Green Sense

RESIDENTIAL CAMPUS INVENTORY

Centre for Science and Environment
New Delhi

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Citation: Anumita Roychowdhury, Rajneesh Sareen, Sugeet Grover and Mitashi Singh, 2018, *Green Sense: Residential Campus Inventory*, Centre for Science and Environment, New Delhi.

Published by
Centre for Science and Environment
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Printed at Multi Colour Services

Contents

1. Introduction

Why this toolkit for green campuses?

Urban areas come with a plethora of challenges. Cities are responsible for 75 per cent of world's energy use and 70 per cent of the world's carbon dioxide emissions.[1] India follows the same trajectory, where rising affluence and increased access to services drives a resource-intensive lifestyle. Reports suggest that around 40 per cent of India's population—a whopping 600 million—will reside in urban areas by 2031.[2] A larger population size means an even more severe impact on resources such as energy, water, air and land.

According to the Indian Ministry of Power, residential buildings are responsible for around 75 per cent of the total electricity consumed in the building sector.[3] Residential buildings consumed around 50 terawatt hours (TWh) grossly in 1995, which increased to 220 TWh in 2015, i.e. a fourfold increase in just 20 years. This consumption is projected to rise to 600–900 TWh by 2030.

According to the Ministry of Power, the increasing demand for room cooling, and use of air-conditioning units, accounts for most of the electricity consumption in residential areas. The International Energy Agency (IEA) has even estimated that India leads the world in residential-cooling-based electricity consumption.[4]

The demand for water and land, and waste generation is projected to follow a similar alarming pattern, with residential areas remaining key contributors.

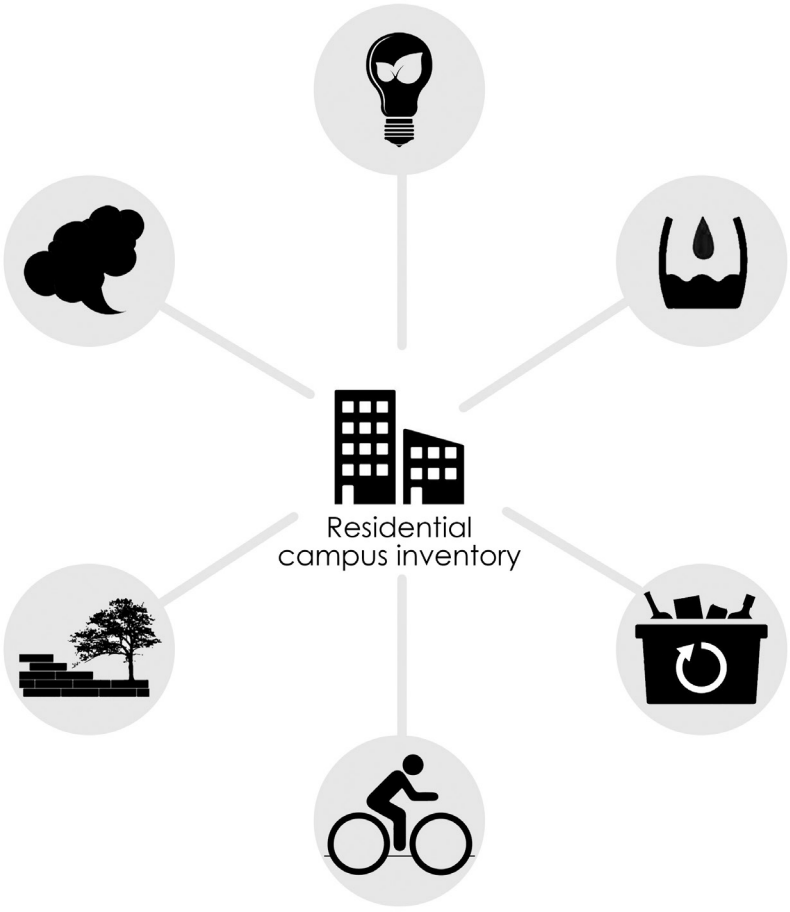
CSE has designed a Green Campus Initiative targeted at residential areas. The initiative aims to provide urban residents with an opportunity to take action towards efficient use of resources and contribute towards environmental sustainability. This toolkit is part of the initiative and provides residents with the means to increase awareness about their surroundings, innovate based on their needs, and act towards changing the respective resource consumption and waste generation patterns.

Every residential campus has common spaces such as stairways, corridors and open areas which are serviced through the common funds of the residents. Water pumping stations, street lights, diesel generators and power backups also incur a common cost in a residential campus. These services are often not paid heed to but this infrastructure degrades over time. This results in losses of resources such as energy and water etc., adding more to the service bills.

This toolkit draws a roadmap to show ways to save resources by simply managing and realigning the infrastructure to standard performance levels. Additionally, it shows ways to open pathways to develop a more environmentally aware and responsible generation of citizens.

What does this toolkit consist of?

This toolkit is an inventory aimed at documenting various facilities and infrastructure in a residential campus. It is divided into six sections — energy, water, land, waste, air and livability. Each section has a set of questions. Responses to the questions will generate sector-wise datasets for the common infrastructure. For instance, how much water is supplied every day and how much energy is required to supply that water? Such datasets will establish a baseline scenario for the respective campus.



Note: This toolkit is an inventory aimed at documenting various facilities and infrastructure in a residential campus. It is divided into six sections—Energy, Water, Land, Waste, Air and Livability.

A baseline scenario tells the inhabitants their current resource consumption and waste generation patterns. It set the performance level of common facilities and infrastructure as per their standards. If the performance is below the standard requirement, the infrastructure is failing to meet the minimum compliance required and needs to be improved. If the performance is at par with the set standards, residents can improve further by committing to bring down their resource consumption and waste generation, and updating the existing infrastructure to reach excellence in performance levels.

Sector-wise datasets generated from this toolkit will allow residents to identify risks, if any, prioritize intervention areas, set targets for improvement, and plan activities to meet those targets. For instance, a campus may choose to work on solid waste management, another campus may choose to replace street lighting with LED lamps, and another may prioritize water conservation. These campuses can then become an example for the city to operate within the limits imposed by land, water and energy resources as well as material and green spaces.

What is a green residential campus?

What makes a campus 'green or sustainable' comprises a wide range of determinants, including its climatic and ecological setting, terrain, design, quality grade of services, technical operations and management practices. While a campus can be designed and constructed as a green campus, CSE's initiative focuses on uplifting performance levels of existing services and infrastructure. 'Green campus' hence becomes an ideology that shapes the efficient use of resources, minimizes wastage and promotes a healthy lifestyle on campuses.

A 'green campus' uses water cautiously, harvests rainwater, enhances energy efficiency, prioritizes renewable energy over fossil fuels, reduces waste, has optimized open spaces, encourages eco-friendly transportation, emphasizes health and wellbeing, and promotes environmentally responsible living.

How can civil society organizations contribute?

The Green Residential Campus Initiative has several benefits for the residents. It:

- Brings residents on one platform to participate and collaborate for their habitat.
- Enables people to understand their surroundings, familiarizes them with the facilities and infrastructure, records data systematically, facilitates creative thinking and analyses, and enables skillful and optimum use of resources.
- Establishes a recurring monitoring process.
- Informs the need for retrofitting, infrastructure planning and long-term policy change for respective campuses.
- Prevents degradation of common facilities and infrastructure, and improves their life-cycle.
- Fosters efficiency in resource management and operations that can contribute to cutting down energy, water and other common service-related bills.
- Contributes in improvement of environmental quality, health and well-being of residents.
- Creates a progressive and proactive environment for the larger community to follow.

2. Campus profiling

About the campus

Name of residential housing	
Name of developer	
Address line 1	
Address line 2	
State	
District	
Pin code	
Name of RWA or equivalent (if any)	
Number of members	
Coordinator	
Coordinator's email	
Telephone number (landline)	
Mobile number	
Contact details of head/team leader	
Name	
Email	
Mobile number	

3. Associational arrangement

Environmental planning for a campus requires a formal arrangement to execute planned development. A mandate document clarifies the framework and a plan of action for the anticipated green campus. Ideally, there should be a dedicated body such as an environment committee or a green team to accelerate implementation of Green Campus strategies. This body shall handle controlled information and is the single point of contact for green campus-related activities.

Q. 1) Association members

NAME OF MEMBER (RWA OR EQUIVALENT)	POSITION	QUALIFICATION	AGE	AREA OF INTEREST

Q. 2) Do you have an environmental vision for your campus?

Goal: Related to land, air, water, energy, waste, livability or other			
How do you plan to achieve it?			
POLICIES	OUTREACH	CAMPAIGN	OTHER

Goal: Related to land, air, water, energy, waste, livability or other			
How do you plan to achieve it?			
POLICY	OUTREACH	CAMPAIGN	OTHER

Goal: Related to land, air, water, energy, waste, livability or other			
How do you plan to achieve it?			
POLICIES	OUTREACH	CAMPAIGNS	OTHER

Goal: Related to land, air, water, energy, waste, livability or other			
How do you plan to achieve it?			
POLICIES	OUTREACH	CAMPAIGNS	OTHER

Q. 3) How frequently does the RWA or similar association meet?

- ☐ Monthly
- ☐ Quarterly
- ☐ Annually
- ☐ Other (specify)

Q. 4) In what percentage of these meetings are you able to reach a quorum so that a decision can be made?

_____

_____

_____

_____

Q. 5) How often is sustainability a topic in your meetings? Did you discuss any recent topics related to sustainability? (E.g., reducing water usage, planting more trees and e-waste bin etc.)

_____

_____

_____

_____

4. Area and population

The use of land and building feature guides the number of persons accommodated for a justified use of the built fabric. Overcrowding and under-occupancy lead to inefficiency. It is also important to know about the different types of population on the campus. With varying operating hours, the consumption of resources and their respective impact may also be different.

Q. 1) Total population

CATEGORY	MALE	FEMALE
Residents		

Q. 2) Area details (mark on Google Earth)

TOTAL PLOT AREA (SQ. M)	TOTAL BUILT-UP AREA (SQ. M)		TOTAL GROUND COVERAGE (SQ. M)	
	ALLOWED	CONSUMED	ALLOWED	CONSUMED

Figure 1: Example of a site plan

Q. 3) Please provide a master plan of your site. The blocks should be given a name or a number, and number of stories should also be mentioned.

BLOCK	NUMBER OF FLOORS	BLOCK	NUMBER OF FLOORS

Q. 4) Typology of dwellings and areas

TYPE OF DWELLING: NUMBER X BUILT-UP AREA OF DWELLING (SQ. M)	TYPE OF DWELLINGS: NUMBER X BUILT-UP AREA OF DWELLING (SQ. M)
Studio	5BHK :
One BHK	Other:
Two BHK	Other:
Three BHK	Other:
Four BHK	Other:

Q. 5) Total support staff

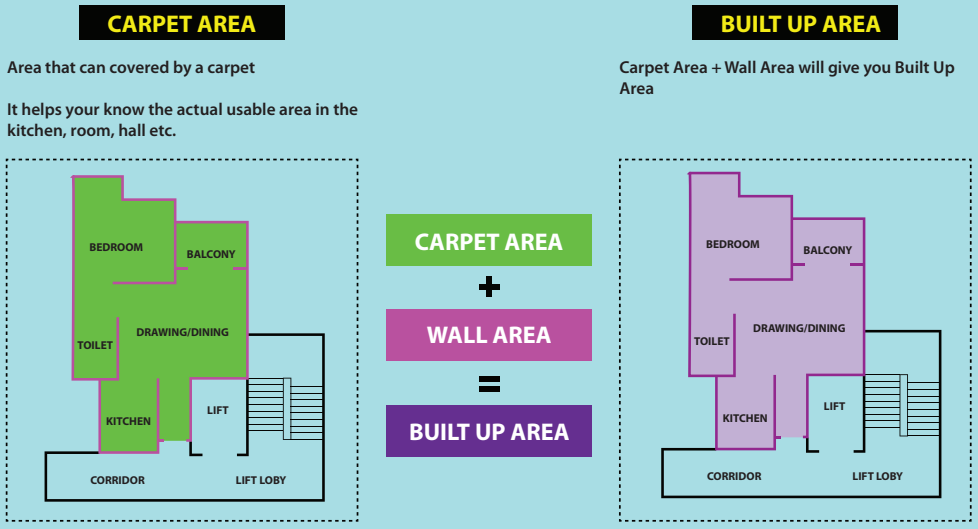
CATEGORY	MALE	FEMALE	OPERATING HOURS
Guards			
Housekeeping			
Drivers			
Gardeners			
Nurses			
Others (specify)			

Box 1

Carpet area: Carpet area is the area enclosed within the walls. It is the actual area to lay the carpet. It is the actual used area in a housing unit which excludes the thickness of the inner walls. Carpet area does not include the space covered by common areas such as the lobby, lift, stairs and play area etc.

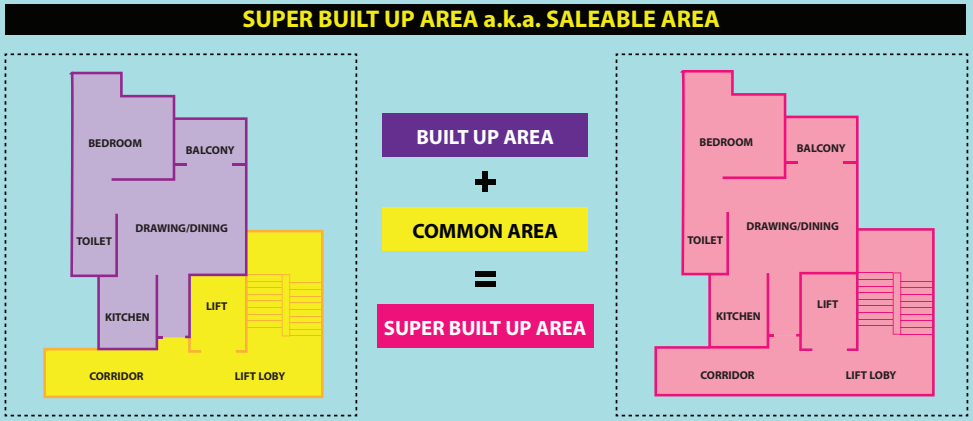
Built-up area: Built-up area is the carpet area plus the thickness of the outer walls and the balcony. Here, the wall area does not mean the surface area, but the thickness of the inner walls of a housing unit.

Figure 2: Carpet area, built-up area



Super built-up area/floor area: This is the total area of the built-up area and the proportionate area. The proportionate area comprises of some common areas such as the lobby, lifts shaft, stairs, swimming pool, garden and clubhouse etc.

Figure 3: Super built-up area



Developers usually price the apartment based on Super Built up or Saleable Area

Let us say that the price per square foot (sft) is Rs 3000 and the SBA of the apartment is 1000 sft.

Then the base price is 1000x3000 = Rs 30 Lakh

Note-
Some developers base their price in Carpet area also, but that's a rare case.

Common areas may include usable amenities like club house, central lobbies, community areas and the definition tends to be vague as well as vary from developer to developer

Source: https://housing.com/news/real-estate-basics-part-1-carpet-area-built-up-area-super-built-up-area/

5. Measurement and monitoring

CATEGORY		DETAILS
Have you pursued a green compound designation? If you have, elaborate (e.g. green building rating, ISO etc.)		
Do you encourage sustainable behaviour via: (tick the appropriate)		
	Campaigns (e.g. saving water, riding a bike, switching off lights, and carpooling)	
	Incentives (e.g. stickers, parking space with shade etc.)	
	Contests	
	Awards	

6. Land

Acting as a significant physical asset, nature and outdoor spaces have the potential to bring functional efficiency and increase environmental footprint of the campus. Land is a resource which needs to be optimized. While, an excess of built-up area will have the problem of insufficient open/lung spaces, too much open space would result in having high rises in order to house the same number of people. High rise buildings come with their own set of problems; services such as water now need to be pumped up to the top floor which is an energy-intensive exercise.

India is home to an extraordinary variety of climatic regions. During summer, huge open spaces can be rendered unusable by the scorching sun. It is the built form as well as the resilience of the trees that make an impact in shading the open areas and in turn make them usable for the public. Appropriate plants and proper irrigation techniques are crucial in order to achieve resource efficiency. This can be done through a landscape plan that is prepared in accordance with the natural features of the campus.

Guiding principles

Protecting and expanding forests and green areas

- Earmark at least 10 per cent of the land area as forests.
- Earmark another 15 per cent as additional green areas, such as tree cover, parks, roadside green belts etc.
- Protect at least 5 per cent as community or conservation reserve.
- Earmark wastelands as forests to increase the forest cover.
- This will help sequester greenhouse gas emissions, trap toxic pollution and prevent heat islands, help recharge groundwater and revive aquifers, protect local biodiversity, and meet community requirements.

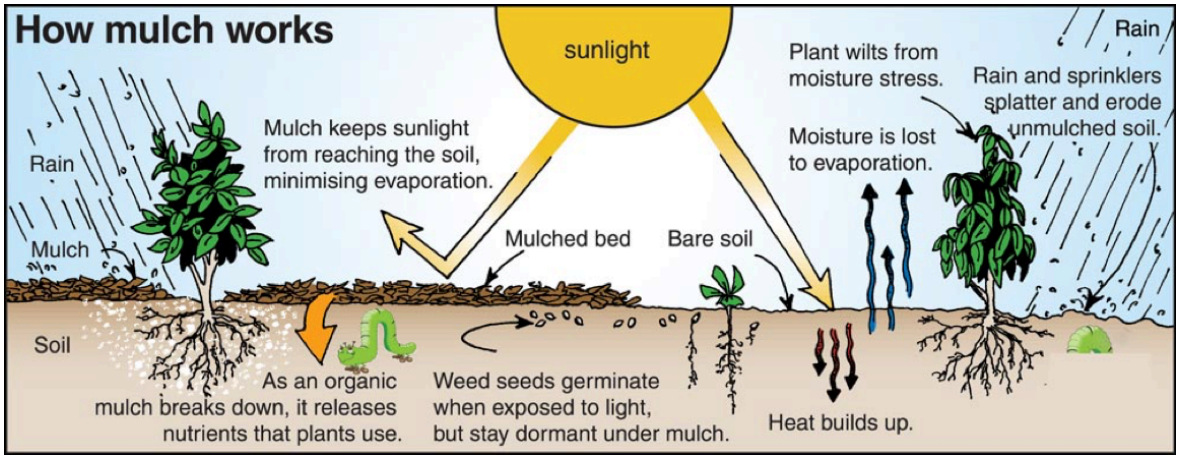
Q. 1) Do you use mulching on your plants?

Yes ☐
No ☐

Mulching (see *Figure 4: Mulching*) is application of a layer of material to the surface of soil to conserve soil moisture, improve fertility and health of the soil, reduce weed growth, and enhance visual appeal of the landscape.

Figure 4: Mulching

Figure 5: How mulch works



Q. 2) Do you use native, drought-tolerant landscaping and grass? Do you have established water-use zones (hydro-zones)?

_____

_____

_____

Drought-tolerant plants can withstand extreme lack of rainfall and water. These plants are mostly native to the region.

Hydrozones: Different plants can be grouped according to their water needs to optimize the irrigation system. This irrigation approach defines a hydrozone, where each zone supplies plants with its desired water needs.

Figure 6: Hydrozones

Q. 3) How much of the total open area is permeable to the ground?

_____

_____

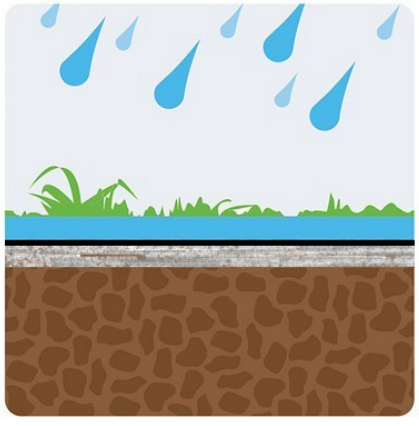
_____

Permeable surfaces (also known as porous or pervious surfaces) allow water to percolate into the soil to filter out pollutants and recharge the water table.

Impermeable/impervious surfaces are solid surfaces that don't allow water to penetrate, forcing it to run off.

Figure 7: Permeable land (the area highlighted in green)

Figure 8: Impervious and pervious surfaces



Urban and suburban sites typically contain large expanses of impermeable surface, causing a host of problems such as:

Pollution of surface water: When storm water runs off impermeable surfaces, it picks up pollutants as it flows into the storm drains. This contaminated water then flows directly into rivers, lakes, wetlands and oceans, generating problems for biodiversity as well as the public health.

Surface water flooding and erosion of stream banks: During periods of heavy rain, large impermeable surfaces generate larger quantities of water that runs off. This sudden influx of runoff into rivers can cause flash flooding and erosion of the stream banks.

Water table is not adequately recharged: Impermeable surfaces send rainwater into storm drains rather than allowing it to percolate down to the aquifers. Impervious surfaces reduce the rate of groundwater recharge, and can, therefore, limit water supply.

Formation of stagnant water puddles: On impermeable surfaces, where runoff has no drainage route, rainwater can form puddles. These puddles or stagnant water can be dangerous in many ways as they provide an incubator than running water for mosquitoes.

Heat island effect: Due to the heat-absorbing quality of asphalt and other paving materials, sites which have a higher ratio of impermeable surface increases ambient air temperatures and requires more energy for cooling.

Box 2: Pervious surfaces

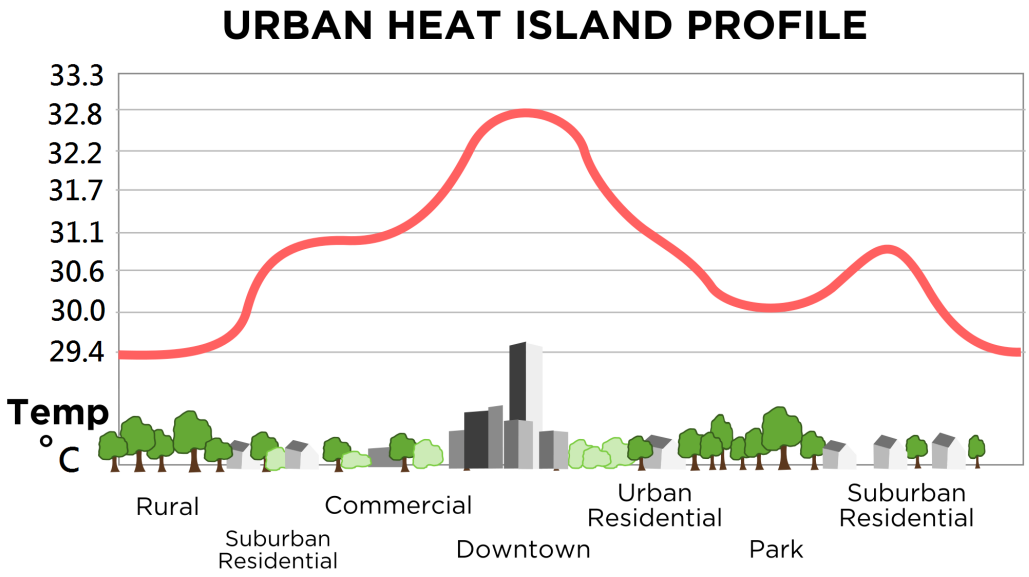
A conventional road is often impervious, it resists the water that flows on it and the drain is often unable to completely take the amount of water that falls on the road. A pervious surface allows the water to be absorbed by the earth. Pervious paver patterns (see *Figure 9: Pervious paver patterns*) and pervious concrete (see *Figure 10: Pervious concrete*) are some of the possible solutions to avoid complete runoff or stagnation issues.

Figure 9: Pervious paver patterns

Figure 10: Pervious concrete

Urban heat island: In the past, India has been facing problems related to an unpredictable climate pattern and extreme weather conditions. Our cities face temperatures that are 3–4 degrees higher than the average. This difference in temperature occurs because of the magnified effect of paved surfaces and a lack of tree cover. The temperature difference is usually larger at night than during the day, and is most apparent when winds are weak. This is known as the urban heat island effect (see *Figure 11: Urban heat island effect*).

Figure 11: Urban island heat effect

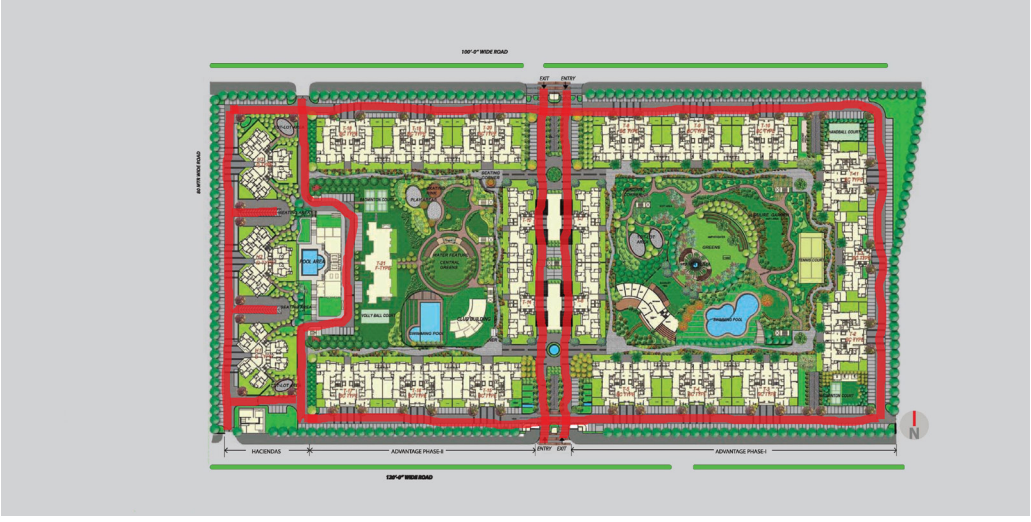


Source: https://nca2009.globalchange.gov/urban-heat-island-effect/index.htm

In India, a 'heat wave' is declared when the temperature is 5 degrees more than the average temperature (recorded over the past three decades). As per research, in the near future, the number of 'heat wave' days may vary from about 5 to 30–40 every year. In 2015, around 2,000 people had lost their lives due to heat waves across India.[1] This effect gives rise to extreme weather events and eventually–natural calamities. Several cities are facing abnormal UV indices, which is a serious hazard carrying medium to high health risks. It is essential to build up resilience through climate change adaptation.

Q. 4) What percentage of your campus allows car?

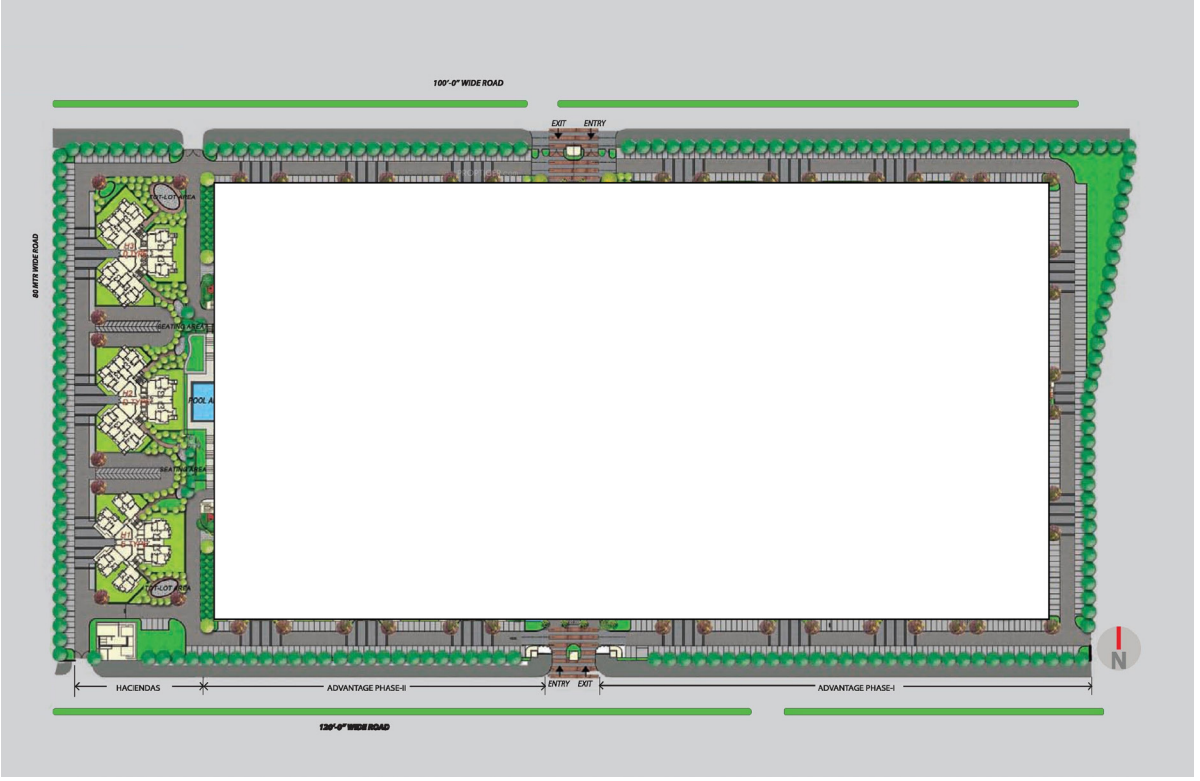
Figure 12: Marking thick lines over the roads on the site plan where cars are allowed can substantiate the data.



Q. 5) According to your housing plan, how much parking space is provided to a household?

Q. 6) What percentage of your site has space for a basement?

Figure 13: The basement can be marked in white. The remaining space also denotes the land that can be turned pervious.



7. Energy

Humans are highly dependent on energy in their daily lives. We consume energy non-stop and in different forms—light, sound, heat and electricity—and often waste it.

When we talk about energy, it is important to recall its sources. There are mainly two types of energy sources—renewable and non-renewable. Renewable sources involve harnessing energy from the sun, wind and water. Biological growth-based fuels such as garbage, dead trees, branches, livestock dung and bio-diesel can also be replenished so they fall under renewable sources of energy.

All forms of fossil fuels such as coal, oil and natural gas are non-renewable sources of energy. Unfortunately, mankind is dangerously addicted to non-renewable sources of energy which is single-handedly responsible for an increase in greenhouse gas emissions, warming of the planet and climate change. Substituting fossil fuels with energy from renewable sources is the most logical answer to the problem.

Guiding principle

Reducing the energy footprint

- Reduce energy consumption of the built environment of the city by at least 30–35 per cent to prevent energy guzzle and contribute towards India's Intended Nationally Determined Contributions (INDC) commitment of reducing energy intensity of growth.
- Improve energy savings in buildings by setting energy performance targets and adopt enabling strategies.

Enhance the use of renewable energy—Take steps to have a solar campus

- Promote rooftop solar power in all new and existing residential, commercial, and institutional buildings and link it to reduce the use of diesel generator sets.
- Install renewable energy solutions to meet electricity generation equivalent to 5 per cent of the demand load.

Box 3: Emissions from electrical appliances

Whether it's an air conditioner (AC) or a light bulb, all appliances that consume electricity send greenhouse gases into the air. Reducing electricity consumption has proven to have a substantially positive impact on the environment.

The comfort standard with regard to ACs in India is set on a temperature around 27°C (with a fan on). This eliminates the need to run a power-guzzling AC the whole day to bring down the temperatures. Many appliances—like the television—consume electricity even when they are switched off because of stand-by modes. A plugged-in mobile charger consumes electricity even when the device is not connected to the charger. To get rid of these energy hogs, switching off the electrical sockets is necessary.

Box 4: Did you know?

A 22-watt compact fluorescent lamp (CFL) bulb has the same brightness as a regular 100-watt bulb. A CFL bulb is said to be 75 per cent more energy efficient than regular bulbs.

Energy conservation can go beyond saving electricity:

- Cleaning/replacing AC filters can save around 160 kg of CO_2 emissions a year. It also ensures faster cooling.
- Buying recycled paper products: It takes 70–90 per cent less energy to make recycled paper and it also prevents the loss of forests, which are 'carbon sinks' for the world. Besides, these products are more aesthetic and presentable.

Source: A. Sikdar et al. 2011. Climate Change and Natural Resources. Centre for Science and Environment, New Delhi.

Energy consumption can be reduced by two techniques: Conservation and efficiency measures. Energy can be conserved by reducing the use of energy services available around us. Efficient-energy use refers to using less energy for the same service. It involves a smart approach. For example, in a building, one can use energy efficiently by making use of natural sunlight, ventilation and maintaining an ideal room temperature. Conducting an energy audit is the first step towards identifying opportunities to reduce energy and its related costs.

Q. 1) Do you have submetering installed? (Tick any)

	Apartment-wise	
	Floor-wise	
	Building-block-wise	
	In common areas	Name the common areas

Submeter: Submetering is the installation of metering devices which have the ability to measure energy usage after the primary meter. It is a system that allows a landlord/property management firm to bill tenants/residents for individual measured utility usage.

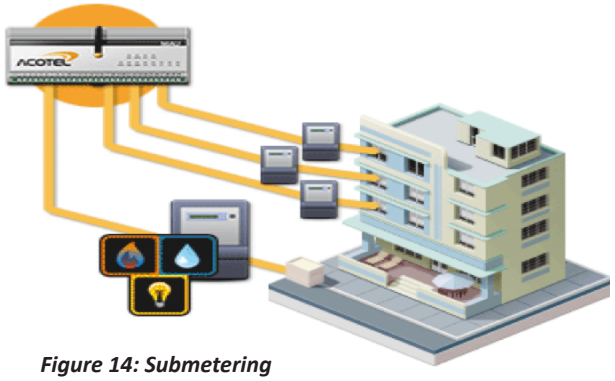


Figure 14: Submetering

Q. 2) Have you conducted an energy audit for the common areas? If yes, give details about the energy consumption source-wise, supported by the submetering data, if available (e.g. common areas, block-wise consumption etc.)

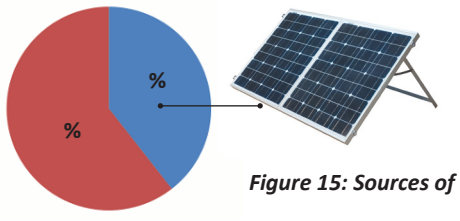
Yes ☐
No ☐

S. NO.	NAME OF THE BLOCK/COMMON AREA	FLOOR AREA (SQ. M)	ANNUAL CONSUMPTION	AC/NON-AC
1.				
2.				
3.				
4.				
5.				
8.				
9.				
10.				

Energy audit is an inspection and analysis of energy use and flow in a building, process or a system, with an aim to reduce the energy input without negatively affecting the output.

Energy in a campus could come from different sources. Conventionally, the source is the grid supply purchased from an electricity service provider. Additionally, energy could be supplied from renewable sources such as solar, micro-hydro and wind. Other sources include diesel generator sets and an uninterrupted power supply for contingency arrangement.

Q. 3) Please provide a pie-chart (see Figure 15: Sources of energy and their percentage composition) with sources (such as thermal, renewables, etc.) and their absolute numbers with percentage composition.

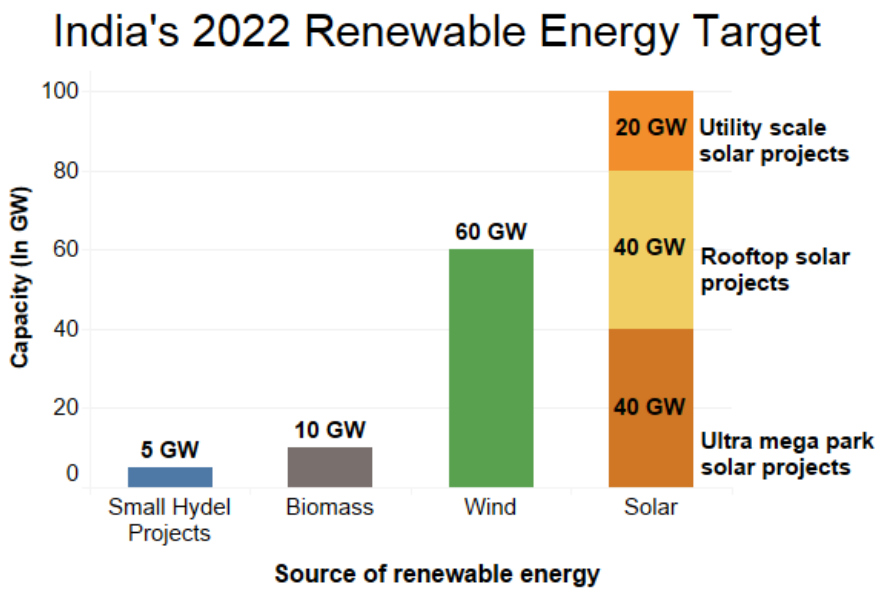


Total connected load: (Kw)
Energy taken from grid: (Kw)
Energy taken from solar: (Kwp)
Energy taken from other: (Kw)

Figure 15: Sources of energy and their percentage composition

India has set a target of installing 175 GW renewable energy capacity by 2022.[1] Currently, wind energy forms the highest proportion of installed renewable energy, followed by solar energy which has a great potential as we get 300 solar days per year on an average. This advantage has enabled another target, that of meeting 8 per cent of India's total energy consumption through solar energy by 2022. Solar energy, at 100 GW, will comprise of the largest wedge of its 175 GW power capacity.

Figure 16: India's renewable energy target (in GW)



Source: http://www.indiaspend.com/cover-story/why-india-might-not-achieve-its-2020-renewable-energy-targets-72549

The government aims to achieve these renewable energy targets through mini-grids and micro-grids. This involves a shift from a central grid system to a decentralized renewable energy (DRE) system. DRE consists of smaller power plants that operate in standalone mode or in parallel with the central grid in case of emergency to supply energy to a group of houses, offices or a campus. This decentralization process provides the ability to isolate from a larger network and therefore presents the consumer with a reliable and self-sustained source of energy.

Box 5: Micro hydropower plants versus big dams

- Small hydropower plants need only a small amount of water flow to generate electricity and therefore the stream need not be blocked by large concrete dams, which can be very expensive. Maintenance, on the other hand, is not too costly as it is with large hydropower plants.
- Large hydropower plants also require a preparation time that is longer than that of a smaller hydropower plant. Large plants need substantial planning and testing because there is no standard procedure for construction of a dam. Every dam project plan needs tweaking for all water bodies are different.
- Micro hydropower plants do not require large reservoirs, and thus there is no submersion of huge tracts of land, no loss of flora and fauna, and most importantly, no displacement of a large number of people.
- Any breach of the dam can also cost lives of numerous humans, trees and animals. In contrast, a micro hydropower plant is a safe option.

Source: A. Sikdar *et al.* 2011. *Climate Change and Natural Resources*. Centre for Science and Environment, New Delhi.

Q. 4) Do you track your energy use and cost? Please provide data for the last five years with trends (support with recent energy bills).

Yes ☐
No ☐

S. NO.	ANNUAL ENERGY CONSUMPTION (kWh)	YEAR	COST (in Rs)
1.			
2.			
3.			
4.			
5.			

Figure 17: Reducing energy usage

Source: https://www.carbontrust.com

Q. 5) Block-wise window wall ratio, if worked out. (Ask the architect to provide data.)

BLOCKS	WINDOW WALL RATIO	BLOCKS	WINDOW WALL RATIO

Window–wall ratio (WWR): WWR is the ratio of window area to the gross exterior wall area for a particular façade. The gross wall area includes both the window area and the area of the wall surface. The walls considered for calculation of WWR are those that form the north and south façade. The east and west façade is generally opaque to avoid heat gain and increase in energy load as a result of the sun's movement.

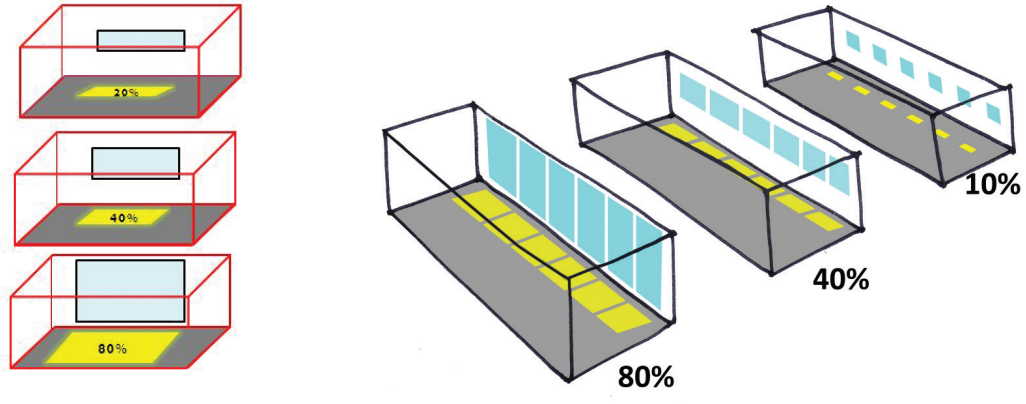


Figure 18: Window Wall Ratio

Q. 6) Have you installed occupancy sensors for lighting control in common areas such as corridors, staircases, sport facilities and common halls? Is there energy efficient lighting in these areas, such as LEDs?

BLOCK	% OF COMMON AREA COVERED		BLOCK	% OF COMMON AREA COVERED	
	LIGHTING SENSORS/ TIMER LIGHTS	ENERGY-EFFICIENT LIGHTS		LIGHTING SENSORS/ TIMER LIGHTS	ENERGY-EFFICIENT LIGHTS

Occupancy light sensor: Occupancy light sensor is a device that senses occupancy of a space by people and turns the light on or off automatically. The sensors may use infrared, ultrasonic, microwave or other technology. These sensors are used extensively in green or energy-efficient buildings as they lead to considerable energy savings.

Lighting power density (LPD)—according to the Energy Conservation Building Code (ECBC), 2017—is the maximum lighting power allowance per unit area of a space and is expressed in watt/m^2. LPD value is defined as per the function of building and also function of space. (See *Table 1: Lighting power density value for areas in an educational campus*).

Table 1: Lighting power density value for areas in an educational campus

CATEGORY	LPD (W/M^2)
Classroom/lecture hall	13.7
Staff room/office	10.0
Laboratory	15.1
Exhibit space/convention centre	14.0
Restroom	7.70
Stairway	5.50
Corridor/transition	7.1
Lobby	9.1
Workshop	17.1
Conference/meeting halls	11.5
Storage	6.80
Electrical/mechanical units	7.1

Source: Energy Conservation Building Code, 2017

Q. 7) Do you immediately report inoperable occupancy light sensors/switches via work order? Provide the service-level agreement for the helpdesk or maintenance services for such initiatives.

Yes ☐
No ☐

_____

_____

Operation and management of utility and services in a campus are sometimes entrusted to an external service provider/agency via a service-level agreement. The service-level agreement includes details such as types of service provided, frequency of services, cost of services and other terms. Swift response by the agency on reporting of inoperable utility indicates efficiency in operation and management.

Q. 8) In common areas, do you turn off lights and other equipment when not in use? If you do, what are manual and automated timings?

CATEGORY	MANUAL TIMINGS	AUTOMATED TIMINGS	CATEGORY	MANUAL TIMINGS	AUTOMATED TIMINGS
Basement parking			Common hall 1		
Sports hall 1			Common hall 2		
Sports hall 2					
Club area					
Outdoor lighting					

Q. 9) Are your common areas air conditioned? If not, then do they have the provision of operational windows?

CATEGORY	AC	WINDOWS		CATEGORY	AC	WINDOWS	
		OPERATIONAL	NON-OPERATIONAL			OPERATIONAL	NON-OPERATIONAL
Basement parking	X						
Sport halls 1	√						
Sport halls 2							
Common hall 1							
Common hall 2							
Club area							

Q. 10) Do you purchase Bureau of Energy Efficiency (BEE) star-rating equipment/ appliances for common areas? Please elaborate and support with recent purchase specification for such orders (for example, copy of purchase order, specifications, etc.)

Yes ☐
No ☐

_____

_____

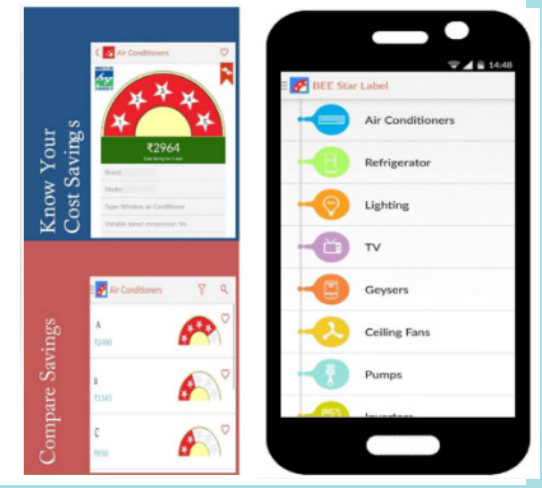
S. NO.	EQUIPMENT/APPLIANCE	DATE OF PURCHASE	BEE STAR RATING
1.			
2.			
3.			
4.			
5.			

The Bureau of Energy Efficiency (BEE) has established a comparative star-labelling system for indoor appliances such as tubular fluorescent lamps, refrigerators (frost-free and direct cool) and ACs. Other appliances include distribution transformer, induction motors, pump sets, ceiling fans, LPG, electric geysers and colour TV etc. The more the number of stars, the more is the energy efficiency of the appliance.

The system was launched in 2006 by the Ministry of Power with an objective to provide the consumer an informed choice about energy saving and thereby the cost-saving potential of the marketed household and other equipment.[2]

Box 6: BEE Star label app

The mobile app is developed by Bureau of energy efficiency, Ministry of Power. This mobile app serves as an awareness and outreach medium to consumers for purchasing decisions. Consumers can compare efficiency of star labeled products vs. baseline appliances as well as check the authenticity of the labeling.



Source : https://www.beestarlabel.com/Home/MobileApp

Q. 11) Do you have an existing policy for maximum and minimum temperature settings for air-conditioned spaces (such as clubs)?

Yes ☐ _____

No ☐ _____

Building Code of India specifies a narrow comfort temperature range between 20°C and 25°C, with an optimum temperature of 27°C.[3] Lower set point temperature has direct bearing on energy consumption of an heating, ventilation, and air conditioning (HVAC) system.

Test results by Tokyo Electric Power Co. indicate that raising an AC thermostat from 26°C to 28°C and using an electric fan can reduce electricity consumption by up to 22 per cent. With the thermostat on 18°C, the compressor will have to operate for longer to bring the heat down, thus meaning that more electricity is consumed. When the thermostat is set at 27°C, the AC brings the room temperature down to 27°C and then turns off the compressor until the room warms up again, saving electricity.

8. Water

Water is one of the most precious substances on our planet and is essential for survival. Though almost 70 per cent of the earth's surface is covered with water, there is still a profound scarcity of water for consumption. This is because only 2.5 per cent of surface water is fresh, of which 70 per cent is frozen as ice caps and glaciers. The remaining 30 per cent is present in aquifers, rivers, lakes and wetlands, leaving only a minuscule amount (0.007 per cent) available for human consumption (see *Figure 19: Top global saltwater and freshwater estimates*).

A global problem faced with regard to water is that it's either available in great quantities or not available at all. While the Amazon River alone carries 16 per cent of the global runoff, the arid and semi-arid zones of the world—that constitute about 40 per cent of the land mass—receive only 2 per cent of the global runoff.[1] This uneven distribution is not only responsible for changes in the climate and ecosystem, but it also conflicts ranging at local, regional and national level. The conflicts mainly result from the competition triggered by scarcity of the resource.

Box 7: Glaciers and their disappearance

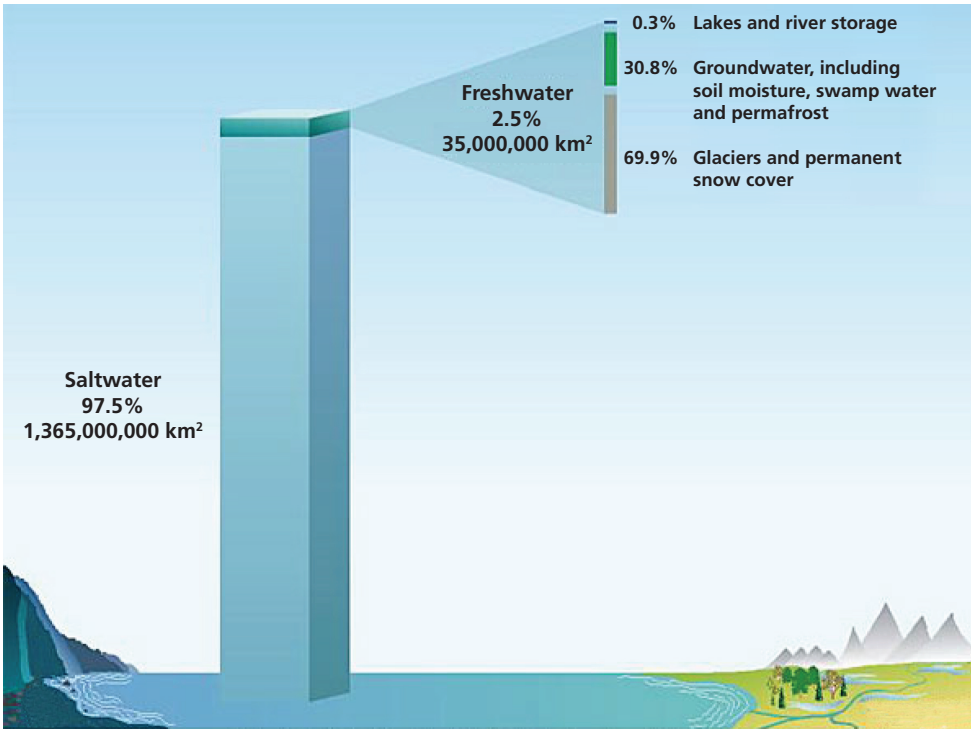
Glaciers are nature's marvel. They not only offer spectacular view on this planet, but also store 70 per cent of the world's fresh water within 10 per cent of world's land area. This great concentration of ice can only exist in low temperature which is found in Polar Regions and mountainous areas. Rising temperatures and changing climate are leading to melting of glaciers at an unprecedented rate. Humans have caused the disappearance of some ice caps, glaciers and even an ice shelf in this century.

The 30.2-km-long Gangotri Glacier and the neighbouring chain of glaciers are lifelines for the Ganga and Brahmaputra River basins. During 1842–1935, the Gangotri glacier was receding at an average of 7.3 m every year and in 1985–2001 at about 23 m per year. Currently, the average retreat is at an alarming 28 metres per year. Other glaciers that feed the Ganga and Brahmaputra River basins face the same threat.

GLACIER	RETREAT OF SNOUT (M)	AVERAGE RETREAT (M/YEAR)
Triloknath Glacier	400	15.4
Pindari Glacier	2,840	135.2
Milam Glacier	990	13.2
Ponting Glacier	262	5.1
Bara Shigri Glacier	650	36.1
Gangotri Glacier	364	28.0
Zemu Glacier	194	27.7

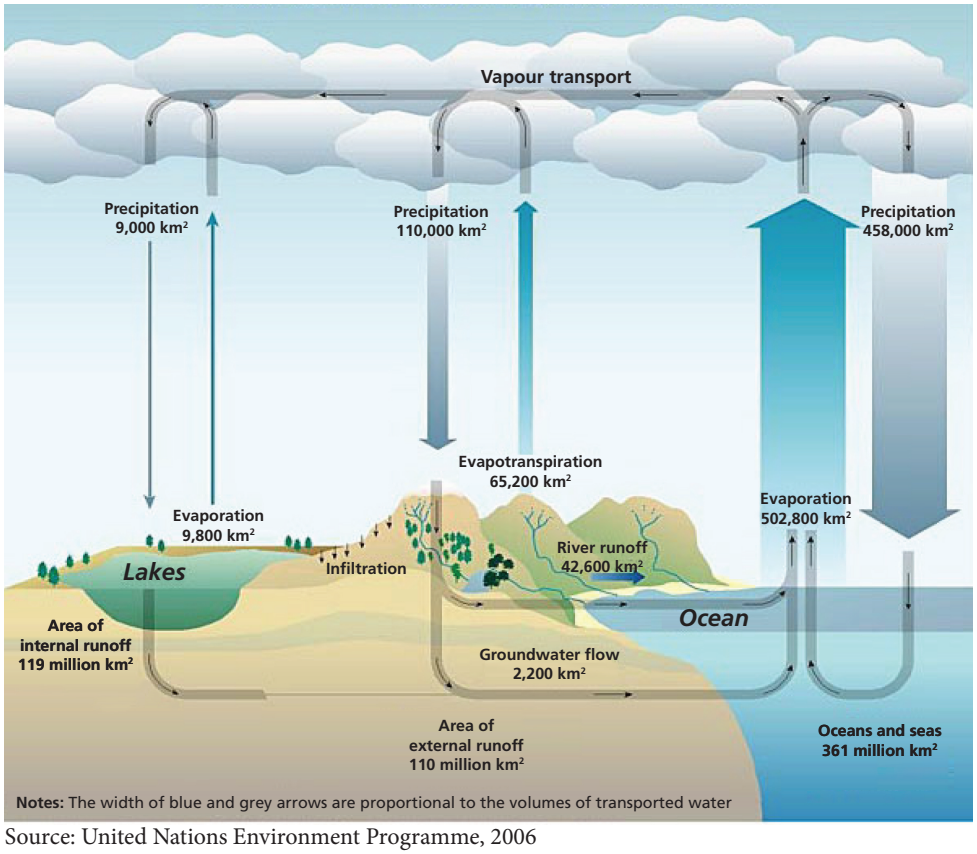
Source: International Union for Conservation of Nature and Natural Resources. 2012. Situation Analysis on Climate Change, Ecosystems for Life: A Bangladesh-India Initiative. Available at http://innovation.brac.net/fif2016/images/library/situation_analysis_on_climate_change.pdf

Figure 19: Top global saltwater and freshwater estimates



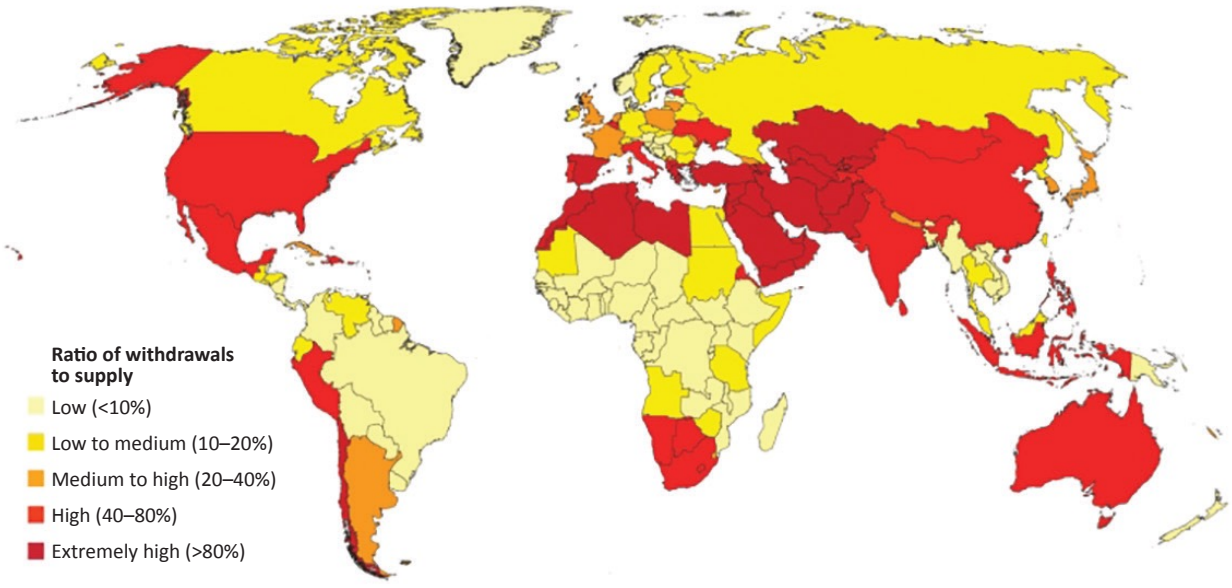
Source: International Union for Conservation of Nature and Natural Resources, 2012

Figure 20 : Water cycle



Source: United Nations Environment Programme, 2006

Map 1: Water stress by country (2040)



Developing countries are expecting their middle class to grow twofold by 2025. Population growth pushes the demand for food up by 69 per cent and agriculture accounts for 70 per cent of the water withdrawals globally. An increase of about 20 per cent in water withdrawal for energy production is also expected between 2010 and 2035. This water-intensive food production and electricity generation are estimated to raise water consumption by a dramatic 85 per cent.[2]

According to estimated for the year 2040, countries like the Middle East and North Africa will facing extremely high water-stress; followed by US, China, India and Australia, which are estimated to have high water-stress. (Refer to *Map 1: Water stress by country [2040]).*

India holds about 4 per cent of the world's water resources. It is estimated that the country receives around 4,000 billion cubic metres (BCM) of rainfall.[3] While rainfall is the country's primary source of freshwater—it varies widely across states, seasons and years—it is still very unreliable.

The Indian rivers play an important role in the lives of the people but they are not adequate enough to fulfill the needs for the country's rapidly rising water demand. Nine of India's 20 river basins—which support a population of 200 million—are already facing water scarcity.[4] Most of these rivers are polluted because every day millions of tonnes of industrial effluents, agricultural run-off—containing fertilizers and pesticides—and domestic wastes flow into them untreated. Even after 26 years of pollution abatement programmes, almost all the major river systems in India contain high levels of organic pollution, low oxygen levels for aquatic organisms, and bacteria, protozoa and viruses which have faecal origin and are a cause of various diseases.

India depends on groundwater resources, and is the largest consumer of groundwater in the world. States like Punjab and Maharashtra have been withdrawing groundwater at an alarming rate. On

an average around 127 to 170 per cent of the available groundwater is withdrawn in India.[5] About 89 per cent of the groundwater extracted is used for irrigation, making agriculture the highest user in the country. This is followed by domestic use, which requires 9 per cent of the extracted groundwater, further followed by industrial use, which requires 2 per cent. Almost 50 per cent of the urban water requirements and 85 per cent of the rural domestic water requirements are fulfilled by the groundwater table.

This huge dependence is leading the nation towards rapid exhaustion of groundwater as well as contamination. Excessive or unscientific exploitation of groundwater, agricultural and industrial activities, poor sanitation and septage management, and solid waste disposal can contaminate aquifers. In parts of India, aquifers are contaminated by arsenic, fluoride, iron and nitrate, making them unsuitable for human use. Government data for shallow aquifers shows that Rajasthan has the highest concentration of fluoride, nitrate and iron, Delhi has its groundwater contaminated with nitrate, and West Bengal has the highest concentration of arsenic.

Exploitation of water resources through over consumption and pollution has left cities in India—which are growing exponentially—struggling to meet their water demands. The situation is more explicitly exhibited by the examples from two of the largest cities in India. In 2005, the official water demand for India's largest cities, Delhi and Mumbai, was a massive 3,973 and 3,900 million litres per day (MLD) respectively. Per capita demand was estimated at 268 litres per capita per day (LPCD) for Delhi and 307 LPCD for Mumbai, which is higher than the domestic average (see *Table 2: Average domestic water consumption in Indian cities*).

Table 2: Average domestic water consumption in Indian cities

USE	CONSUMPTION IN LITRES/DAY/PERSON
Drinking	5 litres
Cooking	5 litres
Bathing	55 litres
Washing clothes	20 litres
Washing utensils	10 litres
Cleaning the house	10 litres
Flushing latrines	30 litres
Total	135 litres

Source: National Building Code of India, 2016

Both cities faced a shortfall of about 600 and 900 MLD, respectively.[6] The situation is worsened by the fact that almost 30-40 per cent of water is lost during transmission and supply in almost every city in India. As a result, about 65 per cent of households across seven major Indian cities faced severe water deficiency in 2005.

Poor water management and diversion of water to cities has led to a series of violent protests, inter-state disputes and tensions at the city level, where neighbouring states do not want to share water and water supply is not equitable within the city.

Guiding principles

Clean water for all

- Reduce overall water demand by at least 25 per cent from current levels through water efficiency and conservation measures while maintaining quality of life.
- Ensure equitable access to clean water for all and prevent water guzzling.
- Promote decentralized wastewater treatment for reuse and recycling.
- Conserve rainwater and increase groundwater recharge in green areas, water bodies, nullahs etc. to augment local availability of water to meet daily water needs and reduce dependence on water supply from longer distances.

The only solution to the crisis is water conservation and efficiency. Conservation begins with reducing water consumption at the users' end. Efficient water management also augments the process of conservation. According to the American Water Works Association (AWWA), by installing more efficient water fixtures and regularly checking for leaks, daily per capita water use can be reduced by about 35 per cent.[7] The nature of such efficiency interventions for water management and their magnitude can be suggested by a **water audit**.

Water audit: A water audit is a qualitative and quantitative analysis of water consumption in a particular establishment or system. It supports the establishment to identify ways of reducing, reusing and recycling water to make the use of water more efficient and also save money.

Q. 1) Have you ever conducted a water audit (water balance chart)? If you have, support your answer with a flow chart from source to discharge process with volume data marked on each stage, including storage volumes.

Yes ☐ _____

No ☐ _____

Figure 21: A typical scheme showing general components of a water management system in a campus

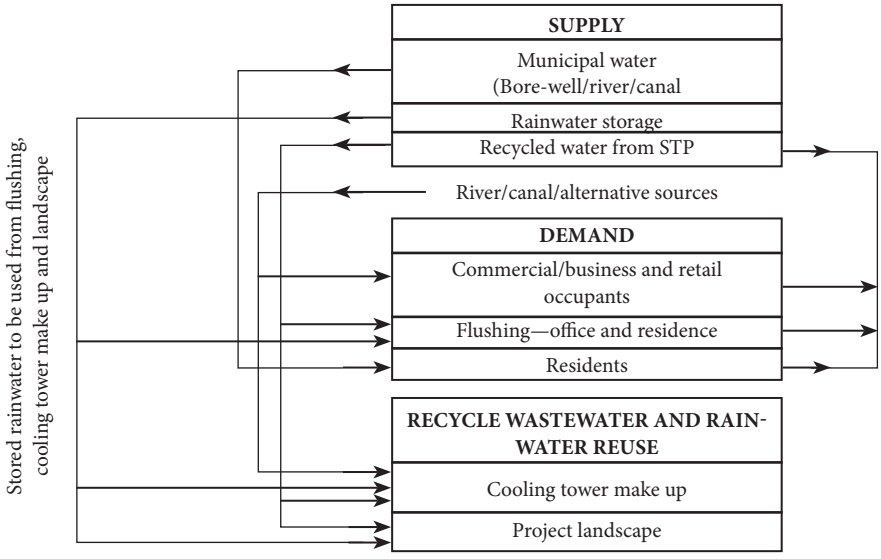
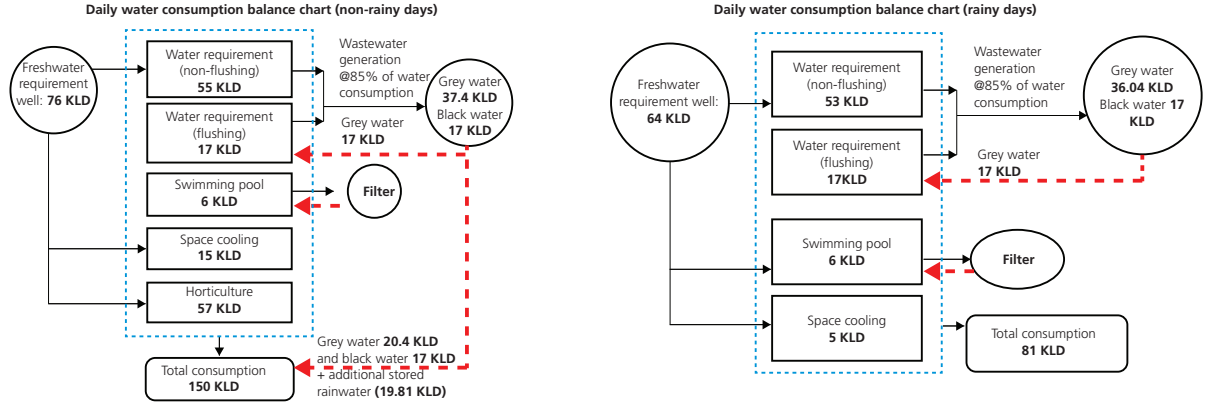


Figure 22: Water balance cycle chart (in kilo litres per day [KLD]) at the Anil Agarwal Environmental Training Institute, Nimli, Alwar, Rajasthan



Q. 2) Do you have sub-metering installed? (Tick any)

	Apartment-wise	
	Floor-wise	
	Building-block-wise	
	In common areas	Name the common areas

Sub-meter: Sub-metering is the installation of metering devices with the ability to measure energy usage after the primary meter. It offers the ability to monitor water usage for individual tenants, departments, pieces of equipment or other loads separately.

Q. 3) What is the source of water on the campus? (For example, groundwater, river, pond etc.) State percent-wise if multiple sources are used.

S. NO.	SOURCE	% OF TOTAL SUPPLY	S. NO.	SOURCE	% OF TOTAL SUPPLY
1.			4.		
2.			5.		
3.			6.		

- Municipal
- External tanker
- Under groundwater
- Wastewater recycle
- Stored rainwater

In India, water in cities is supplied by the municipal body/local authority through a water pipeline network. Unfortunately, this provision has not been able to catch the pace of rapid development and urbanization. A remarkable number of institutions, neighbourhoods and other areas in towns and cities have to arrange for water on their own. For instance, only two-thirds of residents of Gurugram, Haryana, have access to piped water, and the supply is irregular. Because of the demand-supply gap, 70 per cent of the residents—including a sizeable number of those with piped water connections—depend on groundwater.[8]

Groundwater is extracted through tube wells and bore wells. Other sources of water include supply tankers, rainwater harvesting, and treated/untreated wastewater, etc.

Q. 4) Do you track your water use and cost source-wise? (E.g. local authority, tankers, tube wells/borewells, rainwater harvesting, and treated/untreated wastewater) Support with the last five-year trend, with lowest possible distribution (if monitored).

Yes ☐
No ☐

_____

_____

S. no	Source	2013		2014		2015		2016		2017	
		Use (litres)	Cost (in Rs)	Use (litres)	Cost (in Rs)	Use (litres)	Cost (in Rs)	Use (litres)	Cost (in Rs)	Use (litres)	Cost (in Rs)
1.											
2.											
3.											
4.											
5.											

Q. 5) What percentage of the housing unit's water demand was met by water tankers sourced externally?

_____

Q. 6) Do you calculate a liters per capita consumption daily? Provide data for the last five years.

Yes ☐
No ☐

_____

_____

Q. 7) If you are dependent only on groundwater, do you keep a track of your groundwater decline? (Attach the borehole log used for the drilling of the bore well).

Yes ☐
No ☐

_____

_____

A borehole log is a detailed record of geologic formations penetrated by a borehole. It also includes information on water table level and water quality of the aquifer.

Q. 8) Do you have any rainwater harvesting structures? Please mention the details, capacity and number.

Yes ☐
No ☐

_____

_____

Rainwater harvesting: This is a mini-scale water resource project that collects and stores rainwater for productive use. This use could either be for daily activities or recharging of ground water table. The process needs adoption of structural measures for collecting, directing and storing rain water. The collected rainwater is generally used for non-potable uses like flushing, gardening and cleaning. Affordable technology these days allows for an on-site treatment of stored rainwater through a combination of processes, such as membrane filtration, disinfection using chlorination and UV light, ozonation and adsorption.

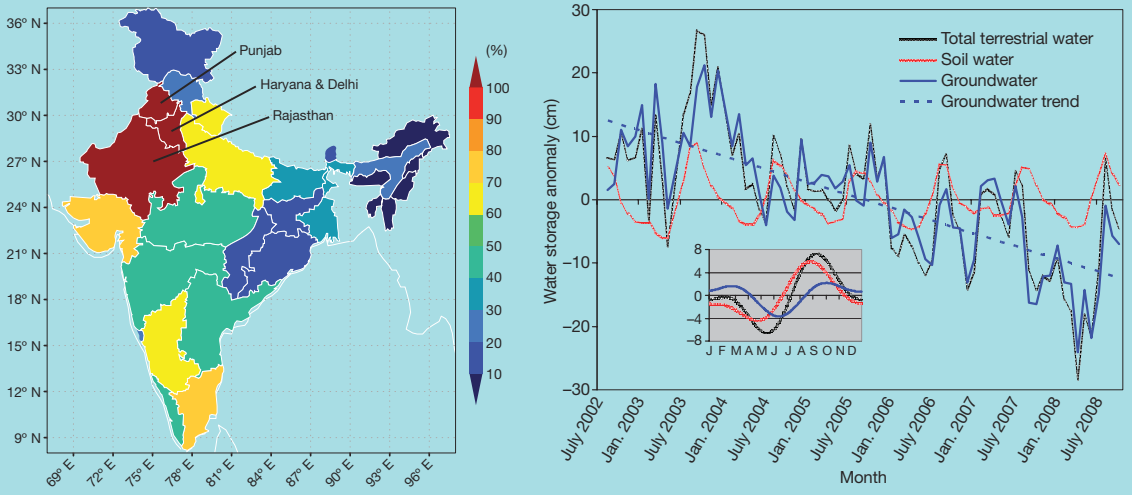
In 2013, another study by the Central Ground Water Board (CGWB) identified three regions facing overexploitation of groundwater: (see *Figure 24: Results of groundwater-level assessment conducted by CGWB*).[9]

1. North-western: Punjab, Haryana, Delhi and Western UP
2. Western: Rajasthan and Gujarat
3. Peninsular India: Karnataka, Andhra Pradesh and Tamil Nadu

Box 8: Groundwater decline in India

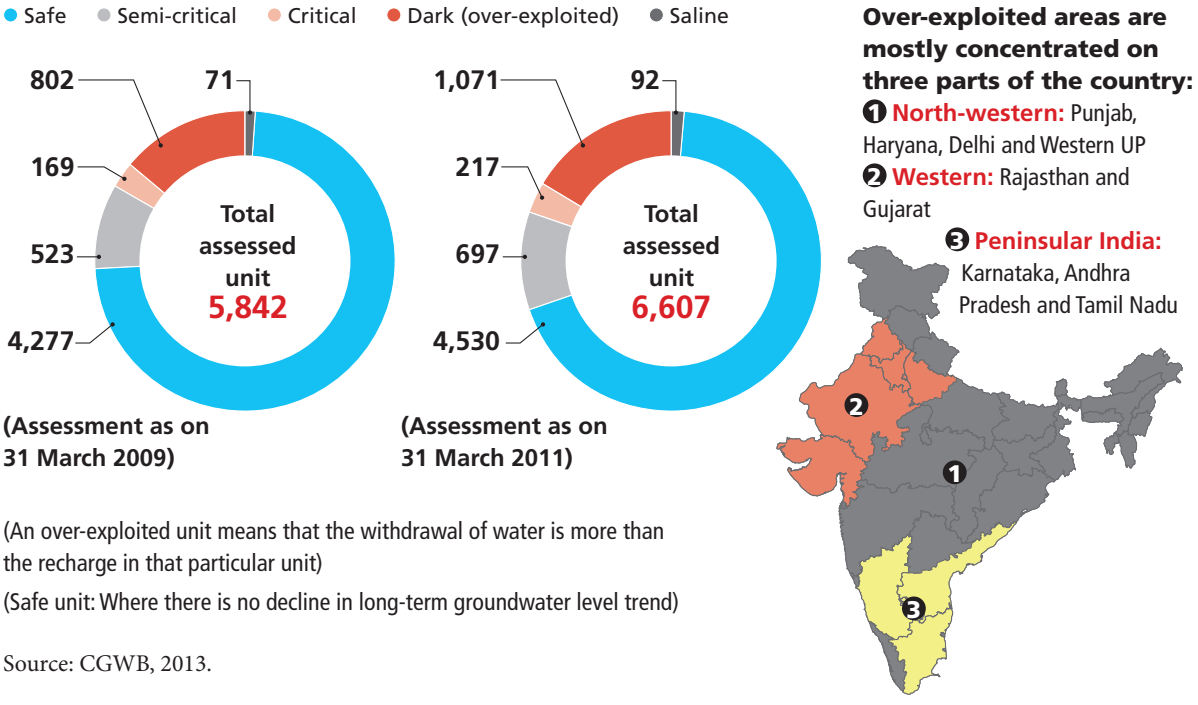
A study using satellite-based estimation suggests that the groundwater decline in India is severe. Most states in the country are not able to recharge groundwater to even half the levels before extraction. The states of Rajasthan, Haryana and Punjab withdraw almost 100 per cent of the groundwater level after recharge. The three states have a semi-arid to arid climate, averaging about 50 cm of annual rainfall (see *Figure 23: State-wise groundwater withdrawals as percentage of recharge*).

Figure 23: State-wise groundwater withdrawals as percentage of recharge



Source: Matthew Rodell, Isabella Velicogna, James S. Famiglietti, 'Satellite Based Estimates of Groundwater Depletion in India', *Nature* 460 (7258): 999-1002. September 2009. DOI: 10.1038/nature08238

Figure 24: Results of groundwater-level assessment conducted by CGWB



(An over-exploited unit means that the withdrawal of water is more than the recharge in that particular unit)

(Safe unit: Where there is no decline in long-term groundwater level trend)

Source: CGWB, 2013.

Q. 9) Do you have a regular or an irregular water supply? Is it a pressurized system or a gravity-based design?

Regular (24 x 7) ☐
Intermittent ☐

_____

_____

Water is distributed using different systems to ensure regular supply, good quality, quantity and pressure. A distribution system is selected depending upon the level of source, topography of the area where it is to be supplied, and other local conditions. A pressurized system involves pumping of treated and stored water at a municipal facility directly to user ends. A gravity-based system supplies water by using the pressure granted by gravity. Generally, treated water is stored in an overhead tank, designed for a neighbourhood or campus, and is released to reach user ends.

Q. 10) Do you monitor and immediately report leaks via work order? Support your answer with measurement, inference process and relevant work orders.

Yes ☐
No ☐

_____

_____

Q. 11) What kind of faucets do you have installed in your apartments and common areas? Provide details and specifications of the selected options. Mark their saving potentials (via facilities/estates department).

CATEGORY	TYPE OF FAUCET 1. Full turn faucet 2. Flow restrictors 3. Automatic faucets 4. Aerators	CATEGORY	TYPE OF FAUCET 1. Full turn faucet 2. Flow restrictors 3. Automatic faucets 4. Aerators
Sports hall 1		Restaurant	
Sports hall 2			
Club area			
Common hall 1			
Common hall 2			

BOX 9: Types of faucets

Full turn faucet: Full turn faucets are the regular taps that use a valve action to release and restrict water flow. The water flow depends on the line pressure and diameter of the outlet rim.

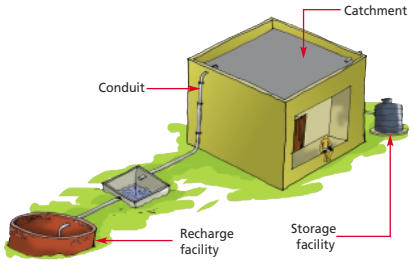
Flow restrictors: These are small control fixtures that deliver a precise volume of water in faucets, typically 5.6–8.3 litres per minute, irrespective of the varying line pressure. These offer a saving potential of 80 per cent.

Automatic faucet: These faucets are equipped with a proximity sensor and mechanism that opens its valve to allow water to flow in response to the presence of a hand or hands in close proximity. The faucet closes its valve again after a few seconds or when it no longer detects the presence of hands. These faucets can achieve a reduction of water use by 7-5 per cent.

Aerators: These are water-saving tools that add air to the water stream to make the flow feel stronger. These can be designed for a water-flow rate from 2–8 litres per minute, and offer a potential to reduce overall consumptions by up to 30 per cent.

A flow restrictor, an automatic faucet, and an aerator

Figure 25: A typical rainwater harvesting system



It is important to get familiar with the term runoff when discussing rainwater harvesting. Runoff is the amount of rainwater that flows away after falling on a surface. It is different for paved and unpaved areas and varies according to the type of pavement (see *Table 3: Run-off coefficient and surface types*).

Table 3: Run-off coefficient and surface types

CATCHMENT VARIETY	SURFACE TYPES	RUNOFF COEFFICIENT
Roof catchments	Tiles	0.8-0.9
	Corrugated metal sheets	0.7-0.9
	Concrete	0.70-0.95
Ground surface covered with	Soil (slope <10%)	0.0-0.3
	Rocky material catchment	0.2-0.5
	Lawns, sandy soils having (slope 2%)	0.05-0.10
	Lawns, sandy soils having (slope 2–7%)	0.10-0.15
	Brick pavements	0.70-0.85
	Park/cemeteries	0.1-0.25
	Play grounds	0.2-0.35
	Asphalt and concrete pavement	0.70-0.95

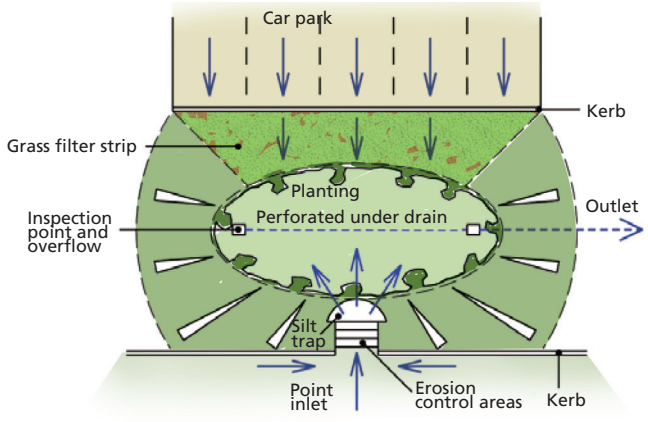
Source: National Building Code of India, 2016.

The quality of runoff from the rooftop is the cleanest, followed by paved surfaces. Unpaved surfaces may lead to a contaminated runoff, therefore, it's not advisable to use this water for drinking purposes.

There are several other techniques to channel, hold and/or absorb runoff with a view to manage and utilize rainwater productively. This broad approach is referred to as Sustainable Urban Drainage Systems (SUDS). These measures can be undertaken in open spaces, generally located outside the envelope of individual developments. Specific measures pertain to the design and characteristics of the site, their location within green spaces and other clearly defined utility areas that can manage storage and conveyance of surface water runoff. The measures could involve either a natural or an artificial structure. A few SUDS measures are described below.

Rain garden is a landscape structure that gives aesthetic and functional advantage over a conventional garden. It is a shallow basin that can be installed on any unpaved surface to temporarily retain and absorb runoff. It can be planted with native shrubs, perennial flowers and other vegetation. It can remove up to 80 per cent of sediments from rainwater runoff and up to 90 per cent of nutrients and chemicals,[10] thereby preventing pollutants from entering into the soil and groundwater. A rain garden can allow about 30 per cent more absorption of water into the ground. A rain garden is not to be confused with a pond or marshy patch of land. A rain garden is mostly dry and holds water during and after rain and for about 12–48 hours.

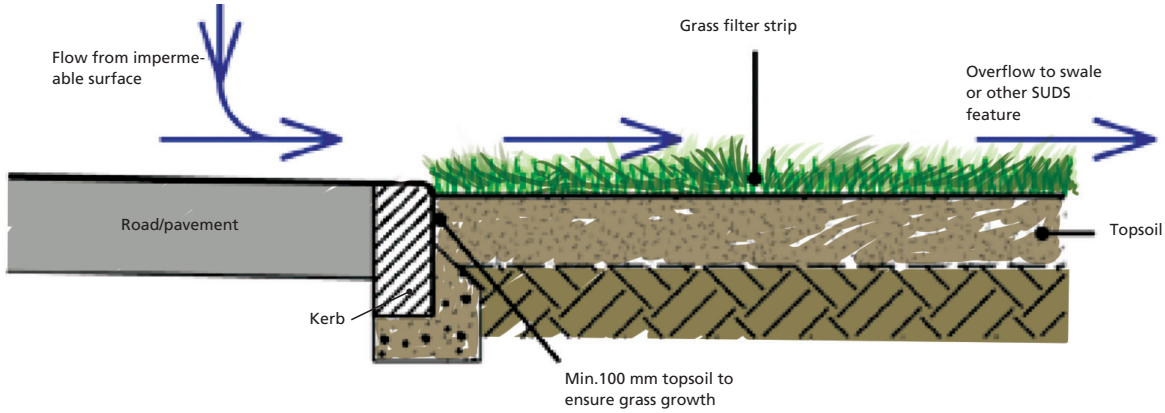
Figure 26: A typical rain garden plan



Source: CSE, 2016

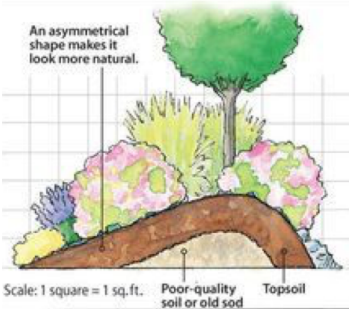
Filter strip is a grassy/densely vegetated strip of land that collects surface water runoff as sheet flow from impermeable surfaces.

Figure 27: A typical filter strip



Source: CSE, 2016

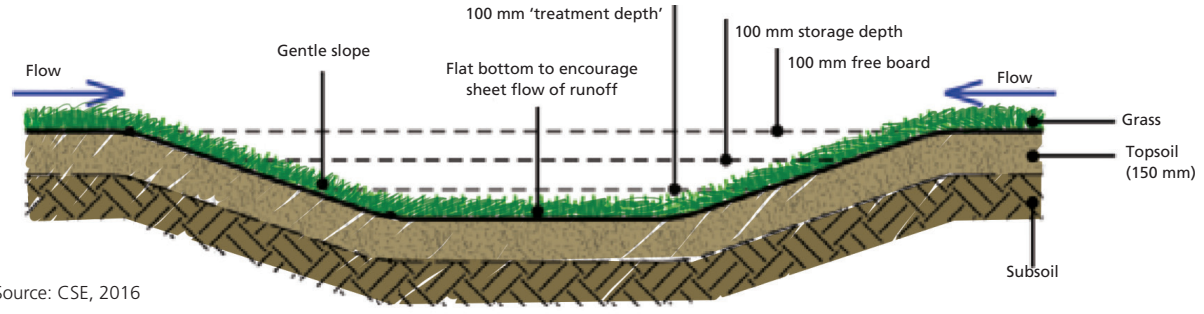
Figure 28: A typical berm



Berm is a raised bank or a barrier separating two areas. It is generally found along canals or rivers and is put in place to avoid flooding. In landscaping, it is used to retain water and add an aesthetic element.

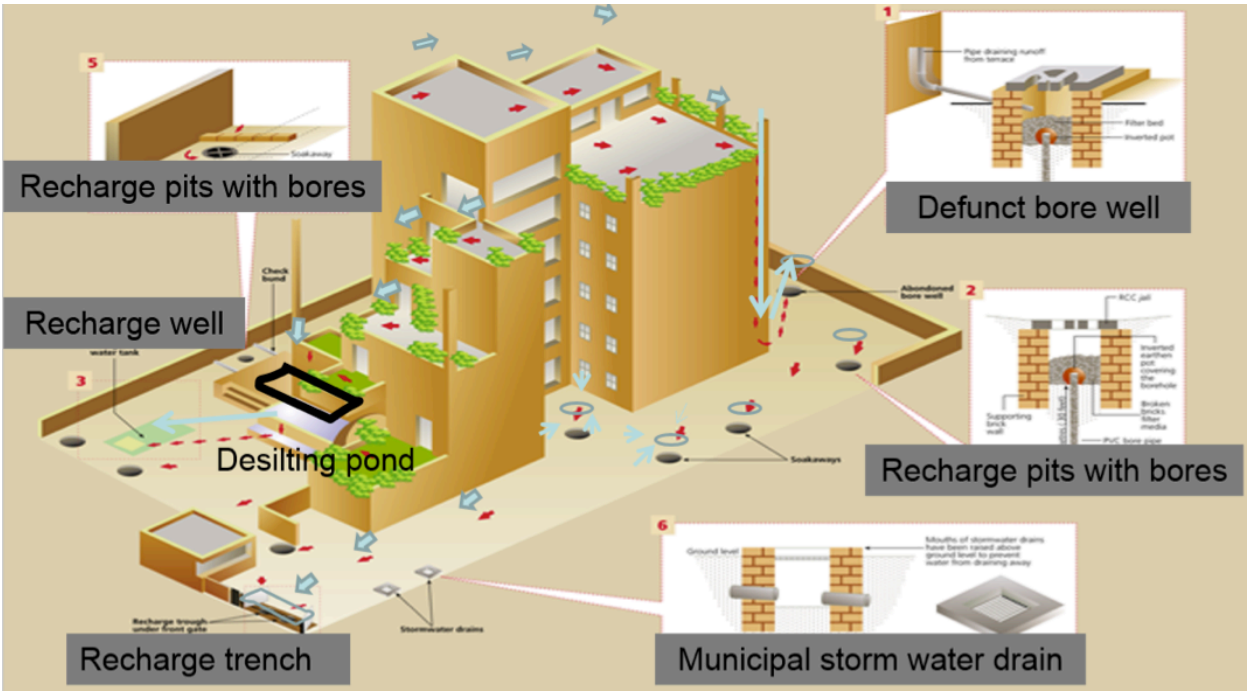
Swale is a water-harvesting ditch used for retaining runoff. It can be constructed in a conduit form with contours or man-made leveling to move storm-water from one place to another. If planted with vegetation, a swale can help in filtration and treatment of the runoff to some extent. Since the movement of water is slow, it does not erode soil, and instead allows passive seepage of water into the soil to further recharge groundwater aquifers.

Figure 29: A typical swale



Source: CSE, 2016

Figure 30: Rainwater harvesting system at CSE, New Delhi



Q. 12) Have you installed any natural structures and/or vegetation to retain water on-site and minimize potable water use? Support with design scheme and percentage of augmentation, and detailing on structures and O&M scheme.

Rain gardens ☐ _____
Berms ☐ _____
Swales ☐ _____
Filter strips ☐ _____
Other (specify) ☐ _____

Q. 13) Do you monitor the impact of rainwater harvesting structure? (Attach the trend of groundwater quantity and quality in the last five years.) If the installed structure is new, then what are the indications for increase in soil moisture?

Yes ☐
No ☐

_____

_____

Q. 14) Have you optimized your irrigation system (if applicable) to:

☐ Operate at night or early morning hours to minimize evaporation
☐ Water the minimum time and frequency necessary for the applicable vegetation
☐ Not optimized

Q. 15) Do you use treated wastewater? If you do, provide details on percentage and type of water processed, technology type and output characteristics, including quality.

Yes ☐
No ☐

_____

_____

S. No	TYPE OF WATER PROCESSED	PER CENT OF TOTAL WATER TO BE PROCESSED	TREATMENT TECHNOLOGY
1.	Waste (black) water		
2.	Grey water		

Details output characteristics here:

Q. 16) How many times in the last year did you have to completely empty your swimming pool? How is the water that is drained-out utilized?

_____

_____

_____

_____

_____

Q. 17) Do your common areas get washed by

- ☐ Normal water hosepipe
- ☐ Pressure washer
- ☐ Other (specify) _____

Pressure washers (see *Figure 31: Pressure washers*) in general are more effective at cleaning and removing dirt and contaminants as the pressurized water effectively gets in behind stubborn dirt and contaminants and lifts them away quickly and efficiently. Even with the increased flow of the water, pressure washers use a considerably lesser amount of water than an open hosepipe, thus helping to save water.

Figure 31: Pressure washers

9. Waste

India faces a major environmental challenge associated with waste generation, its treatment and disposal. Waste is the residual of our daily consumption and production processes. Population growth, rapid urbanization, economic growth and rising affordability together accelerate this cycle of consumption and production. Developing countries are highly vulnerable with issues such as waste management as they try to cope with the burgeoning population, scarce financial resources and smaller capacities. Improper and insufficient management of waste not only contaminates natural resources such as soil and water (both surface- and groundwater), but exposes a substantial population to diseases and unsafe and unsanitary living conditions. It also contributes to greenhouse gas emissions by production of methane. Post-consumption waste is estimated to account for almost 5 per cent of the total global greenhouse gas emissions.

The World Bank estimates that the amount of municipal solid waste (MSW) will almost double by the year 2025 from the current 1.3 billion tonnes per year—a 2012 figure. (See *Table 4: Types of waste as classified by the World Bank*)

Table 4: Types of waste as classified by the World Bank

SOURCE	TYPICAL WASTE GENERATORS	TYPES OF SOLID WASTES
Residential	Single and multifamily dwell	Food wastes, paper, cardboard, plastics, textiles, leather, yard wastes, wood, glass, metals, ashes, special wastes (e.g., bulky items, consumer electronics, white goods, batteries, oil, tyres), and household hazardous wastes (e.g., paints, aerosols, gas tanks, waste containing mercury, motor oil, cleaning agents), e-wastes (e.g., computers, phones, TVs)
Industrial	Light and heavy manufacturing, fabrication, construction sites, power and chemical plants (excluding specific process wastes if the municipality does not oversee their collection)	Housekeeping wastes, packaging, food wastes, construction and demolition materials, hazardous wastes, ashes, special wastes
Commercial	Stores, hotels, restaurants, markets, office buildings	Paper, cardboard, plastics, wood, food wastes, glass, metals, special wastes, hazardous wastes, e-wastes
Institutional	Schools, hospitals (non-medical waste), prisons, government buildings, airports	Same as commercial
Construction and demolition	New construction sites, road repair, renovation sites, demolition of buildings	Wood, steel, concrete, dirt, bricks, tiles
Municipal services	Street cleaning, landscaping, parks, beaches, other recreational areas, water and wastewater treatment plants	Street sweepings; landscape and tree trimmings; general wastes from parks, beaches, and other recreational areas, sludge
All of the above should be included as municipal solid waste. Industrial, commercial, and institutional (ICI) wastes are often grouped together and usually represent more than 50% of MSW. C&D waste is often treated separately: if well managed it can be disposed separately. The items below are usually considered MSW if the municipality oversees their collection and disposal.		
Process	Heavy and light manufacturing, refineries, chemical plants, power plants, mineral extraction and processing	Industrial process wastes, scrap materials, off-specification products, slag, tailings
Medical waste	Hospitals, nursing homes, clinics	ous wastes (bandages, gloves, cultures, swabs, blood and body fluids), hazardous wastes (sharps, instruments, chemicals), radioactive waste from cancer therapies, pharmaceutical waste
Agricultural	Crops, orchards, vineyards, dairies, feedlots, farms	Spoiled food wastes, agricultural wastes (e.g., rice husks, cotton stalks, coconut shells, coffee waste), hazardous wastes (e.g., pesticides)

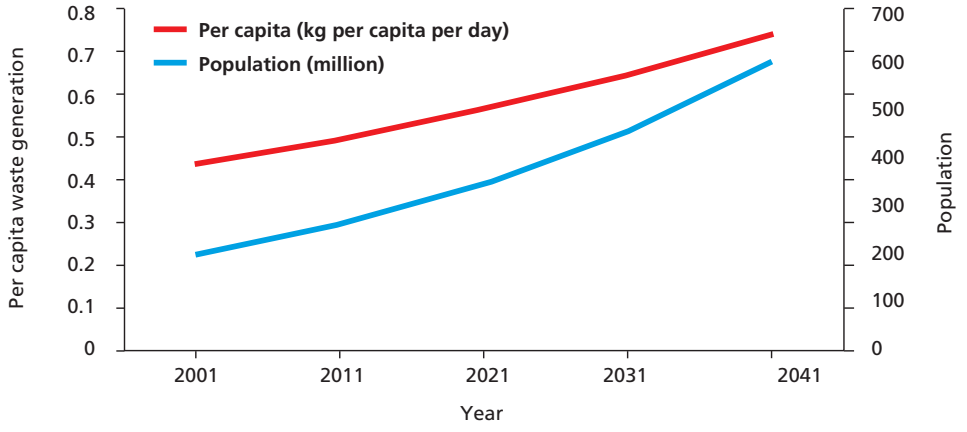
The figure suggests a current footprint of 1.2 kg per person per day, and estimates a footprint of 1.42 kg per person per day in 2025. The annual global cost to manage this amount of waste also goes up from the current $205 billion to $375 billion.[1]

Waste is the only sector in which decisions are directly taken by the municipal body. Effective waste management is expensive and constitutes 20–50 per cent of the municipal budget in countries around the globe. Ineffective waste management further increases this cost. For instance, improper waste disposal may lead to diseases or infections that will require further municipal investment in clinics and hospitals.

The costs to manage waste is projected to increase four-times for low-middle income countries like India, where waste management is highly ineffective and inefficient.

About 170,000 tonnes—i.e. 17,000,000 kg—of MSW is generated every day in India. Per capita waste generation in major cities is 0.4–0.6 kg per day.[2] These numbers are relatively small in comparison to the global average, but considering the incapacity of municipal bodies to manage waste, the figures may not be trivial at all (see *Figure 32: Daily per capita waste generation in India and projections as per population growth*).

Figure 32: Daily per capita waste generation in India and projections as per population growth

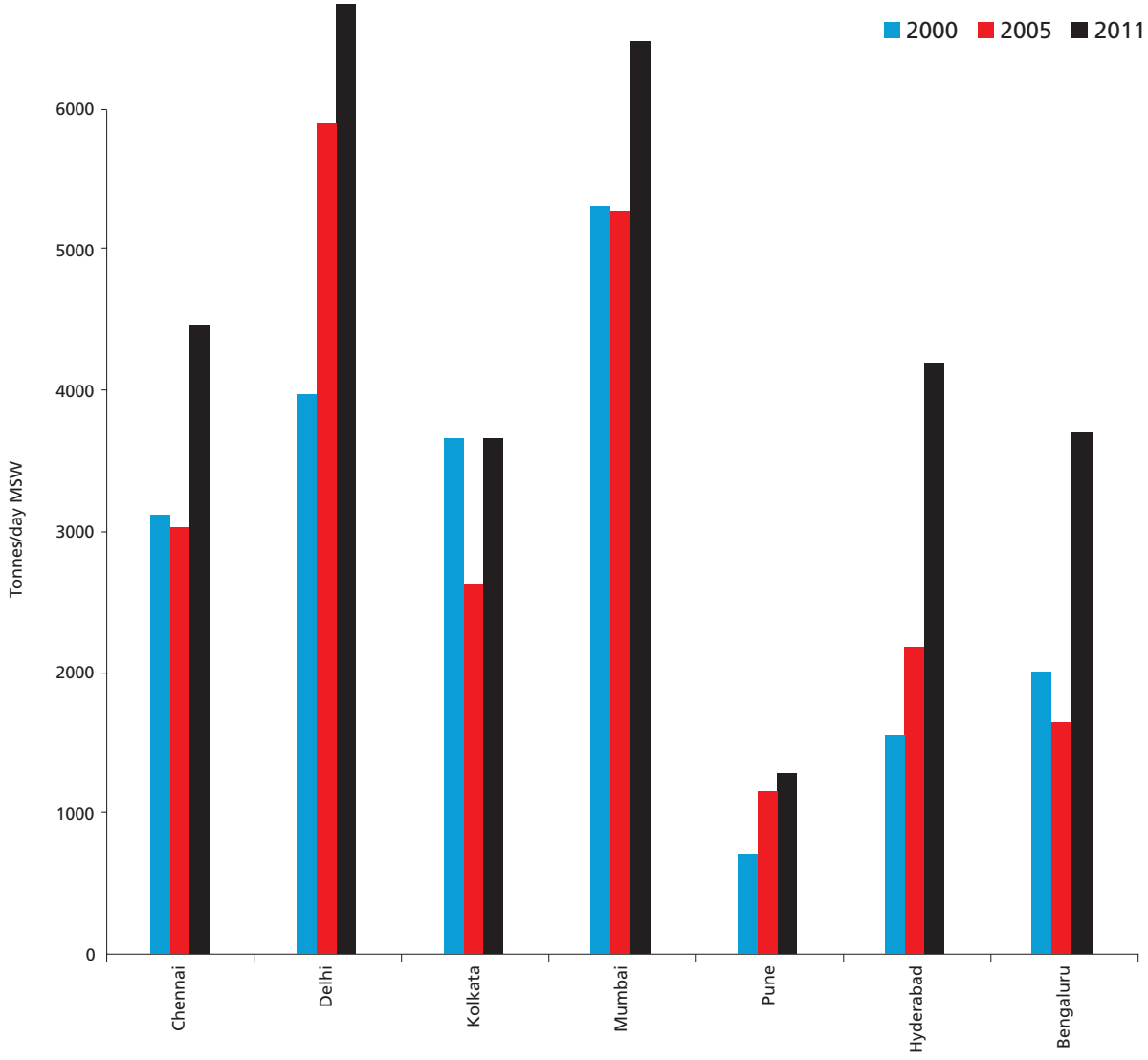


Source: Sunita Narain and Swati Singh Sambyal. 2016. ***Not in My Backyard***. Centre for Science and Environment, New Delhi.

Municipal collection efficiency is 70–90 per cent in major metro cities and is below 50 per cent in small cities. Of this incomplete collection, only 10 per cent goes for treatment and a remarkable 90 per cent is dumped in landfills without any treatment.[3] This level of insensitive dumping fills the dumping sites with e-waste, toxic waste and biomedical waste. A major consequence is that a majority of the municipal bodies are now running out of landfill sites. In addition, the absence of scientific and safe disposal poses a great threat to the health and well-being of the residents of the city as well as the environment.

The steep climb in waste generation in Hyderabad and Bangalore from 2005 to 2011 suggests that newly developing cities—with population above 100,000—need to be prepared the most with effective and efficient waste management systems (see *Figure 33: Largest waste generators in the country*).[4]

Figure 33: Largest waste generators in the country



Source: CPCB-NEERI

The situation becomes financially daunting when this hazardous waste management is spent with Rs 500–Rs 1500 per tonne[5] by the municipal bodies. According to this, Delhi and Mumbai spend between Rs 70,00,000 and Rs 10,500,000 per day on waste management. About 60–70 per cent of this amount is spent on street sweeping and (sub-par) waste collection, 20–30 per cent on transportation and less than 5 per cent on final disposal of waste. Waste management involves 30–50 per cent of municipal staff.

Proper waste management in the country needs addressing at almost all stages of the life-cycle of waste, i.e. generation, collection, transportation, treatment and disposal.

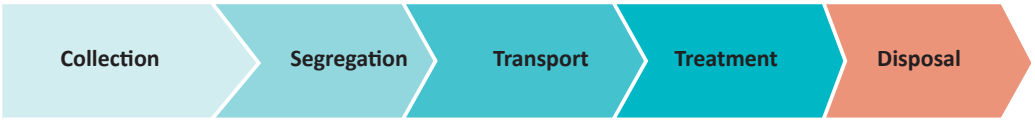
Citizens have a central role

Since cities and city managers are accountable for global waste and waste management respectively, citizens have a primary role in the process. A role that begins with reducing the amount of waste generated. This means adopting a lifestyle inherent with 'waste-free' or 'less-waste' habits. It involves preferring recycled products or products that come with less wastage. From a functional perspective, this ensures a smaller amount of waste going for collection, treatment and disposal (see *Figure 34: Approach to waste management* and *Figure 35: Process of waste collection, transportation and disposal*). As a consequence, resources are saved at each stage and there is a substantial increase in process efficiency[6] (see *Figure 36: Waste-to-revenue approach*).

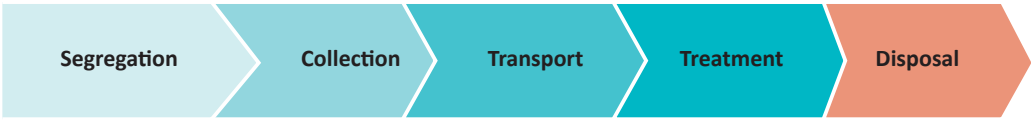
Waste management at the individual level begins with segregation at source. Segregation of waste offers a variety of solutions for recycling, reusing and reducing waste first at the individual level, which aggregates substantially at the city level. The level of segregation varies from city to city. It generally depends on the availability of treatment facilities. Segregation categories can range from dry and wet, biodegradable and non-biodegradable, organic, glass, paper, metal, plastic and hazardous etc.

Figure 34: Approach to waste management

Wrong: The current approach to waste management



Right: The expected approach



India's Solid Waste Management Rules, 2016, suggest segregation of waste in three separate streams, namely biodegradable, non-degradable and domestic hazardous wastes.[7] The rules were notified by the Ministry of Environment, Forests and Climate Change replacing the Municipal Solid Waste (Management and Handling) Rules, 2000. The ministry also notified management rules for plastic, e-waste, biomedical waste and construction and demolition waste around the same time. These new rules indicate the urgency attached with waste management in the country and attempt to provide a holistic framework towards increasing effectiveness and efficiency of the processes.

Guiding principles

Promotion of zero landfill development - minimize and reuse solid waste:

- Aim for near zero-landfill development with not more than 10 per cent of waste to go to landfill sites.
- Promote mandatory decentralized segregation and collection in all residential colonies and institutions, and composting sites at colony and ward levels.
- Promote properly designated and operated construction and demolition waste sites and recycling facilities that are well audited.

Q. 1) How many categories do you segregate waste into?

_____

_____

Q. 2) Do you follow colour-coded bins for segregation?

Yes ☐
No ☐

_____

_____

NOTE:

The Government of India mandates to segregate waste at source into:

- **Biodegradable (in green bins):** Leftover food items, vegetable and fruit peels, egg shells, meat, fish, etc.
- **Non-biodegradable (in blue bins):** Disposable cups, plates, cardboard, metal containers, paper, non-infectious plastics and other recyclables and combustible objects.
- **Domestic hazardous wastes (in black bins):** Insecticides, disinfectants, fumigants, chemical containers, broken thermometers, expired medicines and other chemicals.

BOX 10: Learning from Panaji

The colour-coding scheme for waste segregation at source is followed differently in cities and countries. For instance, Panaji, India, follows:

- **Grey bin** for glass and metal waste
- **Brown bin** for paper and cartons.
- **Orange bin** for Plastic
- **Purple bin** for non-recyclables items like thermocol, ceramics, rubber, rexene, leather, cloth, gloves, broken plates, batteries and tube lights.
- **Green bin** is for compostable waste.

The bins came with a locking system, which eliminated the chances of tipping over by stray dogs or cats. Wet waste was collected everyday while dry waste was collected thrice in a week.

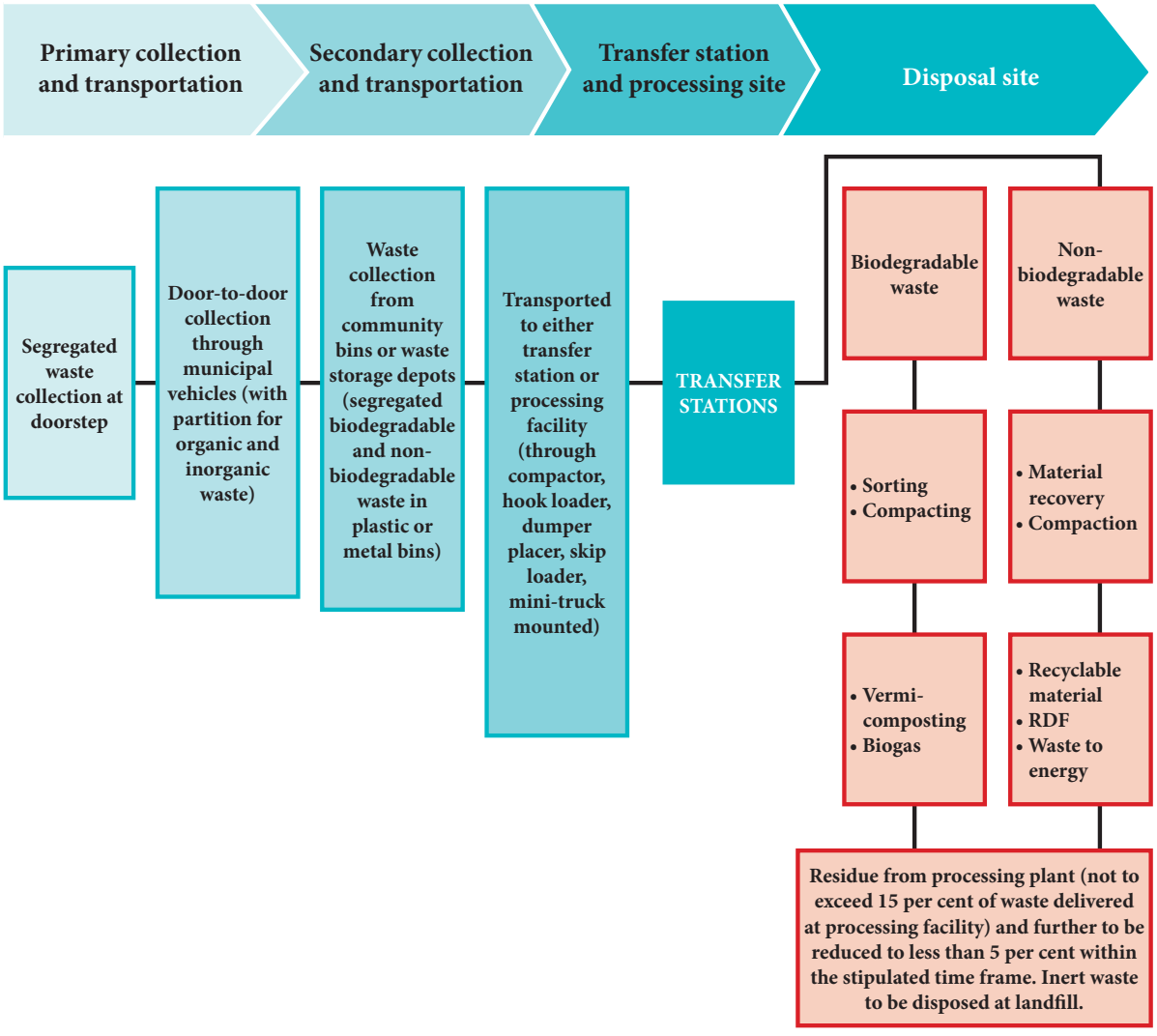
There are around 99 composting units in a city and most of the wet waste is handled in the composting units built within housing colonies and the rest is sent to the big composting unit in the market area.

Source : https://www.cleanindiajournal.com/pantowards_a_'bin -less'_city/, https://www.youtube.com/watch?v=I-bXUBFOxOk

Q. 3) Do you track the waste that goes outside your campus?

Yes ☐
No ☐

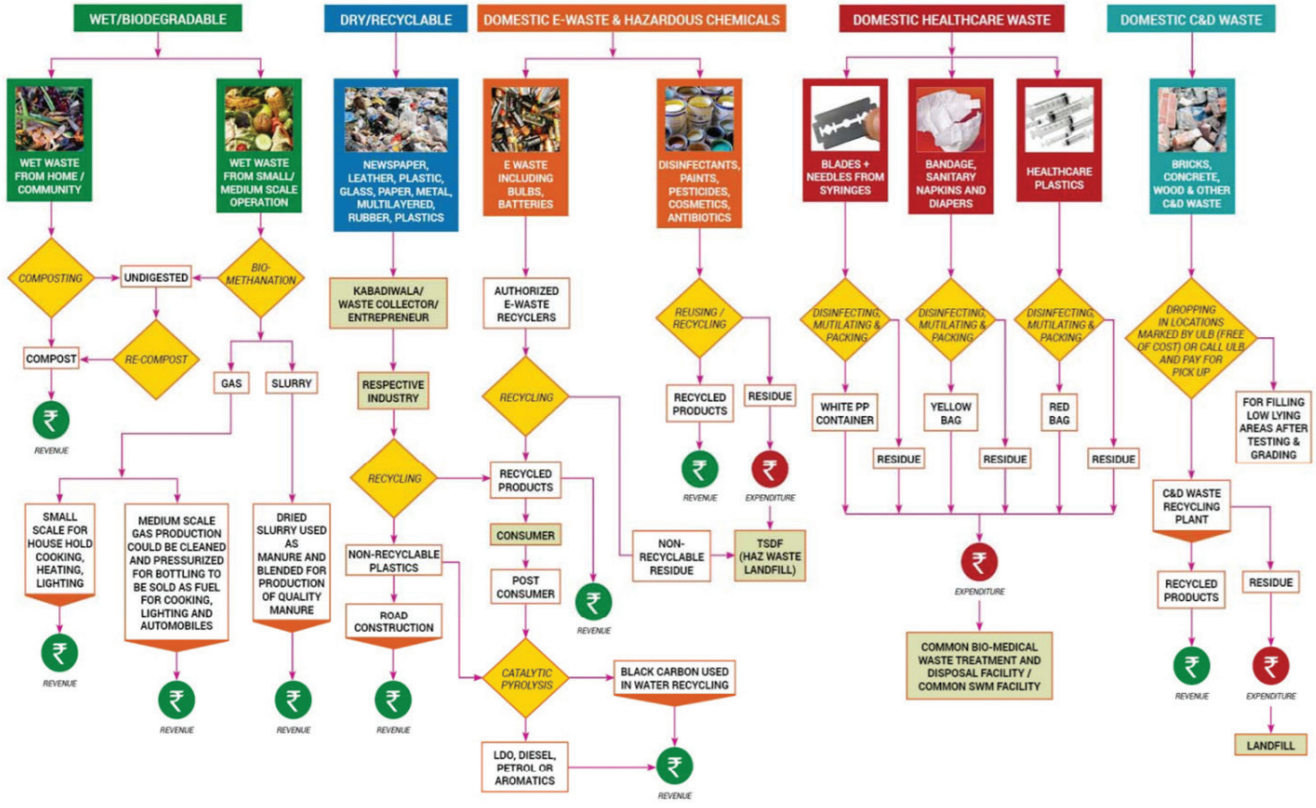
Figure 35: Process of waste collection, transportation and disposal



Source: *Municipal Solid Waste Management Manual*, 2016.

In India, waste is not segregated, but recyclables are removed by waste-pickers prior to collection, during the collection process, and at disposal sites. When recyclables are picked during the (secondary) collection stage or at disposal sites, it exposes the pickers to high risk of injury, disease and hazardous environment. Disposed waste contains needles, broken glass and other sharp objects. The job of disposing waste is executed by the informal sector without any safety equipment. Segregation at later stages also affects the amount and quality of recycling. Recyclables

Figure 36: Waste-to-revenue approach



Source : http://www.cseindia.org/userfiles/ShyamalaMani.pdf

recovered from mixed waste may be contaminated and therefore reduce marketing possibilities.

Q. 4) Are you registered with an authorized recycler/vendor for plastic waste and other recyclables? If you are, support with time-based trends, certificates, and manifestos, etc.

Yes ☐
No ☐

_____

_____

Waste composition: The composition of waste varies by location in a building or campus. It is different for administrative blocks, classrooms, hostels, canteen/mess, laboratories, workshops, halls/auditoriums, sports complex, etc. This variation is primarily due to the specific characteristics of the materials used, which are specific to different locations. For instance, messes/canteens produce more organic waste, classrooms produce higher quantities of paper waste, and laboratories and workshops tend to produce more plastic and e-waste.

On a national level, the composition of MSW at generation sources and collection points consists of a large amount of organic matter (40–60 per cent), ash and fine earth (30–40 per cent), paper (3–6 per cent) along with plastic, glass and metals (each less than 1 per cent).

The Indian government suggests that landfill sites should only be used as a last resort in the waste management process. Landfill dumping should not exceed 20 per cent of the total MSW generated. All biodegradables and recyclables are to be recovered fully prior to land filling. Only inert materials such as ash (from incineration), silt and soil recovered from street sweeping should end into the landfill.

Being informed on the composition of waste is crucial in determining processing and treatment technologies. It enables the organization or campus to:

1. Formulate a waste reduction strategy
2. Be informed of the recycling potential
3. Create awareness about waste on campus
4. Finally reduce the campus contribution to MSW and landfill

Characteristics of waste are determined by:[8]

Density: The density of waste (mass per unit volume, kg/m3) determines the storage and transportation volume requirements. Density of MSW in India is typically 450–500 kg/m^3. Only low density wastes, such as packaging material, plastic waste, etc., can be hauled efficiently with compactors, where a compaction ratio as high 2.5:1 is achievable. High density waste such as street sweeping or inert waste are not cost-effective when hauled with compactors.

Moisture content: It is expressed as ([Wet weight – dry weight]/Wet weight)*100. Moisture content is generally high in waste comprising a higher proportion of food waste. It is typically 20–45 per cent depending on arid climate and wet season.

Calorific value: It is the amount of heat generated from combustion of a unit weight of the waste, expressed as kilojoule per kilogram (kJ/kg). Calorific value determines the potential for recovering refuse derived fuel (RDF) from waste and its utilization (through incineration) in cement, power, and waste to energy plants. The value is determined by using a bomb calorimeter, in which the heat generated from the combustion of a dry sample is measured at a constant temperature of 25°C. Since the test temperature is below the boiling point of water, the combustion water remains in the liquid state. However, during combustion, the temperature of the combustion gases remains above 100°C so that the water resulting from combustion is in the vapour state.

These characteristics can be identified in an organization or campus through a waste audit. Waste audit systematically determines the amount and type of waste generated.

Q. 5) Have you conducted a waste audit? If you have, provide details.

Yes ☐
No ☐

_____

_____

SL . NO	LOCATION/BLOCK	VOLUME	DENSITY	COMPOSITION (%)			
				BIODEGRADABLE	RECYCLABLE	INERT	OTHER (SPECIFY)
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							
9.							
10.							

Q. 6) Do you have collection points for municipal trucks to pick up rejects? If you do, mention the size of the container.

Yes ☐
No ☐

_____

_____

The number and capacity of containers to store waste before collection depend on the volume of waste (as resulted by the waste audit) and frequency of collection. An additional 100 per cent storage is kept to avoid spilling in case of delay in collection.

Q. 7) How do you reduce waste:

☐ By promoting reusable trays, plates, bowls, bottles, and serving-ware during RWA events

☐ By minimizing use of products with excess packaging in common spaces

☐ By engaging occupants to properly sort waste

☐ By engaging occupants to reduce packaging waste and single-serve containers

☐ Other practice/s (specify): _____

A zero-waste ideology encourages a lifestyle that makes sure all products are reused and no waste ends into landfills or incinerators.

Q. 8) Do you practise 'creative reuse' or 'on-site treatment'? Support by examples detailing volumes of waste reused and methodologies (such as vermin-composting, burial, mechanical composting, etc.)

- ☐ Recycling _____
- ☐ Composting _____
- ☐ Other (specify):

Q. 9) Are all stakeholders engaged in campus zero-waste efforts and practice proper recycling and composting? Define broad roles.

- ☐ All
- ☐ A few
- ☐ None

Q. 10) Do you have a disposal provision/facility/policy for:

- ☐ Cleaning products
- ☐ Grease
- ☐ Strippers
- ☐ Batteries
- ☐ Biomedical waste
- ☐ Fluorescent lighting
- ☐ E-waste
- ☐ Other potentially hazardous products (specify): _____

Fats, oils and grease: (FOG) may not be harmful in liquid form but can pose a great problem as they harden and congeal in the waste. FOGs are produced at food service establishments. Proper plumbing system provides grease traps in such establishment to prevent FOGs from entering into the sewage system. Absence of grease traps affects the entire sewage system adversely and presents a high cost to environment and the municipal body. But once FOGs are collected in grease traps they need proper treatment and should end into landfills. Improper disposal forms toxic products, coats plants and animals and suffocates them by oxygen depletion, catches fire in presence of ignition and reduce degradability of otherwise degradable materials.

The E-waste (Management) Rules, 2016, define e-waste as 'electrical and electronic equipment, whole or in part discarded as waste by the consumer or bulk consumer as well as rejects from manufacturing, refurbishment and repair processes'. This equipment could be computer, computer peripherals and accessories, kitchen appliances, household electronics, laboratory equipment, phones, cables, circuit boards, etc. E-waste can contain heavy metals such as lead, copper, cadmium, arsenic, mercury, nickel and flame retardants. Such toxic substances pose a

threat of leaching into the soil and water at landfills and contaminating the environment. E-waste also prematurely fills the landfill sites due to its large volume. The only way to dispose of e-waste as per the rules is to recycle or process at authorized dismantlers, recyclers, manufacturers and refurbishers. Processing at an authorized facility ensures extraction of the mineral trapped inside the e-waste in a safe and controlled environment.

India has emerged as world's second largest market for mobile phones. It has become the fifth largest producer of e-waste with about 18,50,000 tonnes produced annually.[9] Generation of e-waste is directly related to affluence, hence growing cities are largest producers of e-waste. Sixty per cent of the annual e-waste is generated by 65 cities in India. Mumbai tops this list, followed by Delhi and Bengaluru. State-wise, Maharashtra, Tamil Nadu, Telangana, Uttar Pradesh, West Bengal, Delhi, Karnataka, Gujarat, Madhya Pradesh and Punjab are large producers of e-waste.

Currently, 95 per cent of e-waste produced in the country is handled by the entrepreneurial informal sector, which may not be equipped to handle the bulk of e-waste generated in the country. Taking note of the issue, the E-waste (Management) Rules, 2016, set up an e-waste collection target of 30 per cent for electronics manufacturers under extended producers' responsibility.

Q. 11) Do you have an e-waste recycling bin on every:

- ☐ Residential floor
- ☐ Residential building block
- ☐ Centrally located in the campus
- ☐ Non centrally located in campus
- ☐ None or other (please specify)_____

Q. 12) Have you tied-up with an e-waste recycler?

Yes ☐
No ☐

Q. 13) How do you handle compostable waste?

Kitchen/food waste	
Horticulture waste	
Other	

Campuses produce a large quantity of food waste due to the presence of at least one mess/canteen. The volume of food waste is even larger if there is an accommodation facility within the campus. This food waste can make up a substantial share of total campus waste considering the largest proportion of MSW in India is made of organic materials. A higher presence of organic matter

in waste means higher methane emissions as it decomposes not only at landfills but also at local waste collection points, storage facilities and transfer stations. Methane from landfills represents 12 per cent of total global methane emissions. This scenario presents a need to utilization of reduction and reuse methods at source like composting.

Composting: This is a biological waste treatment process that involves decomposing of solid wastes by the action of micro-organisms such as bacteria, yeast and fungi. The process yields fertilizer, known as compost, for plants. It prevents transfer of organic waste to landfills and hence the uncontrolled release of methane. It also reduces dependency on chemical fertilizers for agricultural purposes. There are various types of composting methods that need different balance in chemical properties of waste in order to be processed.

Chemical properties:
Moisture: Microbes need moisture for survival and growth. As the particles decompose, the moisture tends to occupy the free air space between them. Thus, when the moisture content is very high, it prepares anaerobic conditions.

Aeration: The process of composting requires adequate supply of oxygen for natural degradation by micro-organisms. Under aerobic conditions, decomposition rate is 10–20 times faster than anaerobic conditions. Turning or mixing the waste piles at regular intervals ensures ample oxygen supply and aeration.

Carbon to nitrogen (C/N) ratio: The ratio between carbon and nitrogen elements of the waste has to be maintained around 30:1 to allow good decomposition. Carbon comes from brown matter (like wood chips, saw, dust, paper, etc.) and nitrogen from green matter (like food scraps, leaves, etc.). C/N ratio below 25:1 results in production of foul smell and a higher C/N ratio will result in production of ammonia, thus hampering the decomposition process.

Temperature: in aerobic composting, temperatures can rise up to 70°C. Increased temperature results in increase biological activity, provided the materials are stabilized. High temperature helps in destruction of some common pathogens and parasites.

Particle size: Microbes need enough surface area for microbial activity and enough void space to allow air circulation for microbial respiration. Therefore, optimum particle size needs to be ensured for the process.

Vermi-composting: This type of composting involves casting of earthworms into the compost pit. A particular species of earthworm breaks down the organic matter and helps in culturing vermi-compost. Vermi-compost is a nutrient-rich natural fertilizer and soil conditioner that is richer in plant nutrients compared with normal compost prepared from similar material. The earthworm species often used include *Eudrilluseugineae, Eiseniafoetida* or *Lumbricusrubellus*. The species are not suited for waste that is hard and has excessive acidity and alkalinity. These chemical characteristics come from high oil, spice and salt content in food. Moisture content preferred ranges from 40–55 per cent. Vermi-composting can be done in a tank with dimensions 4mx 1m x 0.5 m for waste input of 10kg/day of semi decomposed waste (see *Table 5: Potential problems of vermi-composting, causes and solutions*).

Table 5: Potential problems of vermi-composting, causes and solutions

ISSUES	CAUSES	SOLUTIONS
Foul odour	Overfeeding	Remove the excess food, remove meal or remove daily products if any
	Not enough air circulation or anaerobic conditions	Fluff up or loosen bedding
	Bed too wet	Add bedding to absorb moisture
Flies	Waste exposed	Bury the waste completely
Ant infestation		Immerse the base or feet of the vermin bed in water
		A barrier of chalk or petroleum jelly may repel the ants.
		If bedding seems dry, add water.
Mite infestation		Avoid adding foods with high moisture
Dead worms or escaping worms	Bed too wet	Do not water till it reaches appropriate moisture
	Bed too dry	Sprinkle water till it turns moist
	Excess temperature, not enough air, not enough food.	Sprinkle water till it turns moist, temperature drops, add waste appropriately
	Bed packed tightly	Turn bed and make it fluffy

Figure 37: Windrow composting

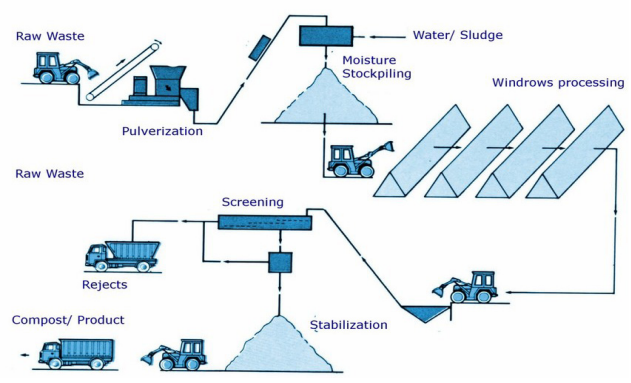
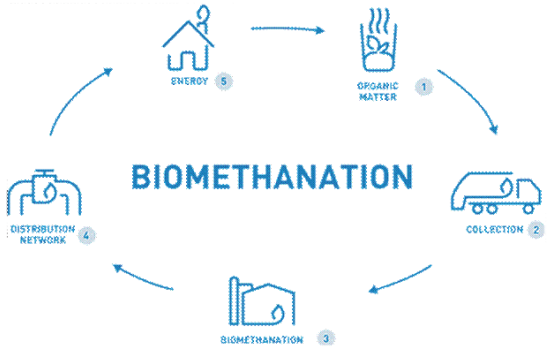


Figure 38: Typical bio-methanation cycle



Windrow composting: The process involves aerobic biodegradation of organic material. It requires placing of pre-sorted feedstock in long narrow piles called windrows (3–6 m high). The placement gap is normally 1–3 m. These windrows are turned on a regular basis to boost porosity and passive aeration.

Bio-methanation: It is a process involving anaerobic digestion of organic matter in presence of micro-organisms. It produces methane and carbon dioxide rich biogas, also known as bio-waste-derived fuel, suitable for energy production and hence, is a renewable energy source. The nutrient-rich solids left after digestion can be used as a fertilizer. The organic matter should not be fibrous as the anaerobic microorganisms do not easily break down woody molecules such as lignin, cellulose, hemicelluloses, etc. Preferred C/N ratio for the process is 25–30:1 and the moisture content should be greater 50 per

cent, which provides better feed, gas production, system type, system efficiency. Area requirement for bio-methanation is approximately 25 m^2.

Q. 14) Has the campus banned use of plastic for RWA events?

Yes ☐
No ☐

_____

_____

Plastic is a hefty cause of environmental breakdown. It does not degrade and produces harmful dioxins that release in the air and contaminate the soil. The pigments and colours used in plastic contain harmful toxic metals like chromium and copper. Plastic then directly impacts plants and animal life in both the land and the sea. While the statistics are incomplete, some conservationists estimate that at least 100,000 mammals and birds die from them each year even as more plastic is produced and consumed around the world.

Plastic bags have become a major part of our daily life. Bags of less than 25 microns are a greater hazard. They cannot be recycled but they have a shorter life span and hence are disposed of quickly. The plastic waste management rules, 2016 have mandated the minimum thickness for plastic carry bags and sheets to be 50 microns.

In India, 15,000 tonnes of plastic waste is generated every day, of which only 9,000 tonnes is collected and processed.[10] The plastic waste management rules, 2016 promotes the use of plastic waste for road construction as per the Indian Road Congress guidelines. Other uses include energy recovery, waste to oil, etc.

10. Air

According to Global Burden of Disease estimates, outdoor air pollution has emerged as the fifth largest killer in India. According to air quality data of the Central Pollution Control Board (CPCB), close to half of the Indian cities have air pollution levels that are classified as critical. While the level of tiny particles of size ranging less than 10 micron (PM10) and 2.5 micron (PM2.5) are the biggest concerns. These particles are very toxic and go deep inside our lungs and get mixed with blood stream. There are several other toxic gases in the air that add to the toxic cocktail (see *Table 6: Air pollutants and their health impacts*).[1]

Though there are national standards for pollutants, most cities are violating the standards. A large number of combustion sources and dust sources contribute to air pollution and require sustained action to be able to meet the ambient air quality target.

Table 6: Air pollutants and their health impacts

AIR POLLUTANTS	SAFE LIMIT	HEALTH IMPACTS
$PM_{2.5}$	60 µg/m^3 (24 hours)	Cause cardiovascular diseases, stroke, respiratory problems including COPD, cancer and a range of other metabolic diseases including hypertension, diabetes, effect on foetus, adverse effect on brain function etc.
PM_{10}	100 µg/m^3 (24 hours)	Prolonged exposure may lead to adverse responses in the lungs triggering an array of cardio-pulmonary problems
SO_2	80 µg/m^3 (24 hours)	Emitted from fuel combustion/coal burning. Affects human suffering from asthma and chronic lung diseases and exacerbates respiratory symptoms
NO_x	80 µg/m^3 (24 hours)	Emitted from both petrol and diesel engine motor vehicles. Precursor of ozone formed in the troposphere. The toxic oxides are immune-toxic and increase susceptibility to respiratory tract infections such as influenza. Frequent exposure causes irritation of the lungs and consequent acute respiratory illnesses.
CO	02 mg/m^3 (8 hours)	Toxic gas emitted from combustion processes as well as from emissions of petrol-fuelled vehicles. CO binds with hemoglobin and impairs transport of oxygen within the blood affecting cardiovascular and nervous systems.
PAHs		Emitted from combustion of petrol and diesel, more from diesel combustion. Inhalation of this semi- volatile particle can even carcinogenic.
VOCs	Benzene 10 ng/m^3 (annual)	VOCs, released from petrol and diesel,as for e.g. benzene, are carcinogenic. Benzene is harmful for human health for its hematotoxic, neurotoxic, leukemogenic and carcinogenic effects.

Also from the public health's point of view, exposure to toxic emissions from local sources in micro environments such as a campus or a neighbourhood can be very serious. It is important to eliminate or reduce exposure from local sources like waste burning, vehicles, construction activities, chulha pollution etc. in micro environments that emit directly within our breathing zone.

The Government of India has already notified the prescribed standards for pollutants under the Air Act that should be met for 98 per cent of the days. Based on this, targets should be set to meet clean air standards throughout the year. In addition, to reduce daily exposure from air pollution that can get aggravated by the weather conditions as in winter, the government has notified an

Air Quality Index to show how dangerous or good the daily air quality is. This helps people take precautions as well as the government to take a graded response action.

Air Quality Index (AQI) is a tool used for communicating air quality status in simple terms. It converts complex air quality data of various pollutants in a single number. The AQI categories are good, satisfactory, moderately polluted, poor, very poor and severe, based on concentration of pollutants in atmosphere and their health impacts (see *Table 7: Air Quality Index and likely health impacts*).

Table 7: Air quality index and likely health impacts

AQI CATEGORY	AQI	LIKELY HEALTH IMPACTS
Good	0–50	Minimal impact
Satisfactory	51–100	May cause minor breathing discomfort to sensitive people
Moderately polluted	101–200	May cause breathing discomfort to people with lung disease such as asthma and discomfort to people with heart disease, children and older adults
Poor	201–00	May cause breathing discomfort to people on prolonged exposure and discomfort to people with heart disease
Very poor	301–400	May cause respiratory illness to the people on prolonged exposure. Effect any be more pronounced in people with lung and heart disease
Severe	401–500	May cause respiratory effects even on healthy people and serious health impacts on people with lung and/or heart diseases. The health impacts may be experienced even during light physical activity.

Take an integrated approach to address outdoor and indoor pollution to reduce overall exposure: From public health standpoint it is not right to address indoor and outdoor air pollution in isolation. According to the Global Burden Disease study for India, indoor air pollution contributes about 25 per cent of outdoor air pollution

Climate co-benefits: Action on air pollution is also expected to provide climate benefits by reducing heat-trapping gases such as carbon dioxide. Improvement in emissions control technologies need to be conjoined with energy efficiency measures that are expected to reduce energy guzzling and greenhouse gases and heat-trapping black carbon in particulate matter.

Indoor air quality in buildings: Indoor air quality is the quality of air in and around a building, which affects health, stress, frustration and overall comfort of building occupants. Persistent exposure to the polluted air as well as asbestos and radon may not cause immediate symptoms but can lead to lung diseases and cancer after many years. The health and comfort of inhabitants are major factors that contribute to their learning, productivity, performance and achievement. Therefore, it is essential to maintain indoor air quality to maintain health and the wellbeing of citizens.

Develop action plan for each source of air pollution: Broadly, the key sources of air pollution in a campus are expected to be vehicles, waste burning, construction activities and eateries. These are sources of highly toxic emissions.

Guiding principles

Clean air for all

- Meet the national ambient air quality standards for all pollutants in a time-bound manner to protect public health.
- Map the exposure levels and local pollution sources across the city for stronger local action to reduce public health risk.
- Take an integrated approach towards controlling outdoor air pollution sources as well as indoor pollution sources such as biomass chulhas as these also contribute hugely to outdoor pollution.

Q. 1) Benchmark air quality and action on air quality

1. Trend in air quality based on the air pollution data from the nearest air pollution monitoring stations or the known trend in your city:

   _____

2. Inventory of air pollution sources in the campus (if you have carried out one):

   _____

3. Nature, type and number of air polluting sources inside the campus, for example, waste burning, vehicles (petrol, diesel, CNG/LPG), construction activities

   _____

4. Nature, type and number of air polluting sources outside the campus within a radius of 500 m:

   _____

5. Estimation of trend in pollution from different sources or any known study in your local area on air pollution:

   _____

Guiding principles: Sustainable mobility

Sustainable and affordable mobility for all

- Ensure that at least 90 per cent of daily motorized travel trips are carried by affordable, reliable and modernized public transport systems, efficient para-transit and extensive non-motorized transport.
- Eliminate traffic fatalities and road injuries.
- Make commuting safe and accessible for women.
- Promote universal road design for the differently abled.
- Promote compact city design to reduce distances and vehicle-km travelled and increase public transport and walking.
- Preserve and build open public spaces and enable equitable access.

Q. 2) Do you provide green transportation infrastructure such as:

- ☐ Safe, connected, and accessible walkways and pathways
- ☐ Bike paths and/or lanes
- ☐ Bike racks
- ☐ Electric vehicle charging points
- ☐ Green vehicle priority parking? (fuel-efficient, alternative fuel, carpool)

Sustainable/green transportation refers to a broad subject of transport, which involves a movement system that does not emit toxic emissions, therefore not contributing to any negative impact on human health and environment. It also incorporates the criteria of health and focuses on effective use of resources, modifying our transport structure. The culture emphasizes on walking, cycling, and using non-motorized transport systems and electric vehicles along with public transport system. The system discourages any use of private vehicles and encourages production of vehicles which utilizes renewable sources of energy such as solar, bio-fuel, (micro) hydroelectricity, etc.

Q. 3) Do you provide priority to green vehicles for parking (electric vehicles, Carpool vehicles, alternate fuels):

- ☐ No
- ☐ Yes. Specify how (e.g. designated covered spaces etc.)_____

_____

Q. 4) Do you have any data about the number of diesel or petrol two-wheelers/three-wheelers that are parked inside your campus?

S. NO.	TYPOLOGY	PETROL	DIESEL	CNG	OTHER
	Four-wheelers				
	Two-wheelers				
	Other, specify:				
	Other, specify:				
	Other, specify:				

Indicators for indoor air quality

There are four major elements involved in development if indoor air contamination:

Sources of air pollution in the surroundings of building: This includes air contamination due to pollen, dust, fungal spores, exhaust from vehicles moving near adjacent roads, any exhaust from

neighbouring buildings, unsanitary debris, use of pesticides, excess microbial growth on rooftops after rainfall crawlspace etc.

Active equipment used within building: This includes both HVAC and non-HVAC equipments. From HVAC system, dust/dirt in ductwork, humidifiers, improper use of biocides, emissions from sealants or cleaning compounds, improper venting of combustion products, refrigerant leakage, etc. disturbs air quality. Similarly from non-HVAC equipments, VOC/ozone emissions contaminate indoor air. Moreover, emissions from office equipments, shops, emissions from solvents, toners, ammonia used in labs, cleaning processes of elevator motors and other mechanical systems add to the above.

Human activities: Various human activities can also contribute to indoor air pollution. These account for:

- Personal activities, which include smoking, cooking, body odour, cosmetic odours etc.
- Housekeeping activities, which include cleaning materials and procedures, emissions from stored supplies or trash use of deodorizers and fragrances, airborne dust or dirt etc.
- Maintenance activities, which include microorganisms in mist from improperly maintained cooling towers, airborne dust or dirt volatile organic compounds from use of paint, caulk, adhesives, pesticides from pest control activities, emissions from stored supplies etc.

Building components and furnishings: Building furnishing elements, including paints, varnishes, aerosol sprays and wood preservatives etc., cause VOC/inorganic compound emissions, which contribute to contaminating indoor air. Similarly, carpets, curtain and other fabrics with textures surfaces, damages asbestos in aged furniture emits dust particles. Unsanitary conditions in water-clogged areas lead to microbial growth, poorly designed drain and sewer systems etc. also contribute in local air pollution in surroundings of a building.

Q. 5) Do you use toxic-free, organic cleaning products? Supplement with policy or any other supporting data.

Yes ☐
No ☐

_____

_____

Q. 6) Do you use no to low-VOC paints while repainting the common spaces? Supplement with policy or any other supporting data.

Yes ☐
No ☐

_____

_____

Volatile organic compounds are carbon-containing compound emitted as gas from certain solids and liquids. In household applications, during painting, certain VOCs get released into the air as the paint dries. (Other products emit solvents, including adhesives, cleaning supplies, and even some home furnishings.) These readily vapourizable compounds when they are released to air react with other elements to produce ozone, which causes air pollution and a host of health issues.

Q. 7) Do you practice integrated pest management using natural, non-polluting treatment methods?

Yes ☐

No ☐

Integrated pest management, also known as integrated pest control (IPC), is an effective and environmentally sensitive approach that integrates practices for economic control of pests with least possible impact for people, land and environment. The approach aims to suppress pest populations below the economic threshold. The UN's Food and Agriculture Organization defines IPM as 'the careful consideration of all available pest control techniques and subsequent integration of appropriate measures that discourage the development of pest populations and keep pesticides and other interventions to levels that are economically justified and reduce or minimize risks to human health and the environment'.

Q. 8) Do you practice a regular housekeeping routine in common areas to minimize dust and allergens? Elaborate methods.

Yes ☐

No ☐

_____

_____

Q. 9) What is the exhaust stack height of your DG sets in reference to the tallest building?

The minimum height of stack to be provided with each generator set can be worked out using the following formula:

H = h+0.2x /KVA

H = Total height of stack in metres

h = Height of the building in metres where the generator set is installed

KVA = Total generator capacity of the set in KVA

Based on the above formula, the minimum stack height to be provided with different range of generator sets may be categorized as follows:

For generator sets	Total height of stack in metre
50 KVA	Ht. of the building + 1.5 metre
50–100 KVA	Ht. of the building + 2.0 metre
100–150 KVA	Ht. of the building + 2.5 metre
150–200 KVA	Ht. of the building + 3.0 metre
200–250 KVA	Ht. of the building + 3.5 metre
250–300 KVA	Ht. of the building + 3.5 metre

Source: http://cpcb.nic.in/openpdffile.hp?id=UmVwb3J0RmlsZXMvMzBfMTQ1ODExMTE4MV9OZXdJdGVtXzE5NF9QQ0xTXzRfRW52aXJvbm1lbnRhbF9TdGFuZGFyZHMucGRm

Q. 10) For AC common spaces, what is the quantity and frequency of getting your refrigerant filled?

11. Livability

Livability includes multiple aspects, recreational opportunities, self-sufficiency as well as a sense of community. A more self-sufficient residential campus will reduce the need for people to commute to other places; therefore a mixture of different commercial activities becomes important. A campus which has better recreational facilities and has cultural events taking place together will foster better communication amongst people leading to a better sense of community.

Any new initiative aiming to reduce environmental footprint will need people's coordination and support.

Q. 1) How many halls are there for public functions?

S. NO.	NAME OF THE HALL	CAPACITY IN NUMBERS	BUILT-UP AREA (SQ. M)
1.			
2.			
3.			
4.			
Total			

Q. 2) Enlist public and private functions in a year

S. NO	NAME OF THE FUNCTION	NUMBER OF ATTENDEES
1.		
2.		
3.		
4.		
5.		
8.		
9.		
10.		

Q. 3) Referring to the following images and information, provide area (in sq. m) under:

CATEGORY	COURT/FIELD AREA (SQ. M)	INDOOR/OUTDOOR	TYPE OF SURFACE
Sports utility:			
Lawn tennis			
Badminton			
Basket ball			
Skating			
Cricket/football			
Assembly area			
Swimming pool			
Terrace			
Others			

A terrace surface may comprise a landscaped/green finish, reflective/heat-resistant tiles, plain cement finish or a polyurethane coating (mainly for waterproofing).

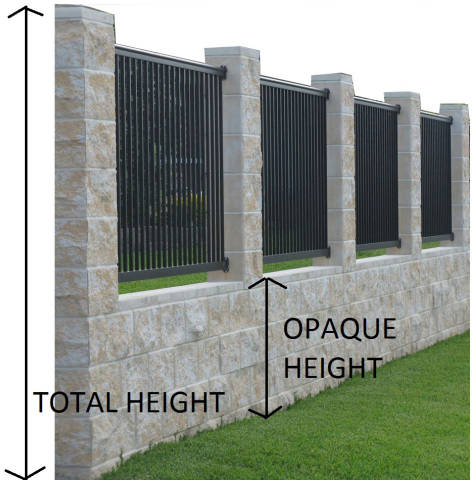
Landscaped/green finish; reflective/heat-resistant tiles; polyurethane coating

Surfaces under sports utility found in the Indian context can be classified into outdoor and indoor categories. Outdoor court surfaces generally range from grass, plain concrete and acrylic paint. Newly constructed courts, while following international standards, may use materials such as poly-propylene tiles and styrene-butadiene rubber carpets. Indoor court surfaces are made of cement, acrylic paints, vinyl sheets, wooden board/veneer.

Plain concrete; polypropylene tiles; acrylic layering

Q. 4) What is the total height of the boundary wall around your compound if any? (Refer to Figure 38: Boundary wall height.) Mention the height of the opaque part separately.

Figure 38: Boundary wall height



Q. 5) Percentage of FAR dedicated to commercial activity, facilities.

_____

Q. 6) Type of commercial (e.g. hair salon, stationery, eatery etc.)

NAME	DESCRIPTION	NAME	DESCRIPTION
1.		5.	
2.		6.	
3.		7.	
4.		8.	

Q. 7) Name all the sport facilities provided in the housing campus.

SPORT/GYM	INDOOR/OUTDOOR	SPORT/GYM	INDOOR/OUTDOOR
1.		5.	
2.		6.	
3.		7.	
4.		8.	

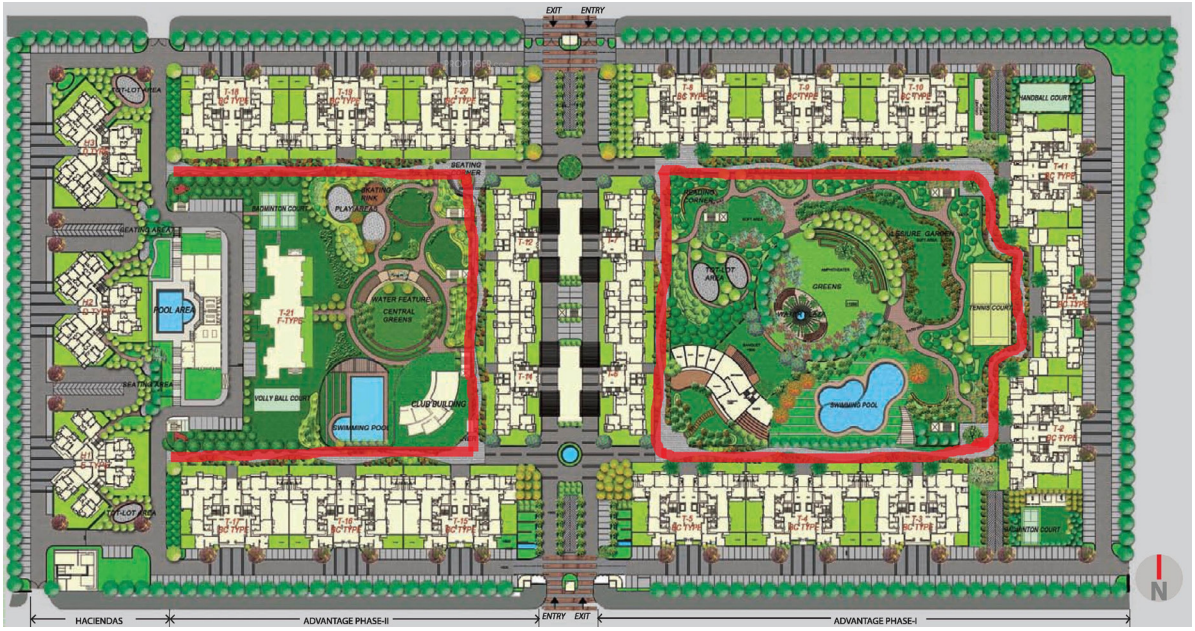
Q. 8) List all celebrations that were organized in your housing complex last year (eg. Diwali mela, Republic Day etc.)

CELEBRATION/FUNCTION	BRIEF DESCRIPTION

Q. 9) In order to use public transport, what distance does a person has to cover in order to get to the nearest starting point? Describe.

TRANSPORT	DISTANCE AND EASE DESCRIPTION
1. Bus	
2. Metro	
3. Gramin sewa/shared auto	
4. Other	

Q. 10) Mark roads designated to the pedestrians only



Marking thick lines over the roads on the site plan where only pedestrians are allowed can substantiate the data.

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Urban areas come with a plethora of challenges. Reports suggest that around 40 per cent of India's population will reside in urban areas by 2031. A large population size means a severe impact on resources such as energy, water, air and land.

CSE has designed a Green Campus Initiative, targeted at residential campuses, to provide urban residents with an opportunity to monitor, benchmark and take action towards efficient use of resources. This toolkit draws a map to show ways to save resources by simply managing and retrofitting the infrastructure to improve performance levels.

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