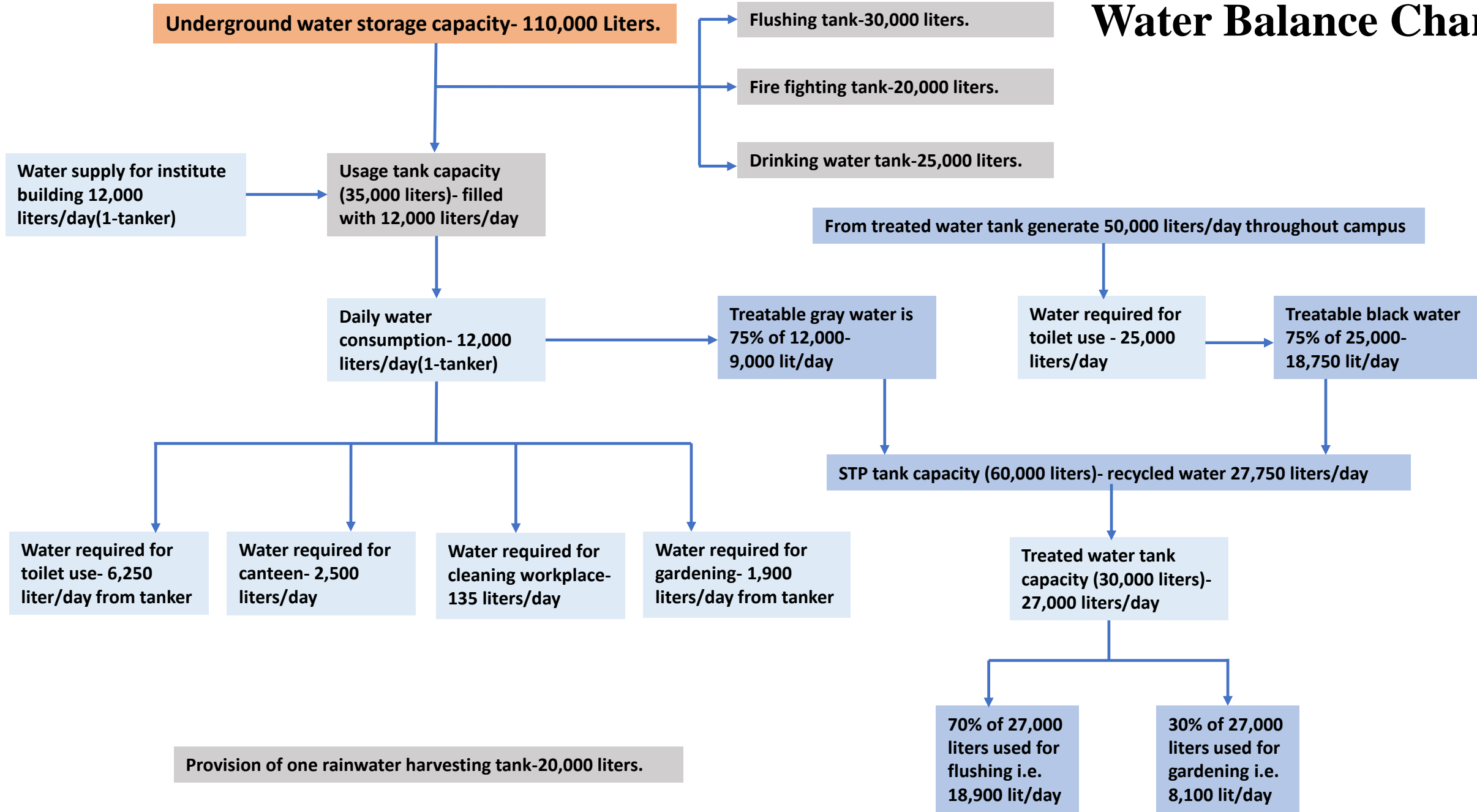
Decomposition of organic waste into fertilizer by vermicomposting pits used for gardening.

2. Toilet waste-

Recycling treatment by sanitary disposal plant to make fertilizer.



Water Balance Char



Rainwater harvesting by roof catchment-

Rainwater harvesting potential= Avg. annual rainfall x Area of catchment x Runoff coefficient.

$$= 0.741 \times 0.0929 \times 0.85 \text{ (1sq.ft- 0.0929 sq.m)}$$

$$= 0.048658 \text{ cu.m}$$

$$= \mathbf{48.658 \text{ Liters} = 48.7 \text{ Lit.}}$$

Run off volume of water (liter) for 1634.72 sq.m catchment area = 1634.72×48.658
= 79,610.86 liters **i.e. = 79,611 liters/year**

Provision of only one tank of 20,000 liter is available on site.

As per run off volume need to required more tanks for 60,000 liter water i.e. 3- tanks of 20,000 liters.

Water Audit Analysis

Total water specifications- in liters

- Building has 4-storage tanks with total storage capacity is 110,000 liters.
- Total portable water consumption is 3,500 liter/day.
- Total non-portable water consumption is 37,700 liter/day.
- Total water consumption by toilets is 25,000 liter/day.
- Total water supply to building is 4,51,000 liter/month.
- Total waste water generation is 27,750 liters/day

Water conservation practices

Water audit			
Water Conservation practices			
sr.no	Conservation practices	yes/no	Specifications
1	Rainwater harvesting system	yes	1- storage tank
	The year of commissioning	2018	-
	Estimated harvesting area	27cu.m	Harvesting area is 3MX3MX3M
	Capacity	20,000 liter	Rainwater harvesting tank capacity 20,000 liter
	Any potential improvement		only one rainwater harvesting tank is available throughout the campus so need to require more harvesting tanks
2	Waste water recycling system	yes	waste water recycling treatment available in campus- one STP plant
	Capacity of STP Plant	50,000 liters	1- STP plant is for whole campus
	Quantity of waste water generated		3,00,000 liters-(10,000 liter/day)- from institute building
	water is recycled per day		25000 liter/day- (for whole campus)
	recycled water usage pattern		recycled water is used for gardening, toilet flushing etc.