Environmental Analysis of Thapar Technological Campus and Environmental Management Plan Development

A Dissertation

submitted in partial fulfilment of the requirement

for the award of the degree of

Masters of Technology

in

Environmental Science and Technology

Submitted
By

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CERTIFICATE

This is to certify that thesis entitled, **"Environmental Analysis of Thapar Technological Campus and Environmental Management Plan Development"** submitted by **Ms. Khushboo** in partial fulfilment of the requirements for the award of degree of **Masters of Technology** in **Environmental Science & Technology** at **Thapar University, Patiala** is an authentic work carried out by her under my supervision and guidance.

To the best of my knowledge, the matter embodied in this thesis has not been submitted in part or full to any other university/ institute for award of any Degree.

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DECLARATION

I, the undersigned, hereby declare that the research work presented in this thesis entitled **"Environmental Analysis of Thapar Technological Campus and Environmental Management Plan Development "** submitted for the award of the degree of Masters in Technology has been carried out by me under the supervision and guidance of **Dr. A. S. Reddy, School of Energy and Environment, Thapar University, Patiala**.

Further, I declare that no part of this Dissertation has been submitted for a degree or any other qualification of any other university or examining body in India or abroad.

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ABSTRACT

Colleges and Universities can nowadays be regarded as small cities due to their large size, population and various complex activities taking place in University campuses, which directly or indirectly affect the environment. The environmental pollution and degradation caused by universities in form of energy and material consumption via activities and operations in teaching, research and in residential areas could be considerably reduced by an effective choice of an Environmental Management Plan. In the present study, Environmental Analysis of Thapar Technological Campus is done in which all the activities which are going on in the Campus were analysed and those activities having significant effect on the environment are identified. Present Management Practices of those activities in the campus were evaluated. Environmental Aspects related to each significant activity were identified and an Environmental Management Plan is developed for the Thapar Technological Campus. Environmental Analysis lists out the significant activities and the Environmental management Plan proposes the mitigation measures, organisational setup as well as the monitoring and measuring requirements. With the implementation of Environmental Management Plan, Thapar University comes in list of those Universities which steps forward towards sustainable development.

Keywords: Environmental Analysis, Environmental Management Plan, Sustainable Development, Thapar Technological Campus

Chapter 1
Introduction

1.1. Man and Environment:

The interaction between primitive humans and the environment in which they lived was one of fear and respect. As humans became more and more civilized, they created newer innovative technology, as a result of which the natural resources such as the soil, the forest, minerals, metals, the air, the water, plants and animals has been increasingly overexploited.
In nutshell, we can say that the relationship between human and the environment has changed specially since the beginning of industrial revolution. Rapid growth of industrialization has resulted in

- ✓ Depletion of natural resources
- ✓ Pollution of the environment.

The survival of humans is now threatened because of Environmental Degradation.

1.1.1. *Environment Degradation:*

Environmental degradation means depletion or destruction of potentially renewable resources such as soil, grassland, forest or wildlife at a faster rate than they are naturally replenished. This has resulted in overexploitation of natural resources. The results of such exploitation are soil erosion, loss of biodiversity and pollution of land, air and water bodies. The degradation of the environment from overexploitation has reached a level which is threatening for human well-being and survival. Thus our effort should be to use potentially renewable resources without reducing its availability throughout the world or in a particular area. Some of the anthropogenic activities that have led to environmental degradation are as follows:

- ✓ Forests have been cut down by humans for converting them into agricultural fields, for building houses and for taking away woods for making shelters, furniture and for use as fuel. Deforestation results in reduced rainfall and soil erosion.
- ✓ Non-renewable energy resources such as coal, natural gas and petroleum are being used up speedily, leading to their depletion. Excessive burning of coal, wood, kerosene, petrol etc. release toxic gases such as sulphur dioxide, nitrogen oxides, carbon monoxide and hydrocarbons in the air and pollute it which adversely affects human health.
- ✓ Acid water from mines, toxic waste of industries, chemical fertilizers and pesticides from agricultural fields has caused pollution in water bodies.

In a nutshell, Human survival itself is threatened due to the damage done to the environment by humans themselves.

1.2. Educational institutions and Environment:

India has a large number of Universities and Colleges and it is well known fact that educational institutions consume resources like water, electricity and generates wastes like many industries. Institutional campuses are mostly located on the outskirts of a city or township. Due to remoteness, the municipal services are generally not available to them and the Institutions are expected to develop and maintain their own essential services, such as water supply, sanitation, solid & liquid waste disposal, electric distribution, health services.

In absence of any norms, the individual institutions devise their own ways to provide the services, often in total disregard to the larger interests of the society and neighbourhood. Indiscriminate pumping of water, far in excess of its requirements leads to fast depletion of underground water table on one hand and generation of excessive liquid waste on the other hand. On the other hand, trash and garbage generated by the community, waste food from the hostels and cafeterias, sludge from the sewage treatment plants, discarded waste from the horticulture operations and hazardous waste from chemical laboratories as well as medical waste from the health centres are also the things to be looked upon.

Institutions end up playing havoc with the atmosphere within and outside the campus. Dumping of hazardous solid waste in the near proximity, without any treatment, leads to contamination of over and underground water bodies and pose a threat to the health of the people in the neighbourhood.

1.3. Environmental Analysis:

Environmental Analysis and environmental audits help the management of an organization to assess the status of its environmental performance and to identify areas for improvement as needed. Environmental Analysis is an ongoing process of collection and assessment of data and information to provide a current evaluation of performance as well as performance trends over time.

1.4. Environmental Impact Assessment:

Environmental impact assessment (EIA) is a procedure for assessing the environmental implication of a decision to enact legislation, to implement policies and plans, or to initiate development projects.

- ✓ An important management tool for ensuring optimal use of natural resources for sustainable development.
- ✓ A process of estimation and evaluation of significant and noteworthy short term and long term effects of a process or project on the quality of its location's environment.
- ✓ A formal process used to predict the environmental consequences whether positive or negative of a project prior to the decision to move forward with the proposed action.
- ✓ Identify ways to minimize, mitigate, or eliminate significant effects and counterbalance for their impact.

1.5. Environmental Impact Analysis of Educational Institutions:

Educational Institutions are somewhat similar to small towns or cities having a group of diverse operations and multiple activities within their campus borders which have various impacts on the environment. Various activities and operations include Research laboratories, Conference halls, Cafeterias, Academic Areas, Student Hostels, Faculty Residences, Power plants or Substations, Drinking Water Supply, Sports Facilities, Wastewater Treatment Plants, Construction and Demolition, Grounds Maintenance, Agricultural or Horticultural Research. Environmental Analysis of an Educational Institute helps us in identifying its environmental aspect and determining which aspects it will treat as significant

1.6. Environmental Aspects and Environmental Management:

Environmental aspect – It is an element of an organisation's activities, products or services that can interact with the environment. E.g. Consumption of paper

Environment Management - A Site or Project specific plan developed to ensure that appropriate management practices are followed during the construction or operation of the project. An Environmental Management Plan is the key to ensure that the environmental quality of the area does not deteriorate due to the operation of the plant under study.

An Environmental Management Plan should include:

- ✓ Summary of environmental impacts identified in the Environmental Analysis report
- ✓ Identification of significant impacts that must be mitigated
- ✓ Description of mitigation measures
- ✓ Description of monitoring and reporting arrangements
- ✓ Description of assignment of responsibilities and schedules

1.7. Environmental Management of Educational Institutions:

Environmental Management Plan is adopted by Educational Institutions with the aim to reduce their environmental impact after realization of significant impacts in terms of environmental pollution and degradation.

The residents as well as the visitors in the institutional campus exert considerable pressure on the campus and pose a challenge to the administrators to protect and preserve the environment against degradation. The administrators of the educational institutions and the Universities across the country did not understand the challenge and as a result, campuses are degrading. The consequences of neglect are before everyone. The environment of an average Indian University is no different than a typical Indian city.

1.7.1. *Waste Management within an Educational Institute:*

A huge dump of garbage, piled all over the campus, is a common site in a typical educational institution in India. An academic institution also generates a lot of waste paper in the form of answer sheets, records and stationery. By using various management practices, we can reduce the volume of waste and also generate biogas and manure as a considerable component of the waste generated is biodegradable. Recycling units can be established for the waste which can be recycled.

1.7.2. *Water Management within an Educational Institute:*

Unchecked withdrawal of underground water leads to generation of high volume of liquid waste. It develops huge pressure on the sewage system that is not designed to carry such a large volume as well as depleting the precious underground water table at an alarming rate. Whereas a large segment of our population does not even getting potable drinking water, the community of a residential campus indulges in excessive consumption, in the absence of a national policy. We have to make plans so as to preserve this scarce natural resource.

1.7.3. *Energy Management within the Educational* Institute**:**

People within the educational institution consume large quantity of electrical energy, essentially due to easy access to reliable supply. Substantial energy is consumed in illuminating public places, such as streets, open spaces surrounding the establishments, building corridors etc. Pumping of water from the deep tube wells also consumes considerable electricity. Measures should be adopted to slash the power bills and save precious energy for the nation. In fact it is quite possible to save the energy cost to the Institution year after year.

1.8. Work Objectives:

1. Environmental Analysis of the Thapar University
2. Preparation of Environmental Management Plan based on the environmental analysis.

1.9. Contents of the report:

1. *Chapter 1- Introduction* – It provides brief information about Environmental impact assessment and Environmental Management in Educational Institutions, states objectives of the study and brings the importance of the work.
2. *Chapter 2- Literature Review* – This chapter provides the meaning of sustainable development, review of Environmental Impact Assessment and Environmental Management Plan in Educational Institutions.
3. *Chapter 3- Overview of Thapar Technological Campus* – This chapter provides the overview of Thapar Technological Campus. It includes brief description of areas, departments and facilities in the campus.
4. *Chapter 4- Methodology* – This chapter identifies the work elements of the study and brings out the approach followed for carrying out the work on identified work elements.
5. *Chapter 5- Environmental Analysis of Thapar Technological Campus* – This chapter includes the comprehensive analysis of the activities going on in the campus.
6. *Chapter 6- Environmental Management Plan* – This chapter provides the Environmental Management Plan developed for the campus based on the Environmental Analysis.
7. *Chapter 7- Conclusion* **–** This chapter includes summary and outcomes of the work, include limitations and short comings of the work and talks about usefulness of the work.

Chapter 2
Literature Review

Universities can be regarded as 'small cities' due to their large size, population, and the various complex activities taking place in campuses, which have some serious direct and indirect impacts on the environment. The environmental pollution and degradation caused by universities in form of energy and material consumption via activities and operations in teaching and research and in residential areas could be considerably reduced by an effective choice of organizational and technical measures. Although many environmental protection measures can be seen at some universities, but a more systematic and sustainable approach to reducing the negative impacts of those activities and making the campuses more sustainable, is generally lacking. (Alshuwaikhat et al., 2008)

2.1. Sustainable Development:

Sustainable development emphasizes that rate of consumption must balance the use of natural resources. Economic and industrial development must go on in such a way that they do not have any harmful damage to the environment. The World Commission on Environment and development defined sustainable development as "Development that meets the needs of the present generation without compromising the ability of the future generations to meet their own needs."

Environmental problems must be approached at three levels:

- ✓ Immediate local problems like water pollution and waste management can be taken up at community level.
- ✓ Regional problems like acid rain, floods, air pollution and deforestation can be dealt with at national or regional level.
- ✓ Global issues like climate change, depletion of ozone layer and the associated problems should involve world bodies for the participating of the nation around the world.

Any environmental problem either local or regional can become a global issue if not addressed in time. If communities address their local issues then bigger problems get solved.

2.2. Environment Impact Assessment:

Environmental Impact Assessment has a crucial role to play in addressing environmental

issues surrounding project development and especially power projects. The integration of environment into development planning is the most important tool in achieving sustainable development. Environmental protection and economic development must thus be dealt with in an integrated manner. EIA process is necessary to prevent an anticipatory and preventive mechanism for environmental management and protection in any development. Several developing countries are still at the initial stage of EIA processes. The need for capacity building for quality EIA is also eminent in these countries. Despite these small setbacks, environmental impact assessment has become an integral part of project planning.

Environment Impact Assessment is a systematic process in which the environmental effects of the actions and the proposed projects are identified, predicted and evaluated. This process is applied before making major decisions. (Fitzpatrick et al., 2003).

If development has to be sustainable, the burden of environmental impacts has to be necessarily reduced. Therefore, Environment Impact Assessment has become an important tool for decision making while pursuing the development (UNU EIA Module 2006).

Environmental impact assessment concerns the assessment and mitigation of the environmental effects of projects. The EIA process involves the screening of projects for possible impacts, the scoping of significant impacts and their detailed analysis, and the analysis of mitigation. Decision makers and planners for the project implementation are guided by the final EIA report. EIA involves important ethical questions about future ethics, and the consideration of nonhumans. In practice, EIA tends toward project development rather than project rejection. (Sadler et al., 2005).

In Bangladesh, a general discussion about the status of the environmental impact assessment system provide an overall understanding and explanations of why some aspects of institutional arrangements are weak, when the quality of environmental impact statements is poor, and why mitigation measures are inadequately implemented. A framework for effective EIA system that may be applicable to developing countries has been proposed. (Momtaz et al., 2013)

Environmental impact assessment has been used in Kenya to ensure that environmental management is integrated into project planning and decision-making with a view of achieving ecologically sustainable development. Due to community participation, Environment Impact Assessment identifies environmental risks, lessens resource use

conflicts, minimizes adverse environmental effects, informs decision-makers, and helps lay the base for environmentally sound projects. In the integration of an EIA, due considerations are made in all stages of a project, from exploration and planning through construction, operations, decommissioning, and beyond site closure. (Biamah et al., 2013)

While investigating the adequacy of institutional arrangements for the environmental impact assessment system, the legal and administrative framework of the Environmental Impact assessment system and the key stages of the EIA process were found out. (Kabir et al., 2014)

2.3. Environmental Management:

A more suitable approach should be used to achieve campus sustainability that could cure the limitations of the current environmental management practices in universities and ensures more sustainability through the integration of three strategies which are university Environmental Management System (EMS), public participation and social responsibility and promoting sustainability in teaching and research. (Alshuwaikhat et al., 2008)

In large university campuses, electricity and water uses are similar to those of medium-sized cities. The diversity of activities and energy end-uses can be considered as significant as in a city where residential, commercial and industrial uses are present. Electricity and water uses on the campus of University of Bordeaux were studied, with support of both the French Electricity Utility and the Regional Water Utility Commission. The method shows the relative share of major uses and allows estimating water conservation potential at the campus scale. For both electricity and water, a special attention was paid to R&D uses, as that sector was the most significant in terms of consumption and annual growth. (Bonnet et al, 2002)

A university campus has the potential to accomplish much more than simply providing the infrastructure in which students and staff carry out the business of education and research. The campus itself can be considered a classroom where the lessons of responsible citizenship and environmental stewardship are modelled on a daily basis through corporate behaviour, campus design, and community engagement. A university can educate its community about climate change and a range of interrelated environmental issues. (Rooney et al., 2010)

Leading institutions of higher education are increasingly utilizing the campus as a laboratory not only for implementing green projects but also for developing the skill set of students to lead the deep organizational change necessary for sustainability. This skill building has been

assessed through surveys, participant observation, semi-structured interviews, and focus groups. While student learning and project success are not directly correlated, students gain a deep understanding of management. While student labour is not “free” in terms of time and energy, there is no substitute for the enthusiasm, creativity, and perspective that students bring to campus sustainability projects when coupled with the appropriate scope, expectations, and communication. Using systems thinking for organizational change as the linking concept between class sessions and group projects provides intellectual continuity and an opportunity for expansive thinking about leadership and change management. (Shriberg et al., 2012)

The conceptual basis for environmental management deserves careful consideration. Without first developing a common conceptual basis, the professional area of environmental management appears to be on unstable and less a science than an art. Issues such as the appropriate landscape classification, the typology to be used, the appropriate scale of mapping, and the identification of the mechanisms driving landscape evolution, leads to apparent or clear differences as perceived by outsiders, unless they are clarified. (Dorney, 1989)

Application of environmental management system (EMS) in urban environment provides a city with orderliness, regularity, quietness and freshness environment. If the whole urban districts design and establish an environmental management system ISO 14001, the development will be faster and more sustainable. As a result of human undergoing development activities, the process of urbanization during many years has caused various environmental impacts. Thus, decision makers and managers considered urban sustainable development as a main strategy. Required steps should be taken in providing sustainable development, safety and health of the organization and citizens in the related district. Dominant environmental aspects, impacts and legal requirements of the related activities and services were identified. Besides, training, internal and external communication, operational control, emergency preparedness and responsibility, obligations to follow environmental rules and achieving certification of ISO 14001; 1996 standard are the most important things while doing urban sustainable development. (Nauri et al., 1996)

Environmental Infrastructure Management presents an integrative methodological framework for sustainable environmental planning and management. This framework seeks to delineate and synthesize essential ecological information utilizing an integrative resource survey

method. This method generates classifications of environmental significance and constraint. Areas of environmental significance and constraint are then linked to appropriate and acceptable resource management actions, implementation tools and institutional and organizational arrangements. Effective integration and implementation of environmental policies is directly related to the effectiveness of environmental management. Developing more effective environmental policy and programs requires coordinating the many factors related to environmental quality. (Boland et al., 1997)

2.3.1. *Waste management:*

Wastes are materials which are discarded after use at the end of their life-span. Waste management is a collective activity involving segregation, collection, transportation, re-processing, recycling and disposal of various types of wastes. Waste management differs for different types of wastes and for different geographical locations such as urban, rural and hilly areas. It is the joint responsibility of the citizens and the local government to manage the non-hazardous domestic waste and the management of commercial, industrial and hazardous waste is the responsibility of the waste generators like commercial establishments, healthcare establishments, industries and the pollution control boards.

In 2008 it was estimated that in India we need to manage 0.573 MMT/d of municipal solid waste of which about 60% is organic waste amounting to 0.292 MMT/d. There are only 110 facilities in the country for treating hardly 50% of the organic waste generated. If segregated and stored separately dry waste and other recyclables can itself lead to 20% of resource recovery from MSW. In the present practice of mixed collection and transportation throughout the country, collection efficiency is only around 60% and the rest 40% lies uncollected and scattered polluting the surrounding land and water resources. About 24 landfill facilities, having the joint capacity of holding 0.06 MMT/d have been constructed in the country for land filling against a total requirement for land filling of about 0.183 MMT/d of inert wastes.The average collection efficiency of municipal solid waste ranges from 22% to 60%. The waste characterization showed that municipal solid wastes typically contain 51 % of organic waste, 17% recyclables, 11% hazardous and 21% inert. There are 86 mechanized compost plants, 20 Vermi-compost plants, 2 refuse Derived Fuel (RDF) plants, and two with energy recovery system established so far in India. Sanitary Landfill Facilities have also been constructed in the country for scientific disposal of MSW, many of which are in operation.

Construction and Demolition Waste comprises of concrete, plaster, bricks, metal, wood, plastics etc. It is estimated that about 10-12 million tons of construction waste is annually generated in India and about 50% of the C&D waste is not currently recycled in India.

There are 602 Bio-medical Waste Incinerators, 2218 autoclaves, 192 microwaves, 151 hydroclaves and 8,038 shredders in the country. About 424 (70.4%) out of 602 incinerators are provided with air pollution control devices and 178 (29.6 %) incinerators are in operation without air pollution control devices.

The increase of electrical and electronic products consumption rates leads to higher generation of e-waste. Electrical and electronic waste is one of the fastest growing waste streams in the world. The E-waste inventory based on the extinction rate in India for the year 2005 had been estimated to be 1, 46,000 tonnes, which was expected to exceed 8, 00,000 tonnes by 2012. Improper disposal of e waste causes huge hazards to health as well as the environment and hence is a matter of grave concern.

Present methods of disposal of today's hazardous household chemicals in the United States are frequently not acceptable because of pathways to groundwater, surface water, and the atmosphere. Potentially hazardous liquid wastes in the household and current disposal practices are identified and an improved management plan is recommended. Laws requiring uniform disposal labelling on packaging are critical. Local, country, and state governments must be encouraged to coordinate the necessary infrastructure. Managing hazardous household wastes can mitigate potential disposal problems. (Robertson et al., 1987)

Pollution prevention is a concept and practice that has quickly taken us beyond our traditional command and control approach to controlling waste and toxic emissions. Because the concept focuses on not generating waste in the first place, it has forced companies to look at the flow of chemicals in the workplace and to look at where and why wastes are generated. Decisions related to pollution prevention have to be made before waste is ever generated from those involved in product and process design and operation, to those making decisions about materials use. (Shen, 1999)

Numerous waste characterization studies have been conducted at the household or municipal level. But for the institutional sector, the studies exist in a very small number. Within institutions of higher education, even fewer studies have assessed the composition of solid waste (Mason et al., 2003)

Campus waste characterization studies are relatively inexpensive and can generate administrative support, cooperation among students, faculty and staff and inspire further involvement in campus sustainability issues (Sharp, 2002).

In addition to the overall desire to become green, rising campus waste disposal costs and shrinking landfill space often demand waste minimization approaches at Institutions of higher education (Noeke, 2000)

2.3.2. *Energy Management:*

The gap between demand and supply of electric energy in the world has been increasing every year. The gap between demand and supply was 4.32% in 2001 and this gap increases to 11.35% in 2010, i.e. more than double in a period of 9 years. This gap has been increasing the challenges towards world power scenario. One of the solutions to tackle this problem was to introduce Energy Audit to check the wastage of electric energy.

The government should be advised about the goal to promote the energy efficiency of existed buildings and also had to accelerate the execution of building energy efficiency strategy. The demand of electricity is increased by 6-8 % every year but production has not increased to same ratio. Two methods can be used to counter this problem. One was to increase generation and second was to conserve the electricity from utility side.

A case study about the energy consumption of air conditioning system was presented. It was concluded that the energy consumption of the lighting system was just less than 10 %. For auditing a commercial building, outer climate and office occupancy rate were two leading factors for the change of the total energy consumption. (Li et al., 2009)

New construction companies were advised to use energy saving and environmental friendly building materials. The material should be selected according to the local climate characteristics. The construction planning, design and material, all could be optimized and combined with other energy saving technologies. (Yuan xu et.al. 2011)

The government should provide free energy saving materials and give faculties to facilitate the development of new energy saving technology. (Wang et al., 2011)

Green building was able to provide significant energy savings by eliminating the stand by consumptions and adopting the behaviour of appliances in the real environment condition.

Global warming was largely caused by human influence on the environment and a 25% reduction below current levels of emission is required in order to stabilize global carbon dioxide concentrations at levels that will not have very adverse impacts. (Stern Review Report, 2006)

In the UK, schools, colleges and universities are thought to comprise more than 5% of all the buildings. The UK education sector accounts for about 14% of UK total carbon dioxide emissions. The main reason was that the student enrolment in the ten year period between 1997 and 2006 was more than between 2005 and 2006 alone with associated increase in staff numbers. Moreover, the enrolment was more in those subjects which have an increased demand for lab equipment often associated with higher energy and water demands. (Universities UK, 2007)

50% increase in postgraduate student population means increased intensity and longer periods of use of facilities and buildings. There is about 2.7% increase in energy consumption levels in the higher education sector between 2001 and 2006, which results in about 4.3% increase in direct energy related emissions. Reduction in energy consumption is a must for the higher education sector and this will save the institutions money, help in reducing the demand for fossil fuels and the associated green house gas emissions taking into account financial, environmental and social benefits thus mitigating harmful climate change and enhancing the corporate image of the institutions. (Ward et al, 2008)Significant progress was recorded with increase in monitoring through submetering for energy consumption as submetering successfully contributed towards energy management. Many institutions have adopted Smart fuel purchasing strategies, involving tariff monitoring and switching in order to reduce energy costs. However, these strategies are aimed at reducing fuel costs rather than achieving reductions in energy consumption. (Altan, 2010)

The adoption of formal quality measures like ISO 14001 was identified as potential strategies for environmental quality assurance in HEIs. As shown by an online survey, only a handful of institutions (11%) have included ISO 14001 certification.

2.3.3. **Water management :**

Almost 97% of the world's water occurs as salt water. Of the remaining 3%, two thirds occur as snow and ice in the Polar Regions. Only 1% of the global water occurs as liquid freshwater. So the liquid freshwater is a finite and limited resource.

St. Petersburg, Florida: An extensive urban water reuse scheme has been in operation since 1977 which supplies an average of about 80,000 m^3/d of recycled water. The recycled water was used for air conditioner chiller water and a backup source for fire protection. (RWCC, 1993).

Mawson Lakes, Adelaide: Wastewater from the site was treated and recycled for toilet flushing and landscape irrigation. Stormwater from the site was collected, treated and recycled to provide lakes and as supplementary water for landscape irrigation. Aquifer storage and recovery was used to store surplus winter flows of recycled water and stormwater and supply peak irrigation needs during summer. (Marks, 1998)

Homebush Bay, Australia: Recycled water from stormwater and treated wastewater sources can be used for toilet flushing in sporting venues, irrigation of open space areas. Microfiltration and reverse osmosis treatment processes are used to achieve the required water quality. The scheme has reduced demands on Sydney's freshwater by 8, 50, 000 m^3/d (Cooney, 2001)

South Bay, California: Authorities ware directed to limit the freshwater discharges to reduce damage to an environmentally sensitive salt marsh environment. A 60,000 m^3/d Water Recycling Scheme for urban, industrial and agricultural uses had been in service since 1998. (Rosenblum, 1998)

Recycled water is a valuable resource. Treated water can be used to reduce the demand on high quality freshwater sources. In nutshell, Universities are beginning to recognize their own ecological footprint resulting from campus production and consumption practices. Higher Educational Institutions have attempted to implement institutional ecology principles and practices to conserve resources, recycle, reduce waste, and improve environmentally sound operations. There are more than 7, 00, 000 educational institutions operating all over India. A developing university consumes 8, 00, 000 litres of water and uses about 5, 333 KWH of electricity per day for their operations. To preserve the environment within the campus, there are various viewpoints that several Universities are applying in order to tackle with their environmental problems such as promotion of the energy savings, recycling of waste, water reduction etc. (Gobinath et al.,2009)

Chapter 3
Overview of Thapar Technological Campus

Thapar University is located in the historic city of Patiala having a sprawling green 250 acres Thapar Technology Campus. Thapar University was established in 1956 through an imaginative and innovative collaboration between the then State of PEPSU (Patiala and East Punjab States Union), the Central Government and the Patiala Technical Education Trust (PTET).

It is today recognized among the premier Deemed Universities imparting technical education of the country and the best of its kind in the north-western region of India. It is an example of pioneering experiment of joint venture between public and private sector in Higher Technical Education. TU is a unique campus with extraordinary potential for development of indigenous technology and its transfer to engineering industries.

Thapar University strives to maintain an environment that encourages scholarly inquiry and research, a spirit of creative independence and a deep commitment to academic excellence.

The Thapar Technological Campus with its three institutions viz. TU, TP and TCIRD, is today a unique Campus in our country with extraordinary potential for development of indigenous technology and its engineering industries.

A Centre of Relevance and Excellence (CORE) has been set up at Thapar University by TIFAC Mission REACH of Department of Science & Technology, Govt. of India in its first phase of setting up eight CORES at various Institutes and Universities spread all over the country. Science and Technology Entrepreneur's Park (STEP) has been established jointly by Thapar University and DST, Govt. of India.

Thapar University has impressively grown in size and activities during the last five decades of its existence. The project is an educational project over a land area of 249.13 acres. The built up area of the project is 309416.91 sq. m. Land was allotted to Patiala Technical Education Trust by His highness Yadavindra Singh. The layout of Thapar University is approved by MC. The total cost of the project is Rs.111.67 crores. Till date, 90% construction activity has been done in the university.

The basic objective of Thapar University is not only to provide education to the students but also adopt developmental approach which leads towards Sustainable Development.

3.1. Brief Description of the Nature of Site, Location of the Project:

The land use of the area is examined. The project site is covered in Master Plan of Patiala as Educational/Institutional area. The project is surrounded by residential area in 500m radius and it is surrounded by many buildings like Mini Secretariat and Central Jail on eastern side, Punjab Pollution Control Board and Industrial Institute of training on southern side. There is no Protected Forest, Ecologically Sensitive area, National Park, Biosphere reserve and Wildlife sanctuary found within 10 km radius of the project site. The University has an easy access to land, power, water, transport and communication and approach through road. The land use of the University is given in Table 3.1

Table 3.1- Land Use details of Thapar University

S. No.	Description	Area in m^2
1.	Plot Area	1008194.06
2.	Built up Area	309416.91
3.	Ground Coverage	106386.33
4.	Green Area	248274
5.	Parking Area	18783

3.2. Key features of Thapar University: The key features of Thapar University are given in Table 3.2

Table 3.2- Key features of Thapar University

Co-ordinates:	30°84”N 76°03 ”E
Net Plot Area:	1008194.06 sq.m/ 249.13 acres
Proposed Ground Coverage:	105622.9416 sq.m/ 26.10 acres
Total Built-up area:	309416.91 sq. M
Green Area:	248274 sq.m/61.39 acres
Maximum Height of Building:	34.76m
Parking area:	18783 sq.m/ 4.64acres
Total Population:	Floating Population-3630 Residential Population-4744

3.3. Location of Thapar University: The location of Thapar University is shown in the map attached along with.

3.4. Academic Areas:

The College has six old academic blocks B, C, D, E, F, TAN and a recently constructed G block. The blocks are well constructed and in good condition.There are 8 departments and 5 schools in the University which offers undergraduate programmes like Bachelor of Engineering (B.E.) degree and postgraduate programmes like Master of Engineering (M.E.), Master of Technology (M.Tech.), Master of Science (M.Sc.), Master of Computer Applications (M.C.A.) and Doctor of Philosophy (Ph.D.) degrees.

Departments: Chemical Engineering, Civil Engineering, Computer Science and Engineering, Department of Biotechnology, Electrical and Instrumentation Engineering, Electronics and Communication Engineering, Mechanical Engineering Department and a Department of Distance Education (DDE).

Schools: School of Chemistry and Biochemistry, School of Humanities and Social Sciences, School of Mathematics, School of Physics and Material Science ad School of Energy and Environment.

Other than CORE and STEP, Centre of Information Technology and Management (CITM) and Centre for Industrial Liaison and Placement (CILP) are there.

3.5. Residential Areas:

There are different types of quarters and hostels for the faculty members and the students respectively. Residential quarters for the faculty and non faculty members are of following types:

A Type=5 quarters, B Type=3 quarters, C Type=10 quarters, Type 4=28 quarters, Type 3=48 quarters, Type 2= 12 quarters, Type 1= 50 quarters, Faculty Residences A = 24, Faculty Residences B = 24. R & D has separate residential quarters i.e. Type A = 12, Type B = 16, Type C = 12

University has five boys hostels and 4 girls' hostels. Each hostel has Gym, Reading Room, Common Room. There is a Cooperative Mess system in each hostel, and a Student Executive Committee headed by the Warden to manage day to day hostel activities.

Hostel –A (Capacity: 252), Hostel –B (Capacity: 282), Hostel –C (Capacity: 320),

Hostel-H (Capacity: 480), Hostel-J (Capacity: 858). Hostel-E (Capacity: 237),

Hostel-PG (Capacity: 288), Hostel –I (Capacity: 407), Hostel – G (Capacity: 234)

3.6. Other Areas:

The University has several playgrounds and well-maintained athletic track. The University has also a Gymnasium-cum-Badminton Hall and a Swimming Pool Complex equipped with all modern facilities.

An in-house market COS (Cultural Open-air Shopping) which has variety of shops including laundry shop, juice bar, general store etc. It also has an open air theatre at its back.

Central Library is in TCIRD building, Thapar Technology Campus, Patiala. The library remains open from Monday to Saturday and remains closed on University holidays. The Community library (meant for staff and their family members located in the circulation service enclosure on first floor) services available on all the working days.

A Sewage Treatment Plant of 1 MLD capacity based on Anaerobic Treatment followed by Aerobic Treatment is there in the University for the Treatment of the wastewater generated in the campus.

The SAI Labs (a registered Society) was established in April 2011 with the main objective of having a central facility in the Thapar University Campus to carry out high end testing, consultancy & research. In addition to research programs, it was envisaged to have state of the art testing & characterization facility to cater to the high end testing needs of the industry, society as well as educational institutes. It is recognized as Environmental Laboratory by Ministry of Environment and Forest and Punjab Pollution Control Board (PPCB).

The University has a bank branch and a post office to cater to the needs of the students. A Guest house for visitors and a Heritage Haveli are also there.

The energy demand of the University is provided by PSPCL. 3 substations are there, each one of them supply power to different parts of the campus. D.G sets are provided for power back up. The Water demand of the University is met by 4 tube wells. The source of water is Groundwater. Proper Parking facilities are provided in the University for students and visitors.

A lot of greenery is there in the campus and green belt is developed along the road sides for the improvement of the environment and general aesthetics.

In nutshell, The Thapar University, Patiala is a state university; the emphasis is on quality education and hands-on practical training. The best research facilities in the region are created here. All locations are good. All hostels and University buildings are facing North-East with big windows and balconies. Some photographs of Thapar University are:

Figure 3.1.New Polytechnic in Thapar University

Figure 3.2.Library

Figure 3.3.Faculty Residences

Figure 3.4.Thapar Technology Campus (Google Earth)

Figure 3.5.Entrance of Thapar Technological Campus

Figure 3.6.Entrance of Research and Development Area

Figure 3.7.Boys Hostels

Figure 3.8.COS Market

Chapter 4
Methodology

Objective of the present study is Environmental Analysis of the Thapar Technology Campus and development of Environmental Management Plan for the Thapar Technology Campus. Approach followed for achieving the objective is described here in brief. The approach included the four aspects of study

1. Preliminary survey
2. Environmental analysis
3. Review of the current environmental management practices
4. Development of environmental management plan

4.1. Preliminary survey:

This involved reconnaissance visit of the campus. Purpose of the visit was to get acquainted with the places, activities and people that matter. People that matter were discussed about the work and about the kind of help and cooperation expected from them. Core and support activities of the campus were identified from the survey. Further, sources for the secondary data required were identified.

4.2. Environmental analysis:

For the Environmental analysis purpose the Thapar technology campus was divided into the following regions:

- Academic area
- Hostel areas
- Staff Residential areas
- Other areas

Further, the analysis was carried out for all the activities identified. The activities were categorized into core activities and support activities and first the core activities were analysed and then the support activities. The activities identified are shown in Table 4.1

Table 4.1- Comprehensive list of Activities	
Primary or Core Activities	**Secondary or Support Activities**
Institutional Activities – Teaching	Water Supply
Institutional Activities - Laboratory, workshop and R&D activities	Electrical Power Supply
Institutional Activities - Library	LPG and other fuels supply
Institutional Activities - Administration and office	Wastewater management
Construction and developmental activities	Solid waste management
Residential Activities	Hazardous waste management
Commercial Activities	E-waste management
Estate Management	Scrap management
	Storm water management
	Transportation
	Recreational Activities

For the environmental analysis, the identified activities were critically analyzed in each of the four areas identified.

The critical analysis included the following:

1. Understanding of the activity
2. Infrastructural facilities employed in the activity
3. Repair and maintenance, and operation and control of the facilities
4. Material and energy inputs for the activity and their environmental importance
5. Material and waste outputs of the activity
6. Trends in the activity from the infrastructure, and from the materials and energy input angles
7. Environmental aspects or concerns associated with the activity

4.3. Review of the current environmental management practices:

All the environmental aspects (of all the University's activities), indentified and considered as significant, were compiled. The legal and other requirements to be complied with relating to the identified significant environmental aspects were then identified and compiled. Further, how each of the identified significant environmental aspects are managed was analyzed, and efforts were made to identify the non-compliances and non-conformances with the requirements. Efforts were also made to assess the potential for environmental performance improvement.

4.4. Development of environmental management plan:

Environmental management plan each of the identified significant environmental aspects was developed. the plan included brief description of what will done for the management of the environmental aspect, identification and detailing of the facilities needed for the management of the environmental aspects and the organizational setup suggested for the management. Monitoring and measurement requirements were also identified and indicated.

Chapter 5
Environmental Analysis of Thapar University

A comprehensive list of activities which are associated with the operation stage of Thapar University has been prepared which are the following:

5.1. Primary or Core Activities

5.1.1. *Institutional Activities - Teaching*

Teaching includes all the activities of providing education to students. Teaching imparts knowledge and instructs the learners to how to do something. As Thapar University is an educational institution, Teaching is a major activity in the University. There are around 6000 students in various disciplines.

Infrastructural facilities employed in the activity: Classrooms, benches, blackboards, projectors, podiums

Repair and maintenance: All the facilities in a classroom should be in a good condition so that while learning, students do not feel uncomfortable.

Material and energy inputs for the activity and their environmental importance: Chalks, markers and pens, laptops, papers for making notes and for taking exams, wooden benches. Paper and benches are made from wood, so trees are cut for making them. Electricity is required for laptops, fans and tubelights.

Material and waste outputs of the activity: Waste paper, plastic coverings of pens, chalk dust etc.

Environmental aspects or concerns associated with the activity: Staff and students consume energy when they travel to and from campus. The method of teaching also affects environment as use of technical teaching models consume energy which result in increased carbon emissions.

5.1.2. *Institutional Activities - Laboratory, workshop and R&D activities*:

Each department and school has Laboratories for practical training of students. Research work by m. tech students and Ph. D scholars is done in laboratories.

The Workshop caters both to students training at various levels as well as production jobs specifically to meet needs of research, development, fabrication and maintenance for various departments and units of the Institute. Various fabrication processes like fitting, machining, carpentry, electroplating, welding and sheet metal are there in the workshop. SAI Labs are there to carry out high end testing. It is recognised as environmental laboratory.

Infrastructural facilities employed in the activity:

Laboratories: Fermenters, Ovens, Laminar Airflows, Autoclave, Deep freezers, Shakers, Distillation units, BOD incubators, Electroporator, Thermal cyclers, Colorimeter, UV-VIS Spectrophotometer, Microscopes, Peristaltic pump, Water bath shaker, COD digestor, Ovens, High Volume Sampler with Stack sampling kit, PI-V Computers with UPS and internet facility.

Central Workshop: Machine Shop, Fitting Shop, Carpentry & Pattern making Shop, Welding Shop, Smithy & Sheet Metal Shop, Foundry Shop, Electroplating Shop and Fabrication Shop

SAI Labs: Water/Waste Water Testing Lab, Air Monitoring Lab, High End Equipment Lab, Microbiology Lab, IC Engine Testing Lab

Repair and maintenance, and operation and control of the facilities: In workshop, machines have to be maintained in proper condition and repair of old machines have to be done from time to time.

Material and energy inputs for the activity and their environmental importance:

Energy Consumption, Books, Machines for different shops, Equipments for Testing Laboratories, Chemicals and reagents.

Material and waste outputs of the activity: Solid Waste, Hazardous Waste, E-waste, Paper waste, lab effluent or waste water.

Environmental aspects or concerns associated with the activity: Lab wastewater generation, Hazardous waste production.

5.1.3. *Institutional Activities - Library*

A Central library which remains open on all working days except University holidays and Sundays is there to cater to the needs of the students and staff members. The Library has a total collection about 60,000 printed volumes including books, textbooks, standards and theses & dissertations. Books are organized on open access shelves in various collections.

Infrastructural facilities employed in the activity: Reading Halls, A collection of general books, reference books, textbooks, Light reading books, Course material, Journal and magazines.

Repair and maintenance, and operation and control of the facilities: Books have to be maintained in good condition. There is a silence zone in the reading hall so that students can study peacefully.

Material and energy inputs for the activity and their environmental importance: Energy Consumption, Books

Material and waste outputs of the activity: E-waste, Paper waste

Environmental aspects or concerns associated with the activity: Trees are cut down for making paper. A lot of paper waste is generated in library.

5.1.4. *Institutional Activities - Administration and office:*

Administration includes the Board of governors, chairman, deans, registrar, heads of departments, and other nominees. It means the group of people who manage or direct an institution. Administration and office activities include the admission processes, documentation, financial activities, and repair and maintenance activities.

Infrastructural Facilities: Computers, Laptops, Printers, Xerox machine, Cabins

Material and Energy inputs: Uninterrupted Power supply, Printer Cartridges, Sheets Rim

Material and waste outputs: Paper waste, E waste

Environmental Concerns: Administration activities generate a lot of paper waste.

5.1.5. *Residential Activities:*

Residential activities include the activities due to faculty members and the students residing in faculty residences and the hostels respectively in the college campus. There are different types of quarters and hostels for the faculty members and the students respectively.

Infrastructural facilities employed in the activity: Uninterrupted Power supply, Water supply, front and backyard lawns, individual LPG connections. water purifiers, washing machines & geysers, gym facility, T.V. room, newspaper stands, high speed internet connection, study tables and almirahs, night canteen, library cum reading room, table tennis room, mess facility, fridge (Hostel J), elevators, Open Air Theatre in Hostel-J, Uninterrupted power supply, Photostat corner, Indoor and Outdoor Games facilities, parking lots, guest rooms, meditation room, wooden chairs, beds.

Activities in residential areas: Washing clothes, Cleaning floors, food preparation in mess, bathing

Material and energy inputs for the activity and their environmental importance: Energy Consumption, Water consumption, raw food, LPG consumption

Material and waste outputs of the activity: solid waste, scrap, Waste water, food waste, sanitary waste, dirt and sweepings

Environmental aspects or concerns associated with the activity: Sports, entertainment, commercial and domestic activities can generate levels of noise. Household activities generate hazardous wastes, ad cause air pollution and storm water pollution.

5.1.6. *Commercial Activities:*

The University has a shopping complex which has 11 shops. There are food related shops, stationary shop, laundry shop, juice bar and a multipurpose store. Apart from this, the university has a cafeteria, amul shop, juice bar and verka shop. In addition to, 2 Aahaar are also there which provides lunch to students during the day time.

Material and energy inputs for the activity: Raw vegetables, fruits, confectionary items, power supply, water consumption

Material and waste outputs of the activity: Biodegradable waste, packaging waste. The cafeteria in the university generates about 210 kg of food waste and 1.5 litres of used oil per

day. The waste is sold to piggeries. All the other waste of the shopping complex which is approximately 250 kg/day is dumped at Sanauri adda dumping ground.

Environmental Concerns: The number of LPG cylinders used for commercial supply is 76 number/ month. Biodegradable Waste generation is there. Energy consumption is also there.

5.1.7. *Estate Management:*

Estate Management includes property management and its operation. It includes landscape management, horticultural activities management etc. The description of areas of Thapar University is given in Table 5.1.

Table 5.1.Description of areas of Thapar University

S. No.	Description	Area
1.	Ground Coverage	26.10 acres
2.	Parking	4.64 acres
3.	Concrete Paving	4.76 acres
4.	Brick Paving	1.68 acres
5.	Cement paving	0.306 acres
6.	Paved Roads	13.29 acres
7.	Katcha Roads	2.84 acres
8.	Open Ditches	0.60 acres
9.	Tennis courts	1.33 acres
10.	Athletic track	4.60 acres
11.	Lawns	14.01 acres
12.	Playgrounds	0.237 acres
13.	Agricultural field	35 acres
14.	Green belt Area	61.39 acres
15.	Other open area	78.347 acres

Plantation and landscaping in the project area will help to improve the terrestrial habitat for birds, effectively serve as pollutant absorbent, act as recreation place for the residents and add to overall aesthetics of the area.

In summers, 4 trolley of grass is trimmed and in winters, only 1 trolley of grass is trimmed. (Except hostel lawns and grounds) Watering of Plants is done each alternate day in summers and after a week in winters.

The lawns are trimmed from time to time. A separate department of Horticulture is there which takes care about the plantations within the campus. A green belt is developed in 61.39 acres of the campus.

5.1.8. Construction and development activities:

All project sites require some level of construction. The construction of the Thapar campus is 90% complete till now. Various construction activities in the Thapar campus are Site cleaning, laying pipes for sewerage system, Temporary shed construction, foundation digging, parking tiles, electrical wiring, fixing window frames, renovation of hostels, faculty cabins renovation etc.

The construction to be undertaken in phases, all excavations to be done with machines and the excavated soil to be used in cut and fill in first opportunity to keep the dust generation minimum and for reclamation of disturbed areas to reduce wind erosion. Regular sprinkling of water around the area under construction should be there.

Environmental Concerns: Due to construction activities, the green cover has been forced to give way to the rapidly developing urban centres. Energy consumption and water consumption is there in construction activities. Dust generation is also an environmental concern.

Repair and Maintenance, and operation and control of the facilities: The repair and maintenance of the activities is done by the construction and maintenance section of the University.

5.2. Secondary Activities:

5.2.1. *Water Supply:*

The water supply of the campus was analysed. The source of Water in the campus is Groundwater. The water demand is met by 4 tube wells.

Infrastructural facilities employed in the activity: Tube wells, Pumps, Pipes, Taps, Overhead tanks. Tube wells are situated at different places in the campus which are as follows:

- 2 tube wells opposite hostel H
- 1 behind COS building
- 1 behind central stores (Lease building)

Overhead Water tanks in campus are as follows:

- OHR near Hostel H having capacity 150000 lit
- OHR near library having capacity 100000 lit
- OHR near Aahaar 2 having capacity 115000 lit
- OHR near STP having capacity 200000 lit

Repair and maintenance, and operation and control of the facilities: The repair and maintenance, operation and control of the water supply system is maintained by the Construction and Maintenance section of the University.

Material and energy inputs for the activity and their environmental importance: Pumping of Groundwater needs motors and this in turn, requires energy.

Material and waste outputs of the activity: Leaks, spills, overflows

Water calculations within the University: Total domestic requirement = 875 KLD. The population of University is 8374. Water Calculations of Thapar University are given in Table 5.2.

Table 5.2.Water calculations within the University

Particulars	Population	Factor in LPCD	Total Water Requirement
Day Staff	400	45 lit/person/day	18000 lit/day
Resident Staff	1004	150 lit/person/day	150600 lit/day
Day Students	2760	45 lit/person/day	124200 lit/day
Hostel Students	3740	150 lit/person/day	561000 lit/day
Visitors	300	45 lit/person/day	13500 lit/day
Mess Servants	170	45 lit/person/day	7650 lit/day
TOTAL WATER			874950 lit/day = 875 KLD

The details of Total Water Pumped through tube wells between September, 2014 to march, 2015 are given in Table 5.3.

Table 5.3.Details of Daily Pumping of water						
S. No.	Month	Pump No.1 (KLD)	Pump No.2 (KLD)	Pump No.3 (KLD)	Pump No.4 (KLD)	Total (KLD)
1.	September,14	426.12	1204.3	296.39	265.2	2191.9
2.	October, 14	405.62	1149.7	350.67	267.6	2173.6
3.	November,14	531.94	1160.1	218.19	269.8	2240.03
4.	December,14	661.98	1220.8	321.3	258.9	2462.98
5.	January, 15	412.80	807.1	230.73	204	1654.63
6.	February, 15	482.67	1259.4	310.71	247.7	2300.48
7.	March, 15	694.61	1287.6	284.29	223.8	2490.3

The Horticultural Department of the University has 5 personal tube wells in addition to the 4 tube wells mentioned above. The horticultural department uses 2000 litres of water per day (2 days per week) for watering plants all over the campus from the above mentioned pumps.

The synthetic tennis court in the campus is washed for 4 hours continuously each alternate day i.e. from 9 am to 1 pm. The amount of water used is not measured as there are no flow meters installed.

Environmental Concerns: Declining Ground Water table and changing groundwater quality, Energy consumption for the pumping and distribution of water, Compliance with the water consumption commitments

5.2.2. *Waste Water Management:*

A Conventional type of sewerage system is there in the university campus having a network of underground pipes that convey wastewater to a treatment facility. A network of sewerage pipes convey the waste water to the main sewerage line which further convey it to the sewage treatment plant of 1 MLD capacity situated in the campus itself. STP is based on Anaerobic Treatment followed by Aerobic Treatment. All the wastewater i.e. from the labs and the sewage is combined and treated in the STP.

Infrastructural facilities employed in the activity: Sewerage system which includes manholes, pipes etc., Inlet Drain, Bar Screen, Wastewater Collection Tank, Baffled Anaerobic Reactor,

Facultative Pond, Roughing Filter, Treated water collection Tank, Sludge Stabilization Tank. 3 Pumps are there to pump the sewage from the sump.

Repair and maintenance, and operation and control of the facilities: The repair and Maintenance, operation and control of the facilities is under the control of Construction and Maintenance section of the University. Assistant Engineers are there in the CMS who take care of the operation of the facilities.

Material and energy inputs for the activity and their environmental importance: Wastewater of the University, Power supply

Material and waste outputs of the activity: Treated water, STP sludge, Screenings at the bar screen

Environmental Concerns: The positive environmental concerns related with this activity are: Water is getting treated and is used within the campus for irrigation. Odour problems for neighbourhood are there. The amount of treated water from 4th May to 7th June is given in Table 5.4.

Table 5.4.Amount of Water treated from STP

S. No.	Day	4-10 may,15 (m^3/day)	11-17 may,15 (m^3/day)	18-24 may,15 (m^3/day)	25-31 may,15 (m^3/day)	1-7 june,15 (m^3/day)	Mean (m^3/day)
1.	Monday	957	1155	1147	1070	938.4	1053.48
2.	Tuesday	1249	1349	1464	1280	861.1	1240.62
3.	Wednesday	1153.7	1144.3	828	1246	1024.4	1079.28
4.	Thursday	1152.6	1111	1278	1175	847	1112.72
5.	Friday	1053.8	1025	1158	1207	984	1085.56
6.	Saturday	1303.9	1273	1137	1092	674	1095.98
7.	Sunday	1286	1185	1125	946	494	1007.2

Treated Water disposal: The treated water has outlets at following places in the campus:

- Water body at Nirvana Meditation Park
- One point each at Hostel A, B, C, D
- One point each at COS and Synthetic Courts

5.2.3. *E-Waste Management and Handling:*

Electronic Waste is any refuse created by discarded electronic devices and components as well as substances involved in their manufacture or use. In Thapar Technological Campus, there are various electrical, computer and electronics labs which generate a lot of E-waste. In addition to, the administrative offices also accounts for the E waste.

Infrastructural facilities: E-waste of the campus is stored in godowns. The godown has a area of $100m^2$.

E-Waste is collected from individual departments and the same is registered in E-Waste maintaining register. E-Waste is stored in the respective godowns and then sold as per PPCB guidelines. The total record for E-waste from October 2013 to October, 2014 is attached at the end.

E-Waste Storage and its Disposal:

1. Receive e-waste from departments and enter it in e-waste register.
2. Keep e-waste material in e-waste godown.
3. Constitute an e-waste disposal committee with the approval of director.
4. Publish notice on the website of the university and inviting quotations from bidders.
5. Receive quotations from approved bidder to lift e-waste.
6. Allow bidder to lift e-waste as per record from the e-waste godown.

Environmental Concerns: The disposal of electronics is a growing problem because electronic equipments include hazardous substances includes discarded electrical or electronic devices such as computers, laptops etc.

The details of E-waste being generated in the campus are given in Table 5.5.

Table 5.5.Details of E-waste being generated in the campus

S. No	Particulars	Oct., 13	Nov., 13	Dec.,13	Jan.,14	Feb.,14	Mar.,14	Apr.,14	May.,14	Jun., 14	July, 14	Aug., 14	Sept., 14	Oct., 14
1.	Printer	1		5	1								1	
2.	Cartridge	7	13	8	17	16	17	10	9	6	9	7	3	6
3.	CPU	1		1										1
4.	Battery	1	4	1	2	2	1	1			3	6		1
5.	Hard disk		1			1	3		2		3	2		3
6.	Power supply		1									1	1	
7.	Charger		1				1	1					1	
8.	Tube lights			568										
9.	CFL Bulbs			140										
10.	Floppies			2 box										
11.	CDs			3 box										
12.	Music System			1										
13.	Processor				1									
14.	Mouse						16	2		1	2	2		
15.	Bulbs			15										
16.	Wires			1 box										
17.	Keyboard							4						
18.	Pump								2					
19.	Engine Rod								1					
20.	Others		2										1	1

5.2.4. *Scrap Management and Handling:*

Scrap consists of recyclable materials left over from product manufacturing and consumption. Scrap is collected from individual departments and is stored in the godown and then sold as per PPCB guidelines.

Scrap Disposal:

1. Receive scrap from departments.
2. Constitute a scrap disposal committee with the approval of director.
3. Publish notice on the website of the university and inviting quotations from bidders.
4. Receive quotations from approved bidder to lift scrap.
5. Allow bidder to lift scrap from the different sites in the campus.

Environmental Concerns: Scrap has monetary value, especially recovered metals, and non-metallic materials are also recovered for recycling. Scrap originates both from residential and business environments.

5.2.5. *Hazardous waste management and handling:*

Hazardous wastes are poisonous by-products of laboratories and substations. The Hazardous Waste (used oil) from DG sets is produced. The lubricating oil is changed during services of DG sets twice in a year or after 500 hours of operation. In addition to, waste is generated from the research laboratories in the campus.

The burnt spent oil is collected in empty drums of 25 litres each and kept at safe places where it is protected from leakage and spillage at substation area and further disposed off to PPCB approved authorized recyclers.

Laboratory waste from the laboratories is segregated into different coloured bags and is disposed to authorized agencies. Only hazardous waste from the biotechnology labs, STEP and CORE has been managed in this way.

The details of Hazardous waste being generated in the campus is given in Table 5.6.

Table 5.6.Details of Hazardous waste being generated in the campus				
S. No.	Month and Year	Yellow (discard)	Blue(recyclable)	Total
1.	March, 14	7.24	-	7.24
2.	April, 14	9.81	22.73	32.54
3.	May, 14	5.76	23.79	29.55
4.	June,14	7.76	14.12	21.88
5.	July,14	24.2	11.14	35.34
6.	August, 14	12.55	15.44	27.99
7.	September, 14	12.95	-	12.95
8.	October, 14	16.01	-	16.01
9.	November, 14	14.23	-	14.23
10.	December, 14	8.91	7.15	16.06
11.	January, 15	12.2	6.18	18.38
12.	February, 15	13.03	8.57	21.6
13.	March, 15	14.97	7.72	22.69
14.	April, 15	16.46	14.49	30.95
15.	May, 15	9.75	10.59	20.34

Environmental Concerns: Contamination of public water supplies, health problems, storm water contamination

5.2.6. *Solid Waste Generation and management:*

Various activities which are going on in the University are producing solid waste. Solid waste consists of household waste, construction and demolition waste, sanitation residue, and wastes from streets.

The garbage is generated mainly from residential and commercial complexes. The type of waste we generate and the approximate time it takes to degenerate is given in Table 5.7.

Table 5.7.The type of waste we generate and the approximate time it takes to degenerate	
Type of waste	Approximate time it takes to degenerate the waste
Organic waste, such as vegetable and fruit peels, leftover residue etc.	A week or two
Paper	10-30 days
Plastic bags	One million years
Glass bottles	Undetermined
Tin and aluminium cans	100-500 years
Wood	10-15 years

About 4 quintals/day of solid waste is generated in the university. The campus waste includes construction waste, packaging waste, biodegradable waste, paper waste and garden cuttings. Paper waste in the year 2014 was 125 quintals. One and a half trolley of grass cuttings are there in summer and 1 trolley in winter every 3 months. The food waste generated from the student hostels is 325.2 kg/day. The other biodegradable waste from the student hostels is 867.2 kg/day if one person generates about 200 gms food residue.

Currently all the generated waste is transported through a trolley and is dumped at the dumping ground of Patiala. No segregation of waste is being done. The grass cuttings are dumped in the campus itself. The food waste is sold to piggeries.

Environmental concerns: Dumping of solid waste raise public concerns because of potential smoke emitted from open burning, odours, insects, rodents, gaseous emissions that may arise.

5.2.7. *Energy supply and management:*

The energy demand of the project is 5915 KW out of which 4190 KW is being provided by Punjab State Power Corporation Limited.

Infrastructural facilities: 8 Transformers are there- 1000 KVA * 2 + 500 KVA * 4 + 315 KVA * 1 + 250 KVA * 1 = 4565 KVA

No. and Capacity of DG sets: 500 KVA * 1 + 400 KVA * 3 + 380 KVA * 1 + 320 KVA * 1 + 115 KVA * 1 = 2515 KVA

Metering Bills: The metering bills of Thapar University from May, 2014 to March, 2015 are given in Table 5.8.

Table 5.8.Metering Bills of the University			
S. No.	Month	TU (KWH)	TCIRD (KWH)
1.	May, 14	729270	94160
2.	June, 14	632220	80480
3.	July, 14	659040	97520
4.	August, 14	850190	100020
5.	September, 14	758510	84700
6.	October, 14	544280	59910
7.	November, 14	508414	45063
8.	December, 14	471370	47980
9.	January, 15	524210	50010
10.	February, 15	454120	39330
11.	March, 15	487990	43780

3 substations are there in the campus which are responsible for the supply of electricity within the campus. Stack heights are provided as per standards.

Environmental Concerns: The environment impact of electricity generation is significant because modern society uses large amounts of electricity. Degradation of fossil fuels is there.

5.2.8. *LPG and other fuels supply and consumption:*

Alternative fuel is used in the campus in the form of LPG and the diesel used in DG sets. Total number of LPG cylinders consumed for faculty residences in Thapar campus is 183 number/month and LPG cylinders consumed for commercial purpose is 76 number/month.

In addition to, in student hostels, LPG consumed per person per day is 0.043 kg. So, the total amount of LPG consumed per day is 187.83 Kg/day.

Digisets are provided in case of power failure. The total capacity of Digisets is 2515 KVA. The detail of Consumption of fuel in Digisets is given in Table 5.9.

Table 5.9.Details of Diesel consumption in Digisets			
Month	2013 (in Litres)	2014 (in Litres)	2015 (in Litres)
January	-	1970.91	2182.11
February	787	2889.465	2282.67
March	1965	2889.465	3831.42
April	1965	1906	3920.76
May	1964.43	nil received	NA
June	1942.35	5917.2	NA
July	3838.38	1972	NA
August	3796.2	3867.8	NA
September	3754.94	1915.38	NA
October	1856.92	1896.22	NA
November	1837.54	4243.25	NA
December	1970.91	4240.28	NA

Environmental Concerns: LPG is derived from fossil fuels. Burning LPG releases Carbon Dioxide, a green house gas. Digisets generate noise.

5.2.9. *Storm Water Management:*

Storm water is surface water in abnormal quantity resulting from heavy rainfall. It can soak into the soil, be held to the surface and evaporate, or runoff and end up in nearby streams. Storm water Management is done to recharge the ground water, store and use water for drinking water purpose and irrigation purpose etc.

The total area of Thapar University is 249.13 acres out of which the roof top area is 26.10 acres. For 105622.94 Sq. m rooftop area, with annual average rainfall of 688 mm and assuming runoff coefficient 0.9, total runoff available is 58135 KL/annum. The ground water is being recharged by providing 12 No. rain water recharging pits to tap roof top water.

Quantification of Storm Water: For the quantification of storm water, Soil Conservation Service Method (Curve number- CN Method)-1972 (for peak runoff rates and volume) has been used. It takes into account the potential of soil to absorb/store water or moisture (S). Potential Storage (S) is related to Curve Number as:

$$S = \frac{25400}{CN} - 254 \qquad (1)$$

Where, S is potential storage in the soil in mm and

CN is curve number

The computation of weighted Curve number for Thapar University is shown in Figure 5.1.

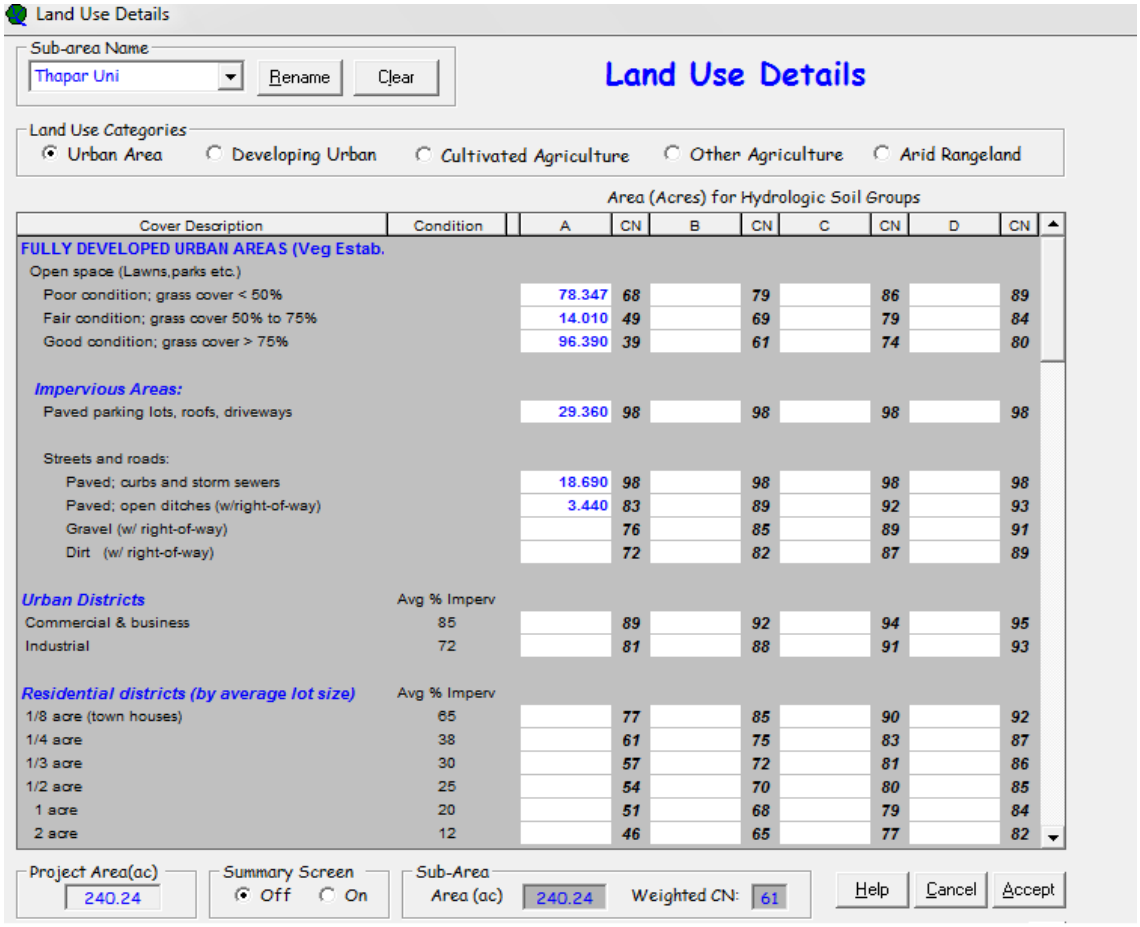

Figure 5.1.Computation of weighted curve number for Thapar University

Curve Number is assigned on the basis of soil type, land use, hydrologic conditions etc. Curve Number of the campus has been calculated with the help of WinTR-55 software.

The rainfall data for the last 10 years is used for the determination of Annual Rainfall for the quantification of Storm water. The rainfall data of Patiala city for the last 10 years is given in Annexures.

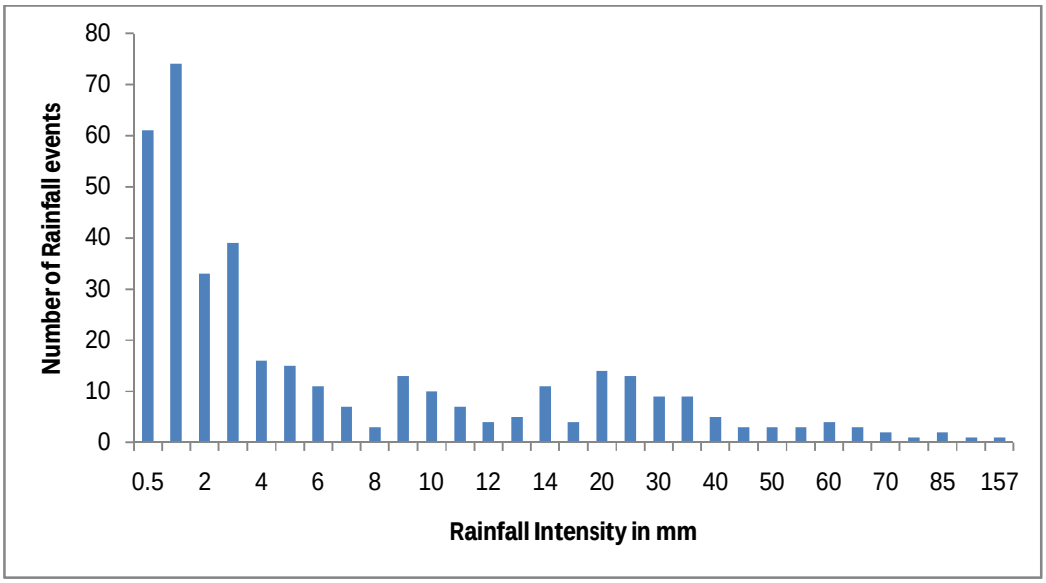

Figure 5.2.shows the number of rainfall events and their intensity in mm

The total storm water available in m^3 per year is shown in Table 5.10.

Table 5.10.Quantification of storm water available for collection

S. No.	Description	Area considered (in m^2)	Total annual rainfall Considered (mm)	Harvesting Surface Runoff coefficient	Total volume of storm water available for collection (m^3)
1.	Water available from Terraces and other roof top surfaces	105623	688	0.90	65402
2.	Paved surfaces, Roads and other built up areas	135352	688	0.65	60530
3.	Lawns, Gardens and all other Horticultural Areas	768902	688	0.20	105801
	TOTAL (in m^3)	1009877			231733
	SAY in m^3 per year				231700

Environmental Concerns: Unmanaged storm water can create two major issues: Volume and timing of runoff water and the Potential contaminants that the water is carrying. Storm water is also a resource and important as world's population demand exceeds the availability of readily available water. Storm water is a major cause of urban flooding.

5.2.10. *Transportation:*

Transportation activities in Thapar University include school buses which pick and drop children of faculty members, personal vehicles of faculty members, student vehicles, visitor vehicles, ambulance, ATM Cash van, rickshaws and battery operated rickshaws. The parking area provided in the campus is 2.5 acres. Parking for students is provided near the main gate. Academic block have its own parking. In addition to, Hostel J and Faculty residences have their own parking.

Parking Lots are provided. Students are not allowed to roam around on their personal vehicles in the University campus. They have to park their vehicles in the student parking near gate. Pollution check programs are arranged every 6 months within the campus Environmental Concerns: Effects Air quality, noise generation

5.2.11. *Recreational Activities:*

Sports and outdoor activities can significantly affect our environment. Two children park are there in the university campus for the residents of the university. Various Sports facilities are there which include athletic track, sports grounds, basketball court, synthetic tennis courts etc. A swimming pool and a gymnasium is provided for students. A Senior Staff Club is also there which is for the arrangement of parties, functions of the staff members.

Swimming pool contains 3, 00, 000 gallon water which is changed from time to time. Sports grounds are maintained time to time.

Environmental Concerns: Green spaces are compromised for recreational purposes. Cement needs to be put down for basketball courts. Sporting events can be enjoyable but people can cause air, soil and noise pollution.

Chapter – 6
Environmental Management Plan

6.1 Water supply

Objective of the water supply system is to minimize pumping of groundwater.

Use of pumped out groundwater for irrigation and horticultural purposes should be avoided. Use of the 5 tube wells by the horticultural department may be banned. Treated sewage may be used for the irrigation and horticultural purposes.

Duel water supply systems, freshwater supply system and reclaimed water supply system, may be used. The reclaimed water supplied may be used in place of freshwater for the toilet and urinal flushing and for the kitchen gardening.

Meter the supplied water. Charges for the water supplied can include two components, fixed system maintenance charge and variable water consumption charge. Initial fixed quantity of water supplied may not be charged, and the rest of the water supplied may be charged after adjusting the water consumption by a power factor. The water charges levied may be calculated using the following formula:

$WC_{monthly} = MC_{wss} + 0.0304\ P\ C_{fw}\ (LPCD_{fw} - LPCD_{ffw})$

Where, $WC_{monthly}$ is monthly water charge

MC_{wss} is fixed maintenance cost of the water supply system

P is population size of the family

C_{fw} is cost of the fresh water

$LPCD_{fw}$ is litres per capita day of fresh water

$LPCD_{ffw}$ is litres per capita day of freshwater supplied free

The cost of fresh water levied (C_{fw}) can include both the supplied water cost and the sewerage and sewage treatment costs.

Reclaimed water may be metered and charged separately. Rebate on the fresh water conserved through the use of reclaimed water may be incorporated into the charging. Charges for the reclaimed water consumed may be calculated by the following equation:

$RWC_{monthly} = MC_{rwss} + 0.0304\ P\ C_{rw}\ (LPCD_{rw} - LPCD_{fw\ stipulated} + LPCD_{fw})$

Where, $RWC_{monthly}$ is monthly charge for the reclaimed water supply (Rs./day)

MC_{rwss} is fixed maintenance cost of the reclaimed water supply system (Rs./day)

P is population size of the family

C_{rw} is cost of the reclaimed water (Rs/m^3)

$LPCD_{rw}$ is per capita reclaimed water supply in L/day

$LPCD_{fw\ stipulated}$ is the prescribed per capita water consumption in L/day

$LPCD_{fw}$is per capita fresh water supplied in L/day

Minimize water supply and distribution losses unaccounted for water being supplied.

6.2 Vehicular emissions and DG sets emissions:

Objective is to minimize vehicular and DG emissions, minimize the use of fossil fuel powered vehicles within the campus and even outside, minimize dependence on the DG sets for emergency power, tackling noise pollution problems and hazardous waste (waste oil and used oil and used batteries) management problems.

DG Sets to be used as per Ministry of Environmental Forests' Guidelines. Acoustic enclosures of Digisets must be there to reduce the generation of noise. Chimneys of adequate heights must be provided so as to prevent air pollution. Diesel of low sulphur content must be used in Digisets so that emissions do not cause much air pollution. Air Pollution Control Devices must be installed on chimneys of Digisets.

The 24 hr Ambient Air monitoring yields the following results:

Table 6.1.Details of Ambient Air monitoring in Thapar Campus

S. No.	Parameters	Nov,14 (μg/m3)	Dec,14 (μg/m3)	Jan,15 (μg/m3)	Feb,15 (μg/m3)	Standard (μg/m3)
1.	$PM_{2.5}$	33.54	34.03	34.22	34.42	35
2.	PM_{10}	94.95	94.67	96.90	96.40	150
3.	SO_2	4.85	4.0	3.91	4.27	80
4.	NO_2	7.33	7.42	7.26	7.31	80

So, air quality must be checked from time to time and compared with standards. The concentration of $PM_{2.5}$ is near the standard. The stack heights must be according to the PPCB guidelines.

For the reduction of Vehicular emissions, Bicycles and Battery operated rickshaws must be used by the students to move from one place to another within the campus. Vehicles must be restricted to surfaced routes wherever possible. Low vehicle speeds must be enforced on unsealed accesses within the campus.

Students are not allowed to keep four wheelers within the University.All the private vehicles must have updated PUC (Pollution under Check) certificate. All operational vehicles must go through regular maintenance and pollution check up. All the outside vehicles must be asked about the PUC certificate before entering the campus. Continuous monitoring of the atmosphere for pollutants should be carried out to know the emission levels. Measurement and monitoring must be done near parking areas.

In general, the estimation of transport related emissions can be based on the equation, $E= e \times a$, where E is the amount of emission (g. Km), e is the emission factor per unit of activity, a is the amount of transport activity. Generally, standard emission rate per ECU (g/sec/m3) and overall ECU load are considered as reference.

The Indian vehicular emissions norms provide the emission factor. The emission factor for CO is 11.2 g/km/vehicle for heavy vehicle, 6.75 g/km/vehicle for normal car or jeep, 0.68 g/km/vehicle for two wheelers. So, in this way, vehicular emissions have to be checked and managed.

6.3 Storm Water

The increasing realization and awareness that groundwater is an extremely precious and a limited resource that needs attention, so that it comes into the useful source during times, when the normal rainfall has failed. Rainwater harvesting and treated water recycling shall be adopted to make campus sustainable for water supply.

The total storm water available for runoff is 231700 m^3 per year. Currently, 12 numbers of recharging pits have been constructed in the campus. Following measures must be done so that no clogging occurs in the recharge pits:

All the storm water drains are to be cleaned regularly. Necessary repair of the drains needs to be carried out wherever required.

No contaminated water to be diverted into the storm water drains.

6.4 Hazardous waste including biomedical waste:

Objective of Hazardous waste aspect is to minimise the generation of Hazardous waste plus the disposal of generated Hazardous waste.

Table 6.2.Management Plan for Hazardous waste

Type of Waste	Colour of Bins	Disposal Method
Used Oil from Digisets servicing	Black with Label	Waste shall be collected in leak proof containers at isolated place and then it will be given to approved vendor of CPCB as per Hazardous waste (Management, Handling and Trans boundary Movement) Rules, 2008, amended in 2010.
Bio- medical waste	Black with Label	It will be disposed off as per Biomedical Waste (Management and Handling) Rules, 1998
Laboratory waste	Black with Label	The laboratory waste must be segregated into recyclables and non recyclables. After segregation, waste must be disposed off to PPCB authorized vendors.

Other things to be kept in mind while managing Hazardous waste should be:

Choose a correct container for the waste, which should be chemically compatible with the material and of appropriate size. Each container holding hazardous waste must be labelled at the time of putting waste first time into it. Label must include: Type of waste i.e. Laboratory waste, Hazardous waste, Biomedical waste etc. Waste containers must be kept closed at all times except when adding waste.

Disposables are to be banned so that less amount of waste is generated. Dustbins have to be installed in each and every department generating hazardous waste. The waste is collected weekly from each department. If any department is not following the rules, strict action must be taken against it.

A Hazardous waste register listing all hazardous materials must be maintained by each and every department. Standard Operating Procedures must be reviewed and followed. Records of waste volumes and disposal locations, including transfer receipts and other documents to validate the appropriate disposal of wastes from the site must be kept.

6.5 Lawn cuttings, hedge cuttings and vegetation clearing, and fallen leaves:

5 trolleys of green waste are generated in the campus in a year. So, it can be used to make manure. Composting Area should be made in the campus where manure should be made. By gathering all the leaves, shredding them completely and adding nitrogen source, compost can be made.

Lawn trimmings and fallen leaves lead to choking of drains. Lawn cuttings shall be managed by filling in the pits within the green belt. Burning shall be strictly prohibited to prevent air pollution. The excess grass must be used to artificially develop those areas where there is no vegetation. The vegetation clearing and grass, if it is in excess, must be sold to outsiders for their animals.

Fallen leaves can be used as mulch. Leaves contain 50-80 % of the nutrients a plant extracts from the soil, making them a great resource for returning sustenance to the soil. Efficient lawn cleaning and grass cutting machines must be used. Storage house or Pits for preparation of bio fertilizers must be there. Lawns and other open areas must be checked at regular intervals. The fallen leaves must be swept from time to time. The Horticultural department must be responsible for the management of fallen leaves, lawn trimmings etc.

6.6 Solid Waste:

The objective is to minimise the waste generation and the disposal of Solid waste being generated in the campus. Currently, there is no waste segregation being done in the campus. The waste must be managed in the following way:

The waste must be segregated at the source itself. Organic waste such as kitchen waste, which is biodegradable, should not be mixed with inorganic waste.

Specially labelled dustbins have to be installed at selected points within the campus as shown below:

Figure 6.1 Specially Labelled Dustbins

Student Hostels have such type of dustbins at each floor. In hostel mess, separate bin for food waste must be there. Cooked and uncooked food must be segregated. Daily inspection of food waste must be there and records must be kept.

At the end of each day, record of each type of waste must be maintained.

Now, after knowing the amount of each type of waste, methods of waste minimization must be planned.

Table 6.3.Management Plan for Solid Waste			
S. No.	Nature of waste	Impacts	Management
1.	Papers and Cardboard	Paper is a biodegradable material. When it goes to landfill, as it rots, it produces methane, which is potent greenhouse gas.	Will be sold to vendors who will in turn sell it to hand-made paper making units. Double sided photocopying, duplex printing, reutilization of unused side of paper and using electronic mail as the main source of communication must be there. A policy should be made requiring all University documents be paperless when possible or printed on both sides where hard copies are required. There should be financial incentive to faculty and students to choose the duplex printing or copying option. Faculty members should accept electronically submitted assignments. Recycled Paper must be used.
2.	Kitchen waste & other biodegradable waste	Kitchen waste contains organic matter which degrades gradually if disposed on ground resulting in unpleasant health conditions.	The kitchen waste must be collected on a daily basis from hostel mess, canteen area, aahaar 1 and 2 and COS market and sent to biogas generation plant. Total cooked food from the college is 1292.2 kg/day. So, with 1292.2 kg/day of cooked food waste, upto 646.1 kg/day biogas can be generated. This is capable of replacing 161.525 kg of LPG which means 11.53 cylinders of LPG.
3.	Non-Biodegradable waste	Includes plastic, polythene bags and results in choking of drains and has adverse impact on environment.	This will be collected on daily basis and sent outside the campus. Records have to be maintained daily.

6.7 Waste Water:

The objective of this aspect is to manage the waste water being generated in the campus and to treat it, minimize generation of wastewater, reuse the treated wastewater, sewage and other wastewater (from laboratories).STP of 1 MLD capacity is already provided in the campus. But the waste water amount is increasing day by day. So, steps must be taken to reduce the amount of waste water being generated in the campus. The treated water from the STP can be used for flushing purposes. The amount of treated water from STP is around 1100 m^3/day. There are 984 toilets in the University out of which 265 are in hostels.

The total population of the Thapar campus including hostellers and day scholars is 8374. One flush requires 1.6 gallon or 6 litres of water. So, if we consider, a person uses 60 litres of water per day when used a toilet 10 times a day, the total water required for flushing is 8374× 60= 502440 litres or 503 KLD water only. So, around half of the treated water is needed for flushing purposes. Other half of the treated water can be used for horticultural and irrigation needs.Flow meters must be installed at the inlet section of the STP so as to know about the wastewater being generated in the campus.

Currently, Wastewater generated from the labs has not been calculated. So, water meters to be installed to know the amount of waste water being generated in the labs. By knowing the quantity of lab waste water, need for effluent treatment plant can be checked out.

6.8 E waste:

The E-waste being generated in the University includes hard disks, printers, batteries etc. The details are attached in table. E-waste should be handled according to E waste management rules. The electronic waste components must not be disposed off in general bins. E-waste storage house must be there. Dustbins with labelling have to be installed in various departments.Regular monitoring must be done to see no obsolete electronic components being disposed into the bins. E-waste must be disposed off to authorized PPCB vendors. Precious metals which otherwise become waste can be recycled from electronic waste.

Each and Every department responsible for the generation of E-waste must maintain a register of waste with their volume and type.

6.9 Construction waste:

The objective of construction waste aspect is to minimise construction waste and the disposal and treatment of Construction waste.

Hydraulic and manual press machines for compressing the waste should be there. Provision of Stockpile/ Store room must be there.

All wastes must be separated and segregated into hazardous and non hazardous wastes, waste states and waste types. Demolition and waste construction materials must be stockpiled well clear of environmentally sensitive areas. Compression of waste must be carried out so as to minimise the quantity of waste. The spills must be prevented from contaminating storm water or soils.

The contractor will be required to accurately calculate and order materials requirements, to assist in minimizing waste due to over-ordering, and will encourage minimum packaging practices. Skilled personnel are required who must be responsible for the separation and stockpiling of reusable and recyclable products for re use on site or collection by an approved recycling contractor. Material Safety Data Sheets for all potentially hazardous substances used on site will be maintained.

6.10 Electrical Energy:

Alternative sources of energy must be used. Solar photovoltaic system can be used so as to reduce the grid electricity consumption and the dependence on Digisets. Solar water heating systems can be used in hostels. All the tube lights in the campus must be replaced with LED lights. Sign boards having energy conservation methods written on it must be placed within the campus at various places. Penalty must be imposed on those who do not switch off lights before leaving the room. A person responsible for the switching off of appliances which are not in use must be hired.

A target should be made to reduce 10% electricity bill by 3 months. Sub meters are to be installed in different parts of the campus. Electricity consumption analysis must be done every month on how to save electricity and to cut down billing amount.

6.11. LPG and other fuel consumption:

Objective of this aspect is to minimise LPG consumption in the Campus and Diesel consumption in Digisets.

Digisets are only to be used in the case of Power Failure so as to reduce consumption of Diesel.

Digisets supply should only be given to those areas where urgent requirement of electricity is there. For e.g. during day time, academic area should be given full supply.

For reducing LPG consumption, alternative sources of fuel must be used. Biogas can be generated in the campus itself from the food waste and can be used in hostels. This can reduce overall LPG consumption of the campus. The biogas generation potential of the campus is as follows:

Cooked food waste from student hostels is 867.2 kg/day and from the cafeteria is 150 kg/day

Table 6.4.Details of cooked waste generated in Thapar Campus	
Area	Amount of waste
Student hostels	867.2 kg/day
Cafeteria	150 kg/day
Shopping complex	100 kg/day
Aahaar 1 and 2	20 kg/day
Faculty residences	125 kg/day

So, with 1292.2 kg/day of cooked food waste, upto 646.1 kg/day biogas can be generated. This is capable of replacing 161.525 kg of LPG which means 11.53 cylinders of LPG.

6.12. Monitoring the Implementation and functioning of the Environmental Management Plan

Internal audits will be conducted on a regular basis of six months at the University. Besides routine internal audits, surprise checks must be there in order to ensure that there are no concern areas in implementation.

Student volunteers will carry out monthly performance evaluation of each domain. Once in a year, an external audit will be conducted.

Chapter 7
Conclusion

Universities across the globe are taking commendable steps to ensure the impact of their day-to-day activities on the environment is minimal. The present study brings out the environmental aspects of Thapar Technological Campus and after identifying the aspects, Environmental Management Plan for the campus has been developed. The University strives to attain sustainability in the long run and the Environmental Management Plan has been considered as one of the measures to attain it. Comprehensive analysis of the activities going on in the campus has been done and the significant environmental aspects associated with the activities were identified. It has been observed that the water consumption, electricity consumption and waste management are the thrust areas that need to be looked upon along with other activities.

Currently, the required management practices in the campus have not been undertaken. The groundwater being pumped out in the University is far more than the required amount and it is not being managed properly. The treated wastewater from the campus Sewage Treatment Plant has not been utilised properly. The waste of the campus is not being managed properly. So, an effort has been made to make a management plan for the activities going on in the campus and the environmental aspects associated with them.

In this work, overall campus was analysed in a time period of one year. The analysis can be better achieved by individually surveying each and every activity in detail in which more time is required.

As a result of this work, carbon footprint calculations can be done in process to know how much carbon footprints are because of Thapar University and how much can be reduced with different mechanisms.

The proposed EMP will be in the process of implementation and with this the university will take one step ahead on the path of sustainability. The university hopes that this would serve as a step in the right direction and more educational institutions in the country would follow this path.

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Annexure

Rainfall Data for 2005

S.No.	Date of Storm Event	Average rainfall (mm)
1.	9/1/2005	0.1
2.	17/1/2005	0.4
3.	21/1/2005	0.4
4.	22/1/2005	11.0
5.	27/1/2005	15.0
6.	5/2/2005	4.0
7.	7/2/2005	6.0
8.	9/2/2005	2.0
9.	15/2/2005	9.0
10.	18/2/2005	1.0
11.	19/2/2005	0.6
12.	1/3/2005	0.3
13.	9/3/2005	6.0
14.	19/3/2005	4.0
15.	21/3/2005	7.0
16.	3/5/2005	2.0
17.	26/5/2005	0.5
18.	6/6/2005	2.0
19.	9/6/2005	3.0
20.	26/6/2005	3.0
21.	28/6/2005	1.0
22.	29/6/2005	0.2
23.	3/7/2005	23.0
24.	5/7/2005	5.0
25.	6/7/2005	13.0
26.	7/7/2005	4.0
27.	8/7/2005	1.0
28.	11/7/2005	0.1
29.	13/7/2005	2.0
30.	21/7/2005	1.0
31.	27/7/2005	3.0
32.	29/7/2005	54.0
33.	4/8/2005	0.2
34.	6/8/2005	7.0
35.	7/8/2005	0.1
36.	13/8/2005	0.6
37.	17/8/2005	5.0
38.	22/8/2005	1.0
39.	9/9/2005	25.0
40.	12/9/2005	9.0
41.	13/9/2005	11.0
42.	14/9/2005	5.0
43.	17/9/2005	65.0

Rainfall Data for 2006

S.No.	Date of Storm Event	Average rainfall (mm)
1	2/1/2006	0.6
2	16/1/2006	1.0
3	26/2/2006	901.0
4	10/3/2006	29.0
5	14/3/2006	5.0
6	25/3/2006	2.0
7	2/4/2006	0.1
8	8/5/2006	7.0
9	19/5/2006	0.5
10	25/5/2006	27.0
11	16/6/2006	8.0
12	19/6/2006	0.1
13	23/6/2006	5.0
14	24/6/2006	21.0
15	9/7/2006	42.0
16	13/7/2006	2.7
17	23/7/2006	0.8
18	26/7/2006	64.0
19	6/8/2006	14.0
20	7/8/2006	7.0
21	24/8/2006	28.0
22	30/8/2006	3.0
23	31/8/2006	2.0
24	1/92006	10.0
25	2/9/2006	60.0
26	20/9/2006	0.9
27	19/10/2006	2.0
28	18/11/2006	0.9
29	22/11/2006	0.3
30	4/12/2006	1.0

Rainfall Data for 2007

S.No.	Date of Storm Event	Average rainfall (mm)
1	30/1/2007	0.8
2	7/2/2007	3.0
3	10/2/2007	25.0
4	13/2/2007	3.0
5	21/2/2007	0.1
6	25/2/2007	0.2
7	28/2/2007	19.0
8	10/3/2007	3.0
9	11/3/2007	5.0
10	12/3/2007	14.0
11	19/3/2007	0.5
12	21/3/2007	1.0
13	18/4/2007	4.0
14	20/4/2007	2.0
15	3/5/2007	0.8
16	4/5/2007	0.5
17	26/5/2007	2.0
18	15/6/2007	25.0
19	16/6/2007	4.0
20	17/6/2007	2.0
21	19/6/2007	0.4
22	3/7/2007	1.0
23	8/7/2007	6.0
24	11/7/2007	2.0
25	13/7/2007	14.0
26	15/7/2007	1.0
27	28/7/2007	1.4
28	1/8/2007	6.0
29	2/8/2007	31.0
30	4/8/2007	28.0
31	12/8/2007	14.0
32	13/8/2007	24.0
33	19/8/2007	33.0
34	23/8/2007	0.8
35	25/8/2007	16.0
36	5/9/2007	28.0
37	6/9/2007	0.5
38	16/10/2007	9.0
39	10/12/2007	1.5

Rainfall Data for 2008

S.No.	Date of Storm Event	Average rainfall (mm)
1	8/1/2008	2.0
2	9/1/2008	3.0
3	18/1/2008	0.6
4	2/2/2008	0.3
5	3/2/2008	0.8
6	3/4/2008	0.6
7	5/4/2008	5.0
8	11/4/2008	1.0
9	16/4/2008	0.5
10	5/5/2008	0.2
11	13/5/2008	1.0
12	16/5/2008	0.3
13	19/5/2008	43.0
14	20/5/2008	9.0
15	22/5/2008	1.2
16	25/5/2008	14.0
17	1/6/2008	1.0
18	5/6/2008	0.2
19	7/6/2008	1.0
20	11/6/2008	2.2
21	13/6/2008	10.9
22	15/6/2008	122.0
23	20/6/2008	8.0
24	25/6/2008	3.0
25	29/6/2008	12.0
26	6/7/2008	2.8
27	8/7/2008	1.0
28	9/7/2008	4.0
29	12/7/2008	3.0
30	20/7/2008	0.4
31	28/7/2008	19.0
32	3/8/2008	0.2
33	4/8/2008	1.0
34	5/8/2008	39.0
35	8/8/2008	53.0
36	10/8/2008	0.8
37	11/8/2008	27.0
38	12/8/2008	40.0
39	13/8/2008	3.0
40	14/8/2008	16.0
41	25/8/2008	2.0
42	30/8/2008	13.0
43	13/9/2008	2.0
44	17/9/2008	57.0
45	18/9/2008	14.0
46	19/9/2008	157.0
47	16/10/2008	2.0
48	19/12/2008	0.2

Rainfall Data for 2009

S.No.	Date of Storm Event	Average rainfall (mm)
1	3/1/2009	1.0
2	18/1/2009	3.4
3	10/2/2009	8.0
4	13/2/2009	0.2
5	3/2/2009	0.8
6	20/3/2009	0.6
7	24/3/2009	3.0
8	25/3/2009	3.0
9	27/3/2009	34.0
10	6/4/2009	9.0
11	8/4/2009	48.0
12	3/5/2009	0.7
13	11/6/2009	0.6
14	15/6/2009	0.3
15	29/6/2009	40.0
16	30/6/2009	6.0
17	1/7/2009	3.0
18	11/7/2009	0.5
19	13/7/2009	21.0
20	21/7/2009	11.0
21	27/7/2009	5.0
22	28/7/2009	2.0
23	29/7/2009	1.0
24	13/8/2009	9.0
25	15/8/2009	3.0
26	18/8/2009	9.0
27	30/8/2009	2.0
28	1/9/2009	1.0
29	3/9/2009	2.0
30	9/9/2009	67.0
31	10/9/2009	28.0
32	11/9/2009	20.0
33	4/10/2009	4.0
34	9/11/2009	1.0

Rainfall Data for 2010

S.No.	Date of Storm Event	Average rainfall (mm)
1	3/1/2010	7.0
2	12/1/2010	1.0
3	8/2/2010	5.0
4	7/5/2010	3.0
5	8/6/2010	56.0
6	1/7/2010	33.0
7	6/7/2010	24.0
8	12/7/2010	4.0
9	6/8/2010	15.0
10	8/9/2010	10.0
11	11/9/2010	66.0
12	22/9/2010	44.0
13	30/12/2010	13.0

Rainfall Data for 2011

S.No.	Date of Storm Event	Average rainfall (mm)
1.	13/1/2011	0.2
2.	7/2/2011	2.0
3.	13/2/2011	1.0
4.	25/2/2011	3.0
5.	2/3/2011	0.4
6.	3/3/2011	1.0
7.	29/3/2011	10.0
8.	2/4/2011	4.0
9.	18/4/2011	1.0
10.	5/5/2011	3.0
11.	20/5/2011	0.3
12.	21/5/2011	0.6
13.	31/5/2011	4.0
14.	11/5/2011	0.8
15.	21/5/2011	1.0
16.	22/5/2011	4.0
17.	24/5/2011	0.5
18.	9/7/2011	29.0
19.	15/7/2011	21.0
20.	23/7/2011	26.0
21.	29/7/2011	16.0
22.	30/7/2011	16.0
23.	3/8/2011	0.6
24.	4/8/2011	0.4
25.	5/8/2011	13.0
26.	9/8/2011	12.0
27.	12/8/2011	23.0
28.	13/8/2011	3.0
29.	14/8/2011	9.0
30.	15/8/2011	82.0
31.	16/8/2011	0.6
32.	19/8/2011	24.0
33.	23/8/2011	0.1
34.	24/8/2011	7.0
35.	31/8/2011	0.6
36.	2/9/2011	18.0
37.	5/9/2011	3.0
38.	8/9/2011	32.0
39.	9/9/2011	40.0
40.	10/9/2011	19.0
41.	11/9/2011	34.0
42.	15/9/2011	89.0
43.	16/9/2011	6.0
44.	6/12/2011	6.0

Rainfall Data for 2012

S.No.	Date of Storm Event	Average rainfall (mm)
1.	15/1/2012	3.0
2.	16/1/2012	3.0
3.	10/4/2012	15.0
4.	11/4/2012	2.0
5.	13/4/2012	0.1
6.	22/4/2012	4.0
7.	29/4/2012	1.0
8.	30/4/2012	1.0
9.	5/6/2012	10.0
10.	6/7/2012	13.0
11.	7/7/2012	14.0
12.	8/7/2012	3.0
13.	10/7/2012	74.0
14.	11/7/2012	38.0
15.	13/7/2012	2.0
16.	20/7/2012	2.0
17.	30/7/2012	3.0
18.	7/8/2012	23.0
19.	10/8/2012	0.2
20.	14/8/2012	16.0
21.	18/8/2012	0.8
22.	20/8/2012	10.0
23.	22/8/2012	3.0
24.	27/8/2012	14.0
25.	28/8/2012	5.0
26.	30/8/2012	2.0
27.	4/9/2012	35.0
28.	5/9/2012	0.3
29.	11/9/2012	19.0
30.	14/9/2012	4.0
31.	17/9/2012	3.0
32.	18/9/2012	10.0
33.	15/10/2012	0.8
34.	23/10/2012	0.2
35.	13/12/2012	14.0

Rainfall Data for 2013

S.No.	Date of Storm Event	Average rainfall (mm)
1.	17/1/2013	17.0
2.	18/1/2013	3.0
3.	3/2/2013	1.0
4.	4/2/2013	2.0
5.	5/2/2013	22.0
6.	6/2/2013	0.6
7.	15/2/2013	3.0
8.	16/2/2013	4.0
9.	17/2/2013	0.3
10.	21/2/2013	2.0
11.	23/2/2013	12.0
12.	27/2/2013	0.4
13.	13/3/2013	1.0
14.	14/3/2013	0.4
15.	23/3/2013	5.0
16.	28/3/2013	0.8
17.	29/3/2013	3.0
18.	14/4/2013	0.6
19.	26/4/2013	1.0
20.	12/5/2013	3.0
21.	6/6/2013	0.5
22.	13/6/2013	53.0
23.	15/6/2013	47.0
24.	16/6/2013	1.0
25.	26/6/2013	3.0
26.	2/7/2013	6.0
27.	8/7/2013	62.0
28.	14/7/2013	7.0
29.	15/7/2013	18.0
30.	17/7/2013	9.0
31.	20/7/2013	0.2
32.	25/7/2013	1.0
33.	31/7/2013	3.0
34.	1/8/2013	10.0
35.	5/8/2013	47.0
36.	9/8/2013	2.0
37.	11/8/2013	5.0
38.	14/8/2013	15.0
39.	15/8/2013	11.0
40.	16/8/2013	0.2
41.	17/8/2013	2.0
42.	18/8/2013	1.0
43.	19/8/2013	5.0
44.	15/9/2013	0.2
45.	21/9/2013	9.0
46.	22/9/2013	2.0
47.	11/10/2013	0.6
48.	21/12/2013	1.0

Rainfall Data for 2014

S.No.	Date of Storm Event	Average rainfall (mm)
1.	17/1/2014	24
2.	21/1/2014	0.9
3.	22/1/2014	31
4.	6/2/2014	0.2
5.	7/2/2014	5.0
6.	13/2/2014	4.0
7.	14/2/2014	16
8.	15/2/2014	0.3
9.	27/2/2014	6.0
10.	1/3/2014	2.0
11.	10/3/2014	3.0
12.	17/3/2014	9.0
13.	21/3/2014	1.0
14.	23/3/2014	3.0
15.	24/3/2014	10.0
16.	28/3/2014	6.0
17.	6/4/2014	2.0
18.	7/4/2014	0.1
19.	17/4/2014	3.0
20.	18/4/2014	11.0
21.	2/5/2014	0.1
22.	4/5/2014	2.0
23.	6/5/2014	0.5
24.	10/5/2014	0.3
25.	12/5/2014	1.0
26.	13/5/2014	10.0
27.	23/5/2014	1.0
28.	13/6/2014	0.2
29.	29/6/2014	2.0
30.	30/6/2014	11.0
31.	1/7/2014	0.6
32.	13/7/2014	0.2
33.	17/7/2014	3.0
34.	18/7/2014	14.0
35.	29/7/2014	4.0
36.	4/8/2014	0.3
37.	6/8/2014	9.0
38.	30/8/2014	0.1
39.	1/9/2014	9.0
40.	2/9/2014	0.3
41.	3/9/2014	35.0
42.	4/9/2014	6.0
43.	5/9/2014	81.0
44.	8/9/2014	1.0
45.	12/9/2014	1.0
46.	13/10/2014	0.3
47.	14/10/2014	1.0
48.	2/12/2014	0.3
49.	3/12/2014	5.0
50.	13/12/2014	12.0
51.	14/12/2014	11.0