BHAKTAPUR PAPER AND PLASTIC RECYCLING CENTRE

Silakhe, Bhaktapur

By:

KRITAN PRAJAPATI

750114

A thesis submitted in partial fulfillment

of the requirements for the

Degree of Bachelor of Architecture

PURBANCHAL UNIVERSITY

KHWOPA ENGINEERING COLLEGE

DEPARTMENT OF ARCHITECTURE

Libali, Bhaktapur, Nepal

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An Undertaking of Bhaktapur Municipality
KHWOPA ENGINEERING COLLEGE
(Affiliated to Purbanchal University)
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CERTIFICATE

This is to certify that the thesis entitled **BHAKTAPUR PAPER AND PLASTIC RECYCLING CENTER** at ***Silakhe, Bhaktapur***, submitted to the Department of Architecture of Khwopa Engineering College by **Mr. Kritan Prajapati** of Class Roll No. 14/ B.Arch./ 075 has been declared successful for the partial fulfillment of the academic requirement towards the completion of the degree of Bachelor of Architecture of Purbanchal University.

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DECLARATION

I declare that thesis entitled, **Bhaktapur Paper and Plastic Recycling Center** is submitted by me in partial fulfillment of the requirement for the degree of Bachelor in Architecture to Purbanchal University, Biratnagar, Nepal. I state that this project is the result of my own independent work/ investigation except where otherwise stated. I hereby give consent for my project, to if accepted to be available for photocopying and understand that any reference to or quotation from my thesis will receive acknowledgement.

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Kritan Prajapati

750114/B.ARCH/075

September,2024

ABSTRACT

Waste are the byproducts of day-to-day human activities. The things that we discard after use turns into waste. The accumulated municipal solid waste from each and every household when disposed off directly in the environment not only deteriorates environment but also the quality of life of people living nearby which can be seen in Sisdol as example.

Bhaktapur municipality has made provision of collecting organic wastes from the households and turns them into compost manure. However, provision has not been made in case of inorganic wastes. Such wastes are used for the construction of river corridors around Hanumnte river bank or are sent to Sisdol landfill sites for disposal.

The project **Bhaktapur paper and plastic recycling center** aims in proper management of municipal solid waste (MSW) of the Bhaktapur municipality without harming the environment. The project aims to properly manage the dry solid waste such as papers, plastics, metals, others, etc. collected by the Bhaktapur municipality by segregating them efficiently. The objective of the project is not only segregating the waste but also turning segregated plastic and paper waste into new products by recycling them. Paper waste can be turned into new craft paper while plastic waste can be turned into outdoor furniture which are aesthetically pleasing by using the machinery equipment.

Hence, the main objective of the project is to create sustainable environment that prevents environmental deterioration and enhance healthy living environment for all. Also enhancing the standard of workers working on waste and engagement of public in the waste management sector.

Keywords: Waste, Municipal solid waste (MSW), dry solid waste, environment, plastic, paper, recycling

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Kritan Prajapati

750114/B.Arch/075

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LIST OF ABBREVIATION

MSW	Municipal Solid Waste
SWM	Solid Waste Management
ADB	Asian Development Bank
ISWM	Integrated Solid Waste Management

1.INTRODUCTION

1.1 INTRODUCTION

We as human beings are bound to perform various kinds of activities to live and sustain our day-to-day life. Waste are the byproducts of the human activities. Even the smallest activity that a human does might generate some sort of waste products. For instance, basic human activities such as preparation of food, plastic wrappers from the food packages, etc. form the vital constituent of solid waste. Even though the waste produced by a single person or a family may seem limited or negligible but once the waste from more people gets accumulated, the volume of the waste become very huge and unmanageable.

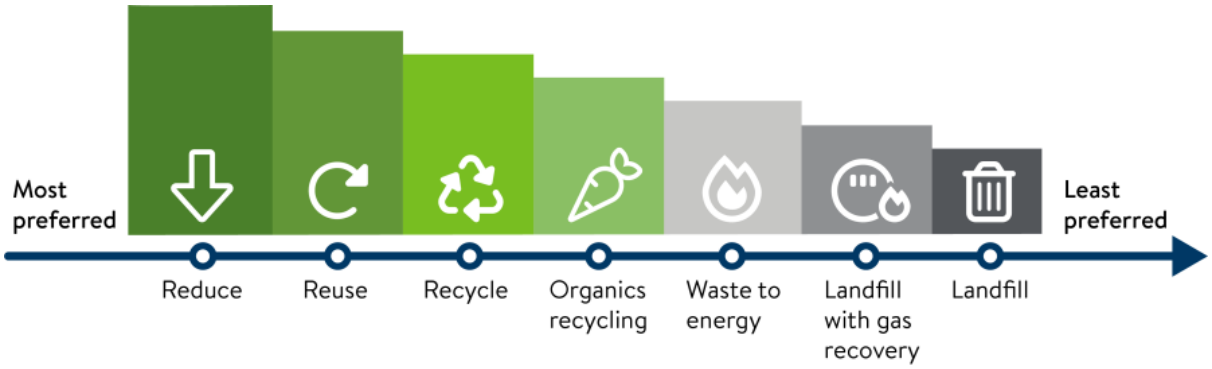


Figure 1. 1 Hierarchy of Waste management

Municipal solid waste more commonly known as trash or garbage – consists of everyday items we use and then throw away, such as product packaging, grass clippings, furniture, clothing, bottles, food scraps, newspapers, appliances, pain ant batteries. This comes from our homes, schools, hospitals and businesses. It does not include the hazardous solid waste from industrial, commercial and institutional establishments, market waste, yard waste and street sweepings. **Paper and plastic** make up the most of the municipal waste produced among all the other wastes.

The project **Bhaktapur paper and plastic recycling center** is a municipal waste management facility which segregates the dry waste collected by the Bhaktapur municipality and recycle the collected plastic and paper waste into useful products while transferring the other segregated dry solid waste into the proper place without disposing them in the environment. The center not only manages and recycles waste but engage public

by letting them learn about the value of waste through education center, exhibitions and visual connections.

1.2 PROJECT JUSTIFICATION

Managing waste properly is essential for building sustainable and livable cities, but it remains a challenge for many developing countries. Solid waste management at municipalities of Nepal is one of the major issues that require a sustainable solution. The present status of waste management in almost all municipalities are open dumping and landfilling without any treatment.

In case of Bhaktapur, also the municipal solid waste is collected with vehicles from door to door from residential community, later dumped in the land fill sites of the river bank which may even pollute the holy hanumante river one of the supporting rivers of Bagmati. At present, despite of having the provision for managing organic wastes in treatment plants, making them the compost, the problem has been still there in case of the inorganic wastes. Such waste is sent to dumping sites which can have severe impact on health of humans working on the site as well as living around the site. The land fill sites, once that is filled the alternative land fill site is to be designated. Thus, the waste created and stored by one generation might have negative impact on many generations to come.

Figure 1. 2 Wastes dumpoe at river banks in Bhaktapur

The need of proper recycling center is crucial at this time. Solid wastes such as paper and plastic shouldn't be taken as waste but instead a resource that can be recycled, upcycled or reused in same or different form. In this case, it can reduce the pollution that has been created by the improper management of the wastes.

1.3 OBJECTIVES

- To design a recycling center with public engagement facilities.
- To provide enough space for making the municipal waste management efficient and effective.
- To provide appropriate space for recycling of dry solid waste i.e paper and plastic.
- To design an architectural facility where the workers working in the waste can ensure healthy living environment within.
- To incorporate landscape within the design that changes the perception of people and provide space for public activities within the waste management center.
-

1.4 SCOPE AND LIMITATION

The project solely deals with the municipal solid waste and its present scenario in case of Bhaktapur municipality. This project only aims to recycle paper and plastic waste but not other inorganic wastes. The project aims to recycle paper and plastic to some useful forms.

The project is not only a processing plant but also an education center in which people visiting can get the information and knowledge about the different wastes, their adverse effects and different methods of solid waste management as well as process of paper and plastic recycling.

2.LITERATURE REVIEW

2.1 WASTE

Waste are the unwanted or unusable materials discarded after primary use that are worthless, defective and of no use. According to the UN, “materials that are not prime products (that is, products produced for the market) for which the generator has no further use in terms of his/her own purposes of production, transformation or consumption, and of which he/she wants to dispose. Wastes may be generated during the extraction of raw materials, the processing of raw materials into intermediate and final products, the consumption of final products, and other human activities. Residuals recycled or reused at the place of generation are excluded.”

2.2 TYPES OF WASTE

Wastes can be of various types on the basis of their physical state, properties based, source based, type based.(Kohli Garg et al., n.d.)

2.2.1 On the basis of physical state

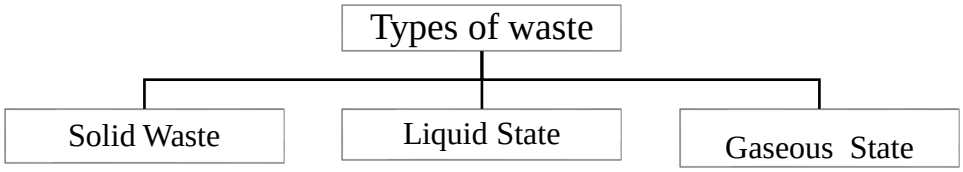


Figure 2. 1 Types of waste on the basis of state

2.2.1.1 Solid waste

Solid wastes are any discarded or abandoned materials that can be solid, liquid, semi-solid or containerized gaseous material discarded by the human society. These include urban wastes, agricultural wastes, biomedical wastes and radioactive wastes. The term refuse is also used for solid wastes.

Examples of solid wastes include waste tires, septage, scrap metal, latex paints, furniture and toys, garbage, appliances and vehicles, oil and anti-freeze, empty aerosol cans, paint cans and compressed gas cylinders, construction and demolition debris, asbestos, plastics, styrofoam containers, bottles etc

2.2.1.2 Liquid Waste

Liquid wastes can be defined as liquids/fluids that are generated from washing, flushing or manufacturing processes of the industries. They are also called as sewage. The most common practice of disposing liquid waste is to discharge it in ground or rivers and other water bodies without treatment.

Examples: domestic washings, chemicals, oils, waste water from ponds, Wastewater from manufacturing industries, manure, waste oil, fats, oils or grease (FOG), used oil, and hazardous household liquids

2.2.1.3 Gaseous State

It is a waste product released in the form of gases from automobiles, factories, industries, burning of fossil fuels etc. and get mixed in the atmosphere. These gases include carbon monoxide, carbon dioxide, Sulphur dioxide, nitrogen dioxide, ozone and methane etc.

2.2.2 On the basis of property

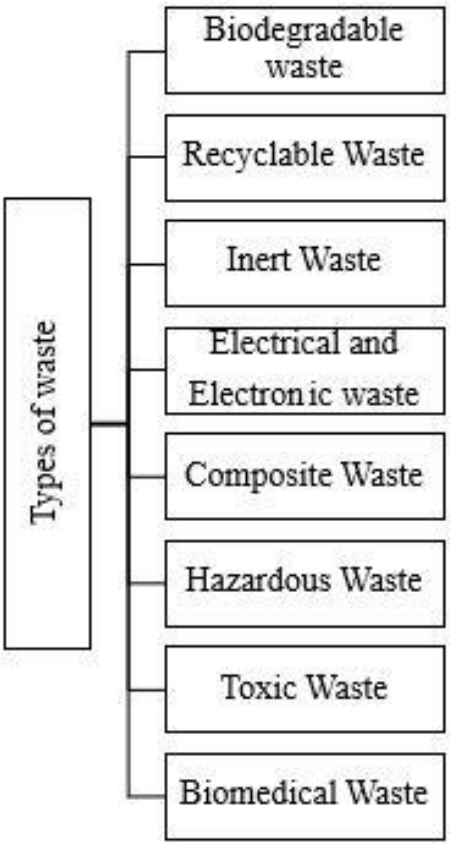


Figure 2. 2 Types of waste based on properties

2.2.3 On the basis of typology

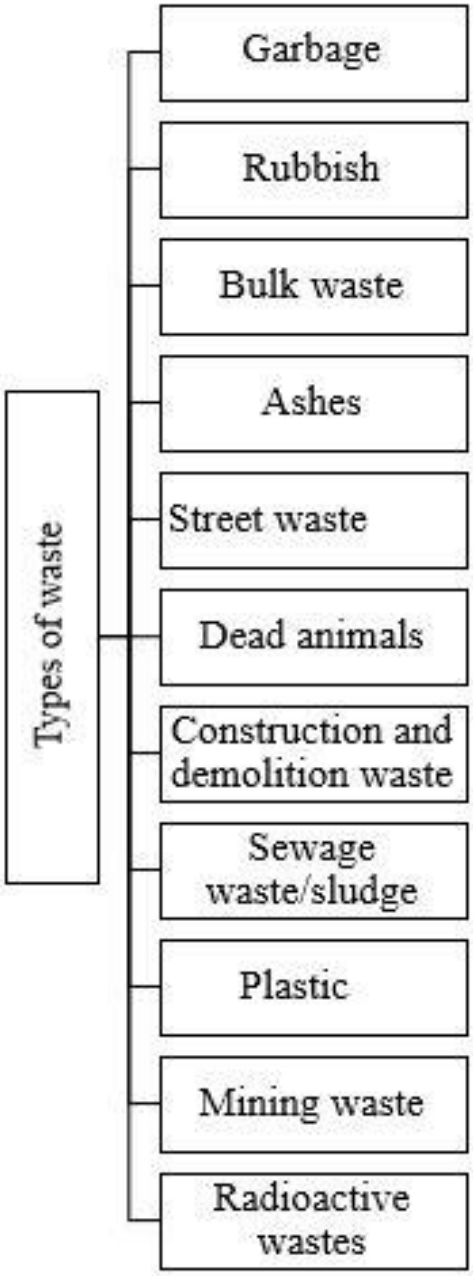


Figure 2. 3 Types of waste based on typology

2.3 SOLID WASTE MANAGEMENT(SWM)

According to Britannica," **Solid-waste management**, the collecting, treating, and disposing of solid material that is discarded because it has served its purpose or is no longer useful. Improper disposal of municipal solid waste can create unsanitary conditions, and these conditions in turn can lead to pollution of the environment and to outbreaks of vector-borne disease - that is, diseases spread by rodents and insects *(Solid-waste management, Britannica).*

Solid waste management system is the complete process of collecting, treating and disposing of solid wastes. The system also includes recycling of garbage that do not belong to garbage or trash. The generation of solid waste is inevitable from various activities that we as a human perform in our settlement. So, the issue of waste will forever be standing beside us unless we develop proper waste management strategies and policies. Solid waste management is all about how solid waste can be changed and use as valuable resource. The goal of waste management is to increase the product's lifecycle and reuse and recover materials where possible, in order to reduce the total amount of waste that goes into landfill and minimize the environmental burden. The final goal pursued through this practice is thus to recreate a valuable resource through responsible disposal of rubbish, which is why waste management plays a crucial role in supporting sustainable development and the transition towards circular economy. *(Waste management, Prysmian Group).*

2.4 MUNICIPAL SOLID WASTE(MSW)

According to the U.S. Environmental protection agency," **Municipal Solid Waste (MSW)**-more commonly known as trash or garbage—consists of everyday items we use and then throw away, such as product packaging, grass clippings, furniture, clothing, bottles, food scraps, newspapers, appliances, paint, and batteries. This comes from our homes, schools, hospitals, and businesses. Every human living in each household produces certain volume of such waste each and every day.

EPA encourages practices that reduce the amount of waste needing to be disposed of, such as waste prevention, recycling and composting. In 2013, Americans generated about 254 million tons of trash and recycled and composted about 87 million tons of this material, equivalent to a 34.3 percent recycling rate. On average, we recycled and composted 1.51

pounds of our individual waste generation of 4.40 pounds per person per day. *(U.S. Environmental Protection Agency)*

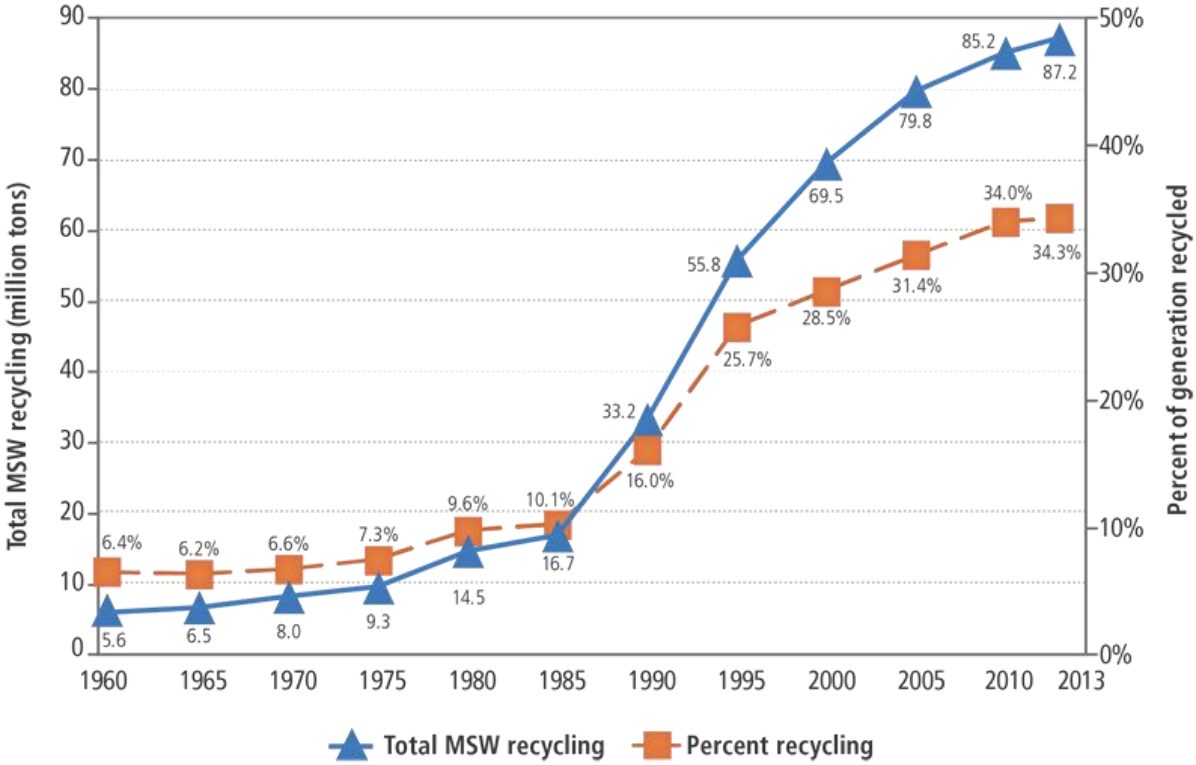


Figure 2. 4 MSW Recycling rates 1960-2023

2.4.1 SCENARIO OF MSW IN THE WORLD

Solid waste management is a universal issue affecting every single person in the world. Individuals and governments make decisions about consumption and waste management that affect the daily health, productivity, and cleanliness of communities. *(Silpa Kaza, Lisa Yao, Perinaz Bhada-Tata, and Frank Van Woerden 2018).*

According to the World bank group, what a waste 2.0, “The world generates 2.01 billion tonnes of municipal solid waste1 annually, with at least 33 percent of that—extremely conservatively—not managed in an environmentally safe manner. Worldwide, waste generated per person per day averages 0.74 kilogram but ranges widely, from 0.11 to 4.54 kilograms. Though they only account for 16 percent of the world’s population, high-income countries generate about 34 percent, or 683 million tonnes, of the world’s waste. When looking forward, global waste is expected to grow to 3.40 billion tonnes by 2050.”

It can be seen that the increase in rate of global waste is parallel to the increased in the urbanization and development in the countries. The change in the composition of waste reflects the change in the consumption patterns of the countries.

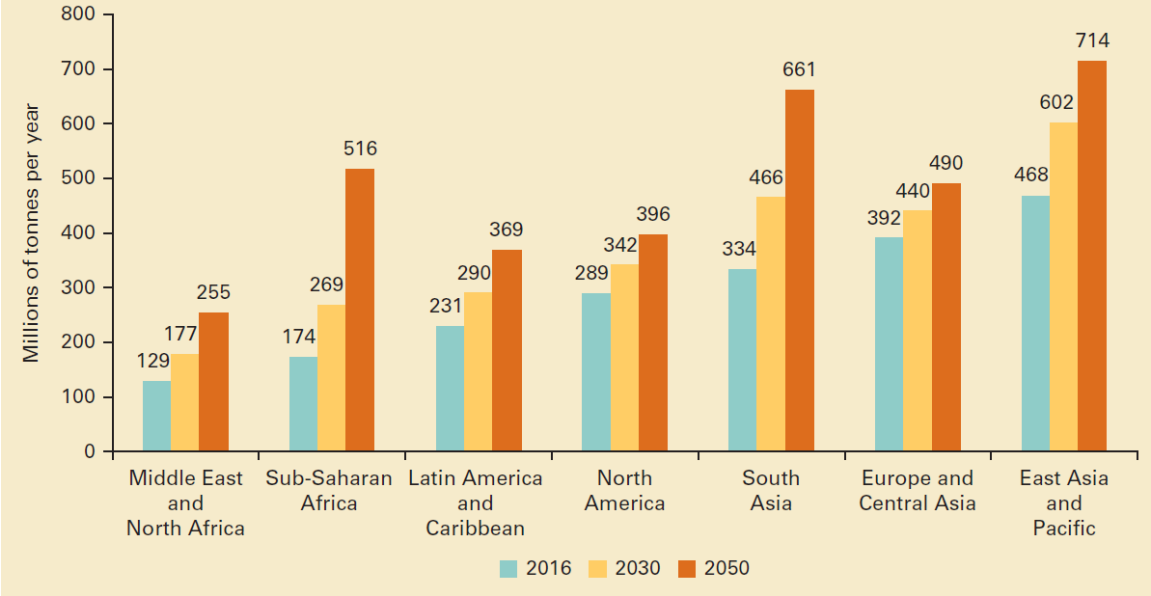


Figure 2. 5 Projected waste generation by regions (millions of tonnes/year)

The bar diagram shows that the East Asia and Pacific region is generating highest tonnes of waste per year and the Middle East and North Africa region is producing the least. However, the fastest growing regions are Sub-Saharan Africa, South Asia, and the Middle East and North Africa, where, by 2050, total waste generation is expected to more than triple, double, and double respectively.

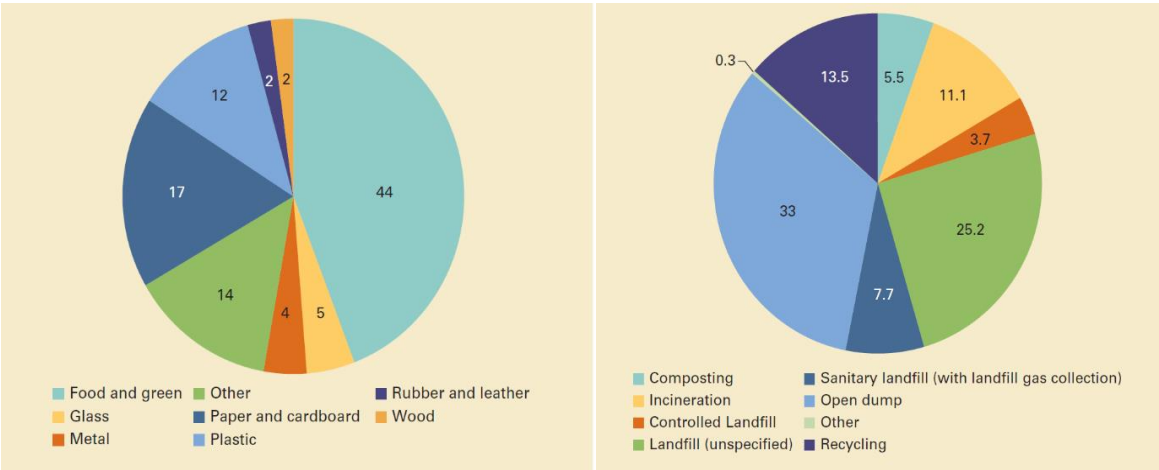


Figure 2. 6 Global disposal and treatment of waste (%)

2.4.2 SCENARIO OF MSW IN NEPAL

Nepal is a developing country with population of around 2,91,64,578 according to the census of 2078 BS. At past, majority of people were engaged in agriculture as their primary occupation. This resulted in the maximum amount of organic wastes. However, due to the rapid urbanization and change in life style of people, the amount of waste has grown significantly. This has also increased in other types of inorganic wastes along with the organic wastes.

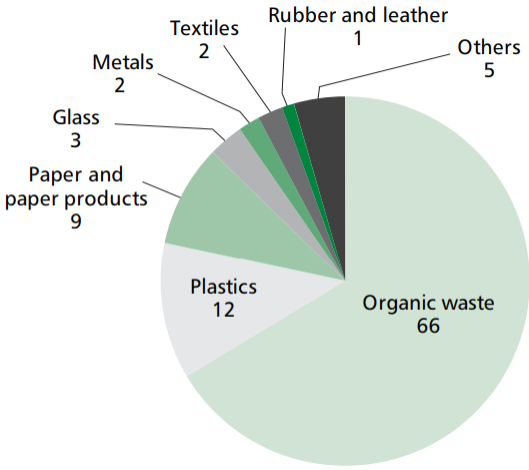


Figure 2. 7 Composition of municipal waste in 58 municipalities of Nepal

Taking baseline data from solid waste management in Nepal report of Asian Development Bank 2013, the estimated waste projection of 2017 has been made. The projected data shows waste generation in municipalities of Nepal is about 3023 tons per day and the average per capita waste generation is 0.223 kg/person/day. On average the composition of waste is primarily decomposable about 60% and about 25% is recyclables such as plastics, papers and metals [2,3]. *(Maharjan, M. K., & Lohani, S. P. 2020).*

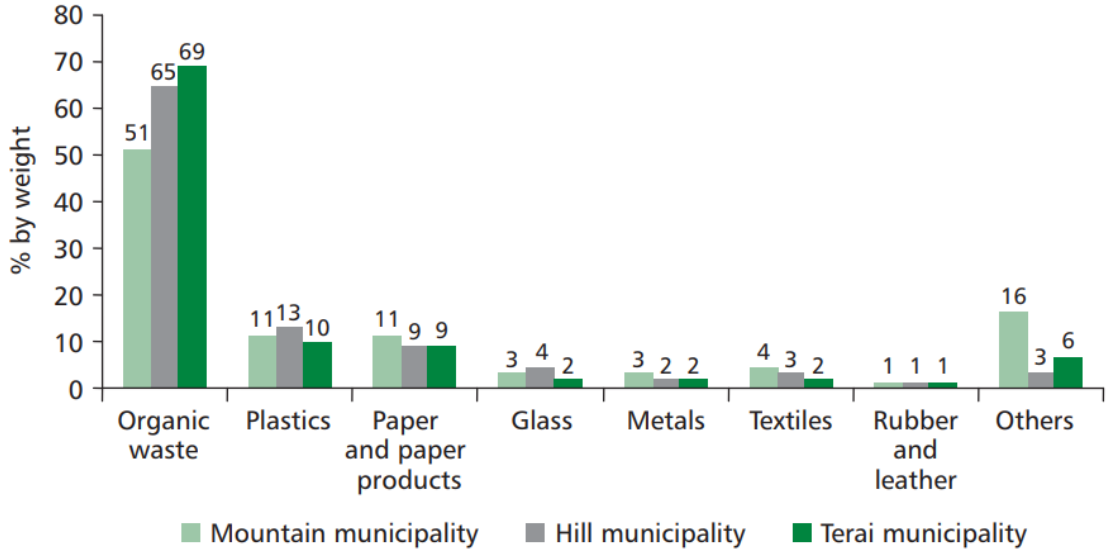


Figure 2. 8 Composition of MSW according to ecological regions (%)

According to the study conducted by Asian Development Bank in 58 municipalities of Nepal, the waste composition included the maximum organic waste i.e. 66%. The various other types of waste such as paper, plastic, glass, metals, textiles, rubber and leather, etc. contributes 29% of waste. This waste is recyclable or reusable. From the study, we can conclude that the maximum number of municipalities perform open dumping and even municipality with no any municipal system were present.

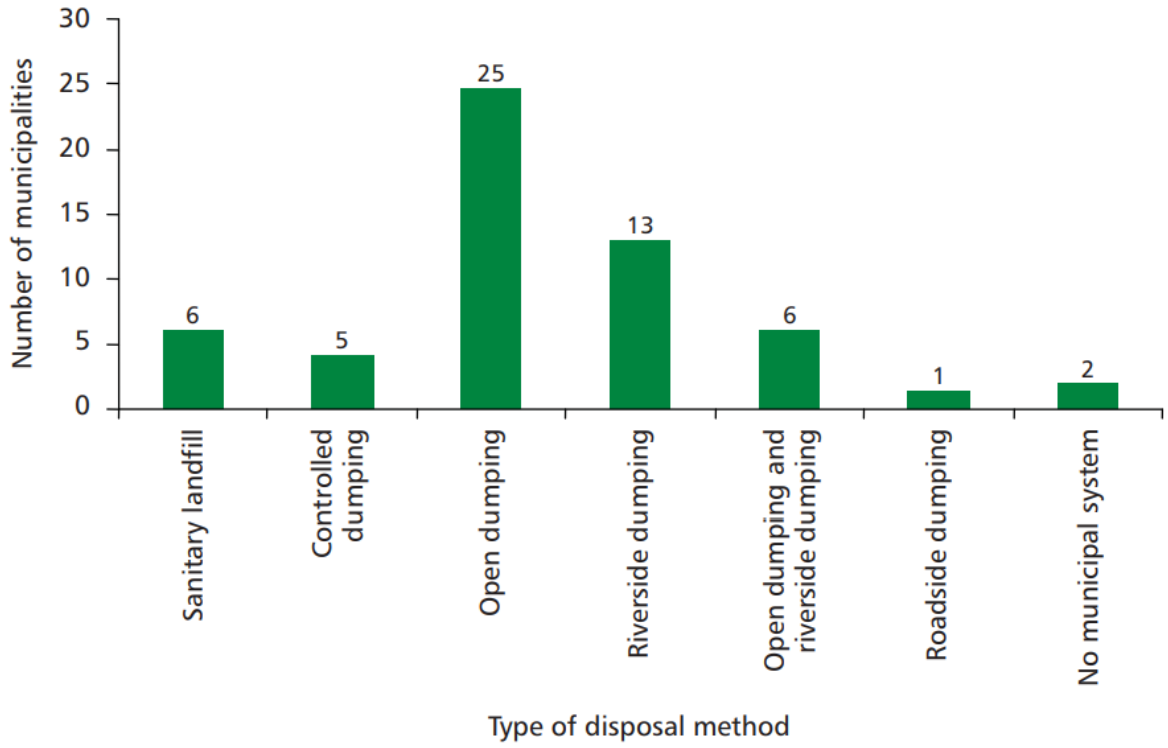


Figure 2. 9 Types of disposal methods used in municipalities of Nepal

2.4.3 SCENARIO OF MSW IN BHAKTAPUR MUNICIPALITY

2.4.3.1 Description of the study area

The study area Bhaktapur municipality (27°40'22.6848" N and 85°25'45.4476" E) is situated in the Kathmandu valley. It covers an area of 6.88 sq.km and lies at 17401 meters above the sea level. According to the 2021 census, the total population of Bhaktapur municipality is 79,136 and the population density is 12,070/ sq. km. There are 10 wards with ward 10 having the maximum male and female population. The total number of house hold is 18,987. *(National Statistics Office)*

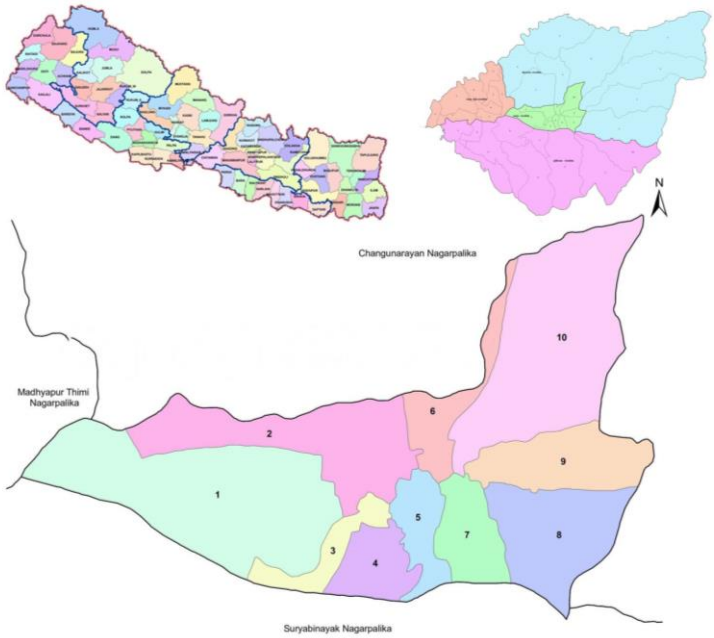


Figure 2. 10 Map of study area

2.4.3.2 History of Municipal Waste management in Bhaktapur Municipality

In the historical town Bhaktapur, waste management was not a major issue prior to the rapid urbanization and modernization in the city. As majority of the people living in Bhaktapur were from agricultural background and the waste generated consisted of agricuktural waste including kitchen waste, sewer and waste from religious activities and festivals. Because of the absence of sophisticated materials and excess packaging, the

Figure 2. 11 SAGA, for waste management in ancient times

volume of waste was probably minimal and the waste was primarily organic in nature. The

communities in the Bhaktapur had developed a fairly effective system for managing this waste. Although many houses were not equipped with toilets, many people used the nearby rivers as their toilets and dumped their waste in an open pit, called saaga, near their houses to produce compost, which they applied in the fields. Saagas were built between houses or in courtyards. At present, most of the people do not use saagas however there are few functioning saagas remaining.

Waste management is built into the culture and religion of Newars, the traditional inhabitants of the Valley. Waste from rituals such as child birth and death ceremonies are disposed at the chwaasa (a particular place in each locality where two lanes cross) or doka (place where one lane meets another, thus forming a "T" junction). There is a belief that demons reside at the doka, and the chwaasa is the place for the Goddess Ajima. Therefore, if anyone dumps waste that are to be disposed at chwaasa at the doka or elsewhere and vice versa, then the person will be troubled by the demons and the Goddess. Similarly, there is also a belief that if the saagas and other areas in the house are kept dirty then the owners will have to bear the wrath of Naag Raja (the serpent king). Waste from various feasts is also traditionally disposed at the chwaasa. Similarly, it is customary to throw old clay pots at the chwaasa on the day of Chwaasala Punhi, the full moon in the month of December *(Prajapati,1986).*

In the 1970s, the German government assisted the Bhaktapur Development Project (BDP) in the restoration and conservation of the ancient temples and the old, traditional houses in the first phase of the project. In the second phase, the focus shifted to cleanliness and sanitation – setting up systems for drainage and sewerage treatment, oxidation ponds and sludge fields. This phase saw development of roads, pavements, and toilets in individual houses. In the second phase of the BDP, the water supply reached individual houses directly. And private toilets were connected to the drainage and sewerage system, which was linked to the oxidation ponds that were connected to the local streams at Hanumante and Khasyangkhusung. The waste water treatment component of the programme did not function well right from the beginning. The sewers were always clogged. Eventually, the programme became incongruous and failed to meet the needs of local people *(Pradhan Prachanda, 2012).*

At present the solid wastes are dumped at a crude dumping site along the Hanumante River. The river is an important tributary of the Bagmati River and is an important source of fresh water supply, major drainage waterway. The river also has special cultural and religious significance among the inhabitants of the city. Due to dumping of untreated solid waste and sewerage of the city it resulted in the degradation of quality of water, and environment along the river bank (Sada, 2010). The disposal of waste without segregation has resulted in increased water pollution, decreased water flow, and foul smell near the area. The foul smell has made an adverse impact on the lives of people living near the area. The municipality had plans to develop sanitary landfill site in Taikabu in 2003 but was not able to implement due to disputes among different stakeholders and residents around the propose area (Nepal, 2008). Since then 4 municipality has been dumping its waste in different locations depending on the availability of land which is not sustainable environmentally, economically nor in the aspect of public health. *(Duwal Indu, 2015).*

2.4.3.3 Present Context of Municipal Waste management in Bhaktapur Municipality

Due to the rapid urbanization, population growth and change in the consumption pattern of people, the municipal waste in Bhaktapur has been increased than the past years. People are engaged in diverse occupation and have different lifestyle than the past years. This not only diversify the waste constituents, but also increases the waste volume of the municipality. According to the Bhaktapur municipality, the average daily municipal waste(summer& winter average) is about 30 tons per day. Among them 67% of waste is organic and rest 33% is inorganic i.e. recyclable or reusable. Average daily collection per day is 28-29% from 17000 households. *(Suwal Dilip,2024)*

According to the survey conducted by Asian Development Bank, the wastes data are as follows:-

Municipal Waste generation and collection efficiency *(Source: Asian Development Bank)*

Average household waste(kg/day): 0.85

Average household size (number of members: 5.47

Average per capita HH Waste (g/capita/day): 155.43

Total HH waste(tons/day): 13.00

Total commercial waste(tons/day): 7.20

Total Institutional Waste(tons/day): 0.62

Average per Capita MSW(g/capita/day): 345.40

Total MSW generation(tons/day): 28.90

Estimated Waste collection(tons/day): 25.0

Collection Efficiency: 86.5

Composition of Household waste *(Source: Asian Development Bank)*

Organic waste: 77.48

Plastics: 8.52

Paper and paper products: 6.79

Glass: 0.55

Metals: 0.79

Textiles: 0.69

Rubber and leather: 0.00

Others: 5.19

Composition of Institutional waste *(Source: Asian Development Bank)*

Organic waste: 30.35

Plastics: 18.77

Paper and paper products: 29.35

Glass: 2.95

Metals: 3.15

Textiles: 3.46

Rubber and leather: 1.68

Others: 10.29

Composition of Commercial waste *(Source: Asian Development Bank)*

Organic waste: 38.73

Plastics: 21.29

Paper and paper products: 18.03

Glass: 2.14

Metals: 6.20

Textiles: 0.73

Rubber and leather: 0.37

Others: 12.51

2.5 FUNCTIONAL ELEMENTS OF WASTE MANAGEMENT

There are six major functional elements of municipal waste management. They are as follows:

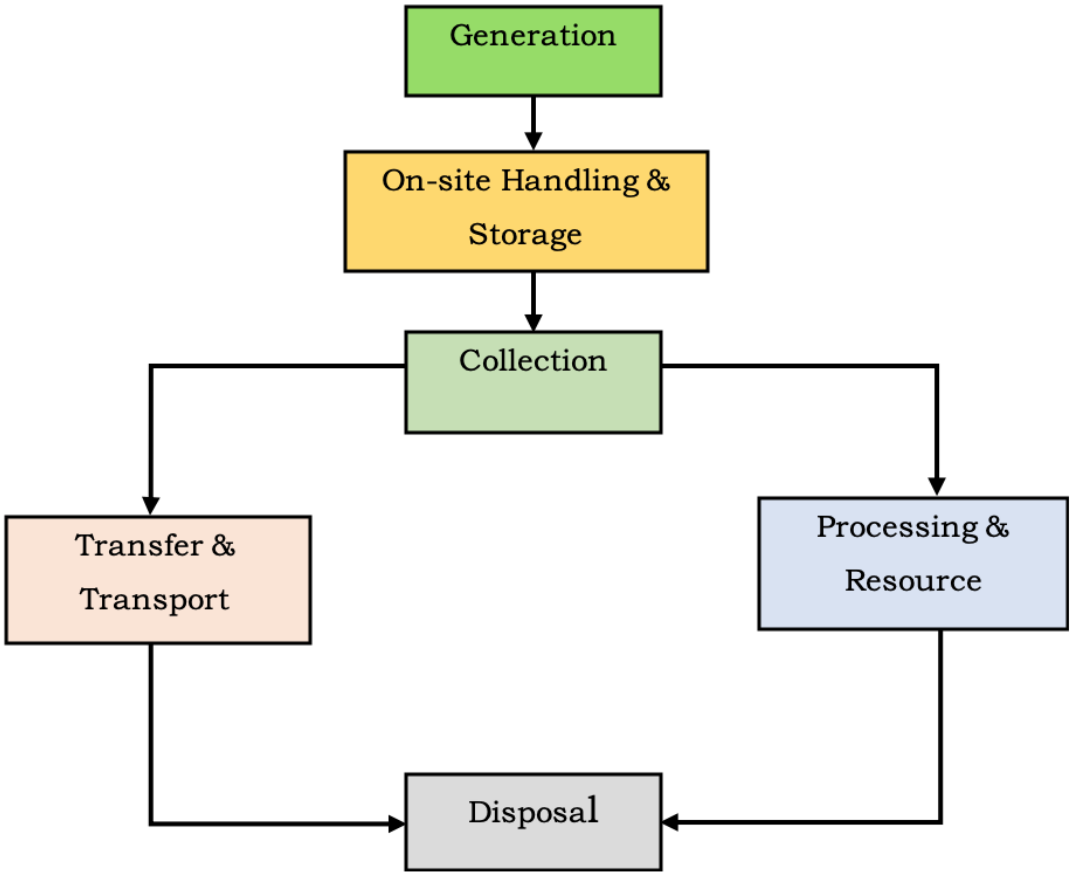


Figure 2. 12 Functional elements in waste management

1. **Waste Generation:** It pertains the production of waste materials through various activities in residential, commercial and industrial settings. The waste can be generated from natural, human and animal activites.

2. **On-site handling and storage:** It involves the various tasks associated with waste management from initial handling until they are placed in the containers designated for storage before collection or transport to the drop-off and recycling centers. For instance, households may employ separated bins for recyclable materials and non-recyclable waste.

3. **Waste Collection:** The term "collection" includes not only the gathering or picking up of solid wastes from various sources but also the hauling of these wastes to the disposal site or transfer station and unloading there.

4. **Transfer and transport:** Transfer and Transport refer to the means, facilities, and appurtenances used to affect the transfer of wastes from one location to another, usually a more distant location. Typically, the wastes from relatively small collection vehicles are transferred to larger vehicles and then transported to distant locations. Transfer and transport involve the movement of waste from the collection points or transfer stations to treatment or disposal facilities.

5. **Resource Recovery and Processing:** This involves the facilities, equipments and technologies that are used to extract value from waste through recycling, composting or energy recovery methods.

6. **Disposal:** Disposal is the final stage of solid waste management when waste that cannot be recovered or recycled is safely and responsibly disposed of. Common disposal methods include landfilling and incineration.
   (Source: Jamal haseeb, 2020)
   (Source: Mukherje Suchandra, 2023)

2.6 METHODS OF MUNICIPAL WASTE MANAGEMENT

There are various methods of solid waste management. They are as follows:-

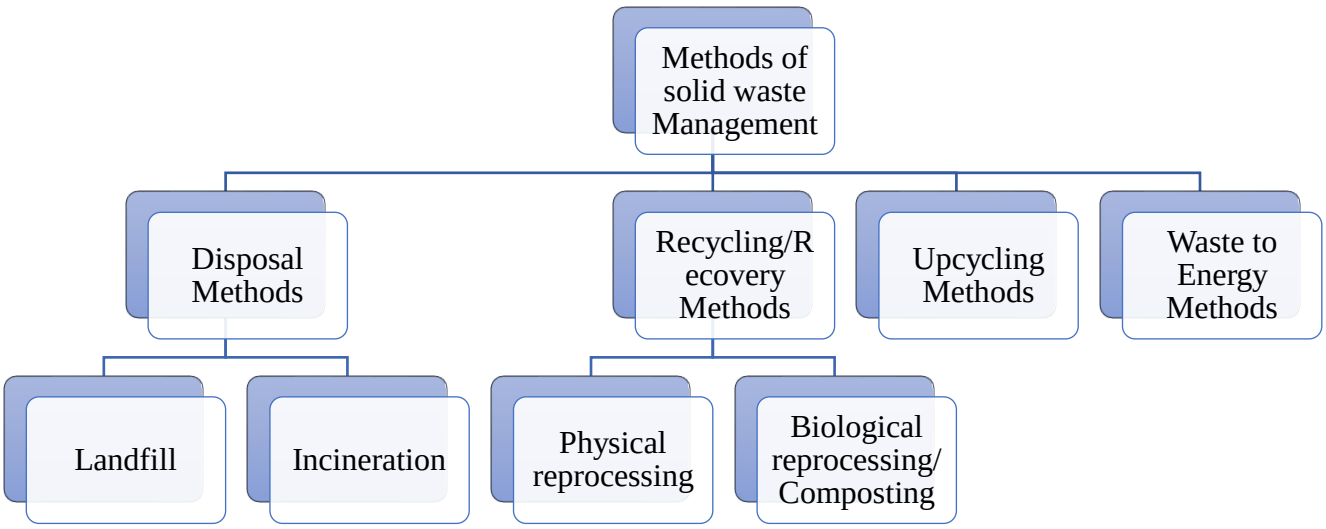


Figure 2. 13 Methods of solid waste management

2.7 RECYCLING

According to the US Environmental Protection Agency, "Recycling is the process of collecting and processing materials that would otherwise be thrown away as trash and turning them into new products." *(US Environmental Protection Agency)*

Among various waste management techniques, recycling is one of the vital techniques that takes waste as a raw material and convert it into the useful forms. In general, recycling is the process by which the unwanted waste materials are processed and converted into the new materials and objects that can be used in our daily life. It is one of the key components of modern waste reduction i.e. reduce, reuse and recycle.

The basic phases in recycling are the collection of waste materials, their processing or manufacture into new products, and the purchase of those products, which may then themselves be recycled. Typical materials that are recycled include iron and steel scrap, aluminum cans, glass bottles, paper, wood and plastics. *(Britanica 2024)*

2.7.1 BENEFITS OF RECYCLING

1. Environment: Recycling provides many benefits to our environment. By recycling our materials, we create a healthier planet for ourselves and future generations.

2. Conserve natural resources: Recycling reduces the need to extract resources such as timber, water, and minerals for new products.

3. Climate change: According to the most recent EPA data, the recycling and composting of municipal solid waste (MSW or trash) saved over 193 million metric tons of carbon dioxide equivalent in 2018.

4. Energy savings: Recycling conserves energy. For example, recycling just 10 plastic bottles save enough energy to power a laptop for more than 25 hours. To estimate how much energy you can save by recycling certain products, EPA developed the individual Waste Reduction Model (iWARM).

5. Waste and pollution reduction: Recycling diverts waste away from landfills and incinerators, which reduces the harmful effects of pollution and emissions. *(US Environmental Protection Agency)*

2.7.2 PAPER RECYCLING

Paper recycling is the process by which waste paper can be turned into new paper products. According to American Forest & Paper Association, about 80% of U.S. paper mills use some recycled paper to make new and innovative products. About 6.79% of house hold waste,

29.35% of

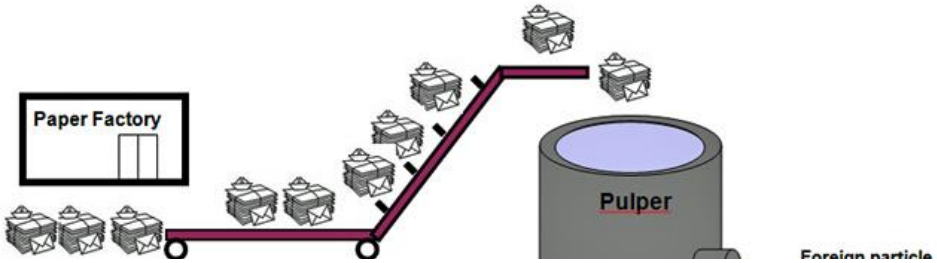


Figure 0.1 Process of recycling scrap paper for food cartoons
Source: Harling Antje

Figure 0.2 Process of recycling scrap paper for food cartoons
Source: Harling Antje

Figure 0.3 Process of recycling scrap paper for food cartoons
Source: Harling Antje

Figure 0.4 Process of recycling scrap paper for food cartoons
Source: Harling Antje

institutional waste and 18.03% of commercial waste in Bhaktapur municipality is paper and paper waste (Asian Development Bank).

2.7.2.1 PROCESS OF PAPER RECYCLING

1. COLLECTION & TRANSPORTATION

This significant step involves the collection of recyclable papers. It entails gathering paper waste from various outlets like your home, offices, and business vicinity. Recyclers and paper merchants collect the paper materials from collection points such as trash bins, paper stores, paper scrap yards, and commercial outlets that generate paper waste.

After collection, they are then measured, graded for quality, and hauled to recycling paper mill facilities. It then gets transported to a recycling plant where the waste paper is sorted and separated into types and grades. *(Conserve Energy Future)*

2. SORTING

At the recycling plant, the papers are sorted and separated. The recyclable papers are sorted based on quantity and paper value by assessing the materials that were used to make the paper. They are classified according to their surface treatment and structure. For example; thin lightweight paper materials such as newspapers are out separately from thicker paper materials like paper folders. *(Conserve Energy Future)*

3. SHREDDING AND PULPING

Shredding is done to break down the paper materials into small bits. After the material is finely shredded to bits, it is mixed with water and chemicals to breakdown the paper fiber materials. It turns the paper materials into a slurry substance, a process termed as pulping. This is the point where it undergoes a heating process that turns it into pulp. Usually, equipment called puller is what recycling companies use for the process of pulping. *(Conserve Energy Future)*

Figure 2. 14 Shredding Machine

4. SCREENING

In this process the pulp gets pushed into screens with space and holes of different shapes and sizes. The end of this process removes contamination from the pulp and filter out unwanted objects. *(Conserve Energy Future)*

Figure 2. 15 Screening machine

5. DEINKING & BLEACHING

Deinking is done only when the paper contains some ink on it. Once the pulp is produced it is then passed through a series of screens to remove larger pieces of contaminants for

e.g.: inks, staples, plastic film and glue. The pulp material is then mixed up with new pulp to help the slurry substance solidify and form a firmer end product. The clean paper pulp is then placed in the machine that uses centrifugal cleaning to spin more of the debris from the paper pulp.

Bleaching is the process to produce white papers by use of chemicals. *(Conserve Energy Future)*

6. ROLLING/DRYING

This is the final step in the paper recycling process. Once the pulp has been de-inked, it's passed through massive rollers to squeeze out excess water from the mixture. Once the moisture has been removed, the pulp is sent through heated rollers to form long rolls of continuous sheets of paper. From there, the rolls of paper are sent to various manufacturers to be produced into paper products. *(Witherspoon Christopher 2023)*

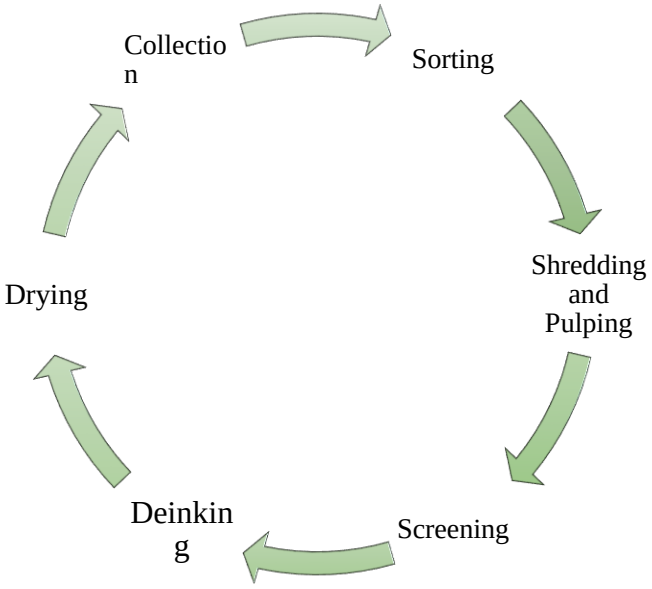


Figure 2. 16 Paper recycling process

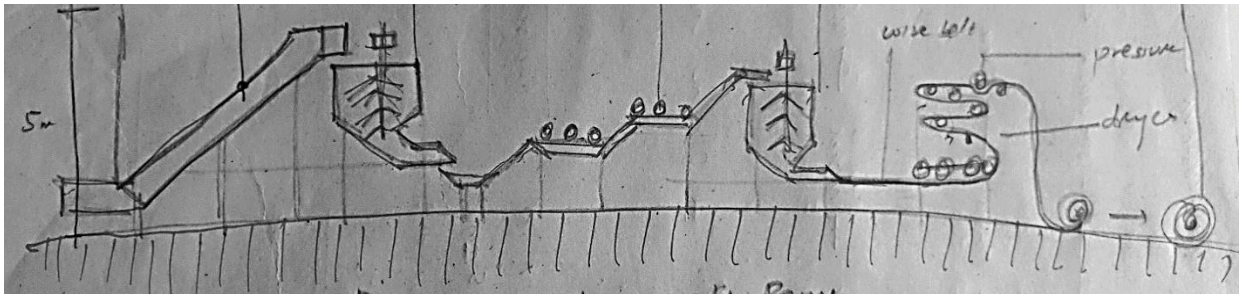


Figure 2. 17 Recycled paper to craft paper making process

2.7.3 PLASTIC RECYCLING

Plastic recycling has been described as the process of recovering scrap or waste plastics and reprocessing the material into useful products, sometimes completely different in form from their original state. *(Merrington DrAdrian 2011).* Plastic waste can take up to 500 years to decompose depending on the composition and disposal methods. The global plastic waste has been increasing and have severe impact on the environment. In case of Bhaktapur municipality, about 8.52% of household waste, 18.77% of institutional waste and 21.29% of commercial waste. *(Asian Development Bank)*

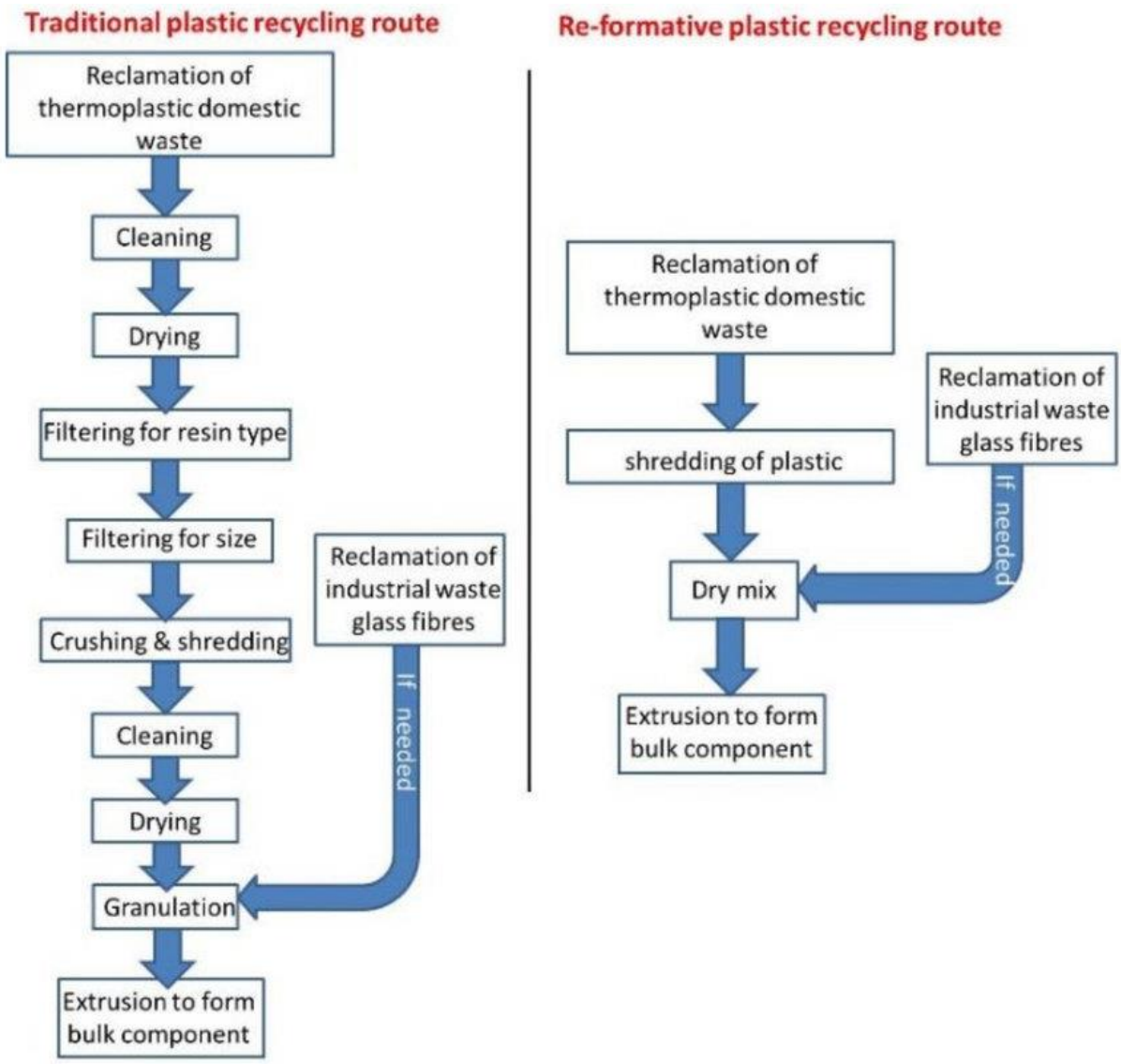


Figure 2. 18 A schematic of the traditional plastic recycling process and the novel re-formative process (Turner P. Richard, Kelly Catherine, Fox Rod and Hopkins Bill 2018)

2.7.3.1 Types of Plastic

Plastic recycling				
RIC number	Plastic name	Abbreviated name	Product use	New products after recycling
1	polyethylene terephthalate	PET or PETE	water, soft drink and juice bottles, carpet, polar fleece	food containers, carpet fibres, filling for jackets and cushions
2	high-density polyethylene	HDPE	milk jugs, bottles, shopping bags	bins, pipes, new containers
3	polyvinyl chloride	PVC	wrapping and packaging, pipes	pipes, traffic cones
4	low-density polyethylene	LDPE	plastic bags, squeezable bottles	rubbish bin liners, compost bins, outdoor furniture
5	polypropylene	PP	refrigerated food containers, dishware	tools, trays
6	polystyrene	PS	disposable plates, cutlery, protective packaging	light switches, packaging, mouldings
7	other	O	acrylic, nylon, composite plastics	low-grade bottles, outdoor products

Table 1 Types of Plastic

2.7.3.2 PROCESS OF PLASTIC RECYCLING

1. COLLECTION

In this step the plastic wastes from different sources are collected. After collection, the plastic wastes are taken to the material recovery facilities (MRF) and are sorted out.

2. SORTING

In the material recovery facility, the wastes are sorted out by placing them on the conveyor belts. The conveyor belt maintains the constant flow of plastic waste through the sorting facility. Various technologies used for sorting are as follows: -

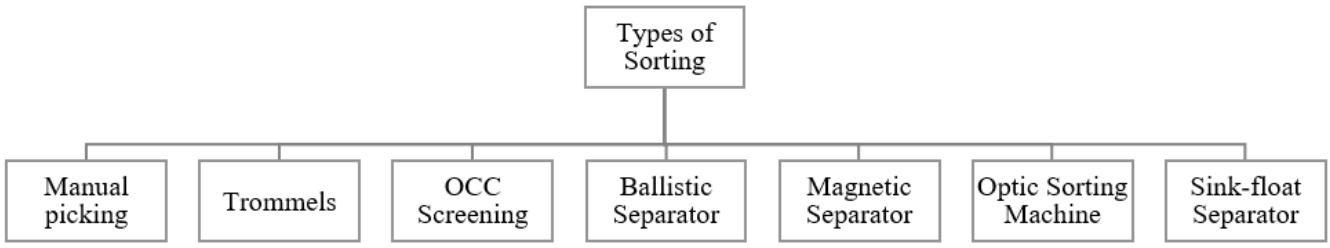


Figure 2. 19 Types of sorting (British Plastic Federation)

3. WASHING

Washing is a crucial step in the plastic recycling process since it removes some of the impurities that can impede the operation, or completely ruin a batch of recycled plastic. The impurities targeted in this step commonly include things such as product labels and adhesives as well as dirt and food residue. *(Guberman Ross 2020)*

4. SHREDDING/GRINDING

The plastic is then fed into shredders, which break it down into much smaller pieces. These smaller pieces, unlike formed plastic products, can be processed in the next stages for reuse. Additionally, the resized plastic pieces can be used for other applications without further processing, such as an additive within asphalt or simply sold as a raw material. *(Guberman Ross 2020)*

5. EXTRUSION

This is the final stage of plastic recycling. Extrusion is the process of melting down the plastic and forcing this through an extruder. The plastic is cut as it comes out of the extruder to form pellets. Pellets are sold onto manufacturers. *(British Plastic Foundation)*

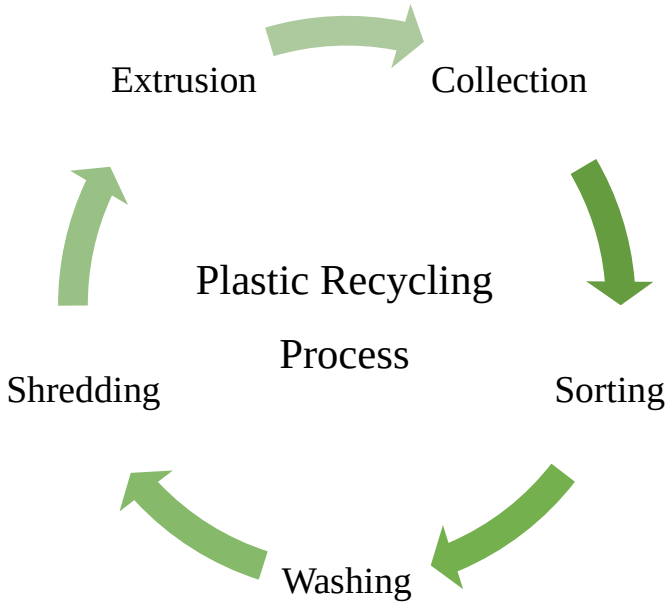


Figure 2. 20 Plastic recycling process

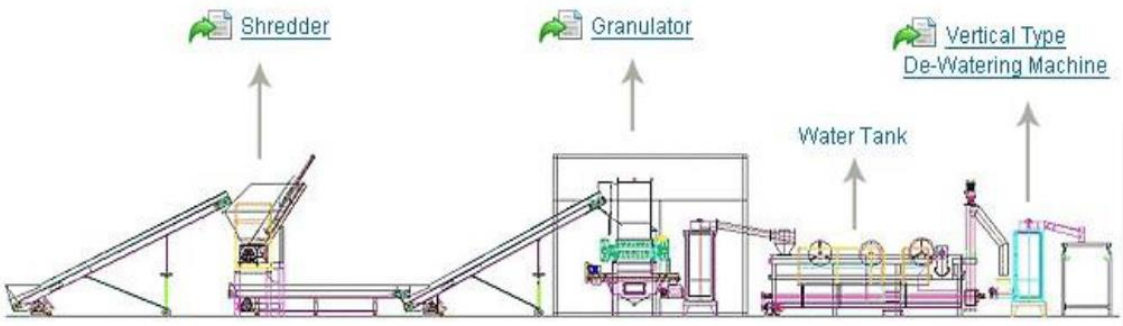


Figure 2. 21 Plastic recycling process

2.8 ARCHITECTURE AND WASTE

Waste management is an important part of our life. Various facilities and processes are available for management of wastes. However, such facilities are considered more of civil or mechanical engineering part. There is a missing link between architecture and waste management however there can be huge impact if architecture is engaged along with the other faculties in the system of waste management. Architecture can enhance different technologies with landscape design, housing, recreation and leisure.

There is lack of architecture in the waste management field. With the proper involvement of architects in such sensitive area, the whole management process can be improved. Proper planning and zoning of the plants with proper linkage and circulation for both man and machineries can be possible with architecture in this field. Architects with their concept can add value to the waste management scenario with proper industrial design that can promote the healthier community through their participation in process. Along with proper planning the architects can give touch of magic to enhance the exterior beauty that enhances the overall landscape which is very much absent at present scenario in the context of Nepal.

2.9 WASTE RECYCLING CENTRE

The **Waste Recycling Centre** is any areas or facility where wastes are collected, stored and recycled. Recycling centre is such place where unwanted become useful. In this place, the waste is collected, sorted and recycled into new forms that has some market value.

The recycling centres are very much important as it decreases the volume of waste in the environment by reusing them. They use the discarded materials and reduce the need to extract or harvest raw materials from the earth.

The waste recycling centre is often designed with the functionality, efficiency and sustainability in mind. There is lack of architectural touch which makes the centres unwelcoming for the general public and are disconnected from the society. Hence, to design the waste recycling centre with proper facilities not only for the working staffs, but also for the general public engagement is important. So, the design should consider the following factors:-

1. Waste Facility
2. Employee Facility
3. Public Facility

2.10 WASTE FACILITY

2.10.1 Tipping building

The tipping floor has a hard, concrete surface, allowing the unsorted materials to be stored before being introduced into the processing system via a loading shovel or other similar equipment. The space dedicated to incoming materials should be a weather-protected area, of sufficient size to hold 1.5 to 3 days' worth of delivered, unsorted materials. The unloading of the materials from the collection vehicles onto the tipping floor must be efficient yet protect the materials. The tipping floor should be big enough to accommodate more than one truck unloading in the MRF during peak hours. Multi large door are required to accommodate waste carrying vehicle. The tipping floor should be covered to protect waste from rain water.

Tipping floor begin with min. 4000 sq. ft. and add each 20 ft2 for each 1 ton of waste

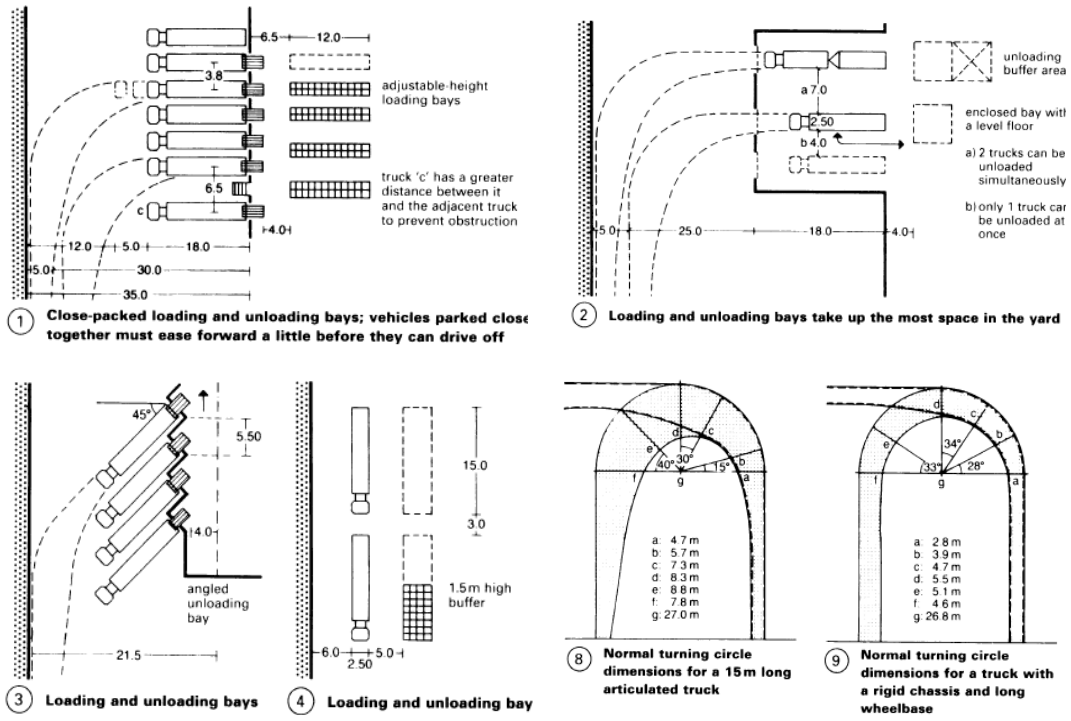


Figure 2. 22 Turning radius of waste truck

Largest turning radius for an articulated truck is about 12m. The safe distance to be allowed between adjacent truck is minimum of 1.5m with the use of loading dock and 3m with the use of loading doors.

Adequate clearance (height, turning radius, straight approach, etc.) should be provided for collection vehicles to manoeuvre and to collect materials obstruction free. Collection/loading area should be located where interference with pedestrian traffic and other vehicular access are minimal. *(Garbage and Recycling Storage Amenity Design supplement)*

2.10.2 Waste storage area/bunker

After the waste is collected from the bays, it is stored in this storage area or bunker before sorting it out and send to the processing plants. The size of the storage area is depended upon the amount of wastes intake in the recycling centre.

2.10.3 Material Recover Facility

A material recover facility serves as the intermediate processing step between the collection of materials that can be recycled to the sale of recyclable materials for use in making new products. It should be designed in such a way that recycling process or operation can be performed smoothly.

2.10.3.1 Design of a Material recovery facility

A typical MRF is sited within a warehouse-type building with concrete flooring and enclosed by a perimeter fence for security. It should have the following components:

(i) receiving or tipping area,
(ii) sorting/processing area,
(iii) storage area for recyclables,
(iv) residuals storage area,
(v) equipment area,
(vi) space for an office,

(vii) loading area for residuals and processed recyclables.

It should also be provided with the basic connections for water and electricity and adequate space for the entry and exit of waste trucks. Provisions for washing and a septic tank must be included. The warehouse design will minimize the placement of columns that could interfere with the efficient movement of materials and equipment, and facilitate the installation of higher ceilings. Receiving areas should have the capacity to receive at least 2 days' worth of the MRF's processing. capacity (Kessler Consulting 2009) in anticipation of equipment breakdown and to provide materials for the second-shift operation where required.

Manually operated MRFs with capacities of less than **2 tpd** usually have roofed floor areas of at least **50 square meters (m2)**, which contain only the receiving, processing, and storage areas.

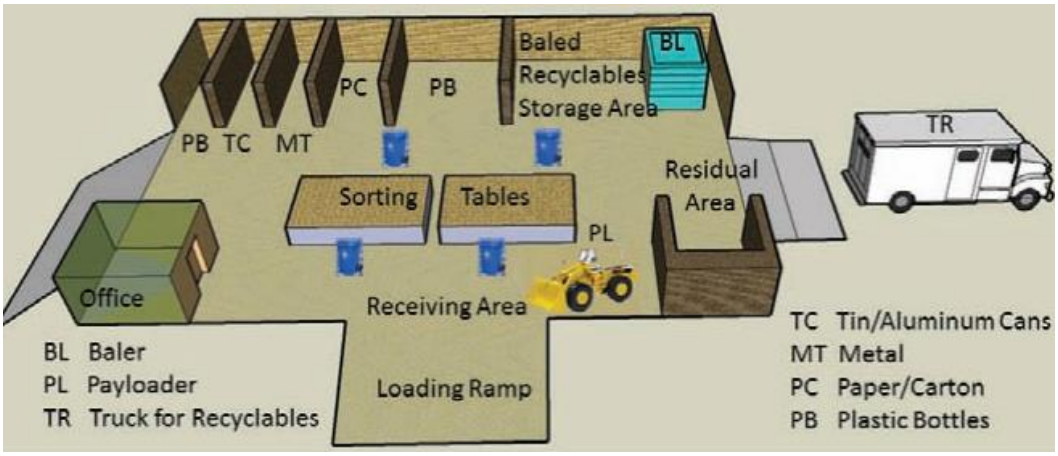


Figure 2. 23 Manually operated MRF

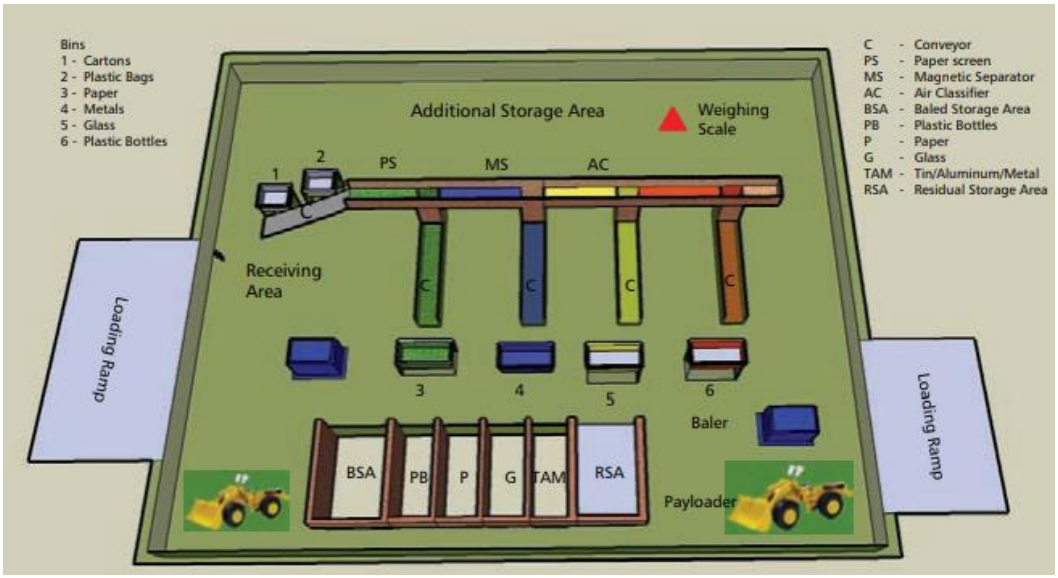


Figure 2. 24 Fully automated MRF

Semi-automated to fully mechanized facilities would require areas ranging from **150 m2 to 1,500 m2**, excluding parking and buffer zones.

The **Material Recovery Facility Handbook of the Recycling Marketing Cooperative of Tennessee (2003)** suggests a building area not exceeding **1,400 m2** for MRFs that process less than **10 tons** of recyclable waste per day and about **1,800 m2** of floor area for facilities that will handle waste not exceeding **100 tpd**. (Asian Development Bank)

2.10.3.2 Major Equipment

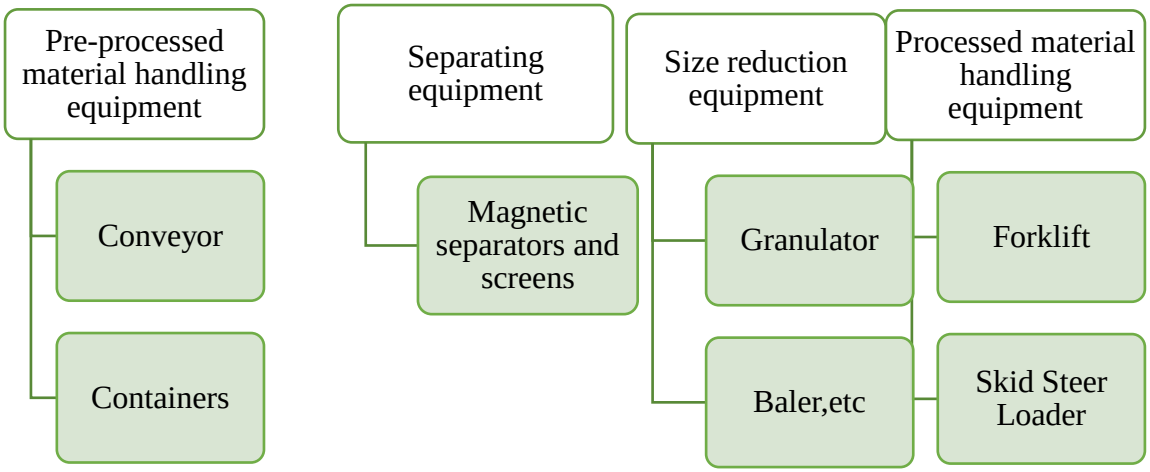


Figure 2. 25 Major equipments

2.10.4 Operational Planning

There should be careful operational planning before planning on the building begins. Process flows are outlined with the type of production and estimated on the basis of annual production figures or number of employees. The usable space requirement can be determined by the machine layout plan and company operating facilities.

The basis for the operational planning is taken from analysis of the following: -

- Operational diagram
- Materials flow diagram
- Machine location plan
- Workforce plan
- Schedule of accommodation
- List of buildings

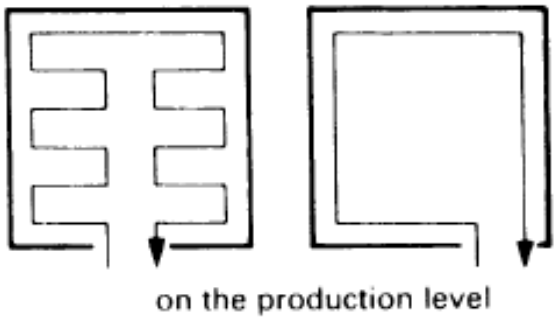


Figure 2. 26 Material flow diagram

2.10.5 Production

The basic form of production is as follows: -

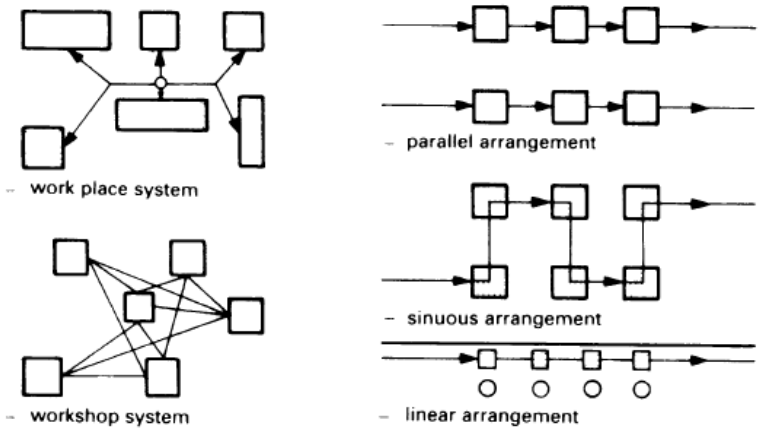


Figure 2. 27 Production system

2.10.6 Building Design

Design method include layout method, design using functional axes, design using grid axes. Guidelines for work station space requirements in factories with work benches and machines are as follows: -

Small machines: 10-15 sq.m.

Standard machines; 15-40 sq.m.

Add on 30% for circulation space.

Width of corridor in exceptional cases can be low as 0.60m.

People (no.)	Width* (normal)
up to 5	0.875 m
up to 20	1.000 m
up to 100	1.250 m
up to 250	1.750 m
up to 400	2.250 m

* guideline dimension

Table 2 Width of corridor

Minimum clear height above circulation routes should be 2m.

2.10.7 Loading bays

In this area, materials are loaded or unloaded from the vehicles. It is one of the important elements of material recovery facility (MRF). It helps in the efficient loading and unloading operations. Loading bridges are used to connect loading decks with the trucks or vehicles in the bays. The gap can be variable so ramp can be adjusted.

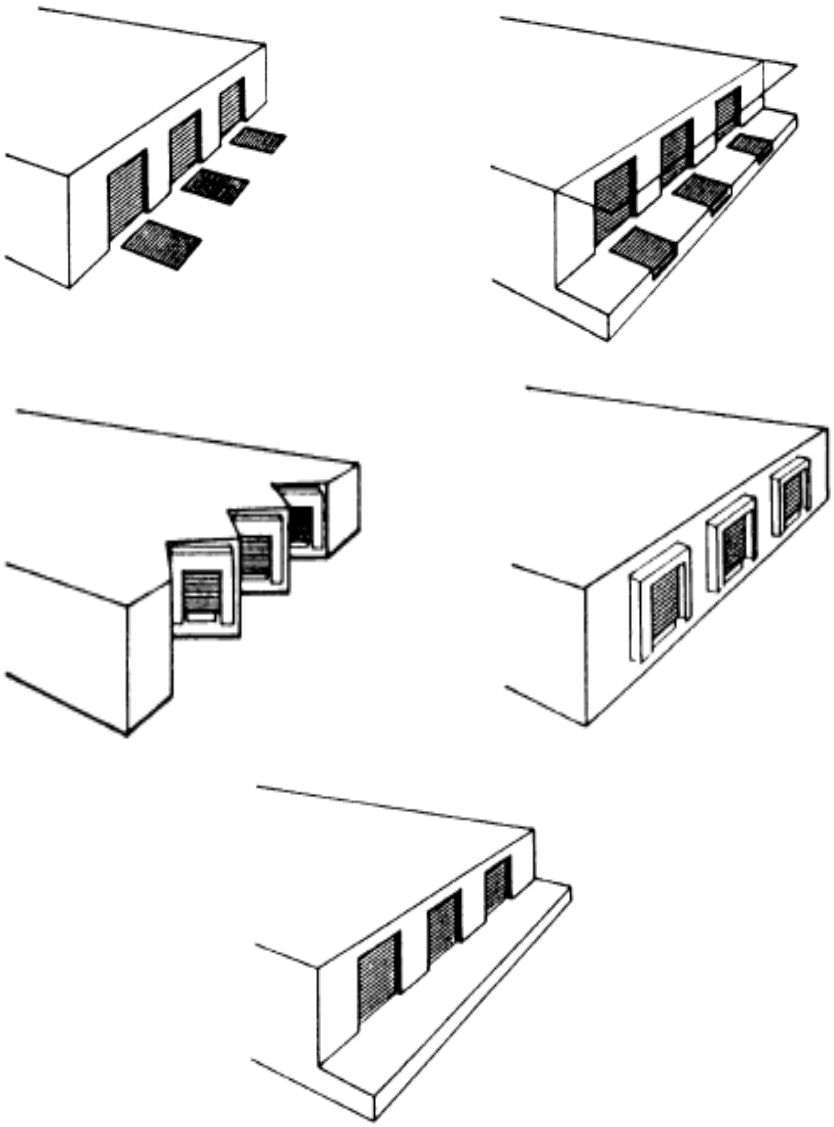


Figure 2. 28 Different types of loading bays

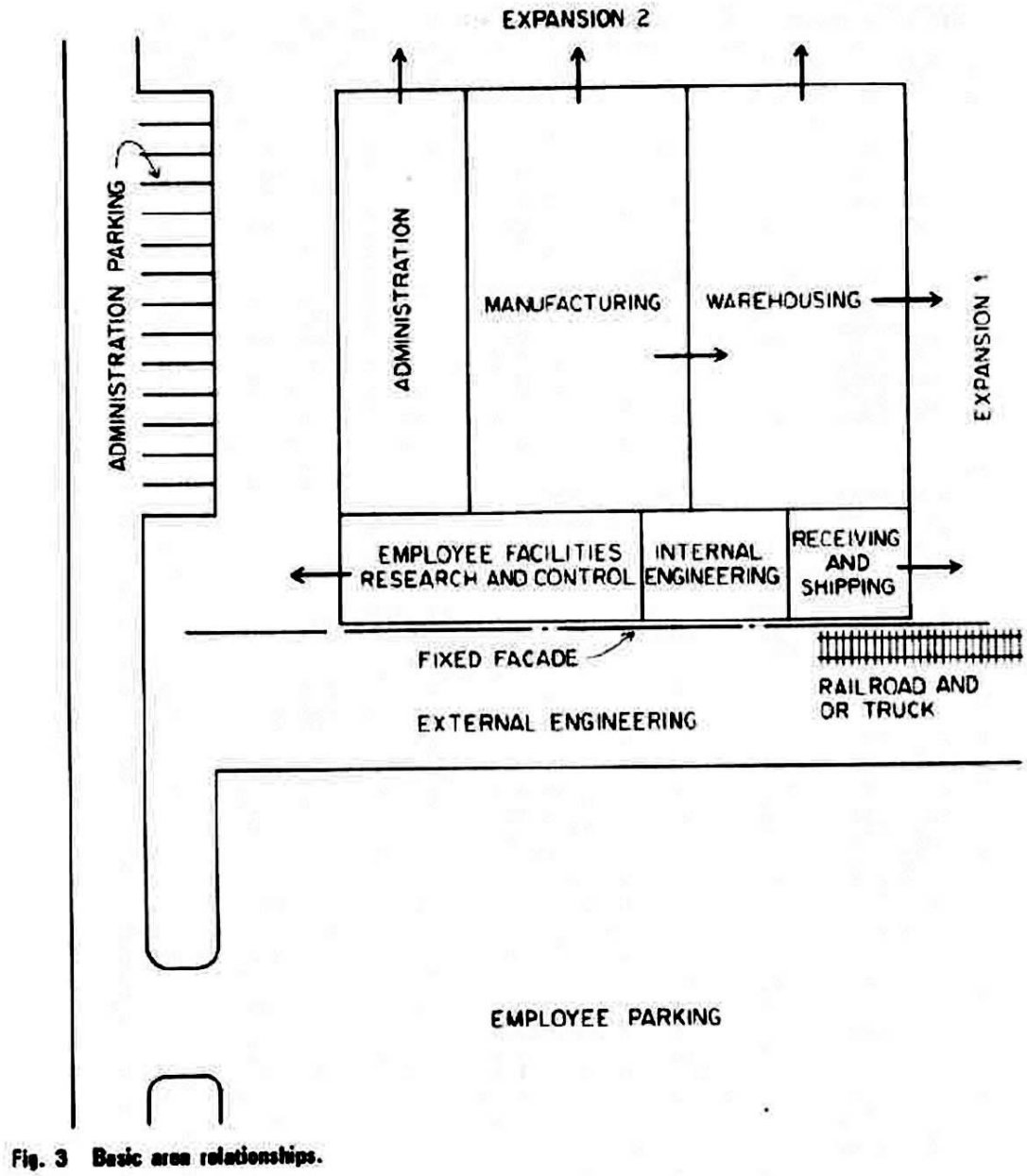


Figure 2. 29 Basic area relationship in industrial building (Time saver standard for bldg. types)

2.10.8 Polywood Furniture

The recycled plastic can be used to make furniture. According to the EPA (US Environmental Protection Agency), an estimated 9 million tons of furniture are tossed in landfills every single year. 'Fast furniture' stores that manufacture hundreds of new furniture models each year to keep up with current trends are contributing to the problem. Fast-manufactured pieces aren't built to last and are often manufactured with irresponsibly-sourced lumber or materials that are not recyclable. These are the types of furniture that end up in landfills at an alarming rate.

Recycled plastic furniture manufacturing has a significant, positive effect on collective consumer waste. This process reduces waste by turning waste products into beautiful, functional outdoor furniture pieces. Recycled plastic furniture is both recycled and recyclable.

Recycled plastic is actually known to be more durable and resistant to damage than many wood materials. Because plastic lumber is made from a mix of strong, impermeable plastics, furniture made from this material can stand strong for years without cracking, splitting or fading in color. HDPE is actually known for its large strength-to-density ratio, meaning its ability to withstand damage under pressure or impact is exceptional. Recycled plastic isn't likely to incur damage, making it the perfect material for outdoor furniture exposed to the elements.

Figure 2. 30 Polywoods

2.10.8.1 How is it made?

To create recycled plastic outdoor furniture, post-consumer plastics are melted down and molded into a plastic lumber that resembles high-quality natural wood. Recycled plastic can then be designed into a variety of shapes, sizes and colors that other outdoor materials cannot yield. While the plastic is melted, dyes are mixed with the material to ensure thorough coloration throughout the material before molding. This powerful coloration process prevents the color from fading, prevents scratches from lifting the color and prevents the need for post-manufacture polishing. CNC machines are used to cut the plastic lumber into desired space and are assemnled.

Figure 2. 31 Polywood furniture factory

Figure 2. 32 CNC cutting machines

2.11 Employee Facility

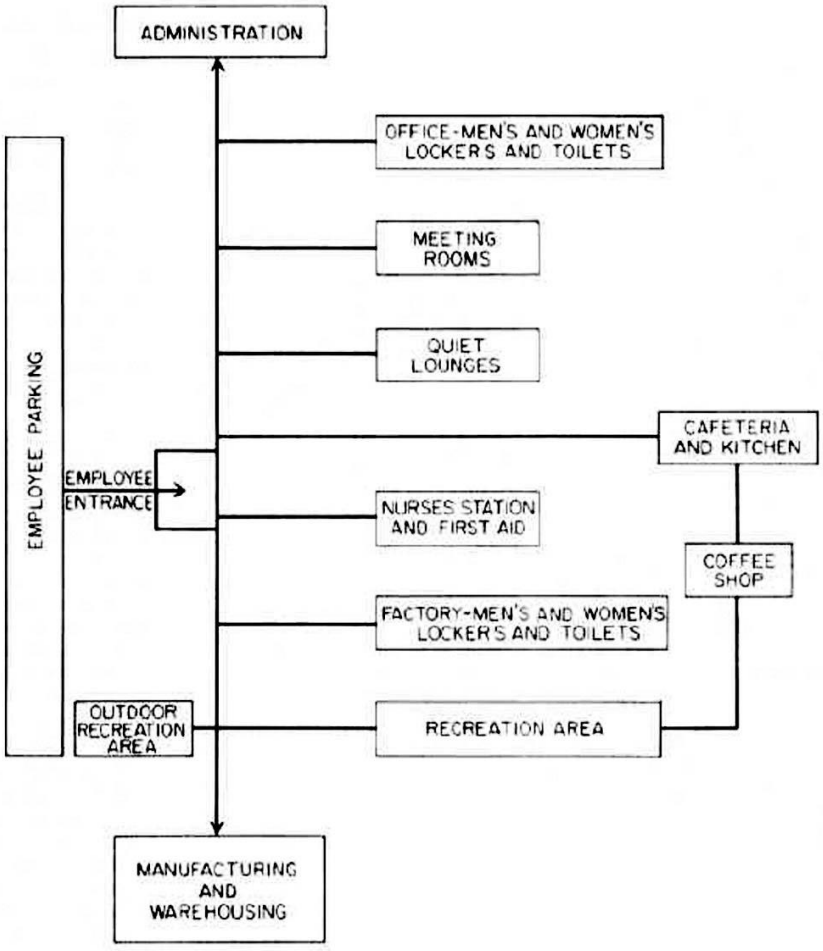


Figure 2. 33 Employee facility flow

2.11.1 Administration

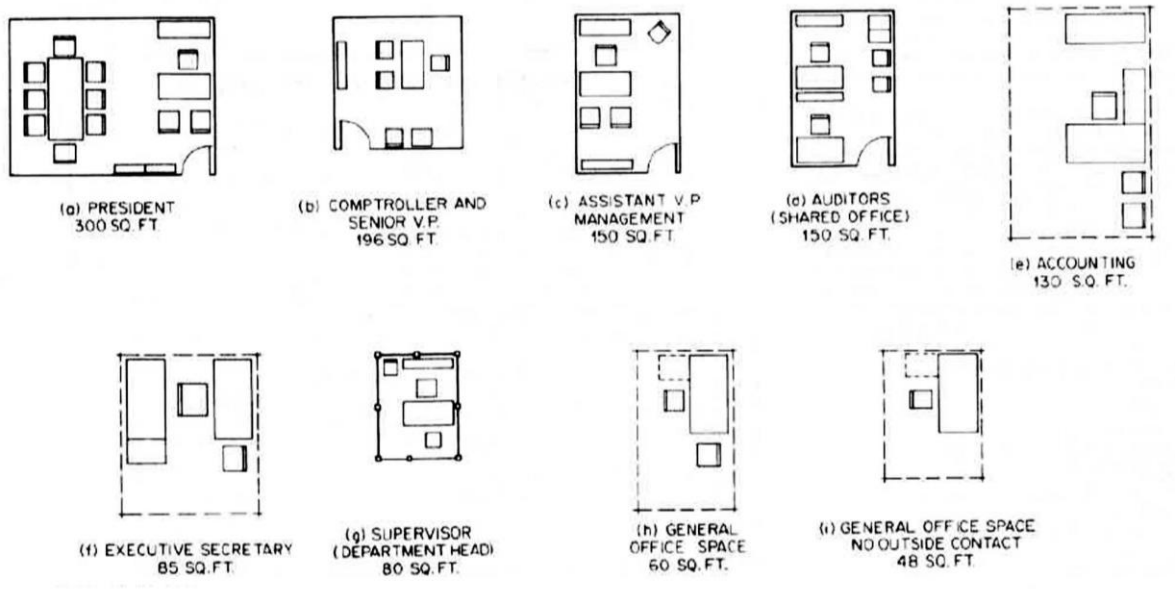


Figure 2. 34 Different office layouts

2.11.2 Changing rooms and locker

- Changing rooms should be between the entrance to the factory and the working areas and be easily accessible.
- Changing rooms with a floor area of upto **30 sq.m** must have a clear height of at least **2.30m** and at least **2.50m** if the floor area exceeds **30 sq.m.**
- The basic floor area of a chaning room shoild be at least **6 sq.m.**
- Width of circulation routes for **20 people or less** is between **0.875 and 1m** wide, for upto **100 people** is **1.10 to 1.2m**, for upto **250 people** is 1**.65 to 1.78m** and for upto **400 people** is **2.2 to 2.4m**.
- Changing space requirements per employee
    - Ideal working figure= 0.50 sq.m
    - With locker and wash basin= 0.50-0.60 sq.m
    - With l;ocker but without wash basin= 0.30-0.40 sq.m

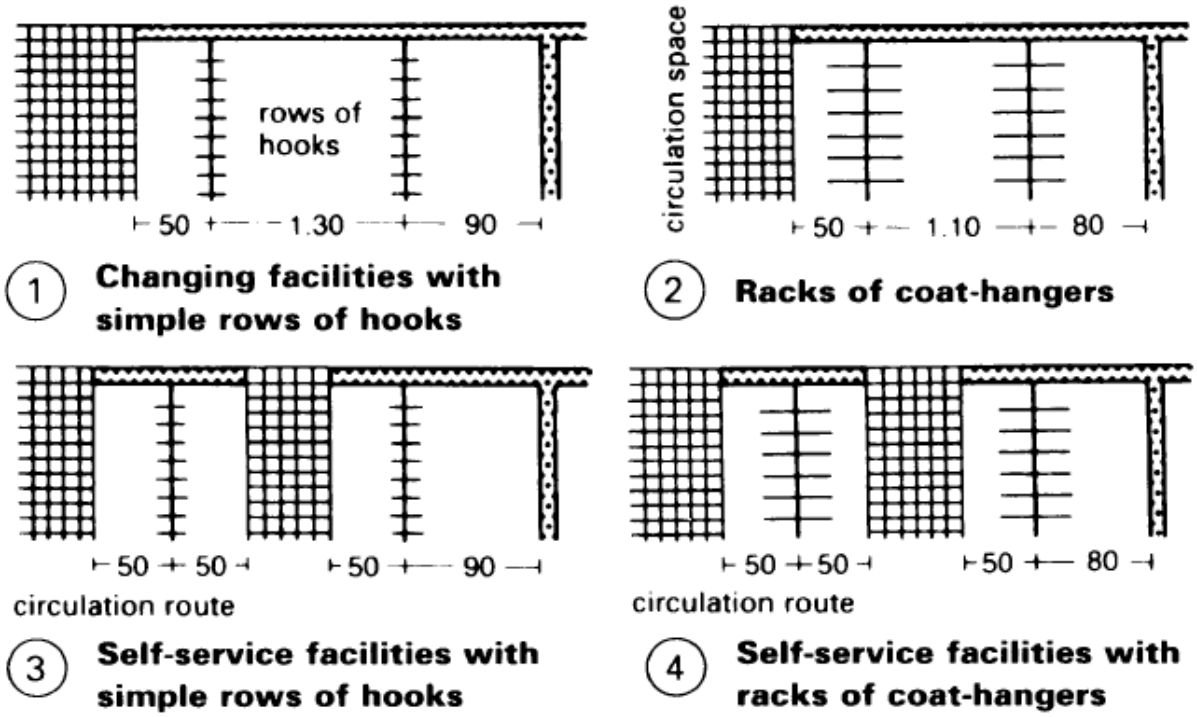


Figure 2. 36 Chaning room layouts

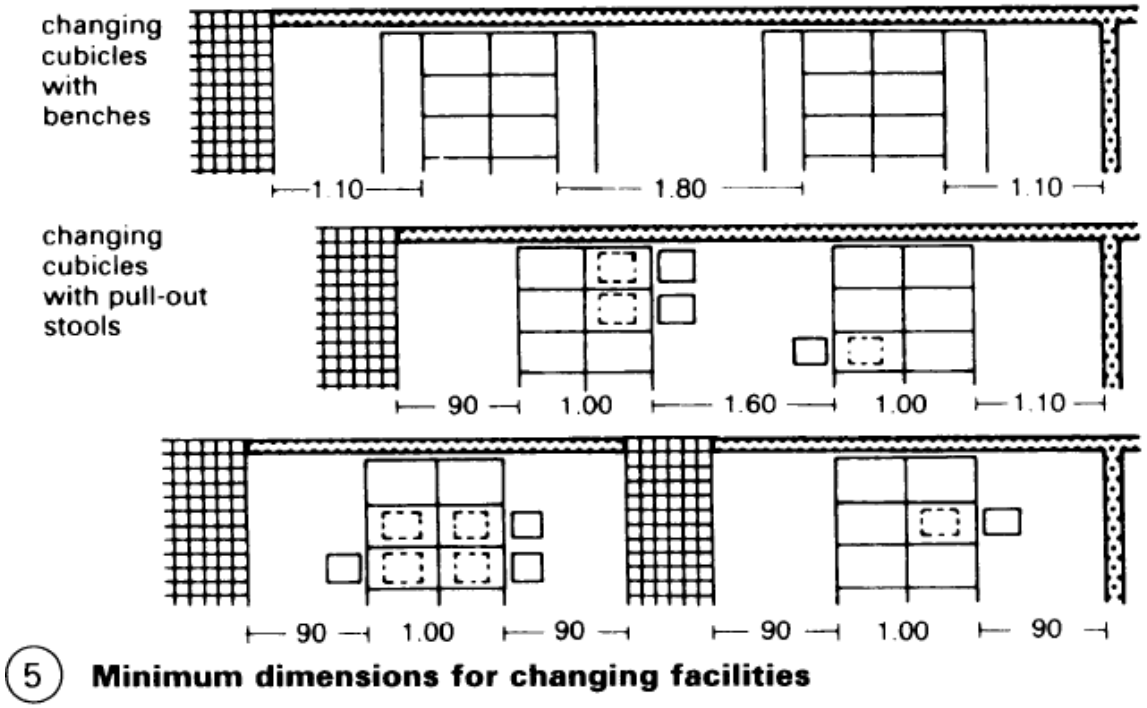


Figure 2. 35 Chaning room layouts

2.11.3 Washing Facilities

- All amenities and rooms used by staff for maintaining personal hygiene divided into washrooms, shower rooms and bathrooms.
- They should have hot and cold water or mixed water supply with at least one drainage point.
- The number of washing facilities depends on type of company. For **100 users**; doing clean work is **15**, doing moderately dirty work is **20**, doing very dirty work is **25**, doing hot, wet, dusty, smelly work or handling toxic or germ carrying substances, in sterile and pharmaceutical processes or the food industry is **25**.
- Depending upon type of company, the facilities should be divided into washing and showering facilities. Also drinking fountains should be provided close to work places.

Washing spaces required

type of work	use per person	no. of users per space given a wash time of	
	min	15 min a	20 min b
slightly dirty	2	7	10
moderately dirty	3	5	6
very dirty	4	4	5

Table 3 Washing space required

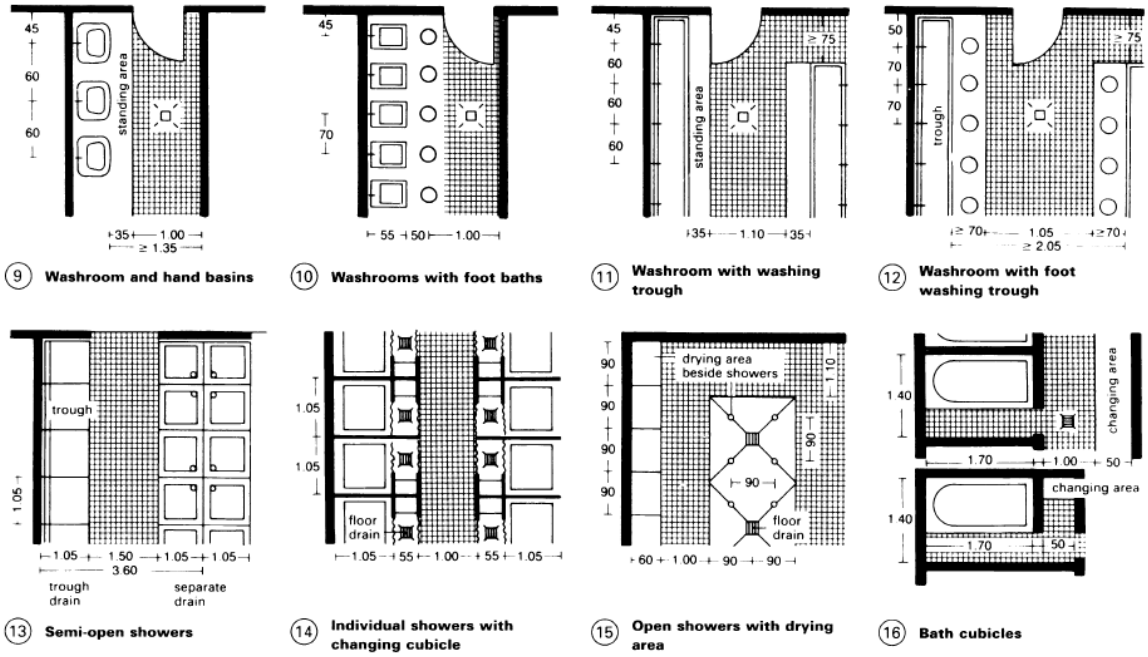


Figure 2. 37 Washing facilities layout

2.11.4 Toilet Facilities

- Toilet should be approximately 100m from each workstation; 765m in case of conveyor belts. In large companies it is useful to divide them into smaller units (e.g. on each floor next to the stairs on the landing).
- In companies with more than **5 employees**, separate toilets should be provided for men and women, as well as toilet for exclusive use.
- If venitlation through toilet is from windows on one side only, an area of **17000 sq.cm** is required or possibly **1000 sq.cm** if space is restricted.
- The minimum room height for toilets with four or fewers WCs can be **2.20m**.

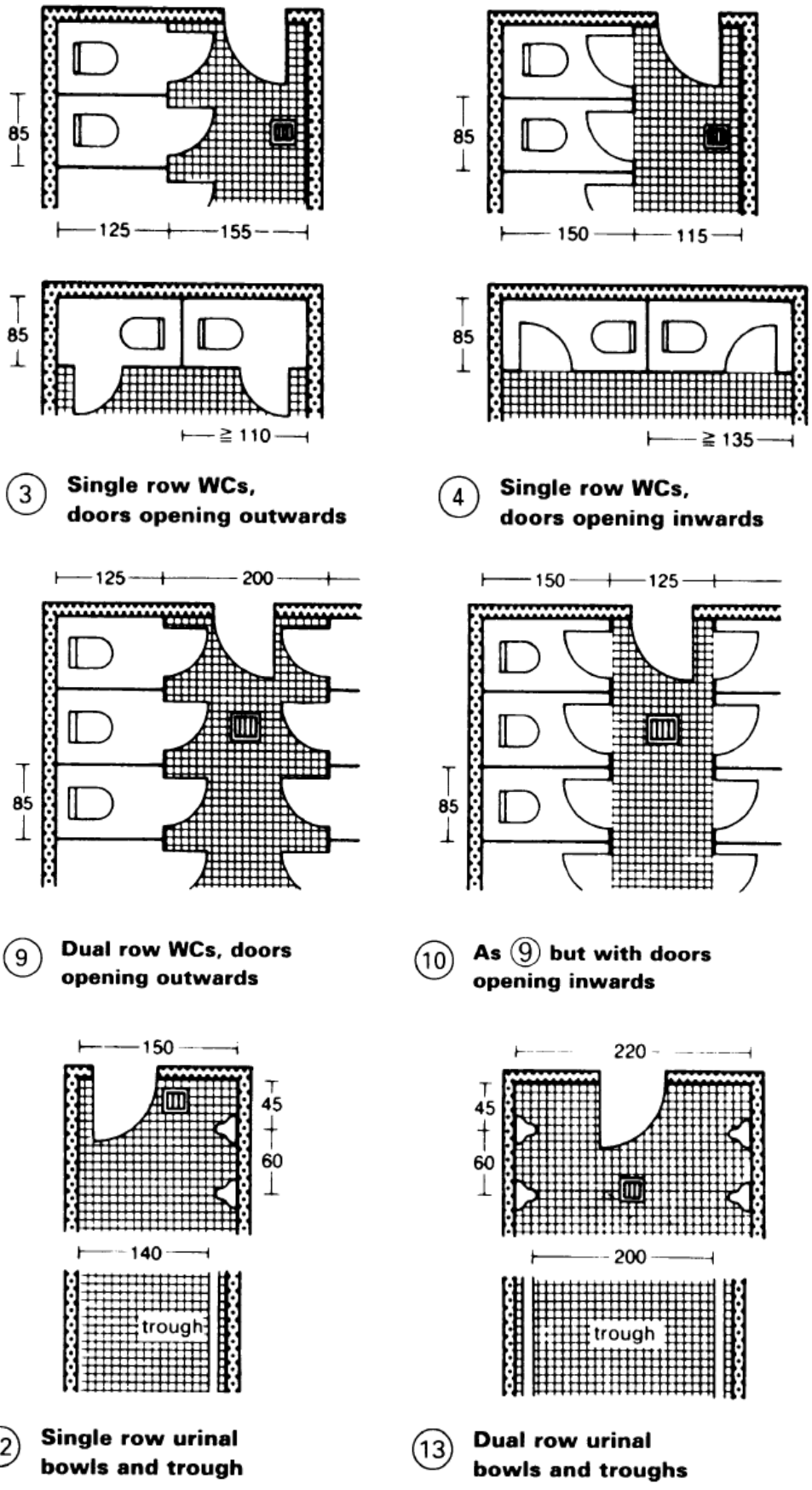


Figure 2. 38 Toilet layouts

2.11.5 Canteen

- Dining area should 40 to 60% of the total space.
- Area of dining space + aisle and traffic space = 12 sq.ft X numbers of persons required (The space occupied by a person when he is sitting in a comfortable position is 12 sq.ft)
- Service area: 30% of total café space with cashier counter, juice counter and a bain marie.
- Kitchen: 1.5 sq.m per employee to move smoothly excludng the equipment space.

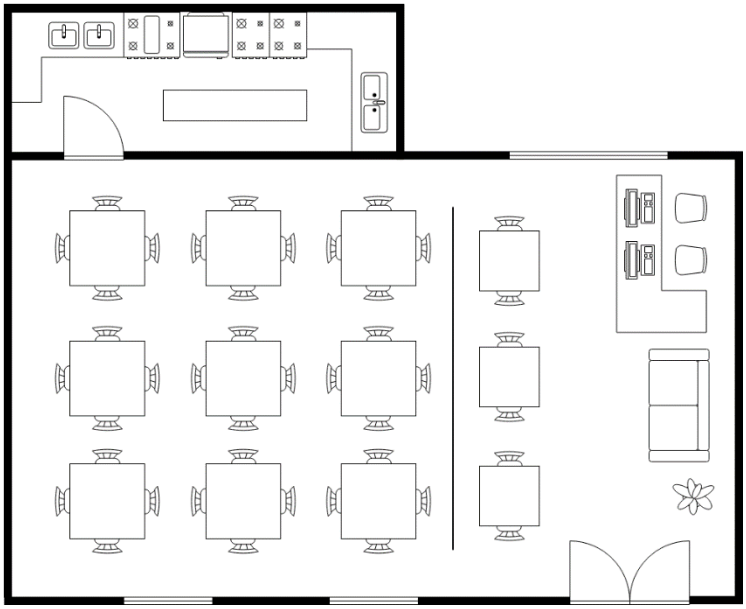


Figure 2. 39 Canteen layout

2.12 Public Facility

2.12.1 Exhibiton area

Creating an exhibition area focused on recycled waste can be a fantastic way to raise awareness about environmental issues, promote recycling, and educate the public on the importance of responsible waste management.

Figure 2. 40 Exhibition area

2.12.2 Education centre

An innovative concept for public involvement in waste recycling plants is an education center. People may learn about the idea of recycling, its significance, and how to recycle at the source level through it. Knowledge of the recycling process can also be acquired through a visual link to a recycling facility.

Figure 2. 41 education center

2.12.3 Community Parks

As community parks, public space for waste recycling can be provided for residents. They can be utilized for community gatherings, children's play, and recreational pursuits like running. These neighborhood parks may combine education, entertainment, and relaxation. These neighborhood parks may double as both educational venues to spread the word about the value of recycling and a place for r rest and pleasure in the middle of a city

Figure 2. 42 community parks

3.CASE STUDY

3.1 NATIONAL CASE STUDY

3.1.1 NEPSEMYAK SEWA PVT. LTD

Site Location: Radhe radhe, Bhaktapur

Site Area: 5 ropanis(approx.)

Project Year: 2054 BS

Project Type: Transfer station

Ownership: Nepsemyak Sewa Pvt. Ltd.

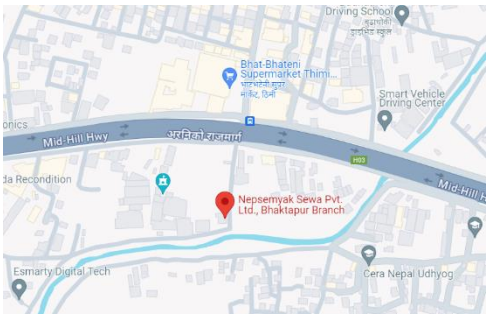


Figure 3. 1 Location Map

❖ **Background**

Nepsemyak Sewa Pvt. Ltd. is a private company that has been working in the field of solid waste management in Nepal. The company was established in 2009 and provides various waste management services including waste collection, transportation and disposal. Before establishment of waste management companies, there was practice of throwing wastes at public places.

The companies has been handling waste in different parts of kathmandu valley. Especially, in Bhaktapur district, the company collects waste from 3 out of 4 municipalities i.e. Suryabinayak municipality, Changunarayan muncipality and Madhyapur Thimi municipality since 2067 BS. Around 8 tipper waste (approx. 2 tons each) come to the site every day. The company collects biodegradable and recyclable waste both. However, the biodegradable wastes are directly send to the compost plant while the recylable waste along with the biodegradable or non recylable waste comes to the site which has to be sorted off before further processing. Around 2 tipper waste is send to the Sisdol landfill site on the daily basis.

Figure 3. 2 Nemsemyak Sewa Pvt, Ltd. (Author)

❖ Spatial Planning

The main function of the project is to function as a transfer station from where the recyvlable wastes are sorted out such as plastics, bottles, papers, metals, rubber, etc to the recyle plants and non-recylable wastes to the Sisdol landfill site. Various spaces have been planned in the project site such as administration block which serves as the brain of the company. The staff quarter lies along with the administration block. Beside the block, there is space for the staff parking and visior parking. A garden can be accessed throught the block.

The waste blocks are separated from the administration block through waste truck parking that can accommodate more than 5 tippers at a time. The tipping block(50'X60') is present beside the parking with area for collection and segregation of recylable and non recyclable waste. The recyclable wastes are furthered sorted out in the next block. The block(60'X70') also house the mezzanine staff accommodation area which can be accessed through staircase. Beside the entry to the block, there is a small changing room. The two wastes block are divided by the storage block(15'X50').

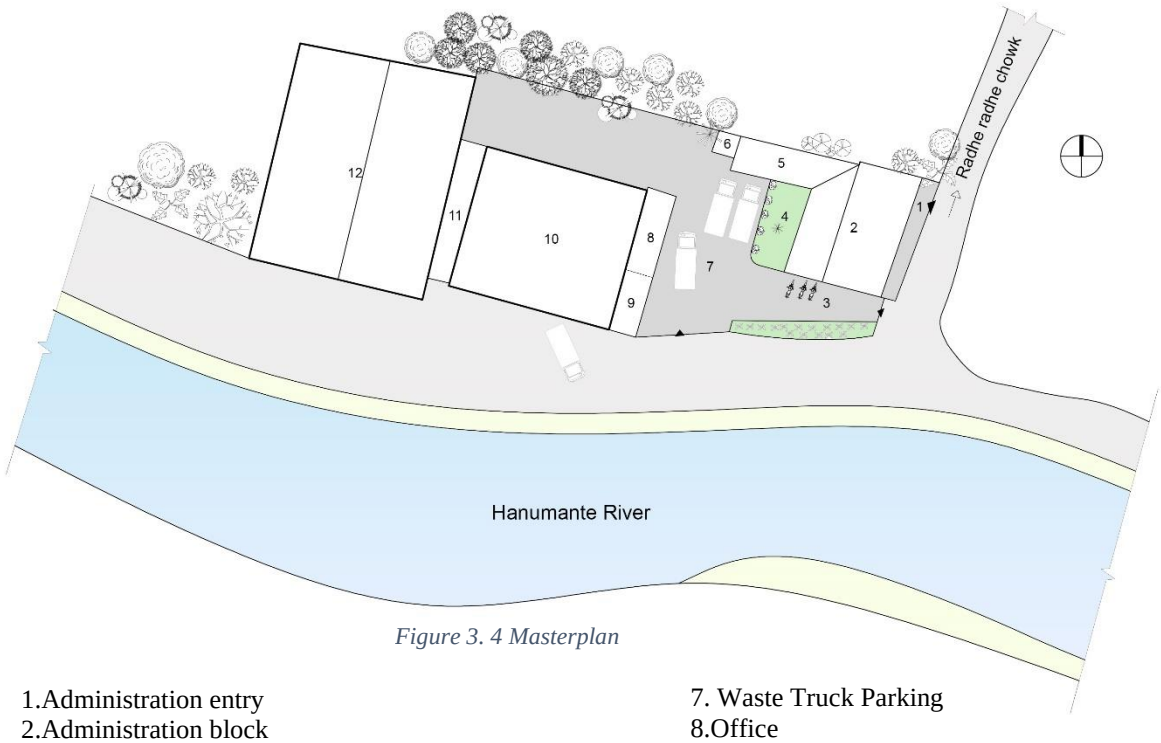


Figure 3. 4 Masterplan

1.Administration entry
2.Administration block
3.Staff and Visitor parking
4.Garden
5.Staff Accommodation
6.Toilet
5.Staff Accommodation
6.Toilet
7. Waste Truck Parking
8.Office
9.Washing Facilities
10.Collection and sorting area
11. Storage block
12. Sorting and storing block
10.Collection and sorting area
11. Storage block
12. Sorting and storing block

Figure 3. 6 Glimpse of waste collection and segregation area

Figure 3. 5 Waste sorting and trasanfering sorted waste to recycling center outside valley

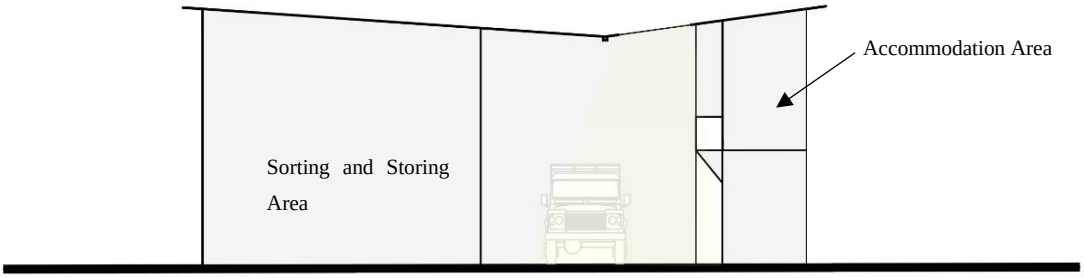
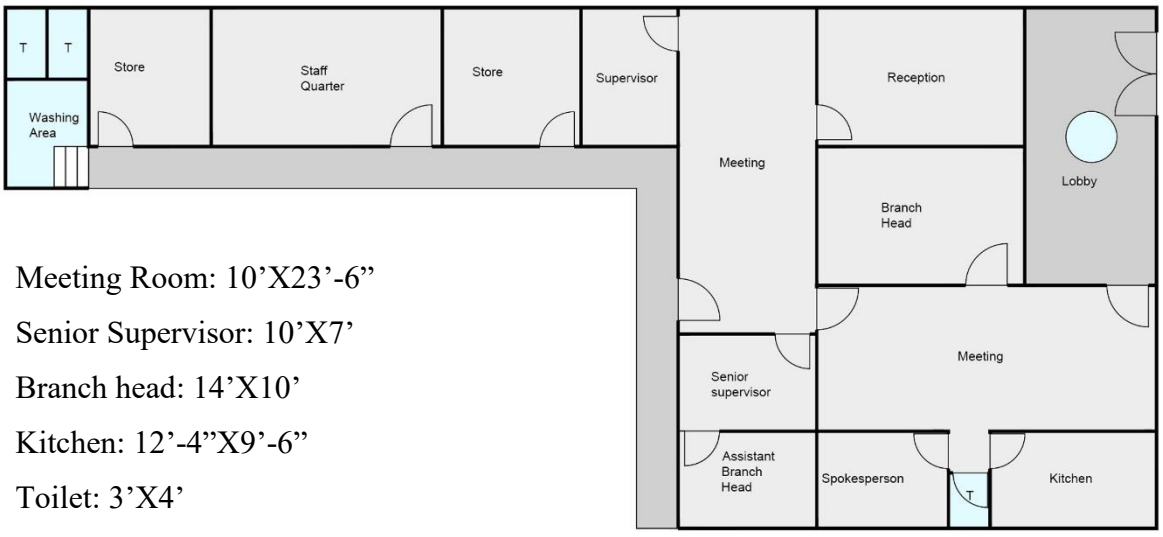


Figure 3. 7 Section showing internal arrangement of spaces

The admin block houses spaces for the various personnels working on the administrative side of the company. Offices for branch head, assistant head, supervisor, senior supervisor, spokeperson, meeting rooms along with reception is present in the block. There is a small pantry and a single toilet in the block.



Meeting Room: 10’X23’-6”
Senior Supervisor: 10’X7’
Branch head: 14’X10’
Kitchen: 12’-4”X9’-6”
Toilet: 3’X4’
Staff Quarter: 16’-8”X10’

Figure 3. 8 Plan of administration block

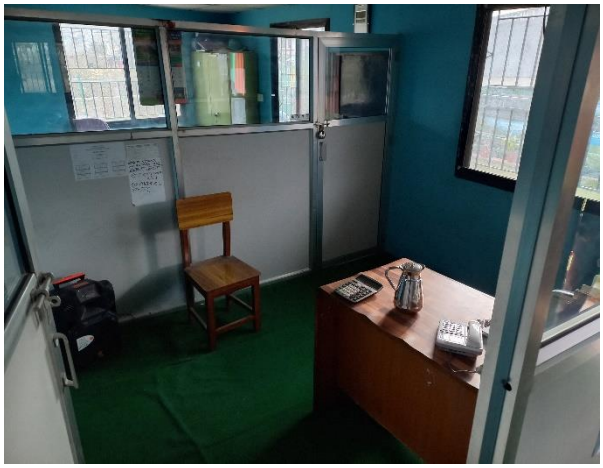
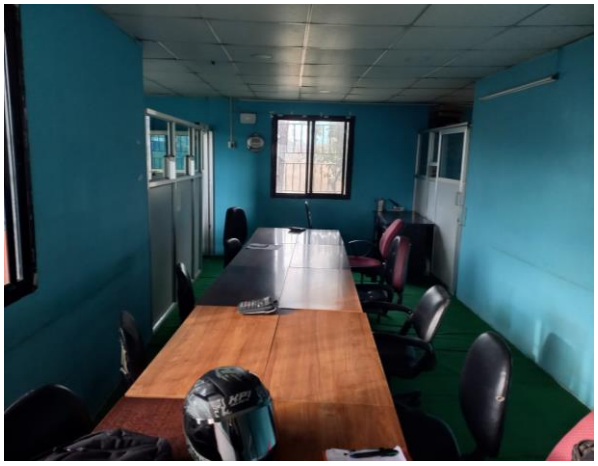



Figure 3. 9 Adminstration block interior

❖ How it works?

The waste is collected from the resgistered houses according to the schedule. The collected waste is brought here in the collection centre/transfer station through tippers. After unloading the wastes in the collection area, they are manually separated by the workers with hands where they segregate the recylable waste and non recylable waste. The non recylable wastes are disposed of in he sisdol landfill site. About 2 tippers wastes are send to the land fill site on daily basis. The recyclable wastes are transferred to the other block through manual carts where the workers segregate the waste such as plastics, papers ,metals, etc manually. After sorting out the recylable wastes, they are stored properly. Then the wastes are transferred to the recyling centres which are located outside the Kathmandu valley.

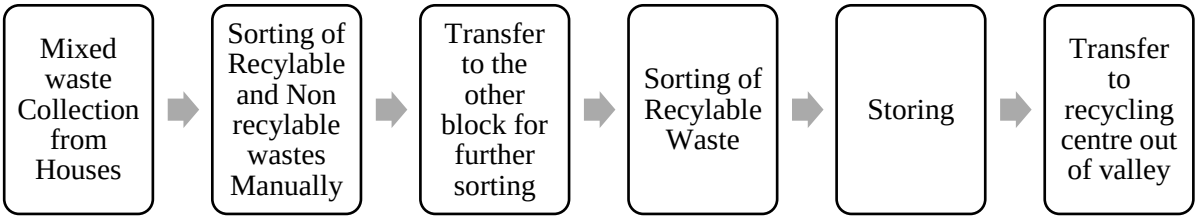


Figure 3. 10 Material flow plan

Waste Sorted per day

Polythene bags: 1500-1600 kg

Glass bottles: 1000 kg

Plastic bottles: 200 kg

Paper: 600-400 kg

Rubber: 700-800 kg

❖ Circulation

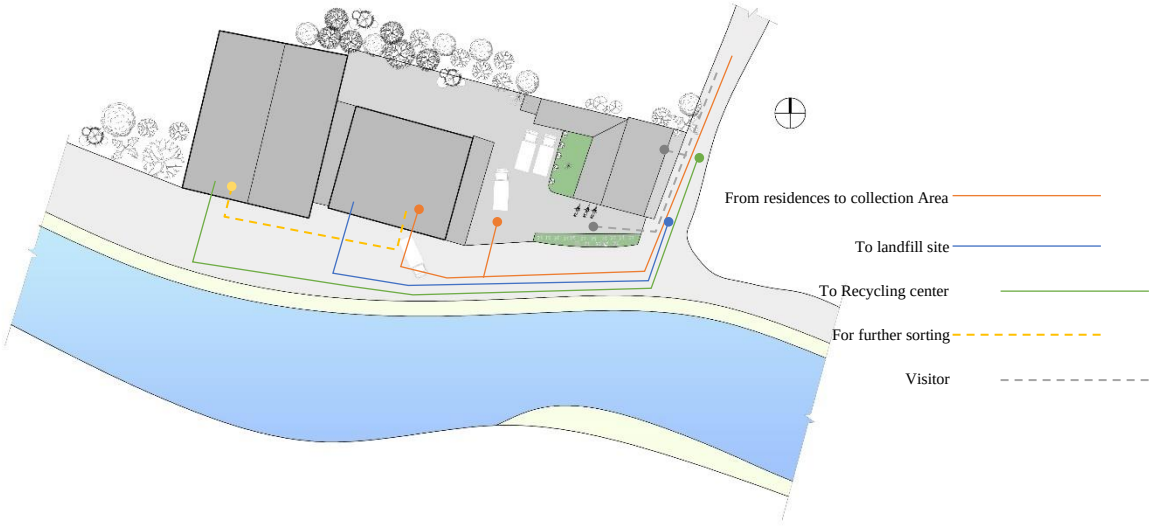


Figure 3. 11 Circulation flow plan

❖ Light and Ventilation

The light is permitted inside the warehouse type buildings through transparent CGI sheets in different portions of the roof and from the huge entrance portion from where the vehicle entry.

There is no any provision of ventilation except the entrance door due to the reason that faulty smell do not pass into the outdoor.

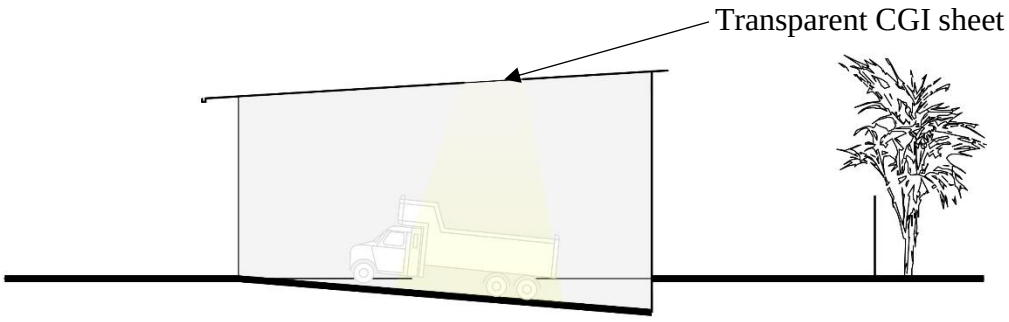


Figure 3. 12 Section showing light entry point

❖ **Building Material**

The main building material is the CGI sheet. All the ware houses are made up of CGi sheets while the administration block is constructed with masonry units at one portion and CGI sheets on the other. The roofing is also of CGI sheets and the flooring is of concrete. Doors and windows are of aluminium.

❖ **Strength**

- Buffer zone between the administration block and the waste blocks.
- Garden as the breakout space for the workers.

❖ **Weakness**

- Lack of proper circulation of waste from one block to another.
- Haphazardly storing of the wastes.
- Staff accommodation inside the waste segregation block with lack of proper ventilation.
- CGI sheet roofing causes rise in interior temperature at day time causing difficulty in working.

❖ **Inferences**

Proper zoning and space allocation based on function is essential.

3.1.2 DOKO RECYCLERS

Site Location: Sanothimi, Bhaktapur
Site Area: 4 ropanis(approx.)
Project Year: 2017 AD
Project Type: Material Recover Facility
Ownership: Private Company

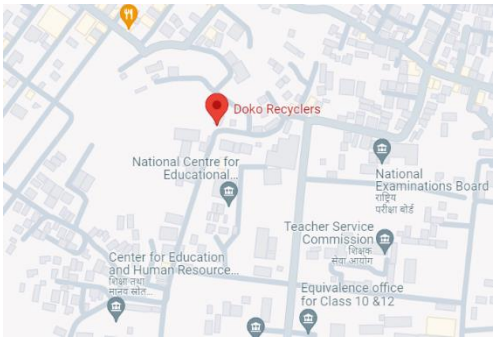


Figure 3. 13 Location map

❖ **Background**

Doko recycler is a material recover facility having vision of supporting green economy that values social and environmental welfare by preserving natural resources and enabling local ingenuity. It is a social enterprise that manages and recycles dry waste. The main aim is to use waste as resources with increased value extraction, recyclingc recovery and reuse.

The enterprise provide waste mangement options ranging from doorstep recycling pickup to repurposing discarded items ranging from furniture to electronics. 80% of the clients are corporate while remaining 20% is households. 2 vehicles carry waste from the designated places 1 carries bulk and other carry waste circulating. Around 5000 kg waste is collected on the daily basis. There are total 14 staffs working on the MRF facility only. Among them 3 are from dismantling team, 6 pickup team, 3 for bailing and 3 technicians for electronic refurbishment. At present, Doko reycler is planning to extend its service at Sallaghari, Bhaktapur. It also performs the recovery facility on site with portable machineries.

Figure 3. 14 Different portions of Doko Recyclers

❖ Spatial Planning

The Doko recycler is spread around land area of four ropanies(approximately). There is separate provision of pedestrian entry and vehicular entry. Besides the entry, there is a guard house where visitors have to entry their names and staff quarter. Along with the guard house, there is a small parking for visitor and waste pick up van. The waste storage area are divided into several compartments varying in their length. The compartments include storage areas for plastic, paper, metal, electronic waste, etc. There is a huge aea for bailing of the cardboard boxes along with storage area. The shredding block is adjoined with the block and between them the narrow road serves as the loading and unloading area where the wastes are drop off. Inside the shredding block or material recovery block, there is space for three different types of machineries including the conveyor. There is a separate space for electronic waste sorting, refurbishment and storage.

The administration block is situated at the back part of the overall plan. The two storey building houses the office room, meeting rooms and account section in the groud floor and rooms for board of directors in the above. It can be accessed through stairs with eight treads. Total of 10 members work in the section with 2 operation team, 1 trading, 1 logistic, 2 account and 4 board of directors. The upstairs access the board of directors rooms.

There are canteen, chaning rooms, toilet and doko store at the back portion of the site.

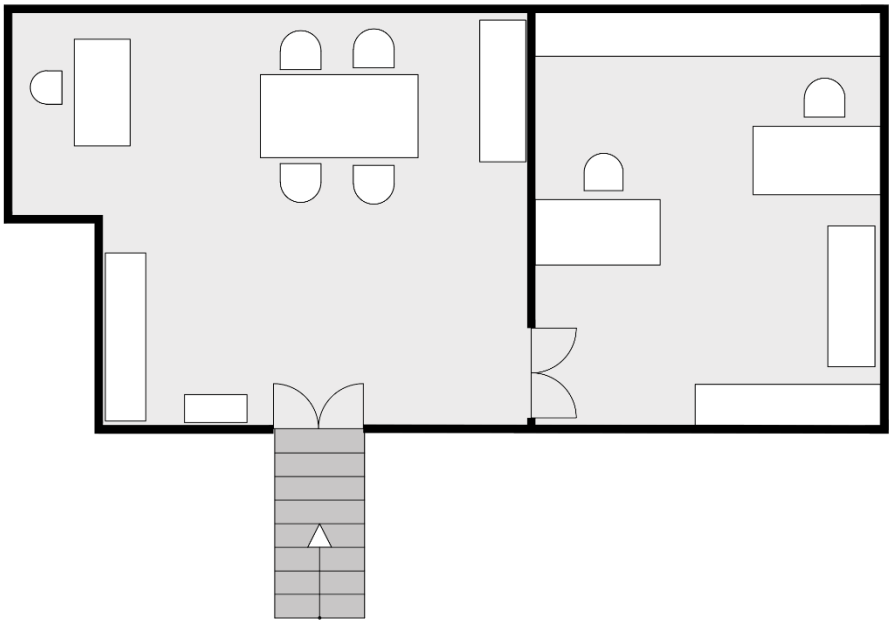


Figure 3. 15 Tentative Plan of Administration section

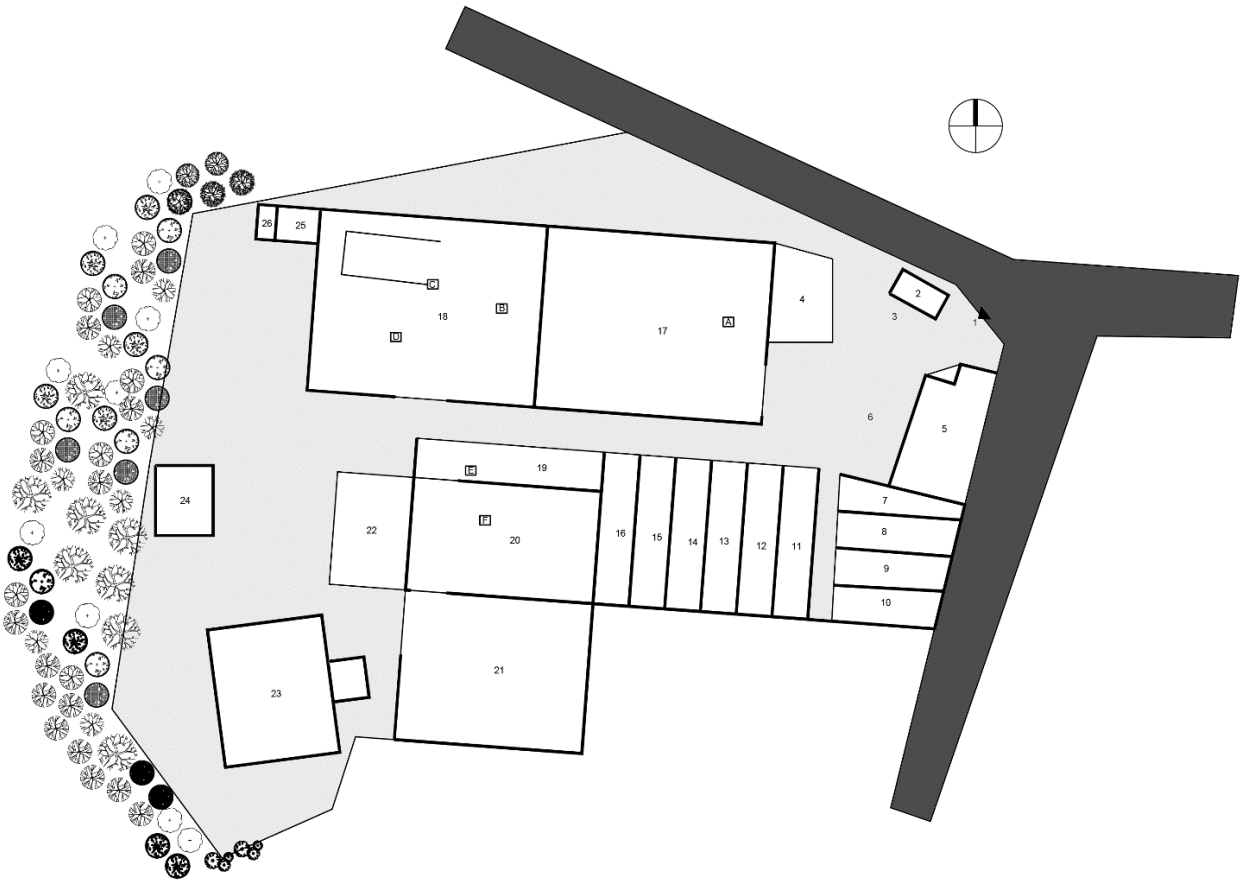


Figure 3. 16 Masterplan

A. Bailing Machine B. Shredder C. Conveyor belt

D. Cable granulator E. Wire stripper F. Bulb meter

1.Entry

2.Guardhouse

3.Guest Parking

4.Store

5.Staff Quarter

6.Parking

7.Plastic bottle store

8.Glass bottle store

9.Glass store

10.Non-recyclable store

11.Metal section

12.Metal Section

14.Paper section

15.Plastic section

16.Plastic section

17. Cardboard bailing and store

18.Material Recovery Area

19.E-waste Refurbish

20.E-waste Refurbish and store

21.E-waste store

22.E-waste store

23.Administration

24.Canteen

25.Doko store

1 Vehicular Entry

2 Guard Post

3 Narrow Road

4 Warehouses

5 Admin. Block

6 Canteen Block

Figure 3. 17 Different portions of Doko recyclers

Unsorted card board storing

Cardboard Bailing Area

Unsorted card board

Bailing Machine

Storing after bailing

Storage Area

Metal storage

Different storage area

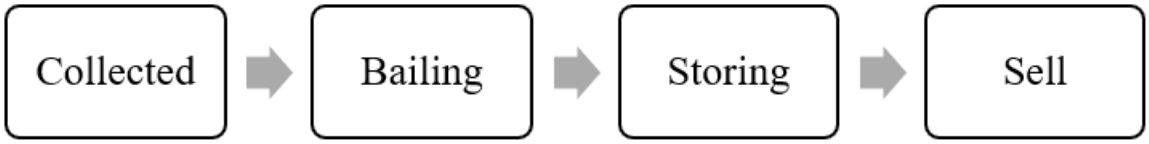
Plastic storage

Figure 3. 18 Processing and storage areas

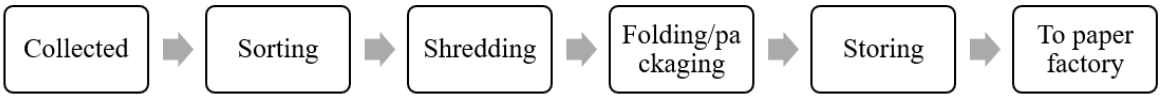
❖ **How it works?**

The waste is collected from the resgistered corporates and households. The corporates or households have to take membership which can be weekly or monthly. Various wastes are collected and processed accordingly. Weekly 2 trucks of paper and 1 truck of metal every 10 to 15 days is send outside for recyling purposes, The processing techniques for various types of wastes are as follows:-

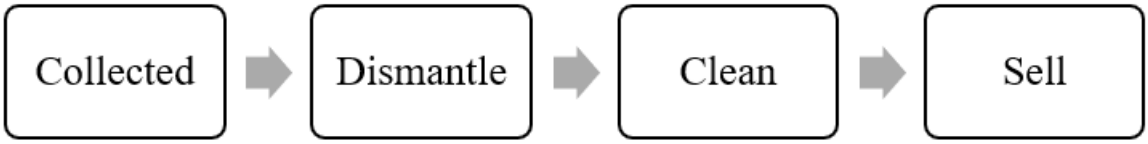
1.Cardboxes



2.Paper



3.Metal



4.E-waste

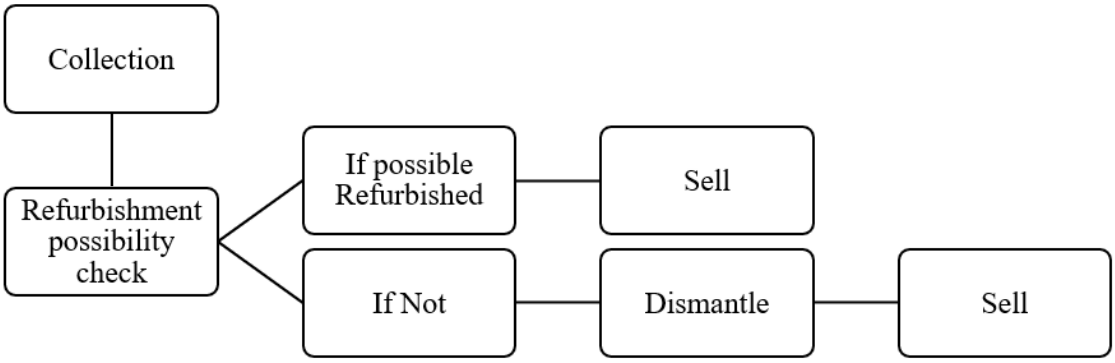


Figure 3. 19 Paper recovery process

Figure 3. 20 E waste recycling area

❖ Circulation

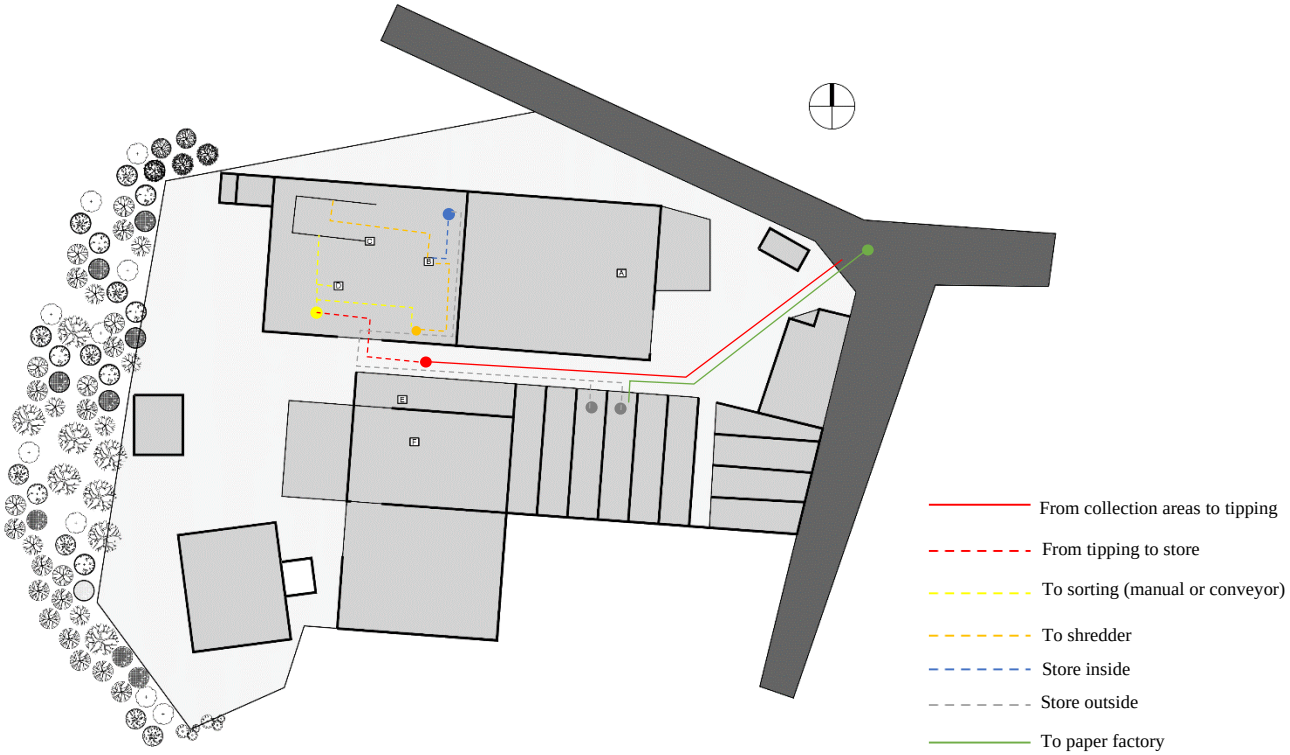


Figure 3. 21 Circulation diagram of paper recovery

❖ Lighting and Ventilation

The lighting is achieved through transparent CGI sheets on roofing along with the addition of artificial lights hanging on the ceiling.

There is provision of cross ventilation through the opening in front and rare CGI sheet envelope.

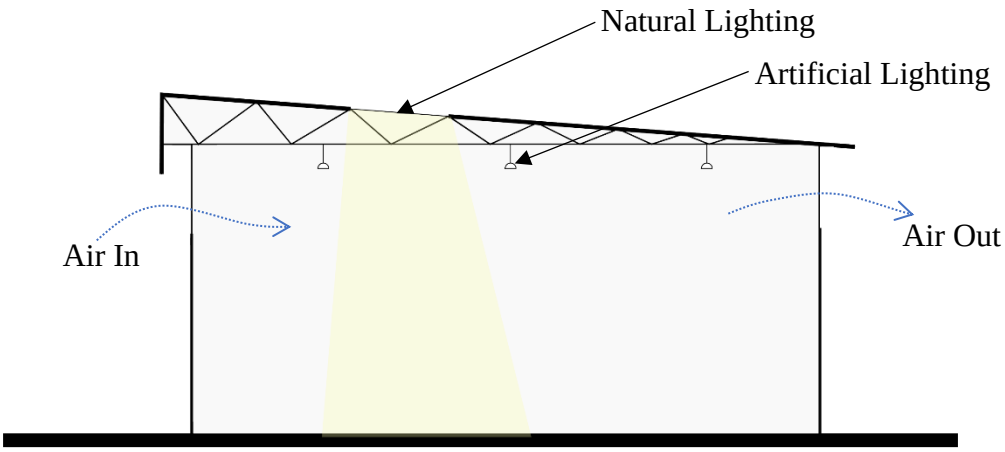


Figure 3. 22 Section showing lighting and ventilation

❖ **Building Material**

The main building material is the CGI sheet. The storage blocks and processing blocks are all constructed from the CGI sheet with CGI sheet doors whereas the administration block is built in steel structure with brick masonry at the ground floor and eco panels at the first floor. The openings were aluminium doors and windows.

❖ **Strength**

- Proper planning of spaces for different purposes.
- Separate compartment for storing of different nature of recylable waste.
- Proper lighting and cross ventilation.

❖ **Weakness**

- Unwelcoming entrance space due to waste storage near the entry.
- Inadequate parking space.
- Inadequate space for loading and unloading.
- The incoming waste is greater than outgoing waste, hence the problem of storage.
- Haphazard storage of waste.
- No consideration to employee and public amenities.

Figure 3. 23 Lack of proper loading and unloading place

❖ **Inferences**

- Proper planning of spaces is required for proper functioning.
- Proper lighting and ventilation is necessary.
- Enough space for loading and unloading is necessary to remove chaos.

3.2 INTERNATIONAL CASE STUDY

3.2.1 SUNSET PARK MATERIAL RECOVERY FACILITY

Location: New York, United States

Area: 140000 sq.ft

Project Year: 2014 AD

Project Type: Material Recover Facility

Ownership: Governmental

Awards: 2015 AIA NY State Award of Merit:Commercial/industrial large

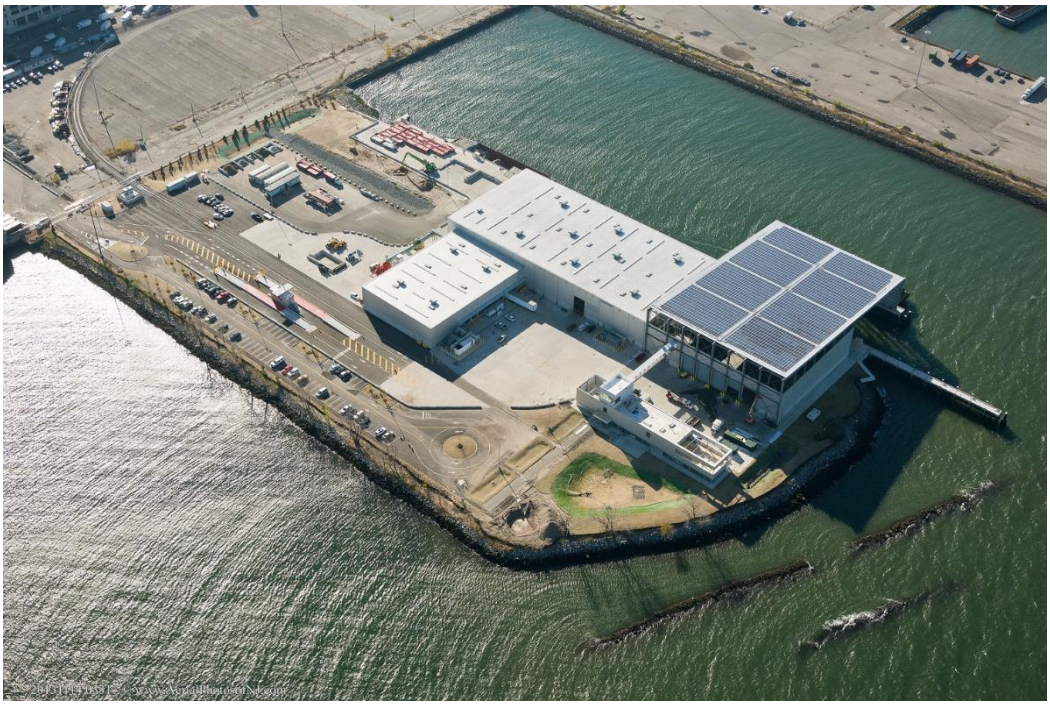


Figure 3. 24 Arial view of Sunset Park Material Recovery Facility (ArchDaily)

- **Introduction**

The New York citty had selected the 29th Street Pier in the South Brooklyn Marine Terminal in Sunset Park, Brooklyn, as the location for a new state of the art recyling facility to be built and operated by the Sims Municipal Recycling. The facility was opened in December 2013 and processes the majority of New York City's commingled curbiside material. It is the largest and most sophisticated plant for commingled residential recyclables in North America.

The Sunset Park Material Recovery Facility is a processing center for New York City's curbside glass, metal, and plastic recyclables. The facility is situated with waterfront pier; hence the facility has made a major environmental contribution to New York City as the

recyclables are delivered by barge. This strategy has major impact on minimizing the distance that the collection trucks must travel i.e. it eliminates around 240,000 miles of annual vehicle travel from City roadways.

- **Spatial Distribution**

The masterplan organizes buildings to support functionality and create distinct circulation systems to separate visitors from operations. The facility includes **a Tipping Building**, where recyclables arrive by barge; **Processing Building** that houses complex sorting equipment, electrical compressor, fire pump; **Bale Storage Building served by eight loading docks**; and **Education Center**, where students and the public can both view and learn more about recycling and **Administration Building**, a building for personnel (lunch room, locker rooms, offices, etc.).

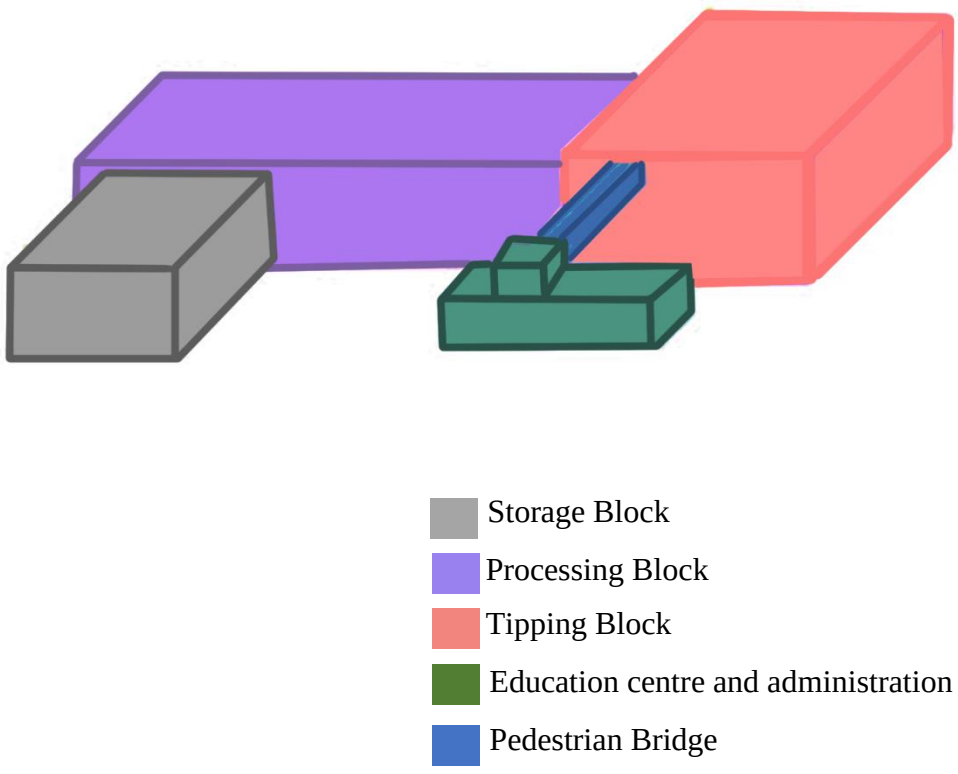


Figure 3. 25 Zoning of Sunset Park Material Recover Facility

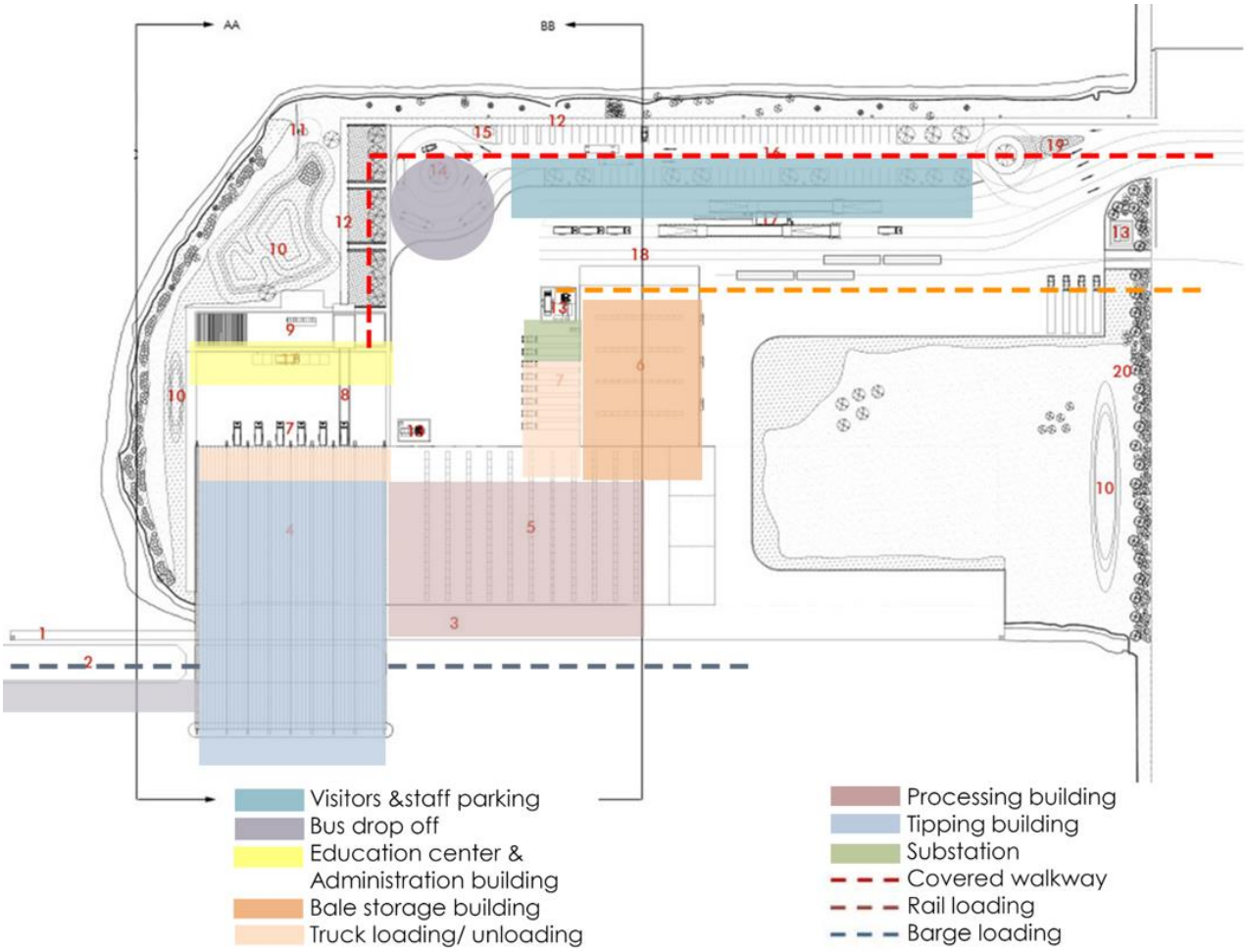


Figure 3. 26 Masterplan

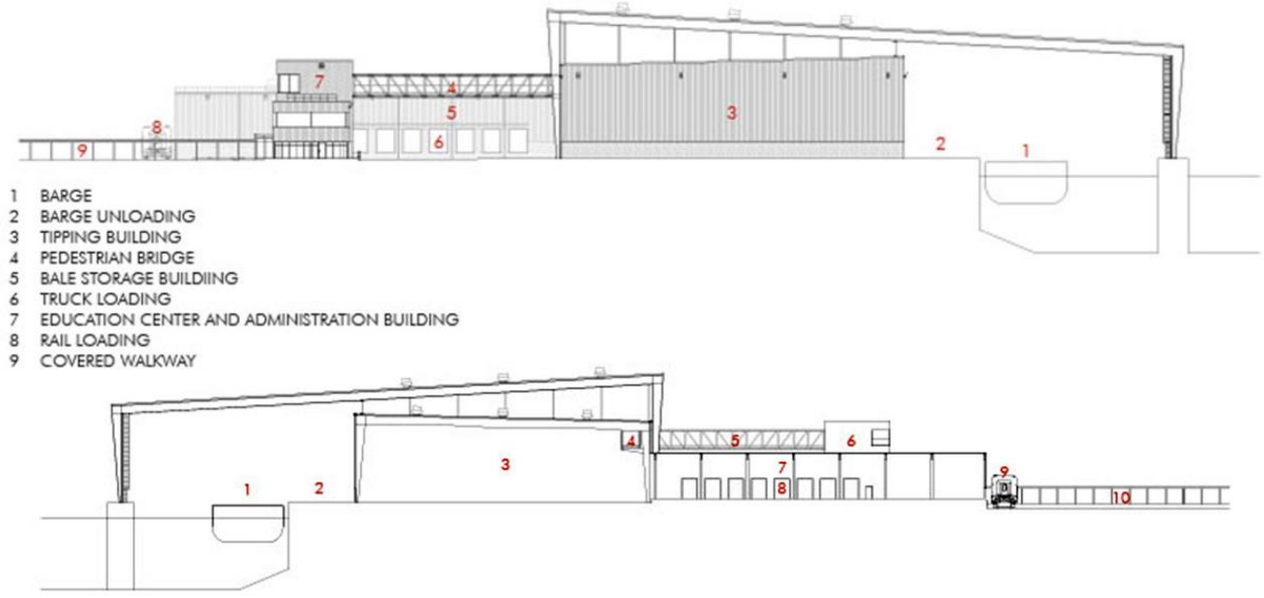


Figure 3. 27 Building sections

1.Tipping building

In this building, the material arrives in trucks and barges. Materials from Queens and the Bronx mostly arrive by barge and material from Brooklyn arrives directly by truck. Each month, the 25,000 tons of residential metal, glass, and paper picked up by the New York City Department of Sanitation. The metal, glass, and plastic (MGP) arrive completely mixed together. The materials first enter a place known as the tipping floor, shown above, where a front-end loader pushes the recyclables onto a conveyor belt. The conveyor feeds up into a "Liberator Shredder," a slow-speed shredder with large gaps between the teeth that is used to open up the plastic bags that the recyclables come in. The recyclables fall through along with the ripped-open bags.

Figure 3. 29 Barges loading and unloading area (Arch daily)

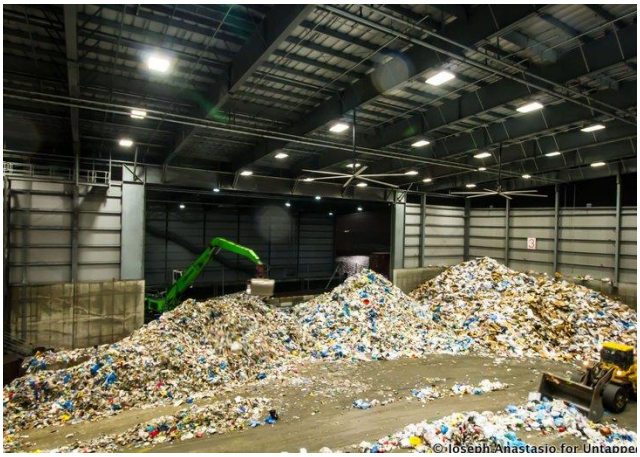


Figure 3. 28 Wastes in tipping floor (Untapped new york)

1. Processing building

From tipping building, the wastes are transferred to the processing building which has about 3.2km long conveyor. The material after going through the liberator shredder, it goes towards disc screens that jostle the items while pushing them forward. The glass shatters, falls through the cracks and is collected. Then, the rest of the items pass over a drum magnet which pulls all the ferrous metals.

The plastics are sorted primarily using 16 optical sorters which are set to look for particular types of plastics and papers using infrared light. When the type is detected, an air jet is triggered at the end of the belt that shoots the item onto the next conveyor belt. At this point, most of the plastic, glass and ferrous metal has been removed from the stream, and what's left passes over an eddy current separator, a reverse magnet that charges metals that

aren’t naturally magnetic. Then, the remaining materials go through a trommel to remove the final unwanted pieces, and the final sort is done by hand.

Figure 3. 30 62 View of conveyor belt from the deck that connect education centre through bridge (Selldorf Architects)

2. Bale Storage building

Each of the separated products are then stored in a large bunker. When those bunkers are full, they will unload onto a conveyor and be sent to the balers. Through a large amount of the force, the balers compress the plastic or aluminum into bales that way about 1,000 pounds each. About 30 to 40 bales can be loaded onto a truck and sent to customers, while other bales leave by rail and barge float.

3. Education centre and administration building

The Education Center is one of the project's most unique features, the structure contains programs for school children and the public including classrooms, exhibitions, and interactive demonstration displays. A key element of the design is a steel bridge which connects the Education Center to a viewing platform inside the Processing Facility where the viewing platform allows students and visitors to see the recycling process in action.

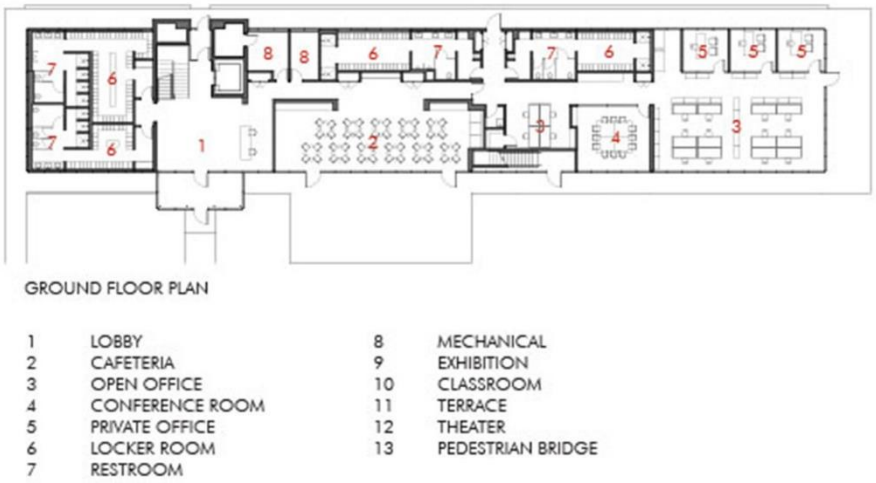


Figure 3. 31 Ground floor plan of education center and admin bldg

Figure 3. 32 Education centre and administration bldg. (Selldorf Architects

Figure 3. 33 View of bridge that connects education center with processing block (Selldorf Architects

- **Building material and technology**

Recycled materials are used throughout: site fill is made from a composite of recycled glass, asphalt, and rock reclaimed from the Second Avenue subway construction; metal buildings are 98% recycled steel; and visitor plazas are finished with recycled glass. Structural elements are inverted to appear on the exterior, giving steel girders and lateral bracing a greater visual impact.

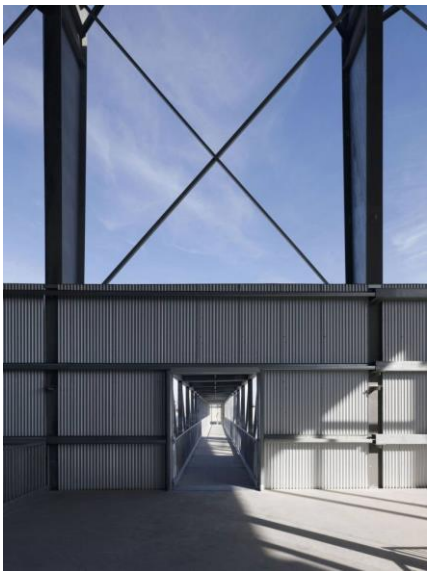


Figure 3. 34 Recycled steel structure exterior

- **Energy**

The Sunset Park Material Recovery Facility is partially powered by renewable energy: 5% comes from the 100kw wind turbine, the first large commercial wind turbine in New York City, and 15% comes from solar panels on the building, one of the largest solar power installations in the city.

Figure 3. 35 Wind turbines

- **Inferences**

- Waste management facility can be developed as a center for public awareness by integrating education center as well as public amenities.
- Despite of need to connect the waste management building and education center, the circulation should not cross each other.

3.2.1 SYDHAVNS RECYCLING CENTRE

Location: Copenhagen, Denmark

Area: 16145 sq.ft

Project Year: 2017-2018

Project Type: Community Recycling centre

Ownership: ARC (Amager Resource Center)

Figure 3. 36 Aerial view of Sydhavns Recycling Centre concealed with manmade hill (Dezeen)

- **Introduction**

A new Danish recycling center by BIG is an innovative new concept that will see the Sydhavns Recycling Center become an important community asset. The beautiful recycling center is submerged under a luscious green hill and have a "recycling square" where patrons can take a peek at the process while enjoying their daily exercise. The recycling centre supports a transition to circular economy, which considers used items a resource rather than pure waste. Residents will be able to hand in material that is suitable for reuse or repair – e.g. old boards and bricks at the Sydhavn Recycling Centre. The projects involve the integration of various amenities and services to enhance the well-being of local residents.

- **Design Development**

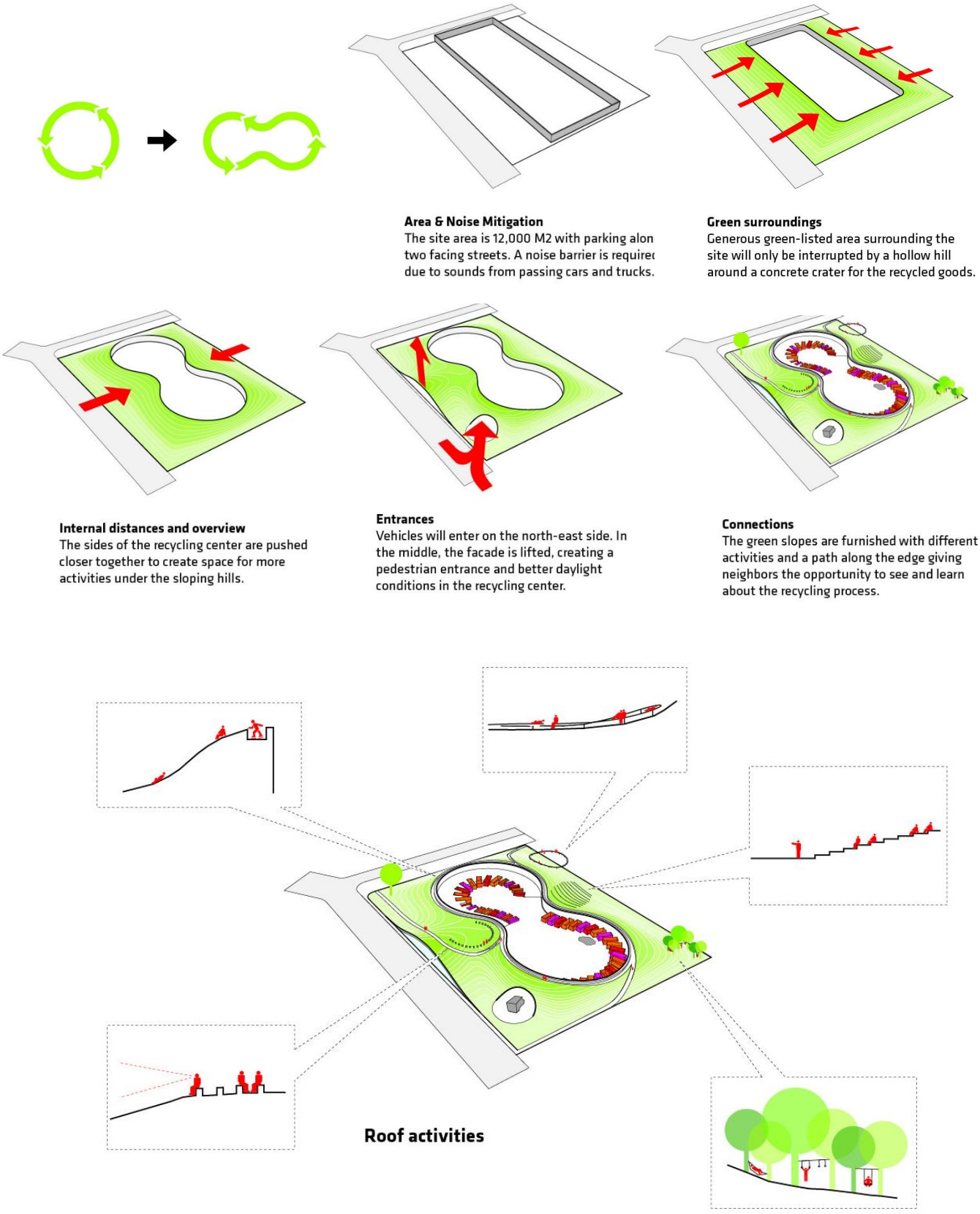


Figure 3. 37 Design Development

- **Spatial Distribution**

The recycling center is located at the waterside of the light industrial zone, embedding itself in the landscape and connected to a large park. This design is not to separate the building from the surrounding environment, but to bury the building in the surrounding environment. The recycling center by BIG includes fitness facilities, outdoor recreational space, a track or pathway overlooking the activities below, workshops, an exhibition/dining/play area and a teaching room.

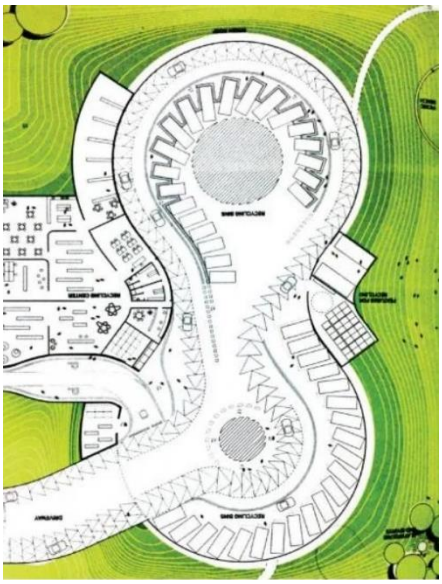


Figure 3. 38 Masterplan

1. Entrance

The heart of the reuse station is a lock at the entrance, where all users are stopped by qualified staff, who inquire whether they have brought suitable items for reuse. It can be wooden boards and planks, tiles, doors, windows, insulation material, furniture and much more. In traditional recycling stations, most of these materials would have been sorted for recycling instead of direct reuse.

2. Reuse station

The reuse station is equipped with a large storage facility, where reusable items are stored. Some of the items are sold directly at the reuse station's own reuse builders' merchant while others are stored for bulk sale directly to local companies via local tenders. In addition, the reuse station acts as an incubator for new circular economy business models. Local

entrepreneurs and innovators work at the reuse station's own workshop to develop new products based on the incoming materials.


Figure 3. 39 Aerial view of reuse station

3. Teaching Room

School classes can come to the recycling depot three times during the years. First visit focus on waste and sorting. Second visit on recycling and a historical view on waste handling. And the third visit focus on waste as a resource and an alternative to exploiting the resources of the Earth. The room lies at a terrace with an overview over the recycling depot.

The sitting stairs gives the communicator the possibility to easily gather the pupils for brief instructions. In the room, wall and pillars of waste are used as design elements and to support the teaching. The walls have mixed waste, while it is sorted in the pillars. (IDEFU)

Figure 3. 41 Learning centre exterior

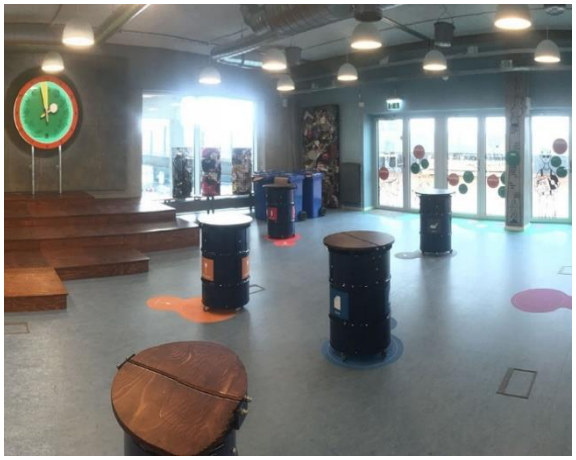


Figure 3. 40 Learning centre interior

- **Circulation**

As the recycling centre also acts as the community centre for public engagement, the centre can be accessed from the artificial hill whereas the waste can be access through the road level. The access for the waste and public is well defined. Also, there is the provision for separate entry and exit of vehicles..

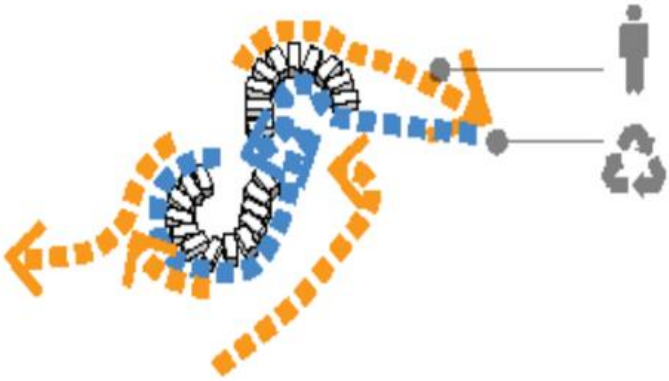


Figure 3. 42 Circulation pattern

- **Building material and technology**

It is a project that moves the boundaries for sustainable reusability of concrete. Nothing less than 2500 t reusable material from an incineration plant's demolished chimney was used for the new recycle centre. That means that up to 40 % of the new concrete consists of reusable material.

Figure 3. 43 Sydhavns recycling center during construction phase (Strabag)

- **Inferences**

- Waste recycling centre should be deisgned with consideration and connection with the surrounding environment.
- While designing, consideration should be given to the public amenities and visual connections.

4. SITE ANALYSIS

4.1 SITE INTRODUCTION

Location : Silakhe, Bhaktapur

Total site area : 17801.83 sq.m.(34-15-3-2

Topography : Contoured land(contour toward west)

Orientation : East oriented

Ownership : Land on lease by Bkt municipality

Latitude : 27°41'19" N

Longitude : 85°26'47" E

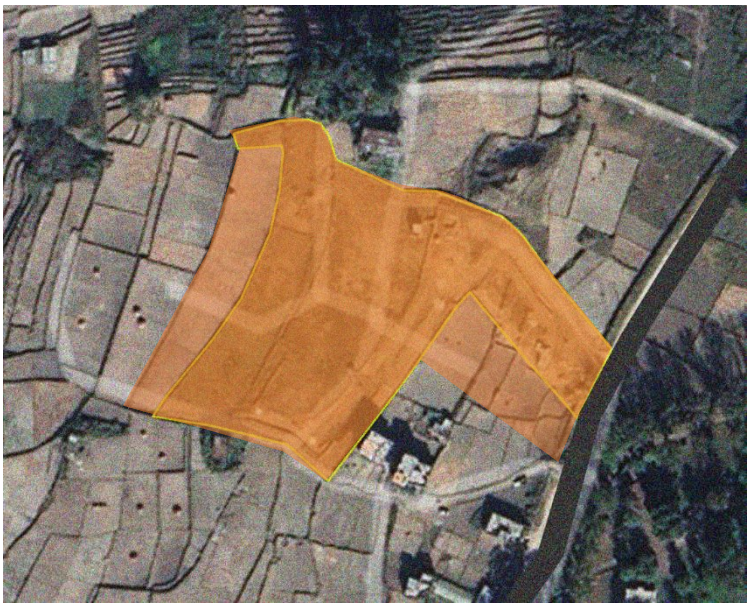


Figure 4. 1 Proposed site

4.2 SITE LOCATION

The proposed site for the project, "Bhaktapur Paper and Plastic Recycling Centre" is located at **Silakhe**, Bhaktapur municipality ward no.10 of the Bhaktapur district, Nepal. It is also the site designated by the Bhaktapur municiaplity for its waste management plan.

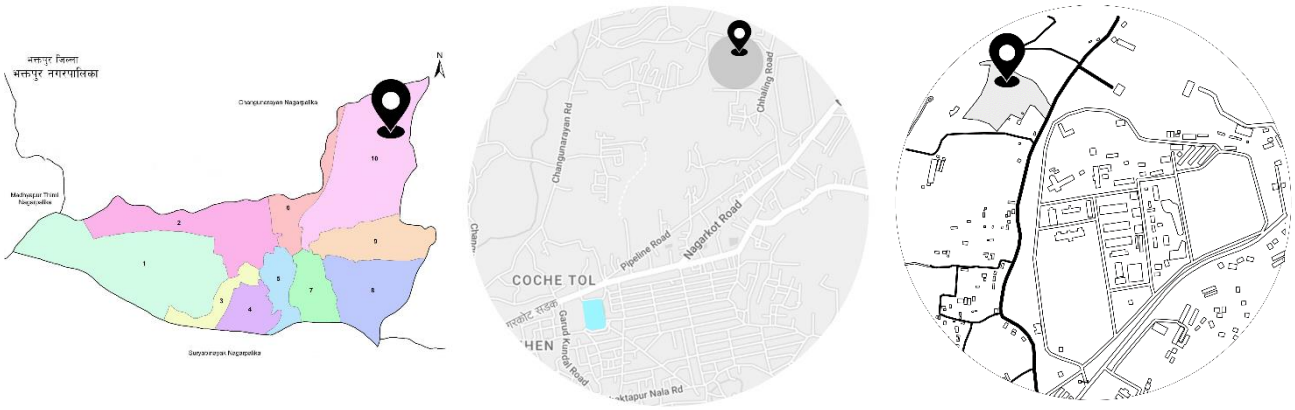


Figure 4. 2 Site location map

4.3 ACCESSIBILITY AND ACCESS

The proposed site is about 1.6 km distance from the Nagarkot bus stop, Kamalpokhari, Bhaktapur. It can be accessed through Nagarkot road and Chhaling road. The accessibility to the site is shown below:

21 min walking distance from Nagarkot bus stop.

5 min distance by private vehicle from Nagarkot bus stop.

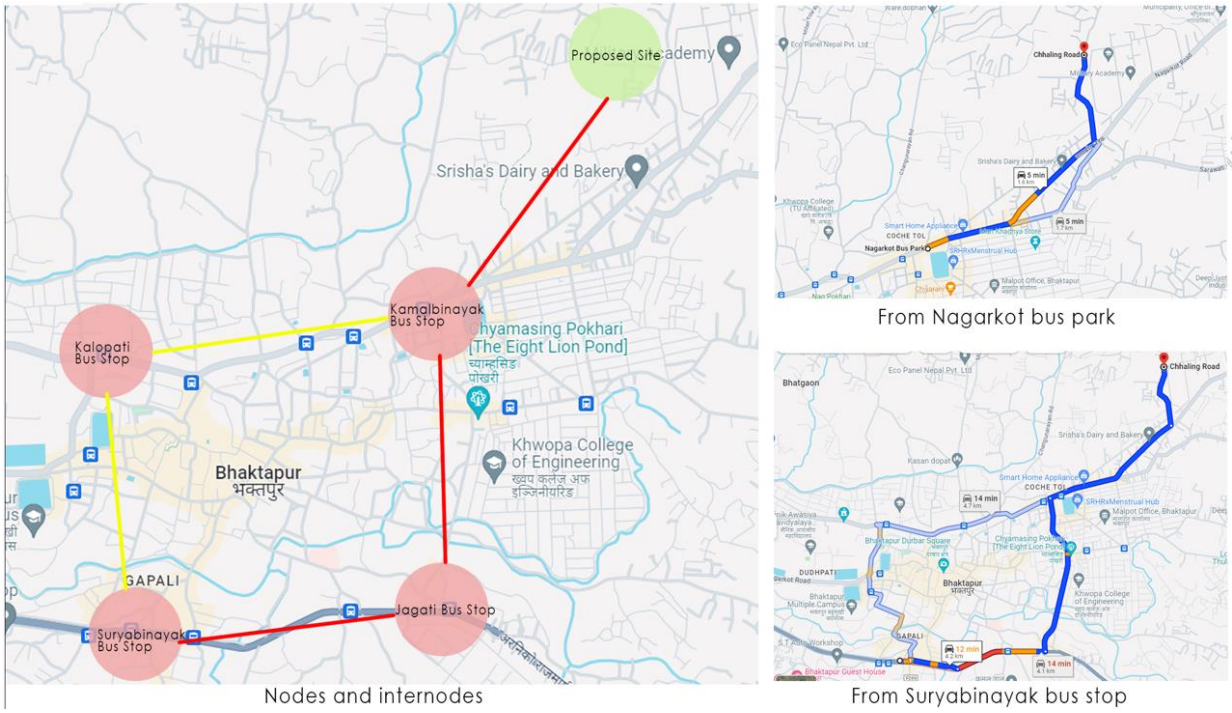


Figure 4. 3 Nodes and internodes

4.4 ROAD NETWORKS

The major road nearby the site is the Nagarkot road which is connected with the Chhaling road which is the road that connects the site. The pipeline road emerging from the main Nagarkot road intersect the Chhaling road through which the site can be appr

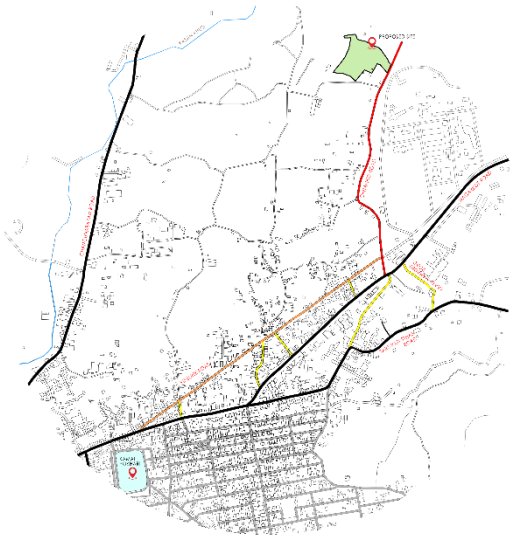


Figure 4. 4 Road networks

4.5 SITE SURROUNDING

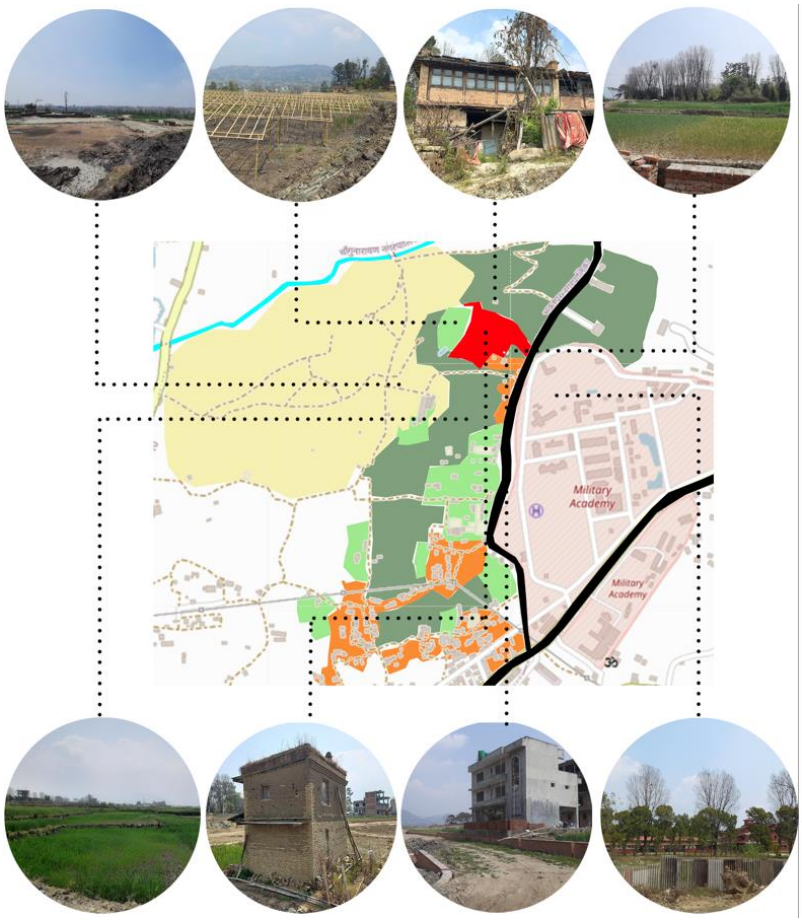


Figure 4. 5 Site surrounding

4.6 INFRASTRUCTURES

1.Electricity

There is proper provision of electricity which are required in my site for running of various machineries. The electric poles are situated along side of the road.

Figure 4. 6 Electrical lines running parallel to the site

2. Road

The road that approaces the site is about 12m wide without footpath. The road condition is under construction.

Figure 4. 7 Road condition around site

3. Water supply and drainage

There is no provision of water supply and drainage system in the site.

Figure 4. 8 View of site from the road level

4.7 SITE PROXIMITY

The project “Bhaktapur Paper and Plastic Recycling center” is proposed to be designed for management of paper and plastic waste produced solely in the Bhaktapur municipality.

In 1.5km radius from the proposed site, the kamalbinayak land pooling area is situated. In around 2km radius Libali land pooling and some parts of the core area is touched and in 3km radius all the core area is situated.

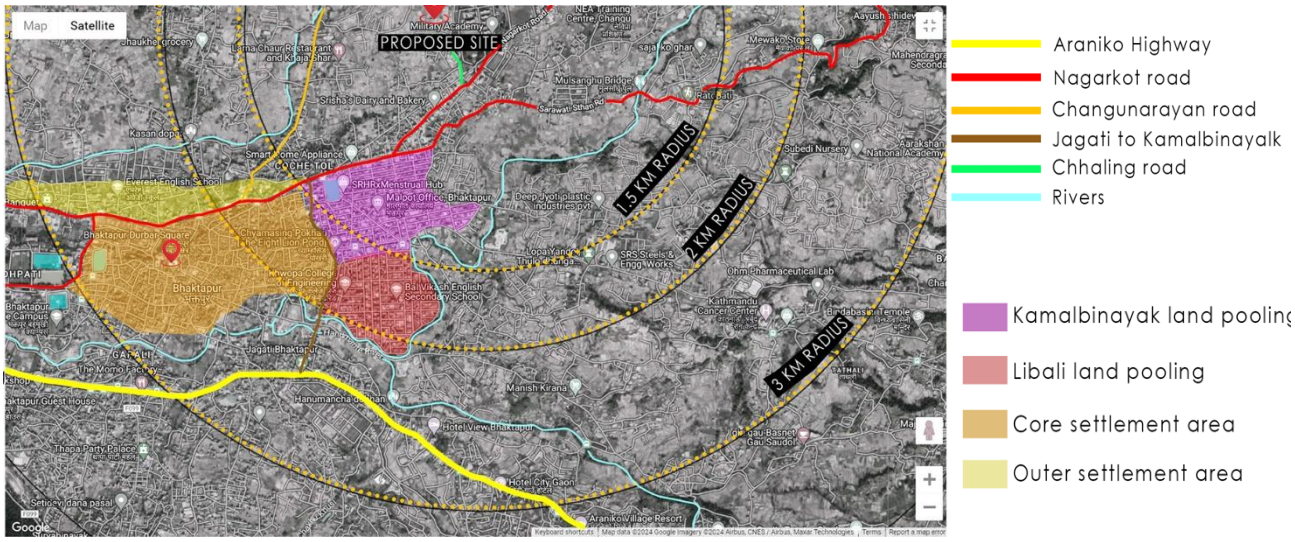


Figure 4. 9 Site proximity analysis

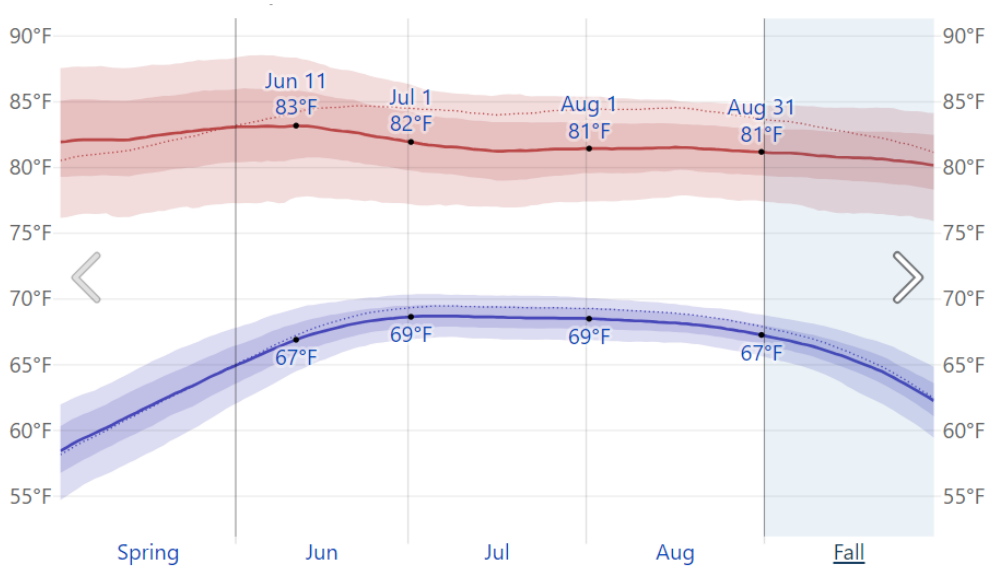
4.8 CLIMATIC ANALYSIS

The site is located at sub tropical zone with average daily high temperature above 79°F. The climatic data of the site are shown as follows:-

1.Temperature

The warm season in Bhaktapur lasts for 6.2 months from April 5 to October 10, with an average daily high temperature of 79°F. The hottest month of the year is June with the average high temperature of 83°F and low of 67°F.

The cool season in Bhaktapur lasts for 21 months, from December 8 to February 11, with an avereage daily high temperature below 68°F. The coldest month of the year is January, with an average low of 37°F and high of 64°F.



The daily average high (red line) and low (blue line) temperature, with 25th to 75th and 10th to 90th percentile bands. The thin dotted lines are the corresponding average perceived temperatures.

Figure 4. 10 Average High and Low temperature in Bhaktapur

2.Precipitation

The maximum rainfall in Bhaktapur occurs in July with maximum rainfall of about 1000 mm and least rainfall occurs in the month of November and December. In the month of July, there is maximum rainfall days and the least rainfall days is in the month of December.

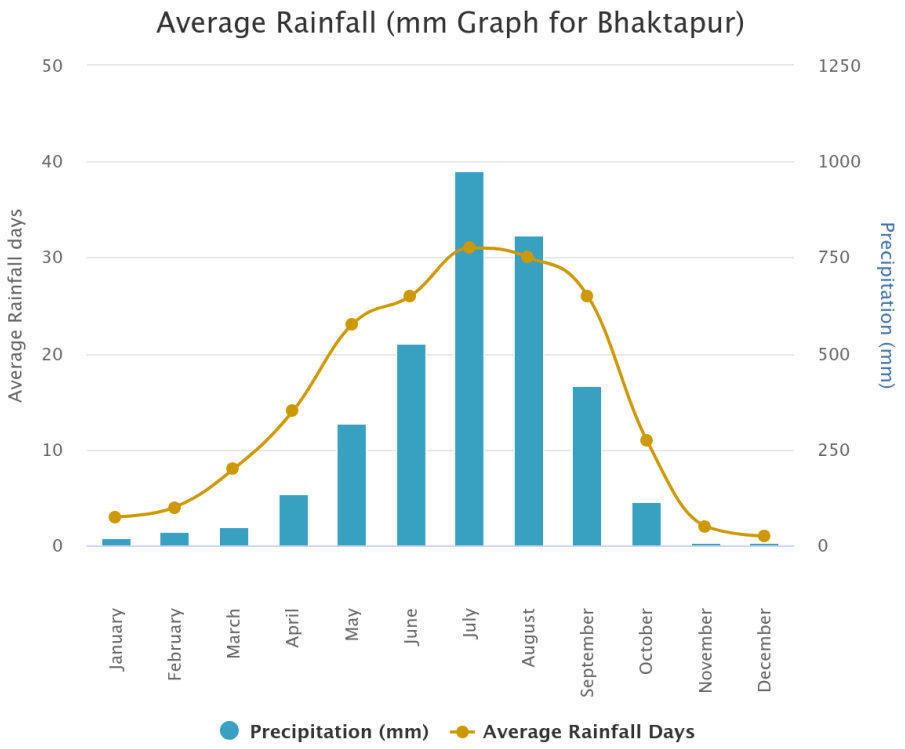


Figure 4. 11 Rainfall in Bhaktapur (worldweatheronline.com)

3.Humidity

The chance that a given day will be *muggy* in Bhaktapur is *very rapidly increasing* during the summer, *rising* from *33%* to *88%* over the course of the season. The highest chance of a muggy day during the summer is *96%* on *August 1*.

The *muggiest day* of the year is August 1 in which the muggy conditions is *96%* of the time, while on *January 1*, the *least muggy day* of the year, there are muggy conditions *0%* of the time.

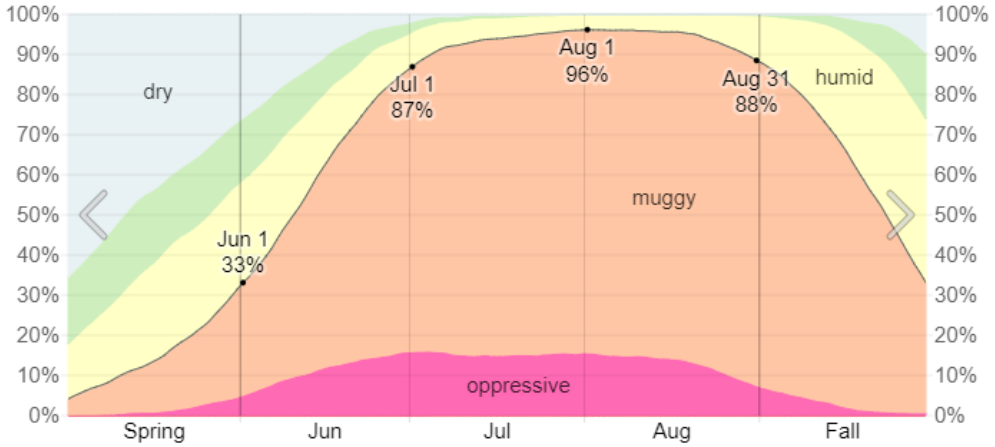


Figure 4. 12 Humidity level

4. Wind

The average hourly wind speed in Bhaktapur is *decreasing* during the summer, *decreasing* from *5.6 miles per hour* to *4.3 miles per hour* over the course of the season. For reference, on *April 12*, the *windiest day* of the year, the daily average wind speed is *6.3 miles per hour*, while on *November 30*, the *calmest day* of the year, the daily average wind speed is *3.7 miles per hour*.

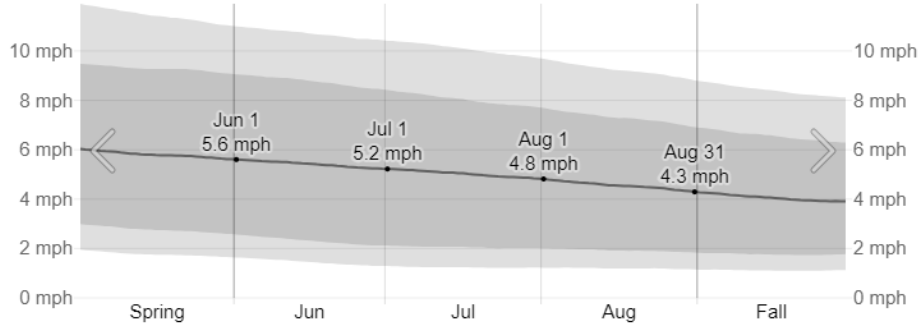


Figure 4. 13 Wind chart

5. SOLAR ANALYSIS

The site is oriented to east. However, the site recieves the unosbtructed sun light from the south. The solar angle during summer solstice is 85.81° and winter solstice is 38.81°.

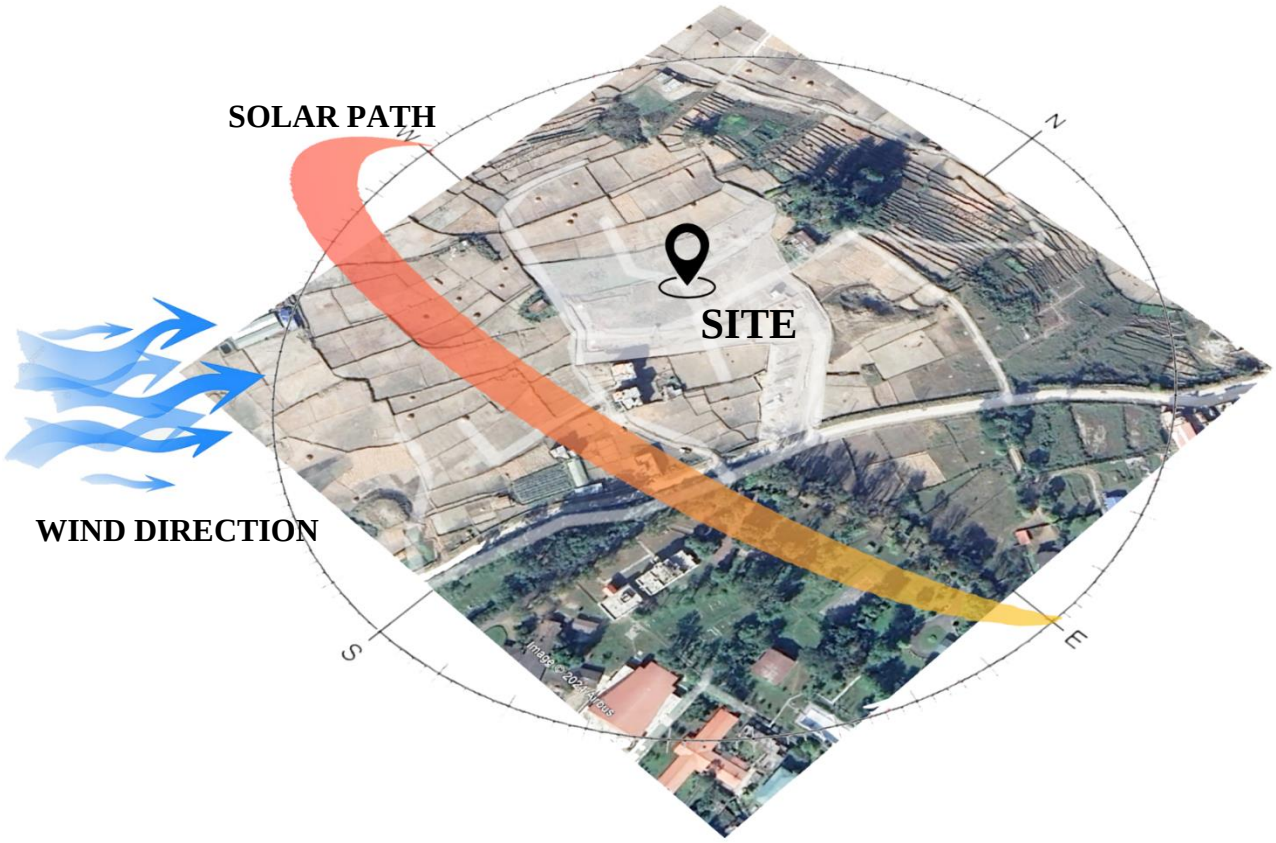


Figure 4. 14 solar analysis diagram

4.9 ZONING AND BY LAWS

The site is situated at the residental subzone.

विनियम	क्रियाकलापहरु/उपयोगहरु	विस्तारित आवाशीय क्षेत्र
६.९	विपत्तिजनक क्रियाकलाप	
६.९.१	पेट्रोलपम्प तथा हानिकारक वस्तुको ठूलो परिमाणमा भण्डारण	अस्वीकृत
६.९.२	फोहर फ्याँकने ठाउँ	विशेष स्वीकृत
६.९.३	पशु वधशाला	विशेष स्वीकृत
६.९.४	फोहर मैला प्रशोधन गर्ने ठाउँ	विशेष स्वीकृत
६.९.५	वर्कशप	विशेष स्वीकृत

Table 4 Bye laws

Ground coverage ratio(GCR): 40%

Minimum Site area: 1 ropani

Setback: 2m for main blocks; , Guard houses, servant quarter electrical sub stations, pump house, etc which are 1 storey or has floor height less than 5m or plinth area less than 200 sq.ft can be constructed upto site boundary.

Floor height: According to the requirement.

Minimum stair and corridor width: 1.5m

Tread: 11”

Riser: 7”

If every floors, floor area is more than 2500 sq.ft, secondary staircase is to be provided.

4.10 SWOT ANALYSIS

Strength

- The site is located at the optimum distance from the settlement area of Bhaktapur municipality so waste can be easily transfered.
- The site is situated outside of the core city so no traffic jams.
- Easy transportation facility for raw material and finished product.
- The site is situated at residential sub zone which is permitted for waste management bldg facility.

Weakness

- No water supply and drainage services at the site which are essential infrastructures for such project.
- The site is situated at the agricultural land which may exploit the fertile land and cultivation capcacity.

Opportunity

- As the land is lower topography from the surrounding, nice visual sense is obtained.

Threat

- A residental buidling is situated near the boundary of the site so proper consideration should be given to provide comfortable environment.
- The plastic waste products may contaminate the agricultural land of the site.

5. PROGRAM FORMULATION

On the basis of literature review, case studies, site survey and existing site conditions, the program formulation is done. Program formulation for the design if waste recycling centre is based on the area requirement for the following three major components:

- **Waste Facilities**
- **Employee's Facilities**
- **Public Amenities**

5.1 Waste Facilities

S.N	Description	Unit	Area per Unit	No. of People	Area (Sq.m)
I.	**Material Recover Facility**	1			
1.	Tipping Building	1	-	4	250
2.	Sorting Area	1	-	6	550
3.	Storage Area		-	4	200
i.	Plastic storage	1			50
ii.	Paper storage	1			50
iii.	Textile storage	1			25
iv.	Rubber storage	1			25
v.	Metal storage	1			25
vi.	Others storage	1			25
4.	Bale storage	1		4	420
II.	Paper Processing		-		
1.	Processing Area	1		10	480
2.	Control Room	1		1	45
3.	Final Product Storage	1		1	320
4.	Chemical Storage	1		3	45

II.	**Plastic Processing**		-		
1.	Processing Area for PET, PP and PE	1		15	520
2.	Control Room	1		1	45
3.	Final Product Storage	1			320
4.	Chemical Storage	1		1	45

5.2 Employee Facility

S.N	Description	Unit	Area per Unit	No. of People	Area (Sq.m)
I.	**Administration**				
1.	Reception and waiting area	1			30
2.	Managing director	1		1	40
3.	Administrative executive	1		1	30
4.	Vice Administrator	1		1	30
5.	Paper recycling coordinator	1		1	30
6.	Plastic Recycing coordinator	1		1	30
7.	Account room	1		1	30
8.	Meeting room	1		25	100
9.	Toilet	2			40
10.	Store	1			24
II.	**Changing and Locker**	2	0.5		

	Rooms			
1.	Male	1		90
2.	Female	1		85
III.	**Toilet Facilities**	2		
1.	Male			20
2.	Female			15
IV.	**Cafeteria**			
1.	Kitchen			100
2.	Dining			300
3.	Store			70
V.	**Medical Room**			**15**
VI.	**Employee Parking**			
VII.	**Library**	1	-	120
VIII.	**Trainning Room**	2	25 each	90
IX.	**Upcycle Studio**	1	30	120
X.	**Paper workshop**	1	25	120
XI.	**Plastic workshop**	1	25	120
XII.	**Conference room**	1	60	250
XIII.	**Indoor sports hall**	**1**	-	320
XIV.	**Accmmodations**	11	25	35
XV.	**Yoga hall**	**1**	-	150
XVI.	**Meditation room**	**1**	-	100

5.3 Public Facilities

S.N	Description	Unit	Area per Unit	No. of People	Area (Sq.m)
I.	**Public Parking**				
II.	**Education center**				
1.	Classroom	2		30 each	120
2.	Exhibition area	1		-	125
3.	Recycling workshop	1		-	50
4.	Multimedia Room	1		-	40
5.	Information center	1		-	45

6. CONCEPT AND DESIGN DEVELOPMENT

6.1 CONCEPT

The Bhaktapur paper and plastic recycling center is a recycling center project that recycles the plastic and paper waste generated in the Bhaktapur municipality as well as waste plastic and paper from the local recyclers. The concept is derived from the logo of the 3R principle.

The 3R principle is a very important terminology that every environmentists or people working in waste management or recycling centre are familiar with. The 3R principle symbolizes three arrows in a cyclic form that depict different meanings. Among the three arrows, one arrow means to reduce, other means to reuse and the last means to recycle. The concept is dragged from the shape of the arrow of the recycle that is possessed by the famous logo.

The shape of arrow is transffered to the shape of a block. Then the block is placed on the site such that it blends with the site perfectly.

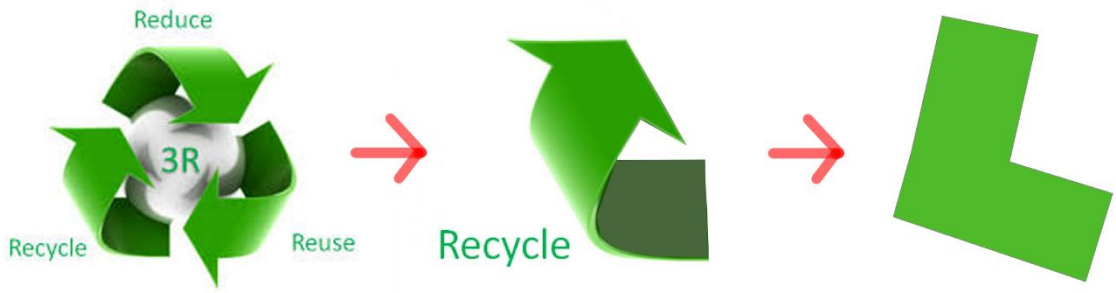


Figure 6. 1 Concept from 3R logo

6.2 ZONING

The site is divided into two zones; the public zone and the private zone. The public zone comprises of the community park where people can come and enjoy the landscape. Public amenities such as the education center, exhibition area, workshops, multimedia room, viewing area along with the administrative facilities are all included in the public zone.

The private zone is more secluded area where all the processes take place. The waste is brought in this area which undergoes sorting and different processing processes. It comprises of the production area plus different research labs. Also, the various amenities for staffs working on the waste such as accommodations, indoor sports hall, yoga hall, meditation room, training rooms, etc are provided in this zone.

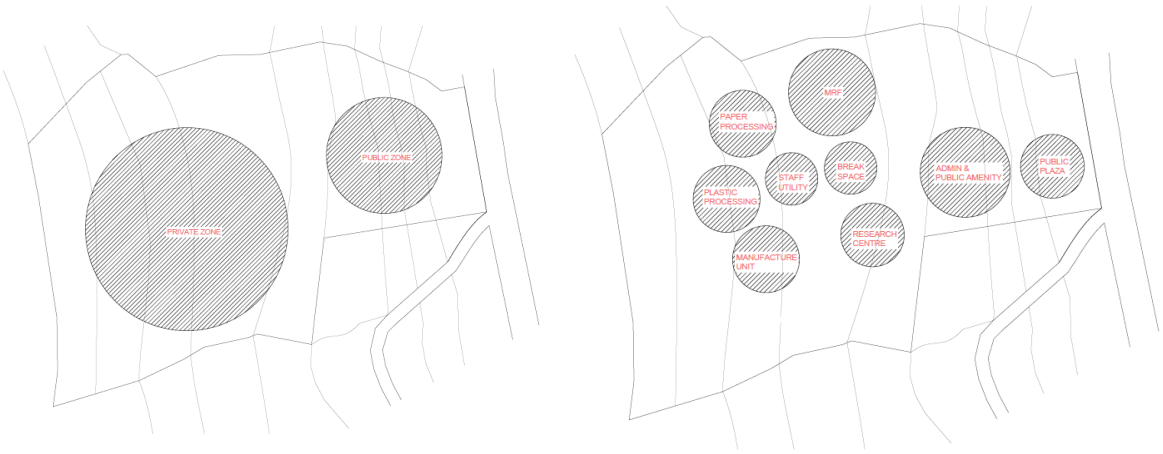


Figure 6. 2 Zoning

6.3 FORM DEVELOPMENT

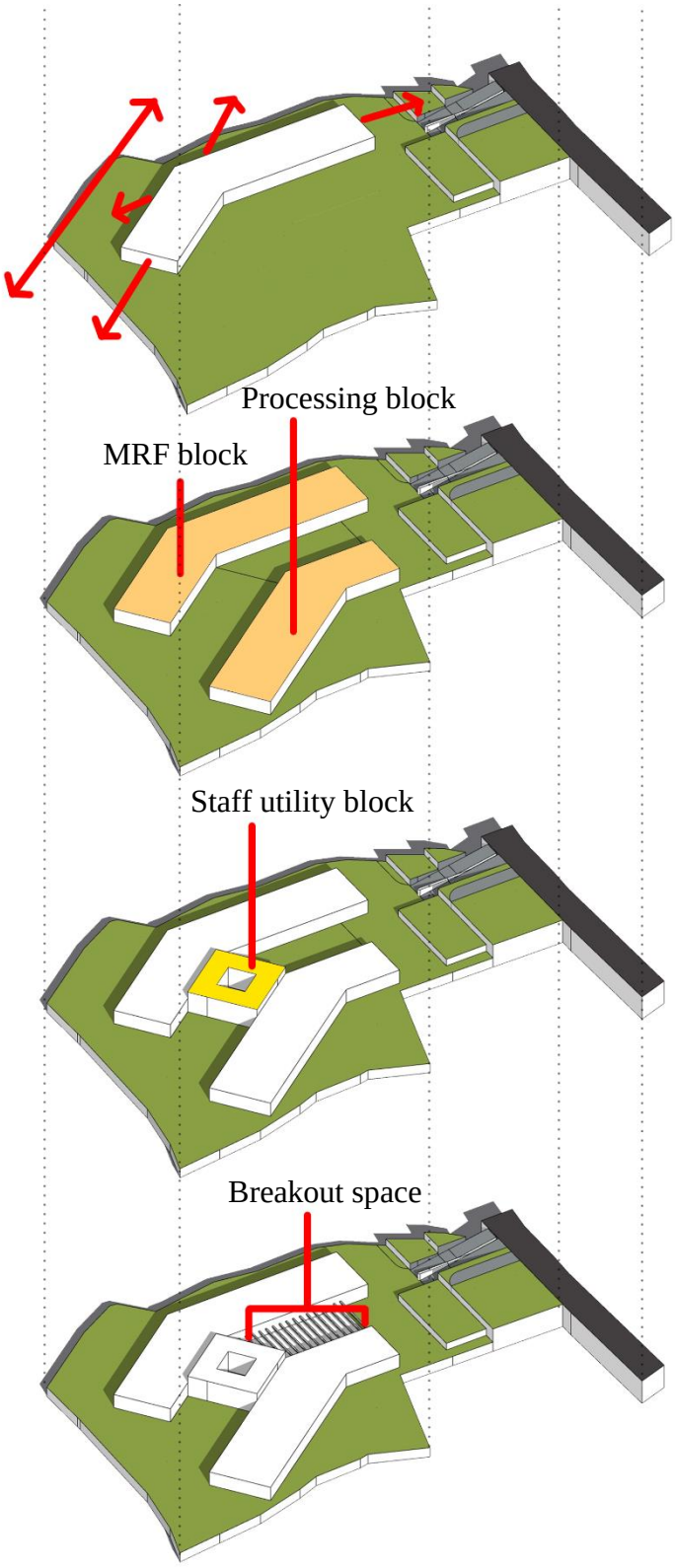


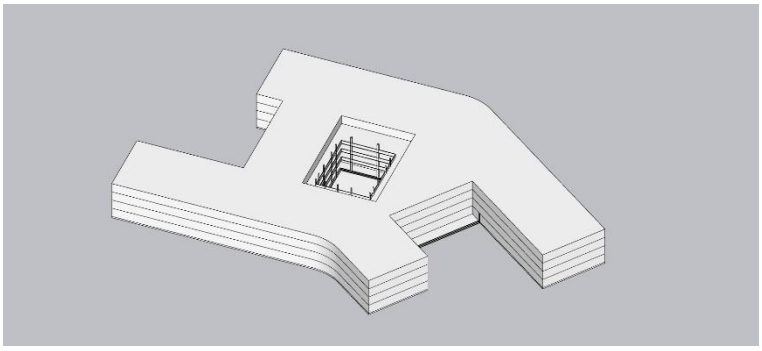
Figure 6. 3 Form development

The block is placed on the site with reference from the shape of the site with longer axis of the block parallel to the longer axis of the site.

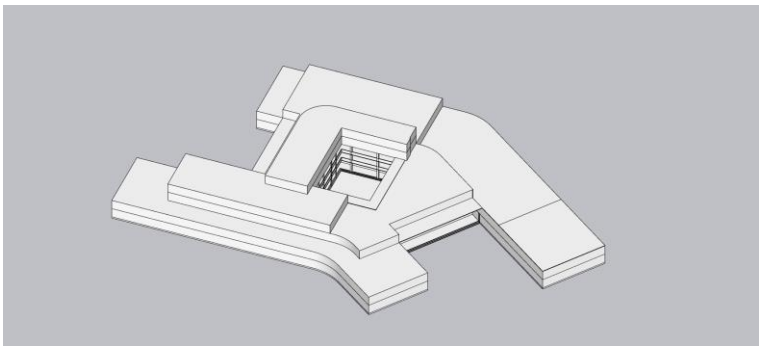
Between the two factory blocks, a third block is added which includes the utilities for the staffs or workers such as changing rooms, lockers, etc. and other recreational activities for the staffs.

Another similar block is replicated and used as the processing block, the previous being as material recover facility (MRF) block.

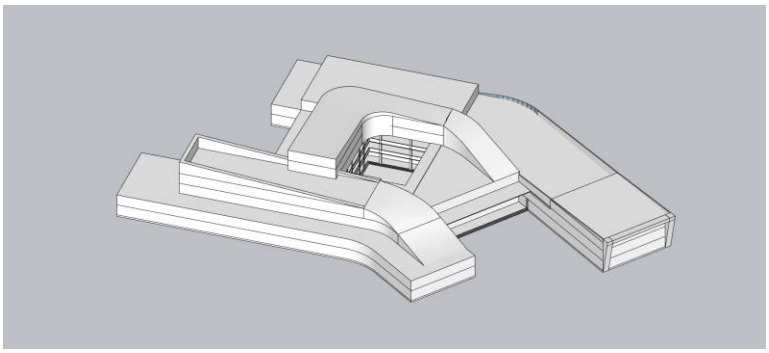
A breakout space is added between the blocks where the factory workers can spend their leisure time and also gain some refreshment.



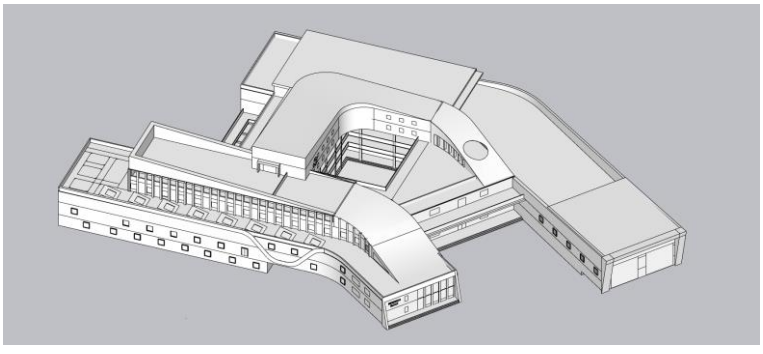
Stacking of blocks vertically, providing mass to the building.



Subtraction of building mass such that the building gets proper sunlight from the south.



Insertion of slopes in order to get nice visual image from the surrounding, especially from the road level that connects the site.



Final volume development after the insertion of various functional elements such as windows, voids, vertical elements.

Figure 6. 4 Overall form development

6.4 DESIGN DEVELOPMENT

The masterplan is develop according to the zoning and the conceptual design. The site is connected at the road from east. The site is gradually contoured from road level at 0 level to lower level at -10 level. Hence, for easy circulation and flow of waste and material the building is designed in split level. For human and vehicle flow ramp and stairs is designed with 1:12 ratio. The public and administrative building is planned near the road level for easy access of public with various public amenities including a public park. A basement is planned near road level with the slab of basement comes to the road level where public park is built.

The design is all based on proper flow of waste into the site and proper flow of material within the site and finally proper flow of final products from the site to the outside. Proper plantation of vegetations to create buffer around the site is done. Proper outdoor landscapes is planned in relationship to the inside factory spaces.

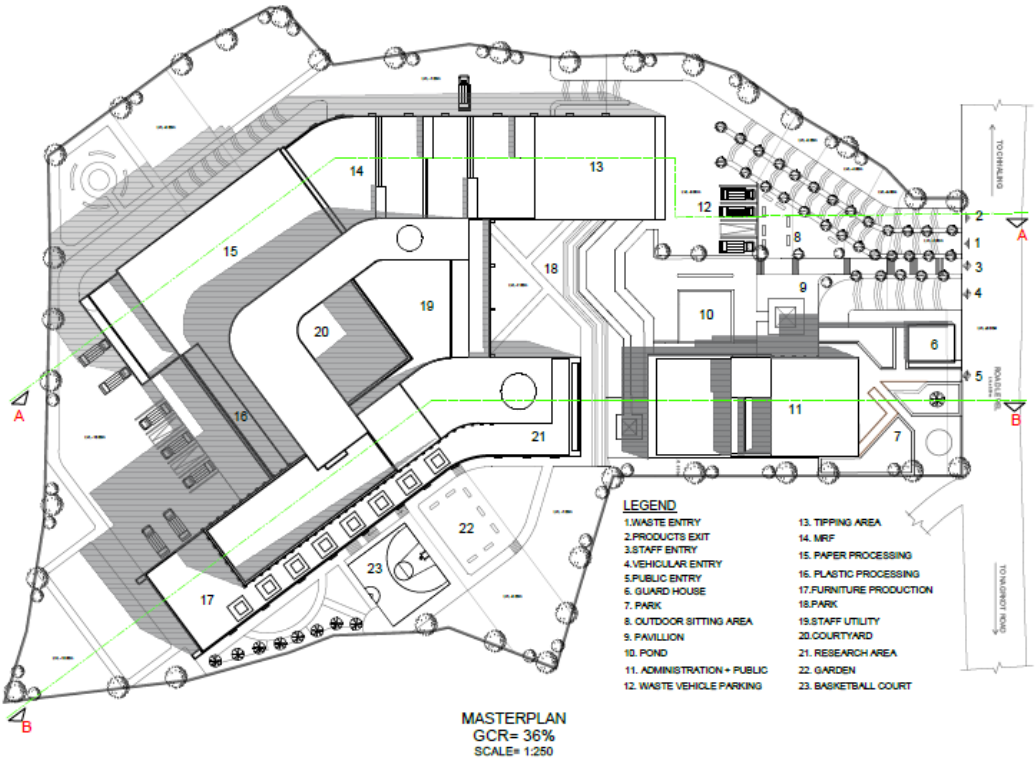


Figure 6. 5 Masterplan

6.5 DESIGN OF INDIVIDUAL BLOCK

6.5.1 ADMINISTRATION AND PUBLIC BLOCK

This block is planned near the entrance in split levels. The block is designed in split level with the 0m level connecting the road comprises of information center, exhibtion area for public and toilet facilities. The -3m level comprises of classrooms, workshop room, viewing deck and basement parking. The -6m level comprises of areas of administrative works with various offices and meeting room.

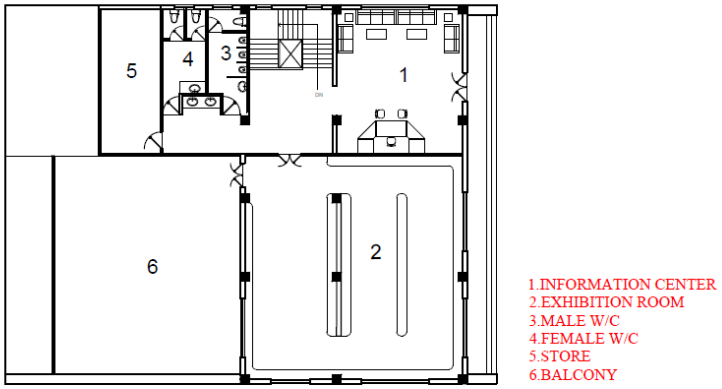


Figure 6. 6 Plan at +/-0.000m administration and public block

6.5.2 PROCESSING AND STAFF BLOCK

This block comprises of chaning rooms,infirmary, tipping hall for dumping the waste, waste segregation area, paper and plastic processing area with control room, chemical storage room and toilets each. A polywood furniture manufacturing area is also present in this block, all of which are in -7m level. The -10m level floor consists of final product storage and dispatch area. All the upper areas comprises of various amenities for the betterment and welfare of waste workers such as canteen, accommodations, trainning halls, workshop rooms, library, indoor sports arena, yoga hall and a meditation room. The block is designed with the green roof, roof garden and provision of sky lights.

Figure 6. 8 Plan at -7.000m of processing and staff block

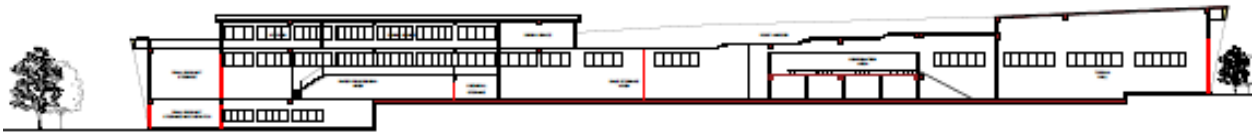


Figure 6. 7 Section of processing and staff block

7.CONCLUSION

Bhaktapur paper and plastic recycling center is the place where the recycling of paper and plastic takes place with the vision of betterment of lifestyle of people working in the waste. The design helps to engage people in the waste recycling process diretly or indirectly by providing information and educating them with the knowledge of recknowledge of recycling with its importance.

The waste recycling center utilizes the waste which unfortunately passes to the landfill site to create a better product which not only preserves the environment from degradation but also provides employment for the people. The products craft paper from waste paper can help to promote the local handicrafts whereas outdoor furniture from the waste plastic can help to enhance the landscape design plus reduce depenency on wooden and metal furnitures.

The project engages waste and public activity with the demonstration of recycled products to the public trying to change the perception of people towards the use of waste. The project also tries to change the perception of general public toward the people working in the waste. In such way, the waste management problem in the developing country like ours can be eradicated, if not reduced.

REFERENCES

Nathanson, J.A. (2018). Solid-waste management. In: *Encyclopædia Britannica*. [online] Available at: https://www.britannica.com/technology/solid-waste-management.

www.prysmian.com. (n.d.). *The importance of waste management | Prysmian Group*. [online] Available at: https://www.prysmian.com/en/insight/sustainability/the-importance-of-waste-management.

archive.epa.gov. (2016). *Municipal Solid Waste | Wastes | US EPA*. [online] https://archive.epa.gov/epawaste/nonhaz/municipal/web/html/#:~:text=Municipal%20Solid%20Waste%20(MSW)%E2%80%94.

The World Bank (2018). *Trends in Solid Waste Management*. [online] datatopics.worldbank.org. Available at: https://datatopics.worldbank.org/what-a-waste/trends_in_solid_waste_management.html#:~:text=The%20world%20generates%202.01%20billion.

Maharjan, M.K. and Lohani, S.P. (2020). Municipal Solid Waste Management in Nepal: Opportunities and Challenges. *Journal of the Institute of Engineering*, 15(3), pp.222–226. doi:https://doi.org/10.3126/jie.v15i3.32185.

Mukherjee, S. (2023). *Exploring the Functional Elements of Solid Waste Management*. [online] Enterclimate. Available at: https://enterclimate.com/blog/elements-of-solid-waste-management/.

Jamal, H. (2020). *Functional Elements of Solid Waste Management System*. [online] www.aboutcivil.org. Available at: https://www.aboutcivil.org/functional-elements-solid-waste-management-system.

US EPA, O. (2013). *Recycling Basics and Benefits*. [online] www.epa.gov. Available at: https://www.epa.gov/recycle/recycling-basics-and-benefits#:~:text=Recycling%20is%20the%20process%20of.

Ua-bw.de. (2024). *UA-BW | The Making of a Recycled ...* [online] Available at: https://www.uabw.de/pub/beitrag_printversion.asp?subid=0&Thema_ID=3&ID=1767&Pdf=No&lang=EN [Accessed 29 Aug. 2024].

Guberman, R. (2020). *The Complete Plastics Recycling Process*. [online] Recycle Track Systems. Available at: https://www.rts.com/blog/the-complete-plastics-recycling-process-rts/.

www.hse.gov.uk. (n.d.). *Ergonomics at materials recovery facilities*. [online] Available at: https://www.hse.gov.uk/waste/mrf.htm.

Anon, (2019). *Introduction to Materials Recovery Facility | EcoMENA*. [online] Available at: https://www.ecomena.org/materials-recovery-facility/.

Idefu (2020). *Learning environment at Sydhavn Recycling Depot for teaching 0.-6. grade*. [online] Idefu. Available at: https://www.idefu.dk/en/sydhavn-recycling-depot/ [Accessed 29 Aug. 2024].

Rosenfield, K. (2015). *BIG Designs Danish Recycling Center as Neighborhood Asset*. [online] ArchDaily. Available at: https://www.archdaily.com/601048/big-designs-danish-recycling-center-as-neighborhood-assets [Accessed 29 Aug. 2024].

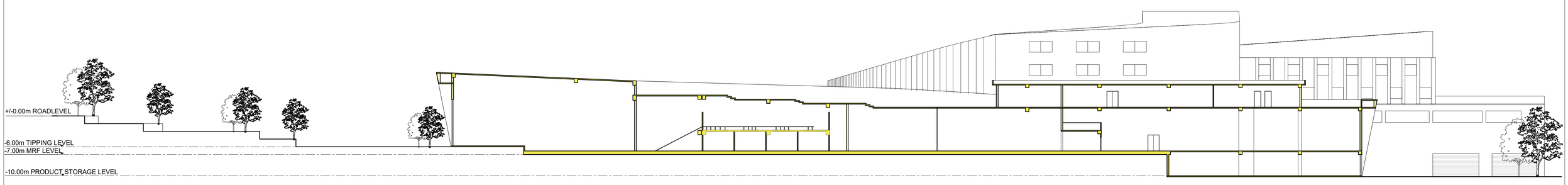
COWI. (n.d.). *Recycling centre ARC Denmark*. [online] Available at: https://www.cowi.com/solutions/environment/recycling-centre-arc-denmark.

SMR. (n.d.). *Material Recycling Center in Brooklyn, NY | Sunset Park Recycling Center*. [online] Available at: https://smrecycles.com/locations/sunset-park-mrf/.

ArchDaily. (2014). *Sunset Park Material Recovery Facility / Selldorf Architects*. [online] Available at: https://www.archdaily.com/509387/sunset-park-material-recovery-facility-selldorf-architects?ad_source=search&ad_medium=projects_tab [Accessed 29 Aug. 2024].

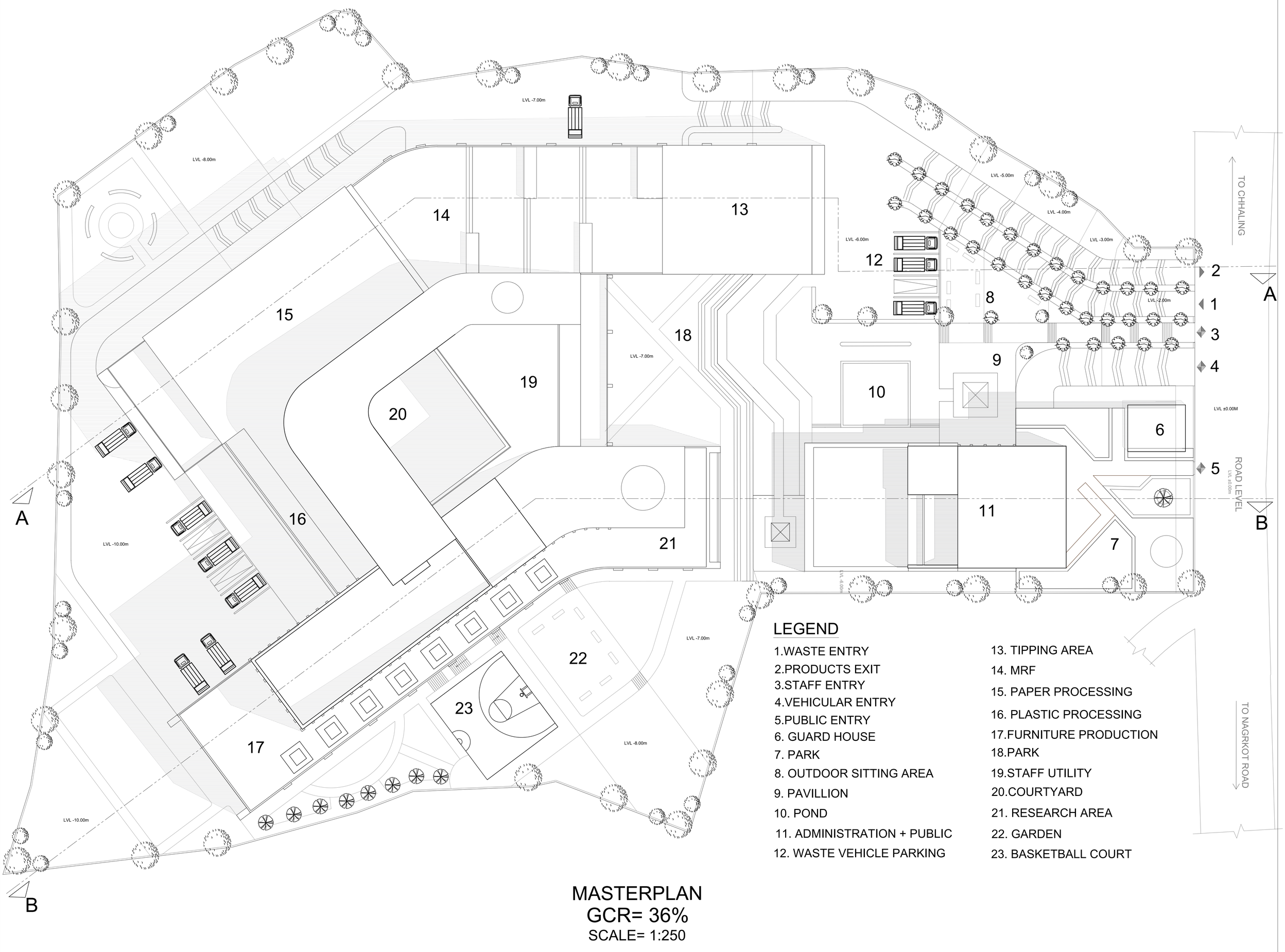
Open House New York. (2023). *Sunset Park Material Recovery Facility - Open House New York*. [online] Available at: https://ohny.org/place/sunset-park-material-recovery-facility [Accessed 29 Aug. 2024].

BHAKTAPUR PAPER AND PLASTIC RECYCLING CENTER



PROFILE SECTION AT A-A

SCALE= 1:250



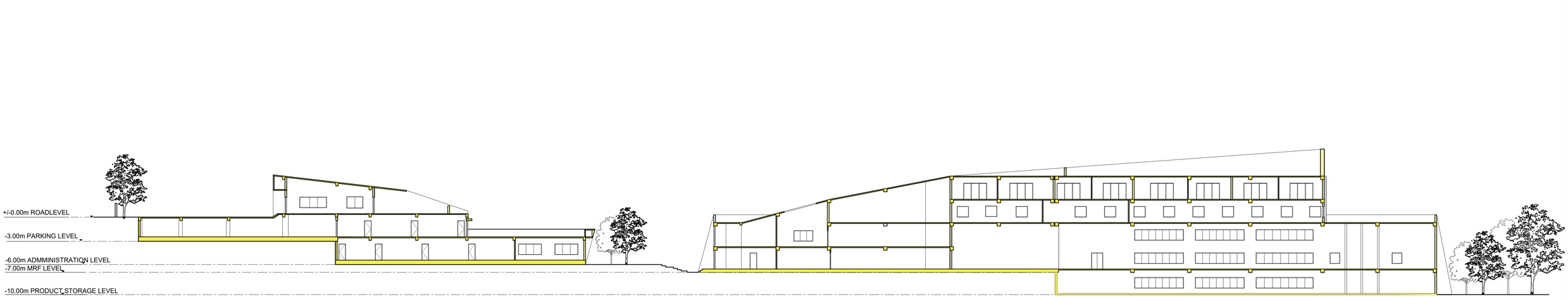
LEGEND

1. WASTE ENTRY
2. PRODUCTS EXIT
3. STAFF ENTRY
4. VEHICULAR ENTRY
5. PUBLIC ENTRY
6. GUARD HOUSE
7. PARK
8. OUTDOOR SITTING AREA
9. PAVILLION
10. POND
11. ADMINISTRATION + PUBLIC
12. WASTE VEHICLE PARKING
13. TIPPING AREA
14. MRF
15. PAPER PROCESSING
16. PLASTIC PROCESSING
17. FURNITURE PRODUCTION
18. PARK
19. STAFF UTILITY
20. COURTYARD
21. RESEARCH AREA
22. GARDEN
23. BASKETBALL COURT

MASTERPLAN

GCR= 36%

SCALE= 1:250



PROFILE SECTION AT B-B

SCALE= 1:250

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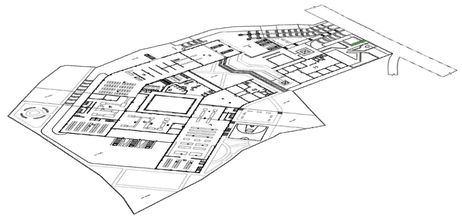
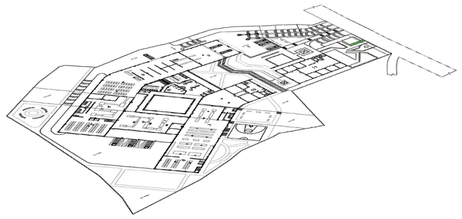
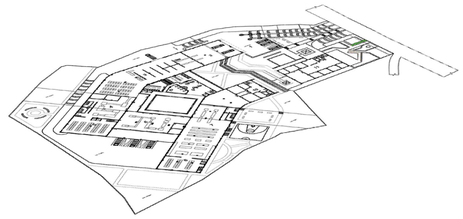
BHAKTAPUR PAPER AND PLASTIC RECYCLING CENTER



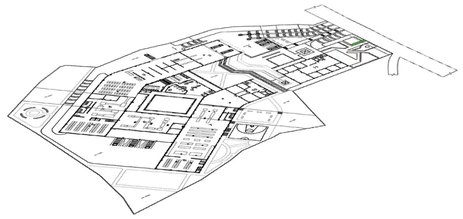
WASTE CIRCULATIONS



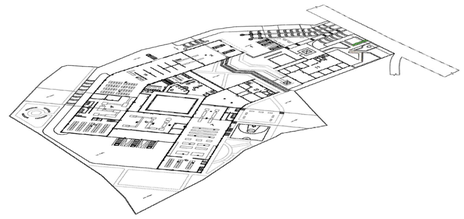
FINAL PRODUCT CIRCULATIONS



STAFF CIRCULATIONS

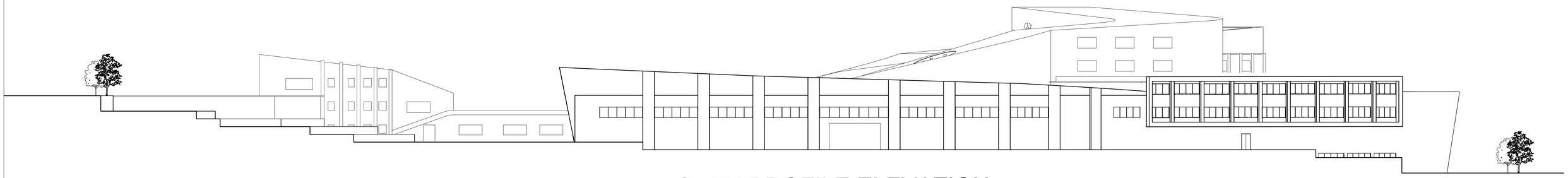


ADMIN/RESEARCHER CIRCULATIONS



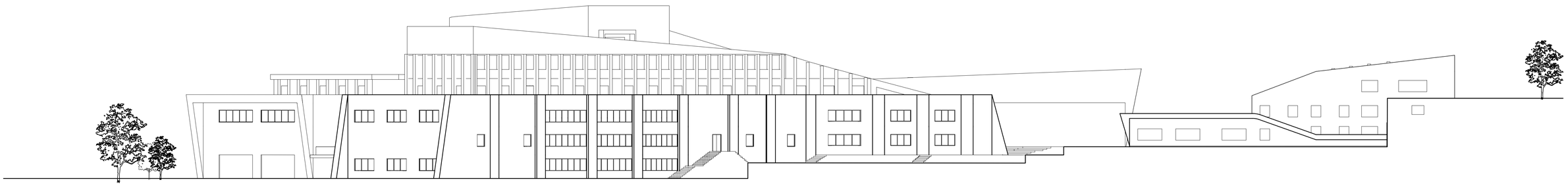
PUBLIC CIRCULATIONS

CIRCULATION DIAGRAMS



NORTH PROFILE ELEVATION

SCALE= 1:250



SOUTH PROFILE ELEVATION

SCALE= 1:250

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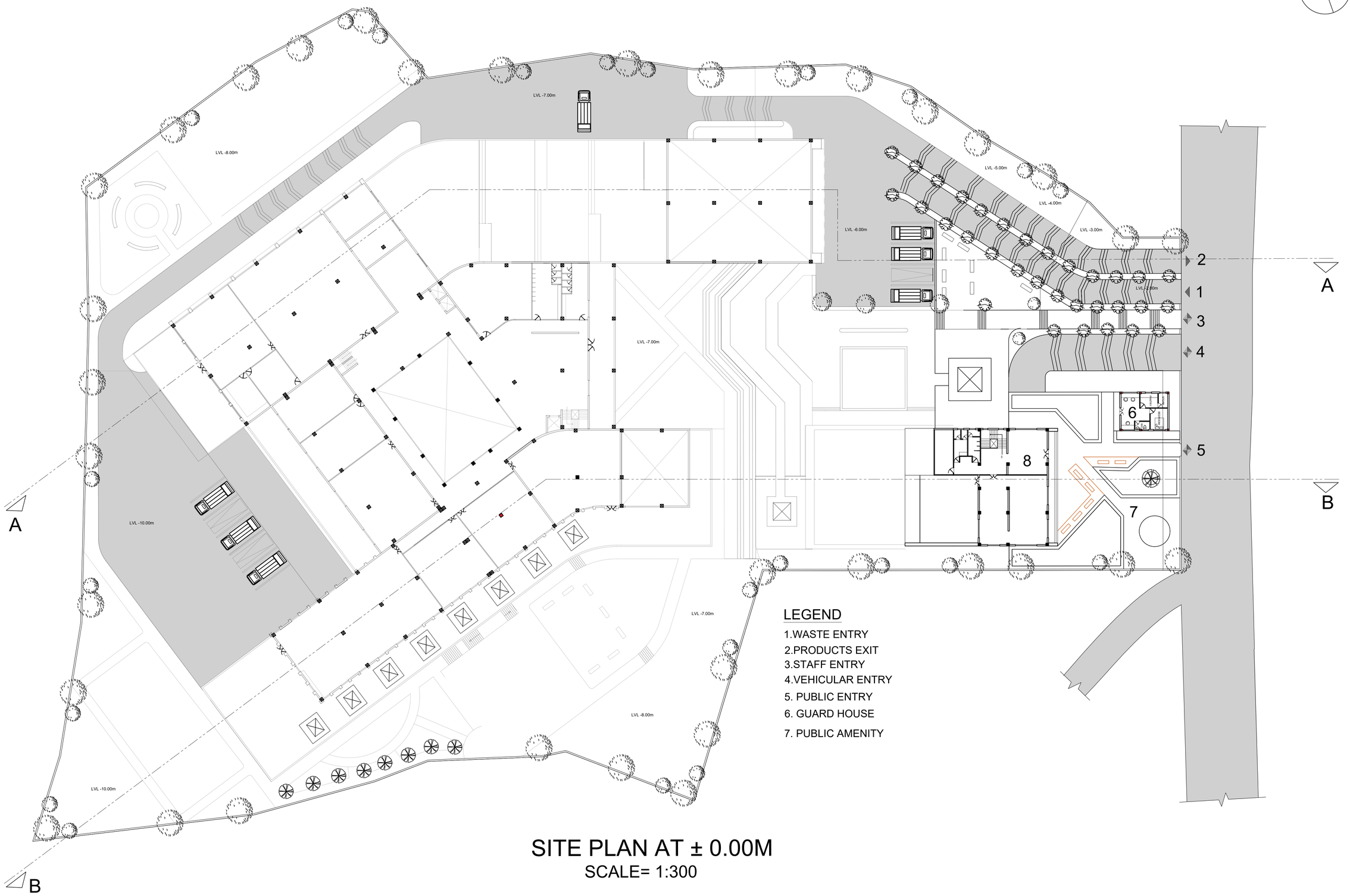

LEGEND

1.WASTE ENTRY
2.PRODUCTS EXIT
3.STAFF ENTRY
4.VEHICULAR ENTRY
5. PUBLIC ENTRY
6. GUARD HOUSE
7. PUBLIC AMENITY

SITE PLAN AT ± 0.00M

SCALE= 1:300

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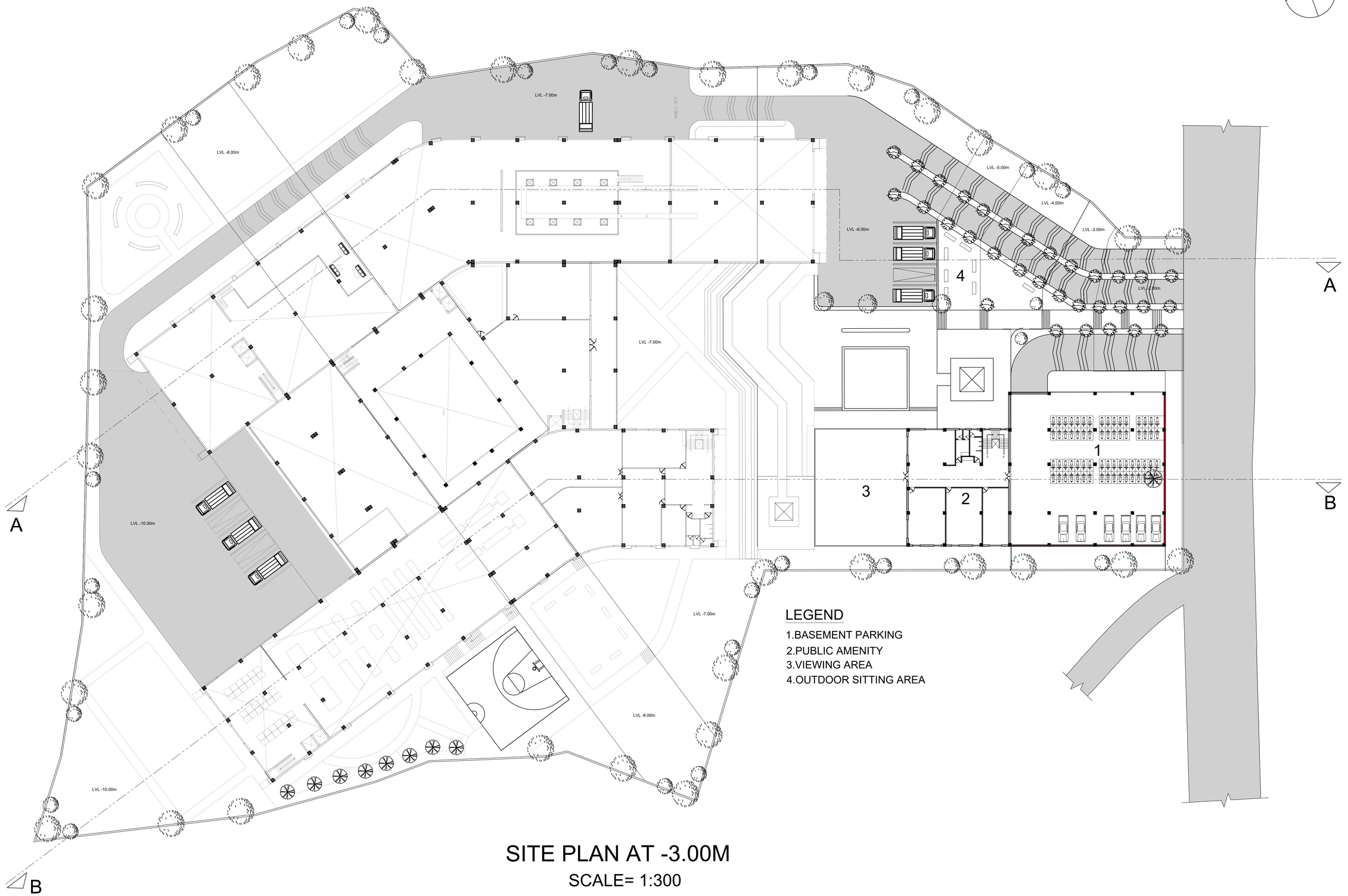
BHAKTAPUR PAPER AND PLASTIC RECYCLING CENTER



LEGEND

1.BASEMENT PARKING
2.PUBLIC AMENITY
3.VIEWING AREA
4.OUTDOOR SITTING AREA

SITE PLAN AT -3.00M

SCALE= 1:300

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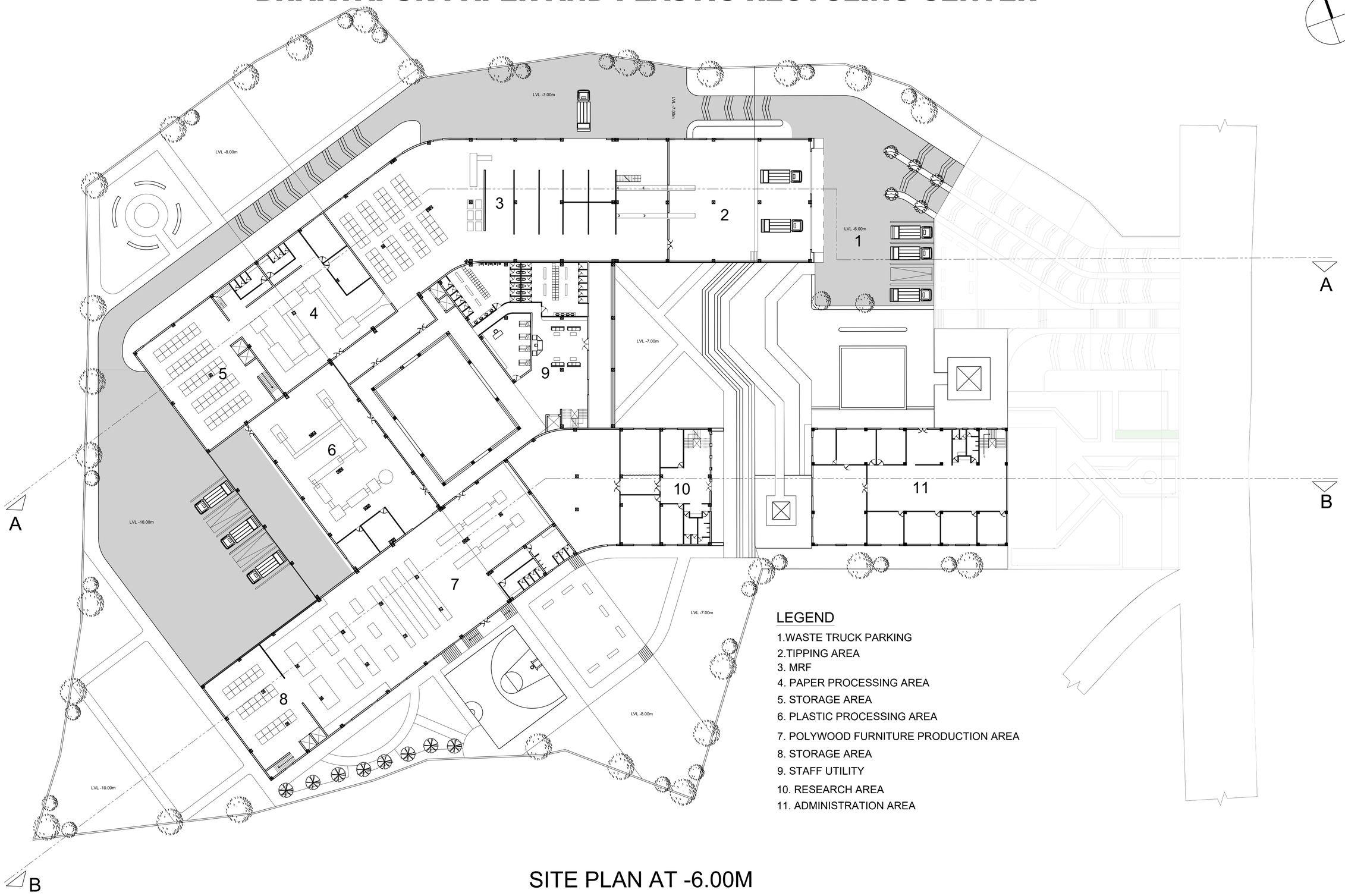
BHAKTAPUR PAPER AND PLASTIC RECYCLING CENTER



LEGEND

1.WASTE TRUCK PARKING
2.TIPPING AREA
3. MRF
4. PAPER PROCESSING AREA
5. STORAGE AREA
6. PLASTIC PROCESSING AREA
7. POLYWOOD FURNITURE PRODUCTION AREA
8. STORAGE AREA
9. STAFF UTILITY
10. RESEARCH AREA
11. ADMINISTRATION AREA

SITE PLAN AT -6.00M

SCALE= 1:300

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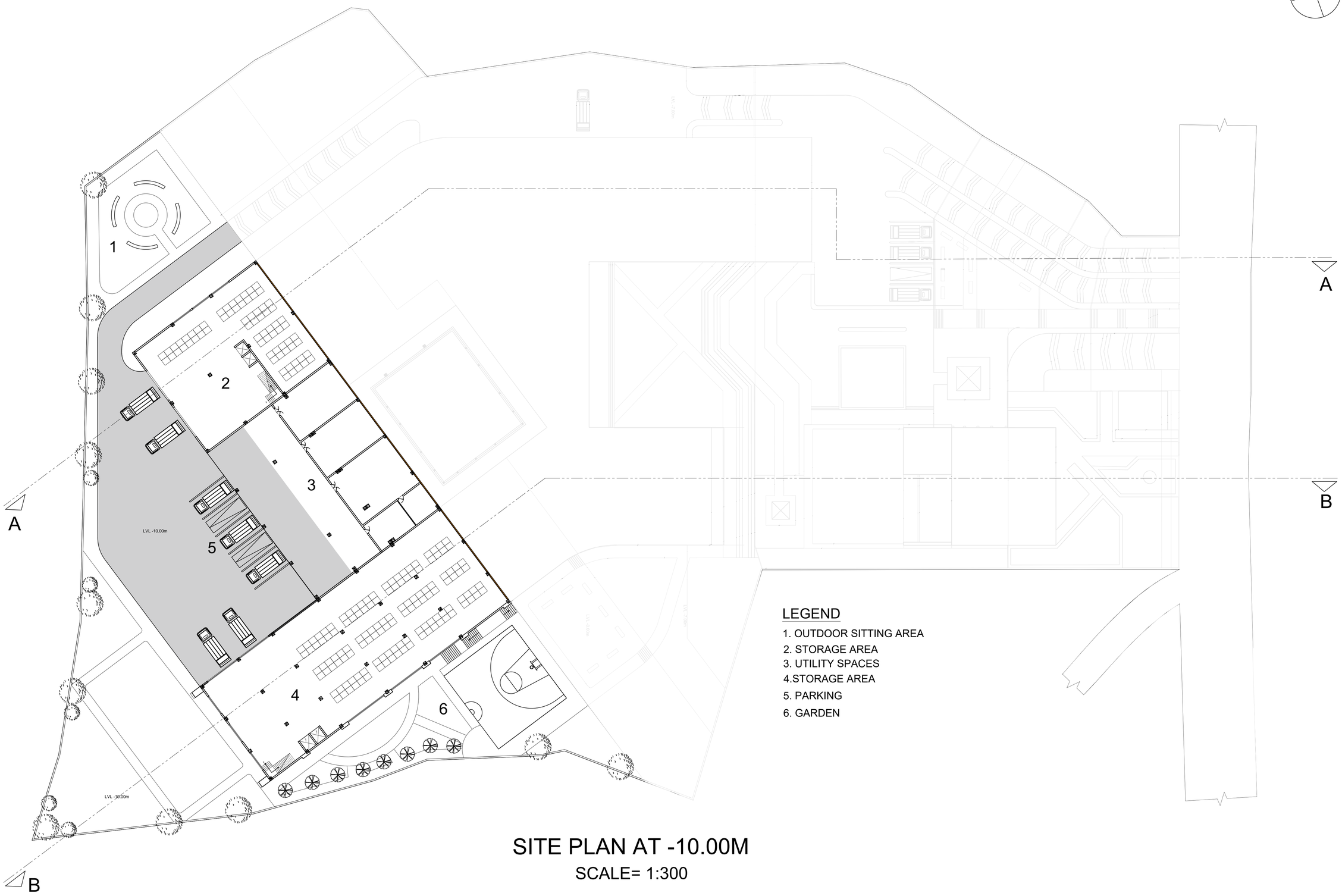

LEGEND

1. OUTDOOR SITTING AREA
2. STORAGE AREA
3. UTILITY SPACES
4.STORAGE AREA
5. PARKING
6. GARDEN

SITE PLAN AT -10.00M

SCALE= 1:300

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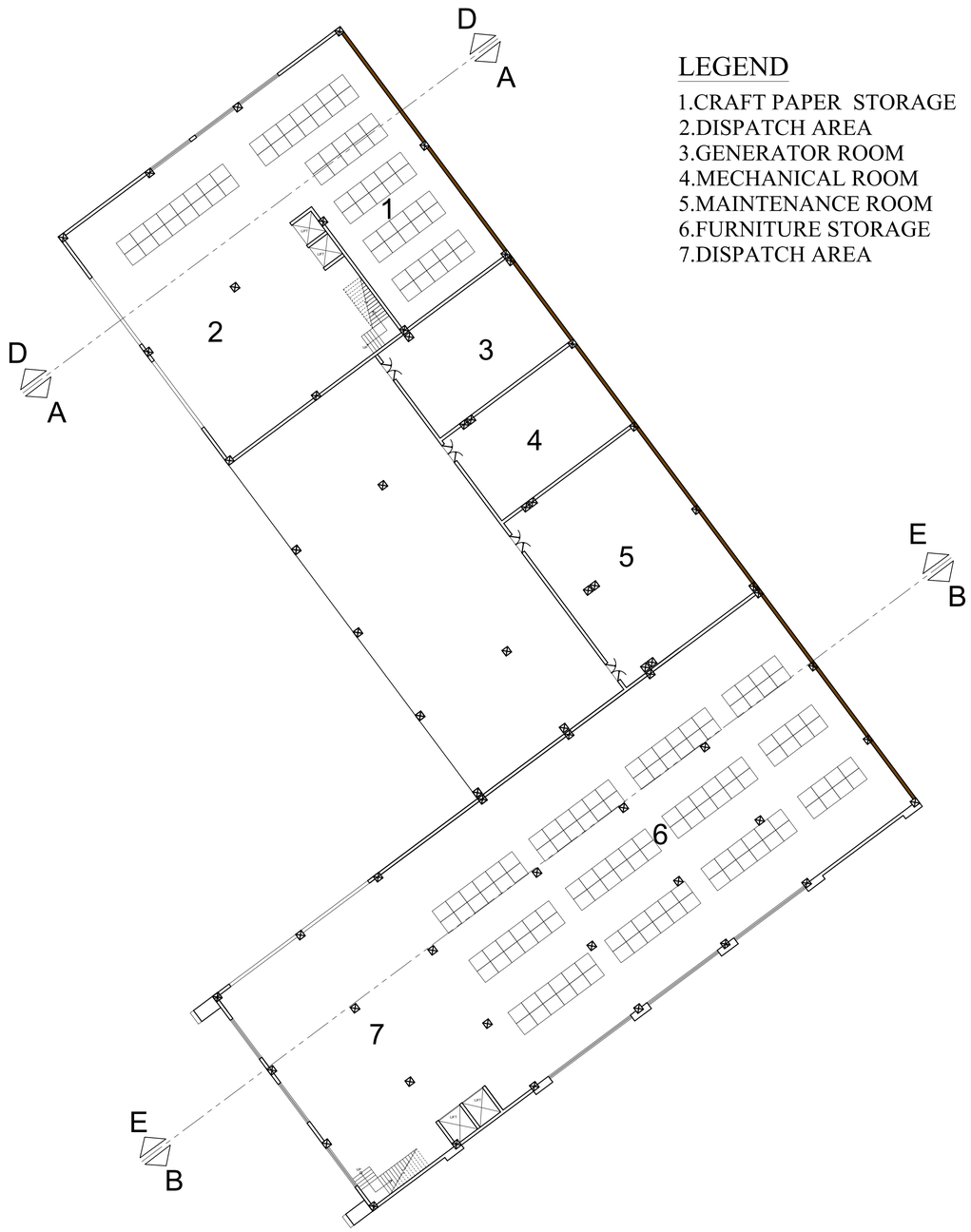
BHAKTAPUR PAPER AND PLASTIC RECYCLING CENTER

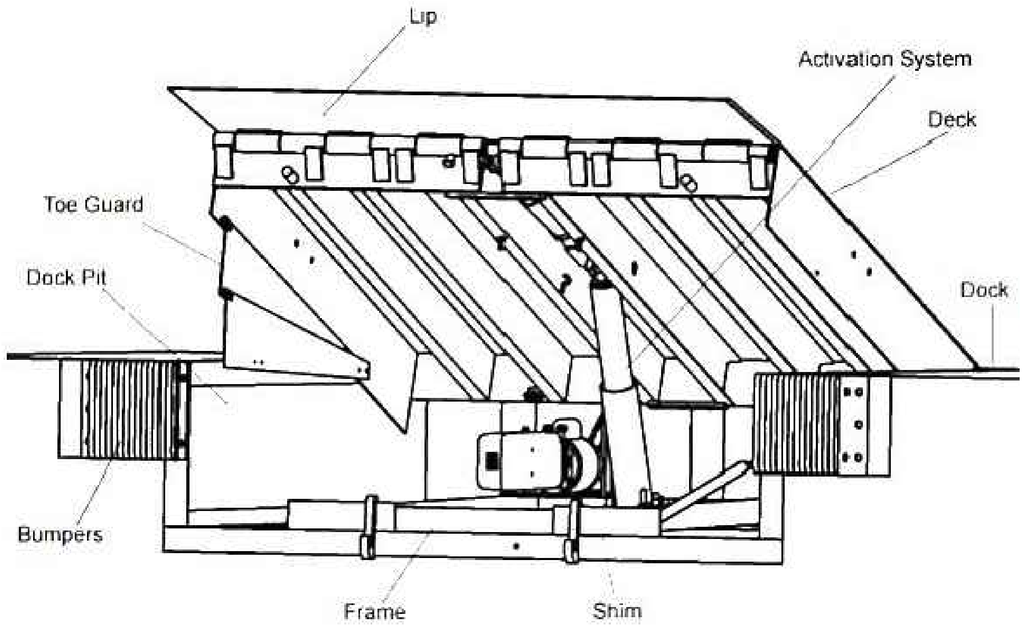
PROCESSING & STAFF BLOCK



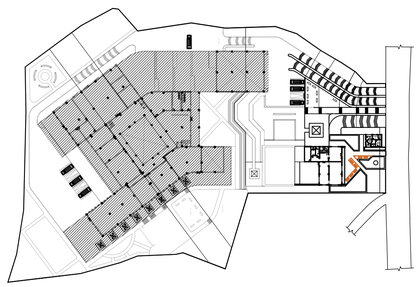
LEGEND

1.CRAFT PAPER STORAGE
2.DISPATCH AREA
3.GENERATOR ROOM
4.MECHANICAL ROOM
5.MAINTENANCE ROOM
6.FURNITURE STORAGE
7.DISPATCH AREA

LOADING DOCK DETAILS



KEYPLAN



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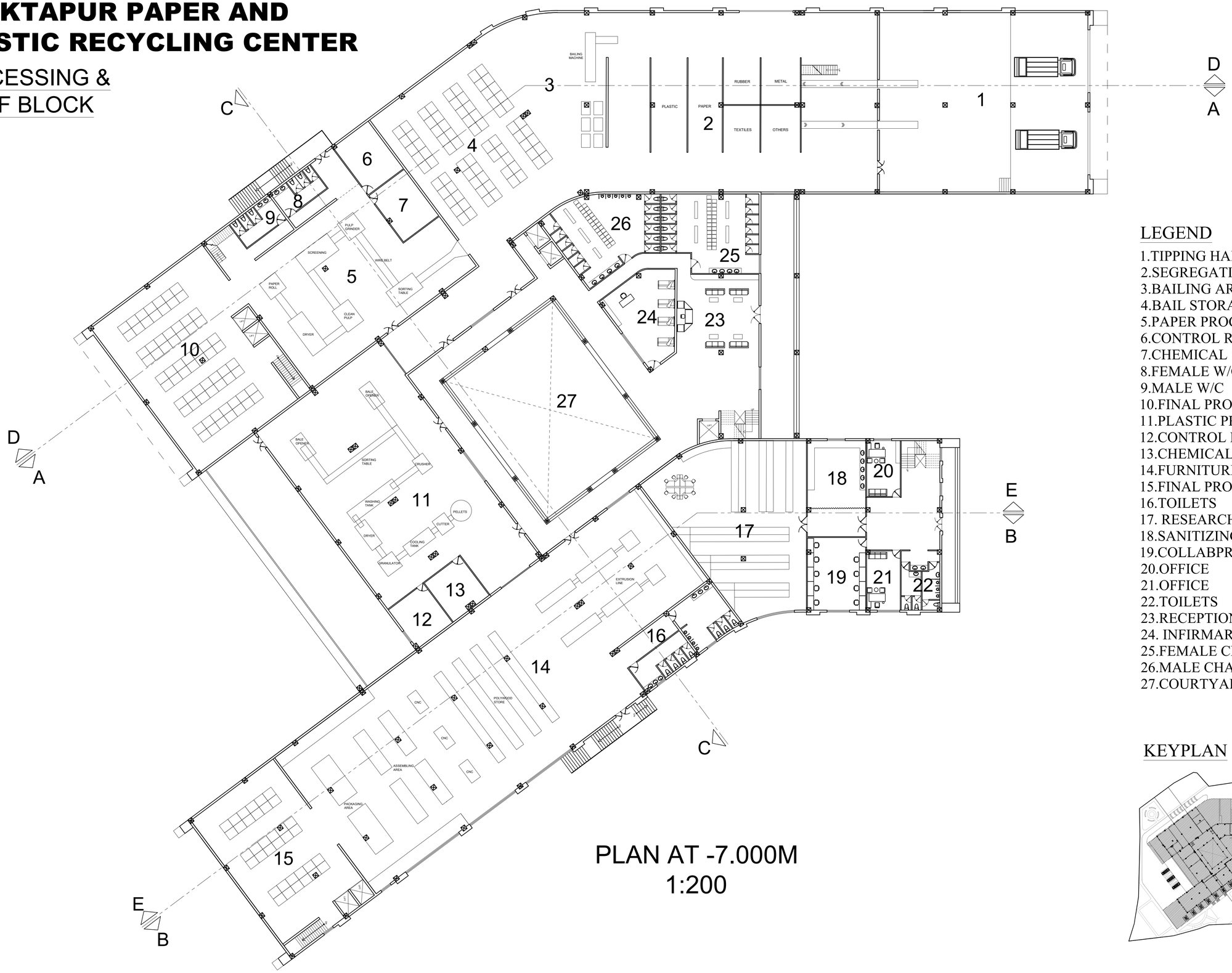
BHAKTAPUR PAPER AND PLASTIC RECYCLING CENTER

PROCESSING & STAFF BLOCK

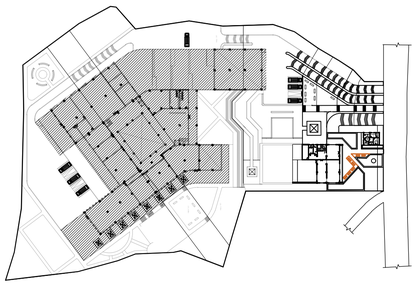


PLAN AT -7.000M
1:200

LEGEND

1.TIPPING HALL
2.SEGREGATION AREA
3.BAILING AREA
4.BAIL STORAGE
5.PAPER PROCESSING AREA
6.CONTROL ROOM
7.CHEMICAL STORAGE
8.FEMALE W/C
9.MALE W/C
10.FINAL PRODUCT STORAGE
11.PLASTIC PROCESSING AREA
12.CONTROL ROOM
13.CHEMICAL STORAGE
14.FURNITURE PRODUCTION AREA
15.FINAL PRODUCT STORAGE
16.TOILETS
17. RESEARCH AND DEVELOPMENT
18.SANITIZING ROOM
19.COLLABPRATIVE WORK SPACE
20.OFFICE
21.OFFICE
22.TOILETS
23.RECEPTION
24. INFIRMARY
25.FEMALE CHANGING ROOM
26.MALE CHANGING ROOM
27.COURTYARD

KEYPLAN



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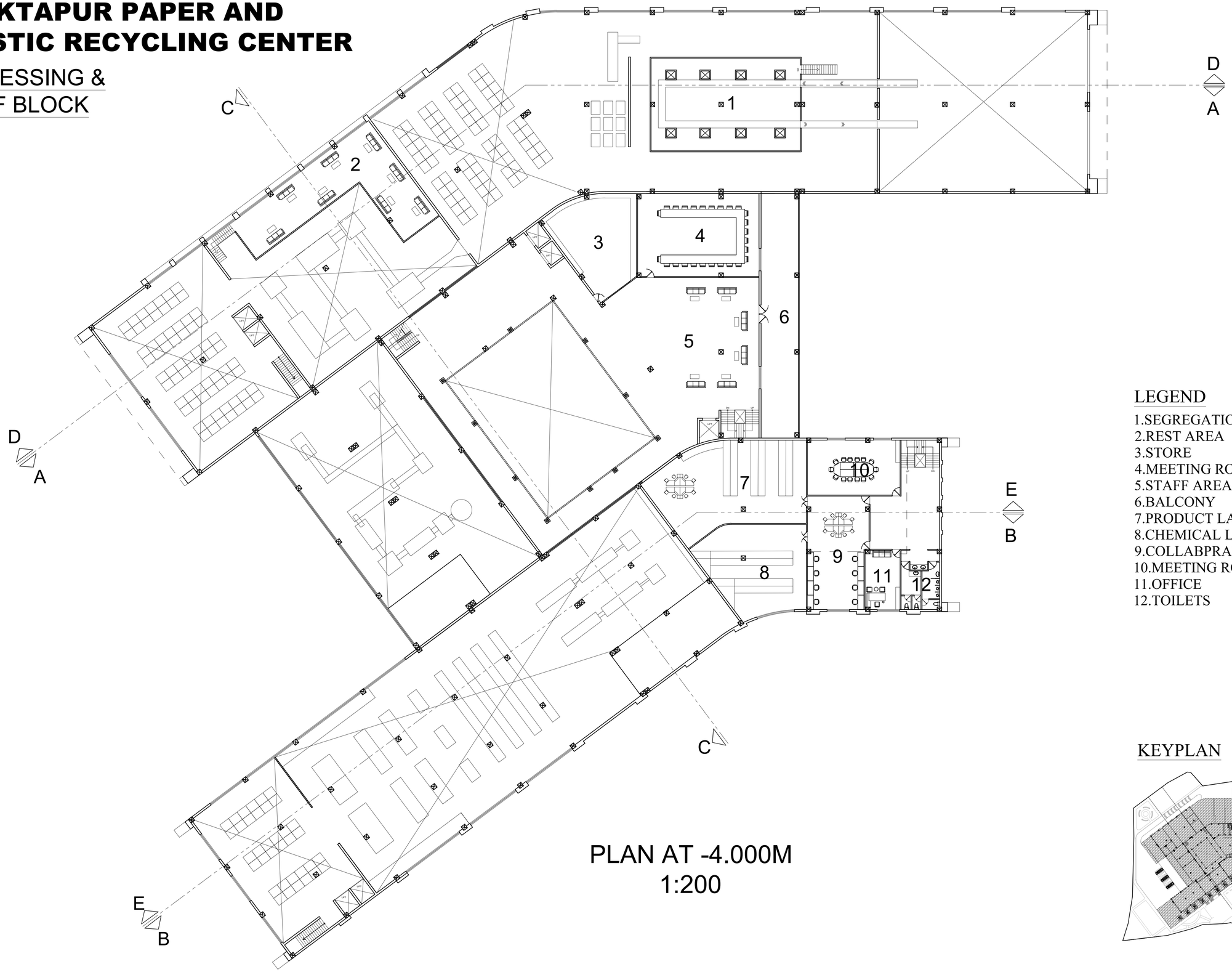
BHAKTAPUR PAPER AND PLASTIC RECYCLING CENTER

PROCESSING & STAFF BLOCK

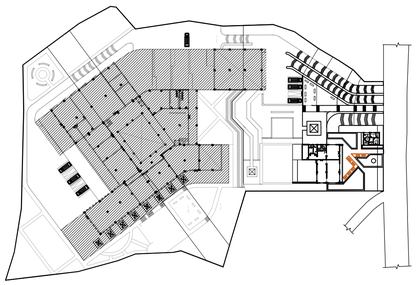


PLAN AT -4.000M
1:200

LEGEND

1.SEGREGATION AREA
2.REST AREA
3.STORE
4.MEETING ROOM
5.STAFF AREA
6.BALCONY
7.PRODUCT LAB
8.CHEMICAL LAB
9.COLLABPRATIVE WORK SPACE
10.MEETING ROOM
11.OFFICE
12.TOILETS

KEYPLAN



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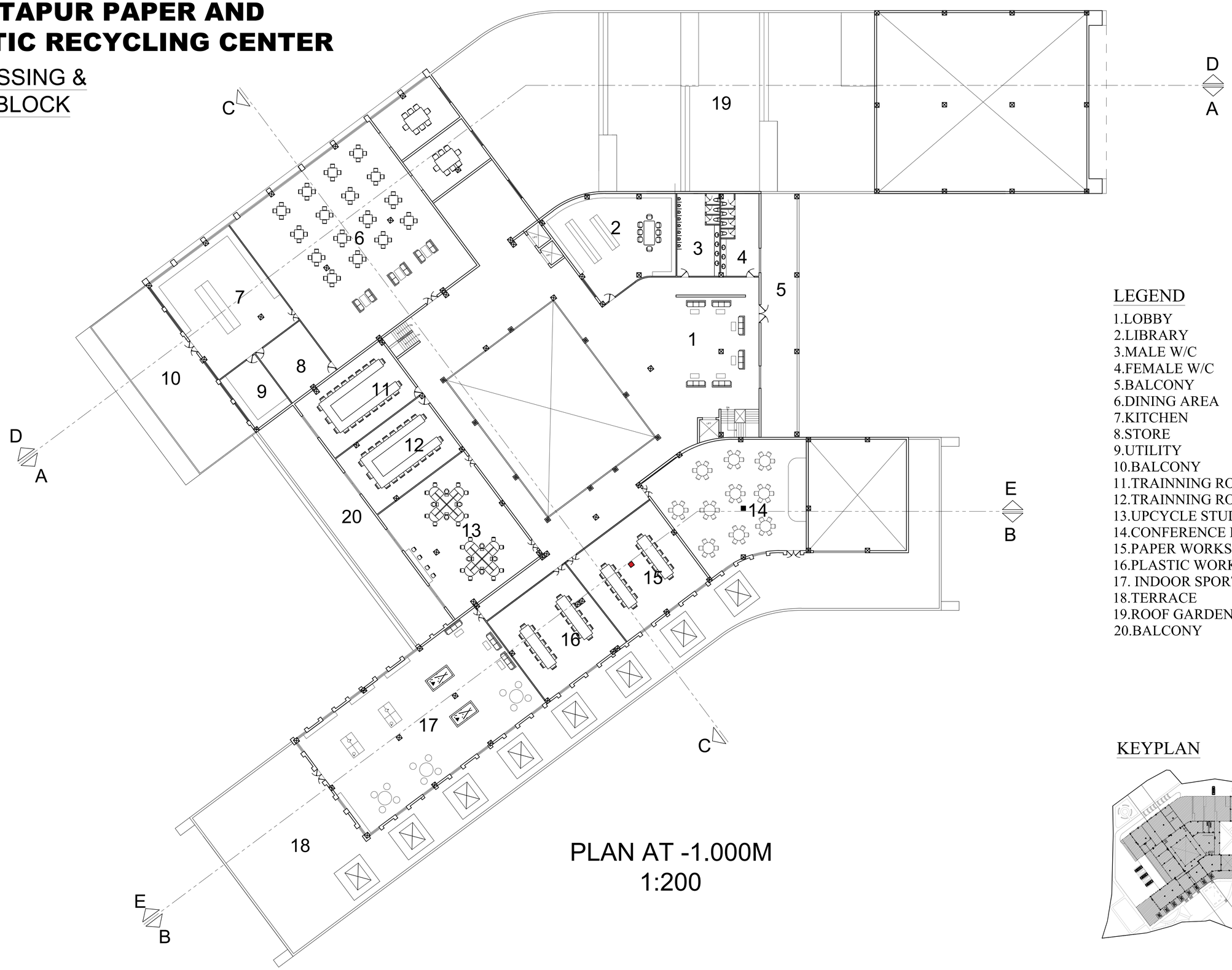
BHAKTAPUR PAPER AND PLASTIC RECYCLING CENTER

PROCESSING & STAFF BLOCK



PLAN AT -1.000M
1:200

LEGEND

1.LOBBY
2.LIBRARY
3.MALE W/C
4.FEMALE W/C
5.BALCONY
6.DINING AREA
7.KITCHEN
8.STORE
9.UTILITY
10.BALCONY
11.TRAINNING ROOM
12.TRAINNING ROOM
13.UPCYCLE STUDIO
14.CONFERENCE ROOM
15.PAPER WORKSHOP
16.PLASTIC WORKSHOP
17. INDOOR SPORTS HALL
18.TERRACE
19.ROOF GARDEN
20.BALCONY

KEYPLAN

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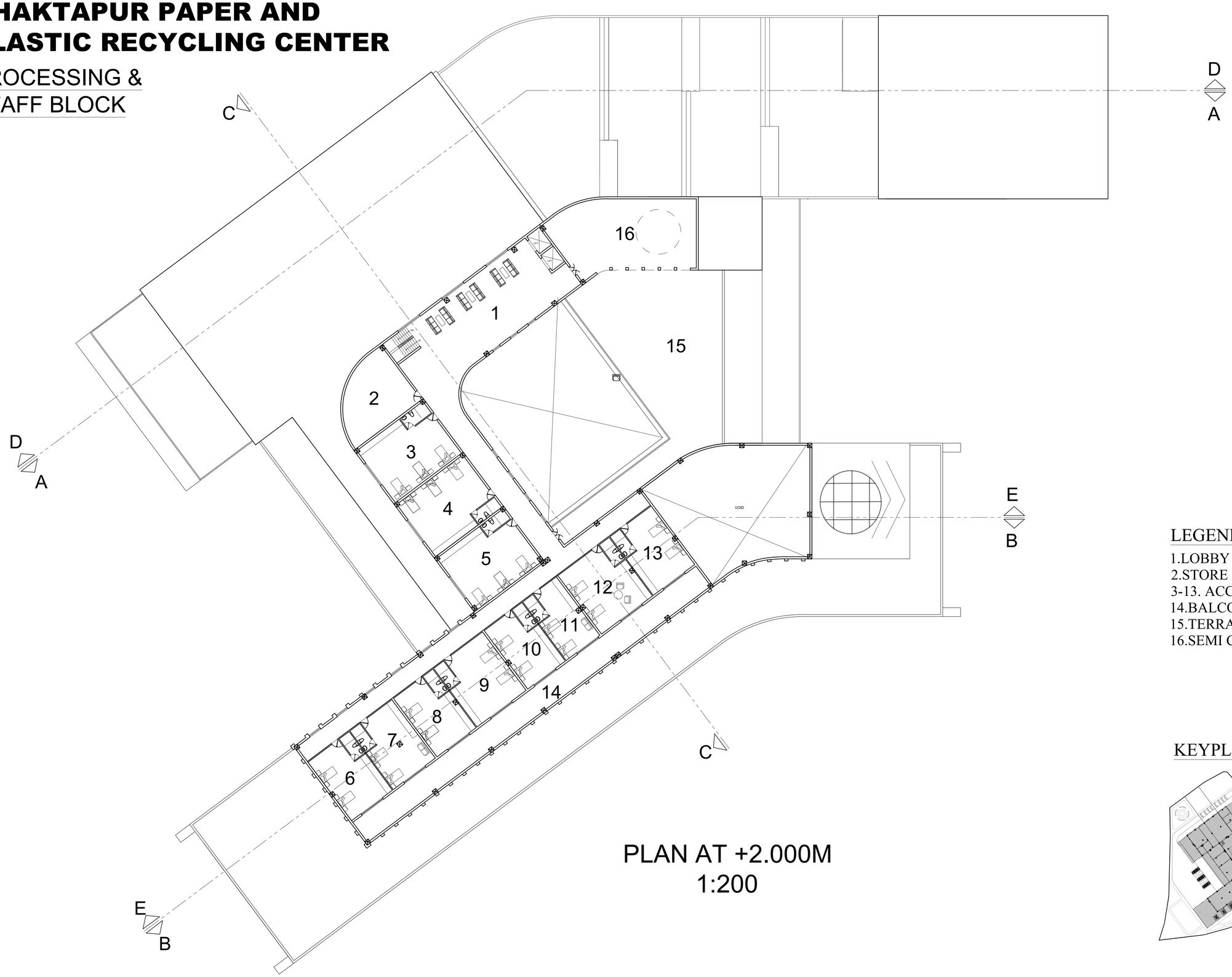
BHAKTAPUR PAPER AND PLASTIC RECYCLING CENTER

PROCESSING & STAFF BLOCK

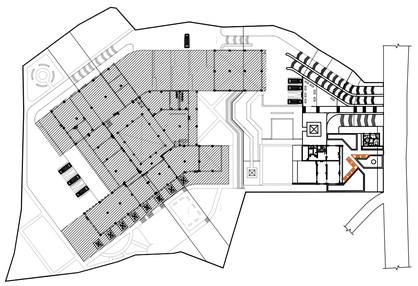


PLAN AT +2.000M
1:200

LEGEND

1.LOBBY
2.STORE
3-13. ACCOMMODATIONS
14.BALCONY
15.TERRACE
16.SEMI COVERED TERRACE

KEYPLAN



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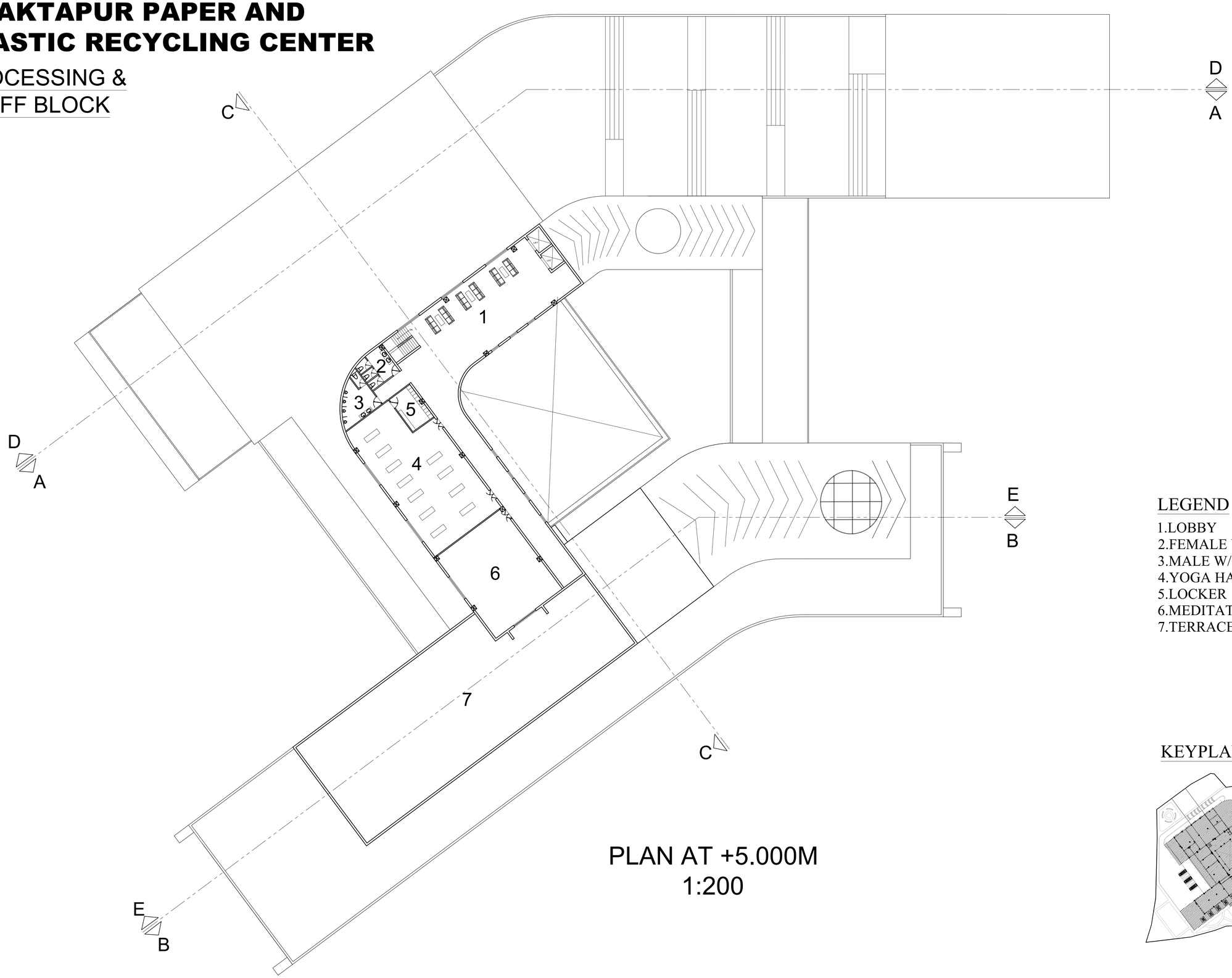
BHAKTAPUR PAPER AND PLASTIC RECYCLING CENTER

PROCESSING & STAFF BLOCK

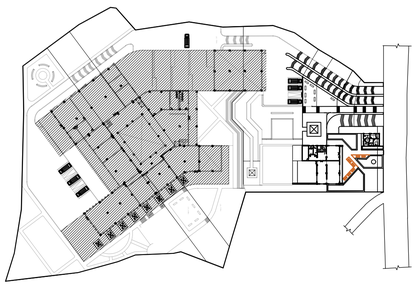


PLAN AT +5.000M
1:200

LEGEND

1.LOBBY
2.FEMALE W/C
3.MALE W/C
4.YOGA HALL
5.LOCKER
6.MEDITATION ROOM
7.TERRACE

KEYPLAN



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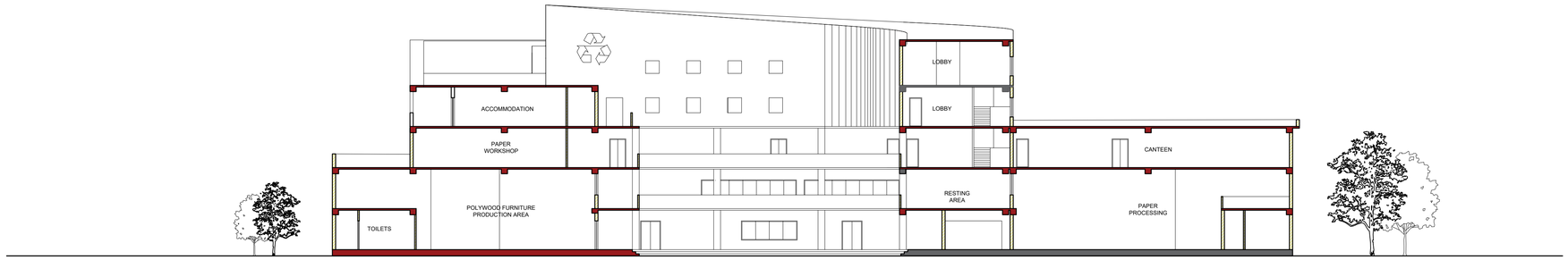
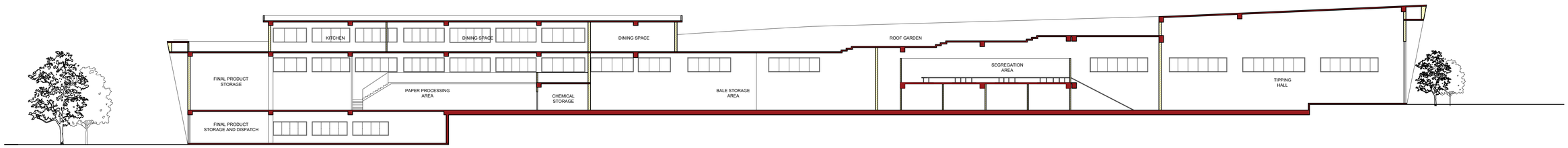
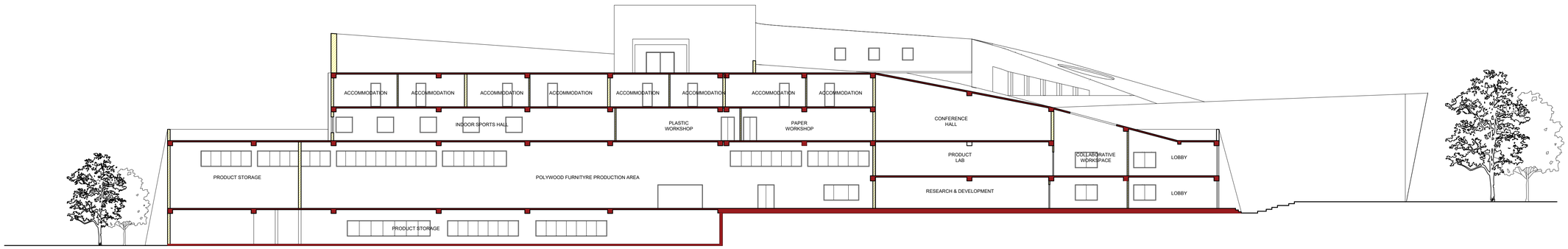
BHAKTAPUR PAPER AND PLASTIC RECYCLING CENTER



SECTION AT C-C
1:200



SECTION AT D-D
1:200



SECTION AT E-E
1:200

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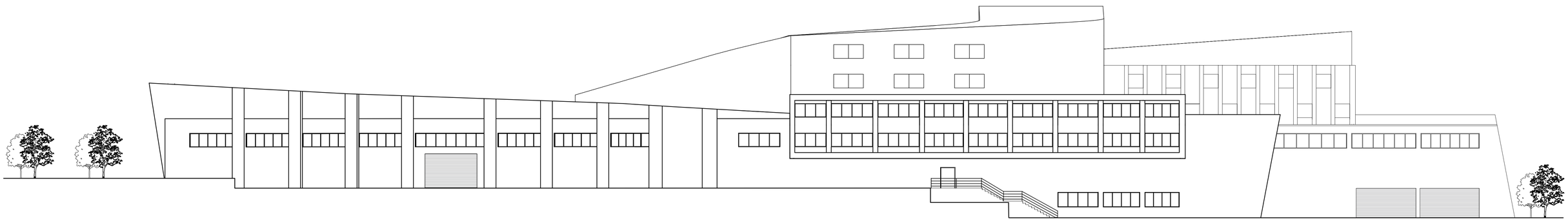
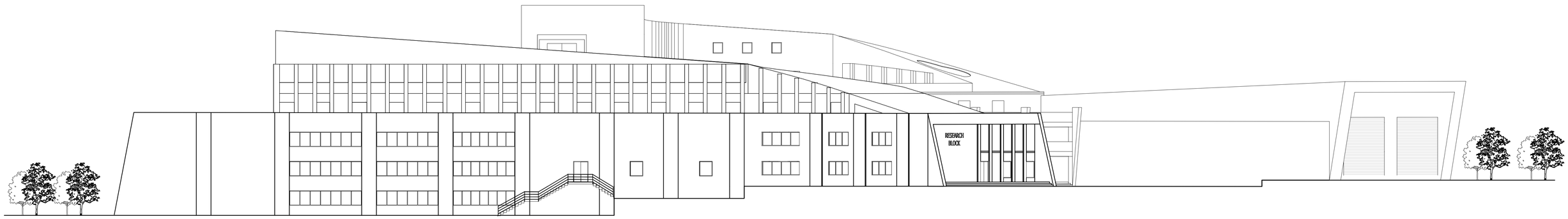
BHAKTAPUR PAPER AND PLASTIC RECYCLING CENTER



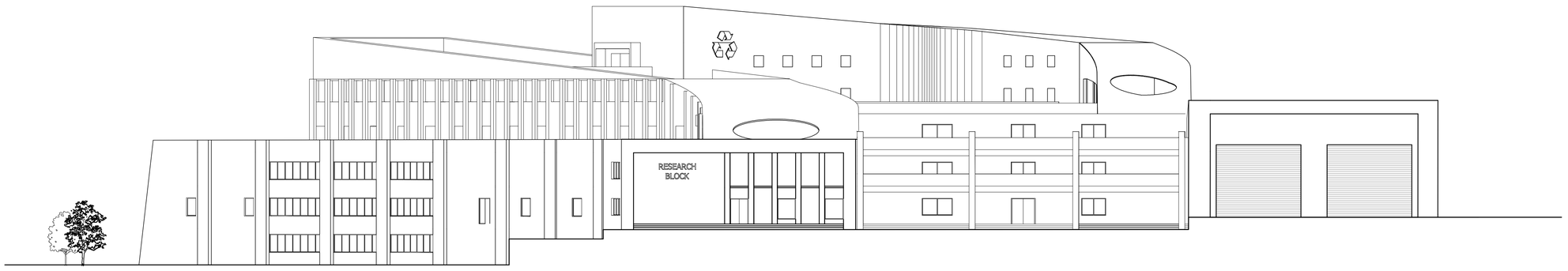
NORTH WEST ELEVATION
1:200



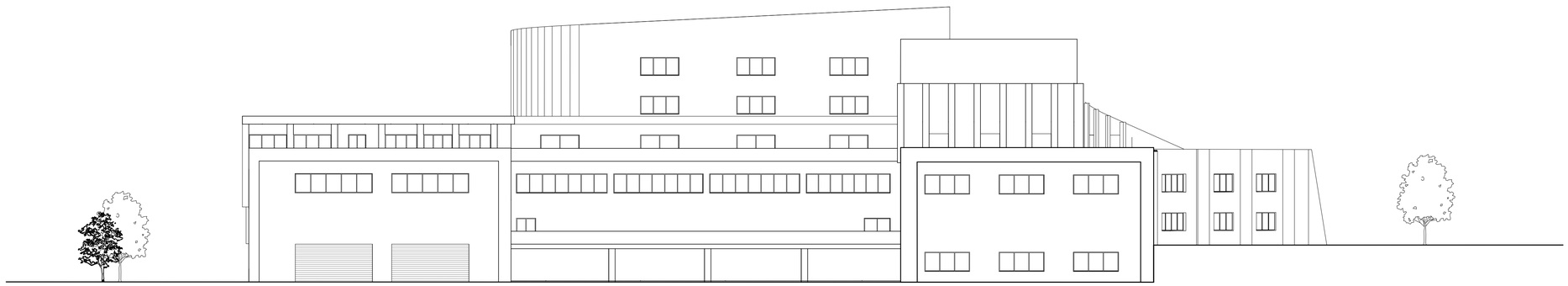
SOUTH EAST ELEVATION
1:200

Purbanchal University Khwopa Engineering College Department of Architecture Libali, Bhaktapur	Final Presentation B. Arch Thesis	Name: Kritan Prajapati Roll.no: 750114	DATE: 2081-04-06	19

BHAKTAPUR PAPER AND PLASTIC RECYCLING CENTER



EAST ELEVATION
1:200



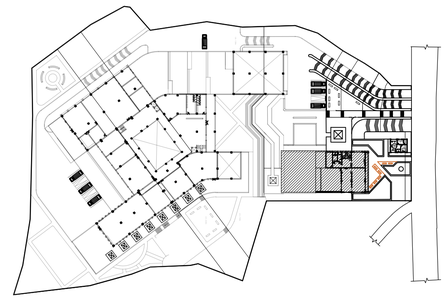
SOUTH WEST ELEVATION
1:200

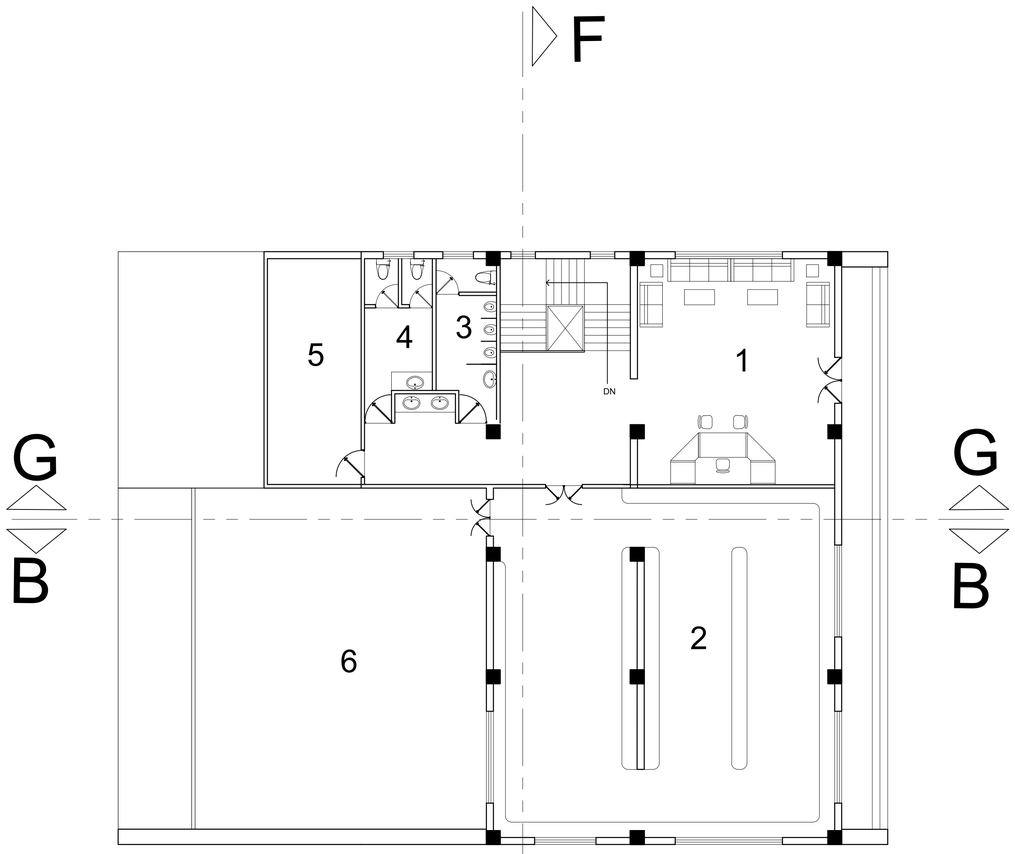
Purbanchal University Khwopa Engineering College Department of Architecture Libali, Bhaktapur	Final Presentation B. Arch Thesis	Name: Kritan Prajapati Roll.no: 750114	DATE: 2081-04-06	20

BHAKTAPUR PAPER AND PLASTIC RECYCLING CENTER

ADMINISTRATION & PUBLIC BLOCK

KEYPLAN



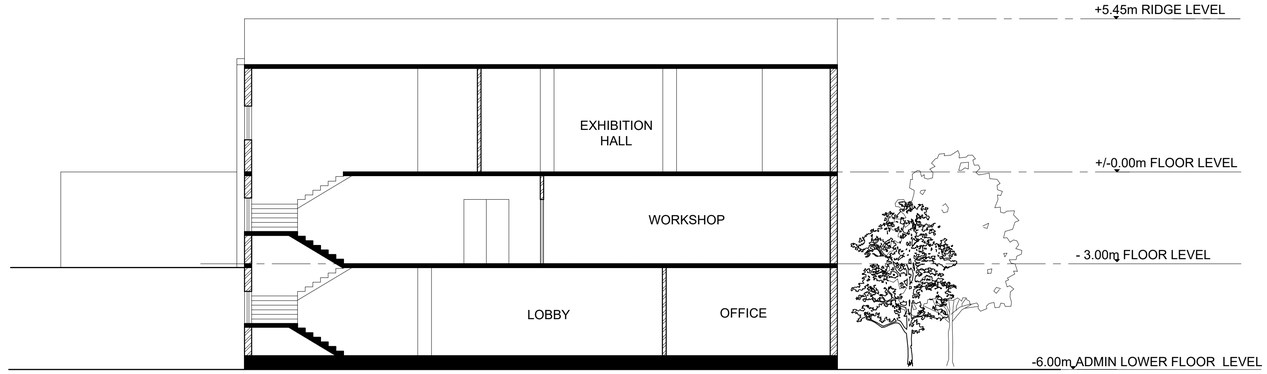


PLAN AT ±0.00M

SCALE= 1:100

LEGEND

1.INFORMATION CENTER
2.EXHIBITION ROOM
3.MALE W/C
4.FEMALE W/C
5.STORE
6.BALCONY



SECTION AT F-F

SCALE= 1:100

Purbanchal University
Khwopa Engineering College
Department of Architecture
Libali, Bhaktapur

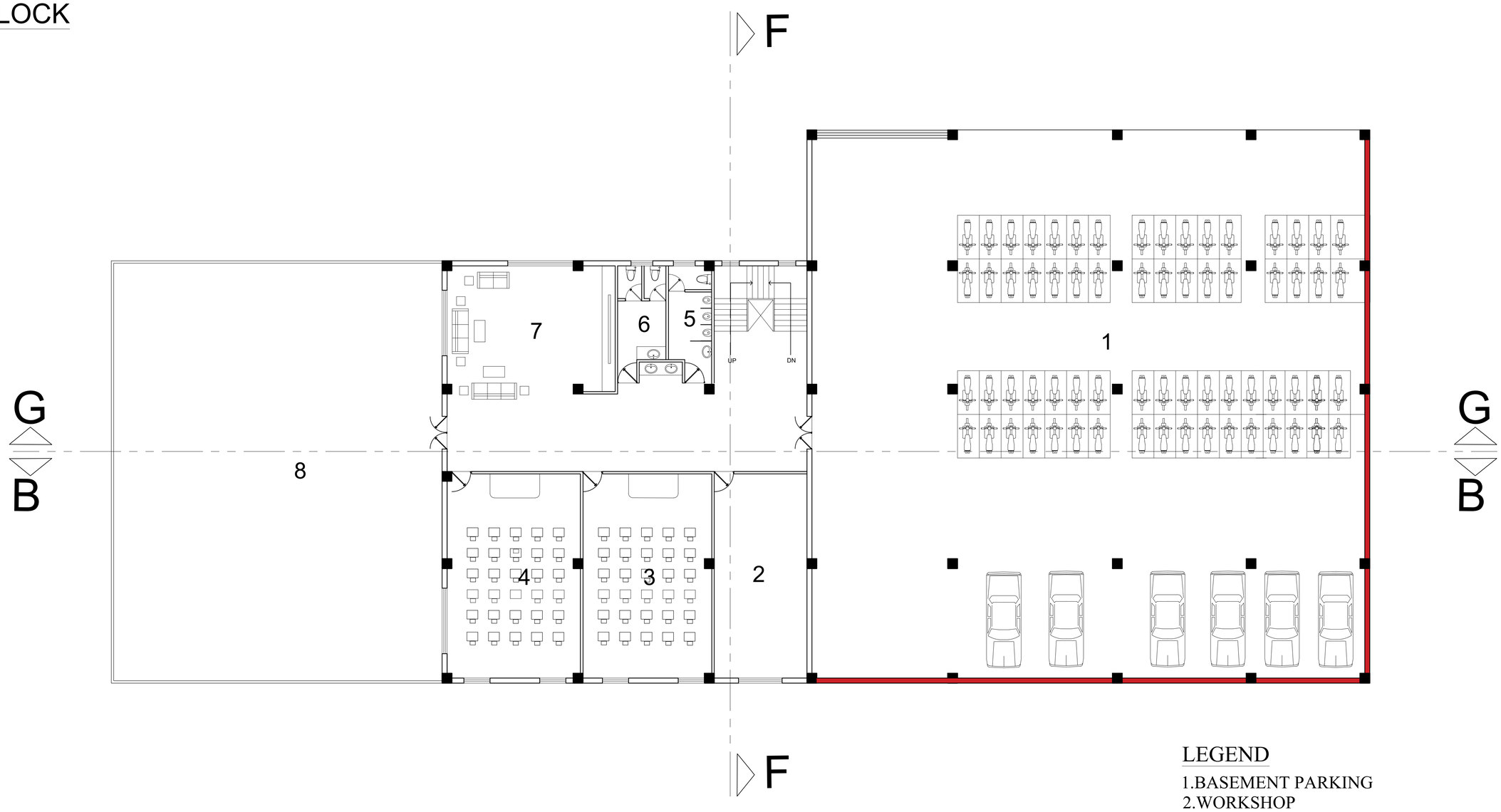
Final Presentation
B. Arch Thesis

Name: Kritan Prajapati
Roll.no: 750114

DATE: 2081-04-06

BHAKTAPUR PAPER AND PLASTIC RECYCLING CENTER

ADMINISTRATION &
PUBLIC BLOCK



LEGEND

1.BASEMENT PARKING
2.WORKSHOP
3.CLASSROOM
4.CLASSROOM
5.MALE W/C
6.FEMALE W/C
7.MULTIMEDIA ROOM
8.VIEWING AREA

PLAN AT -3.00M
SCALE= 1:100

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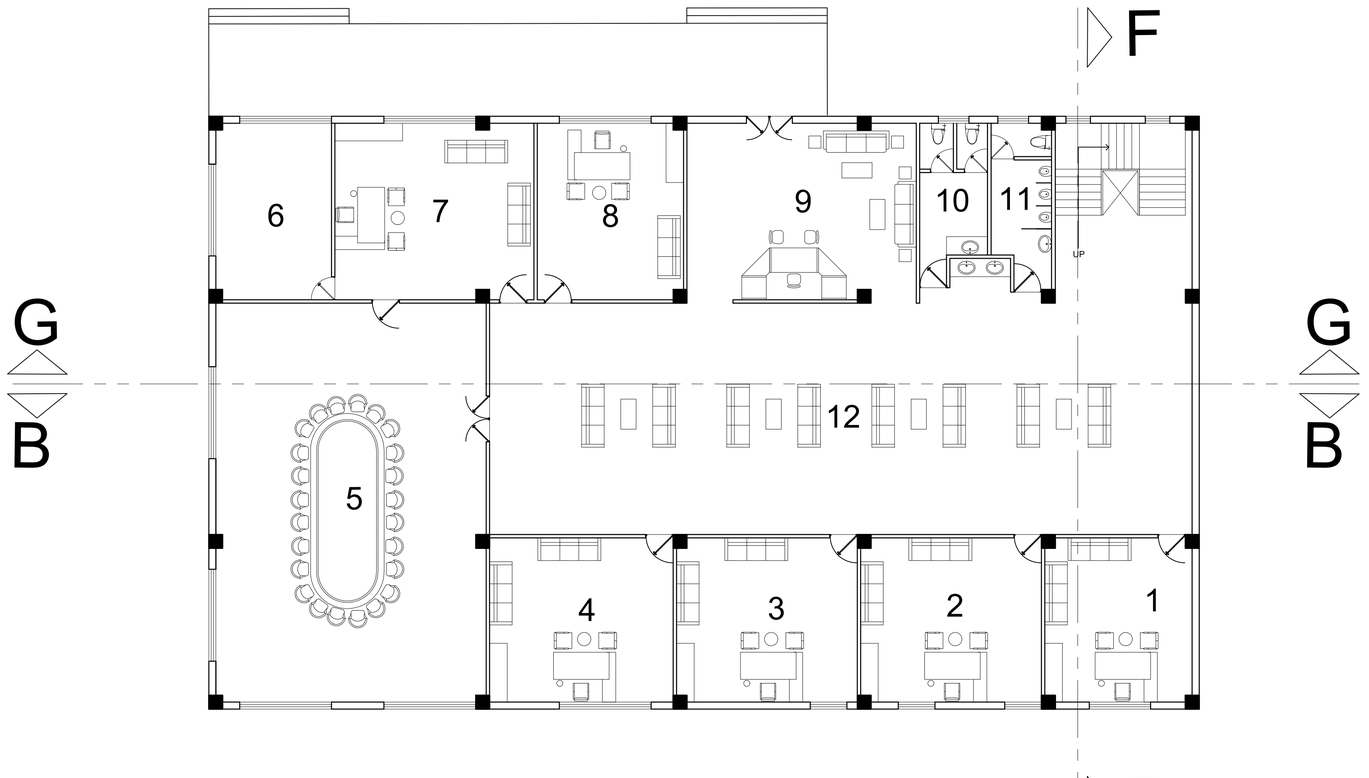
BHAKTAPUR PAPER AND PLASTIC RECYCLING CENTER

ADMINISTRATION &
PUBLIC BLOCK

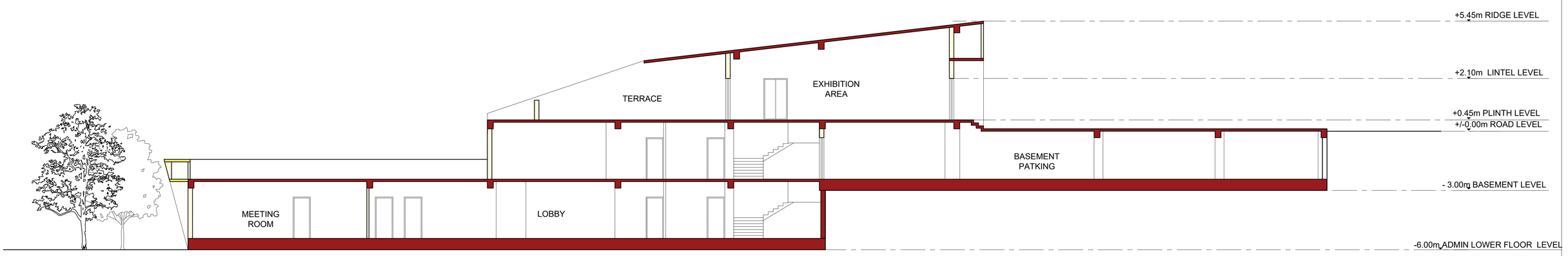


LEGEND

1.PAPER COORDINATOR
2.PLASTIC COORDINATOR
3.VICE ADMINISTRATOR
4.ADMINISTRATOR
5.MEETING ROOM
6.STORE
7.MANAGING DIRECTOR
8.ACCOUNT
9. RECEPTION
10.FEMALE W/C
11.MALE W/C
12. LOBBY

PLAN AT -6.00M

SCALE= 1:100



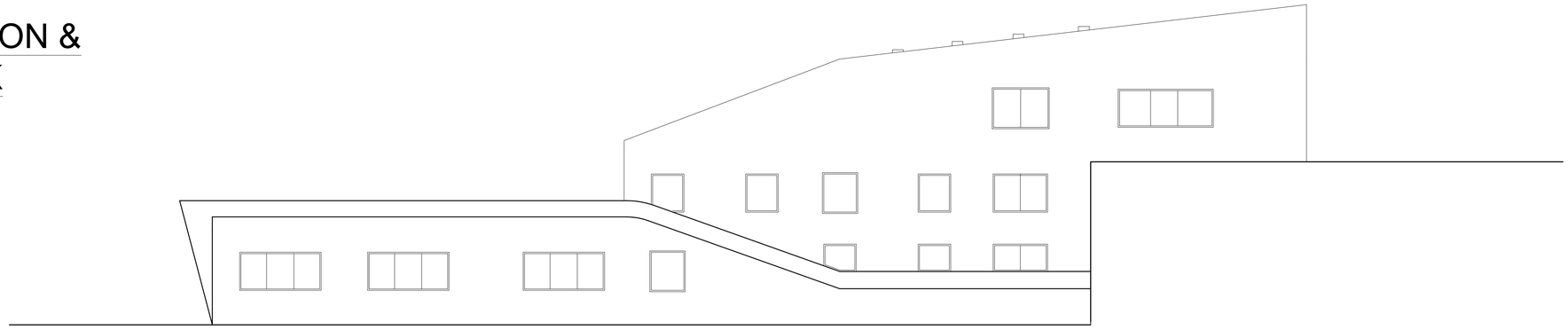
SECTION AT G-G

SCALE= 1:100

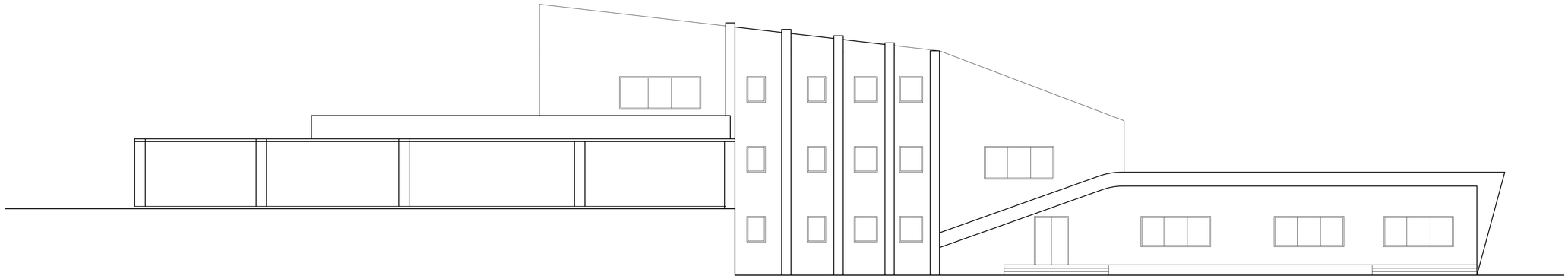
Purbanchal University Khwopa Engineering College Department of Architecture Libali, Bhaktapur	Final Presentation B. Arch Thesis	Name: Kritan Prajapati Roll.no: 750114	DATE: 2081-04-06	23

BHAKTAPUR PAPER AND PLASTIC RECYCLING CENTER

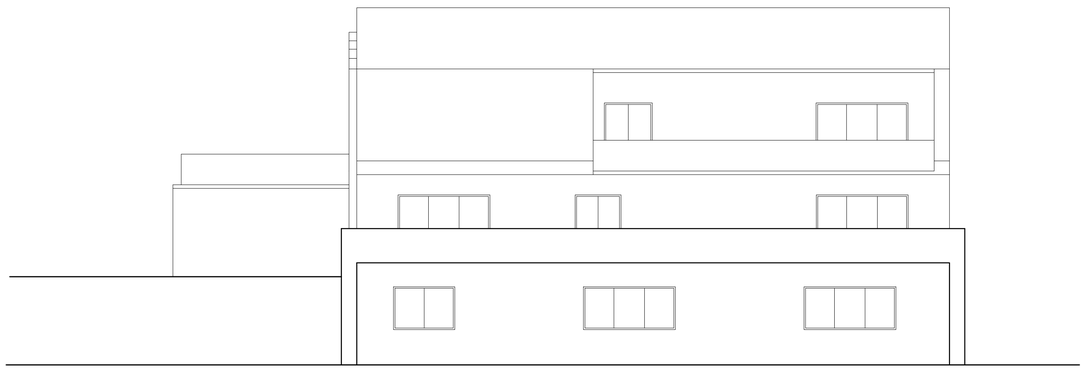
ADMINISTRATION &
PUBLIC BLOCK



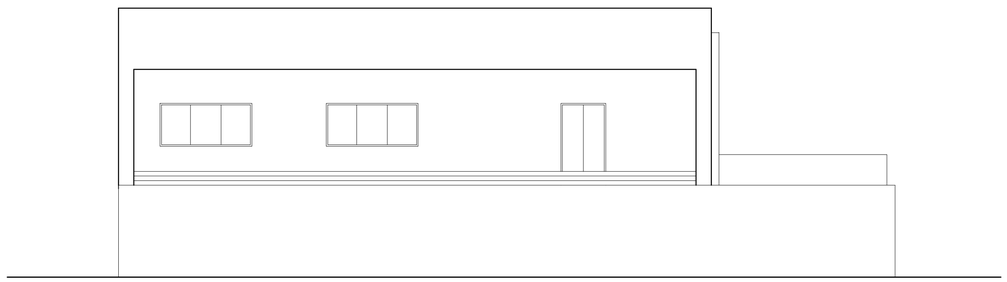
SOUTH ELEVATION



NORTH ELEVATION



WEST ELEVATION

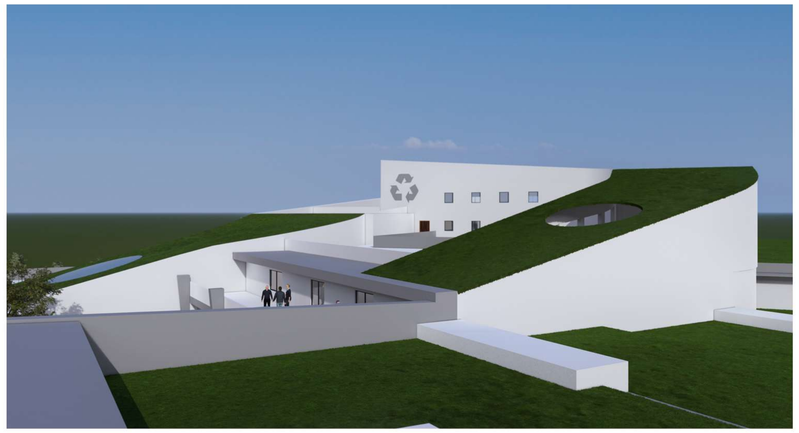


EAST ELEVATION

BHAKTAPUR PAPER AND PLASTIC RECYCLING CENTER

BHAKTAPUR PAPER AND PLASTIC RECYCLING CENTER

Front view of the processing and staff block



Green roof view from the roof garden

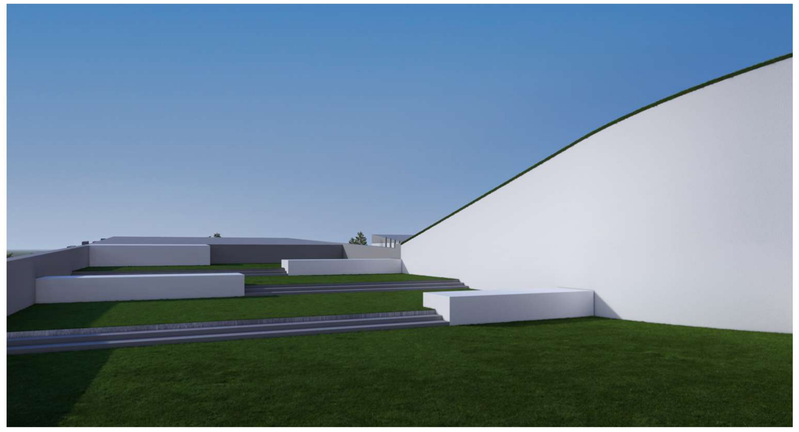
View of ramp

View from the entrance

Basketball court for workers' refreshment

Front view of the administration and public building

Birdeye view of the overall site



Roof garden for staff interaction

Administration+Public Amenity block

PHOTOGRAPHS OF MODEL