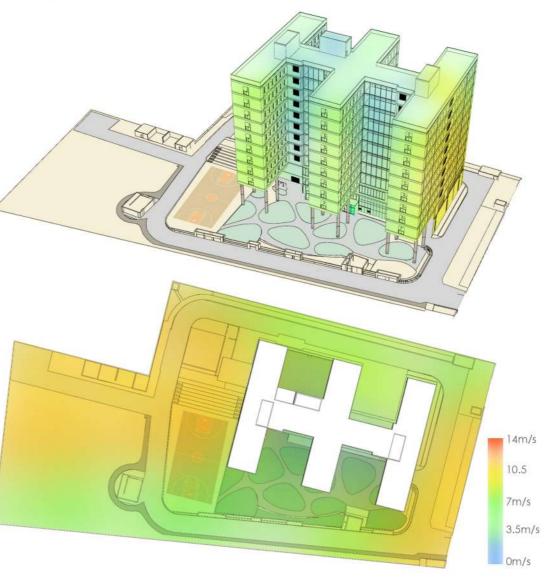


Due to the lack of high-rise structures around, the roof receives direct heat gain, whereas the recesses of the facade line receive minimal heat gain due to shadows caused by the protrusions. This heat gain can be used to our advantage by employing potential strategies.

### Wind speed analysis



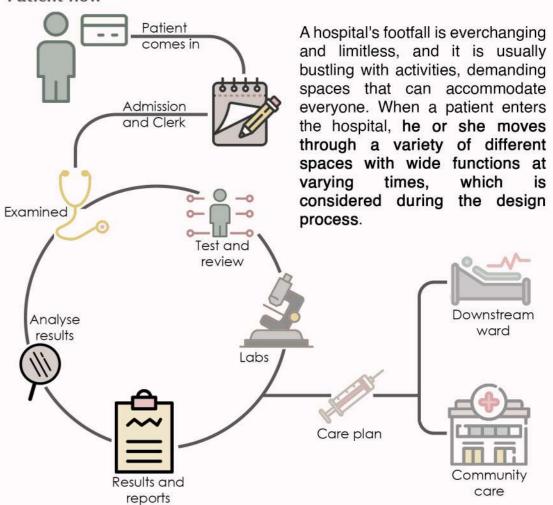
The shorter west side of the structure receives the most dominant wind annually. This wind can be harnessed using micro wind turbines to generate energy and help cut down energy consumption.

Devising the design spaces

Hospital circulation and designation of spaces largely depends upon the services it provides. Based on the demographic and context analysis, following departments are included:

**Out Patient Department** In Patient Department **Emergency Department** Administrative Block Operation Theatre ICU Radiology Department Wards Pharmacy

### **Patient flow**



Design process plays a major role while planning any healthcare space. Hospitals have their own set of rules which form the basis of their working. The steps followed while planning this hospital building were



1. Assessing the needs of the stakeholders



2. Listing out the required spaces



3. Selecting green building strategies



4. Intervention design



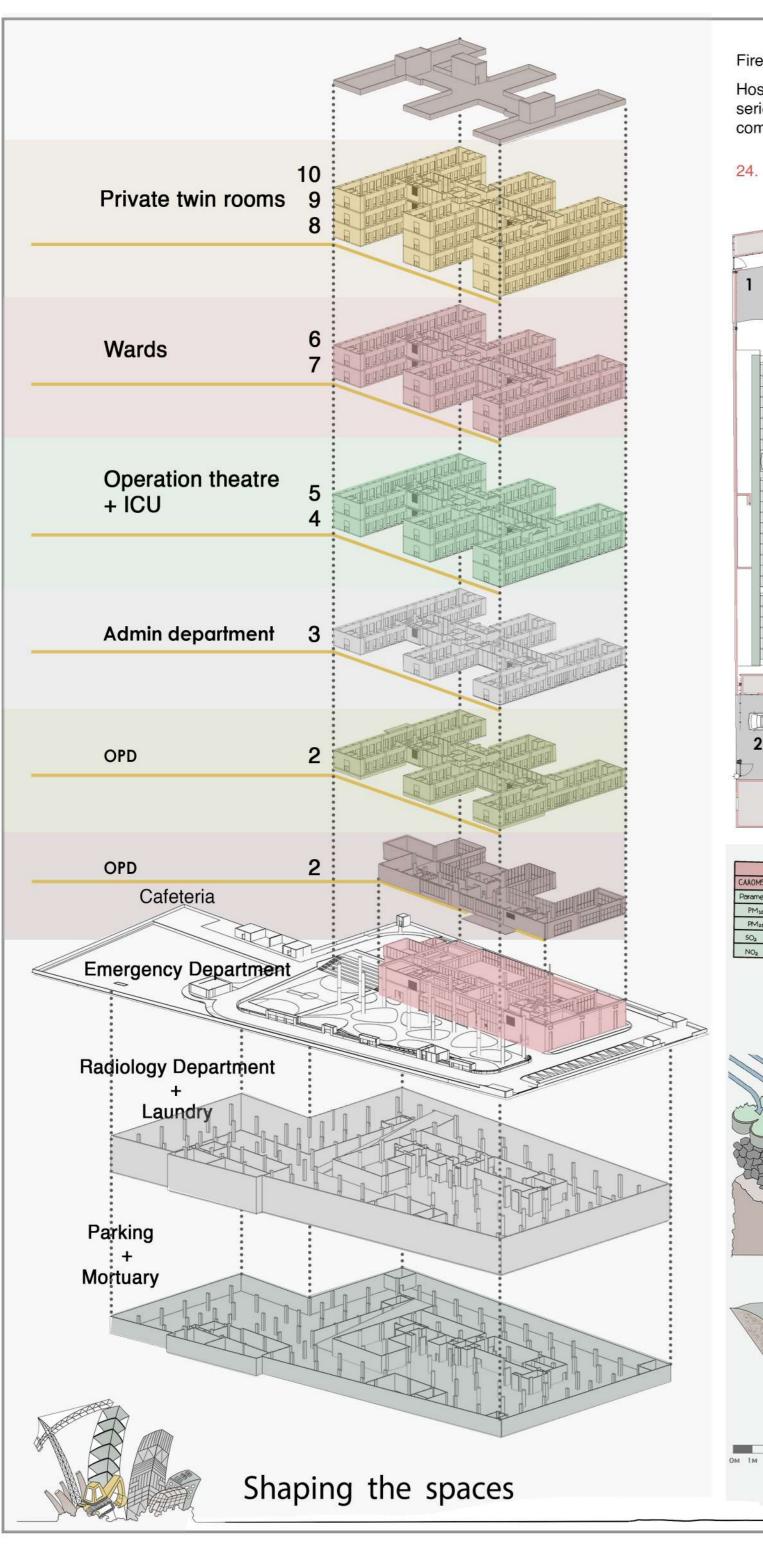
5. Detailing out the plan

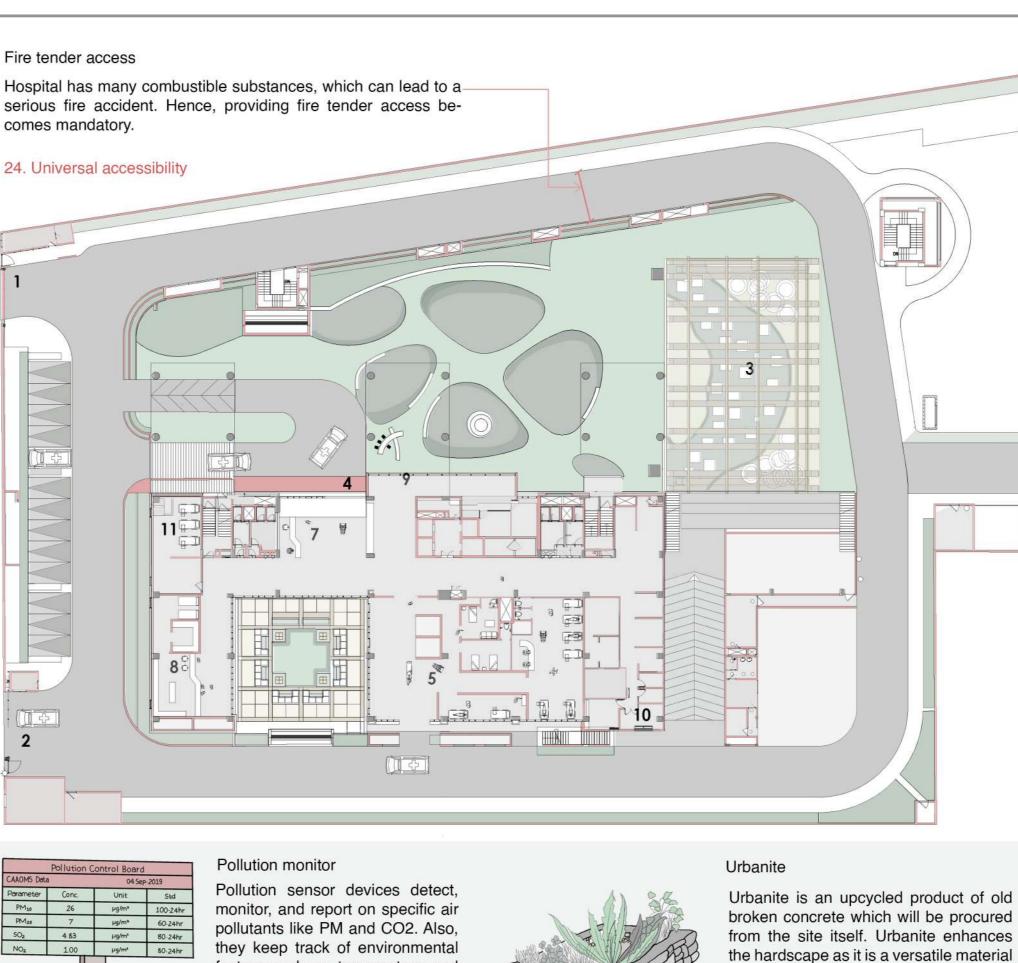
Hospital designing is a complex process and requires proper planning of spaces. While designing this building, stepwise procedures have been followed keeping the stakeholder experience in mind. As an existing structure had to be retrofitted, spaces were designated thoughtfully without making much alterations.

> Registration code:









they keep track of environmental factors such as temperature and



Permeable pavers

1. Green Infrastructure

1. Green Infrastructure

2. Design to mitigate UHIE

15. Rainwater Management

Rain garden

28. Smart metering and monitoring

Permeable pavers take up to 5% of the site, increasing its overall per-

2. Low Impact Design Strategies

Raingardens use rainwater to recharge the ground water table while also growing native plants.



### 19. Utilisation of alternative materials in building

21. Alternative materials for external site development

and will be used for multiple functions such as patios, pathways and seating

30. Innovation



### Pod filters

Grey water is treated by pod filters and can be used for irrigation and flushing.

- 13. Water demand reduction
- 14. Wastewater treatment
- 15. Rainwater management
- 16. Water Quality and self sufficiency

### Xeriscaping

Xeriscaping is a low-water landscape that is dry but effective.

13. Water demand reduction



1 Entrance 1

6. Courtyard 7. Reception area

8. Pharmacy 9. Waiting area

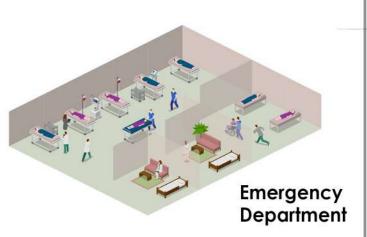
10.Staff entry 11.Rest room

2. Emergency entrance

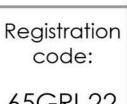
3. Sensory garden 4. Entrance to building 5. Emergency Department

Pharmacy

NASA



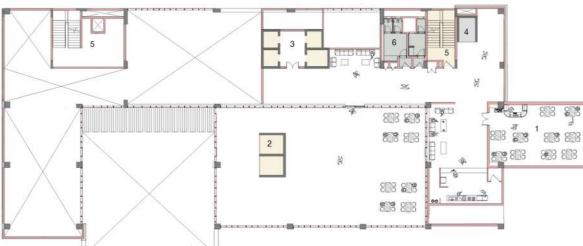
code:







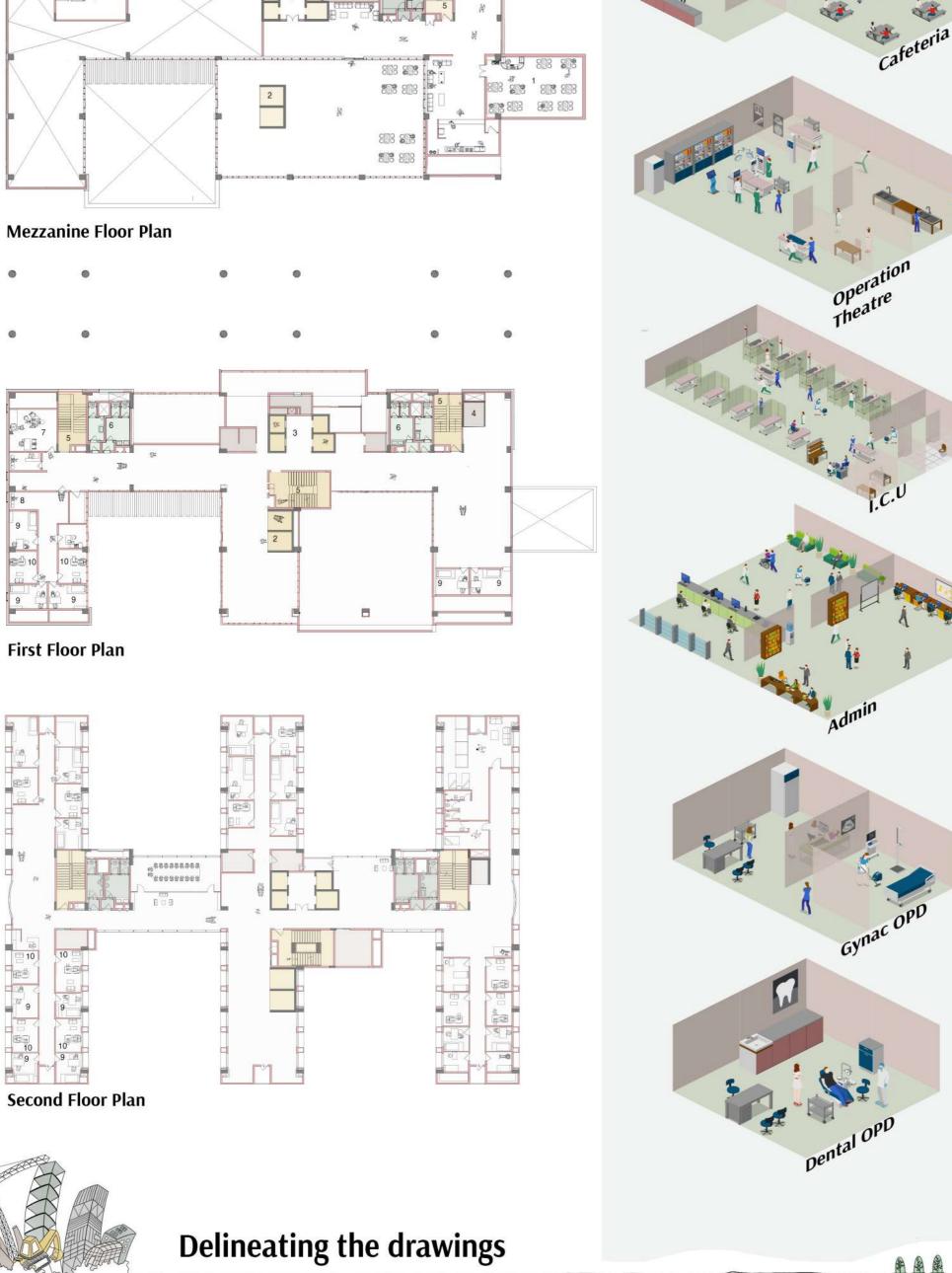
All of the spaces are designed with the sensitive nature of the hospital in mind, but limited walls are touched to keep carbon emissions to a minimum. Approaches that take advantage of the building's orientation, climate, existing infrastructure, and resources are strategically placed.





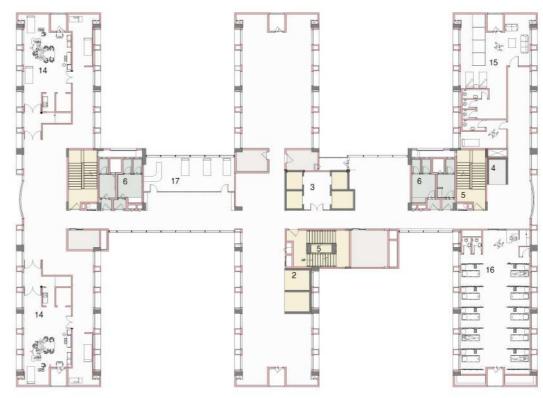
First Floor Plan







### Third Floor Plan



**Fourth Floor Plan** 



### **Indoor plants**

Indoor plants enhance the indoor air quality along with including positivity in the internal atmosphere.

10. Visual Comfort

12. Indoor Air quality

26. Positive social impact



### **Tactile Tiles**

Tactile tiles aid the visually imparied in navigating through the premises.

24. Universal Accessibility

### **Staff washrooms**

Special washrooms are provided for the hospital staff to prevent contamination.

25. Dedicated facilities for service staff





### Perimeter access control

Perimeter access monitors technology systems to protect from unauthorized access and intrusion, for safeguarding people, places, and property.

28. Smart metering and monitoring



### Prayer and meditation space

Prayer and meditation spaces help patients as well as their family a place to go to for **spiritual refreshment**. 26. Positive social impact

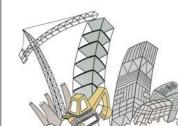


### Granite

Granite, a natural stone and with natural grains and a light colour is used as per its mention in the GRIHA Manual Vol. 2019. 9. Low ODP and GWP materials

- Cafeteria
- Bed Lifts
- Lift Llobby
- Service Llft
- Staircase
- Hygiene Core
- Dental Care
- Waiting Area
- 9 O.P.D.

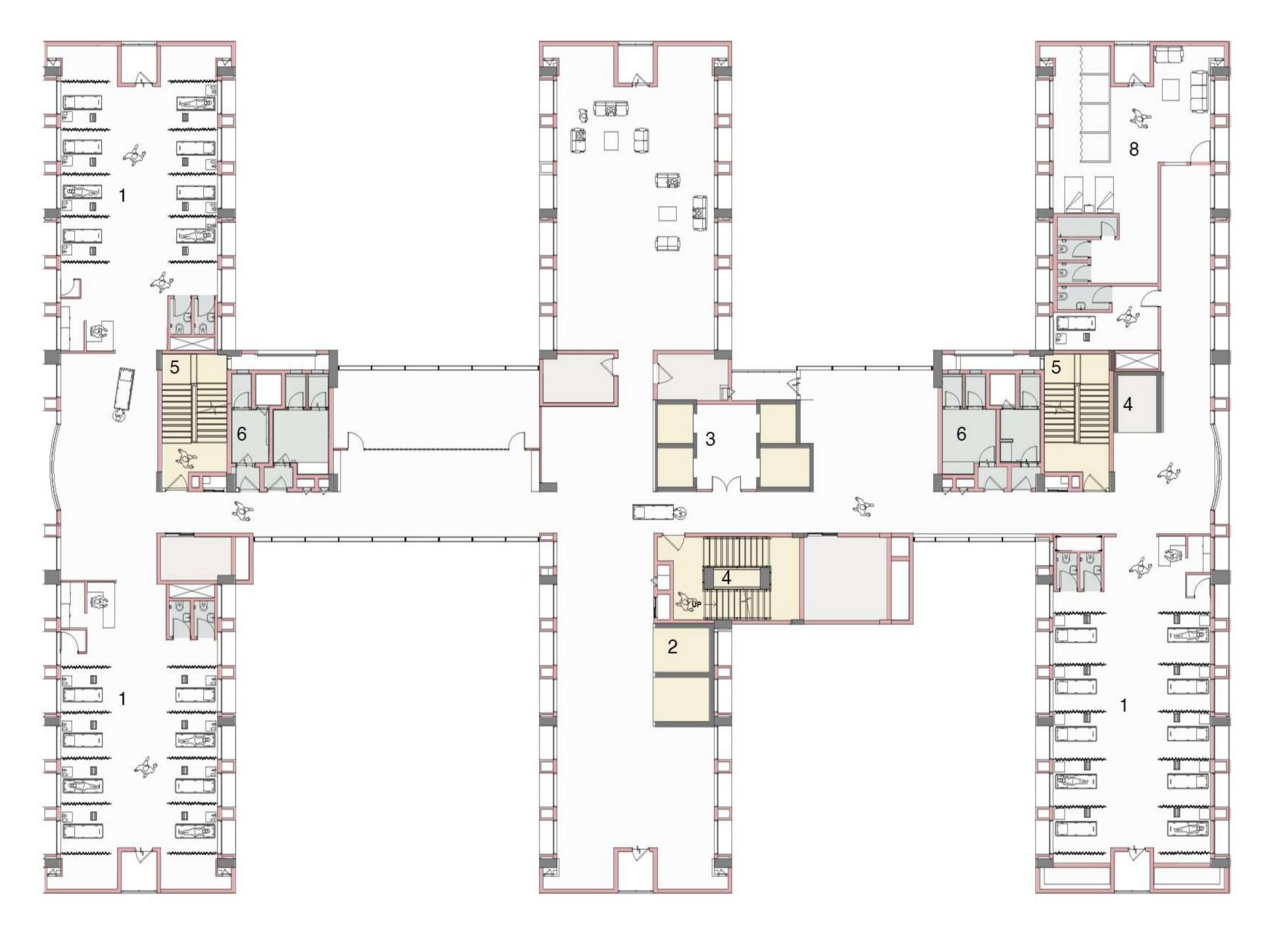
- 10 Treatment Room
- Conference Room
- 12 Private room 13 I.T. Department
- 14 Operation Theatre
- 15 Doctor and Nurse Room
- 16 I.C.U.
- 17 Pre OP Room
- 18 Admin Department





Registration code: 65GRI-22





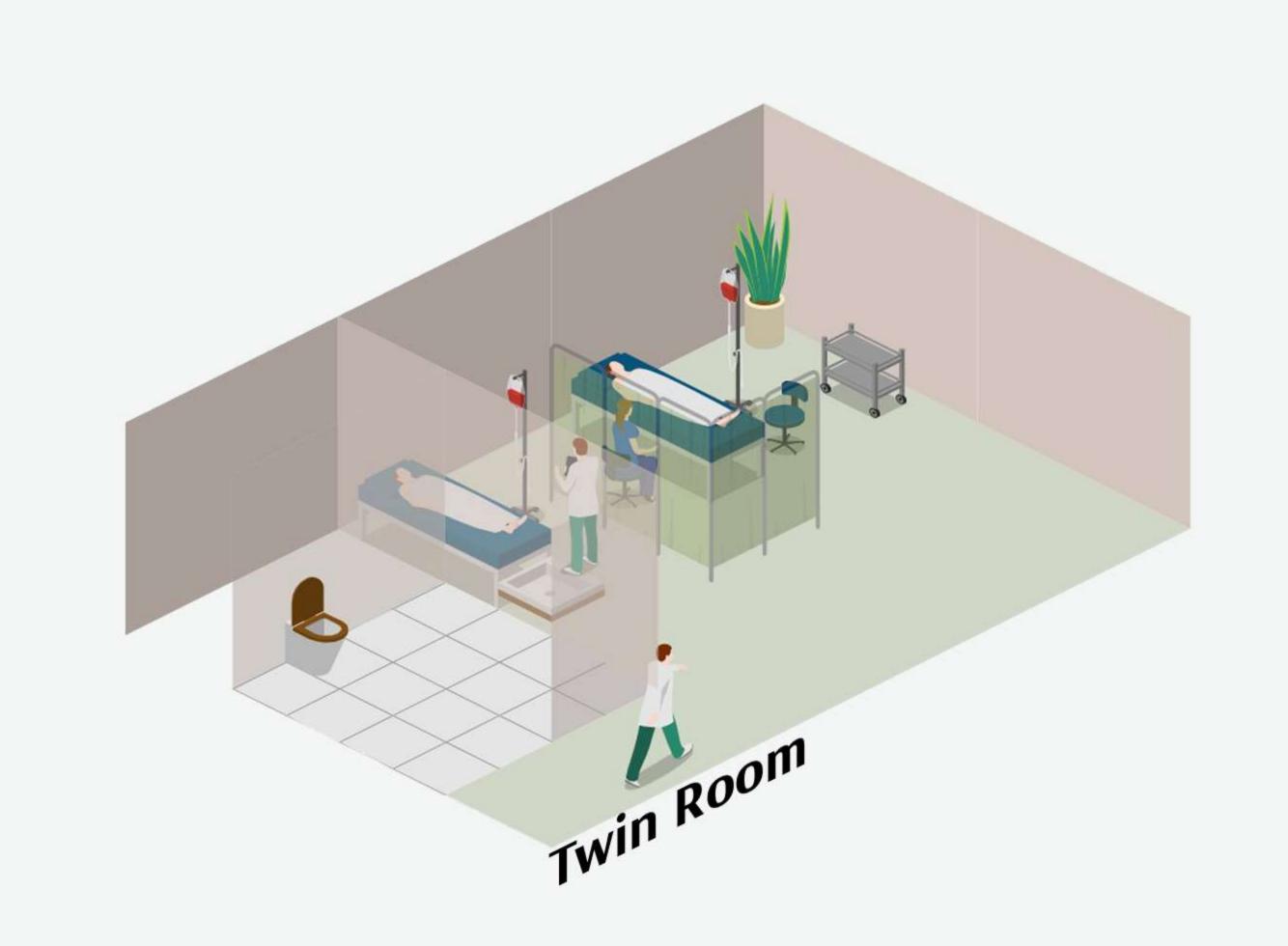
**6th Floor Plan** 

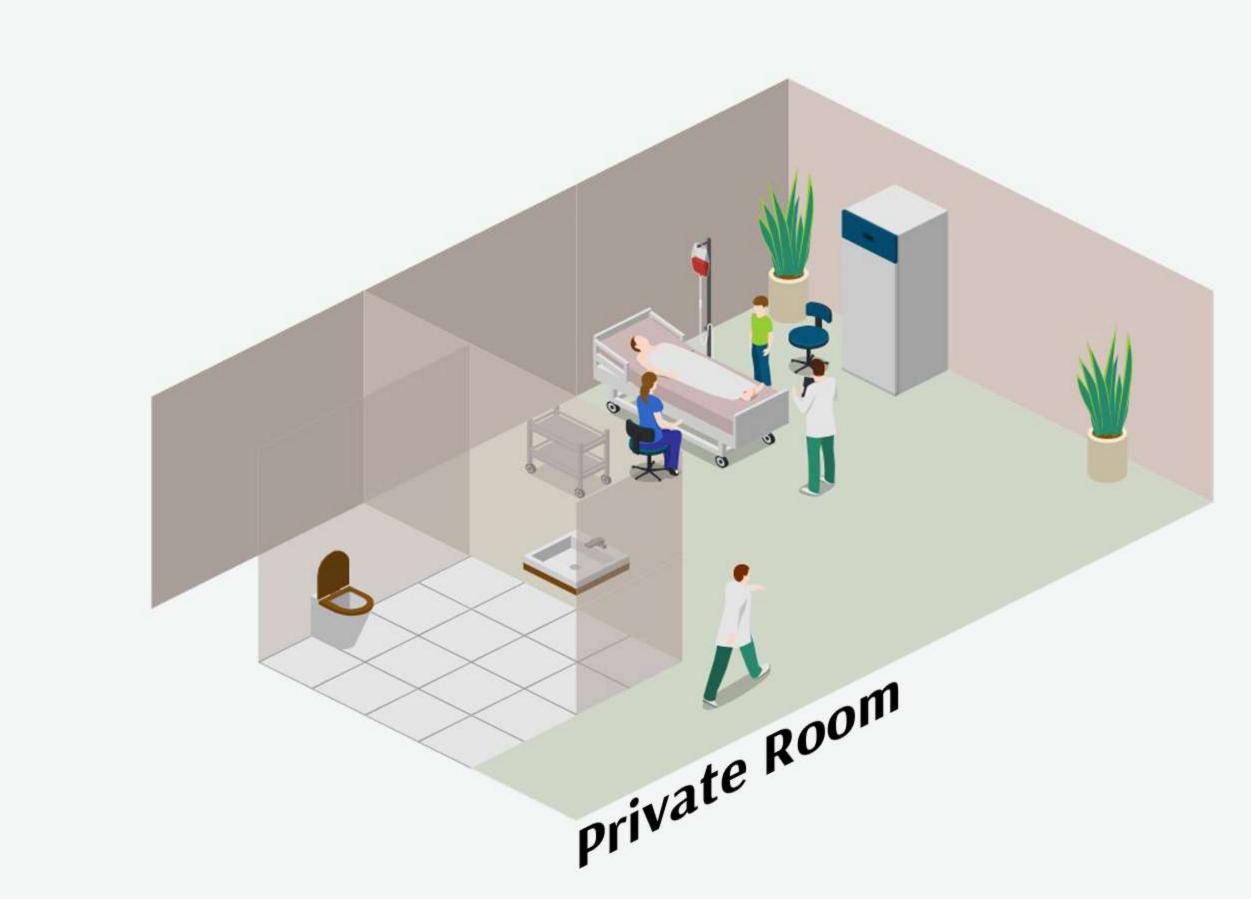


7th Floor Plan



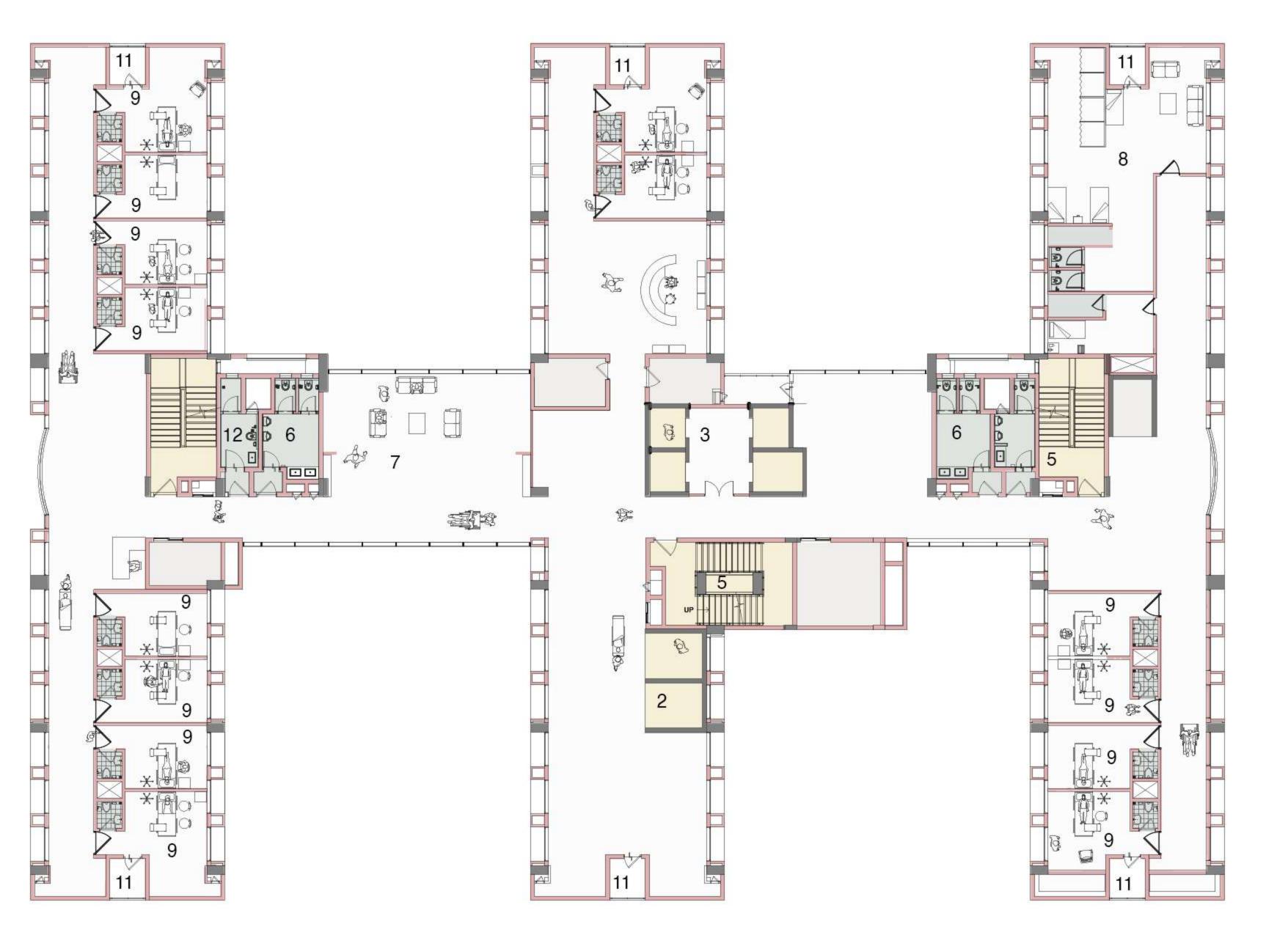
**8th Floor Plan** 







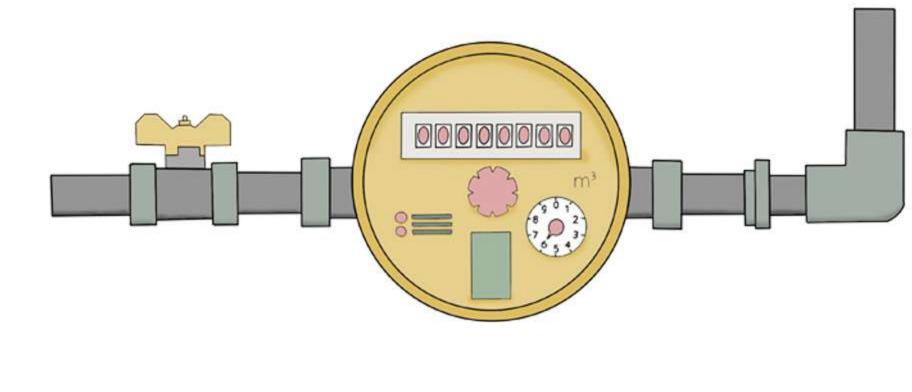
1	Wards
2	Bed Lifts
3	Lift Lobby
4	Service Lift
5	Staircase
6	Hygiene core
7	Waiting Area
8	Doctor and Nurse room
9	Private Room
10	Twin Room
11	Balcony
12	Universal toilet

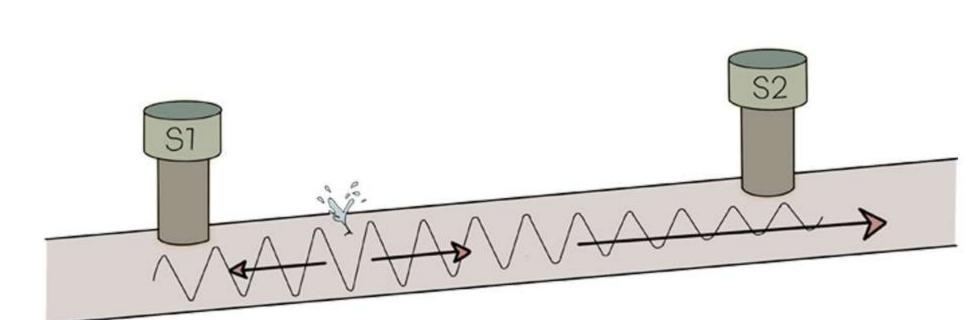


9th Floor Plan



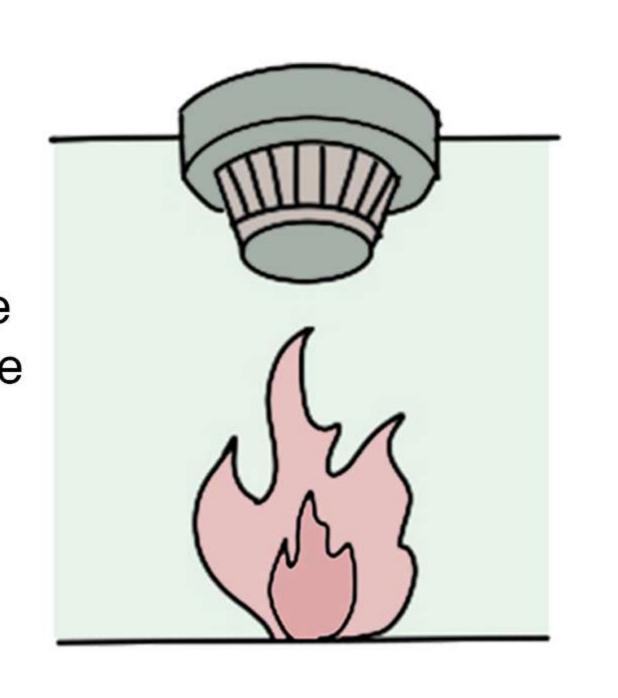
**10th Floor Plan** 





# Smoke detector

detectors in the hospital use Smoke photoelectrics to detect the slightest of fire smoke 28. Smart metering and monitoring

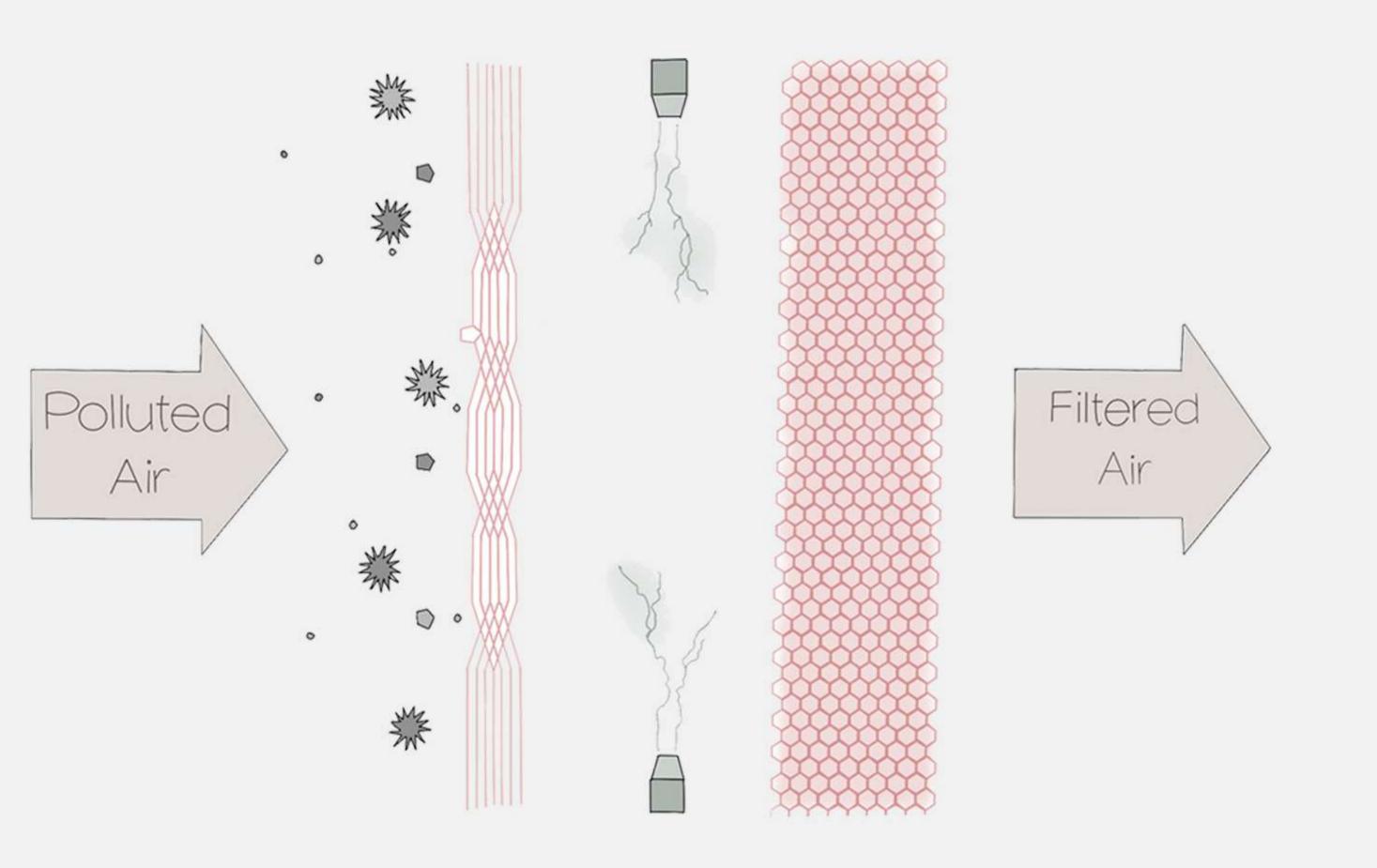


Water leakage sensors

through a pipeline and cuts

off water flow in case of any

abnormality.



# Magnetic air filter

Magnetic air filters use magnetic fields to attract particles out from air.

28. Smart metering and monitoring



# **Low VOC Paints**

Low VOC paints reduce the number of toxins being released in the internal envelope.

12. Indoor Air quality



Natural lighting is believed to have healing qualities and hence every space in the hospital is made to experience it.

10. Visual Comfort

26. Positive social impact



# Water leakage sensors monitor the flow of water

# Dehumidifiers

Dehumidifiers monitor the humidity rate in the atmosphere and soak

12. Indoor Air quality



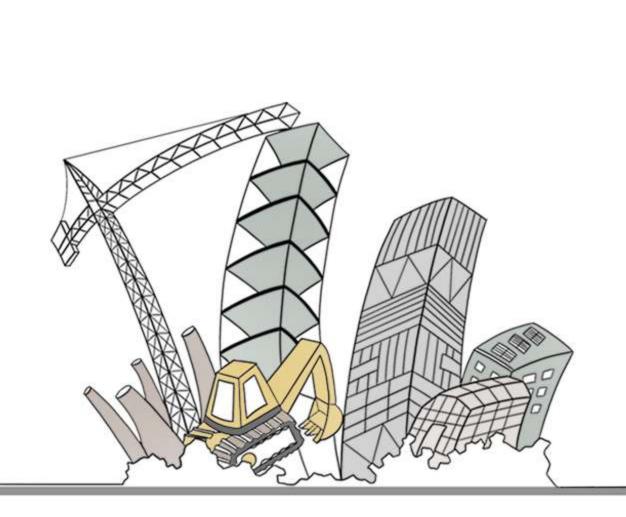
## **Universal toilets**

Universal toilets and a barrier-free environment are provided to make the patients feel independent and less vulnerable. It makes it possible to improve the lives of all patients who find themselves in a situation of disability.

24. Universal Accessibility



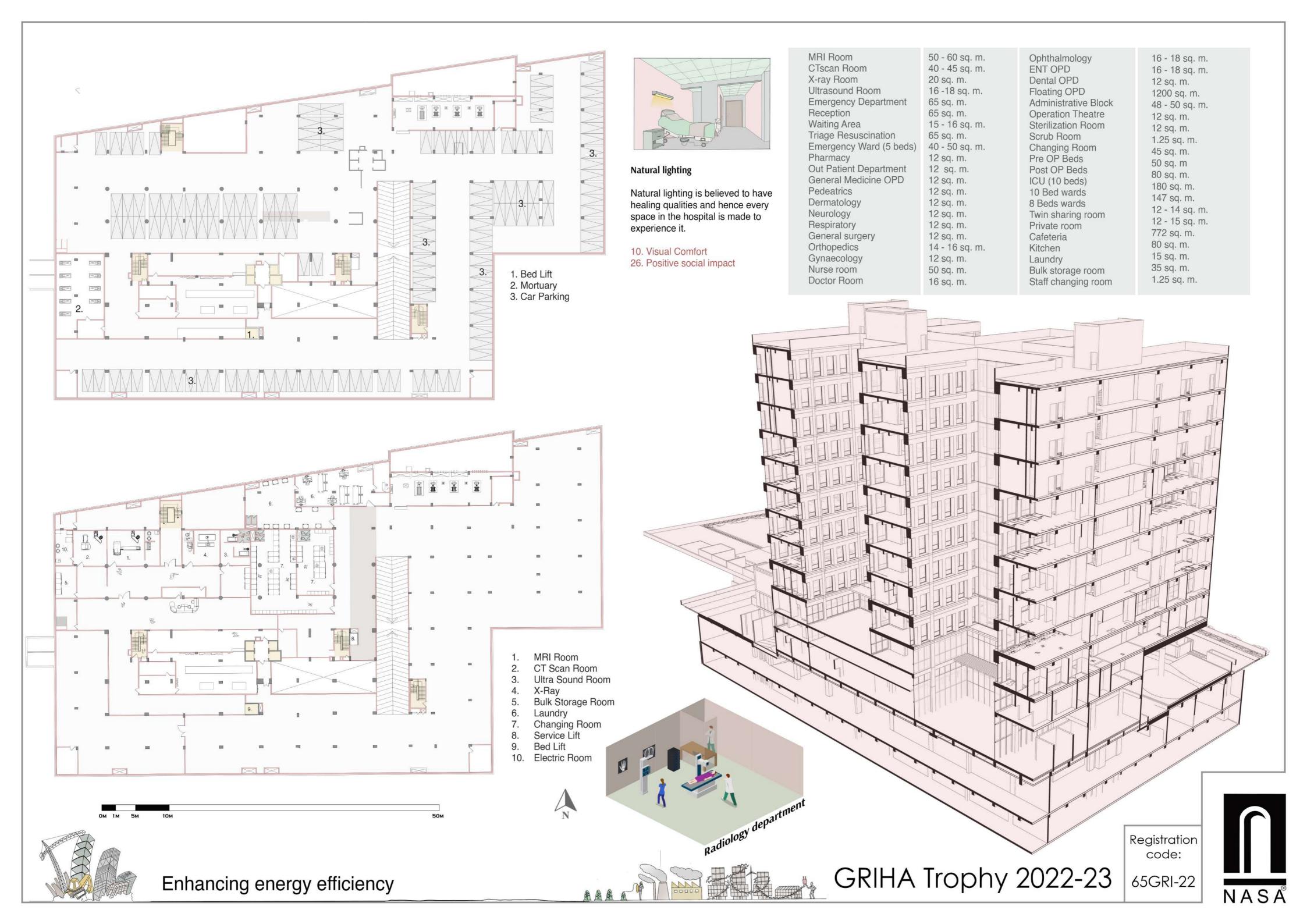
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Delineating the drawings



GRIHA Trophy 2022-23



### Total energy consumption per year

0,				
Product	Power consumed on daily basis (kWh)	Power consumed annually (kWh/year)	Quantity	Total annual consumption (kWh/year)
Lights	0.144	52.56	1634	52.56
AC	2.03	744	173	744
Solar water heaters	307.58	109,500		109,500
UPS	2,769	1,008,560		1,008,560
Bed lift	48.49	17,700	2	17,700
Lifts	1.31	481	5	481
Diagnostics	520	189,800		189,800
Street lights	1.2	438	50	438
Bollard lights	0.072	26.28	30	26.28

### **Strategies**

 $\rightarrow \downarrow \downarrow \rightarrow \downarrow \downarrow$ 

on

Consultancy rooms and offices - Glamox C70 -R600LED - 33 Watts

Front desk and back office - Glamox C15 - R600LED -

Corridors and meeting rooms - Glamox D70-R - 11Watts and produce 40% less heat Stairwells - Glamox A10-S350 LED - 15 Watts

Utility and storage rooms - Eminent 1200 LED - 9 Watts investment and helps the Foyer - Glamox A50-P - 33 Watts

Secondary corridors and stairwells - Glamox E85-R LED grid. and Glamox E-80-S-LED - 11 Watts



Smart lighting like sensor lights and optimum lux lights consume 30% less energy This is an extremely efficient building shift completely off



### **Smart film**

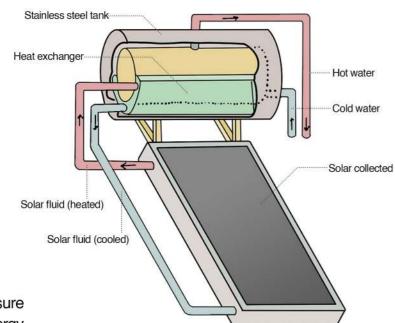
Smart film is a coating for glass that can be retrofitted on any glass. It has IR-blocking capabilities, blocking 12 percent when powered on (transparent) and 73 percent when powered off (opaque). This aids in lowering solar ( heat gain, improving thermal comfort, and lowering energy consumption of a space. Reflective Surface



Manually operative blinds reduce heat gain of the space using absorptive and reflective finishes. Patients will control the amount of sunlight and heat they want to let in. This will also add on to the energy efficiency of the building.

### **Low VOC paints**

Paints on indoor walls majorly affect the internal environment. Use of low VOC paints on the internal walls makes the environment less toxic and more healthy. It prevents the release of allergy-causing toxins into the air. Hence, indoor air quality and patient's health is enhanced.



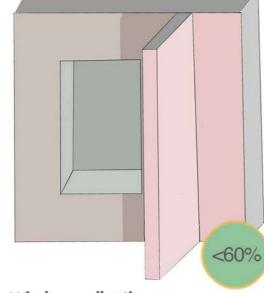
### Electric meter

An electric meter will measure and monitor the energy consumption of the hospital. This will help achieve better energy efficiency in the building.



### Solar water heater

A solar water heater uses solar energy to heat water and then stores it in an insulated tank to keep the temperature intact.

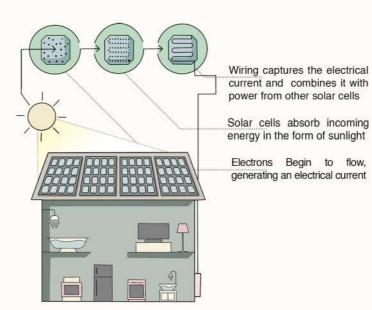


Absorptive Surface

### Window wall ratio

Cooling and heating energy of a building largely depends upon the Window Wall ratio. In this case, a maximum 60% WWR is deemed ideal after consulting the Griha Manual VOL. 2019.

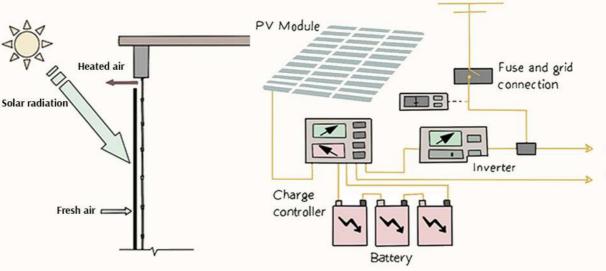
### **Solar Panel**



As rooftops experience the most heat gain, installing solar panels on roofs provides insulation while producing a large amount of energy. Because they emit no greenhouse gases, these panels help combat global warming potential

Energy produced by 1 solar panel in 1 day	1.75 kW
Energy produced by 1 solar panel in 1 year	638.75 kWh
Total number of solar panels installed	3500
Total energy produced by all solar panels in 1 year	2,235,625 kWh

### **Building Applied Photovoltaic Cell**



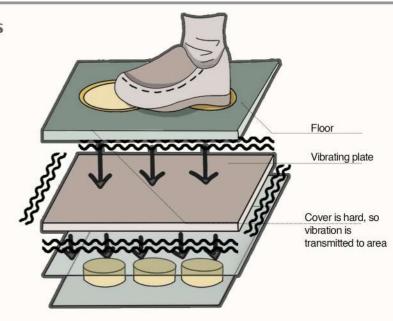
Solar photovoltaics is the most promising renewable energy technology because of it advantages in energy generation and maintenance. Solar photovoltaics have been attached to the building with the help of moving rails for energy optimization.

Area of 1 panel	1.44 sq. m.
Total number of panels	300
Area of installation	432.5 sq. m.
Energy produced by 1 panel	0.5 kW
Total sunshine hours recieved	7 hrs
Total energy produced by 1 panel in 1 day	3.5 kWh
Total energy produced by all panels in 1 day	1050 kWh
Total energy produced by all the panels in 1	3,83,250 kWh
year	

### **Energy Net Positive**

Energy efficiency in hospitals is a challenging task as the energy bills need to reduce substantially without compromising patient's health. The building produces energy off-grid through renewable energy sources and passive facade strategies.

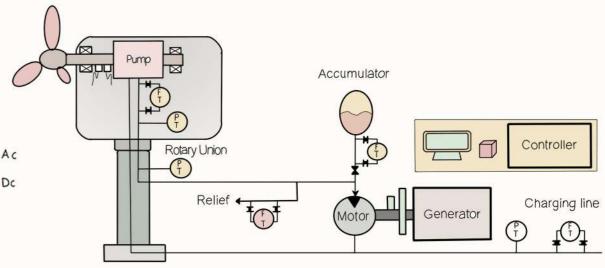
### Piezoelectric tiles



Piezoelectric tiles are aimed at harnessing the otherwise wasted energy with minimum interference to the regular activities. The piezoelectric tiles convert surface stress into electrical energy, one step is equivalent to 0.05 watts.

Number of footsteps in 1 day Energy generated by 1 tile Energy generated by 10,000 footsteps in	10,000 0.05 W 500 Wh
1 day Total number of tiles used Total energy generated by 50 tiles in 1	50 25 kWh
day Total energy generated by 50 tiles in 1 year	9,125 kWh

### Micro wind turbines

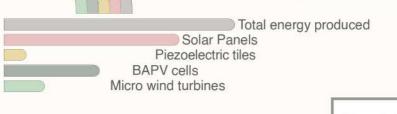


Micro wind turbines are light-weight, portable energy source specially designed for places where the usual large-scale turbines cannot be put to use. These 10m high turbines produce 8-10kWh/day using the western and southwestern winds.

Total no. of turbines used	20
Total energy produced by 1 micro turbine in 1 day	5 kWh
Total energy produced by all turbines in a day	100 kWh
Total energy produced by all turbines in a year	36,500 kWh

Total Required= 13,27,000kWh/year

Total Produced= 26,64,500kWh/year



**100% SAVING** 

Registration code:

65GRI-22

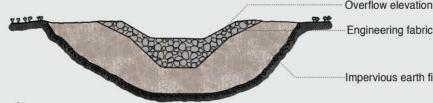
GRIHA Trophy 2022-23



**Enhancing energy efficiency** 



### **Construction management strategies**



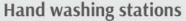
### Sedimentary traps

Small, transient ponding basins called sediment traps are used to treat stormwater by enabling sediment particles to settle out of the water. They usually sit in a drainageway or other point of discharge from a construction site, capturing stormwater before it enters the surrounding



### **Portable toilets**

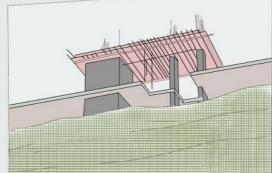
Portable toilets function based on biological treatment hence reducing water consumption, while maintaining proper cleanliness and sanitation standards. Since they are self-contained, sewerage disposal is not required.



Hand washing stations on site allow construction workers to clean themselves after using the portable toilet. It also reduces the risk of the workers being exposed to health issues.

### Plastic mesh

Use of plastic mesh to provide 3m high continuous barricading along the site boundary to contain the dust particles on the construction site and protect the surrounding area.



### Pollutant absorbing plants

In a process known as phytoremediation, plants called

**Enclosures and barriers** 

Use enclosures and barriers to limit dust

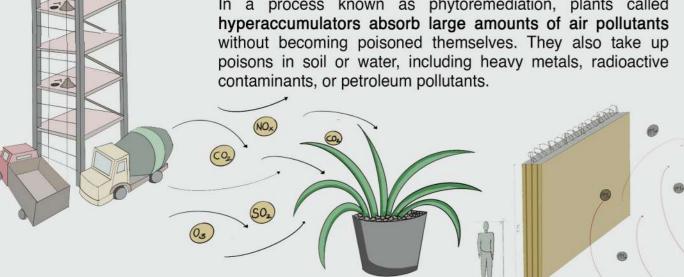
and debris from traveling off site - To avoid

the dust and debris from spreading in the

surrounding, the construction site will

include 3 m heighted construction barriers

as per the GRIHA manual Vol. 2019.



### Storage piles

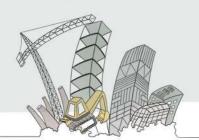
Locate storage piles away from downwind site boundaries in close proximity to sensitive population

### **Erosion control mats**

Erosion control mats, made from PP or PE material, features economical, excellent chemical and UV resistance in preventing water and soil loss.

### Silica free abrasives

Use of silica free materials including silica free abrasives for sanding and blasting. Free silica in sandblasting environments represent a significant health and safety risk for operating and incident personnel who may accidentally ingest free-flowing silica particles.



### **Strategising smartly**

Socio-economic strategies



### Ramps

Ramps are provided to access the hospital premises for the patients who are bed-ridden or on wheelchairs gain easy accessibility with the help of ramps.

### Fire tender access

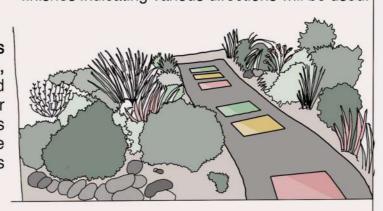
Hospital has many combustible substances, which can lead to a serious fire accident. mandatory.

### Sensory garden

The sensory garden stimulates and engages the senses of sight, smell, sound, touch, and taste. It connects the users to nature and makes them more aware of their surroundings. Different surfaces and textures are used for the sense of touch, and for the taste buds, fresh herbs, vegetables, and fruits are planted.

### **Tactile tiles**

Tactile tiles will assist the visually impaired in navigating the hospital without any challenges. Hence, providing fire tender access becomes For better understanding, different textures and finishes indicating various directions will be used.



### Dedicated facilities for service staff

Dedicated staff spaces such as washrooms, changing rooms, and relaxation spaces provide them with their private space after long and exhausting work hours. This allows the individual to feel more comfortable, respected, potentially happier in their environment, and more likely to return to their service.

### Prayer and meditation space

When people face challenges due to their poor health conditions, they need a quiet place to go. Prayer and meditation spaces aim at providing families a space to pray for patients, and doctors to pause for refreshment.



### Indoor healing plants

Indoor plants can be extremely useful in absorbing harmful gases and cleaning the air indoors. It also adds value to the aesthetics of the interior apart from enhancing health.

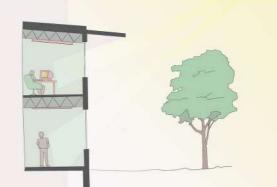
### **Outdoor Views**

The outdoors surroundings aid in the healing process and keep the patients hopeful and inspired. When they need a breather, this also helps in calming down the patients and their visitors. Natural light supplemented with light therapy solutions exposes patients and staff to the benefits of the sun's healthy wavelengths.



### Landscaping

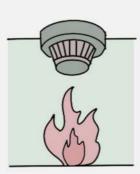
In order to control the temperature of the surrounding area, green space is very crucial. Well designed landscape also avoids soil erosion and potential stormwater runoff. The patient spaces are positioned such that the green spaces are visible from inside as



### Performance metering and monitoring

### **Dehumidifiers**

Excess humidity in the air makes the environment uncomfortable for patients. Also, moisture in the air causes damage to the heavy machinery of the hospital. Dehumidifiers installed all over the building reduce excess moisture in the air. Damp rooms such as the basements require the maximum number of dehumidifiers.



### Smoke detectors

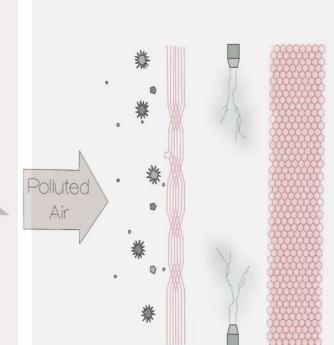
Smoke detectors detect smoke as a primary indication of fire in a building. These sensors are battery devices that use photoelectric and temperature sensors for maximum possible protection in case of fires. As soon as the sensors sense smoke, the detectors emit a loud, high-pitched alarm tone accompanied by a flashing light.

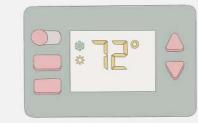


Waste anaesthetic gas monitors are special devices that monitor the anaesthetic gas levels in a hospital building. Exposure to gases like isoflurane, sevoflurane, desflurane, enflurane, and halothane may lead to several symptoms. The hospital staff directly or indirectly comes in contact with these gases daily.

### **Thermostats**

Thermostat devices connect with the building's HVAC systems and control indoor humidity levels. They automatically sense in the air and signal the air conditioning systems to remove the excess moisture from the air, making the indoors comfortable and healthier maintaining a low energy bill.





### Perimeter access control

Perimeter access control systems aim to protect the internal perimeters of the hospital, control access to restricted areas, and monitor and detect abnormalities.



### Magnetic Air cleaning filters

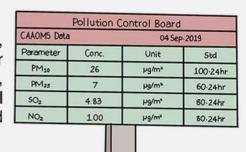
Magnetic Air cleaning filter is an advanced air purification technology that uses the processes of impingement, polarisation, and agglomeration. A dual polarity is created through an underlying dielectric mesh, trapping very fine particles and neutralising bio-aerosols from the air. It is a "Trap and Kill" process that removes PM 2.5, disease-causing germs, and allergens.



### **Pollution monitors**

Pollution sensor devices detect, monitor, and report on specific air pollutants like PM and CO2. Also, they keep track of environmental factors such as temperature and No2

Tobacco	Smol	ke Contr	ol	
Smoking	is pr	ohibited	within	the
premises	to	maintai	in pa	tient
healthcare	€.			



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### Water requirement

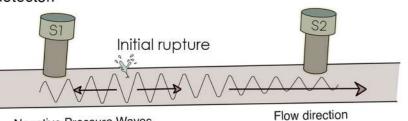
Water requirement for 1 bed for one day Water requirement for 150 bed for one day Water requirement for 150 bed for one year

450L 67,500L 24,637,500L

### Water leakage sensors

Negative Pressure Waves

Water leakage sensors monitor the flow of water through a pipeline. These leak detection systems are fit at the water's point of entry into the building. If any abnormality is detected, the system cuts off the water flow to the entirety of the household by closing a valve within the leak detector.



### **Dual-flush systems**

Liquid Flush

Solid Flush

Concealed dual flush cisterns use a lower volume of water to flush the toilets hence reducing water consumption. Dual-flush toilets allow one to choose between single flushing, start/stop flushing, and dual flushing.

### Xeriscaping

Xeriscaping makes minimum use of water and is very easy to maintain. Native plant species, grass alternatives, and low-water plants are used that reduce the need for water.

### Low-flow fixtures

Low-flow fixtures are plumbing fixtures designed to reduce water flow by having a low flow rate of water or a smaller quantity per flush. These faucets help save water, energy, and money.

### Water demand reduction

Low flow fixtures reduce water demand by Dual flush system reduce demand by Xeriscaping reduce water demand by

60-70% 67% 50-70%

Total water required= 24,637,500 L

Total water demand reduced= 16,014,375 L

### Waste water produced

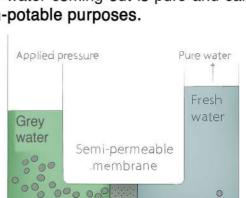
Waste water produced for 1 bed for one day Waste water produced for 150 bed for one day Waste water produced for 1 bed for one year

480L 72,000L 26,280,000L

### **Pod filtration**

Rain Garden

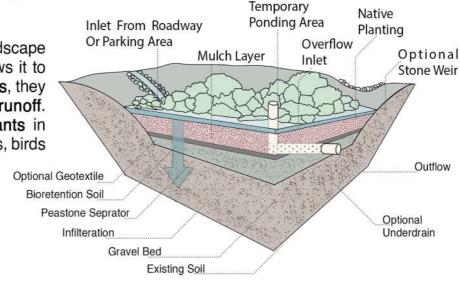
Wastewater is treated using pod filters containing multiple layers of sieves that trap impurities. Sieving, interception, adsorption, and absorption are the main processes involved. The water coming out is pure and can be used directly for non-potable purposes.



Water flow

### Water treatment

Water coming to the hospital from the main municipal line is purified with the help of filters. These filters use the process of Reverse osmosis, which works on the principle of particulate matter moving from high concentration to low concentration. Filtration takes place when water passes through a RO membrane that improves water quality when it comes out through the other end.



A rain garden is a depressed area in the landscape that collects rain water from the site and allows it to soak into the ground. Planted with native plants, they are cost effective and a beautiful way to reduce runoff. Rain gardens can also help filter out pollutants in runoff and provide food and shelter for butterflies, birds and other wildlife.



**Envomed 80** 

Using 100% permeable pavers will absorb stormwater with zero runoff. This eco-friendly paver made up of absolute recycled plastic will recharge groundwater with an infiltration rate of 2540mm/h. It is also resistant to potholes, puddles, and cracks. Permeable pavers are the better paving alternative to concrete and asphalt.

Envomed 80 is a sterilization

machine that has a powerful 4-shaft

shredder and a chemical

disinfection system. It can treat 80

litres of infectious and sharp medical

### Water meter

A water meter will measure the amount of water being consumed by the hospital. Measuring the quantity of water will help in proper monitoring and efficient savings.

### **Stormwater harvesting**

Stormwater harvest and reuse systems retain stormwater during the monsoons so that the water can be used later for different purposes. The water from rooftops and runoff water is collected separately in two different vessels as they serve different purposes.

Storm water harvesting tank calculation	
Highest rainfall received -in the month of August	259 mm
Annual precipitation	778mm
Average rainfal received in a day	8.6mm/hour
Terrace	
Total terrace surface area	1598m <sup>2</sup>
Volume of water collected	12.78m <sup>3</sup> /day
Landscape	100 40-2
Total greencrete area	162.42m <sup>2</sup>
Volume of water collected	1.29m³
Total softscape area	1077.25m <sup>2</sup>
Total permeable tiles area	239m²
Volume of water collected	1.91m <sup>3</sup>
Total volume of water collected	15.98m <sup>3</sup>
Total volume of water	15.98m <sup>3</sup>
Doubling the volume to avoid water wasteage	31.96m <sup>3</sup>
Total volume of water collected	31,960 ltr
Average tank size=2x*x*1.5 (lbh)	
Breadth, x	3.26m
Length, 2x	6.52m
Height	1.5m
~	7.53.53

Water, sanitation and hygiene services are the basic requirements for infection control in hospitals. All the greywater and blackwater generated on site is treated according to the contamination level, using pod filter and reverse osmosis system. Treated water is then reused again, forming a sustainable cycle of water.

### Waste produced Waste produced Solid waste produced in 1 day in 1 year 8.9kg 3250kg Sharps waste 71.3kg 26030kg Infectious waste 42.7kg Pathalogical waste 15620kg Non infectious waste 169.39kg 61830kg Non infectious plastic waste 17.83kg 6510kg Infectious plastic waste 35.6kg 13020kg 345.72kg 1,26,260kg











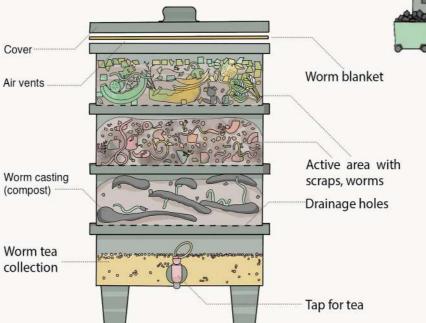
### Waste categorization

Biomedical waste management requires categorization as a first step. Hence, 4 different types of bio-medical waste come out from the hospital, with colour codes for each type of waste. Yellow-coded waste includes biodegradable, anatomical, soiled, medicinal, and microbiological waste. Red-coded waste includes

contaminated yet recyclable waste. White stands for waste sharps including metals while blue stands for glassware.

### Vermicomposting

Hospital wastes are hazardous and need proper disinfection before disposal. The bio-degradable part of this hospital waste is treated using Vermicomposting without causing any adverse impact on the environment & human health. It involves earthworms as they enhance the beneficial microbes and suppress harmful microbes to convert different infectious hospital wastes into risk-free compost.



# waste in just 18 minutes.

### Waste management

Fertilizer produced by vermicomposting

By Envomed80

GRIHA Trophy 2022-23

Fertilizer produced by vermicomposting from pathalogical, non infectious and non infectious plastic waste in one day

Fertilizer produced by vermicomposting from pathalogical, non infectious and non infectious plastic waste in one year

Envomed80-sharps & infectious 80 ltrs in 18 min and solid phase-80% less in volume in one year

42,300kg to 33,840kg

1kg=0.5kg fertilizer

230.02kg=115.01kg

83,960kg=41,980kg

Waste management

The proposed hospital design ensures all the waste procured is carefully segregated and then sent for treatment within the site. Modern day equipments like Envomed 80 are used which help in effective disposal of non-biodegradable waste, along with the production of renewable energy obtained from waste incineration.

Total waste produced= 1,26,260 kg/annum By vermicomposting Total waste treated= 75,820 kg/annum

Registration

code:





### Life Cycle Assessment (LCA) Element Urban Embodied Carbon, **Emission Factor** Transportation Transportation Carbon, GWP Mode of Fuel Consumption (kg)-Weight (kg) Quantity Density GWP/KG GWP (kgCO2eq) Unit Unit Products (kgCO2eq) for 1 km diesel for 100 km (kgCO2eq) distance (km) transportation weight x element GWP (kgCO2e) -1.3 31,898.5 100 Pergola- Air Dried Sawn Timber 48.7 cu.m 655 kg/cu.m -41,468.05 Truck 2.79 12.23 34.12 12,759.4 -1.3 19.48 -16,587.22 100 Truck 2.79 12.23 Internal Wall- Air Dried Sawn Timber cu.m 655 kg/cu.m 34.12 29.15 1,020.25 0.36 265.27 100 Truck Internal Wall- Gypsum panel 35 kg/cu.m 2.79 12.23 cu.m 34.12 Internal Wall (Radiology)- Brick- Hoffman Kiln 0.31 62.2 cu.m 1760 kg/cu.m 109,472 33,936.32 100 Truck 2.79 12.23 34.12 0.14 14.34 21,510 3,011 100 Truck Internal Wall (Radiology)- Mortar cu.m 1500 kg/cu.m 2.79 12.23 34.12 0.92 0.92 1,324 1,205,56 100 Truck Internal Wall (Radiology)- Cement (ratio- 1:4) cu.m 1440 kg/cu.m 2.79 12.23 34.12 0.01 3.7 6,216 62.16 100 Truck Internal Wall (Radiology)- Sand (ratio- 1:4) cu.m 1680 kg/cu.m 2.79 12.23 34.12 34.3 269,598 2.8 100 Truck **Emergency Section- BOF Steel** cu.m 7860 kg/cu.m 754,874.4 2.79 12.23 34.12 Ramp- Glass Reinforced Concrete 194 cu.m 2550 kg/cu.m 495,720 0.16 79,315.20 100 Truck 2.79 12.23 34.12 Internal Doors- Plywood 60.1 36,060 -0.31-11,178.60 100 Truck cu.m 600 kg/cu.m 2.79 12.23 34.12

11.76

7,090.72

100

100

Truck

Truck

2.79

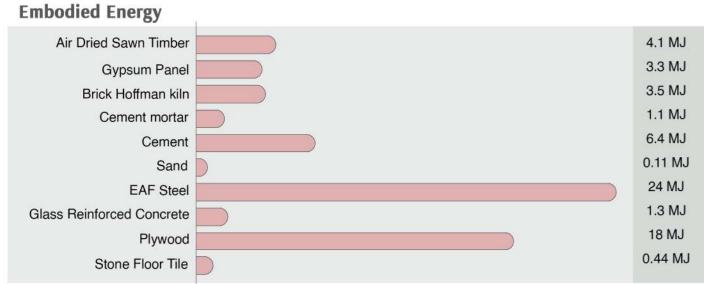
2.79

12.23

12.23

34.12

34.12



0.7

48.7

cu.m

cu.m

1680

2600

Total Upfront Embodied Carbon, GWP (kgCO2eg) (weight x element GWP) Total Transportation Carbon, **GWP** (kgCO2eq) Weight of carbon dioxide equivalent (kgCO2e) emitted per

square meter

1,176

126,620

kg/cu.m

kg/cu.m

810,538.92

409.4604

0.01

0.06

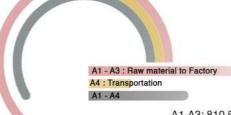
Total Upfront Embodied Carbon/ Total Built-Up Area

= 20.53 kgCO2e/m2

### Urban Embodied Carbon, GWP (kgCO2eq)

Pergola- Air Dried Sawn Timber -41,468.05 Internal Wall- Air Dried Sawn Timber -16,587.22 Internal Wall- Gypsum panel 265.27 Internal Wall (Radiology)- Brick- Hoffman Kiln 33,936.32 Internal Wall (Radiology)- Mortar 3,011.40 Internal Wall (Radiology)- Cement (ratio- 1:4) 1,205.56 Internal Wall (Radiology)- Sand (ratio- 1:4) 62.16 **Emergency Section- BOF Steel** 754,874.40 Ramp- Glass Reinforced Concrete 79,315.20 Internal Doors- Plywood -11,178.60 Landscaping-Sand 11.76 Landscaping- Stone Floor Tile 7,090.72

The life cycle cost analysis is calculated from stage A1 to A4, that is, from raw material extraction to delivery of the finished product on site. By reusing existing materials on site and bringing in low GWP and ODP materials, the carbon footprint is drastically reduced.



A1-A3: 810,538.92 kgCO2e A4: 409.4604 kgCO2e A1-A4: 810,948.38 kgCO2e

Costs are reduced by retrofitting the existing structure with reused materials. Such brownfield developments reduce the carbon footprint of novel constructions.

### Life Cycle Costing (LCC)

Landscaping- Sand

Landscaping- Stone Floor Tile

Life Cycle Costing (ECC)					
Products	Quantity	Unit	Rate (₹) (reference:SOR Uttar Pradesh)	Unit	Total (₹)
Pergola- Air Dried Sawn Timber	68.18	cu.m	7,686	per cu.m	524,031.48
Internal Wall- Gypsum panel	2915.16	sq.m	198	per sq.m	577,201.68
Internal Wall (Radiology)- Brick- Hoffman Kiln	62.2	cu.m	4,393	per cu.m	273,244.6
Internal Wall (Radiology)- Mortar	14.34	cu.m	140	per cu.m	2,007.6
Internal Wall (Radiology)- Cement	0.92	cu.m	300	per cu.m	276
Internal Wall (Radiology)- Sand	3.7	cu.m	2,100	per cu.m	7,770
Emergency Section- BOF Steel	34.3	cu.m	7,237	per cu.m	248,229.1
Ramp- Glass Reinforced Concrete	194.4	cu.m	4,153	per cu.m	807,343.2
Internal Doors- Plywood	60.1	cu.m	750	per cu.m	45,075
Landscaping- Sand	0.7	cu.m	500	per cu.m	350
Landscaping- Stone Floor Tile	48.7	sq.m	756	per sq.m	36,817.2
					₹2,522,346.0



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**Estimation of the eco-balance** 

Section	Criterion no.	Criterion name	Max points	Strategies used	
Sustainable site planning	1	Green Infrastructure	5	Permeable Pavers Landscape Rain Garden Sensory Garden	$\langle \rangle$
	2	Low impact design strategies	5	Permeable Pavers Minimum Site Disturbance Landscaping Reuse of existing materials on site	$\langle \! \rangle$
	3	Design to mitigate UHIE	2	Blinders Smart film Landscaping Rain Garden	<b>€</b>
Construction Management	4	Air and soil pollution control	1	Sediment traps Pollutant absorbing plants Plastic mesh	$\checkmark$
	5	Top Soil Preservation	1	Sediment traps Soil erosion control mats	<b>(4)</b>
	6	Construction management practices	2	Enclosures and Barriers Locating storage piles away Silica free abrasives Wheel washing facility	<b>₹</b>
Energy Optimization	7	Energy Optimization	12	Building Applied Photovoltaics (BAPV) Smart Film Blinders Solar panels Piezoelectric tiles Micro wind turbines Electric meter Natural Lighting Less than 60% WWR	$\checkmark$
	8	Renewable Energy Utilization	5	Solar Panels Micro wind turbines Piezoelectric tile	$\checkmark$
	9	Low ODP and GWP materials	1	Gypsum wallboards Wooden planks Granite tiles	<b>⊘</b>
Occupant Comfort	10	Visual Comfort	4	Ambient 1500 lux lights Outdoor views Natural light Indoor plants Less than 60% WWR	<b>₹</b>
	11	Thermal and Acoustic comfort	2	Blinders Acoustic comfort sensors Smart film	<b>₹</b>
	12	Indoor air quality	6	Indoor plants Low VOC paints Dehumidifiers Central air cleaning type magnetic filter	Ý
Water Management	13	Water demand reduction	4	Low flow fixtures Dual flush system Greywater reuse through pod filters Xeriscaping Water leakage sensors	$\checkmark$
	14	Wastewater treatment	2	Greywater reuse through pod filters Reverse osmosis filteration	4

Section	Criterion no.	Criterion name	Max points	Strategies used	
	15	Rainwater management	5	Stormwater collection through permeable pavers and roof Rain garden	₹)
	16	Water quality and self sufficiency	5	Greywater reuse through pod filters Wastewater treatment through RO filtration Stormwater harvesting	₹)
Solid waste management	17	Waste management post occupancy	4	Categorised Bins Envomed 80	₹)
	18	Organic waste management	2	Vermicomposting	(4)
Sustainable building	19	Utilisation of alternative materials in building	5	Gypsum wallboards Urbanite (Broken concrete pieces of walls) Glass Recycled Concrete Air dried sawn timber Recycled Plastic permeable pavers	$\checkmark$
	20	Reduction in global warming through LCA	5	Using low carbon emission materials Reuse of existing site materials Generating energy on site Final carbon emission: 20.53kgCO2e/sq.m (considering A1 to A4 stages)	<b>₹</b>
	21	Alternative materials for external site development	2	Recycled plastic permeable pavers for pathways Glass recycled concrete for ramps Urbanite for landscape elements	<b>⊘</b>
Life cycle cost	22	Life cycle cost analysis	5	₹ 25,22,345	$\checkmark$
Socio economic strategies	23	Safety and sanitation for construction workers	1	Portable Toilets, Hand washing stations	$\checkmark$
	24	Universal Accessibility	2	Ramps, Tactile tiles, Fire tender acess, Sensory garden, Lifts	$\langle \rangle$
	25	Dedicated facilities for service staff	2	Staff washroms, Staff restrooms, Staff changing rooms	<b>(4)</b>
	26	Positive social impact	3	Prayer and meditation space, Landscaping, sensory garden, Indoor plants, Outdoor views, Pollution Monitors	<b>⊘</b>
Performance metering and monitoring	27	Project commissioning	0		
	28	Smart metering and monitoring	7	Water Leakage sensor, Pollution monitors, Perimeter access control, humidity sensor, smoke sensor, waste anesthetic gas monitors, central air cleaning type magnetic filter	Ý
	29	Operation and maintenance protocol	0		
	30	Innovation	5	Sensory garden, Indoor healing plants, Piezoelectric tiles, Novel meters, Reusing urbanite, Combination of natural and artificial light, going 100% off-grid.	Ý

The hospital effectively satisfies all of the GRIHA criterias by harnessing renewable energy sources and taking advantage of the climate and its impact on building orientation. Additionally, it is a Net Positive building, producing all of its energy on-site and giving back to the environment.

