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SCHOOL OF BUILDING AND MANAGEMENT

DEPARTMENT OF ARCHITECTURE

UNIT – I – Principles of Site Planning – SAR1203

DEFINITIONS OF SITE PLANNING

- **The art of arranging structures on land and shaping the spaces between them – Kevin Lynch**
- **Site planning is the organization of the total land area and air space of the site for the best use by the people who will occupy it. - Garrett Eckbo**
- **Site planning is a creative process requiring the manipulation of many variables. It involves the location, placement and relationship of all site elements.**
- **Site – can be defined as the existing conditions of the land. A place where something is or will be located.**
- **Planning – where to build and where not to build is understood in planning. A detailed proposal for design and construction.**

Site Categorization: The site is categorized into Plot, Site, Land and Region.

1. **Plot / Site area**

The area of contiguous parcel of land enclosed by definite boundaries over which the applicant has legal right for development (or) as a continuous portion of land held in own ownership. Plots will be in square feet or square meter or grounds.

Noida Authority to offer 442 plots in city's 'last' residential scheme

2. **Site**

Segments of land with artificial boundaries and there is a human intention to assign a land for a specific purpose in square meter, grounds, acre or hectare.

3. **Land**

The land is solid part of earth's surface. Large in areas. Natural or manmade intervention for certain economic activities. Eg. Agricultural or forest land, measured in Sq.Kilometres

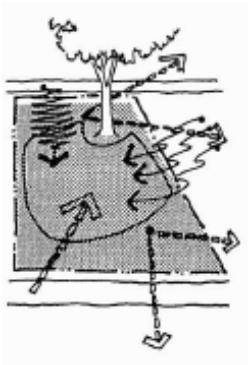
4. **Region**

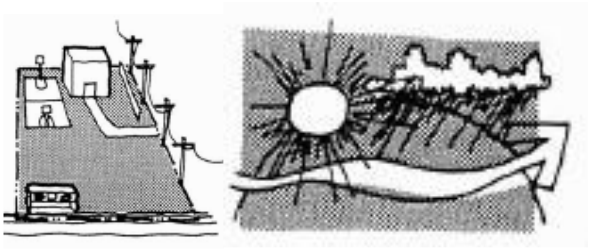
Defined as the part of country. Space, place of more or less definitely marked boundaries or characteristics. A large, usually continuous segment of a surface or space. A large, indefinite portion of the earth's surface. An area, division, or district of administration. A land surface with common geographical or topographical characteristics. A specified district or territory.

The Factors influencing site are

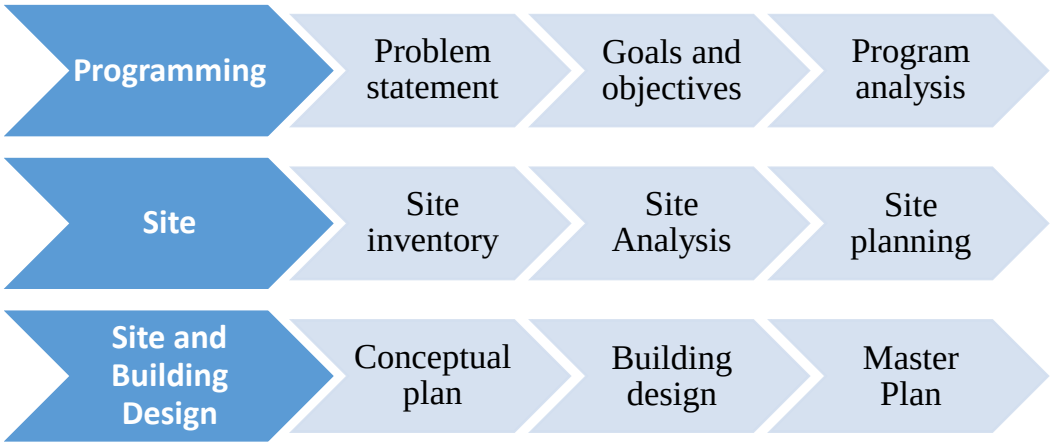
- **Natural Physical Features**
- **Man-Made Features**
- **Sensory**

- **Climate**





Site planning and design process



SITE ANALYSIS

Site Analysis is a Part act or process of investigating the natural and cultural characteristics on and around the site to determine how these characteristics present opportunities and limitations or constraints to achieve the project design goals

Site analysis is the process of investigating basic data that relates to a particular site, such as survey information, topographic data, geological information, zoning ordinances, existing character, microclimate, development patterns, social patterns, etc. The purpose of site analysis is to determine whether a parcel of land is suitable for a specific proposed use.

Site Inventory

It is the act of collecting relevant data like

1)Reports

2)Photographs

3)Databases

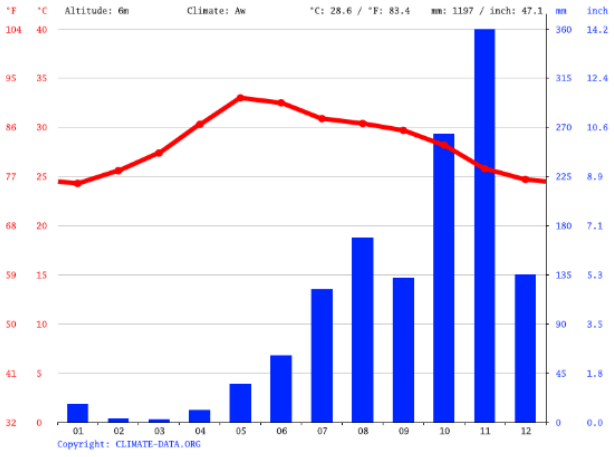
4)Mapping

5)Survey base map

6)Simple recording what exists on the site


TEST REPORT

RESULT



Natural resources includes

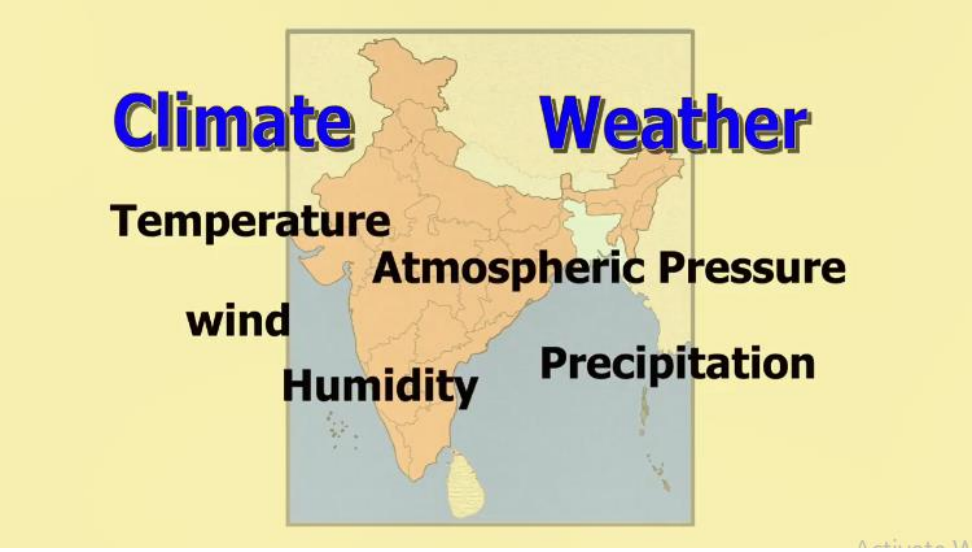
- **Topography including high and low points.**
- **Gradient, drainage pattern.**
- **Soil types, permeability of ground, stability and fertility.**
- **Water bodies including permanence and fluctuations.**

- **Subsurface matter, geology of the underlying rock including existence of sand, gravel coal and water.**
- **Vegetation types, individual specimens.**
- **Wildlife including the existing of desirable habitat as low cover for plea sants, causes for fears, berms for birds.**

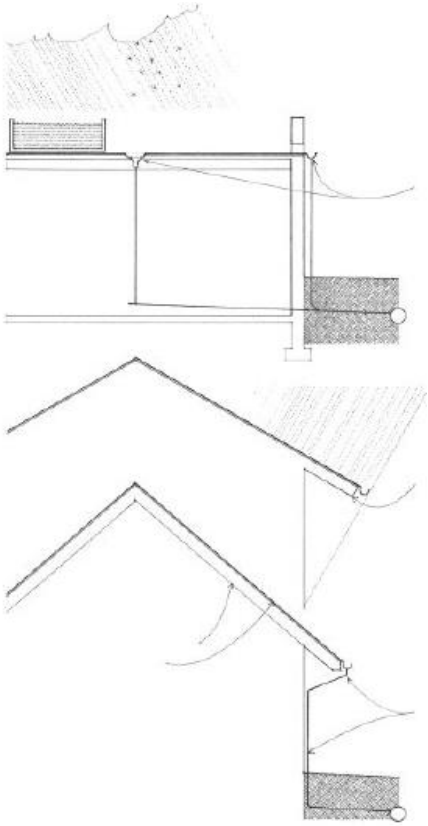
<u>Artificial elements (man –made)</u>

- **Private holdings and public easements.**
- **Buildings, bridges, other structures with historical and archaeological significance**
- **Roads, walkways, other transportation ways.**
- **Electric lines, gas lines, utilities,**
- **Zoning regulations.**
- **legal and physical boundaries**

<u>Natural forces _ Site Climate</u>



- **Temperature (day and water), especially day , night and seasonal norms, extremes**
- **Sun angles of various seasons and times of the day**
- **Wind directions (daily and seasonally)**
- **Precipitation, rain , snow ,storm frequencies.**



Sun and Wind

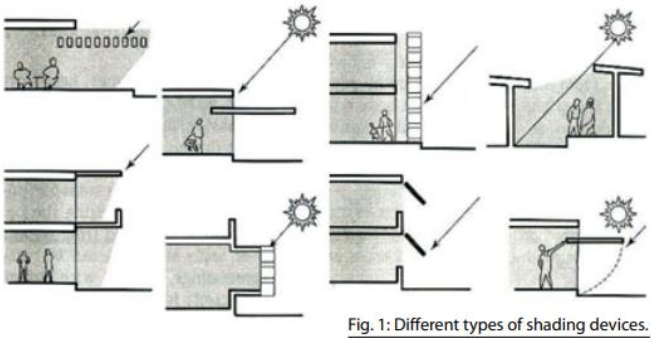
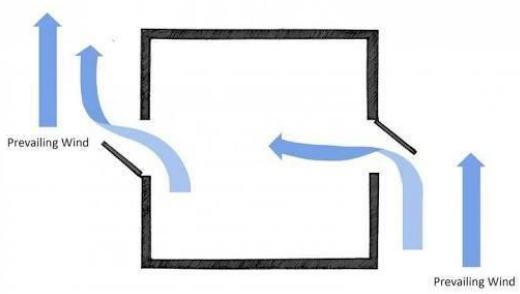


Fig. 1: Different types of shading devices.



Climate of India

Factor Affecting India's Climate

1. Latitude
2. Altitude
3. Pressure and Wind system
4. Distance from the sea
5. Ocean currents
6. Relief features

CHECKLIST TO COLLECT ON CLIMATIC DATA

1. Temperature averages and extremes

2. Precipitation averages and extremes

3. Snowfall averages and extremes

4. Wind intensity and directions

5. Humidity patterns

6. Solar angles

7. Days of sunlight

8. Frost data

<u>Perceptual Characteristics</u>

- **Views into and from the site**
- **Smell, sound and their sources**
- **Spatial pattern, any aesthetic**
- **Lines, forms, textures and colour that give site peculiar character**
- **General impression regarding the experience potential of the site and its parts.**

<u>CHECK LIST ON SENSORY QUALITIES</u>

1. Scenic vistas

2. Spatial illusions

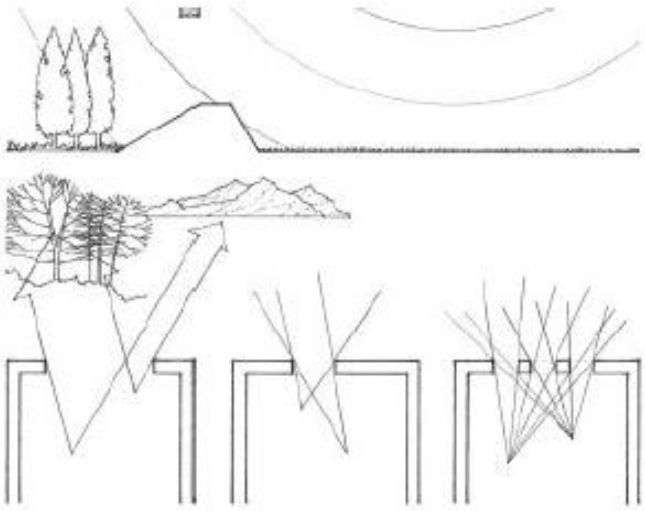
3. Quality of light

4. Characteristic smells

5. Characteristic sounds (noises, echoes, etc.)

6. Sensation of natural forces

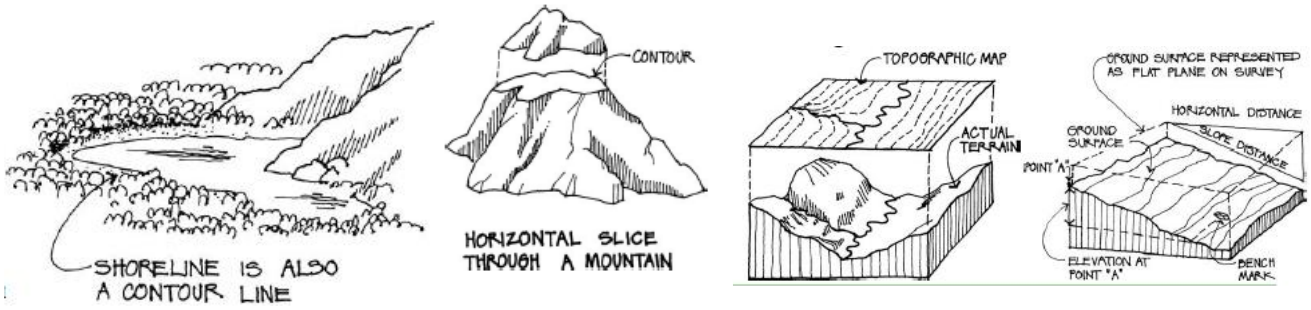
7. Perception of textures



Expansive view • Restricted view • Filtered view

1.1 NATURAL RESOURCES _ TOPOGRAPHY

Topography is the graphic representation of an area's surface features. It is synonymous with landform or the shape of the ground. It may encompass mountains, rolling hills, prairies, and plains, while at a different scale, it may include mounds, ramps, berms, and even ripples in a sand dune.



TOPOGRAPHY

Topography has great environmental significance, since it affects the aesthetic character of an area, its microclimate, drainage, views, and the setting for structures. A topographic map allows one to understand the pattern of the land, since it indicates slopes, ridges, valleys, summits, stream beds, and drainage patterns. Topographic information always influences and frequently determines site use, site circulation, and distribution of utilities, placement of buildings, and the disposition of open spaces.

TOPOGRAPHIC MAPS

Topographic maps are developed either from aerial photographs or surveys, where smaller parcels are involved. For Larger areas – satellite images. Aerial photos have the inherent advantage of depicting the land with a high degree of detail. Individual photos can be interpreted separately; however, they are most useful when combined in pairs and viewed stereoscopically. With the use of special equipment, aerial photos may be scanned to determine lines of equal ground elevation, that is, contours. Topographic surveying consists of obtaining field data, from which a map is plotted showing the configuration of the ground surface. Chain survey, Plane table, Theodolite, compass surveying etc.

SURVEYING

A land survey involves locating and measuring both man-made and natural features using the principles of mathematics, geometry, and other sciences. By using various tools, a land surveyor can measure things such as elevation, angles, and boundaries on a property.

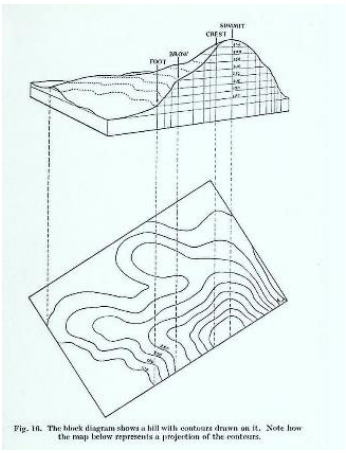
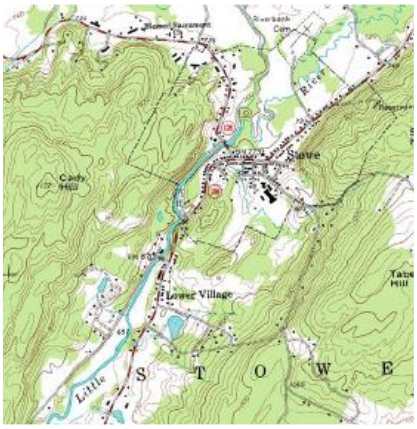


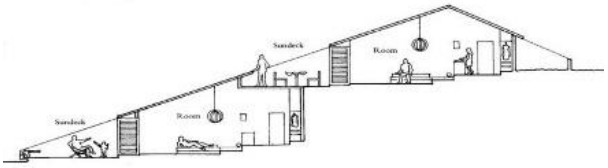
Fig. 16. The block diagram shows a hill with contours drawn on it. Note how the map below represents a projection of the contours.

TOPOGRAPHIC MAPS

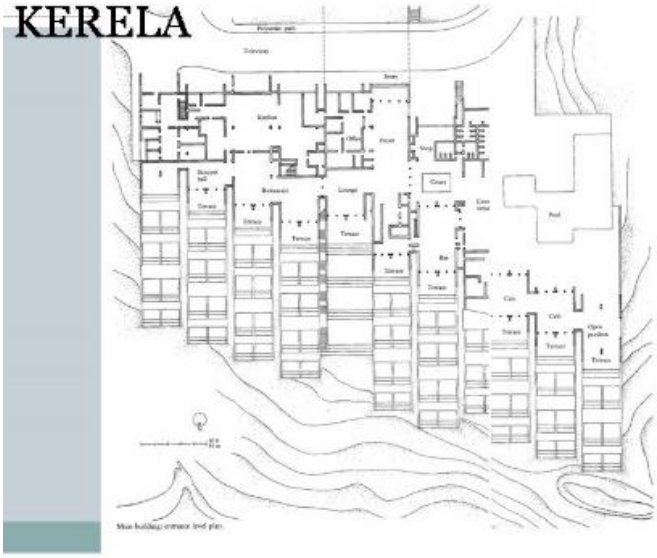
Topographic maps also generally show property lines, roads, structures, trees, etc., in addition to ground surface elevations. Surveys that extend over a relatively small area ignore the earth's curvature and assume the ground surface to be a flat plane. Horizontal distances, therefore, are considered to be straight and are measured along a flat plane. Vertical distances, or elevations, are designated as the distance above sea level or above any other bench mark, that is, any permanent point of known elevation.



KOVALAM BEACH RESORT, KERALA _ Ar. Charles Correa



KOVALAM BEACH RESORT, KERELA



CHECKLIST TO BE DONE FOR TOPOGRAPHIC STUDY

1. Elevations

2. Slope amount and direction

3. Unique landforms

4. Natural drainage patterns

5. General topographic character of site

6. Areas of steep slope

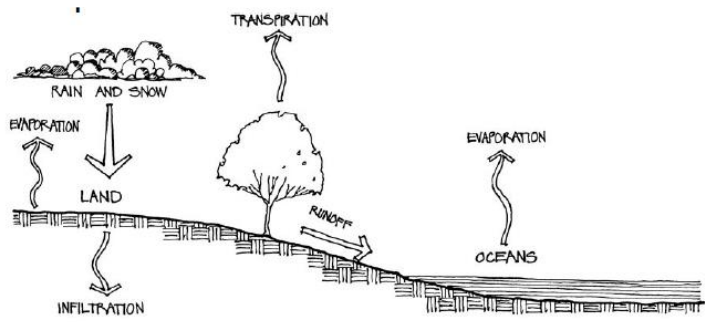
7. Aspect and/or orientation of slopes

8. Site access

9. Slope stability

1. 2. NATURAL RESOURCES _ HYDROLOGY

Water passes over and through the site in a complete cycle of percolation, interception, surface run off, evaporation, transpiration and ground water flow the complex process involves cloud formation, rainfall a watershed of rivers, lakes and streams all interwoven into a dynamic, balanced phenomenon.

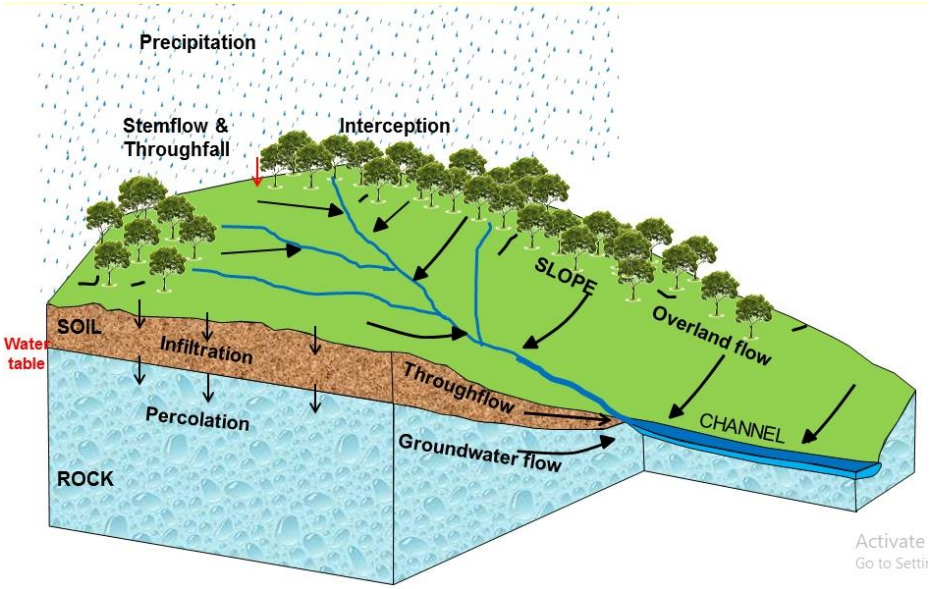


THE WATER CYCLE

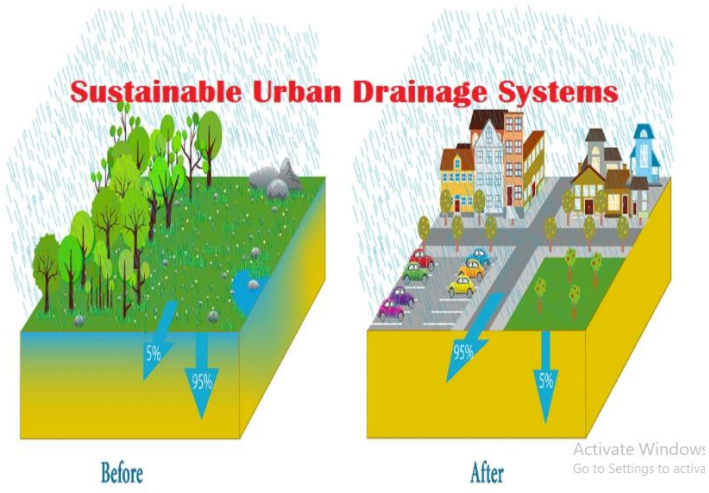
The Analysis on hydrology includes

- **Surface water –stream, lakes, pond.**
- **Yield of groundwater (rainfall)**
- **Ground water level (at what depth)**
- **Portability of water (No. of persons usage)**
- **Quality w.r.t construction**
- **Drainage basin**
- **Springs/pumping wells location.**

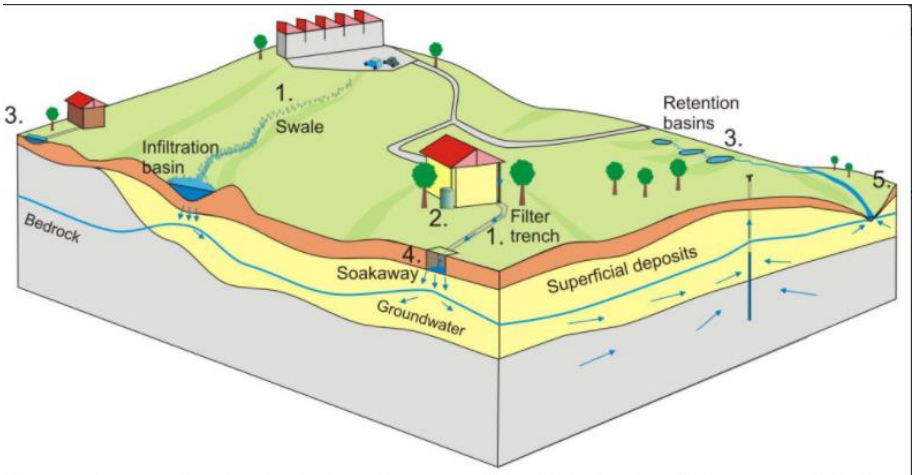
Drain Pattern



Sustainable Drainage system



Sustainable Drainage system



During a storm event, surface water flows through swales and filter trenches that remove entrained polluants (1). The peak river discharge is delayed and reduced by; storage of water for re-use (2), storage in ponds (3), or infiltration of water to the ground through infiltration basins and soakaways (4). This process improves the quality of water in rivers and decreases peak river discharge (5).

Schematic cartoon of the subsurface beneath a soakaway system

An example pre-treatment system (infiltration trench)

https://www.bgs.ac.uk/research/engineeringGeology/urbanGeoscience/SUDS/what.html

CHECKLIST TO BE DONE FOR HYDROLOGICAL STUDY

1. Sketch existing drainage pattern, off site and on site

2. Presence of surface water features

3. Quality of surface waters

4. Floodplains

5. Wetlands

6. Springs

7. Wells

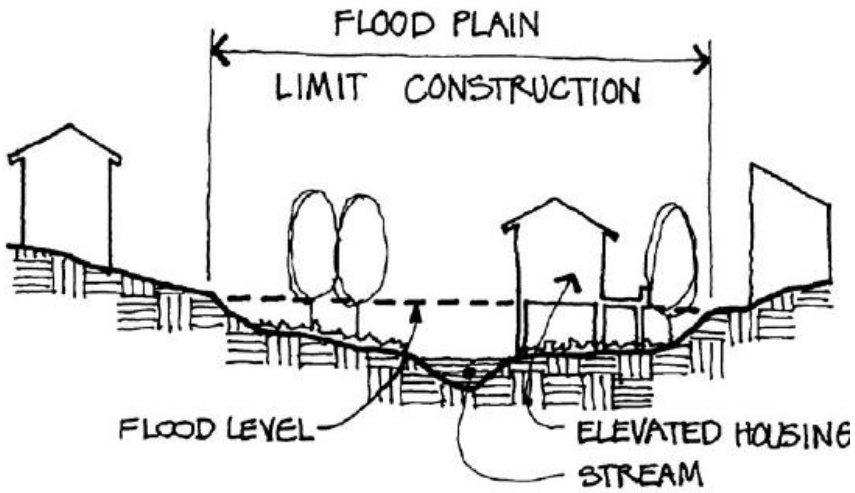
8. Aquifer

9. Anticipated drainage pattern

10. Character and quality of receiving waters

11. Runoff rates

12. Subsurface water characteristics



1.3.NATURAL RESOURCES _ SOIL

SOIL:

The upper layer of earth in which plants grow, a black or dark brown material typically consisting of a mixture of organic remains, clay, and rock particles.

SOIL TEXTURE

Generally coarser texture and sandy soils are good for construction. In the weaker layer the parking lot and movements are provided.

SOIL _ TYPES OF SOILS

1. Expansive soils – expand due to water, shrink in dry, attack foundation

2. Soil subject to creep – sloppy sites, slow movement of the soil down hill. Building foundations supported on piers below firm stable soil or bedrock will prevent damage to the structure.

3. Weak soils – do not provide adequate support to foundation, where structure will sink

4. Poorly drained soil – flat soil, clay, poor drainage called plastic' soil, less infiltration.

5. Excessively drained soil – Sand or gravel, in steep slopes –no time to infiltration, sewage go with ground water sources.

<u>Soil Conditions</u>

Designation	Building consideration	Drainage characteristics
Gravel and gravellary soils	Best location for const of building, play areas, parking	Excellent permeability
Sand and sandy soil	Good location for main building, accessory building	Excellent to impervious
High compressibility fine drained	Not good for buildings retain on permanent given belts	Fair to practically impervious
Peat and other fibrous organic soils	Poor location for structures, retain as open space.	Fair to poor impervious
Rock	Poor location for structures, excavation difficult, retain as open space.	Impervious

CHECKLIST TO BE DONE FOR GEOLOGICAL STUDY

1. Soil types
2. Moisture content
3. Depth of organic topsoil
4. Depth to water table
5. Depth to bedrock
6. Drainage characteristics
7. Susceptibility to compaction
8. Soil fertility
9. Rock outcroppings

1. Depth to groundwater
2. Seasonal high water table
3. Engineering capabilities class of soils (density, compressibility)
4. Existing indication of slope instability and/or site erosion
5. Sinkholes
6. Fault zones

VEGETATION

1. Types and extent of vegetation

2. Density of vegetation

3. Heights of vegetation

4. Health of vegetation

5. Vegetation and/or Wildlife

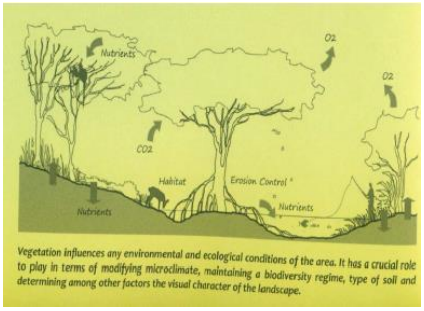
6. General types of existing vegetation

7. Quality of vegetation

8. Presence of known protected species

9. Presence of valuable specimens or communities

10. Presence of exotic and/or invasive species

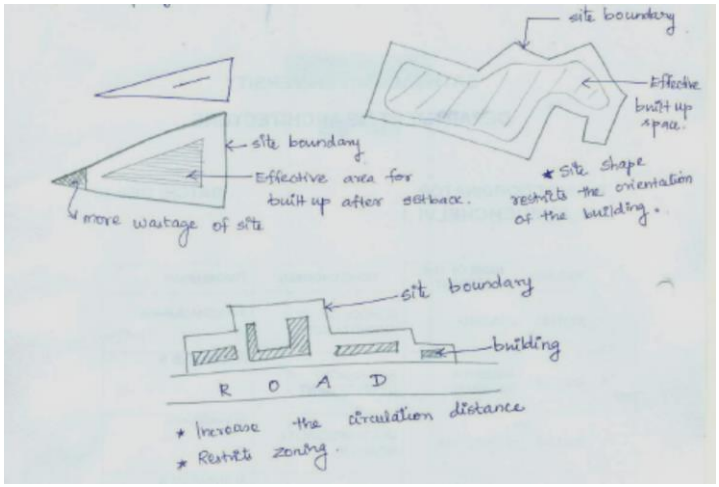


Vegetation influences any environmental and ecological conditions of the area. It has a crucial role to play in terms of modifying microclimate, maintaining a biodiversity regime, type of soil and determining among other factors the visual character of the landscape.

2. ON SITE FACTORS – ARTIFICIAL ELEMENTS

SIZE AND SHAPE OF THE SITE

Size and shape of the site decides form, zoning circulation pattern, usage of interior space etc. The shape of the site refers to both 2 dimensional (plan) and 3 dimensional (topography) form of the site.



3. NATURAL FORCES

CLIMATE

Sum total of meteorological elements that characterize the average and extreme conditions of the atmosphere over a long period of time at any one place or region of the earth surface.

WEATHER

State of the atmosphere, defined by measurement of the site meteorological element viz., air temperature, atmospheric pressure, velocity, humidity, clouds and precipitation.

Climate control – Major considerations include

i. Building placement and location (orientation)
ii. Location of roads and walkways
iii. Plant and their locations.

CLIMATE

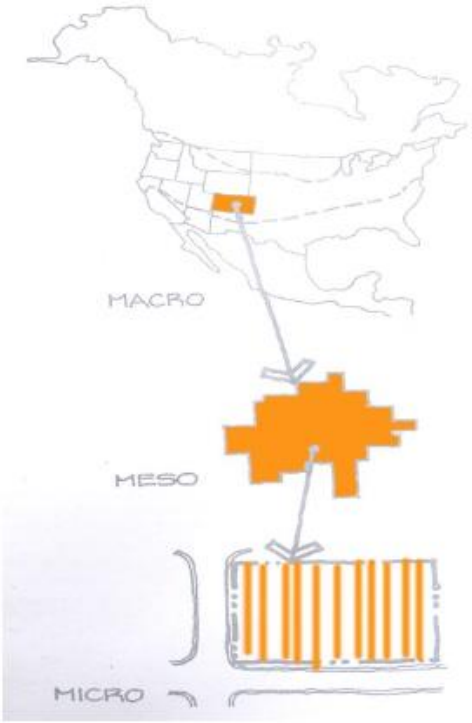
The main levels at which design for climate occurs are the :-

- **MACROCLIMATE - the broad regional climate zones.**

- **MICRO CLIMATE - the small-scale, site-specific climate variations in those larger zones.**
- **MESO-CLIMATE - applies to an area, smaller than a region but larger than a single site.**

Delhi is of the HOT-ARID REGIONS: The regions are characterized by

clear sky, dry atmosphere, extended periods of overheating, and large diurnal temperature range.



The three levels of climate
(source: Kim W. Todd- site, space & structure)

MICROCLIMATE

Refers to more localized areas site where conditions may deviate from the immediately surrounding area such as an area which is shaded and cooler better.

MACROCLIMATE

Refers to climate condition of a large regional area such as metropolitan are climate data on regional or local condition often includes

- **i. Temperature -(avg max and min , extreme cold/hot)**
- **ii. Wind -(monthly directions, average velocity, storm winds)**
- **iii. Humidity –(monthly average)**

- **iv. Precipitation –(amount of distribution)**
- **v. Sun angles**

CLIMATE – Atmospheric Pressure

Mountain and Valley Breeze
During the day, sunlight first reaches the upper elevations of the mountains before it reaches the valley floor. The air high up in the atmosphere is heated up by the mountain surface sooner than that in the valley floor. As the warmer air expands, a low pressure zone is created near the top of the mountain. This attracts the air from the valley, creating a valley breeze that blows from the valley floor upwards on the valley slopes, towards the upper elevations of the mountain. In the night, conditions of pressure are reversed and cold air from the mountain top flows down the slopes to the warmer valley below, as mountain breeze.

Land and Sea Breeze
The movement of wind between land and water is a result of differences in air pressure over the land and the ocean. As the temperature of the land surface cools down, the warm air, being less dense rises and creates a small area of high pressure above the land surface. The net movement of wind in these conditions is from the shore to the water, as the air above the sea surface is cooler and denser. This is known as land breeze. Sea breeze blows from the sea to the land, when conditions of air pressure are reversed

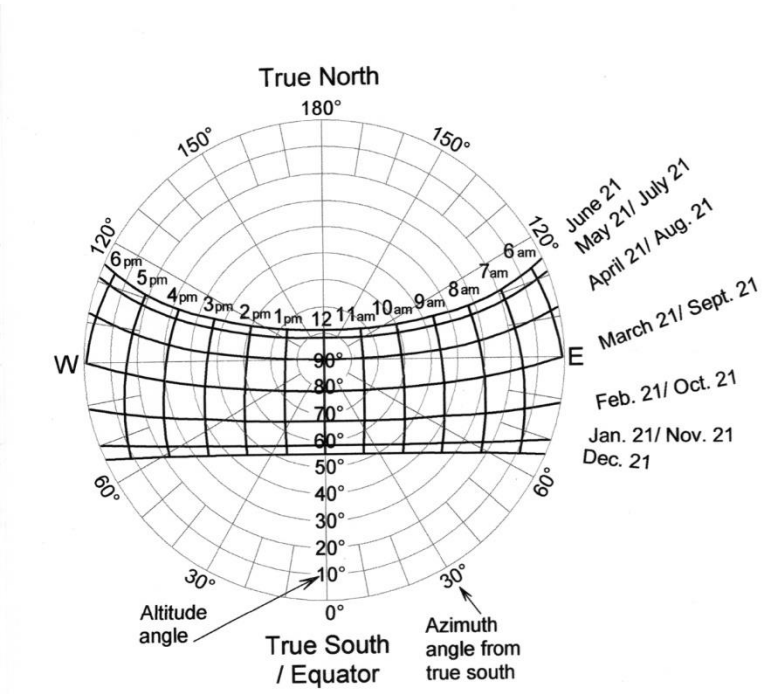
CLIMATE – Precipitation

The amount of annual and seasonal precipitation expected for a building site should influence the design and construction of the roof structure of a building, the choice of building materials, and the detailing of its exterior wall assemblies. Flat roofs require either interior roof drains or scuppers along their perimeter for drainage.

In cold climates, flat roofs are subject to heavy snow loads. The layer of snow may serve as additional insulation. Overhangs protect the exterior walls of a building from the weathering effects of sun and rain. Steeply pitched roofs shed rainwater quickly. If the angle of the slope is greater than 60°, the roof may also be able to slough off snow. Gutters and downspouts lead to a storm sewer or to a natural outfall on the site.

Sunpath Diagram

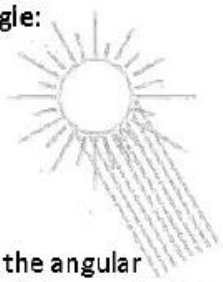
- **Altitude Angle – 0 to 90**
- **Azimuth Angle – 0 to 360**
- **Date line – Summer solstice, Winter solstice, Equinox**
- **Hour line – 6 am to 6 pm**



Sun Path Diagram, 12° N Latitude

www.HarvestingRainwater.com

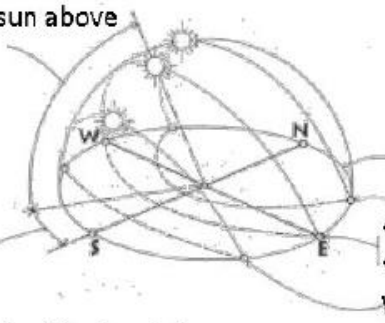
3. Sun angle:



The location, form, and orientation of a building and its spaces should take advantage of the thermal, hygienic, and psychological benefits of sunlight.

The path of the sun through the sky varies with the seasons
and the latitude of a building site.

Altitude is the angular elevation of the sun above the horizon

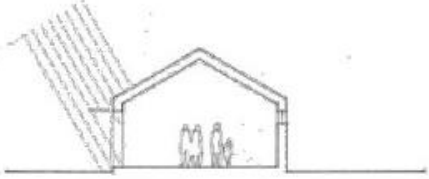


Horizon

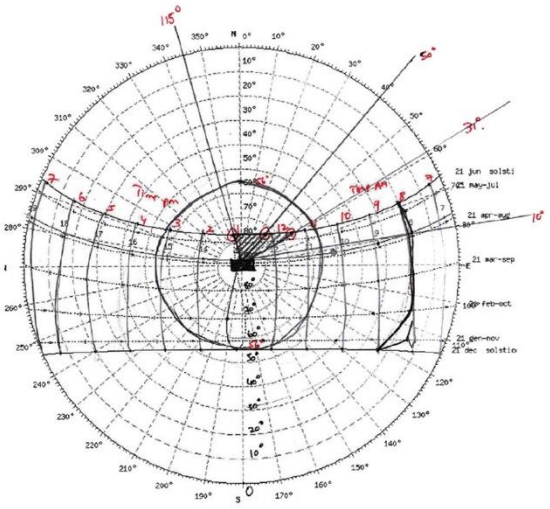
- Summer solstice (June 21)
- Spring equinox (March 21)
- Autumnal equinox (September 22)

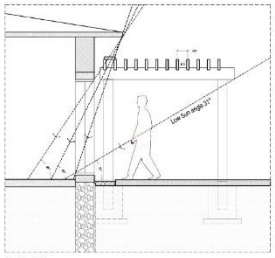
Winter solstice (December 22)

Azimuth is the angle of horizontal deviation, measured clockwise, of a bearing from a standard south direction.



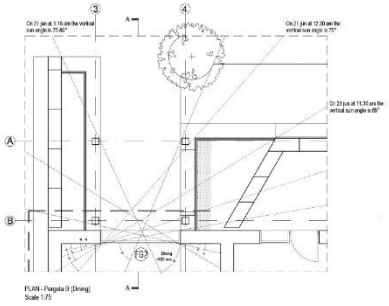
Sun Path Calculations





Section AA
Scale 1:50

Critical vertical sun angle is 56° - 71°



Northern viewport pergola

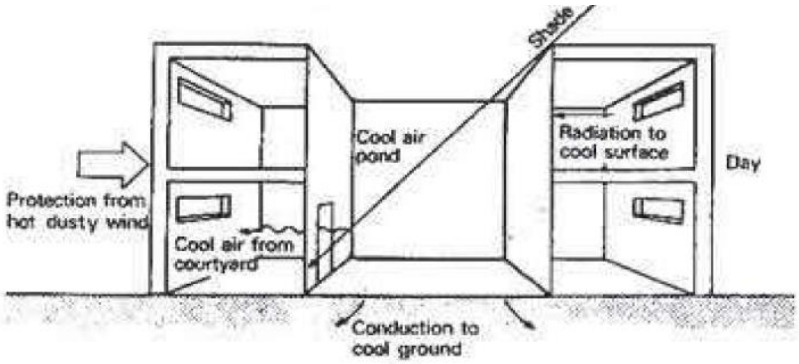
Design Parameters

The following are recommended forms and orientations for isolated buildings in different climatic regions. The information presented should be considered along with other contextual and programmatic requirements.

HOT-ARID REGIONS

Building forms should enclose courtyard spaces.

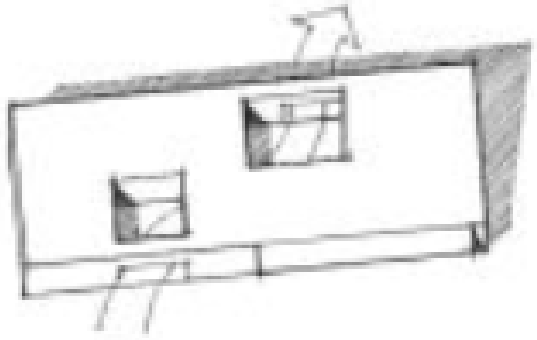
1. **Reduce solar and conductive heat gain.**
2. **Promote cooling by evaporation using water features and plantings.**
3. **Provide solar shading for windows and outdoor spaces.**



HOT-HUMID REGIONS

Building form elongated along the east-west axis minimizes east and west exposures.

1. **Reduce solar heat gain.**
2. **Utilize wind to promote cooling by evaporation.**
3. **Provide solar shading for windows and outdoor spaces.**



CLIMATE – Wind

Prevailing wind refers to the direction from which the wind most frequently blown in a given area of the country. Wind flow changes due to mountains, large bodies of water valleys, canyons, river basins, sea shores, flood plains, deserts.

The direction and velocity of prevailing winds are important site considerations in all climatic regions. The seasonal and daily variations in wind should be carefully considered in evaluating its potential for ventilating interior spaces and outdoor courtyards in warm weather, causing heat loss in cold weather, and imposing lateral loads on a building structure. Prevailing wind refers to the direction from which the wind most frequently blown in a given area of the country. Wind flow changes due to mountains, large bodies of water valleys, canyons, river basins, sea shores, flood plains, deserts.

The direction and velocity of prevailing winds are important site considerations in all climatic regions. The seasonal and daily variations in wind should be carefully considered in evaluating its potential for ventilating interior spaces and outdoor courtyards in warm weather, causing heat loss in cold weather, and imposing lateral loads on a building structure. The movement of air through a building is generated by differences in air pressure as well as temperature. The resulting patterns of air flow are affected more by building geometry and orientation than by air speed.

The wind system is generated by the atmospheric pressure gradient; winds blow from zones of higher atmospheric pressure to those of lower atmospheric pressure. On a global scale, the general direction of movement is from the poles to the equator. The wind system transports heat and moisture to the atmosphere. The direction of prevailing winds and their velocity in different seasons is of great significance in planning for human settlements and farm-land.

II. OFF SITE FACTORS (Surrounding Environment of the Site)

i. Land use patterns

ii. Stream and drainage source (outside the site boundary)

iii. Visual, smells, sounds (borrowed views).

iv. Neighboring aesthetic character

v. Public utility locations and capacities

vi. Transportations ways and systems

vii. Access, skyline (buildings), temples, (eg.Madurai).

A. Natural Hazards

1. Earthquake fault zones

2. Hurricane zones

3. Tornado zones

4. Flood plains

5. Tidal inundation areas

6. Wet zones (peat bogs, quicksand, etc.)

7. Areas of poisonous plants

8. Areas of poisonous snakes or reptiles

9. Areas of annoying insects

B. Historic Or Cultural Features And/Or Community Interests

1. Known historical features

2. Unique natural features or character

3. Existing parks or public areas

4. Existing informal public access and/or use on the site

5. Community character such as architectural style and/or conventions

6. Local landscaping

7. Local materials

C. Environmental Concerns

1. Past site uses

2. Neighboring site uses

3. Evidence of fill, dumping, or disposal

4. Evidence of contamination (stained soils, stressed and/or dead vegetation, and so on)

5. On-site storage

6. Impact of site development on local water and air quality

NATURAL FACTORS	SURVEY INDICATES
Soil: To determine suitability of site to support buildings and roadways and gaining insight into existing plant communities	•Soil characteristics at various depth (geology) •Subsoil water level •Soil fertility •Rock cut crops (experts civil engineer)
Vegetation: Vegetation type and patterns represent a major visual, recreational and ecological resource. This component is influential in determining the location of most natural based outputs.(Horticulturist Engineers)	•Types of plants (Botanical name) •Spread of trees. •Radius of the trunk and tree •Understorey heights, over storey heights.
Hydrology: The type and quality of onsite water is a critical visual and recreational resource and major infrastructure.(Environmental engineers.)	•Survey water, stream, pond, lake, reservoir •Drainage basins. •Springs/ pumping wells. •Yield •Quality of water potability.

Climate: Design of built environment is directly connected to the climatic factors and solar orientation. Temperature, rainfall and wind date are required to design. (Meteorological dept)	•Sun path diagram •Temperature max/min •Rainfall average •Wind breeze direction •Onsite north point.
Topography: Basic landform or topographic structures of a site is a visual and aesthetic resource that influence the location of various land uses. Helps to reveal spatial configuration of the site	Contours at regular intervals
Aesthetics: Theyareresponsibleforlocatingsitesforrecreation.Ithasitsrelevancewithurbancontextalso.	•major spatial determinants, landforms. •Landmarks eg. Mountains •Scenic vista •Water image.

Existing Land use: A thorough knowledge of existing land uses on or adjacent to site provides an understanding or constraints	•Present land use of the site surroundings. •Future land use as per master plan to check compatibility.
Physiographic obstructions: They are natural elements that obstructor hazardous to ettain types of development seg.,earthquake,floods.	•Fault zone •Flood plains •Quick sand.
Man made obstructions: These are man made elements that can obstruct or influence a certain type of developments. Eg. Buildings (Heritage). Service lines - water,sewer,electricity,telephoneline,drives,transportation,masonrywalls,wells,ponds,etc.,	•Buildings outline detailed plan. •Service lines alignment details like length, radius, capacity etc., •Well, depth etc.,

DRAINAGE PATTERNS

1. **Surface Drainage**

Surface drainage involves the removal of runoff water by means of surface devices only. It is generally preferred over subsurface systems, because it is less expensive, it allows some water to percolate into the ground. The following are some general rules of surface drainage:

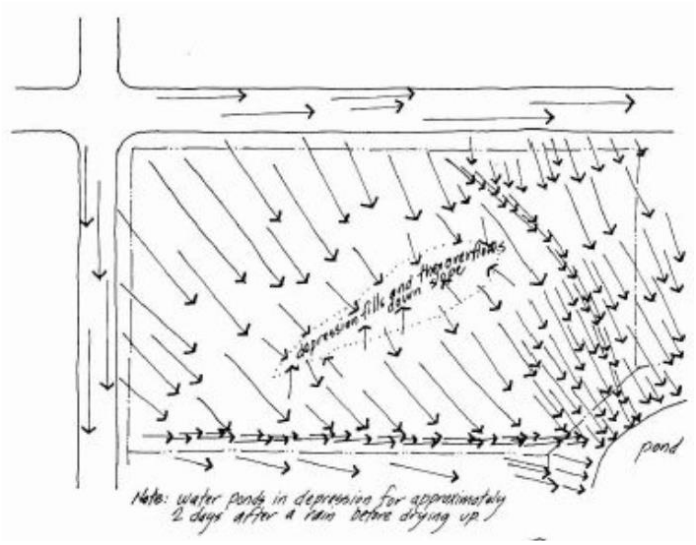
1. Water flows as a result of gravity; therefore, all surfaces must be sloped for drainage.

2. Water always flows perpendicular to the contours.

3. Good drainage requires a continuous flow. Slow-moving water may create bogs, while water moving too fast will cause erosion.

4. Water should always be drained away from structures.

5. Large amounts of water should never be drained across circulation paths.



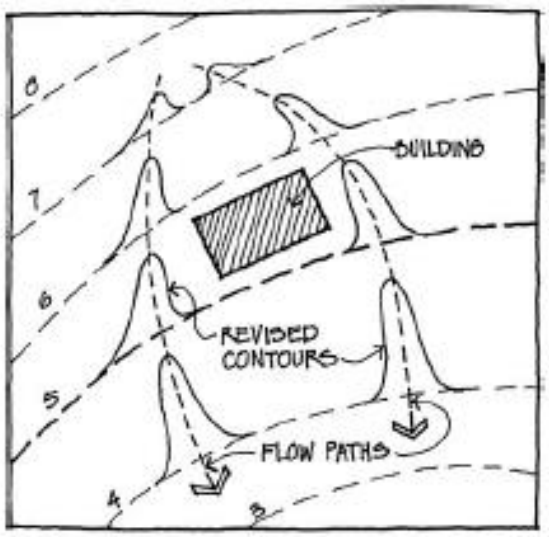
Desirable slopes for surface drainage are as follows

- **Open land -1/2 % minimum**
- **Streets -1/2 % minimum**
- **Planted areas -1 % minimum to 25 % maximum**
- **Large paved areas -1 % minimum**
- **Land adjacent to buildings -2 % minimum**
- **Drainage swales -2 % minimum to 10 % maximum**
- **Planted banks -up to 50 % maximum**

Following are the most common methods of surface drainage:

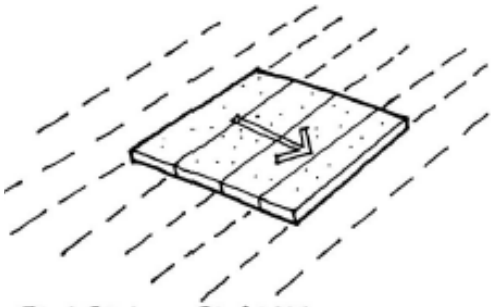
1. <u>Swale.</u> Sloping areas can be drained by creating swales, which are graded flow paths similar to valleys. Swales are graded around structures with finish contours always pointing uphill and flow paths shown perpendicular to the revised contours.

2. <u>Sloping plane.</u> This is the simplest, cheapest, and, consequently, the most common way to drain a relatively level area. The area tilts in one direction, so that the water drains to the low side. Adjacent structures are always located at the high side.

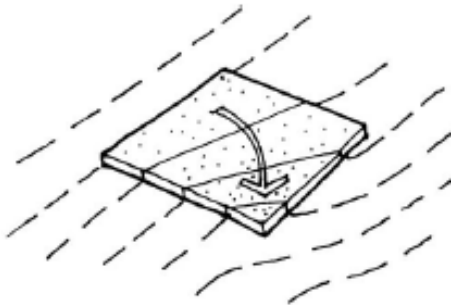


CREATING SWALES

3. <u>Warped plane.</u> The high side is level, similar to the sloping plane. The contours, however, are fan-shaped, so that the entire area drains to one low corner.

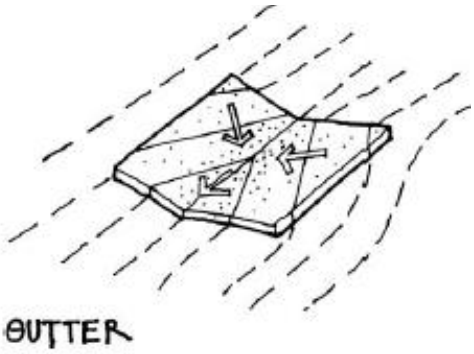


SLOPING PLANE

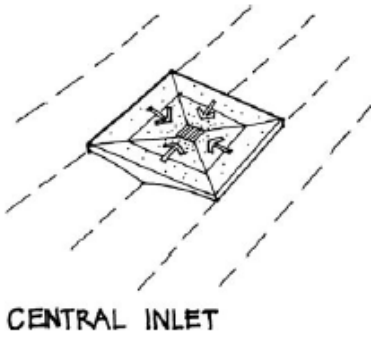


WARPED PLANE

4. <u>Gutter:</u> Gutters are formed by two sloping planes that create a valley. The planes are slightly warped so that water can run down the valley to a collection point. When adjacent to a structure, the top edge of one sloping plane will be level.

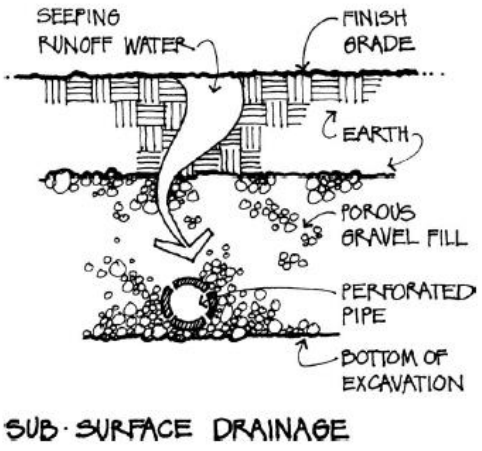


5. <u>Central inlet:</u> Large flat areas, especially where enclosed (courtyards, patios, etc.) employ a central drain toward which all surfaces slope. The disadvantage of this arrangement is that it requires a catch basin and sub-surface piping to dispose of the water.



2. Sub-Surface Drainage

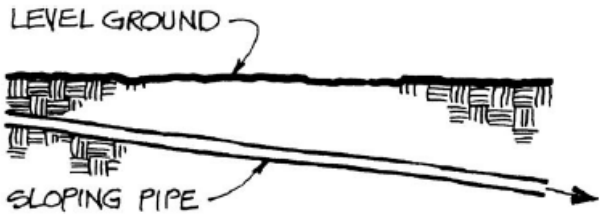
Sub-surface drainage refers to the collection, conduction, and disposal of water below ground level. Runoff water flows not only on the surface, but also below the ground surface. Collection of sub-surface water utilizes gravel-filled ditches and perforated drain pipe, or drain pipe laid with open joints. Runoff water that seeps into the earth flows vertically through the gravel until it reaches the openings of the drain pipe. This pipe collects the free-flowing water and carries it away in the direction of the sloping pipe.



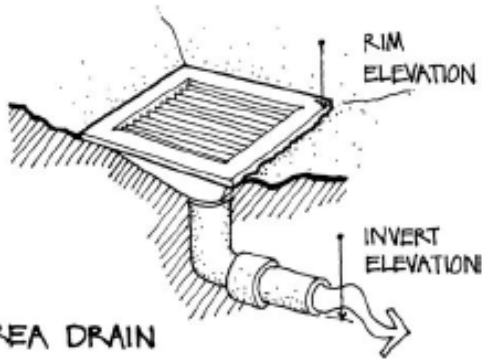
Closed sub-surface systems consist of various fabricated collectors together with sections of closed pipe, which are used to carry water below grade from collection points to disposal areas. Such systems are useful in level areas, since drain lines can be buried progressively deeper, assuring an adequate slope for drainage.

Among the common fabricated collectors are the following:

1. **<u>Area drain</u> - This device collects water from the low point of a limited area and conducts it.**

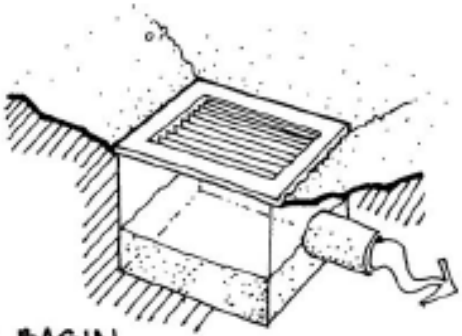


DRAINAGE INDEPENDENT OF GROUND SLOPE



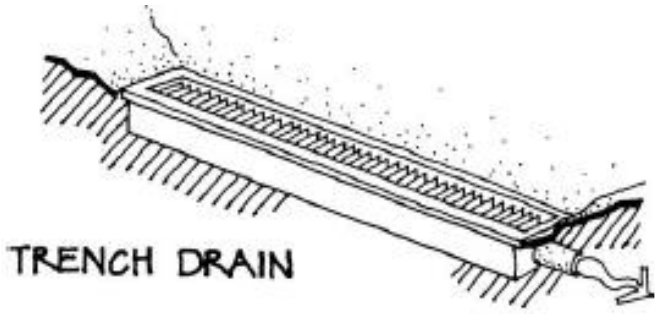
AREA DRAIN

2. **<u>Catch basin</u>: This is similar to an area drain, except deeper and generally larger in order to catch and retain sediment which may clog the system.**

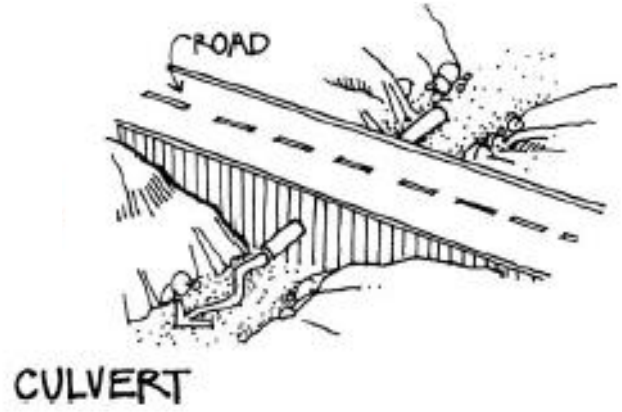


CATCH BASIN

3. **<u>Trench drain:</u> This device is used to collect water along a wide strip before conducting it to underground pipes. It is suitable at the entrance to an underground garage, for example, where it collects the runoff water flowing down a sloping driveway.**



- **Pipes which run underground beneath roads, driveways, or paths are referred to as *culverts.* They vary in size from six inches to several feet.**
- **Culverts should be straight, cross the road at right angles, and be sufficiently strong to resist moving traffic loads.**



DRAINAGE SYSTEMS

Drainage pipes are manufactured from clay, concrete, plastic, or composition materials. They are rarely less than four inches in diameter and require a minimum slope of one percent to assure proper flow. Following are some sub-surface drainage general rules:

1. Always determine a site's disposal points before designing the drainage system.

2. Sub-surface drain lines should travel in straight lines; changes of direction occur only at catch basins.

3. Avoid running drain lines beneath or through building foundation walls, retaining walls, or other construction.

4. Drain lines should follow the natural site slope as much as possible to minimize the depth of trenches.

5. Drainage systems often require several lines, and a branching system is frequently the most efficient solution.

DISPOSAL SYSTEM

A. Disposal Of Unwanted Rain Water

B. Disposal Of Solid And Liquid Waste (Sewage Disposal)

Sources of water:

1. Municipal water

2. Lakes, ponds, reservoirs, streams and rivers

3. Wells

4. Effluent water

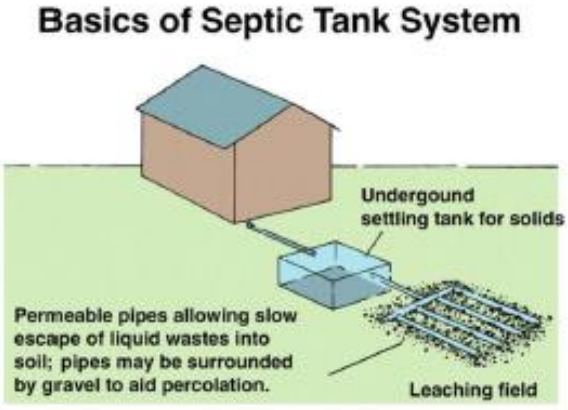
DISPOSAL SYSTEM – Water Shed

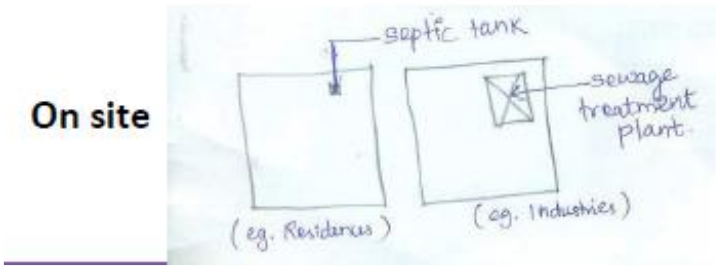
A water shed is the area of land that drains to a particular point along a stream. Each stream has its own watershed. Topography is the key element this area of land. The boundary of a watershed is defined by the highest elevations surrounding the steam to deep of water falling outside of the boundary will drain to another watershed.

Sewage disposal

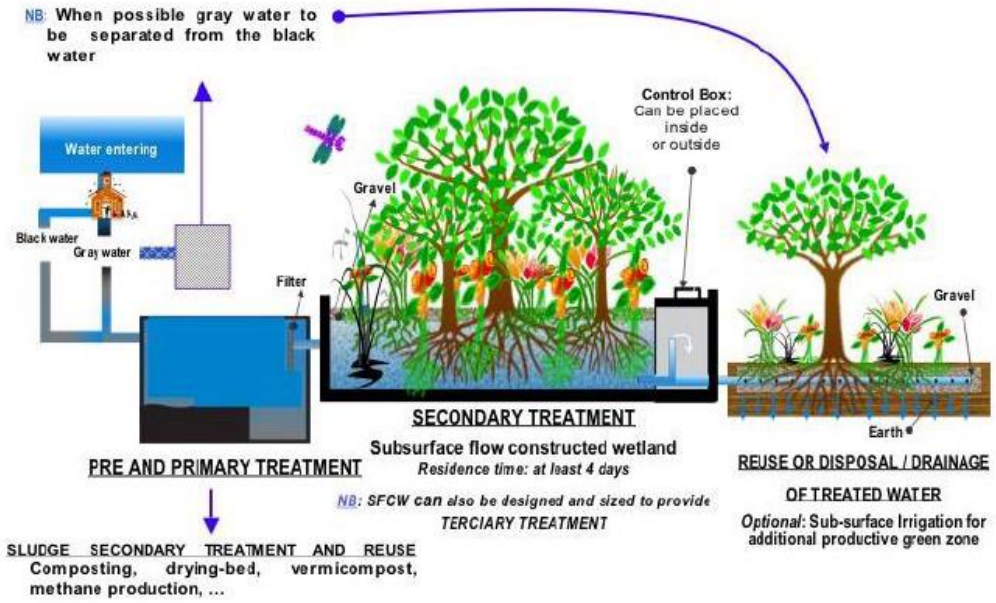
- **Refuse from residences and other buildings.**
- **Necessary in most building development.**

They are piped offsite to municipal water system. Treated and disposed of on site for protection of public health safety and welfare.

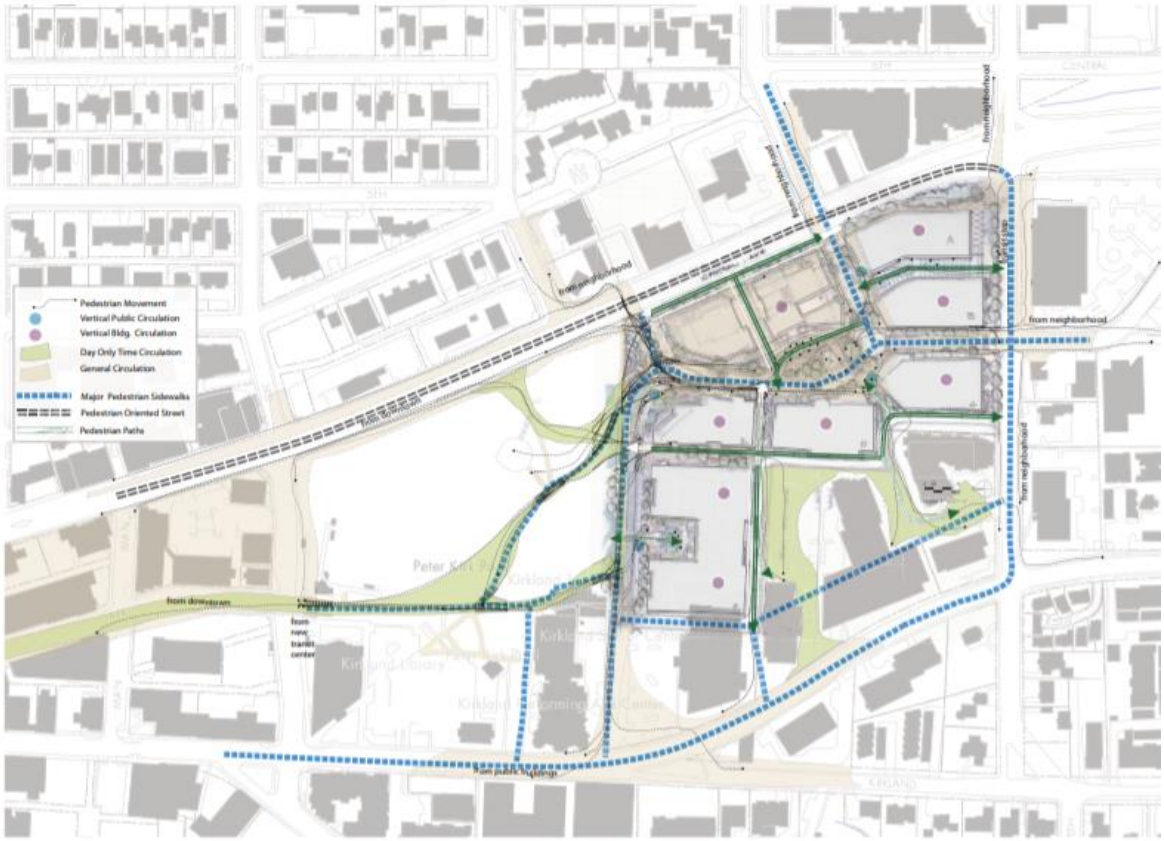


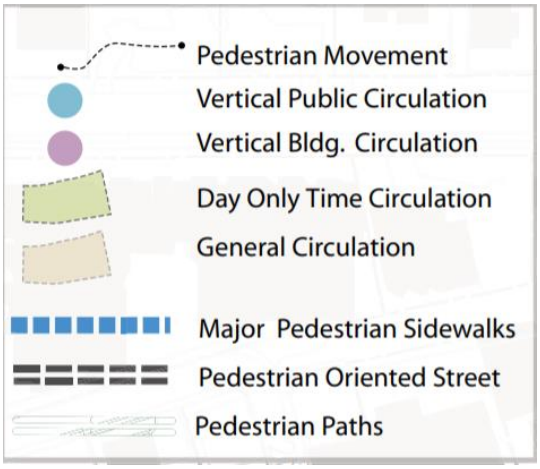


Treatment System



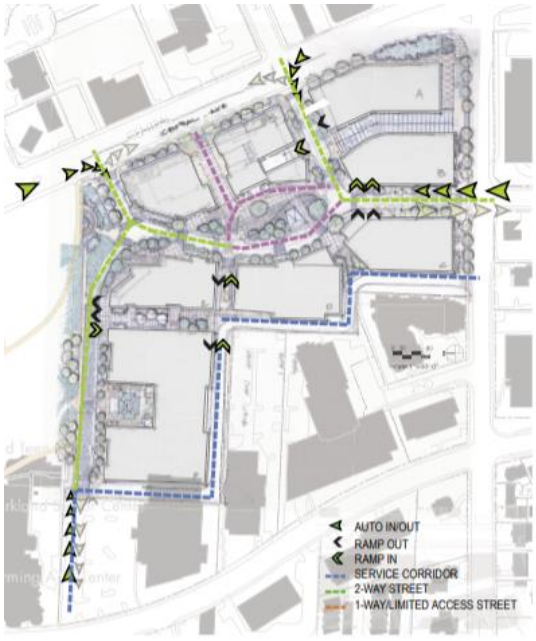
ORGANIZATION OF VEHICULAR AND PEDESTRIAN CIRCULATION





VEHICULAR CIRCULATION

This plan introduces a hierarchy of street types that will circulate vehicular, pedestrian and service groups in a logical network about the site. The street network establishes a city grid to improve pedestrian and vehicular circulation within the site, and create strong connections with the surrounding street system. Access to the parking garage will be located in several places adjacent to these entries point with the primary access from Street.



The central circulator street functions as the site's main street, supporting pedestrians and vehicles also could support special events, with removable bollards to create a pedestrian only zone for festivals and community events. A slip street at Central Way will improve the pedestrian environment on this busy street and allow for the presence of street level retail. Service and fire access to be established.

A road classification system divides and categorizes the roads into different groups or classes depending on the type of service each road is required to provide. The classification system clearly defines which roads should carry higher volumes of traffic and which roads should carry lower volumes.

TYPES OF ROADS

The Roads are classified into Three System

1. Primary System:

a) Expressways.

b) National Highways (NH).

2. Secondary System:

a) State Highways (SH).

b) Major District Roads (MDR).

3. Tertiary system or Rural Roads:

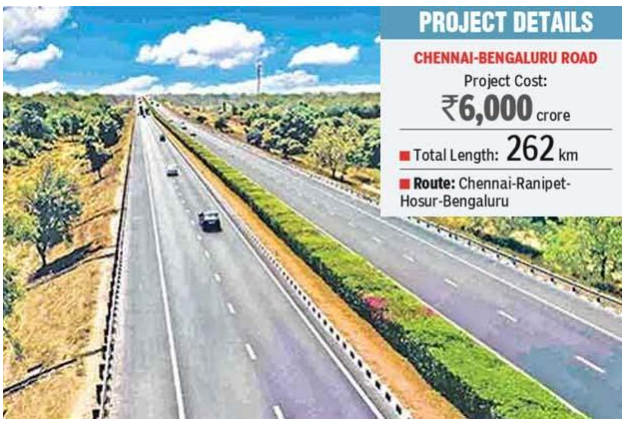
a) Other District Roads (ODR).

b) Village Roads (VR).

1. Primary System:

a) Expressways

An expressway is a divided highway for high-speed traffic with at least, partial control of access.Have superior facilities and design standards. These may be NH of SH. Multilane, No cross traffic, No stop signs, No parking.



b) National Highways (NH)

Main Highways running through the length and breadth of country. Connects major ports, foreign highways,State capitals, large industrial and tourist centers.

2. Secondary System:

a) State Highways (SH)

State highways are highways connecting major cities through-out a state. They also connect with National Highways or state highways of neighboring states.

SH-49 Upgraded as NH,332A (ECR)	Thiruvanmiyur – Mahabalipuram – Marakanam – Puducherry
SH-49A (Rajiv Gandhi Salai)	Chennai – Mahabalipuram
SH-49B	Thirukalukundram – Mahabalipuram

b) Major District Roads (DR).

Important roads within a district serving areas of production and markets. Connects some other MDR or with National Highways.

3. Tertiary system or Rural Roads:

a) Other District Roads (ODR)

Serves rural areas of production. Connects to market centers, taluka headquarters, block development headquarters or other main roads.

b) Village Roads (VR).

Roads connecting villages or groups of villages with each other and to the nearest road of higher category

HIERARCHY OF ROADS (functions and capacities)

- **Expressway (High Speed Traffic)**
- **Arterial Roads,**
- **Sub-arterial Roads,**
- **Collector Roads,**
- **Local Street.**

(1) Arterial

A street primarily for through traffic, usually on a continuous route. These should be coordinated with existing and proposed expressway systems. These are divided highways with full or partial access.

(2) Sub-arterial

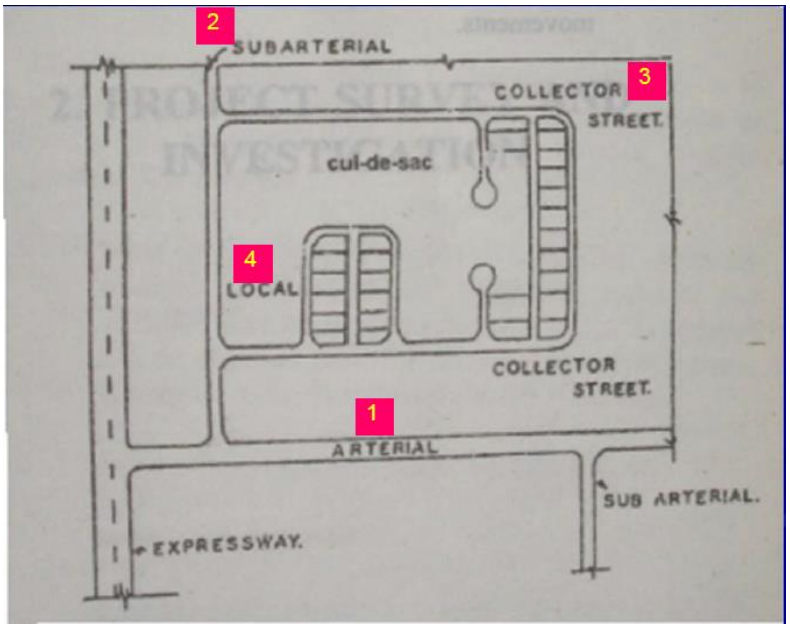
A street primarily for through traffic, usually on a continuous route but offering somewhat lower level of traffic mobility than the arterial

(3) Collector Street

A Street for collecting and distributing traffic from and to local streets and also for providing access to arterial streets.

(4) Local Street

A street primarily for access to residence, business or other abutting property.



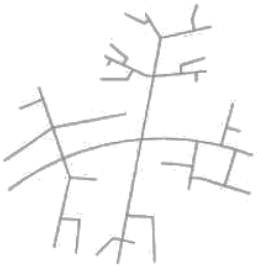
Source:https://www.scribd.com/doc/80602972/Classification-of-Roads-in-India

https://en.wikipedia.org/wiki/Roads_in_India

ROAD PATTERN AND NETWORKS

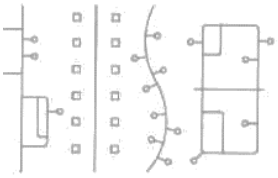
The primary mode of transport from one part to another. Divides the landmass into various pattern to provide the best suitable path between destinations. Can be classified in many ways. Most common classification is based on speed and accessibility. Classification combine to form a pattern.

ROADWAY PATTERNS



Classic Pattern

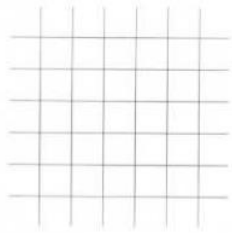
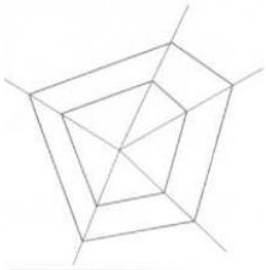
- Favors the specialization of major vs. minor arteries
- Makes the intersection problem manageable by distributing instead of concentrating at center
- Very sensitive to interruptions at single point



Linear System

- Flow primarily between two points
- Typically found along railroads, canals, highways
- Lack of focus

Table 342-1. TYPICAL ROADWAY PATTERNS

		Advantages	Disadvantages
	*Grid Pattern*	• Simplicity, regularity • Ease of layout (engineering) • Convenient access • Good orientation, easy to follow • Good on level land • Suitable for complex distributed flow	• Visual monotony • Disregard of topography • Vulnerability to through traffic • Lack of difference between heavily and lightly traveled ways
	*Radial Pattern*	• Good direct line of travel	• Not good when neither origin nor destination are related to center • Difficult for service • Causes problems in local flow and creates difficult building sites

Road network can be laid in various patterns. These patterns in which the road network is laid could be

1) Rectangular/Grid /Block pattern

2) Radial Network

3) Organic City Layout

4) Grid and Radial Pattern

5) Concentric and Radial

6) Hexagonal Pattern

1. RECTANGULAR / BLOCK PATTERN

In this pattern, the whole area is divided into rectangular blocks of plots, with streets intersecting at right angles. The main road which passes through the center of the area should be sufficiently wide and other branch roads may be comparatively narrow. The main road is provided a direct approach to outside the city.

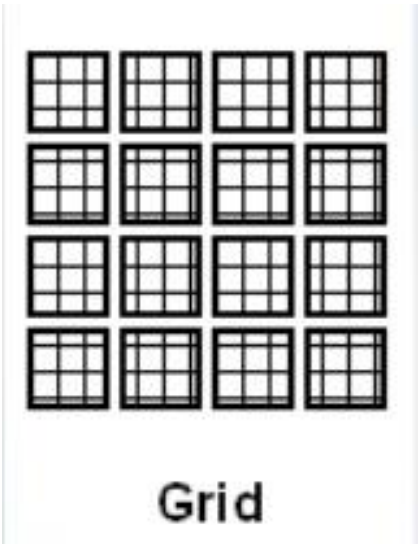
<u>Advantages:</u>

The rectangular plots may be further divided into small rectangular blocks for construction of buildings placed back to back, having roads on their front. In this pattern

has been adopted for the city roads. The construction and maintenance of roads of this pattern is comparatively easier.

Limitations:

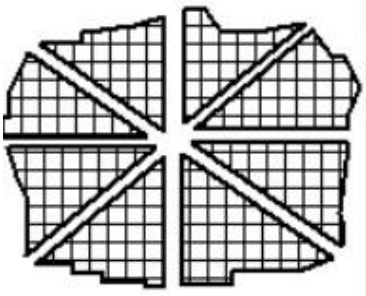
This pattern is not very much convenient because at the intersections, the vehicles face each other

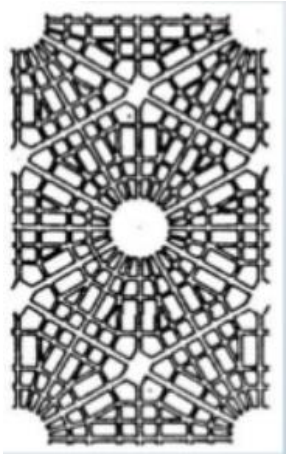


EXAMPLE: CHANDIGARH HAS RECTANGULAR PATTERN

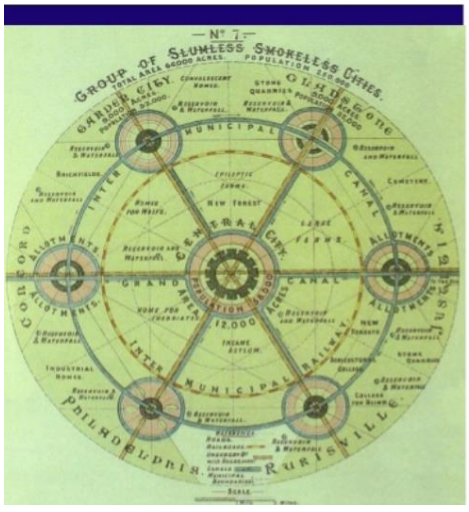
2. RADIAL PATTERN

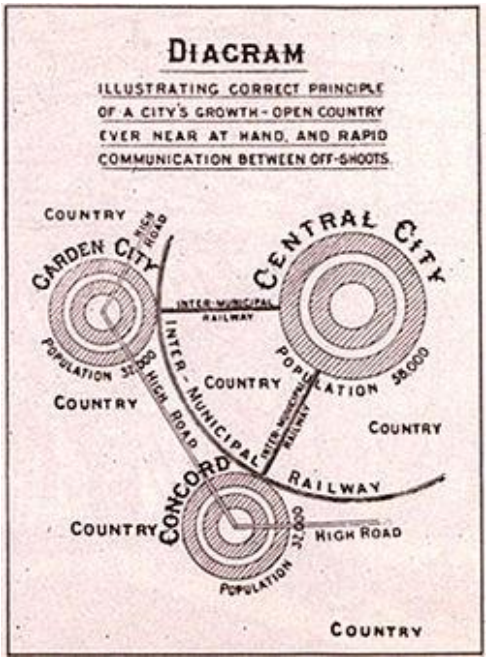
Based on Star Layout. Inner outer ring roads linked by radiating roads. Core has the business area. Industrial area interspersed with residential. Periphery has green belt.

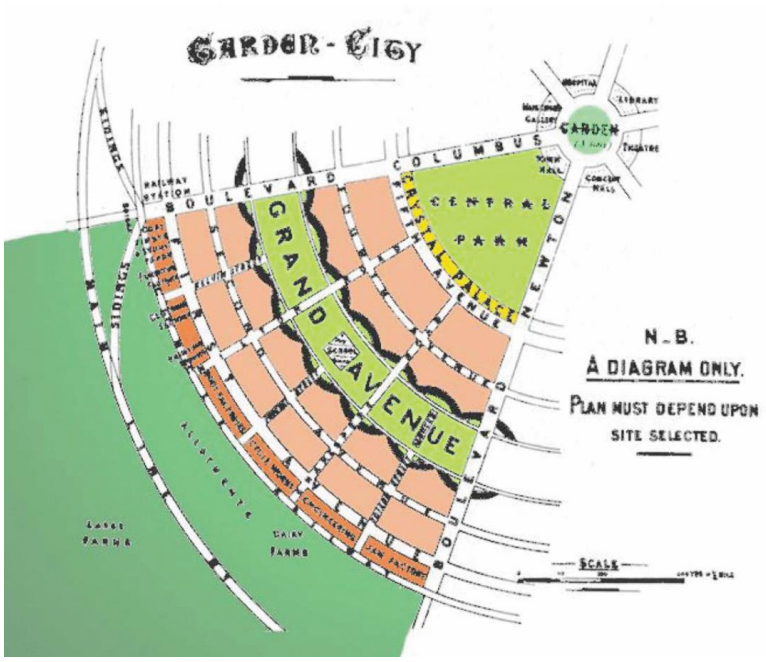




CONCEPT BASED ON RADIAL PLANNING

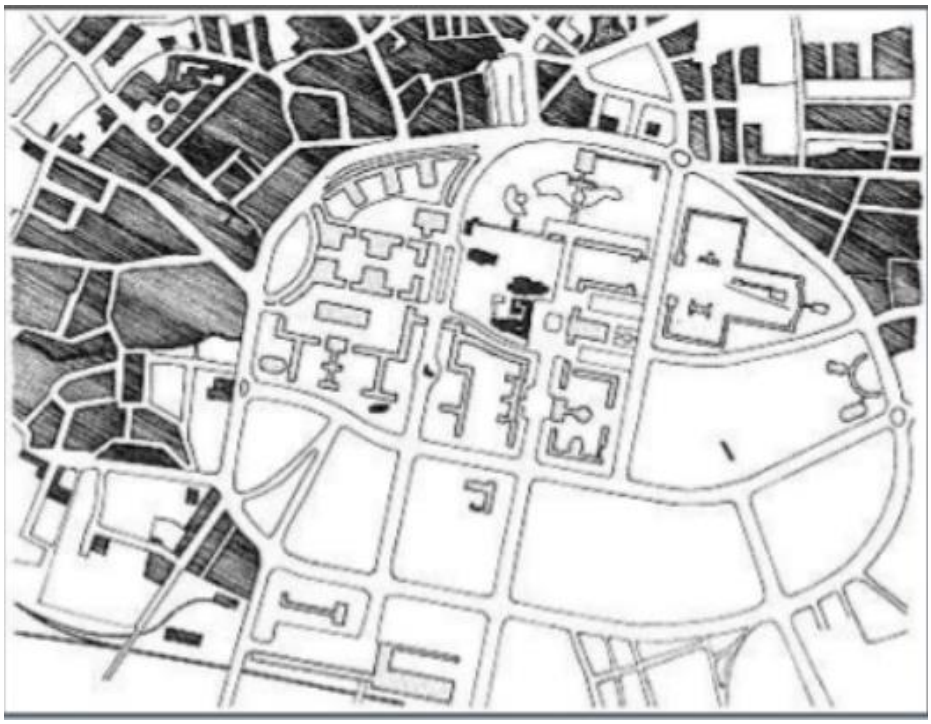






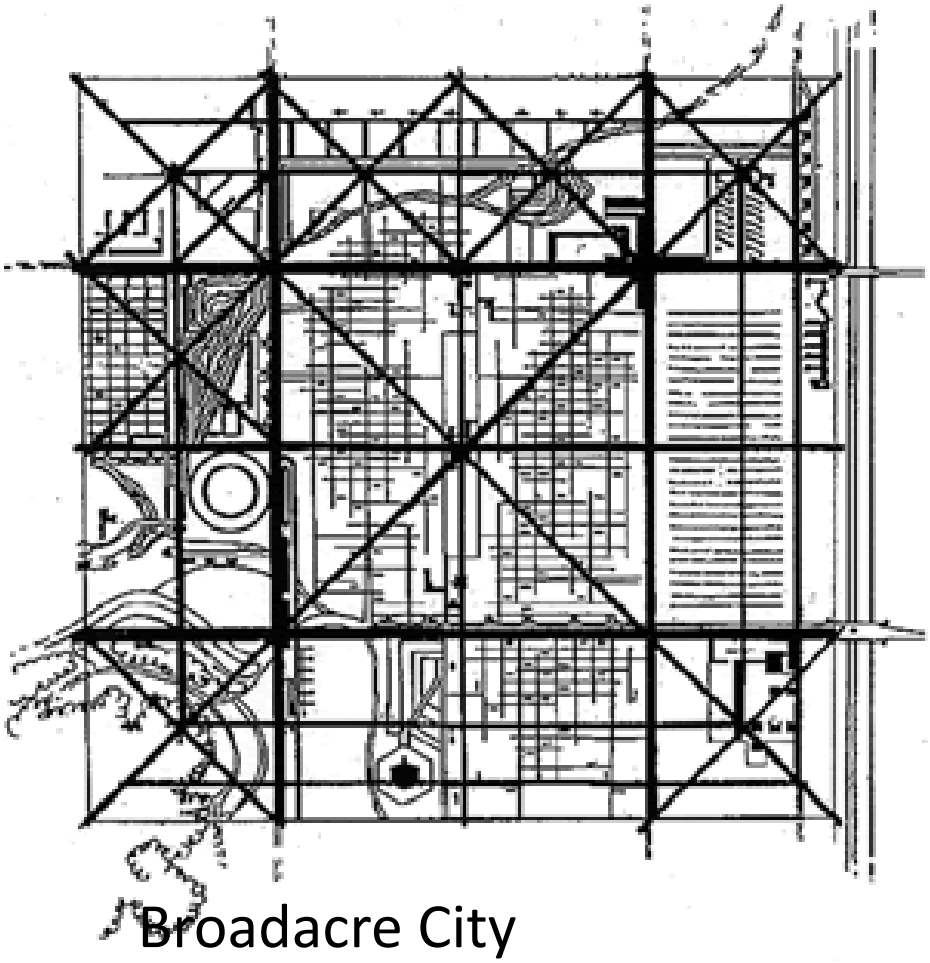
3. ORGANIC PATTERN

Amoebic pattern. Roads placed wherever necessary. Lack of acute pointed angles. Parabolic in Nature



4. GRID AND RADIAL PATTERN

This type of network is a combination of radial and block pattern. A radial network of roads radiate from the center outwardly with block pattern network of roads in between the radial main streets.



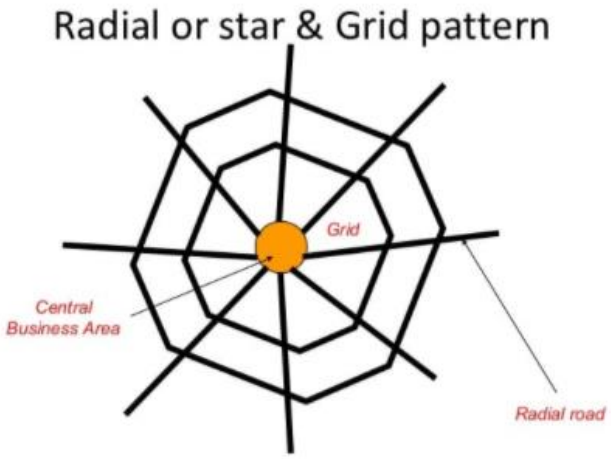
5. RADIAL PATTERN AND GRID

Advantages:

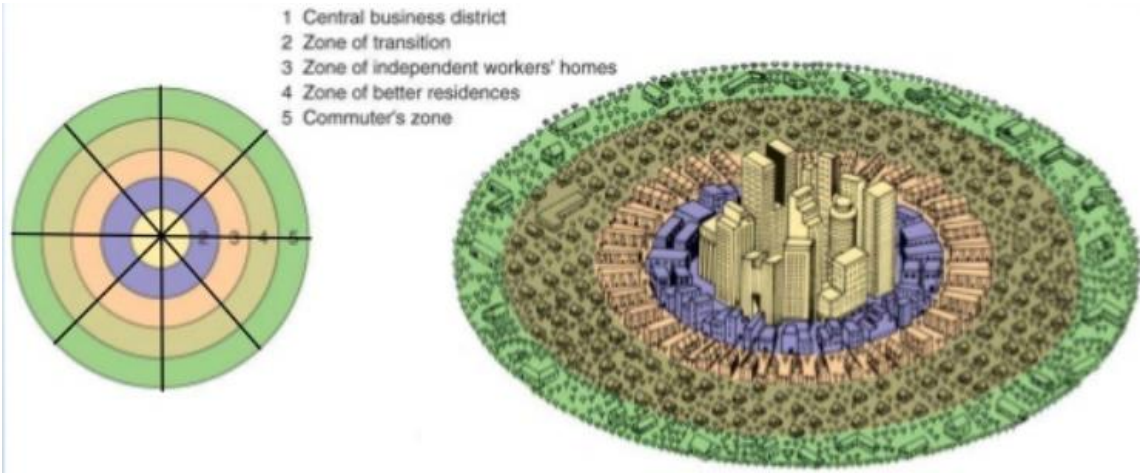
Keep vehicular traffic safe with a high proportion of 3-way intersections. Improve traffic flow in both directions. Improve land use efficiency and unit density.

Limitations:

Islands separating the approach and exit lanes, known as splitter islands, should extend far enough. Traffic signs, pavement markings, and lighting should be adequate so that drivers are aware that they should reduce their travel speed.



6. CONCENTRIC ABD RADIAL PATTERN



Advantages:

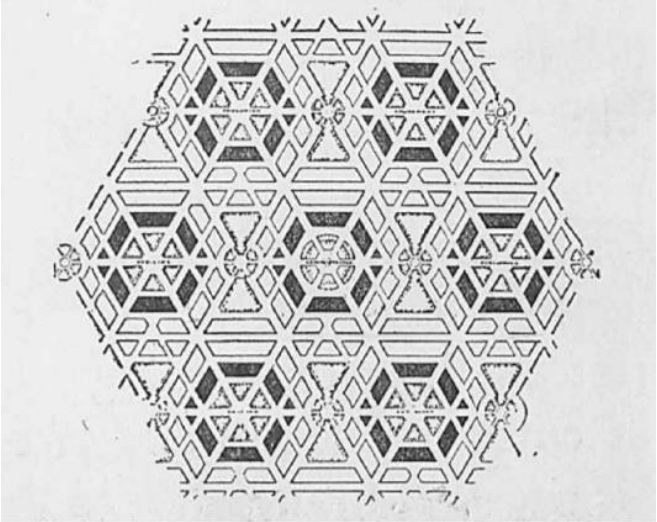
At traditional intersections with stop signs or traffic signals, some of the most common types of crashes are right-angle, left-turn, and head-on collisions. These types of collisions can be severe because vehicles may be traveling through the intersection at high speeds. With circular pattern, these types of potentially serious crashes essentially are eliminated because vehicles travel in the same direction. Installing circular pattern in place of traffic signals can also reduce the likelihood of rear-end crashes.

Limitations:

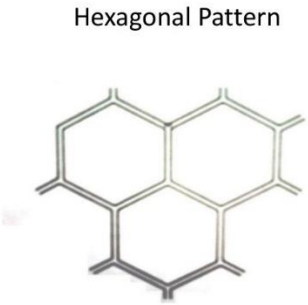
Approach roads should be sufficiently curved, far enough in advance of circular pattern, to reduce vehicle speeds. Traffic signs, pavement markings, and lighting should be adequate so that drivers are aware that they are approaching a roundabout and that they should reduce their travel speed

7. HEXAGONAL PATTERN

Hexagon permit interesting variety in the treatment of the street facades over that developed by any straight or continuously curved street.



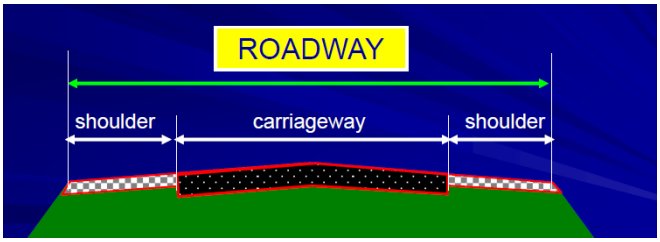
Hexagonal plan, Charles Lamb, 1904. Source: Triggs (1909).



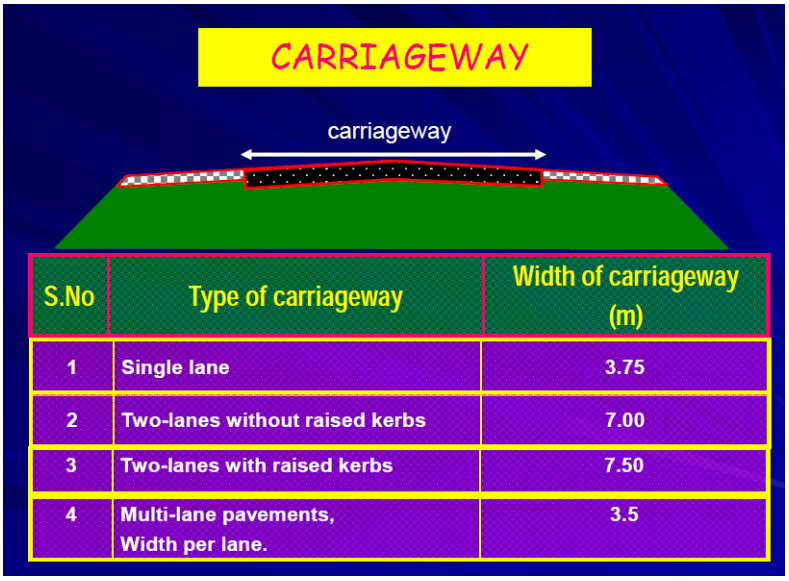
Lamb advocated his hexagonal city plan as a practical yet artistic solution to the modern city. The more this plan is studied, Lamb wrote, the more it will be found to approach the idea of practicability, primarily in regard to shorter distances that a person would have to walk or drive from any one point to another

ROAD WIDTHS

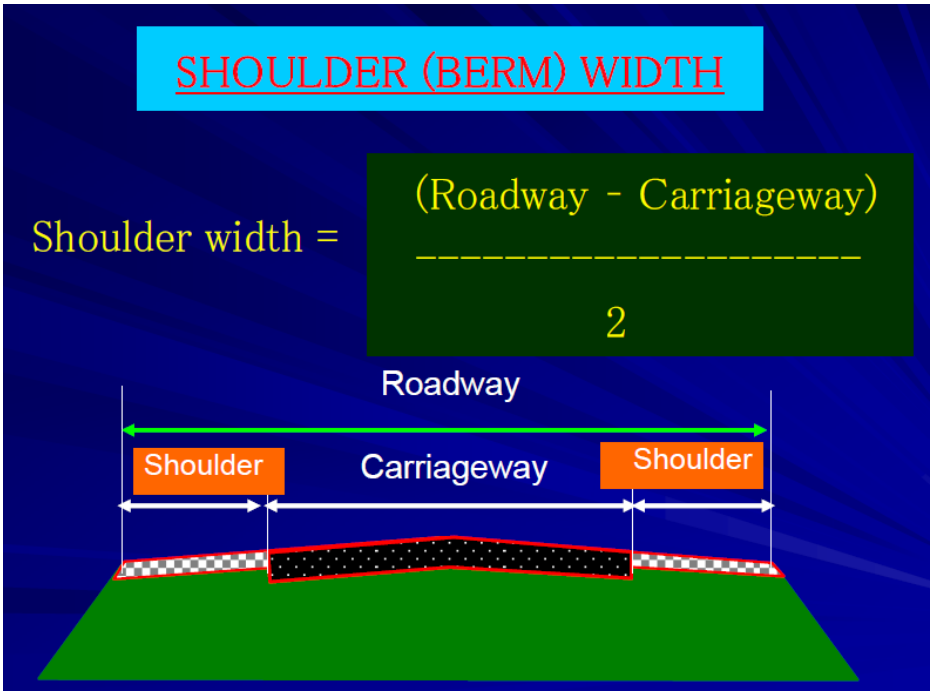
Roadway width is the sum total of carriageway width and shoulder width on eitherside.

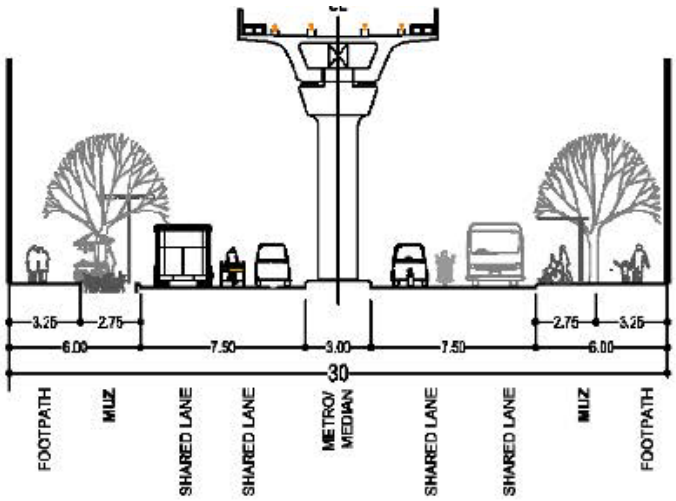


A carriageway consists of a width of road on which a vehicle is not restricted by any physical barriers or separation to move laterally. A carriageway generally consists of a number of traffic lanes together with any associated shoulder.



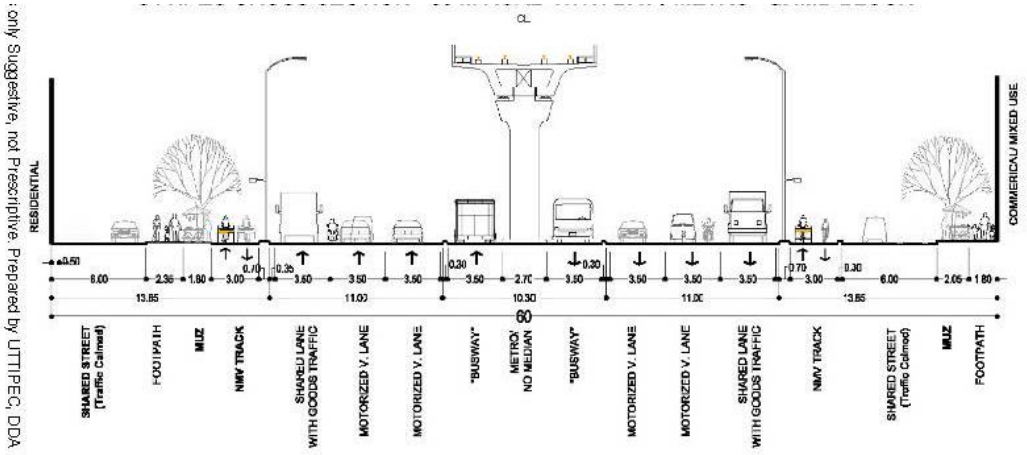
S.No	Type of carriageway	Width of carriageway (m)
1	Single lane	3.75
2	Two-lanes without raised kerbs	7.00
3	Two-lanes with raised kerbs	7.50
4	Multi-lane pavements, Width per lane.	3.5





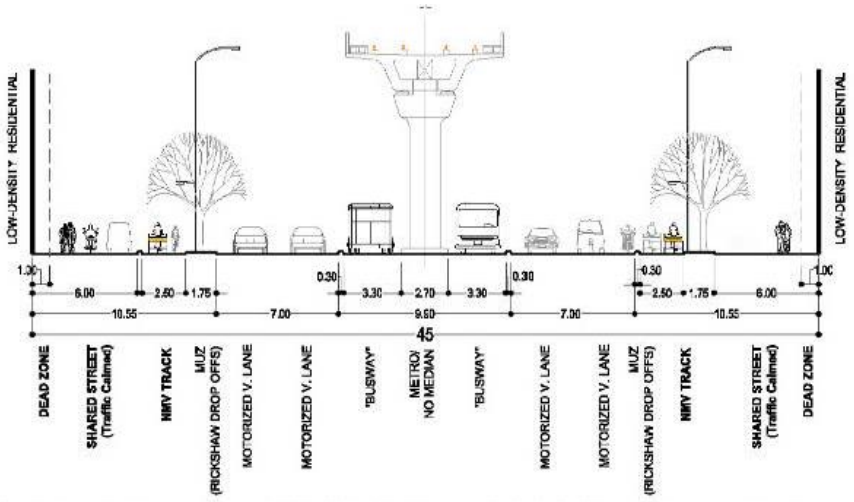
30 M ROAD WITH 6-Lane MIXED (Design Speed <20km/hr)
Collector/ Neighborhood Road Funtion

HIERARCHY



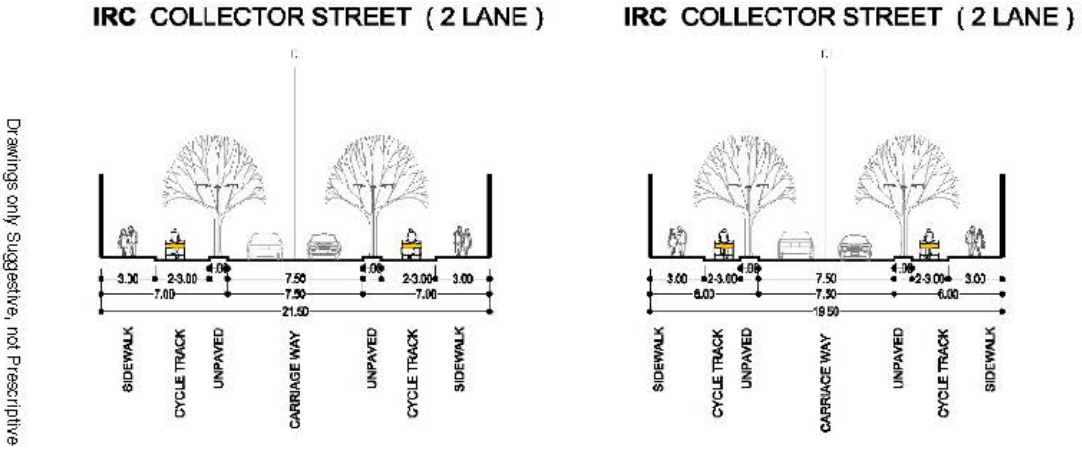
UTTIPEC CROSS SECTION - 60 M ROAD WITH BRT / METRO - at BUS STATION

: only Suggestive, not Prescriptive. Prepared by UTTIPEC, DDA

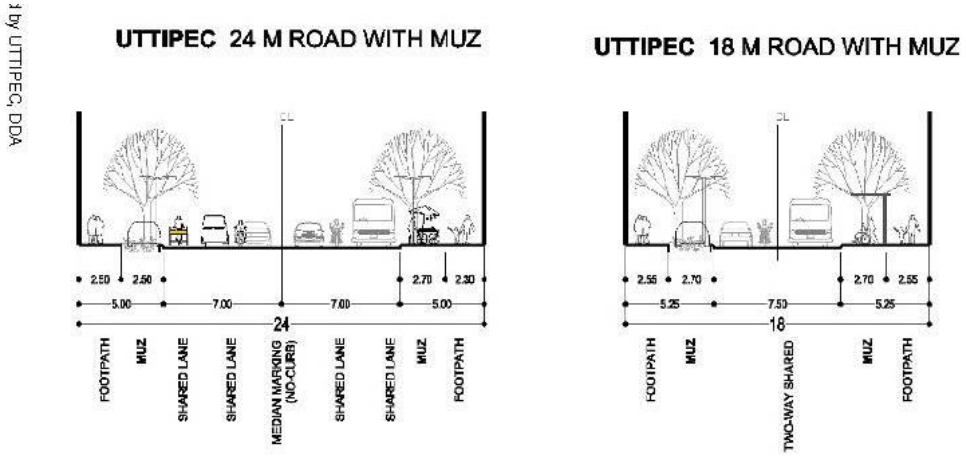


i) 45 m ROAD WITH BUSWAYS/ METRO at JUNCTION - Residential Frontage

Indian Road Congress



UNIFIED TRAFFIC AND TRANSPORTATION INFRASTRUCTURE (PLANNING & ENGINEERING)



WIDTH OF ROADWAY FOR SINGLE-LANE AND TWO-LANE ROADS IN PLAIN AND ROLLING TERRAIN

S.No	Road Classification	Roadway width (meters)
1	National Highways (Single or two lanes)	12.0
2	State Highways (Single or two lanes)	12.0
3	Major Dist. Roads (Single or two lanes)	9.0
4	Other Dist. Roads – (i) single Lane (ii) two Lanes	7.5 9.0
5	National Highways (Single lane)	7.5

WIDTH OF ROADWAY FOR SINGLE-LANE AND TWO-LANE ROADS IN MOUNTAINOUS AND STEEP TERRAIN

S.No	Road Classification	Roadway width (meters)
1	National Highways (i) single lane (ii) two lanes	6.25 8.80
2	State Highways (i) single lane (ii) two lanes	6.25 8.80
3	Major Dist. Roads (Single lanes)	4.75
4	Other Dist. Roads (Single lane)	4.75
5	Village Roads (Single lane)	4.0

STANDARDS

SUMMARY OF MINIMUM DESIGN STANDARDS FOR URBAN STREETS

	Principal Arterial			Collector Streets		Local Streets	
Design Elements	Freeways and Expressways	Other	Minor Arterials	Single-Family Residential Areas	Other	Single-Family Residential Areas	Other
Design Speed, km/h (mph)	95 (60)	65 (40)	50 (30)	50 (30)	50 (30)	30 (20)	50 (30)
Number of Traffic Lanes	4 up	4 up	4-6	2	4	2	2-4
Width of Traffic Lanes, mm (ft)	3 660 (12')	3 660 (12')	3 660 (12')	3 660 (12')	3 660 (12')	3 050 (10')	3 355 (11')
Width of Curb Parking Lane or Shoulder, mm (ft)	3 660 (12')	3 050 (10')	3 050 (10')	3 050 (10')	3 050 (10')	2 440 (8')	3 050 (10')
Width of Right-of-way, mm (ft)	36 575 up (120' up)	36 575 up (120' up)	30 480 - 36 575 (100-120')	18 290 (60')	18 290 (80')	15 240 - 18 290 (50-60')	18 290 - 24 385 (60-80')

General Design Guidelines & Principles to consider when designing vehicular systems at any scale

1. **The location of roadway should be based on**
    - **Present and proposed land uses,**
    - **Area where redevelopment or change is desirable,**
    - **existing and planned transportation infrastructure**
    - **Topographic features**
    - **Ecological factors**
    - **Cultural and historic factors**
    - **Scenic opportunities**
    - **Social, economic and political structures**
    - **Safety**
    - **Acquisition and development costs**
    - **Operations and maintenance costs**
2. **Responsive to natural forces and features**

In very hot condition asphalt layers lose their stiffness. At low temperature, asphalt layers become brittle and cracks are formed.

3. Must include consideration of its effect on adjacent properties in terms of noise and fumes

4. A roadway should be so aligned and constructed as to preserve and accentuate the best qualities of the landscape ,providing for a variety of visual experience

<u>Operating Characteristics</u>

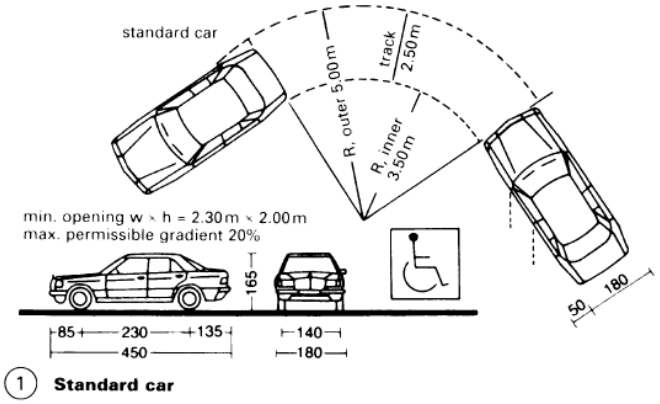
Three operating characteristics that influence roadway design are turning radius, acceleration and braking distance

Turning Radii: the turning radii of the design vehicle are used to determine spatial dimensions for maneuvering on roads and in parking areas

Acceleration: The time required to cross an intersections from stationary position. The distance required to pass another vehicle. The gap acceptance

Braking Distance: The braking ability of a motor vehicle and the forward friction factor between tires and pavement determine the slowing and stopping abilities of the vehicle

Turning Radius - Sufficient turning radius shall be provided for adequate maneuvering of vehicle



① **Standard car**

type of vehicle	length (m)	width (m)	height (m)	turning circle radius (m)
motorcycle	2.20	0.70	1.00[2]	1.00
car				
- standard	4.70	1.75	1.50	5.75
- small	3.60	1.60	1.50	5.00
- large	5.00	1.90	1.50	6.00
truck				
- standard	6.00	2.10	2.20[1]	6.10
- 7.5t	7.00	2.50	2.40[1]	7.00
- 16 t	8.00	2.50	3.00[1]	8.00
- 22t (+16 t trailer)	10.00	2.50	3.00[1]	9.30
refuse collection vehicle				
- standard 2-axle vehicle (4 × 2)	7.64	2.50	3.30[1]	7.80
- standard 3-axle vehicle (6 × 2 or 6 × 4)	1.45	2.50	3.30[1]	9.25
fire engine	6.80	2.50	2.80[1]	9.25
furniture van (with trailer)	9.50 (18.00)	2.50	2.80[1]	9.25
standard bus I	11.00	2.50[3]	2.95	10.25
standard bus II	11.40	2.50[3]	3.05	11.00
standard vehicle - bus	11.00	2.50[3]	2.95	11.20
standard vehicle - articulated bus	17.26	2.50[3]	4.00	10.50–11.25
standard articulated truck	18.00	2.50[4]	4.00	12.00[5]
tractor		2.50[4]	4.00	
trailer		2.50[4]	4.00	
max. values of the road regulations				
2-axle vehicle (4 × 2)	12.00	2.50[4]	4.00	12.00
vehicle with more than 2 axles	12.00	2.50[4]	4.00	12.00
tractor with semi-trailer	15.00	2.50[4]	4.00	12.00
articulated bus	18.00	2.50[4]	4.00	12.00
trucks with trailer	18.00	2.50[4]	4.00	12.00

notes:
[1] height of driver's cab; [2] total height with driver, about 2m; [3] with wing mirrors, 2.95m; [4] without wing mirrors; [5] turning circle radius adjusted up to max. as per regulations

BASIC VEHICLE DATA

type of vehicle	length (m)	width (m)	height (m)	turning circle radius (m)
motorcycle	2.20	0.70	1.00[2]	1.00
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- standard	4.70	1.75	1.50	5.75
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- large	5.00	1.90	1.50	6.00
truck				
- standard	6.00	2.10	2.20[1]	6.10
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standard vehicle - articulated bus	17.26	2.50[3]	4.00	10.50–11.25
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tractor		2.50[4]	4.00	
trailer		2.50[4]	4.00	
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2-axle vehicle (4 × 2)	12.00	2.50[4]	4.00	12.00
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articulated bus	18.00	2.50[4]	4.00	12.00
trucks with trailer	18.00	2.50[4]	4.00	12.00

notes:
[1] height of driver's cab; [2] total height with driver, about 2m; [3] with wing mirrors, 2.95m; [4] without wing mirrors; [5] turning circle radius adjusted up to max. as per regulations

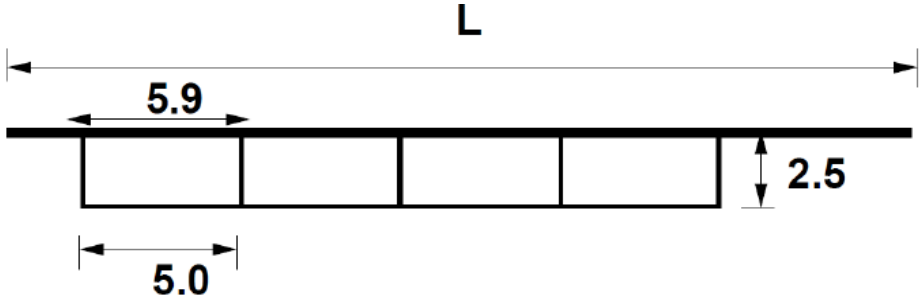
type of road	type of district	standard vehicle	R (m)	notes
accessible lightly used residential road	residential	car	6	turning circle for car special regulations for refuse collection vehicles (e.g. link road connection via lanes with limited traffic access)
residential road	mainly residential	cars, 2-axle (4 × 2) refuse collection vehicles	8	turning circle for small buses + most refuse collection vehicles room to turn by manoeuvring back and forth for all vehicles permitted under the regulations
residential road	residential area, heavily interspersed with business premises	cars , refuse collection vehicles, trucks with 3 axles (6 × 2 and 6 × 4), standard bus, articulated bus	10 11 12	adequate turning circle for most permitted trucks and buses turning circle for newer buses turning circle for articulated buses
	mainly for business premises	truck articulated truck articulated bus	12	turning circle for the largest vehicles permitted by the road regulations
1m wide clearance on the outside of the turning areas is provided to allow for the rear overhang of vehicles				

PARKING SYSTEM

On street parking means the vehicles are parked on the sides of the street itself. This will be usually controlled by government agencies itself. Common types of on-street parking are as listed below. This clarification is based on the angle in which the vehicles are parked with respect to the road alignment. As per IRC the standard dimensions of a car is taken as 5x2.5meters and that for a truck is 3.75x7.5meters.

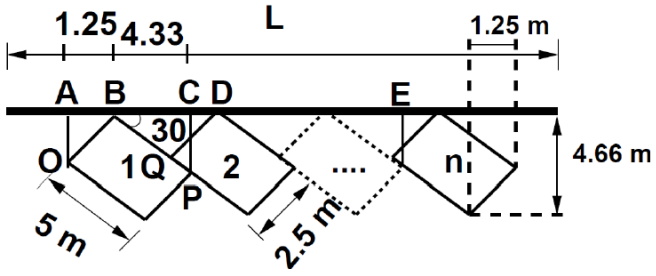
1. **Parallel parking**

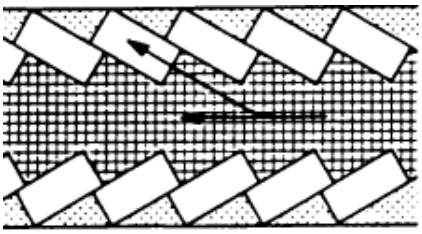
The vehicles are parked along the length of the road.Here there is no backward movement involved while parking the vehicle.Hence ,it is the most safest parking from the accident perspective. However it consumes the maximum curb length and therefore only a minimum no.of vehicles can be parked for a given kerb length



2. 30° PARKING

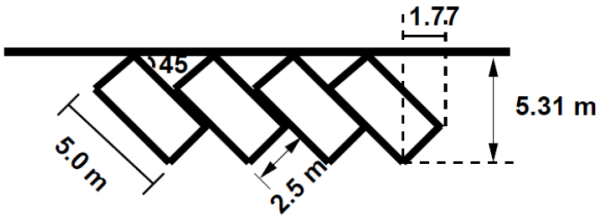
The vehicles are parked at 30° with respect to road Alignment, in this case more vehicles are parked compared to parallel Parking

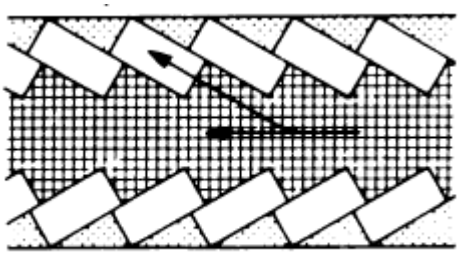




3. 45° parking

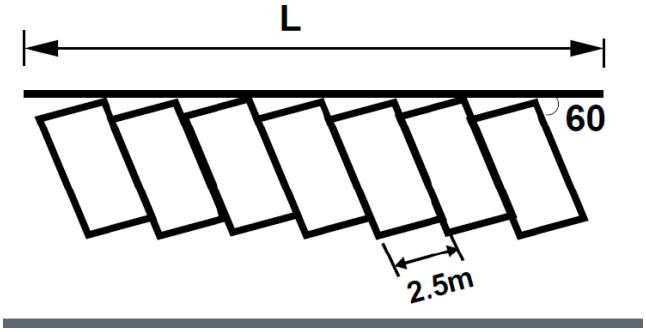
As the angle of parking increases , more number of vehicles can be parked. Hence compared to parallel & 30°parking , more no.of vehicles can be accommodated in this type of parking. The driveway width shall be 3.0m for one-way movement and 6.0m for two-way movement

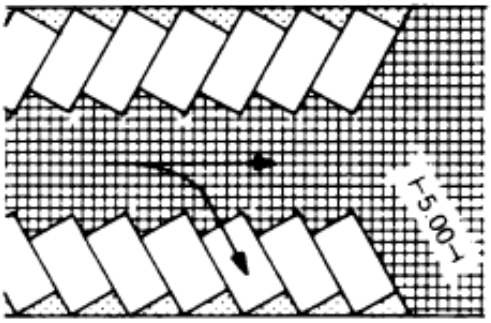




4. 60° PARKING

The vehicles are parked at 60° to the direction of the road. More no. of vehicles can be accommodated in this parking type. Driveway width can be increased

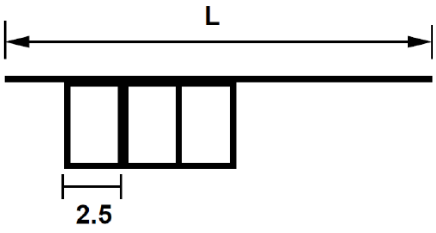


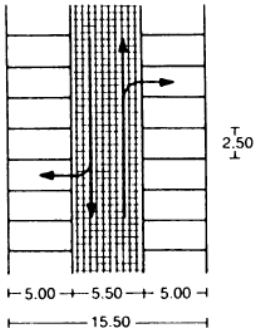


Source :TNCDBR

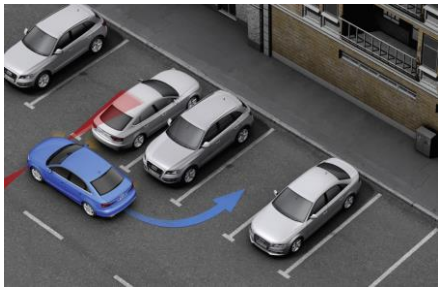
5. 90° parking or Right Angle parking

The vehicles are parked perpendicular to the direction of the road. Although it consumes maximum width ,kerb length is very little .In this type of parking ,the vehicles need complex manoeuvring and this may cause severe accidents .However it can accommodate the maximum no.of vehicles for a kerb length





90° entry/exit to parking spaces for two-way traffic Parking space 2.50 m wide



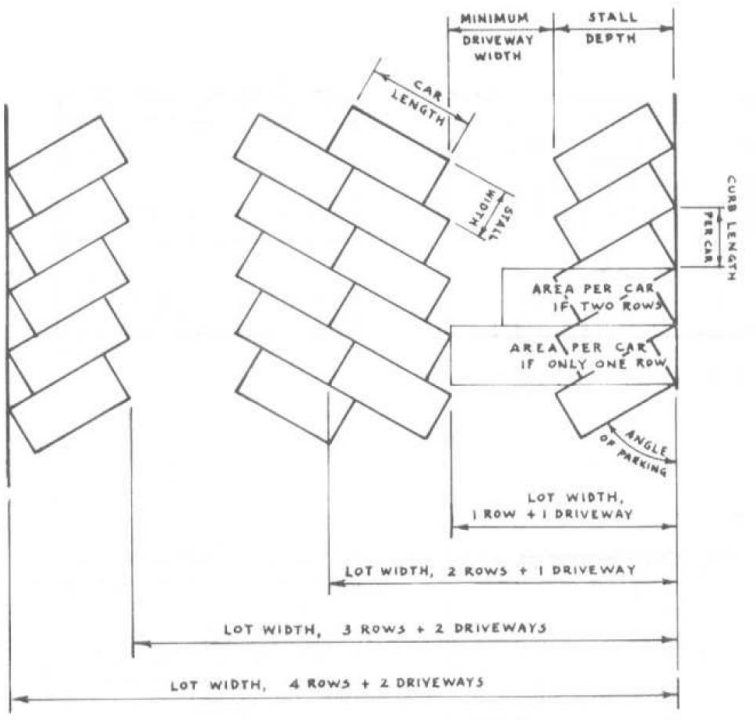


Fig. 1

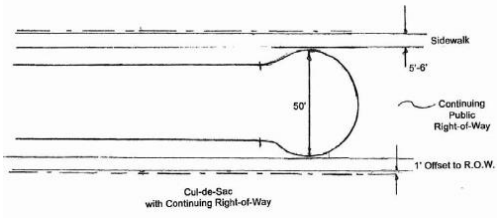
Table 1. Parking lot dimensions

Angle of Parking	Stall width	Curb length per car	Stall depth	Minimum driveway width	Lot width 1 row + 1 driveway	Sq ft per car	Lot width 2 rows + 1 driveway	Sq ft per car	Lot width 3 rows + 2 driveways	Sq ft per car	Lot width 4 rows + 2 driveways	Sq ft per car
Along curb = 0°	9′	23′	9′	12′	21′	483	30′	345	51′	391	60′	345
	10′	23′	10′	12′	22′	506	32′	368	54′	414	64′	368
30°	9′	18′	17′4″	11′	28′4″	510	45′8″	411	66′2″	397	83′6″	376
	10′	20′	18′3″	11′	29′3″	585	47′6″	475	68′0″	453	86′2″	431
45°	9′	12′9″	19′10″	13′	32′10″	420	52′8″	336	79′0″	376	98′10″	315
	10′	14′2″	20′6″	13′	33′6″	490	54′0″	383	80′4″	379	100′10″	358
60°	9′	10′5″	21′0″	18′	39′0″	407	60′	313	95′0″	330	116′0″	305
	10′	11′6″	21′6″	18′	39′6″	455	61′	351	95′6″	366	116′6″	335
90°	9′	9′	19′	24′	43′	387	62′	279	105′	315	124′	279
	10′	10′	19′	24′	43′	430	62′	310	105′	350	124′	310

Refer to Fig. 1.

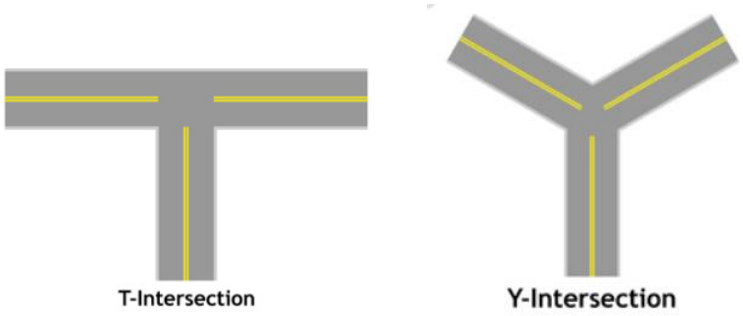
Cul de Sac

Where no outlet is provided on a street ,the ability to turn a vehicle around should be provided without the vehicle entering private property ,in order to avoid forcing vehicles to back out to the nearest intersection.The dead end street must meet the roadway width requirement for a two way street

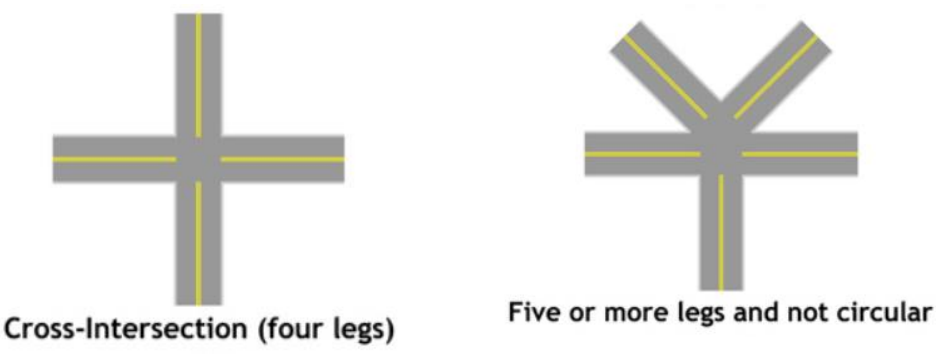


STREET INTERSECTIONS

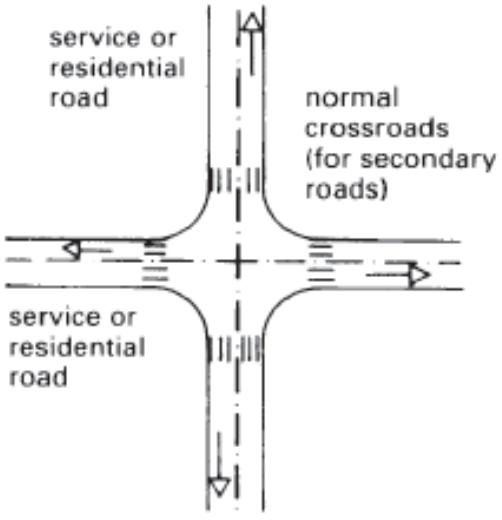
INTERSECTIONS are the Junctions are where one road flows into another directly.



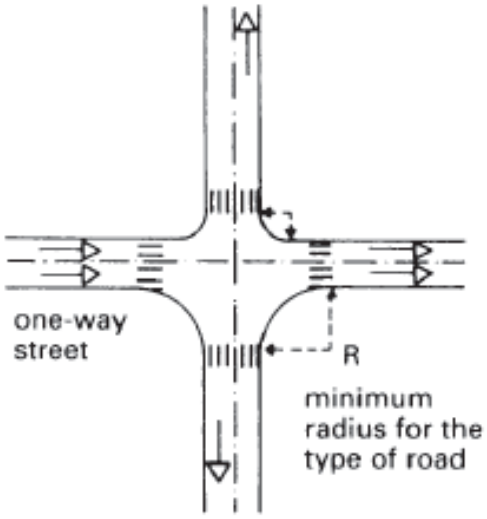
3-way intersections



Cross roads are where two roads cross each other at their point of intersection

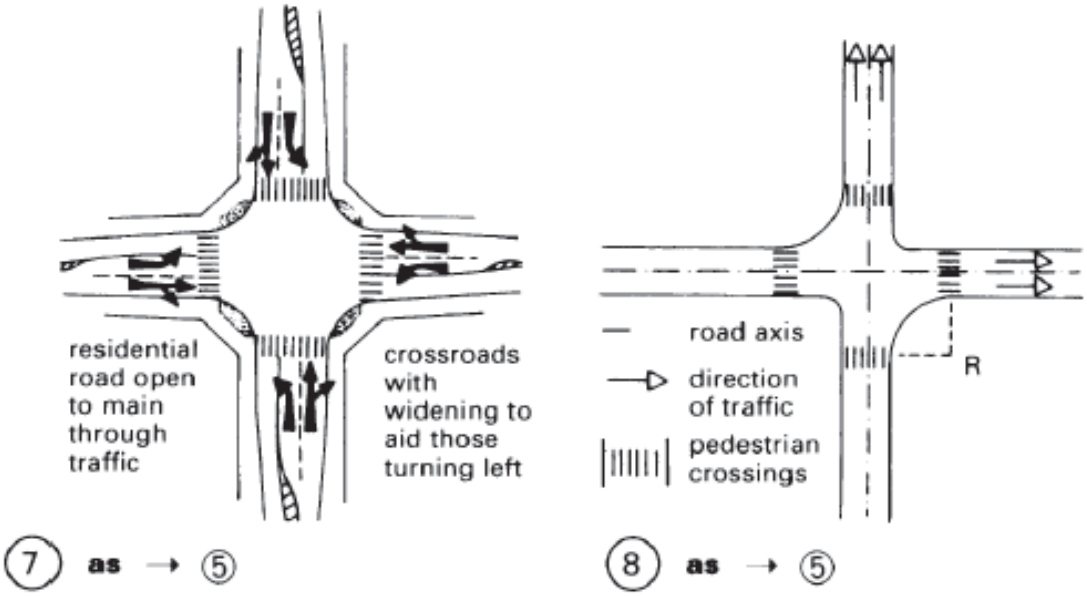


(5) **Crossroads – on same level**



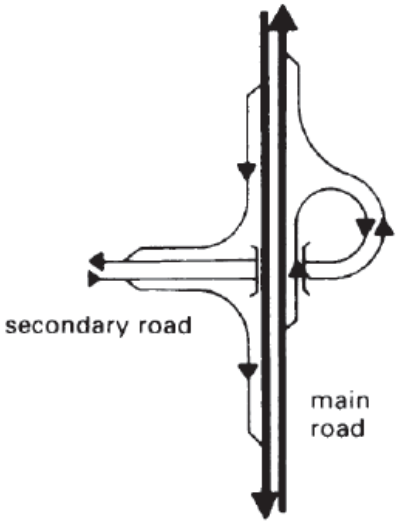
(6) **as** → (5)

4-way intersections

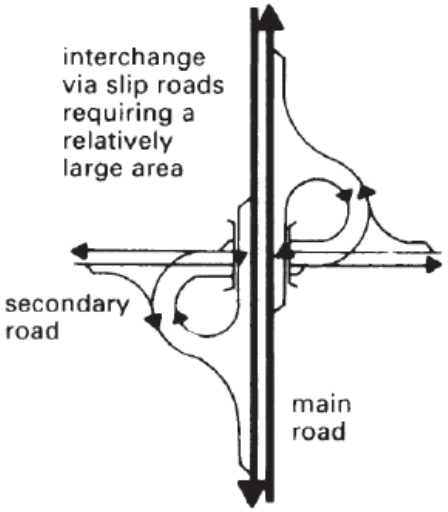


Roundabout

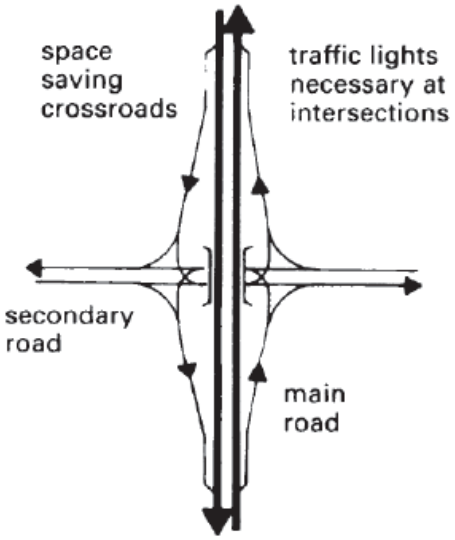
Round abouts are a form of Intersections popular in some countries (eg.UK). They offer several advantages /reduced risk of serious accidents. Traffic lights are rarely necessary ;there is less noise generated and energy is conserved. The diameter of the roundabout depends on the available space and the acceptable length.



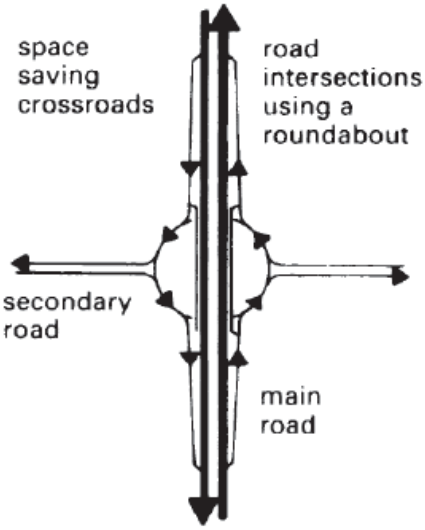
⑨ **Junctions/crossroads – at different levels**



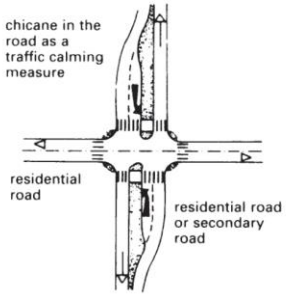
⑩ **as** → ⑨



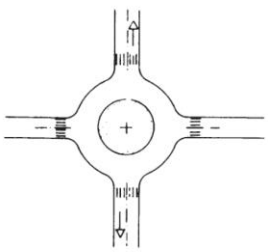
⑪ **as** → ⑨



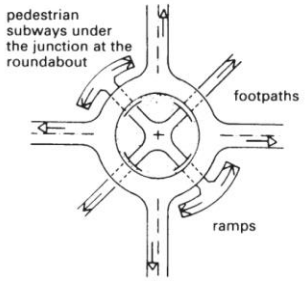
⑫ **as** → ⑨



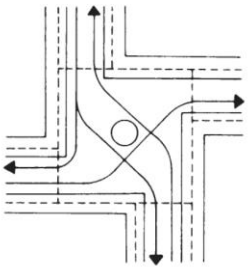
⑬ **Reduction in the width of the carriageway**



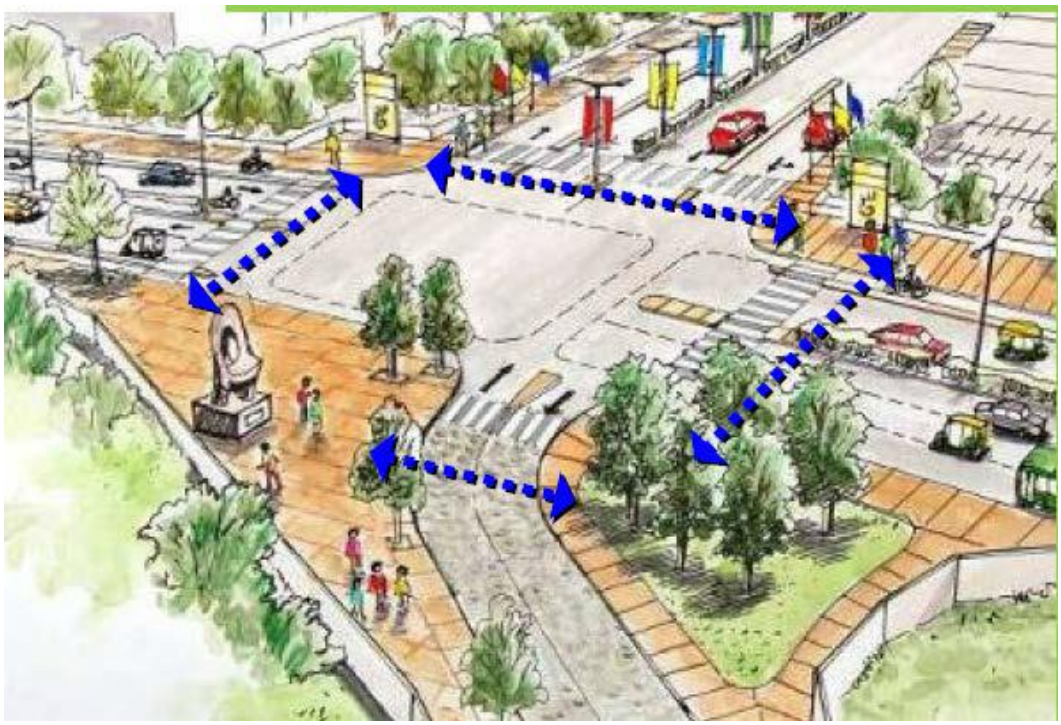
⑭ **Roundabout**



⑮ **Roundabout with pedestrian subways**



⑯ **Offset crossroads only for slow traffic**



Design Consideration

Site Zoning Regulations- Land Use Regulations-development

LAND USE CLASSIFICATION AND USES PERMITTED

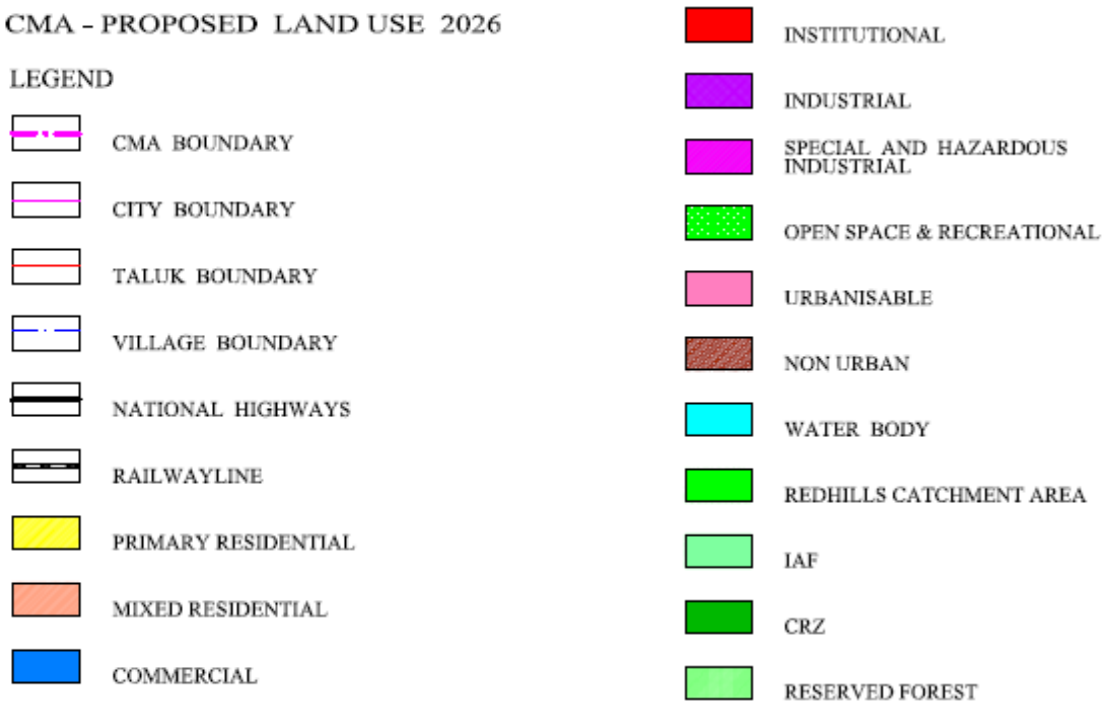
Sl No.	*Use Zone (Level 1)*	*Use Zone (Level 2)*
(1)	(2)	(3)
i)	Residential (R)	Primary Residential Zone (R-1) Mixed Residential Zone (R-2) Unplanned/Informal Residential Zone (R-3)
ii)	Commercial (C)	Retail Shopping Zone (C-1) General Business and Commercial District/Centres (C-2) Wholesale, Godowns, Warehousing/Regulated Markets (C-3)
iii)	Manufacturing (M)	Service and Light Industry (M-1) Extensive and Heavy Industry (M-2) Special Industrial Zone Hazardous, Noxious and Chemical (M-3)
iv)	Public and Semi-Public (PS)	Government/Semi-Government/Public Offices (PS-1) Government Land (use determined) (PS-2) Educational and Research (PS-3) Medical and Health (PS-4) Social, Cultural and Religious (PS-5) Utilities and Services (PS-6) Cremation and Burial Grounds (PS-7)
v)	Recreational (P)	Playgrounds/Stadium/Sports Complex (P-1) Parks and Gardens — Public Open Spaces (P-2) Special Recreational Zone — Restricted Open Spaces (P-3) Multi-Open Space (Maidan) (P-4)

Sl No.	*Use Zone (Level 1)*	*Use Zone (Level 2)*
(1)	(2)	(3)
vi)	Transportation and Communication (T)	Roads (T-1) Railways (T-2) Airport (T-3) Seaports and Dockyards (T-4) Bus Depots/Truck Terminals and Freight Complexes (T-5) Transmission and Communication (T-6)
vii)	Agriculture and Water Bodies	Agriculture (A-1) Forest (A-2) Poultry and Dairy Farming (A-3) Rural Settlements (A-4) Brick Kiln and Extractive Areas (A-5) Water Bodies (A-6)
viii)	Special Area	Old Built-up (Core) Area (S-1) Heritage and Conservation Areas (S-2) Scenic Value Areas (S-3) Village Settlement (S-4) Other Uses (S-5)

17. Correlation of land use zones in Master Plan, Detailed Development Plan and Development Rules:

Sl. No.	**Use classification in Master Plan**	**Use classification in Detailed Development Plan**	**Use classification in Development Rules**
01.	Primary Residential Use	Primary Residential or Residential use	**Residential**
02.	Mixed Residential use	Mixed Residential	**Residential**
04.	Industrial use or Light Industrial use or Controlled Industries use	Industrial use or Light Industrial use	**Industrial use**
05.	General Industrial	General Industrial	**Industrial use**
06.	Special and Hazardous Industrial Use	Special and Hazardous Industrial use	**Special and Hazardous Industrial use**
07.	Institutional or Educational use or Public and Semi-public use	Institutional or Educational use or Public and Semi-public use	**Institutional**

08.	Open space and recreational use	Open space and recreational or Park or Play space	**Open space recreational** (in Chennai Metropolitan Area) Public use zone (in other areas of the State)
09.	Non-urban	Non-urban	**Non – urban only in Chennai Metropolitan Area**
11.	Urbanisable	--	**Urbanisable use (only in Chennai Metropolitan Area)**



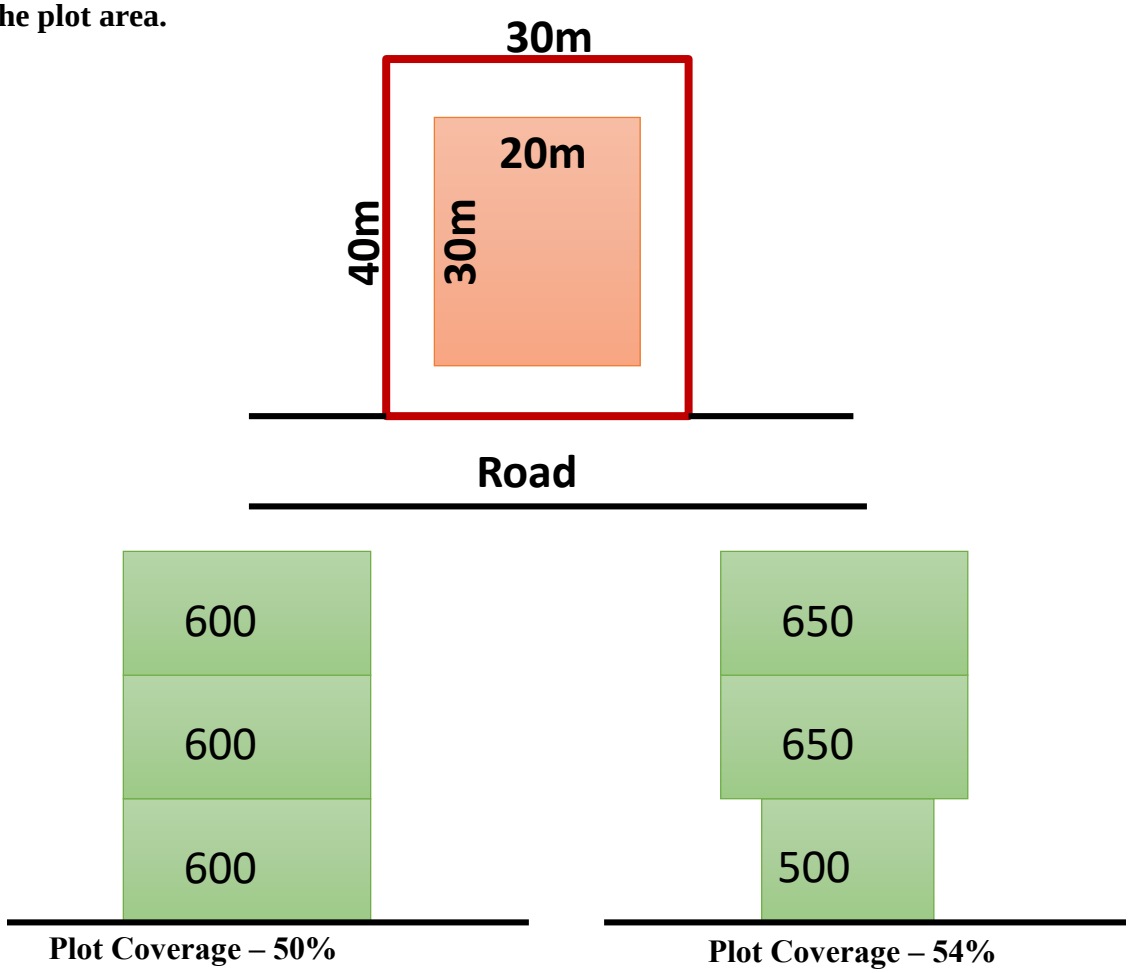
Control Rules Of Local Bodies

1. **<u>Building Setbacks</u>**
2. **<u>Set-Back Line</u> — A line usually parallel to the plot boundaries and laid down in each case by the Authority, beyond which nothing can be constructed towards the plot boundaries**
3. **<u>FSI (Floor Space Index)- Far</u>**

Floor Area Ratio (FAR) — The quotient obtained by dividing the total covered area (plinth area) on all floors by the area of the plot:

$$FAR = \frac{\text{Total covered area of the floors}}{\text{Plot area}}$$

"Plot coverage" means the extent to which the plot is covered with a building or structure 12-noon shadow and expressed as a percentage of the ratio of the built up area to the plot area.



Site Area = 30 x 40 =1200 Sq.m

Plot Coverage – 50%

=50/100 x Site Area

=50/100x1200=600Sq.m

FSI ----1.5

=1.5 x Site Area

=1.5 x 1200=1800 Sq.m

OSR-(Open Space ratio)

As the OSR space is vested with competent authority or Local Body, no structure shall be constructed or erected on OSR land.

WHAT HAS CHANGED

New building rules for open space reservation

Extent of layout	Reservation
For first 3,000sqm	Nil
3,000sqm - 10,000sqm	10% of area or pay guideline of equivalent land
Above 10,000sqm	10% of area excluding roads

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SCHOOL OF BUILDING AND MANAGEMENT

DEPARTMENT OF ARCHITECTURE

UNIT – II – Site Selection and Analysis – SAR1203

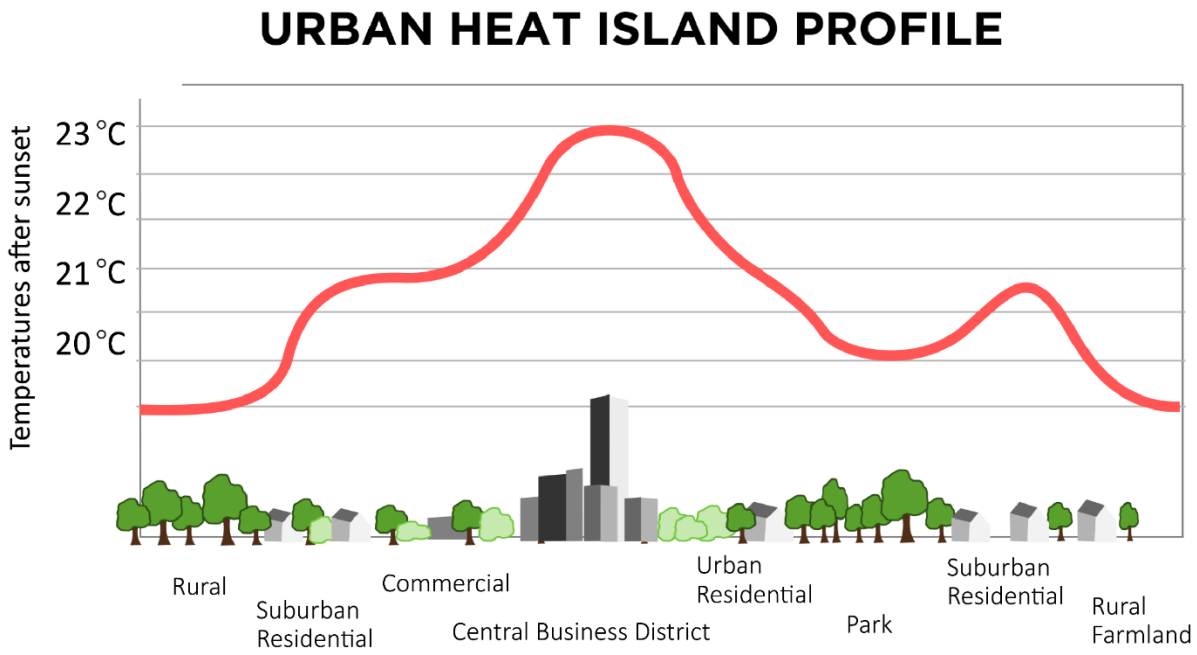
MICRO CLIMATE

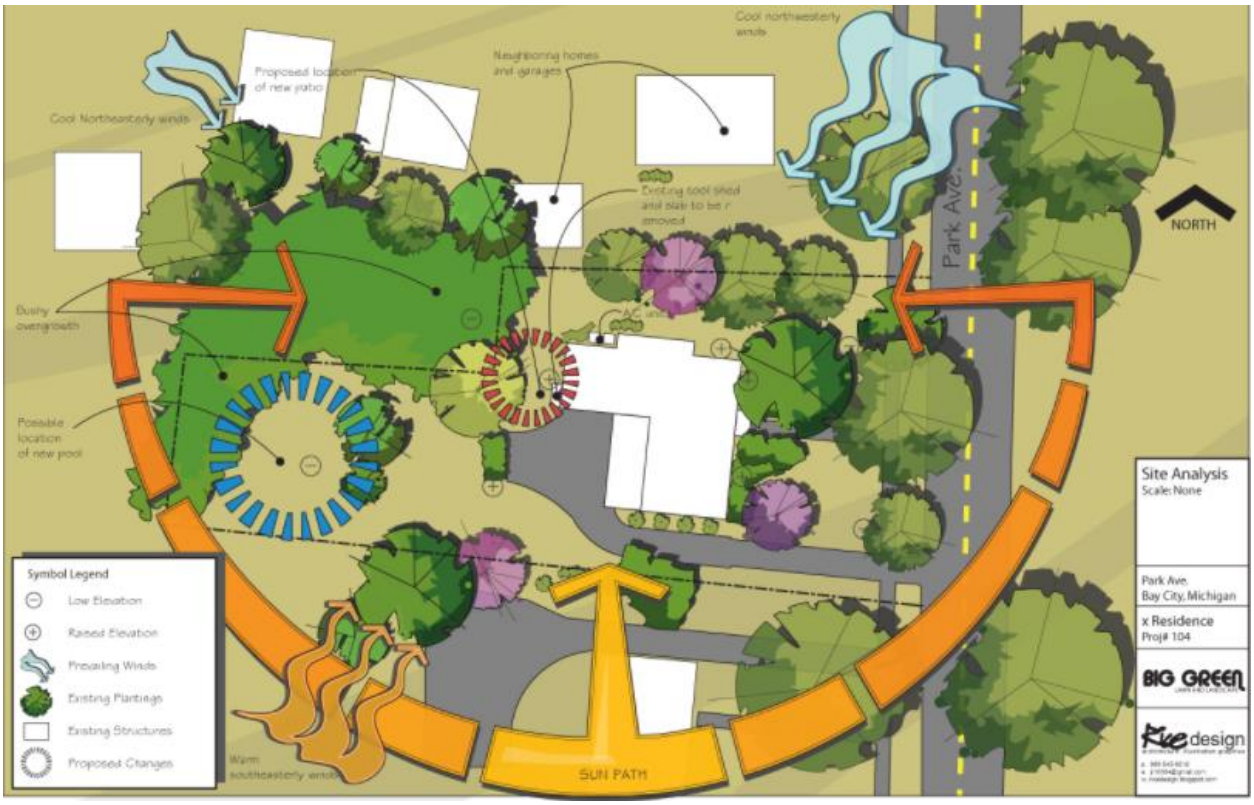
Microclimate is a condition of solar & terrestrial radiation, wind, air-temperature, humidity and precipitation in small outdoor open spaces. for example, near bodies of water which may cool the local atmosphere, or in heavy urban areas where brick, concrete, and asphalt absorb the sun's energy, heat up, and re-radiate that heat to the ambient air: the resulting urban heat island is a kind of microclimate.

MAJOR MICRO CLIMATE FACTORS

1. **Wind**
2. **Solar radiation**
3. **Temperature**
4. **Precipitation and humidity**

These are the influencing factors ,which can be modified by landscape elements to affect thermal comfort.

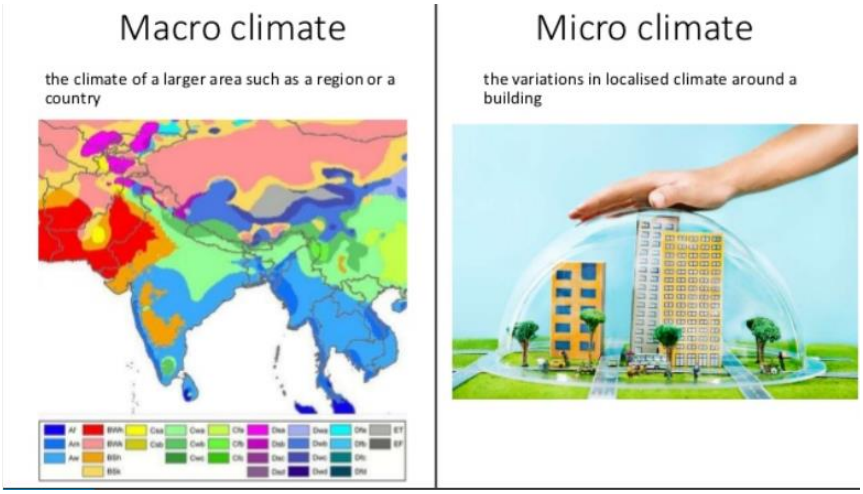




Source:https://landarchbim.com/2015/01/22/site-analysis-with-detail-components/site-analysis_5_11_12_jaret_rice/#main

What is macro climate?

Macro Climate is the climate of a larger area such as a region or country. Seasonal Accumulated temperature difference are a measure of the outside air temperature, not a measure of the available solar. Typical wind speeds and direction. Annual totals of solar radiations. The driving rain index relates to the amount of moisture contained in the exposed surface and will effect thermal conductivity of the building.



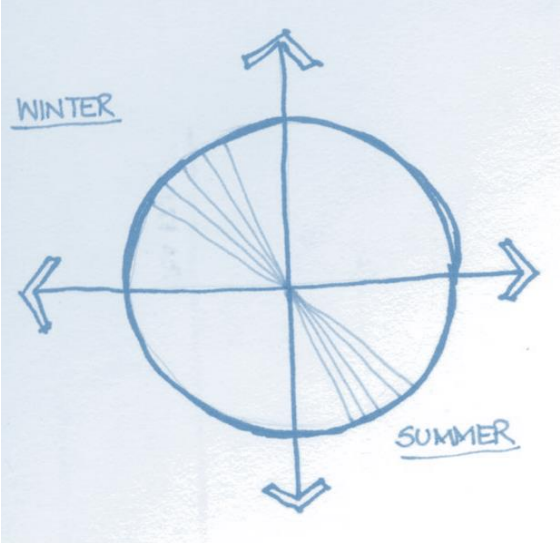
MICROCLIMATE – WIND PATTERNS

Wind consists of the movement of air. It is characterized by three variables:-

- **Direction**
- **Velocity or speed**
- **Degree of uniformity and turbulence.**

DIRECTION

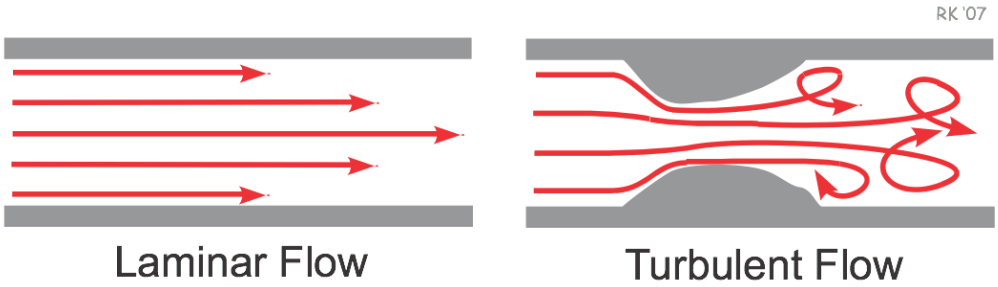
In most climates and at most sites, the direction of the prevailing winter-wind is nearly 180 degrees opposite to the prevailing summer winds.



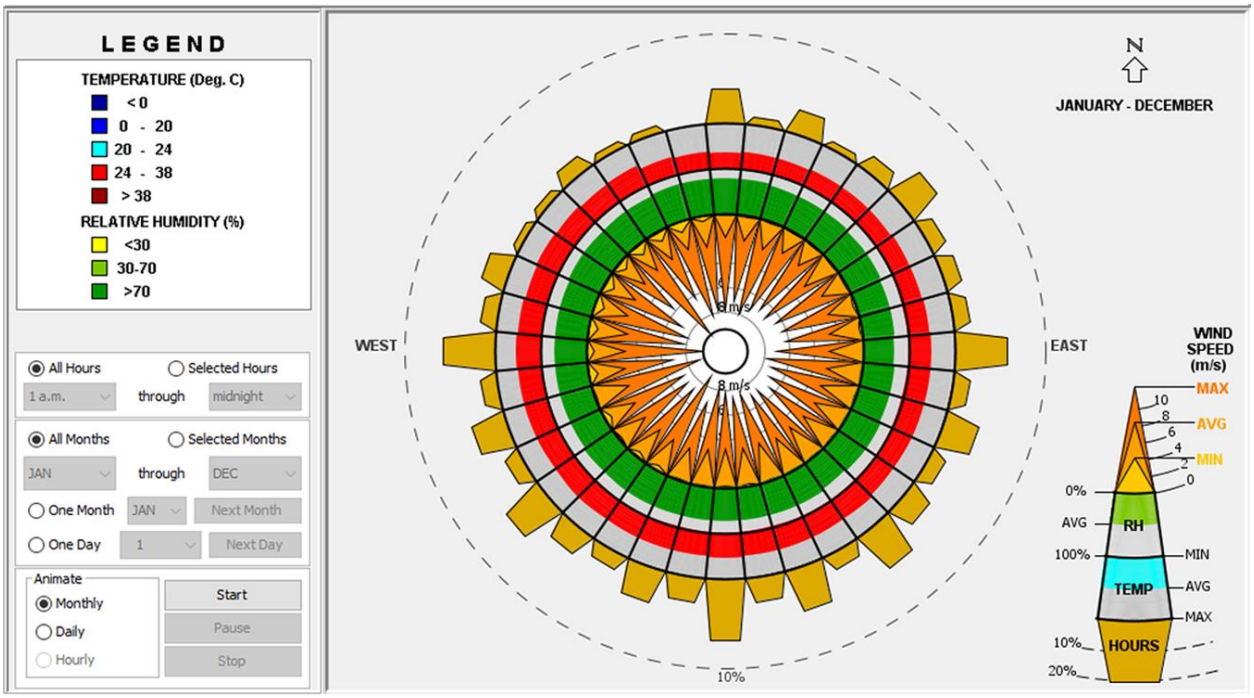
Prevailing winds are often opposite one another in winter and summer. Velocity and directions combined together to create prevailing wind pattern for a given site.

Winds blow in different types of patterns,

- **Laminar flow (Regular paths)**
- **Turbulent flow (irregular paths)**



Wind Rose Diagram-Example Chennai



Source:Climate Consultant Software

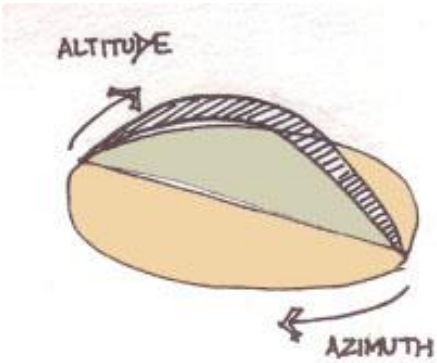
MICROCLIMATE - SOLAR RADIATION

The amount of solar radiation reaching a site depends on the site's latitude and the earth's point of rotation on its axis; together these determine the angle of sun in the sky. The angle is described in two different ways:-

Altitude- the angular distance of the sun above the horizon.

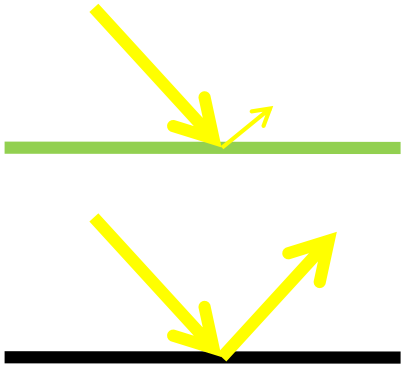
Azimuth- the angular distance of the sun from true north to true south.

Measured along the horizon in a clockwise direction in the northern hemisphere and in the counterclockwise direction in the southern hemisphere.



Sun angles
(source: Kim W. Todd- Site, space & structure)

Sun angle changes during the year, altering the amount of radiation reaching a particular site, and these radiations affect any site in 4 different ways, as listed:-

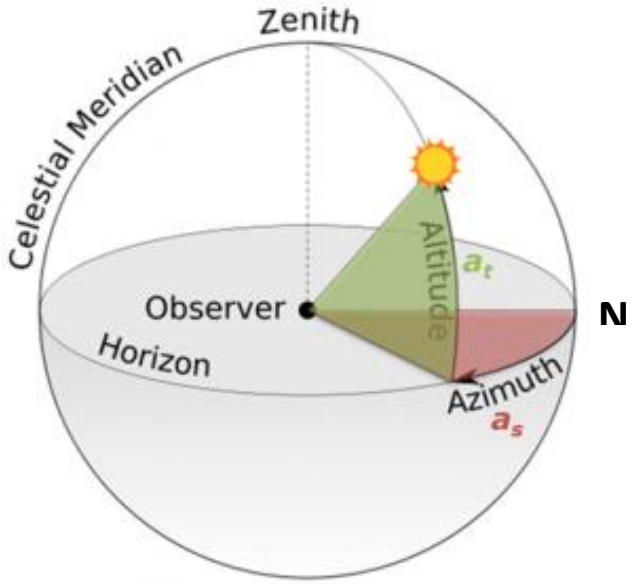


Reflectivity and Absorption of different surfaces

Sun's Position can be determined by two angles

Altitude : Measured upwards from the horizon

Azimuth: Measured in the horizontal plane from north



a) REFLECTIVITY AND ABSORPTION

Different surface materials are able to absorb and to reflect sunlight at different rates. The reflectivity of a surface is measured on a scale from 0.0 to 1.0 called albedo. An albedo

of 0.0 absorbs all heat and light, and radiates quickly. A material with a black matte surface is likely to have an albedo of 0.0. An albedo of 1.0 is completely reflective, absorbing nothing.

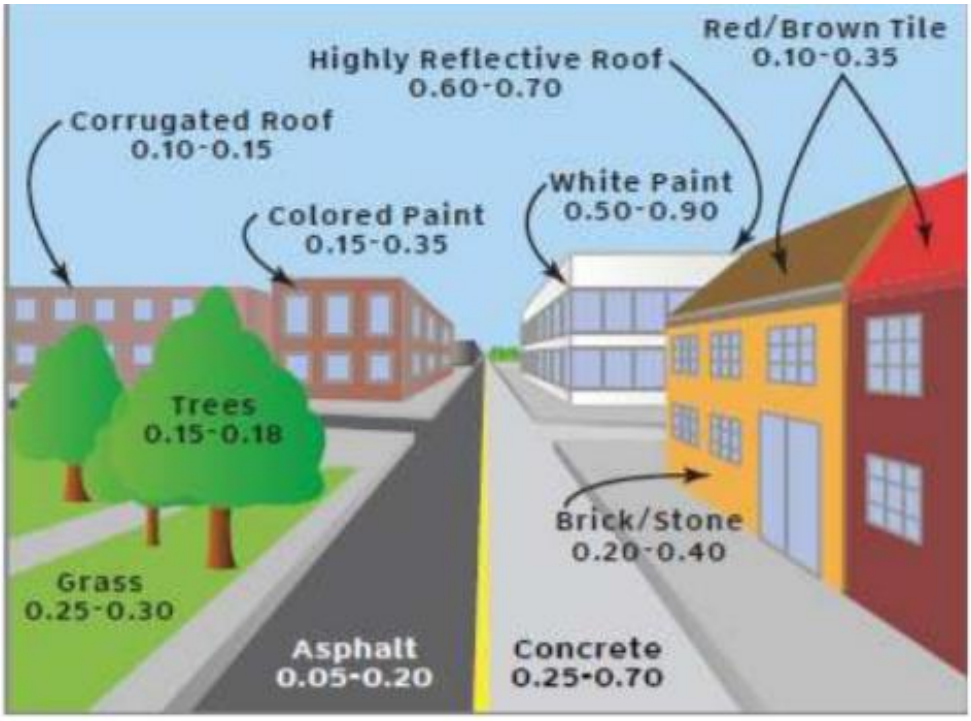
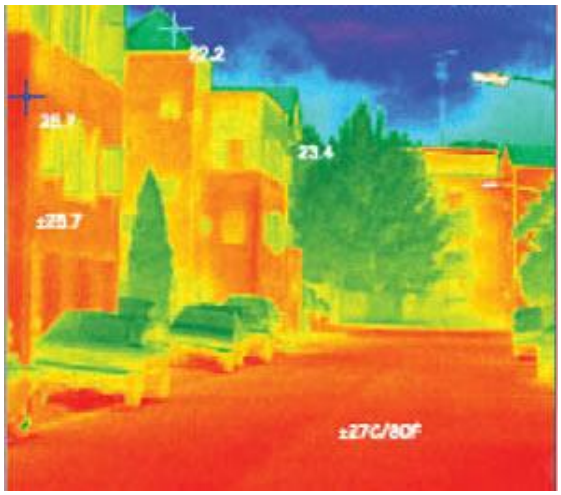


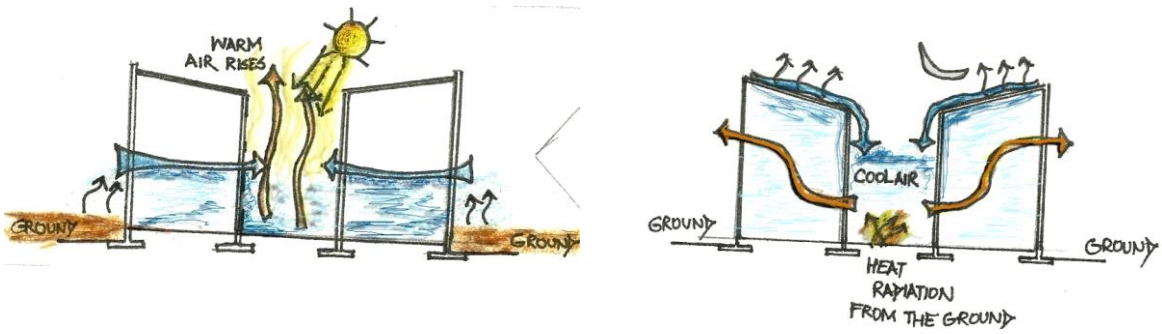
Fig. 5. Albedo ranges of various surfaces typical to urban areas *(Source: NASA, Akbari and Thayer, 2007)*



Summer temperatures over asphalt 10-25 C° higher than air temperatures and bare soil 1-5 C° higher. Greater diurnal cooling for soil & vegetation than for asphalt.

b) CONDUCTIVITY

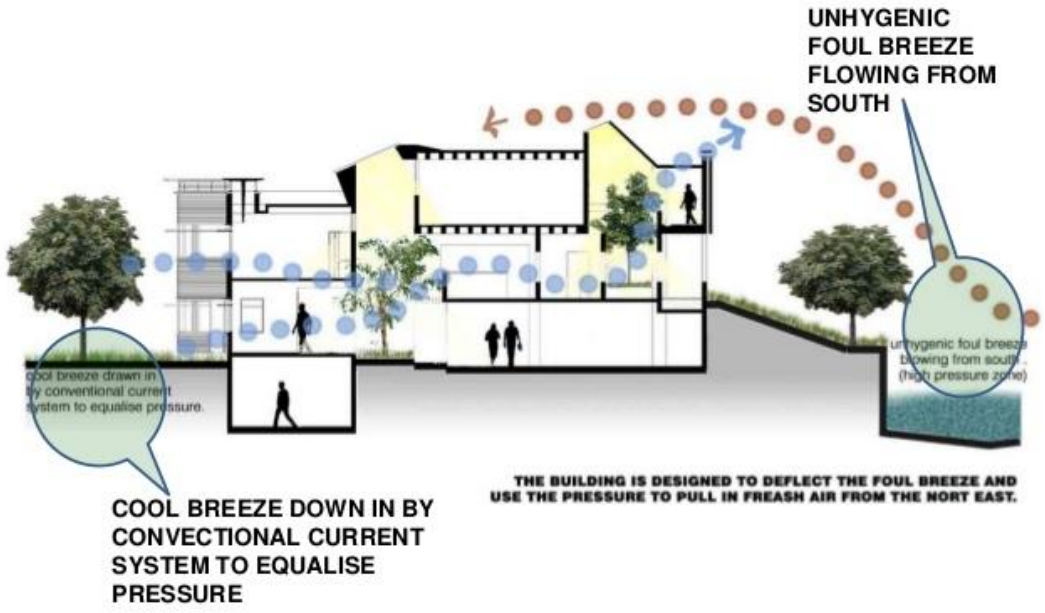
It is describes the speed with which heat passes through a material. The drier and more porous or the lighter a material is, the lower Its conductivity will be.



Section of the courtyard showing convection

c) CONVECTION (the transfer of heat by circulation of gas or liquid)

Convection also helps determine the relative comfort of a site. The most significant impact of convection involves the action of the wind in producing convective cooling. The convective exchange is based on a fluid-type movement of the air. The more turbulence is associated with the movement, the more heat will be dispersed. As air warms during the day. it becomes lighter and rises. This causes a flow of cooler air to fill the void left by the rising warm air; and as the air moves, a slight cooling breeze is created.



MICROCLIMATE – TEMPERATURE, PRECIPITATION AND HUMIDITY

TEMPERATURE

Temperature is described in two forms in relation to the climate; as:-

ACTUAL TEMPERATURE- is the DRY BULB TEMPERATURE-uninfluenced by sun and shade.

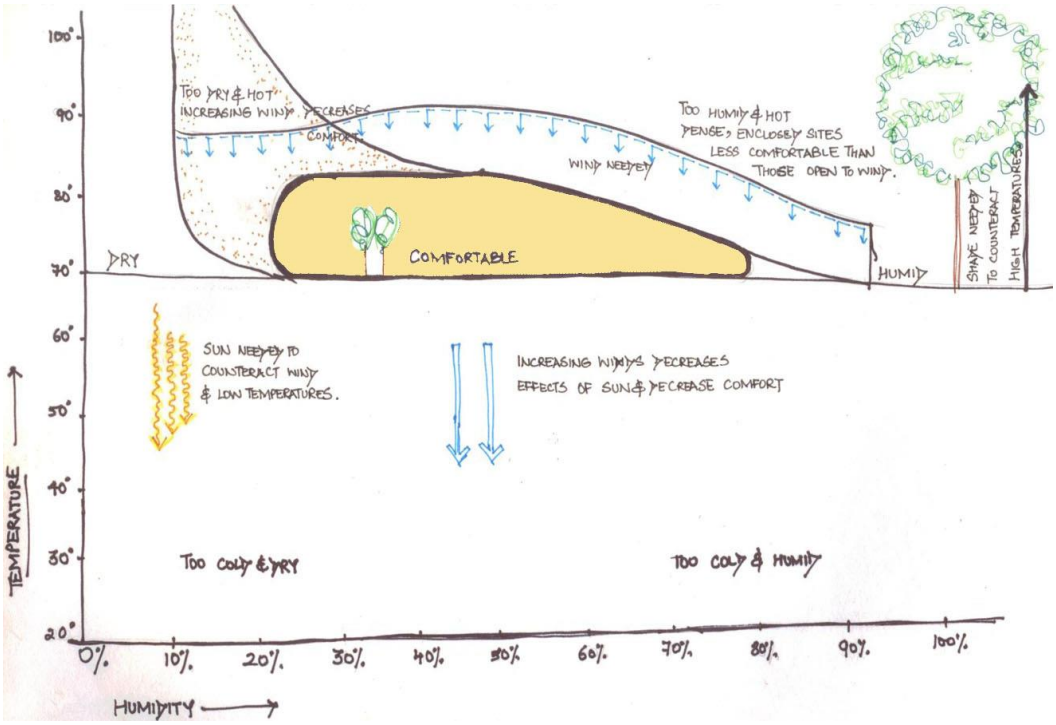
EFFECTIVE TEMPERATURE- is the temperature the body actually perceives as a result of the combined effect of radiation, humidity or precipitation.

A site's temperature is determined in part by the topography of the region, since temperature changes predictably as altitude changes. A decrease of 1deg F for each 330 feet of rise during the summer and a change of 1deg for each 400 feet of rise during the winter will occur as the air becomes thinner and less able to hold heat.

PRECIPITATION AND HUMIDITY

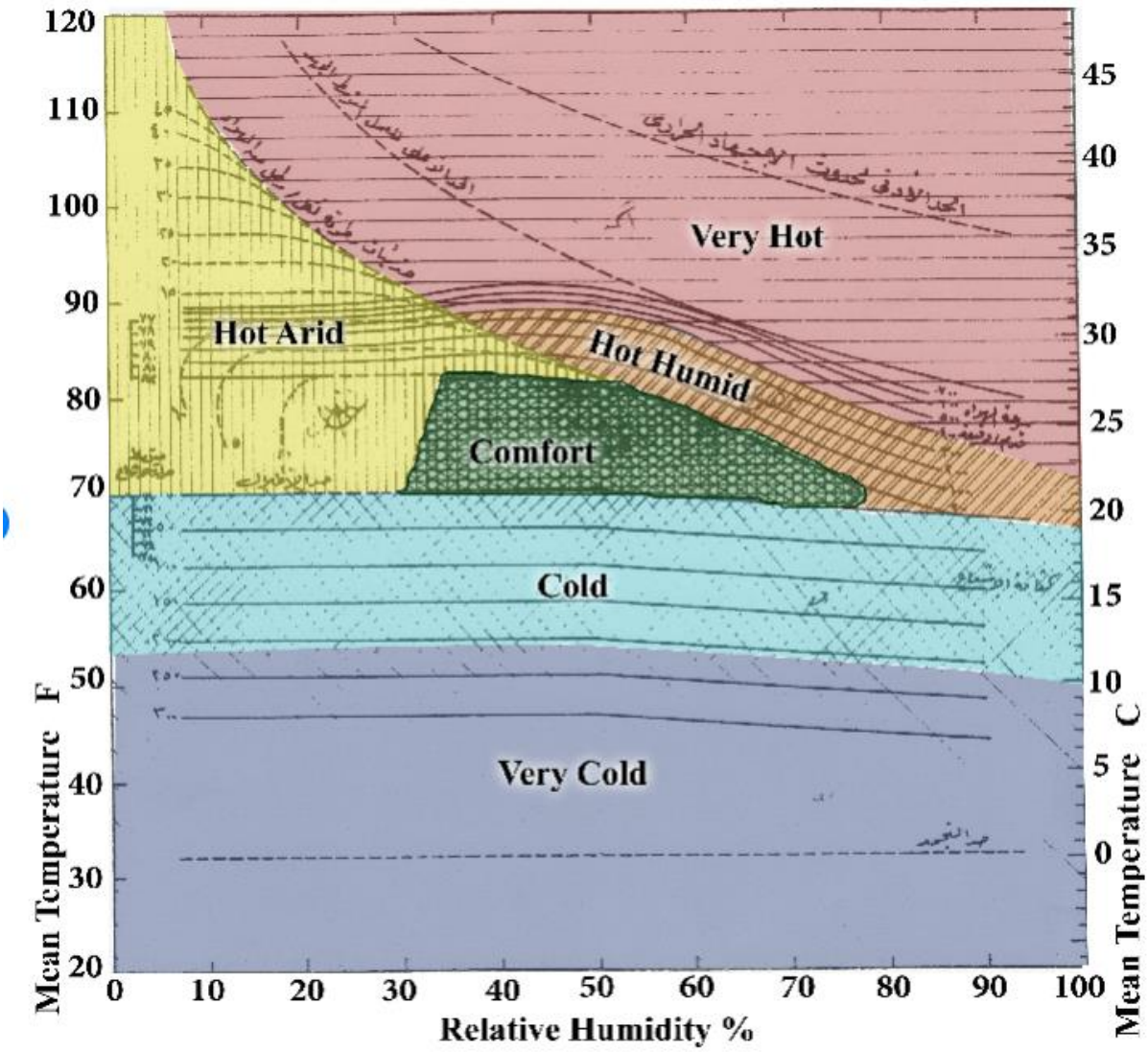
Precipitation and humidity refer to the amount of moisture in the air at a given time and to whether that moisture is being held or released. The higher the vapor pressure becomes, the more uncomfortable people will be.

As the water vapor builds and as the temperature changes because of wind and air movement, the air reaches a saturation point, and the vapor begins to fall to the ground in the form of. rain, fog, snow, or drizzle (depending on the temperature).



SCHEMATIC COMFORT ZONE

Source: Victor Olgay, Design with climate



Bioclimatic chart, also known as Victor Olgyay's chart (Source: Prof. Bahaa Bakry, edited by Author)

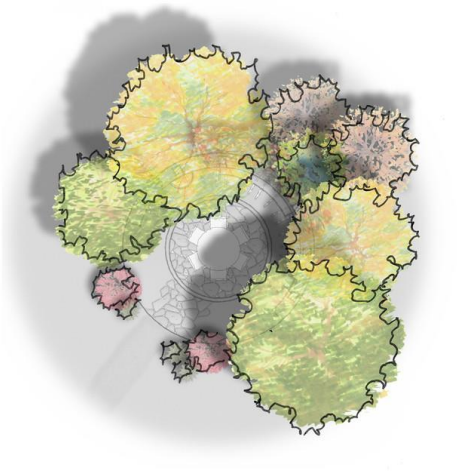
ELEMENTS

Microclimate of a site is strongly influenced by

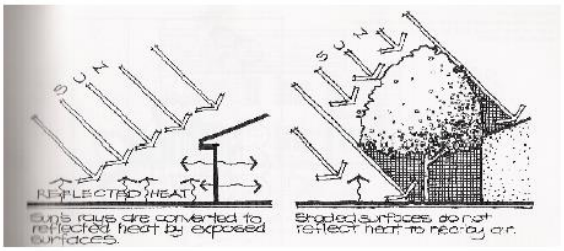
1. **Vegetation**
2. **Wind**
3. **Landforms**
4. **Water**

1. VEGETATION INFLUENCING THE MICROCLIMATE

Vegetation absorb 90% of light falling on it. Large and small trees check undesirable winds. Coniferous plants are used to control wind speed. Trees channelize wind, in order to increase ventilation in some areas. Vegetation, esp. needle leaves, to capture fog thus increasing sunlight reaching the ground. Deciduous and well as evergreen trees to screen sunlight during the summer to reduce the required heating load.

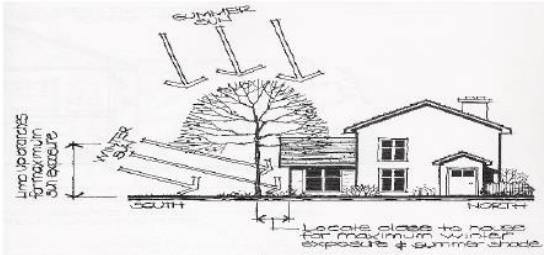


METHODS



USE OF SHADE TREES TO SHIELD ROOFS,EXTERIOR HOUSE WAALS ,AND THE GROUND FROM THE SUN'S RAYS.

TALL SHRUBS &VINES ON WAALS CAN PROVIDE SHADE FROM THE LOW SUN ANGLE TO THE EAST & WEST.

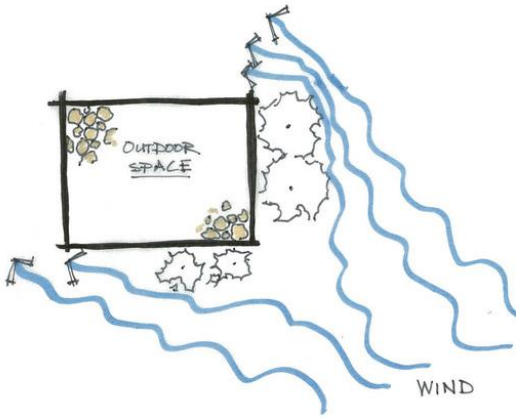


DECIDUOUS TREES SHOULD BE PLACED CLOSED YO THE WALLS FOR MAXIMUM WINTER SUN EXPO

Source : The role of plants in Climate responsive design by rana saqa

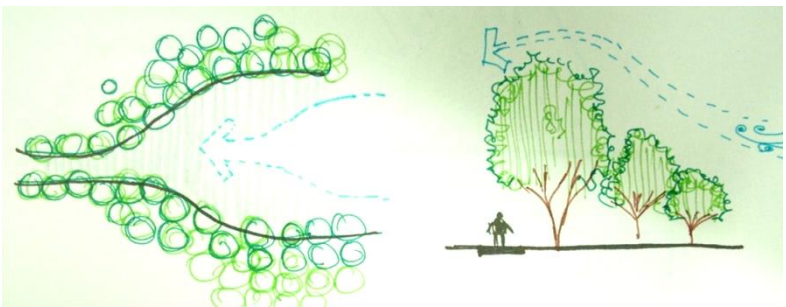
VEGETATION CONTROLLING WIND MOVEMENT

The most noticeable effect of forest is on the movement of wind. Wind may be reduced within the forest by 50-70- % or more , as compared to open spaces. The reduction is greatest near the ground and noticeable in all velocities. In case of velocities below 8 km/hr in open , the condition in the forest may be almost calm.



- **Obstruction,**
- **Filtration,**
- **Guidance and**
- **Deflection**

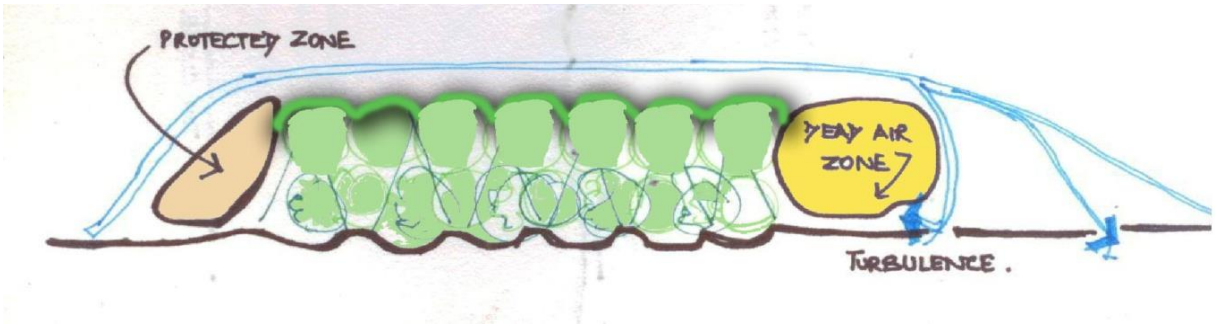
Obstruction **Filtration**



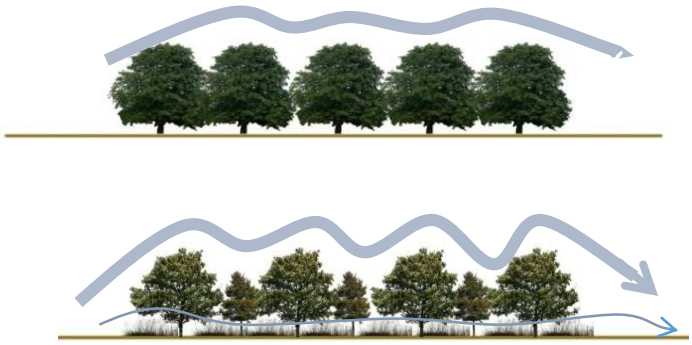
Guidance **Deflection**

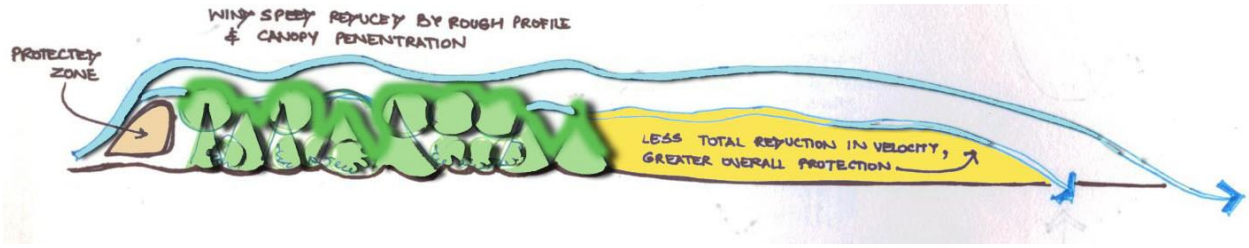
VEGETATION AS WIND BREAKERS/shelterbelts

The ability of plant material's to block or channel the wind effectively is well known. The protected zone is a function of the height, penetrability, profile, and density of the materials used to create the windbreak.



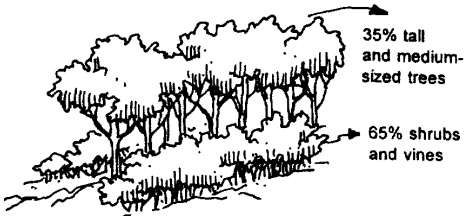
A solid barrier creates a relatively great difference in air-pressure between the windward and the leeward sides, which in turn reduces the size of the protected zone on the leeward side.

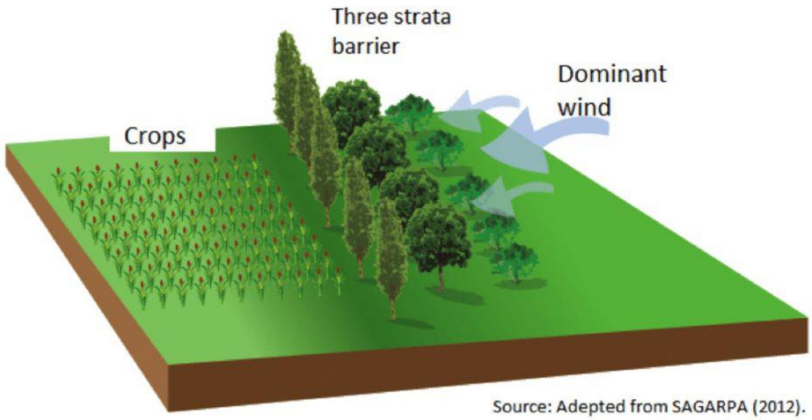




A windbreak of completely uniform height is not highly efficient in reducing wind velocities; additional speed reduction can be accomplished through increased friction and small air pockets if the height along the top of the windbreaks vary slightly.

Reduction of wind velocity by windbreak





The main design considerations for windbreaks are:

1. **Height**

A windbreak protects a distance from 2 to 10 times it's height. So a 5 metre high windbreak would protect a distance up to 50 metres away .Plant & tree species selection plays a role, and the best windbreaks are multi-layered comprising various plants & trees to block wind at multiple heights

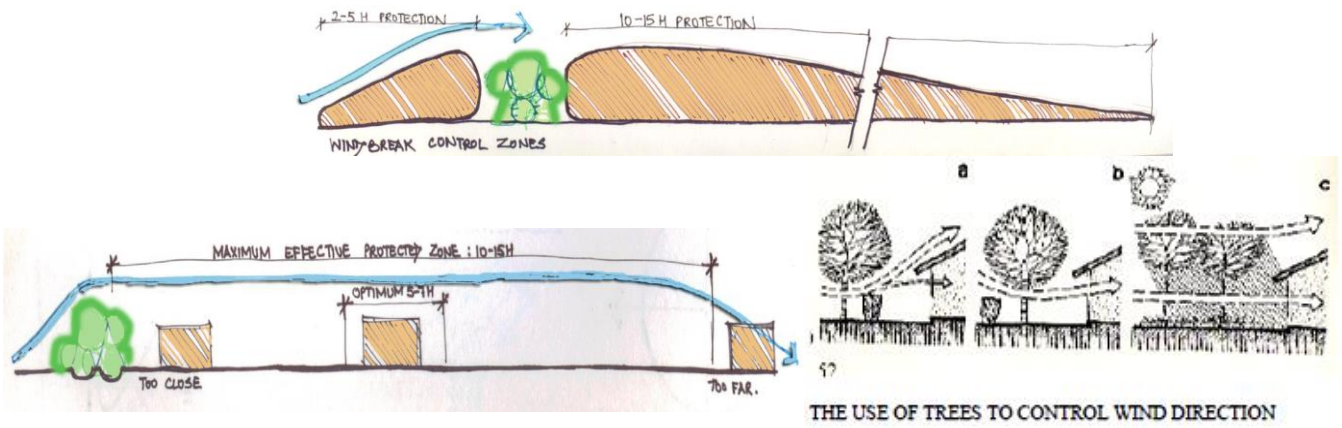
2. **Density**

The density of a windbreak determines how effective it is at reducing the speed of the wind. Density can be managed by choice of species, such as conifers or decidous, the spacing of the trees and the number of rows in the windbreak.

3. **Orientation**

To achieve maximum effectiveness, windbreaks should be oriented as close to perpendicular (90 degrees) to the prevailing winds as possible.

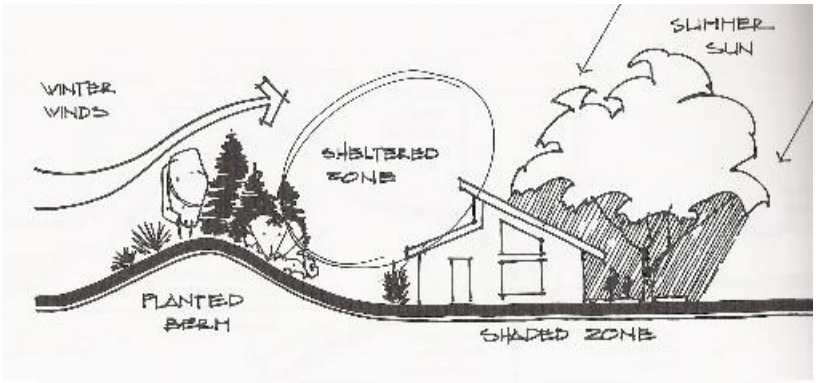
The actual reduction in velocity is determined by the profile of the wind break and by its density. The more penetrable the wind break is ,the longer distance of the protection zone will extent on to the leeward side, and the lower the actual reduction in velocity will be.

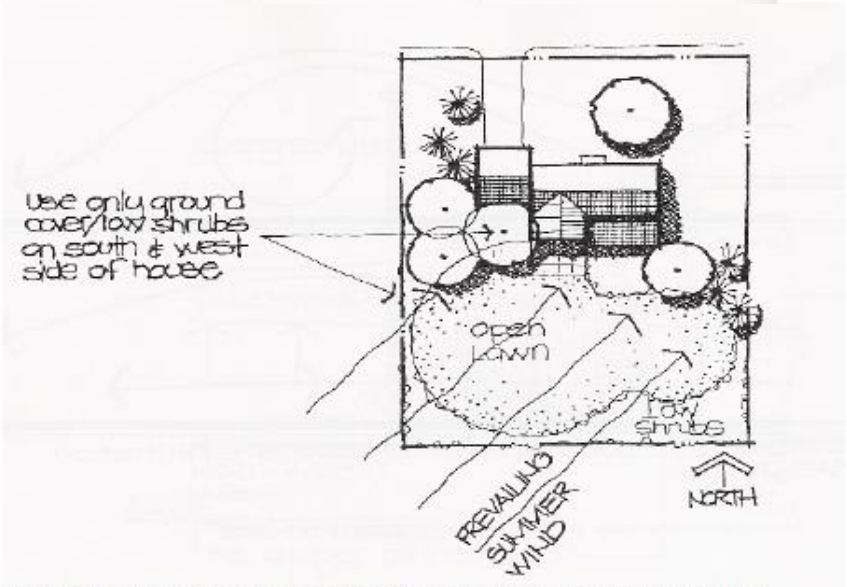


THE USE OF TREES TO CONTROL WIND DIRECTION

The structure should not be placed too close to the windbreak because there is dead air pocket where little air-movement may occur, just to the leeward side of the break; neither they should be situated too far distant, where the velocity reduction is no longer significant.

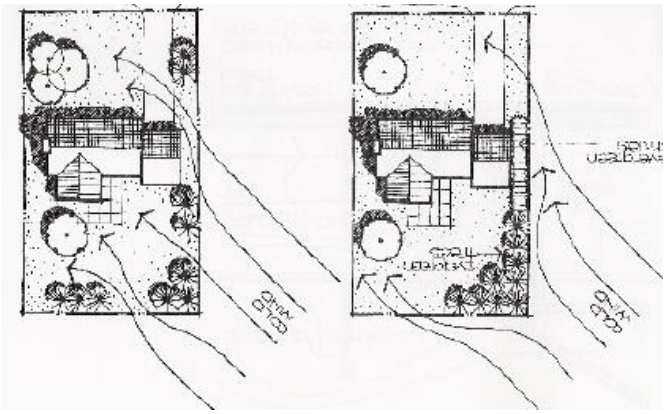
METHODS



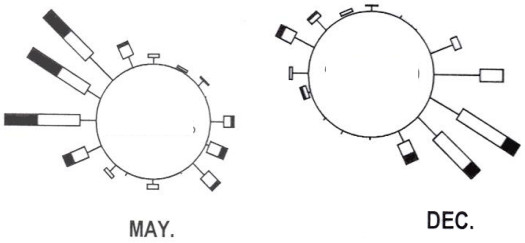


AN OPEN LAWN AREA TO THE SOUTH WEST OF A HOUSE WILL GIVE MAXIMUM EXPOSURE TO PREVAILING SUMMER WIND.

- **Large and small trees and shrubs may be used to screen out undesirable winds;**
- **Conifers should be used to control winter winds.**
- **Trees may be used to channel winds, to increase ventilation in specific areas.**



USE OF TREES AS WIND BREAKERS.



Delhi wind (summer/winter) direction

Source :www. envis.org

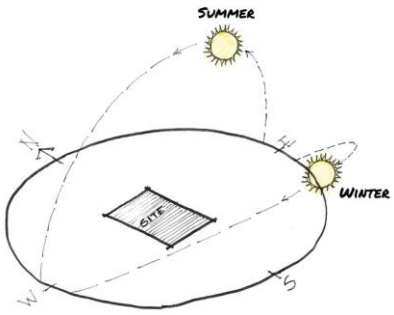
VEGETATION CONTROLLING SOLAR RADIATION

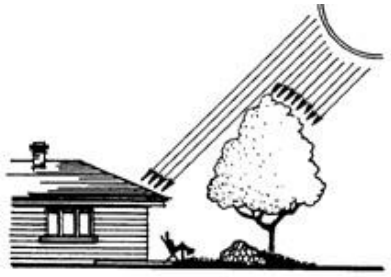
Trees and forests are best devices which control the solar radiation

The provide control mainly in 4 ways :

- **Absorption**
- **Reflection**
- **Radiation**
- **Transmission**

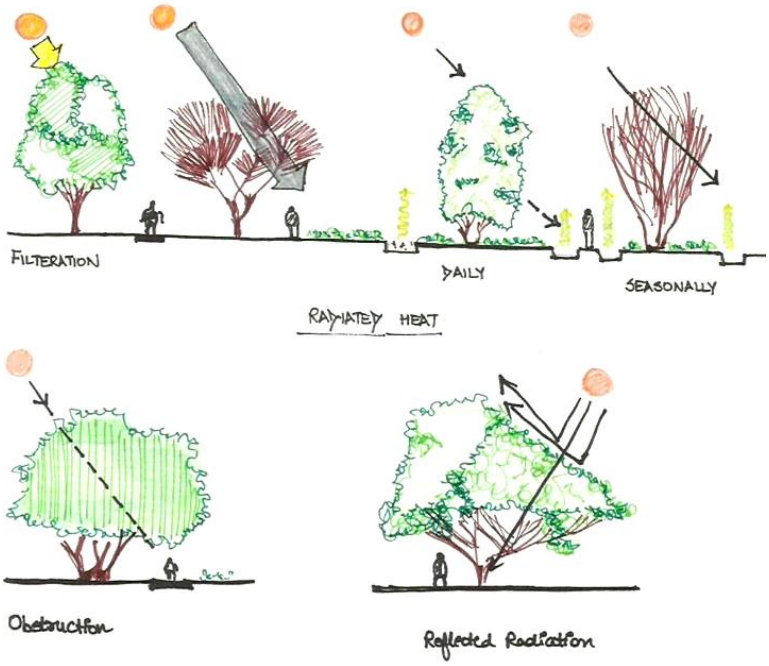
Trees absorb all solar radiation throughout the day.In the absence of wind and with restricted convection, leaf temperature may be much as 13deg higher than air temperature.





VEGETATION AFFECTING SOLAR RADIATION

Trees and forests play an important role in controlling excess or unwanted solar radiation.



Vegetation controls the sun's effect by filtration of the direct solar radiation, by control of the ground surface and hence the amount of heat radiated from these various surfaces, either daily or seasonally through the

- **alteration of the ground temperature,**
- **through the control of reflected radiation, and**
- **through total or major obstruction of the solar radiation itself.**

Deciduous trees will screen out direct sunlight during the summer, to reduce required cooling loads, but allow it to pass through in the winters, reducing required heating loads.

TREE SHADOWS- SHADOW

Different shadow patterns formed by different trees (source: www.google.com)

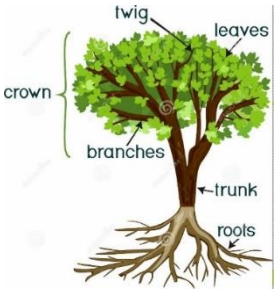
Depending on the

- **Density of the cover,**
- **The darkness of the leaves, and**
- **The distance between plants,**

Forested regions can absorb nearly all of the solar radiations falling on them. The density of the plant determines the shadow pattern it throws. The light when falls on the leaves the leaf shadow pattern falls on to the ground which is called as dapple shadow. A very fine textured tree will throw a shadow that barely reduces the amount of light reaching the ground or building surface.

On the other hand, some plant materials are so dense that almost no light penetrates them; these very effectively limit the radiant energy reaching the space or structure, but often allow nothing to be grown under their canopy.

PLANT SELECTION CONSIDERATIONS



PLANT SELECTION CONSIDERATIONS

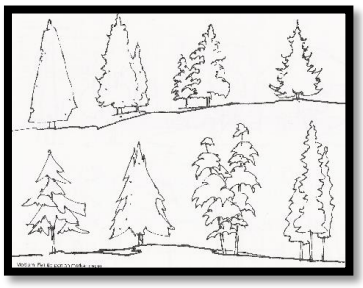
Tree shapes are very diverse .The density of a tree's leaves or needles is important to consider. Dense ever-green, like cypresses, make great wind-breaks for winter winds. To impede summer winds, a tree or shrub with more open branches &leaves would be better. Such trees are also good for morning sun from the east, while denser trees are better for blocking harsh afternoon summer.

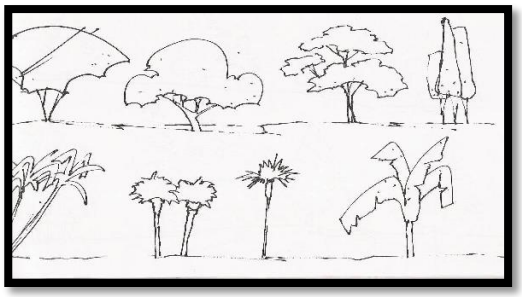
Plants Selection Considerations:

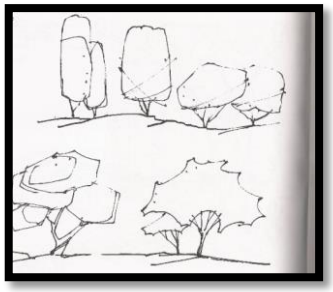
1. Tropical rainforest: tall trees, flat crowns, broad leaves

2. Temperate forest: medium height, round crown, broad leaves

3. Cold areas: very tall, cone, shaped crown, Needle like leaves.







VEGETATION with affect to TEMPERATURE

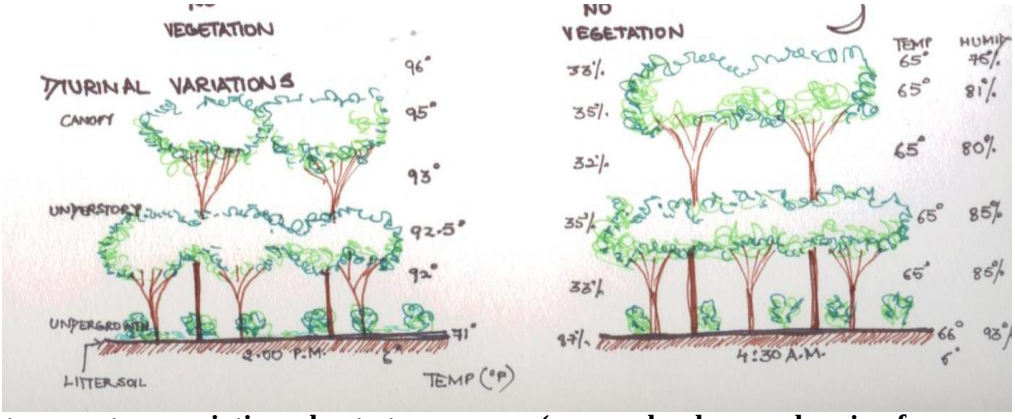
Sketch showing diurnal temperature variations (source: landscape planning for energy conservation)

Trees and forests are among the best exterior solar radiation control devices. As plant materials grow, they also control temperature variations, both during the day and at night.

A forest canopy may reduce the solar radiation to less than 1 percent to 4 percent of that in the open leads logically to the expectation that, because the sun is the source of the heat, the day time temperature where part of the sun's radiant energy is intercepted by the trees will be lower than those in the open.

SHADE and ABSORPTION of the radiant that strikes a plant, very little will penetrate it, whether the radiation is direct or reflected. The shaded side has cooler temperature than the radiated side. [3]

3: Gary O Robinette; Landscape planning for Energy conservation; 1977

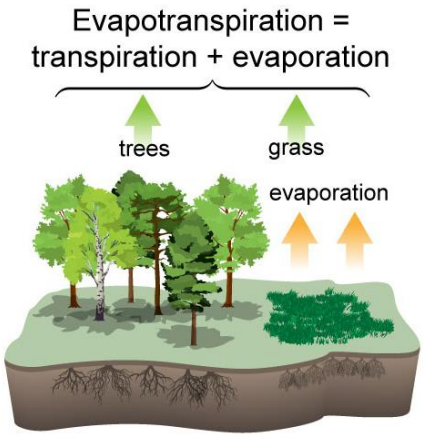


Sketch showing temperature variations due to tree canopy (source: landscape planning for energy conservation)

The temperature of an area may be reduced by plants, even if they are not tall enough to give shade. Plants and grassy cover reduces temperatures by scattering of light and radiation and the absorption of solar-radiation, and also by evapotranspiration process.

It is found that temperature over grassy surfaces on sunny summer days are about 10 to 14 degrees cooler those of exposed soil. The influence of the forest in reducing maximum soil temperature results partly from the shade of the crowns and partly from the insulation of the forest floor.

EVAPOTRANSPIRATION



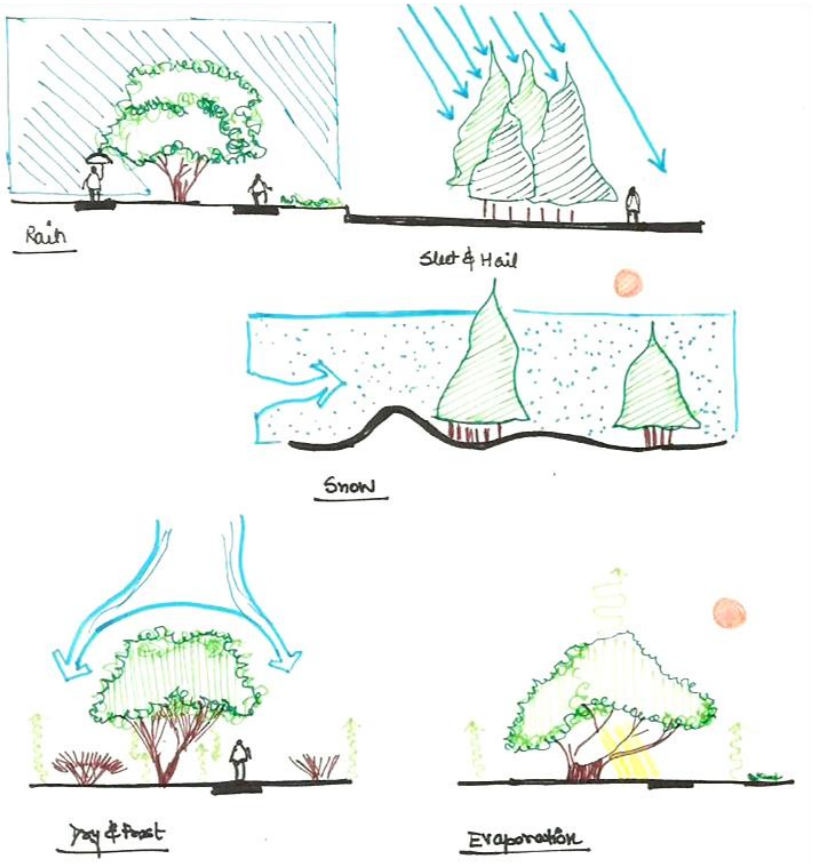
Evapotranspiration, alone or in combination with shading, can help reduce peak summer temperatures by 2–9°F (1–5°C).

Benefits a Reduced energy use; improved air quality and lower greenhouse gas emissions; Enhanced stormwater management and water quality; reduced pavement maintenance; improved quality of life.

Source:https://www.epa.gov/heat-islands/using-trees-and-vegetation-reduce-heat-islands

VEGETATION effecting HUMIDITY & PRECIPITATION

PRECIPITATION in different forms is controlled to various degrees by vegetation. Plant materials control the impact of rain, of sleet and hail, the position and amount of snow deposition etc.

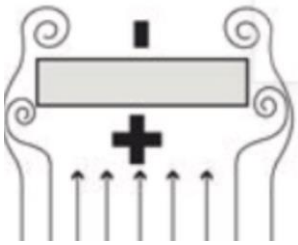


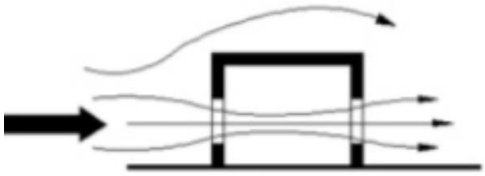
Sketch of trees in affect to precipitation & humidity (source: landscape planning for energy conservation)

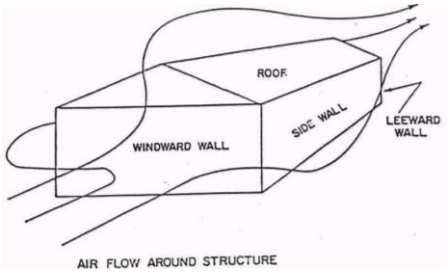
Planting will reduce accumulation of snow on the ground. Vegetation, especially needle-leaved trees may be used to capture fog, and thus increase sunlight reaching the ground or the collector unit. Evergreens capture and hold more moisture (particularly in the form of frost or fog) than deciduous trees because of their pointed needles and because of the sharp angles at which the needles join the twigs. The high humidity and low evaporation rate of areas situated under trees help to stabilize the overall temperature and microclimate of the site.

Five Basic Principals of Air Movement

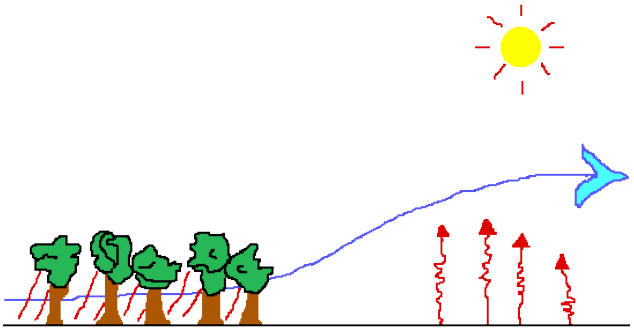
- **As a result of friction, Air velocity near the site is much lower due to roughness of ground which includes vegetation configuration and contour changes**
- **Second principle – Air tends to continue moving in the same direction, when it encounters an obstruction. As a result it tends to flow around objects**
- **Third principle – Air flows from high pressure to low pressure areas. Eg. Cross ventilation is created by positive pressure being built up in the wind ward side and negative pressure in the leeward side.**



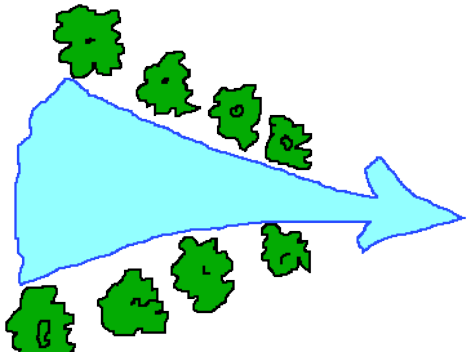




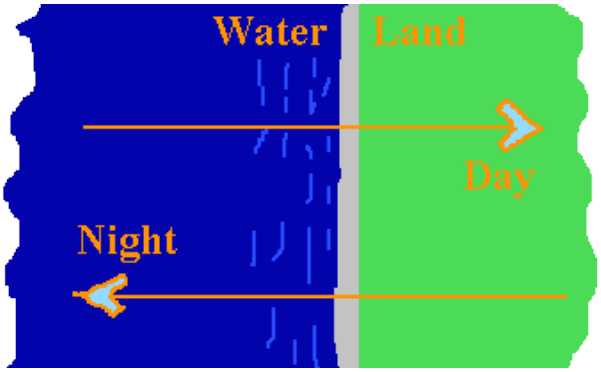
- **Fourth principle is convection – involves temperature and density of air. For eg., air flowing from forested area to meadow will rise because the meadow is exposed to solar radiation, making that air warm and dense.**



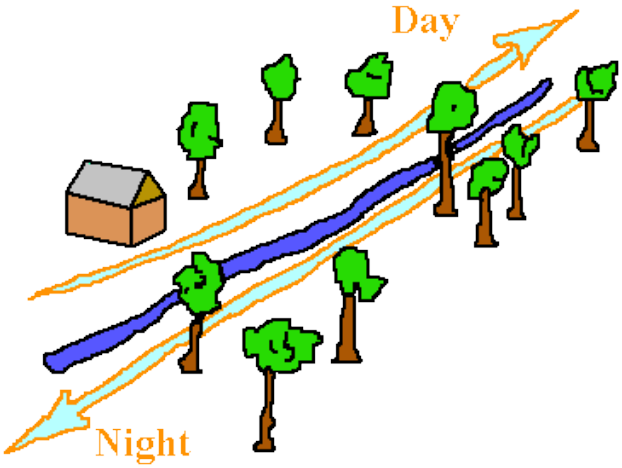
- **When air flow is channeled and restricted, the pressure rises and velocity increases.**



- **The wind pattern near large water bodies is generated by heat loss, heat gain and heat storage variations between land and water.**



- **In valleys, the wind moves uphill during the day, as the sun warms the air causing it to be less dense. At night air flows down the valley because the top area cools faster and becomes heavier.**

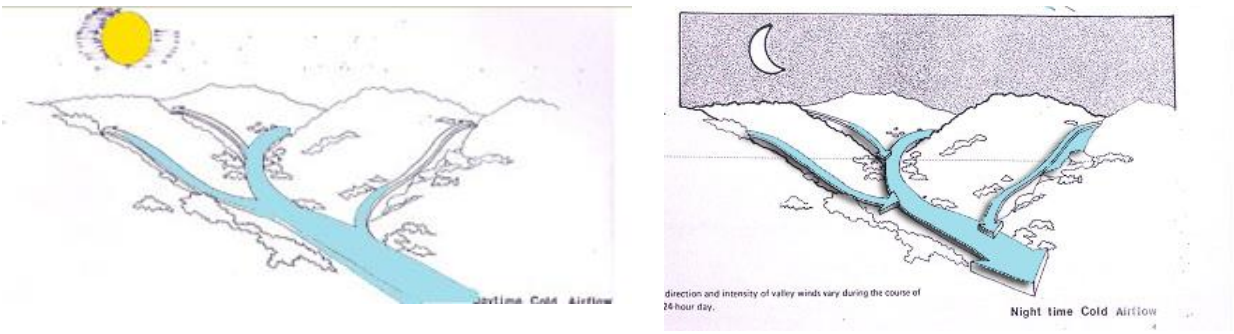


- **Humidity – Sites near large water bodies tend to be more humid. Wind direction also effects humidity. Downwind from water bodies is more humid than up wind.**
- **Vegetation also increases humidity in air.**
- **Water vapor constitutes air along with other gases but acts independently.**
- **Water vapor exerts its own pressure. It migrates from high vapor pressure area to low vapor pressure area.**

LANDFORM WITH RESPECT TO CLIMATIC FACTORS

1. LANDFORMS TOPOGRAHY

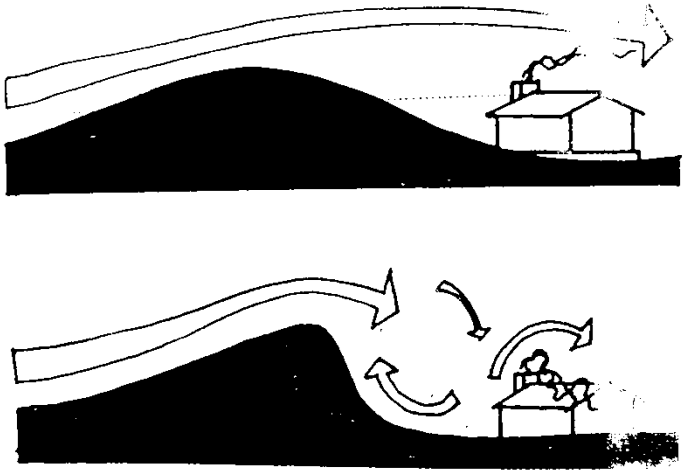
As mentioned before, the general pattern of wind prevailing for an area depends on the topography or the landform profile of the site. e.g: Wind blowing across flat sites remain laminar wind and at full force.



The direction & intensity of valley winds vary during the course of the 24 hour day. (source: Gary O. Robinette- Energy conservation)

However, the profiles of hills and valleys creates variation based on steepness and on the orientation of the slopes with respect to the prevailing pattern. Because cold air is heavier than warm air, the airflow tends to be downhill during the night and uphill during the day. If the windward side of the hill is steeper than the leeward side, the change in the wind pattern is more abrupt than if the leeward side is steeper.

For example: Rolling hills break the wind slightly at each peak, and the wind speed in the valley is reduced somewhat.



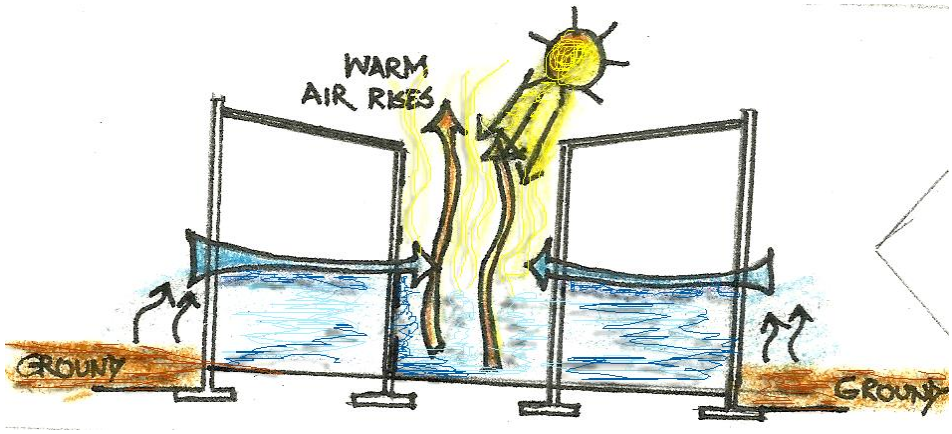
Air flow over rolling hills (Source: 3:Gary O Robinette; Landscape planning for Energy conservation

2. LANDFORM SURFACES

The surfaces across which the wind blows affects the wind's force, path, and composition. A smooth surface offers nothing in the way of resistance; wind blowing across a smooth surface with an even topography will reach peak speeds in a predictable direction. A very rough surface on the other hand, will break the wind at ground level, introducing separation or turbulence.

<u>LANDFORM with affect to SOLAR-RADIATION & TEMPERATURE</u>

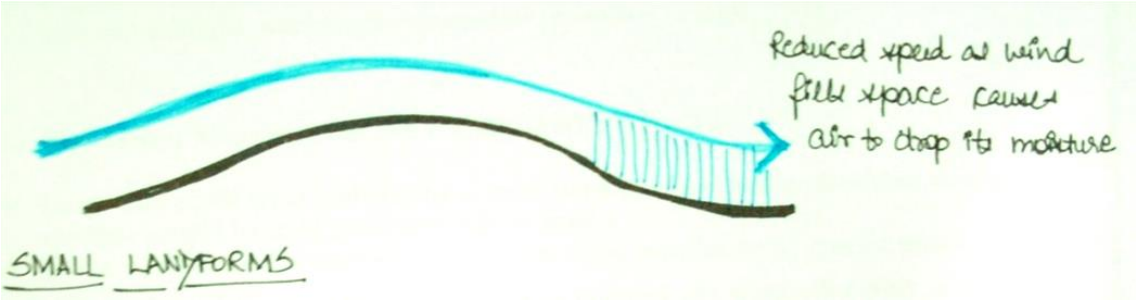
The most important interaction between the wind and the other major climatic factors is its influence in reducing the effective temperature of the site through both convective and evaporative cooling will result from convention. The more turbulent the wind is the more cooling will result from convection.



In the process of evaporation, heat is removed along with moisture from objects and from the air. When no moisture is present, however, the wind makes dry air seems even drier. Consequently, the more surfaces available from which the wind can draw more moisture, the greater the natural potential for cooling the site will be.

3. LANDFORM WIND

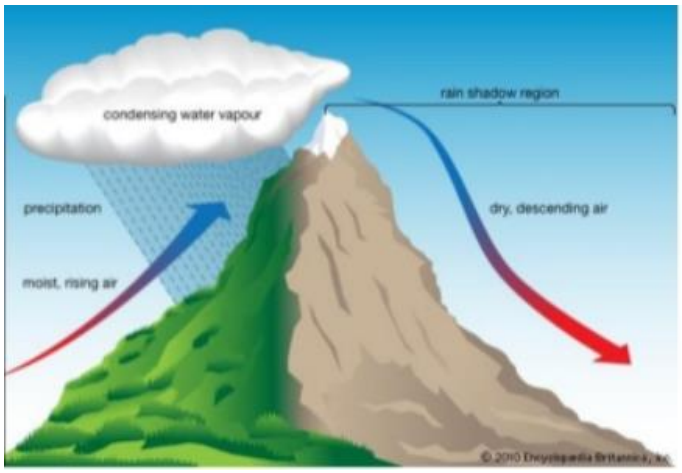
Wind can make the difference between comfort and discomfort when the air is heavy and humid, since it is able to remove humidity through evaporative and convective cooling. Because topography affects the pattern of the winds that carry moisture.

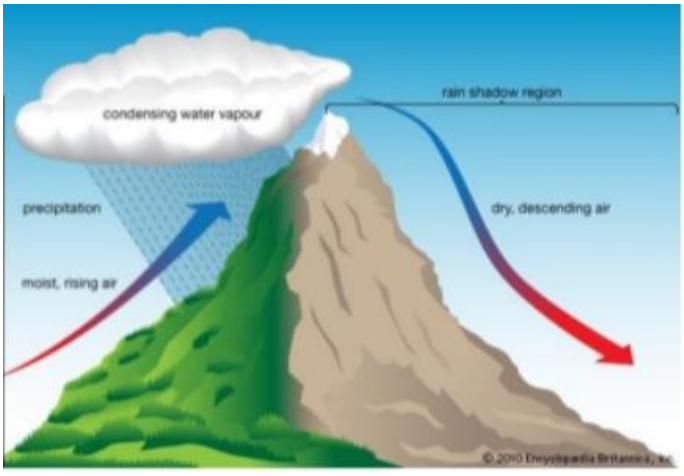


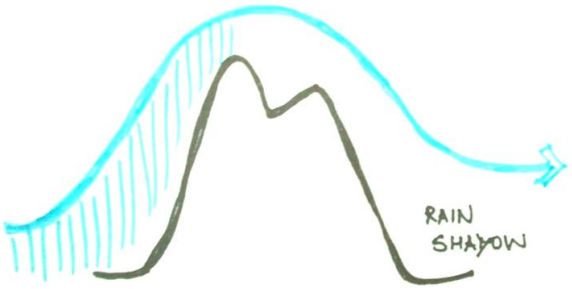
Reduced speed as wind fills space causes air to drop its moisture

Small landforms receive relatively heavy precipitation on the leeward side of the hill (the side away from the direction of the prevailing wind). As the moving air begins to climb the windward side of the hill, the bottom layer of the air speeds up and the top layer begins to cool. A sudden void develops beneath the moving layers of air as the topography drops, away beyond the crest of the hill.

This change in air pressure causes the air to drop its moisture . with more available space to occupy, the air moves less swift, and the moisture load carried by the air can no longer be sustained.







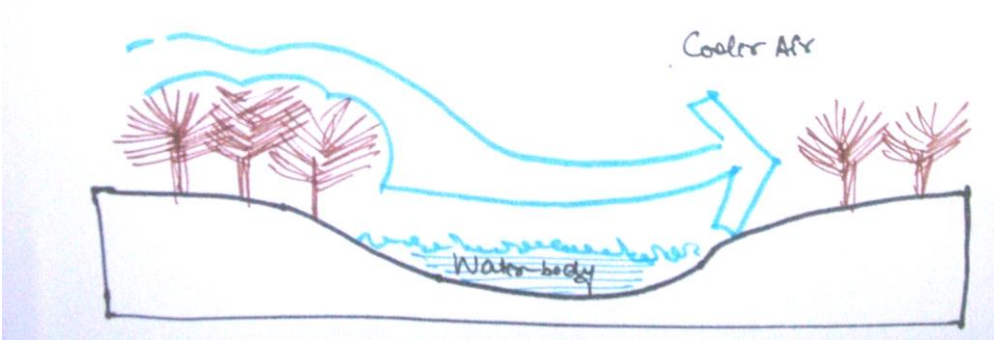
Effect of landform on wind & precipitation

For large landmasses the size of the mountain ranges and the landforms whose windward sides are much steeper than their leeward sides, the opposite effect occurs , as the warm, moisture-laden air begins to climb the steep windward face of the landform, it cools and finally reaches a point at which it cannot hold the water any longer. This accounts for the huge amount of rains received on the windward side.

4. WATER EFFECTING MICROCLIMATE

Water Effecting Wind

The wind moving across the surface of a major body of water inland during the day and in the opposite direction at night. When the air temperature is very high, even the slightest breeze across water will produce evaporative cooling and make the weather more bearable.



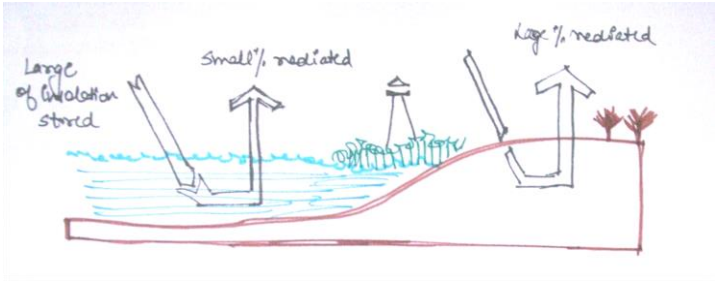
Wind blowing on the water surface (source: landscape planning for energy conservation)

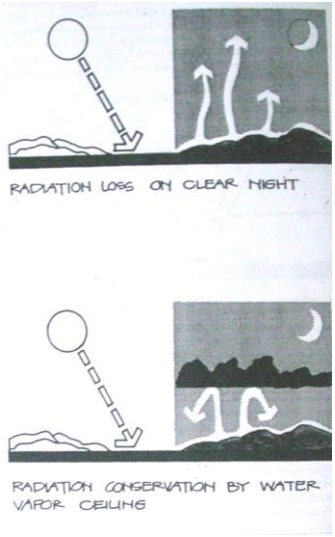
POSITION OF THE SITE WITH RESPECT TO THE WATER BODY

The leeward side of the water body will always be cooler since the wind is cooled as it moves across the surface of the water body. Therefore areas or activities which need to be naturally cooler should be located on the leeward side of water bodies. Functions or areas which need extra heat or warmth should be located on the windward side of water bodies where possible because of this. Therefore water, ranging in form from an ocean to the water particle in a cloud, is able to moderate or effect extremes of climate and to assist in energy conservation.

<u>Water Affecting Solar-radiation</u>

The mass of water acts as a heat reservoir, warming up gradually during the spring and remaining at a reasonably constant temperature throughout the warm seasons. Except when the sun is low in the sky, the albedo of water is very low, causing little reflection to surrounding surfaces. The surface temperature of an ocean may vary no more than 18 degrees during the year .

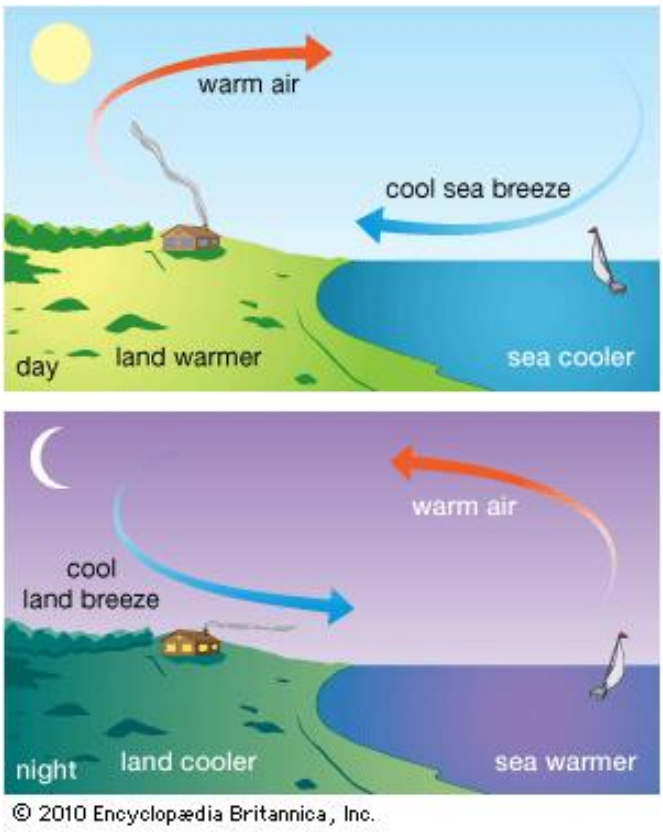




Breezes flow from the water body onto the shore during the day and off the land area onto the water body at night. Water in the form of clouds has an impact on climate as does liquid moisture. Radiation which has been absorbed by the earth quickly and readily escapes back into the atmosphere on a clear night. On an overcast night the cloud cover inhibits this radiation loss and thus the temperatures are generally higher on an overcast night than they are on a clear night.

Therefore water, ranging in form from an ocean to the water particle in a cloud, is able to moderate or effect extremes of climate and to assist in energy conservation. The ocean can seldom, if ever, be modified, but its effects on microclimate can be accepted and utilized in landscape planning.

Breezes flow from the water body onto the shore during the day and off the land area onto the water body at night.(source: landscape planning for energy conservation)

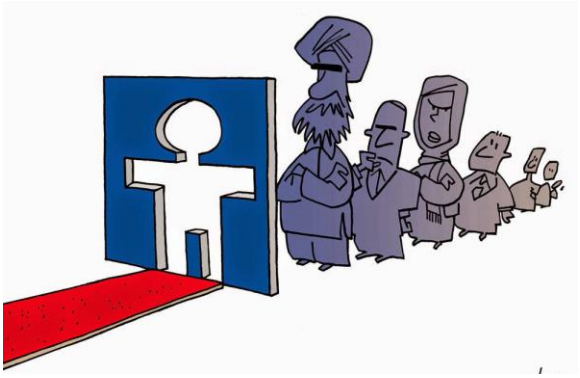


Site Selection Process and Site Selection Criteria

- **Housing Development**
- **Commercial Project**
- **Institutional Project**

Introduction

Site search and selection is a major element of the process of creating a supportive project. With some exceptions, it is impossible to seek permanent financing and community support until the site is identified and site control has been secured.



The site selection process is most successful when it is a methodical search for the site that best meets established criteria, including size, location, proximity to services and price — factors that will help ensure the project fulfills the needs of future tenants.

Initial Steps

Prior to site selection, Project concept has to be finalized

- **Site requirements –Location, proximity to service, price etc.**
- **Configuration –size, building types etc**

Possible setbacks

- **Inadequate inventory of available sites**
- **shortage of funding**
- **competition from other investors**

PRIMARY COMPONENTS OF THE SITE SELECTION PROCESS INCLUDE:

Establishing Site Selection Criteria:

Prior to initiating the site search, or while reviewing an opportunity to acquire a site, it is essential to carefully define the appropriate criteria for the proposed project by considering the following:

- **Scale**
- **Housing type and construction**
- **Location**
  - **Public transportation**
  - **Employment opportunities**
  - **Neighborhood amenities**
  - **Community-based services**
  - **Day care**
  - **Public schools and related programs**
  - **Security**
- **Acquisition or lease costs**
- **Zoning considerations**
- **Community acceptance**

Engaging in the Site Search:

- **Exploring diverse potential sources of sites**
- **Using a real estate broker**
- **Conducting a site search independently**

HOUSING

Housing Development

- **Scale/ size**
- **Level of need for housing**
- **Capacity of management to develop/ manage property**
- **Contextual –height/ density of surrounding buildings**
- **Degree of community support**
- **Maximum allowed development area**

Housing Type/ Construction Approach

Housing type –Depends on neighbourhood

> Scattered site, one and two family houses for low density neighbourhood

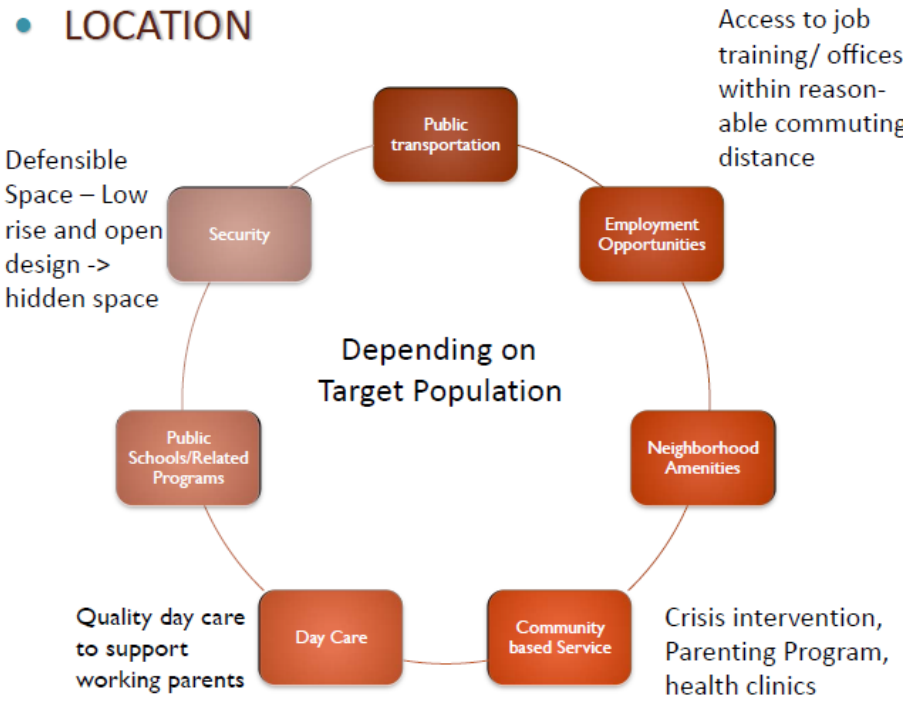
> Multi units for high density

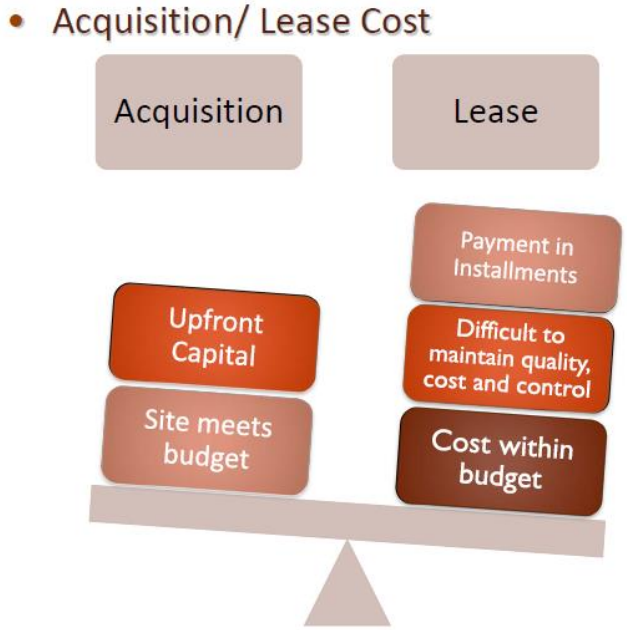
Construction Approach

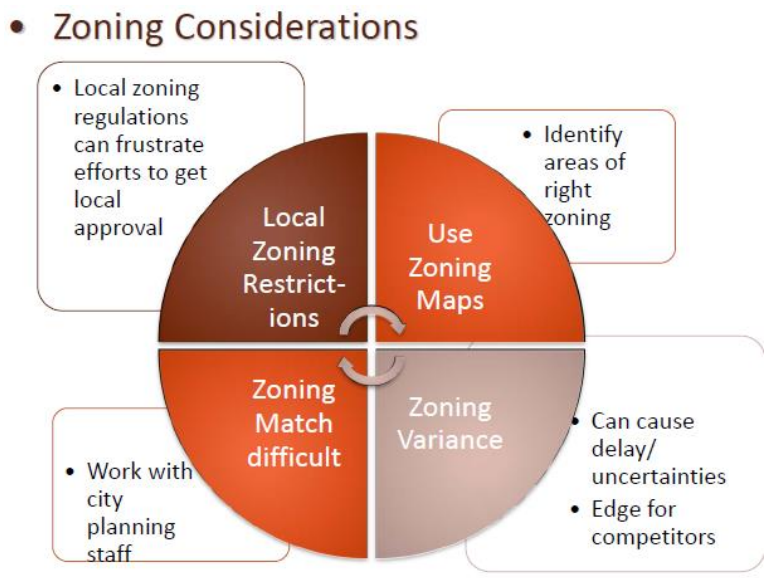
> New construction –Vacant sites available, buildings for demolition, Funds

> Rehabilitation –sites with empty, partial or fully occupied buildings

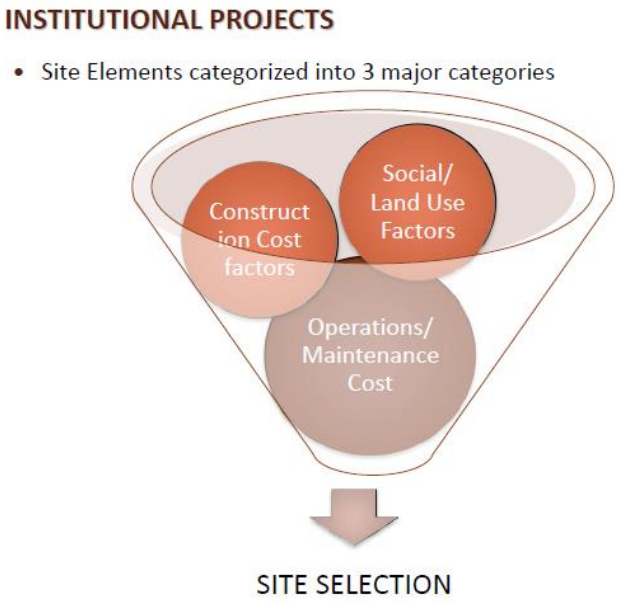
> Challenges, Cost and Inevitable delays of tenant relocation –setbacks of relocation







INSTITUTIONAL



SOCIAL AND LAND USE FACTORS

- **Size of Site –Building footprint, Parking Space, Playground area**
- **Proximity to Population to be Served –Safe Walking distance or easy accessibility by public transport**
- **Proximity to Future Expansion of Community –20 years down the line, still population centers/ residential areas**
- **Proximity to Important Existing Facilities –Shared services like food services, swimming pools, stadiums etc.**
- **Site Topography –Fairly level with some topographic relief**
- **Road Access -Minor arterials/ collectors preferred to high volume roadways**
- **Visibility, conflict of driveways –Entry to drive void of curves, slopes and other obstacles to vision**
- **Safe Routes to School for Pedestrians and Bicycles –Safe walking routes enable students within short distance to walk or cycle safely**
- **Roadway Capacity, Safety Needs –School generate traffic, requires turning movement –wide roads and turning options accordingly**
- **Aesthetic Value –Vegetation, topography, views and surroundings –subjective yet preferred**
- **Sun Orientation –take full advantage of sun angles, playground to receive normal sunlight, north facing slopes preferred**
- **Protection from Elements -Wind protection, driving rain important for both indoor and outdoor educational activities**
- **Site Drainage –Sites with good drainage easier to develop and maintain**
- **Proximity to Natural Hazards –Safe from natural disasters (mud slides) as well as health (garbage/ sewage dumps) and safety hazards (cliffs, water bodies)**
- **Zoning/Land Use –Compatible with current/ projected zoning delay for permit**
- **Proximity to Fire Response Equipment –May or may not effect rural areas site, but proximity an advantage in urban areas**
- **Flooding -Site should not be located within a flood plain**
- **Existing Site Development –Vacant sites preferred. Demolition/ relocation - alternatives**

- **Access to Outdoor Recreation/Learning –Complimentary parks/ recreation resources –extension of the classroom**
- **Noise –Incompatible noise detrimental to education delivery**
- **Potential for Hazardous Materials –Past use free of industrial use and hazardous storage**

Construction Cost Factors

1. **Soil/ Foundation Conditions**
2. **Availability of Water Utilities**
3. **Availability of Sewer Utilities**
4. **Availability of Electric Power**
5. **Availability of Fuel Storage/Distribution**
6. **Roadway Capacity, Safety Needs Construction Cost Factors**
7. **Ease of Transporting Construction Materials**
8. **Site Availability**
9. **Site Cost**
10. **Site Drainage**
11. **Proximity to Natural Hazards**
12. **Site Erosion**
13. **Existing Site Development**
14. **Potential for Hazardous Materials**

Maintenance/ Operating Cost Factors

- **Safe Routes to School for Pedestrians and Bicycles**
- **Site Drainage**
- **Site Erosion**
- **Sun Orientation**
- **Protection from Elements**
- **Proximity to Natural Hazards**
- **Alternative Energy Sources – solar/ wind energy**

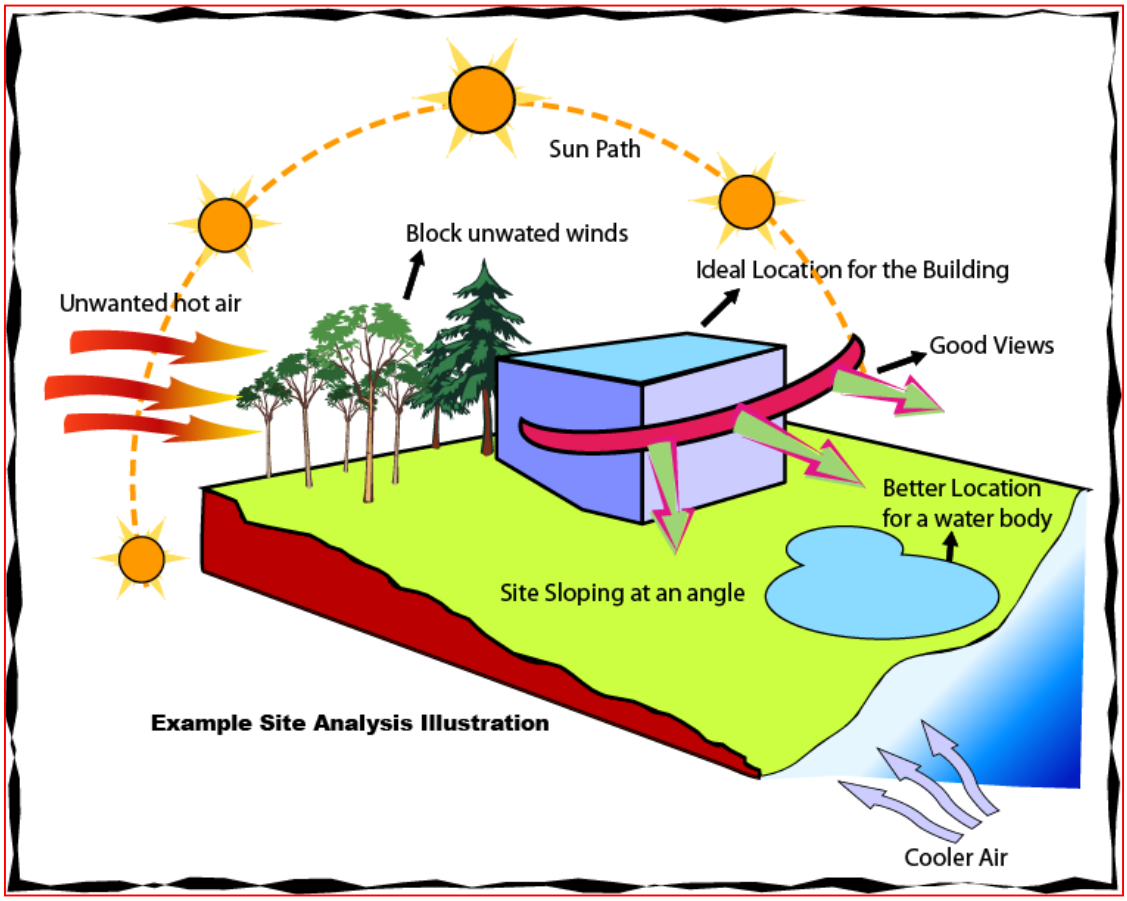
COMMERCIAL PROJECTS

- **Location: The value of building depends upon its location – it should be on the main road and in the center of the region.**
- **Climate of Region: strength and stability of building depends upon climate. Commercial buildings expensive from economic points of view - constructed according to the safety requirements**
- **Availability of Raw Materials: require more construction materials. Before the construction, make sure that raw materials are available near by – cost effective**
- **Cost and Time Frame: depends upon the location and the availability of Raw materials.**
- **Populations of The Region: to meet the need of the local population. Must be constructed in the region having sufficient population to restore its cost.**
- **Visibility : Maximum visibility to store front > Signage – Check for any restrictions pertaining to signage**
- **Pedestrian/ Vehicular traffic Parking**
- **Income : Depending on the type of goods, target income group to be fixed – HIG, LIG or Middle**
- **Competition : Retailers should have an idea of where competitors are likely to locate, so potential tenants will have preference**

GOAL OF SITE ANALYSIS

- **To achieve a successful design, site analysis is a must & should be done carefully.**
- **Site Analysis involves taking an inventory of site elements and analyzing these factors relative to the client's needs & aims.**
- **Gather relevant information about the properties of the site, from topography to climate to wind pattern and vegetation.**
- **Analyze these features and incorporate them into the design.**

Example of a Site Condition



- **Under Topography, slope is noticed.**
- **Analyzing the conditions, ideal location for building can be established.**
- **High spot might be right for building & low spot for water body.**
- **For prevailing hot winds, trees would act as buffer.**
- **Openings in building could be placed to absorb cooler winds.**

Site Analysis: Inventory List

1. Subsurface Features

- **Geology: Geological history of the area, bedrock type & depth etc.**
- **Hydrology: Underground water table, aquifers, springs etc.**
- **Soil Genesis: Erosion susceptibility, moisture (pF), reaction (pH) organic content, bearing capacity etc.**

2. Natural Surface Features

- **Vegetation: Type, size, location, shade pattern, aesthetics, ecology etc.**
- **Slopes: Gradient, landforms, elevations, drainage patterns**
- **Wild Life: Ecology, species etc.**
- **Climate: Precipitation, annual rain/snow, humidity, wind direction, solar intensity & orientation, average/highest/lowest temperature**

3. Cultural & Man-made Features

- **Utilities: sanitary, water supply, gas, electrical etc.**
- **Land use: Usage of site, adjacent use, zoning restrictions, easement etc.**
- **Historic notes: archeological sites, landmarks, building type, size, condition**
- **Circulation: linkages an transit roads, auto & pedestrian access, mass transit routes etc.**
- **Social Factors: population, intensity, educational level, economic & political factors, ethnicity, cultural typology etc.**

4. Aesthetic Factors:

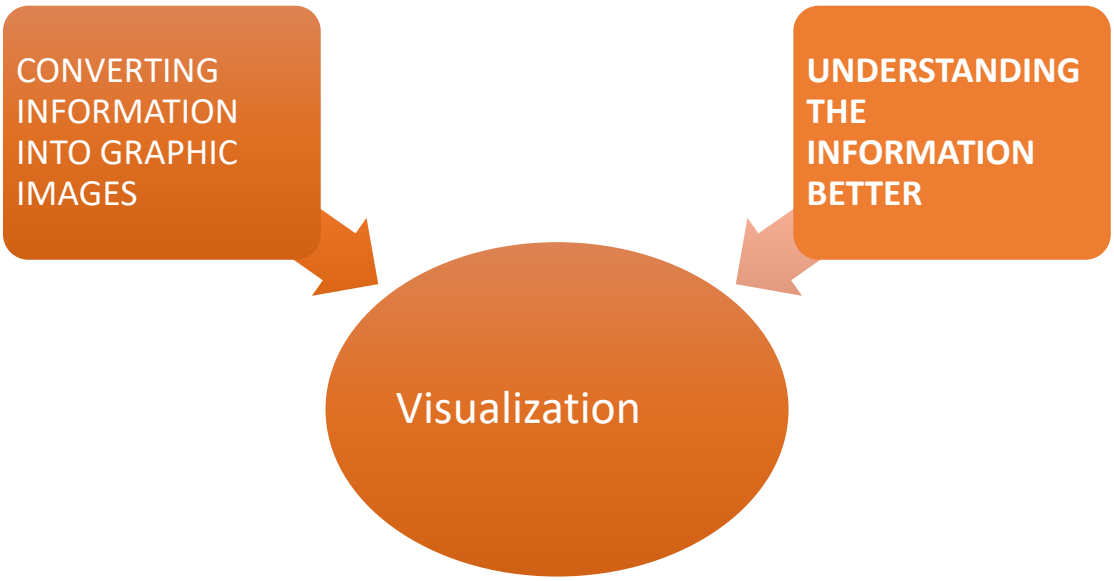
- **Spatial Pattern: views of the site, views from the site, spaces existing, potential for new areas, sequential relationship**
- **Natural Features: significant natural features of the site, water elements, rock formations, plant materials**
- **Perceptual: General impression regarding the experience potential of the site and its parts. Site peculiar character, smell, sound etc.**

Techniques for site Analysis

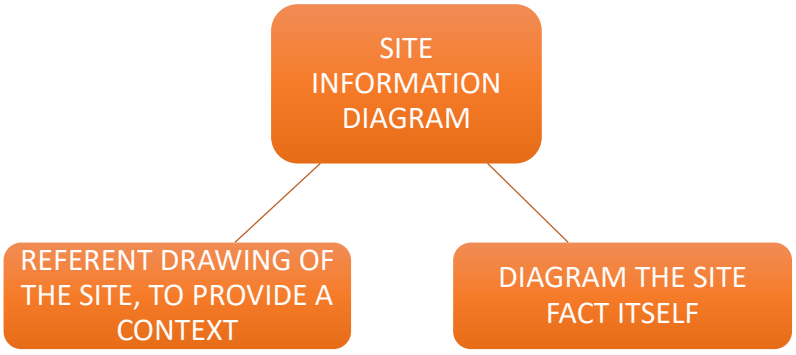
We sometimes overly anxious to draw the architectural answers to ill-defined project questions and reluctant to invest in graphic techniques that help us to understand the project needs and that stimulate responsive and creative design concepts. Ability to draw needs, requirements and early design concepts = our ability to draw final building design solutions > profoundly influence the quality of our building designs.

SKILLS AT DRAWING **THE PROBLEM** =

SKILLS AT DRAWING **THE SOLUTIONS**

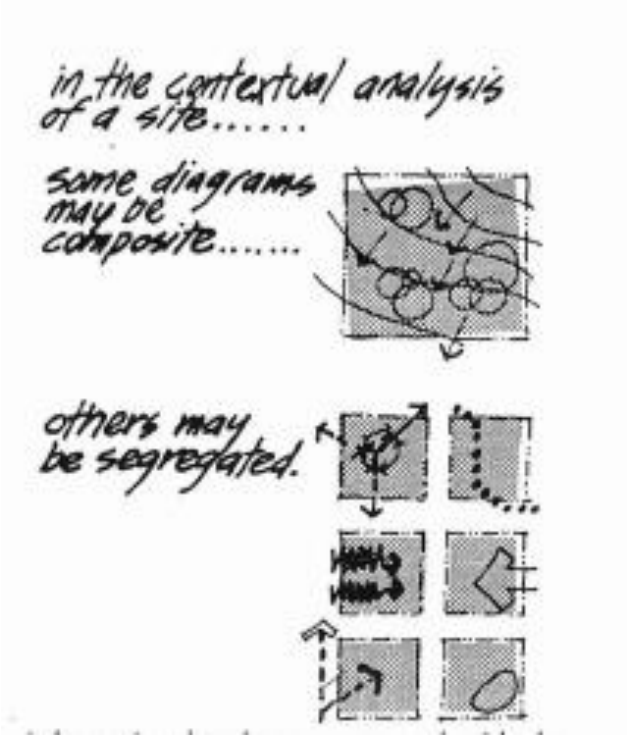


Diagramming is a way to get close to the problem , to engage it, to absorb it, to restate it in our own terms and to render it second nature so that we can attend to the selection and integration of potential solutions.



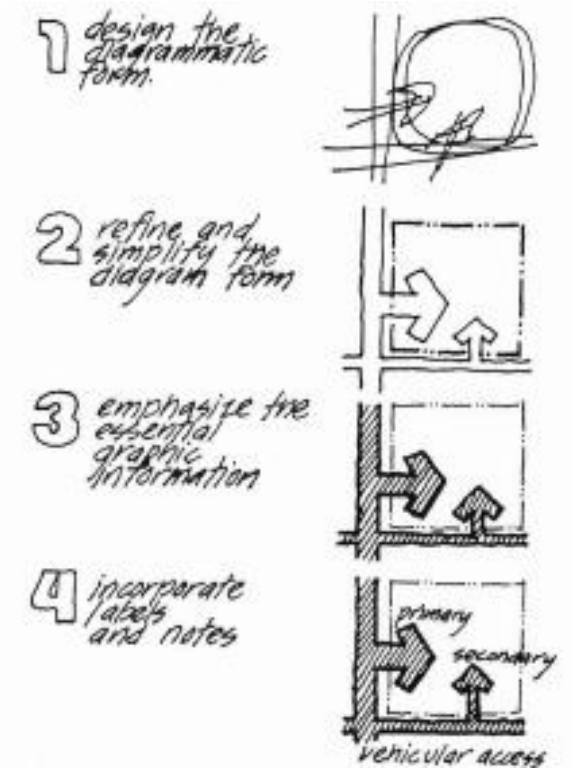
SITE ANALYSIS

- **COMPOSITE ANALYSIS – More easily see the relationship between the information.**
- **SEGREGATED ANALYSIS – Less likely to miss out on details or facts.**

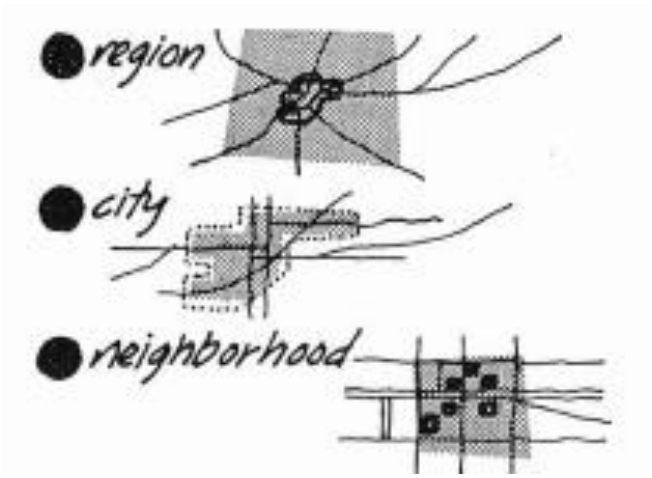


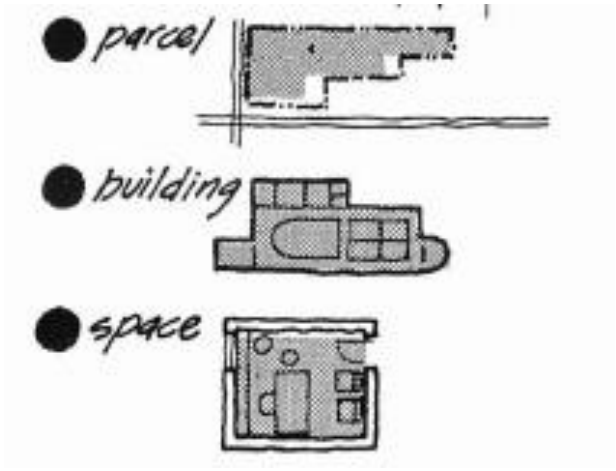
STEPS IN DIAGRAMMING

- **Four Steps to diagramming any site fact**
- **Develop our own vocabulary of diagrammatic forms**



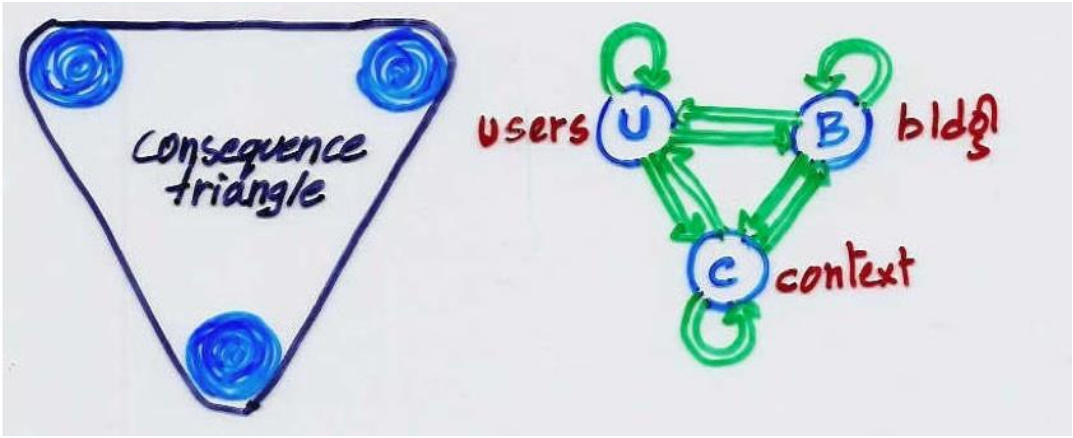
Contextual Analysis may be applied to situation of any scale





CONSEQUENCE TRIANGLE

Model for understanding the network of contextual causes and effects and how they relate to other aspects and issues of the project. - The building, the users and the context.



The building includes all the interior and exterior physical manifestations of our design (the walls, floors, ceilings, structure, mechanical, furniture, lighting, color, landscaping, paving, doors, windows, hardware accessories). The users include all those who own, work, maintain, service the building. The context includes all the conditions, situations, forces and pressures that constituted the existing site prior to the construction of the building.

WHY DIAGRAMMING?

- **Accountability: the building evaluation process needs to be more systematic and rigorous. Diagramming is a tool which can assist us in coping with information overload and in more thoroughly addressing the project requirements in design.**

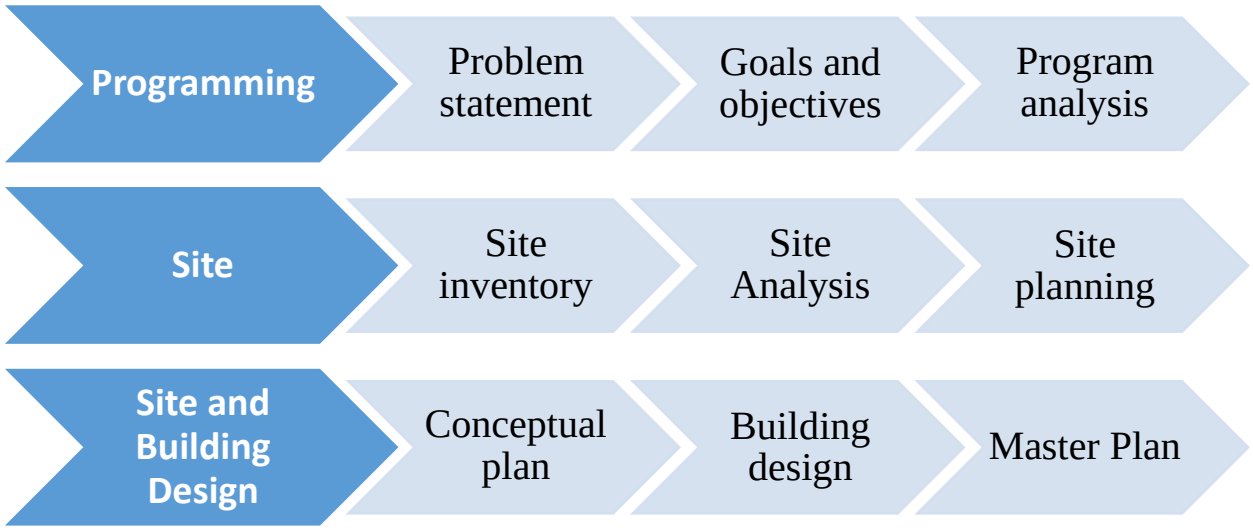
- **Communications: It is important for us to leave decision tracks that can be retraced and to be able to explain how we arrived at a particular design proposals. Diagramming is an effective means of increasing the quality of communication in our building planning processes.**
- **Efficiency: We should have tools which can help us to cause design solutions to occur in relatively short time. This needs for techniques extends beyond problem analysis and conceptualization into the synthesis, testing and refinement of design solutions.**

SITE ANALYSIS PROCESS

Issue identification

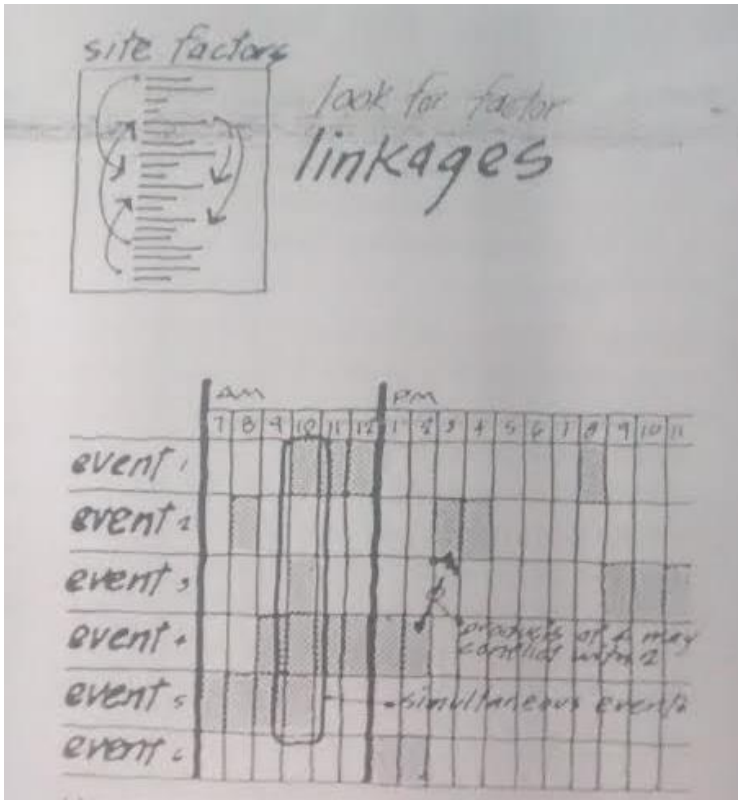
We should think about the nature of the project, its needs, requirements and critical issues. The hands-on direct encounter with site from a personal and sensory point of view gives us another set of clues for choosing the types of site information that should be addressed in our contextual analysis.

Site planning and design process

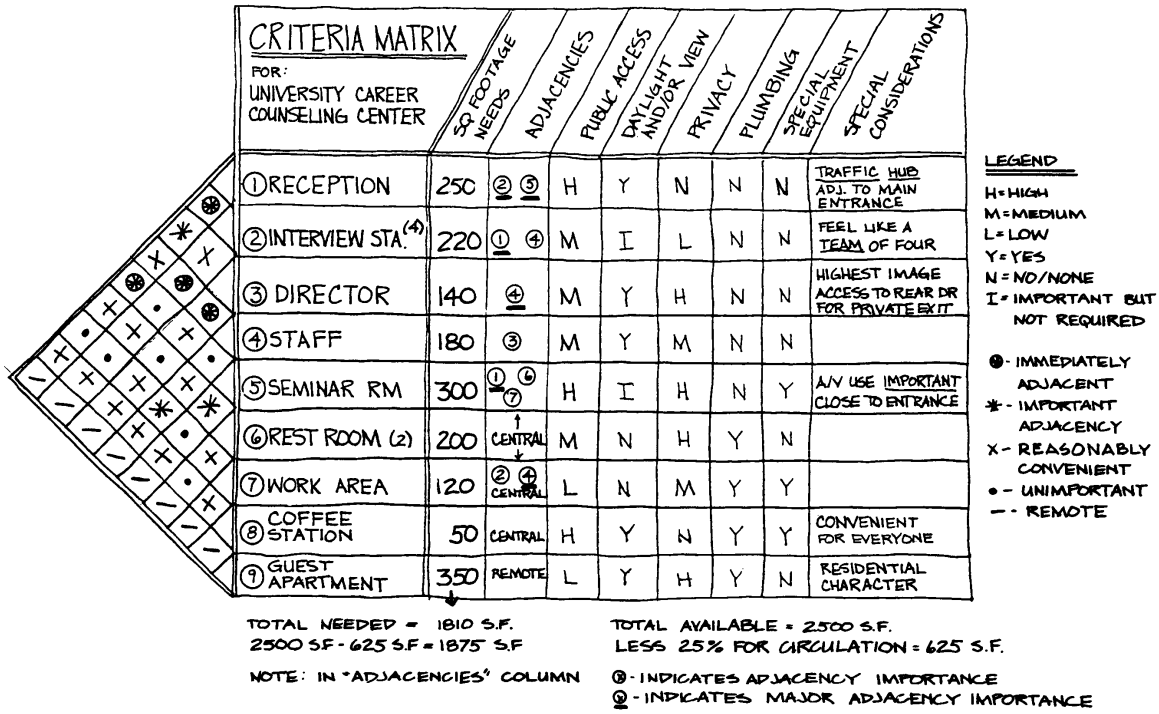


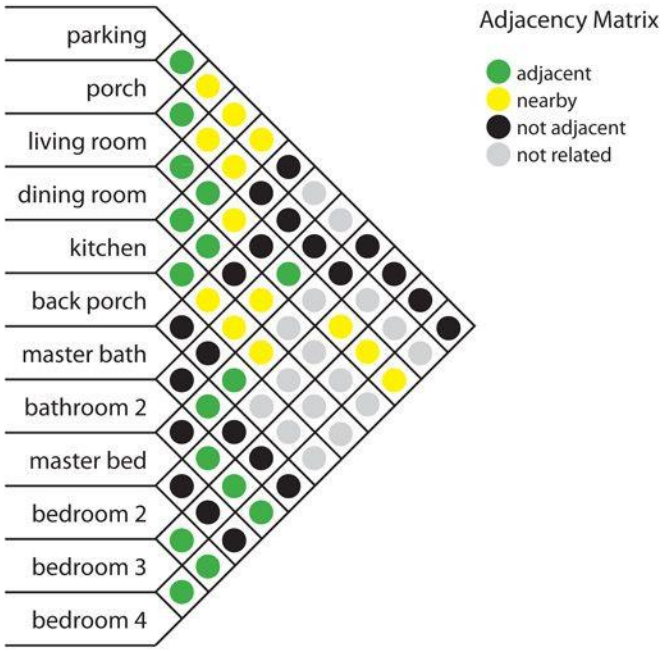
- **Checklist: A prototypical checklist of potential site issues. Checklist gives us a sense of false security. It can inhibit our understanding of the linkages between site conditions. To juxtapose all the issues dealing with time or schedule on the time frame of a typical day and for different times of the year.**

MATRIX ANALYSIS



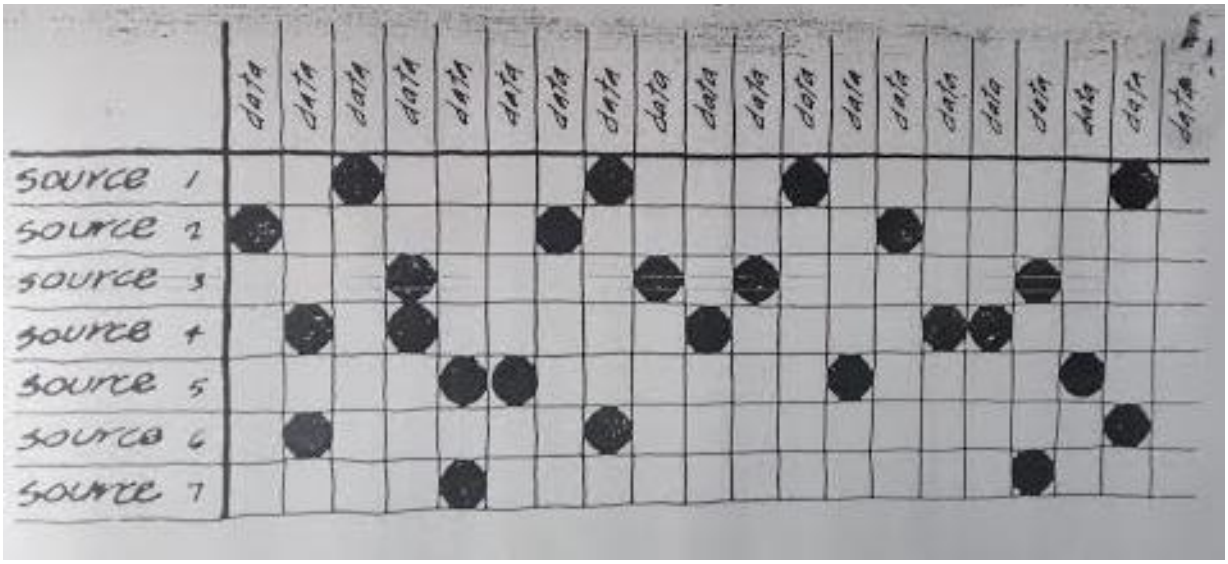
Matrix - Flat (two-dimensional) table in which the elements or entries appear at the intersections of rows and columns, governed by certain rules.



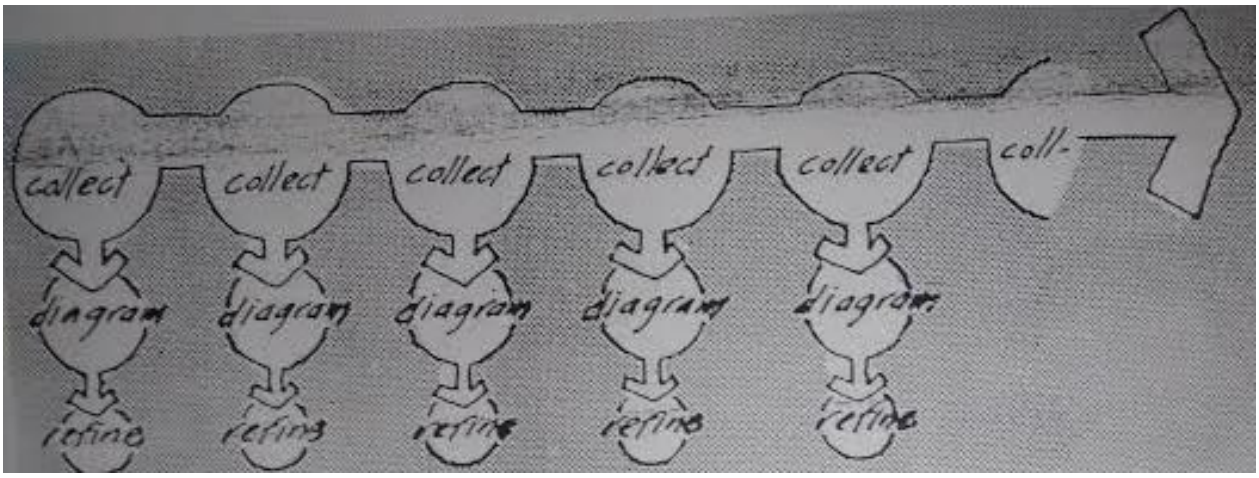


SITE DATA

- **Collecting the data – Sources of information may vary from site to site or from city to city. There will be multiple sources for each data. A matrix analysis could be done to designate the various sources for each data.**

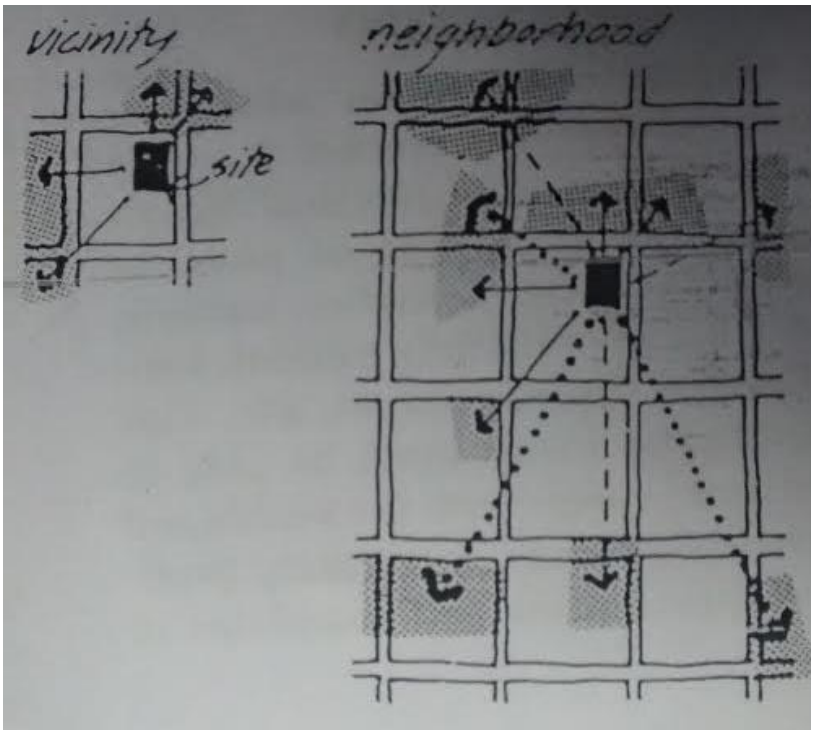


- **Making the diagrams – It is useful to diagram the site information as we collect it.**

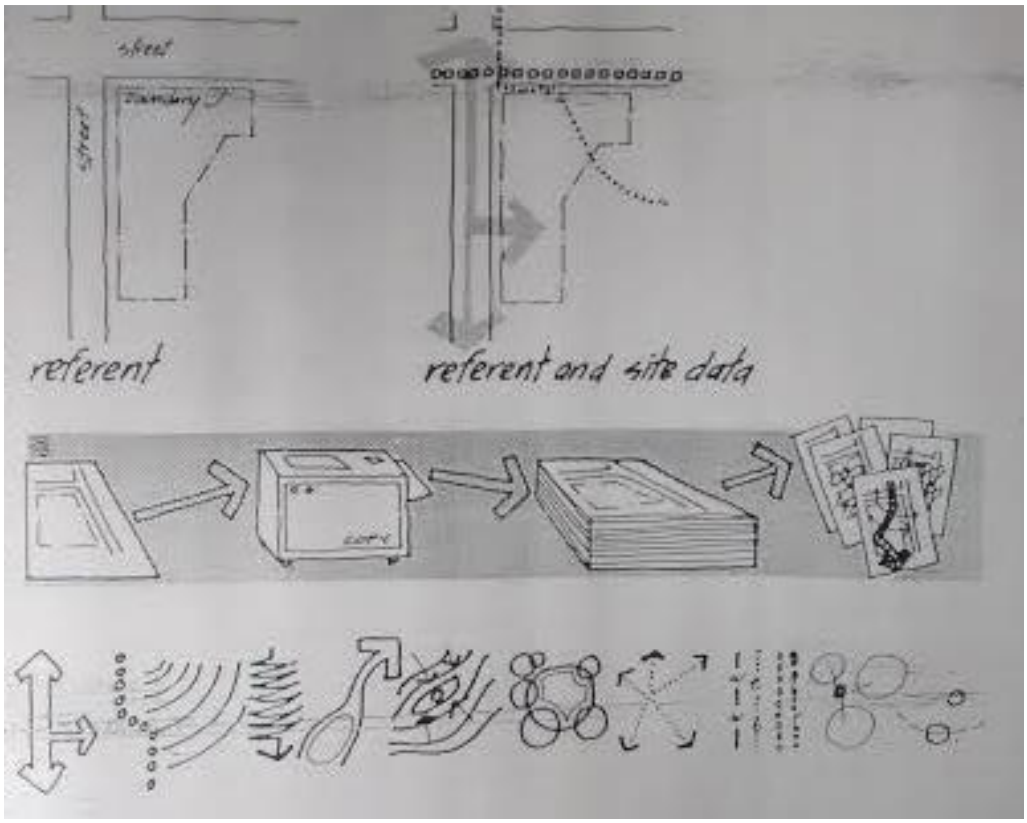


- **Choose the suitable referent drawing**

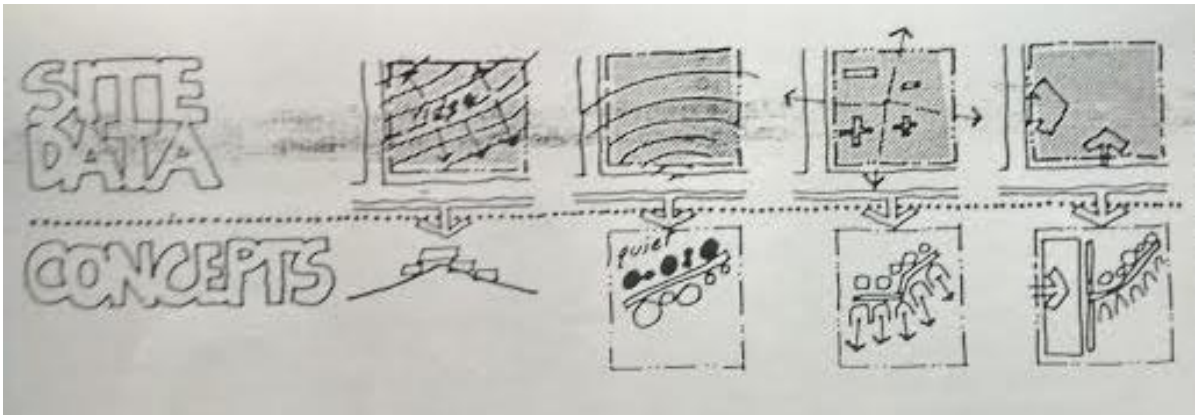
- **Choose the scale of analysis for each data**



- **Diagrammatic forms – Must record and express both visible and invisible forces.**



DERIVATION OF CONCEPTS



SITE ANALYSIS

The end product of the site analysis phase is a composite analysis map (sometimes referred to as an opportunities and constraints sheet). This is developed through an overlay process (similar to McHarg's planning approach, although greatly simplified) delineating the most suitable and least suitable areas of the site for each analysis factor.

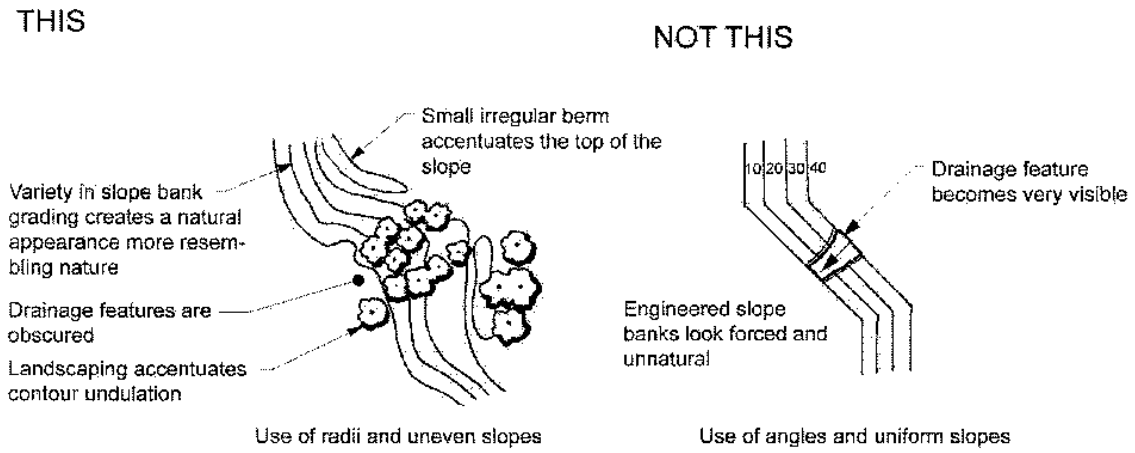
Generally, these areas will reinforce one another. That is, steep slopes, poor soils, areas of vegetation to be protected, etc. will fall in the same general locations, although what is suitable for one type of land use may be unsuitable for another. This is why it is important to have some idea of the program prior to completing the site analysis.

The composite analysis map provides clear justification to the designer for where the most intensive development should occur on a site with the minimum environmental impact. It also highlights particularly positive elements of the site that should be accentuated in the subsequent design development.

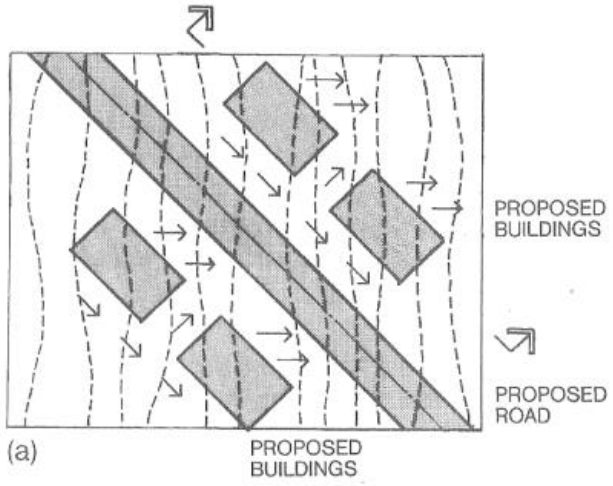
<u>LAYOUT AND GRADING</u>

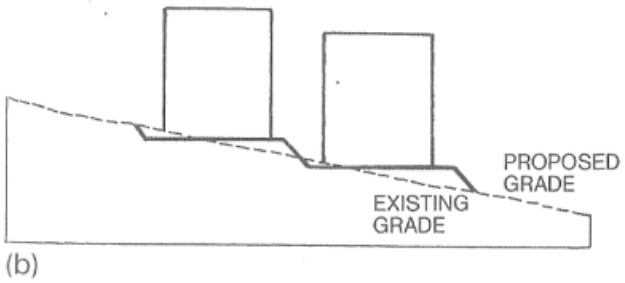
We modify the surface of the land to meet the requirements of a design and program.

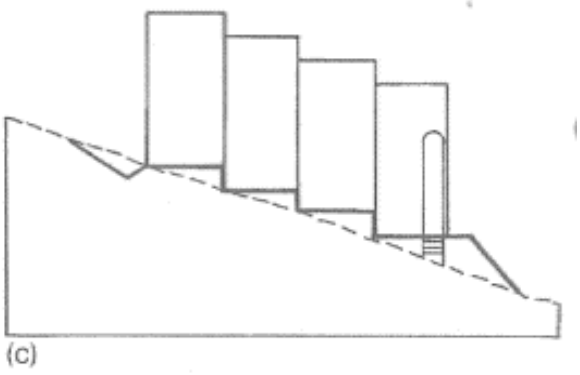
- **Environmental constrains – Topography, Drainage, Vegetation, Soil**
- **Functional Constrains - Restrictive Conditions, Activities & Uses**
- **Economic Constrains**



- **Most economical grading plan is one in which there is a minimum of earthwork and the amounts of cut and fill are in balance.**
- **To design a balanced site, the professional needs geotechnical information regarding the soil's character, the bearing capacity of the soil, and its bulking factor, as well as the depth and character of the bedrock.**





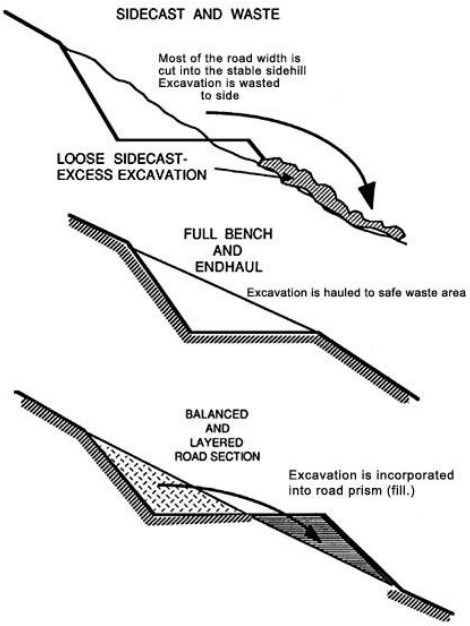


The Balanced Site

Site grading proceeds from a conceptual grading plan that attempts to balance the site and to locate the structures or program elements to maximize the site. From the initial design concept, the grading plan undergoes a series of iterations, each one bringing a greater level of detail to the design until the grading plan is final.

NEED FOR GRADING CONTOURS

Development of attractive, suitable and economical building sites. Provision of safe, convenient and functional access to all areas for use and maintenance. Disposal of surface runoff from the site area without erosion or sedimentation, or its collection as needed.



Diversion of surface and subsurface flow away from buildings and parameters to prevent undue saturation of the sub-grade that could damage structures and weaken

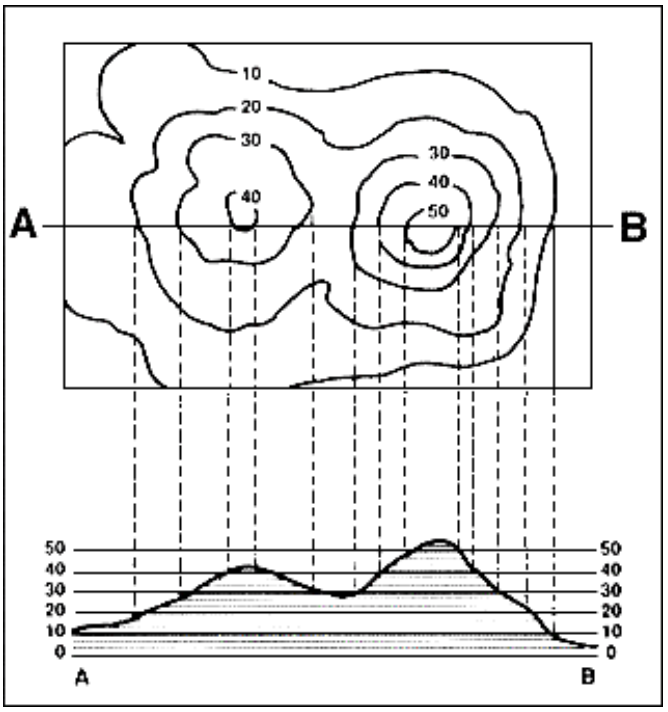
pavements. Preservation of the natural character of the site by minimum disturbance of existing ground forms and meeting of satisfactory ground levels for existing tress to be saved

Optimum on-site balance of cut and fill: stockpiling for reuse of existing topsoil suitable for the establishment of ground cover or planting. Avoidance of filled areas that will add to the depth or instability. Avoidance of earth banks requiring costly erosion control measures, except where these are needed in place of costly retaining walls. Avoidance of wavy profiles in streets and walks and of steps in walks

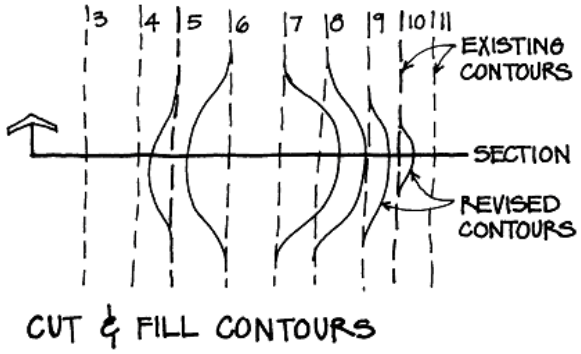
Keeping finished grades as high as practicable where rock will be encountered close to the surface, thus reducing the cost of utility trenching and other excavation for improving growing conditions for vegetation. Avoidance of runoff water over roadways, Ice forms during freezing weather and a hazardous driving situations.

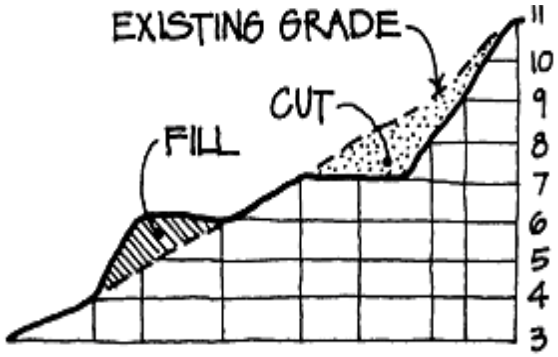
The layout and grading scheme of a site should consider

1. **Minimize the need for large cuts and fills.**
2. **the designer begins to mitigate the impact of the development.**
3. **The design should retain as much of the original terrain and character of the site as is feasible.**
4. **By grading smaller areas individually, the amounts of time and area of exposure and disturbance are minimized.**



Two ways - by removing earth (cutting) or by adding earth (filling). The greatest economy results when the amount of earth cut is approximately equal to the amount filled. Grading plans - indicate cut or fill - new, solid contour lines (Proposal), shown dashed (existing contours). A proposed contour that moves in the direction of a lower contour line indicates fill. Conversely, a proposed contour that moves in the direction of a higher contour line indicates cut.

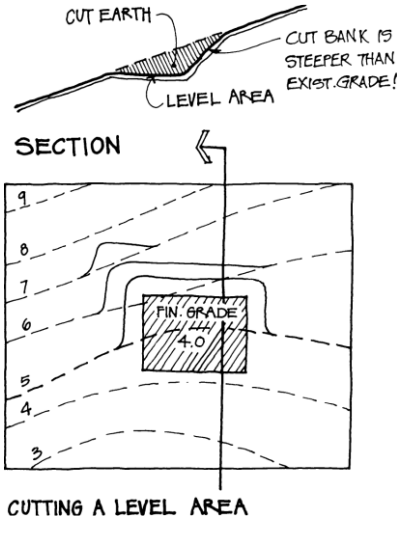


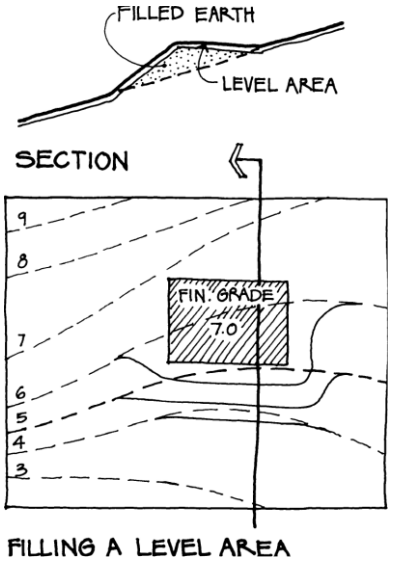


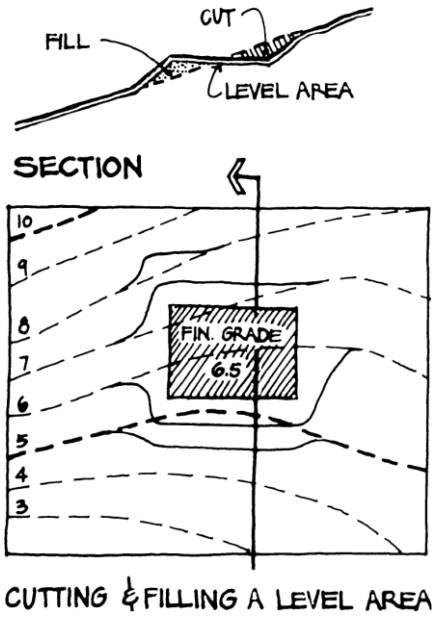
Level Areas

A level area can be created in one of the following three ways:

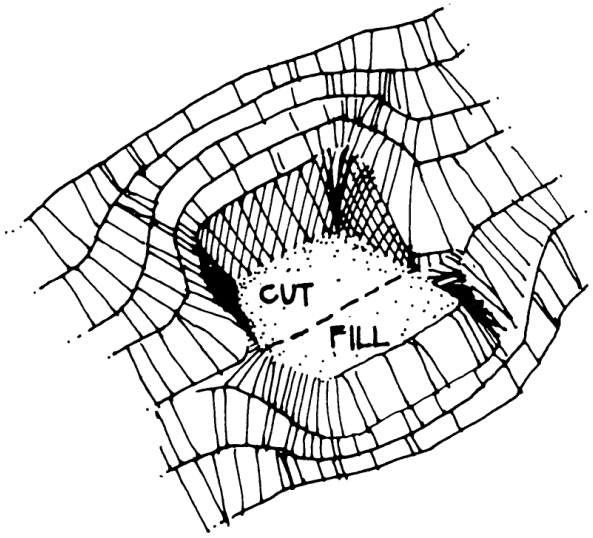
1. **By cutting into the slope**
2. **By filling out from the slope**
3. **By a combination of cutting and filling**







CUTTING & FILLING A LEVEL AREA

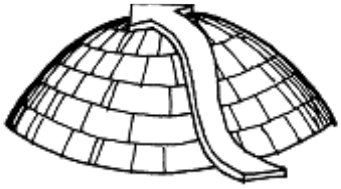


CUT & FILLED LEVEL AREA

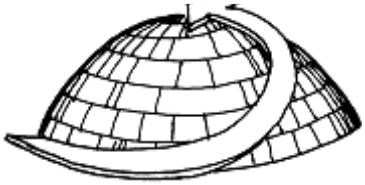
CIRCULATION PATH

One can move parallel to the contours, which is level but requires extensive grading because of its length. Perpendicular to the contours, which results in the steepest path but requires less grading. Normally, circulation paths are graded somewhere between perpendicular and parallel to the contours.

GRADUAL BUT LONGEST ROUTE



QUICKEST AND SHORTEST ROUTE

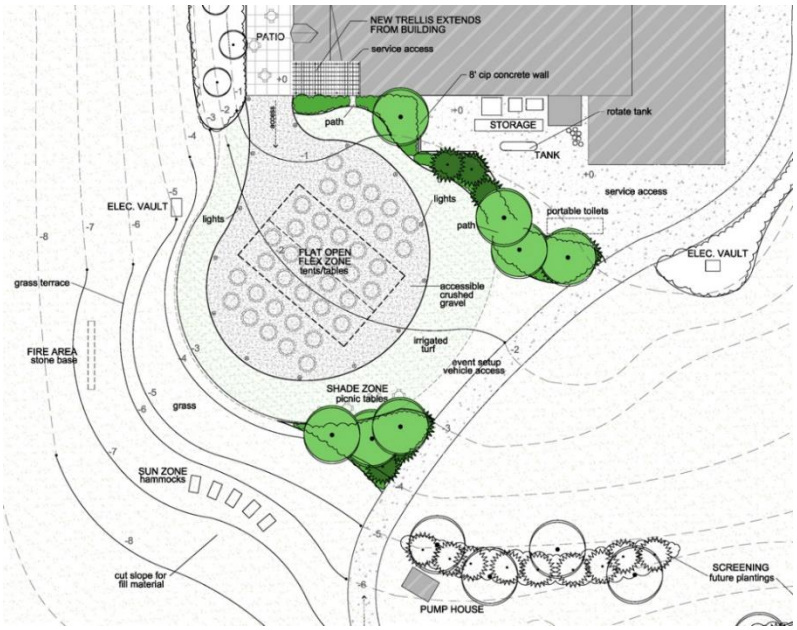


MOST NORMAL ROUTE

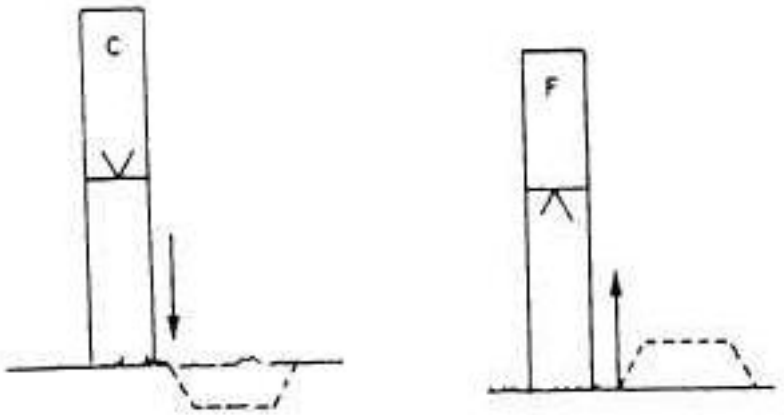
Before laying out a path, one must determine its required width and the maximum allowable steepness. (Generally 1:20 i.e. 5%). The slope of the path should be as uniform as possible. This means that contour lines along the path's route will be more or less evenly spaced. It is usually best to locate paths in valleys or along stream beds and avoid placing them on steep slopes. Highways commonly run long distances around a mountain, rather than going directly over or through it and creating extensive grading or tunneling problems.

Site Grading Process

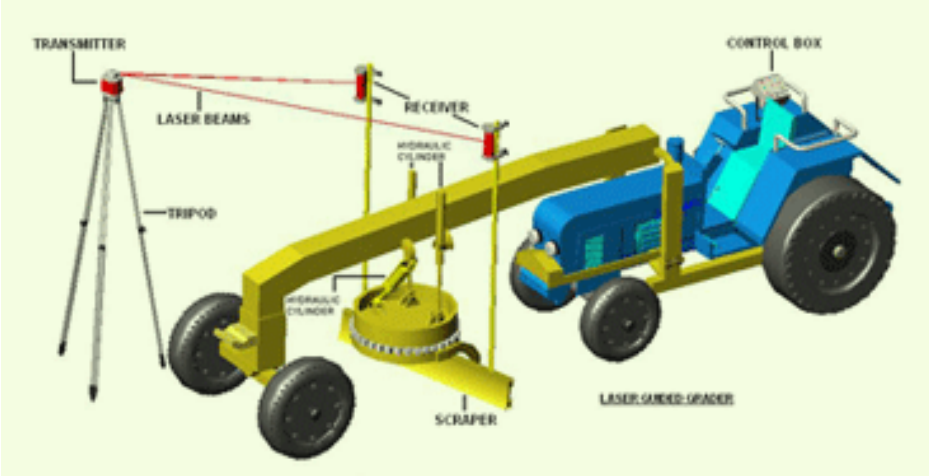
A conceptual grading plan that attempts to balance the site by locating the structures or program elements to maximize the site. The grading plan undergoes a series of iterations, each one bringing a greater level of detail to the design until the grading plan is final. Grading plans use contours, notes, and a variety of special symbols to describe what must be done to reshape the land into the desired forms.



The principal aim of all grading work is to make the land appropriate for its purpose and to preserve a stable system. The finished grade should have positive drainage, stable slopes, balanced cut and fill, and pleasant and harmonious visual forms. Grading operations begin by removing the topsoil, which is stored on the site and later reused over the modified ground forms. Grade stakes are then placed at intervals in the subsoil to indicate the required new levels.



Grade stakes are located at all critical points, such as peaks, valleys, roads, walls, and other points of grade change. Grading machines then cut or fill the earth to the staked levels and shape it into the desired configuration. Among the machines employed for this purpose are bulldozers, scrapers, graders, power shovels, rollers, and scarifiers. With the extensive range of machinery available today it is rarely necessary to do any expensive hand shoveling.



<u>Important general rules of grading:</u>

1. Do not extend grading beyond the property lines.

2. Strip and save all topsoil prior to grading.

3. Avoid the destruction of valuable existing vegetation.

4. Attempt to balance all cut and fill.

5. Avoid flat grades that create drainage pockets.

6. Avoid erosion by grading slopes within their natural angle of repose.

7. Be certain finish grades enable water to flow away from all structures.

8. Avoid grading solutions that rely on expensive retaining walls, steps, or other construction.

<u>Problems faced in Grading:</u>

- ***Loss of topsoil:*** **It takes hundreds of years of natural decomposition of organic material to produce a thin layer of topsoil. Since it is absolutely essential to plant life, topsoil must be retained.**
- ***Loss of vegetation:*** **Vegetation replenishes the oxygen, moderates the climate, and helps control erosion. All mature plants, therefore, must be preserved.**

- ***Altered drainage patterns:*** **Modified runoff patterns can cause erosion and contamination of downstream waterways. New drainage patterns must be carefully planned.**
- ***Unstable earth:*** **Grading earth that is unstable can produce slides, slippage, and cave-ins. Work done at one location can affect other sites, even if relatively distant.**
- ***Aesthetic damage:*** **Grading that alters existing site qualities may destroy the uniqueness of an entire area. Designers should remain sensitive to existing conditions.**
- ***Unique conditions:*** **Some areas are excessively steep or contain extensive rock outcroppings; others provide a natural habitat for wildlife. Such areas, if possible, should be left in their natural state and not graded or developed in any way.**

Methods of Expressing Slope

- **Slope is expressed in terms of a percentage,**
- **a proportional ratio, or a degree of slope**
- **Percentage of slope = number of meters (feet) rise in 100 m (100 ft) of horizontal distance, typically referred to as rise/run.**
- **If the slope rises 2 m (2 ft) in 100 m (100 ft), it is considered a 2 percent slope. The percentage of slope can be calculated by the following formula :by the following formula :**

$$G = \frac{D}{L} \times 100$$

where D = vertical rise, mm (ft)
L = horizontal distance, mm (ft)
G = gradient, %

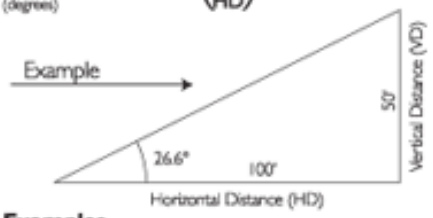
- **Proportion (of Slope) : Slope can also be expressed as a ratio of the horizontal distance to the vertical rise, such as three to one (3 :1) . The ratio method is used typically for slopes 4 :1 (25%) or steeper.**
- **Degree (of Slope): Slope is expressed in degrees only on large-scale earth-moving projects such as strip-mining and other extractive operations.**

Slope Determination Formulas

Slope Ratio: HD:VD

Slope Percent: $\left(\frac{VD}{HD}\right) \times 100$

Slope Angle: (degrees) $\text{Arctan}\left(\frac{VD}{HD}\right)$

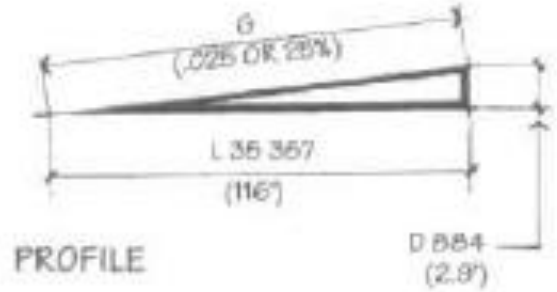


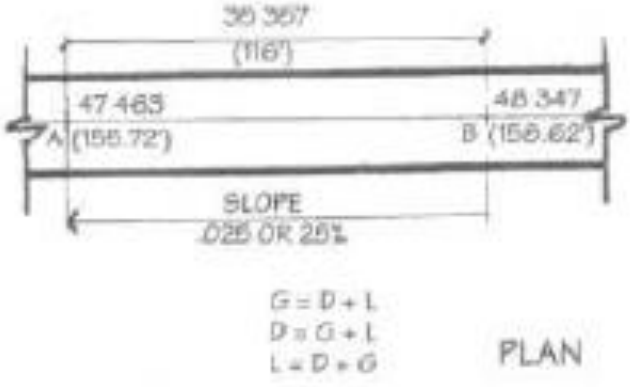
Examples

Slope Ratio: 100:50 = 2:1

Slope Percent: $\left(\frac{50}{100}\right) \times 100 = 50\%$

Slope Angle: (degrees) $\text{Arctan}\left(\frac{50}{100}\right) = 26.6°$





Elevation of point B = 48 347 mm
(158.62 ft)

Elevation of point A = 47 463 mm
(155.72 ft)

Vertical difference D = 884 mm (2.90 ft)

Horizontal difference L = 35 357 mm
(116.00 ft)

Therefore:

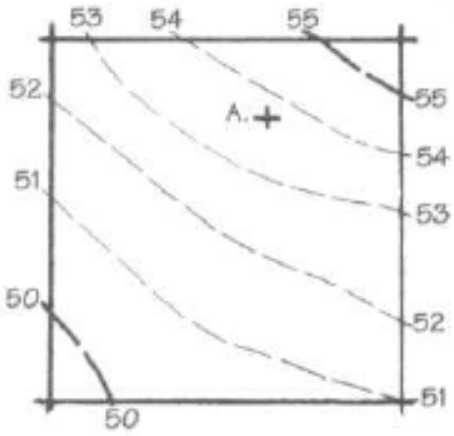
$$G = \frac{D}{L} \times 100$$

$$= \frac{884}{35\,357} \times 100$$

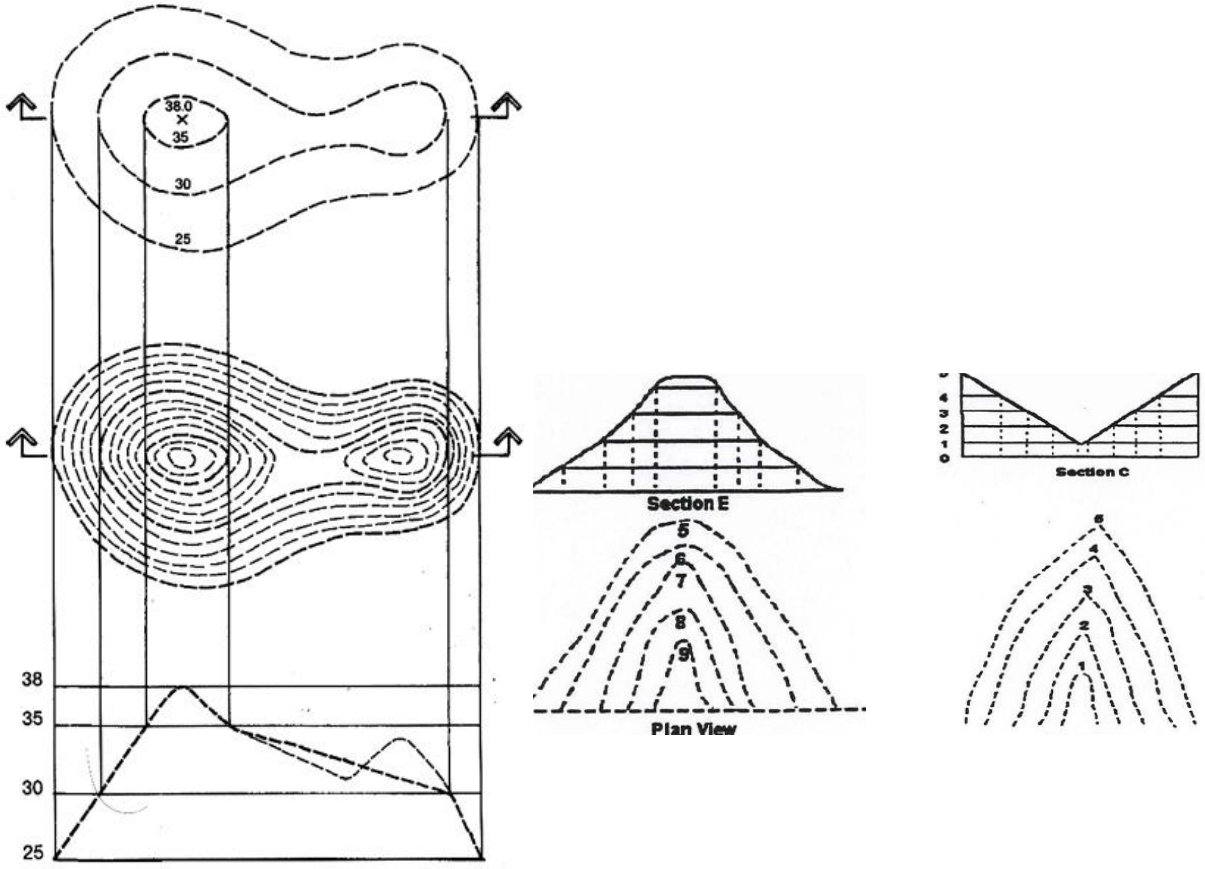
$$= 2.5\ \%$$

SPOT ELEVATIONS

- **Spot elevations – Elevations of point on map/ chart from reference datum**
- **establish limits of slope**
- **to locate contour lines, and to provide detail for establishing control points that cannot be obtained via contour lines.**
- **elevation of any point on an accurately drawn contour plan may be determined by interpolation.**
- **Interpolation is the process of computing intermediate value between two related value**



- **Point A lies about 7/10th the distance from contour 53 to contour 54; thus, A has an approximate elevation of 53 .7 . Interpolation assumes, of course, that slopes are uniform, which in many cases is not true in reality. Therefore, interpolated figures are approximations and should not be relied on as much as surveyed spot elevations for crucial measurements.**



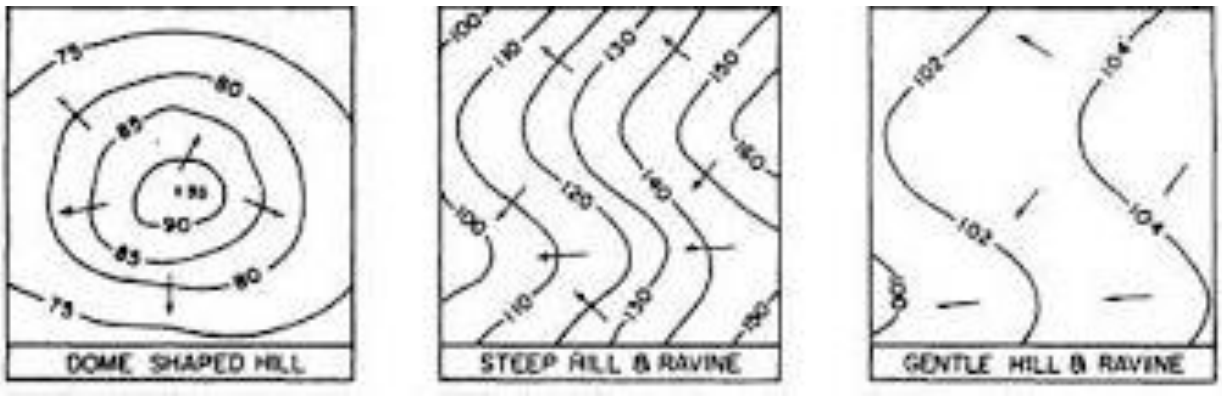
Contour interval and accuracy of form.

RIDGE AND VALLEY

A ridge is simply a raised elongated landform. A valley is an elongated depression that forms the space between two ridges. The contour pattern is similar for both the ridge and valley; therefore, it is important to note the direction of slope.

CHARACTERISTICS OF CONTOUR LINES

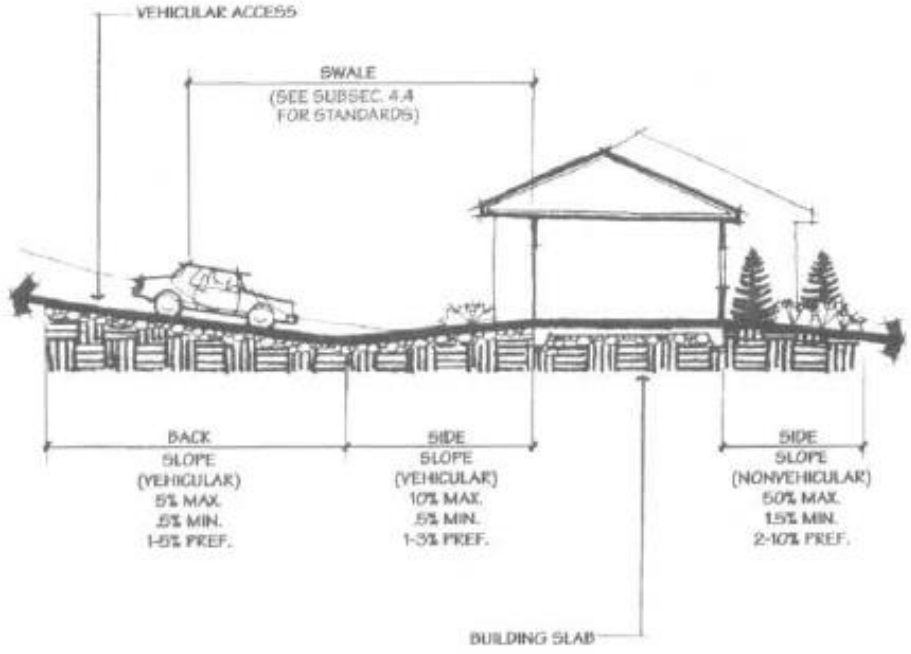
By definition, all points on the same contour line are at the same elevation. Every contour line is a continuous line, which forms a closed figure, either within or beyond the limits of the map or drawing. Two or more contour lines are required to indicate three-dimensional form and direction of slope



Consistent with the preceding point, water flows perpendicular to contour lines. For the same scale and contour interval, the steepness of slope increases as the map distance between contour lines decreases. Equally spaced contour lines indicate a constant, or uniform, slope. Contour lines never cross except where there is an overhanging cliff, natural bridge, or other similar phenomenon. In the natural landscape, contour lines never divide or split. However, this is not necessarily true at the interface between the natural and built landscape.

GRADING

Grading of outdoor areas is aimed at controlling surface storm water runoff while providing safe and efficient pedestrian and vehicular movement. Essentially, all surfaces should have some slope, or pitch, for proper drainage.



GRADING CRITERIA
(TSS Landscape – Pg. 320-16 to 320 – 28)

Earth fill against buildings

May be desirable for insulation or aesthetic reasons. Soil and related moisture may cause decay and/or promote the growth of insects that may damage or destroy some of the materials used in the construction of the building. The exterior surfacing and structural system of a building determine the height to which fill may be brought up against a structure.

Road ways

The standards for streets and local access roads in residential, institutional, commercial, and industrial areas are determined by local city or county standards.

Roadway design consists of two major phases:

Alignment of the road-giving it horizontal and vertical direction. Grading the adjacent landscape to the road edge. The designer of a roadway should go beyond merely satisfying the engineering requirements and see the user as an active player to be choreographed through the landscape.

The following criteria should be considered during the grading phase of the roadway:

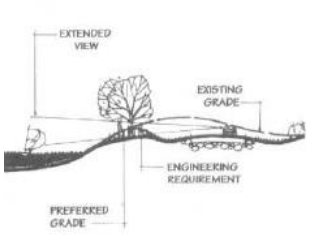


Figure 320-46. Grading to expose vista.

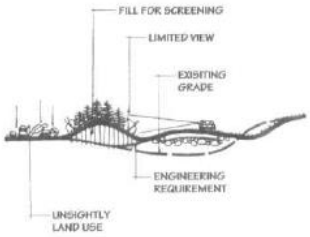


Figure 320-47. Grading to screen undesirable view.

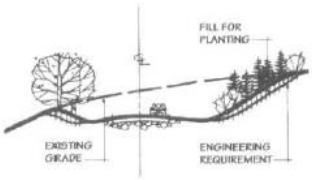


Figure 320-48. Grading to facilitate better plant growth.

Remove extra Use roadside Blend the new

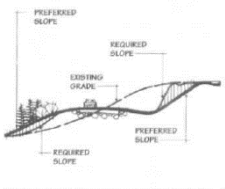


Figure 320-49. Grading to blend slopes with existing terrain.

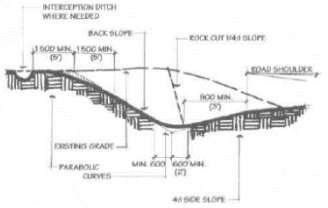


Figure 320-50. Cut side of cross section through road.

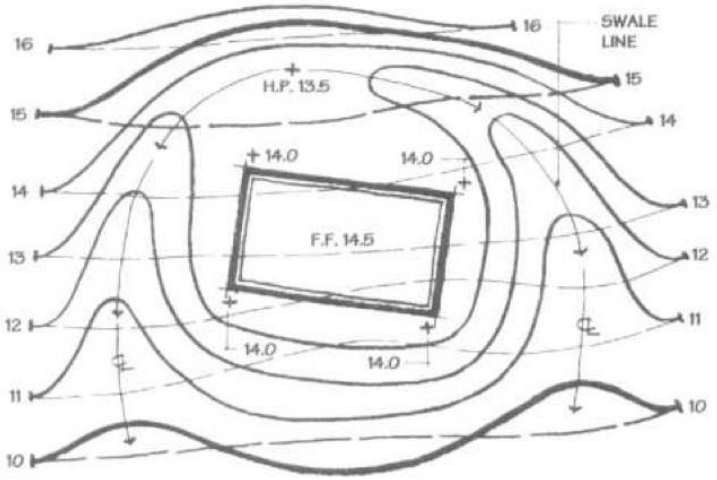


Figure 320-53. Swales to divert water around building. *Note that the channel widens and the slope diminishes as the swale approaches existing grade.*

Swales and Ditches:

Typically, swales are shallow, have a parabolic cross section, and are very wide, while ditches are deeper and have a narrower ---- Velocity 6 ft per second.

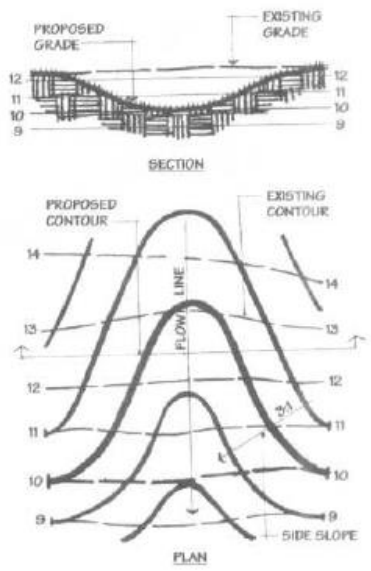


Figure 320-54. Typical grass swale grading.

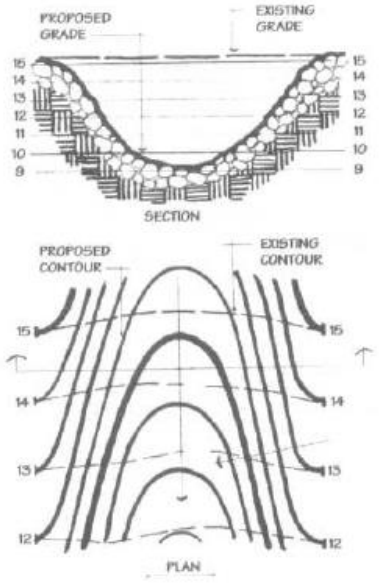
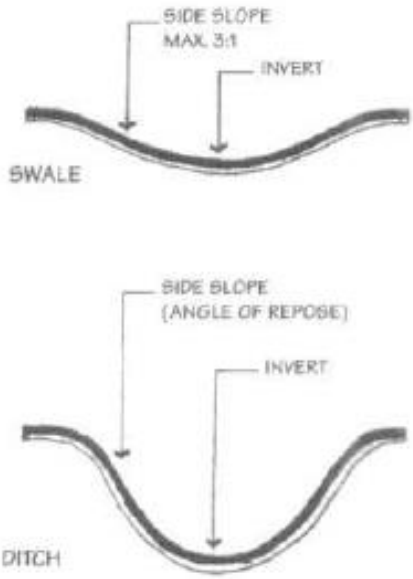


Figure 320-55. Typical ditch grading.



DRAINAGE CHANNELS WITH UNPROTECTED SOIL

Velocities should be reduced for depths of flow under 150 mm (6 in) and for water which may transport abrasive materials.

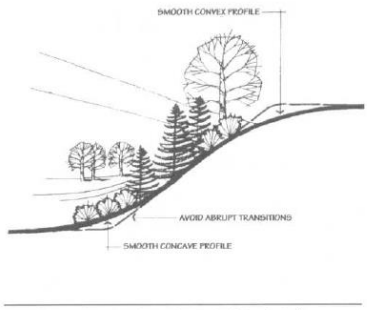


Figure 320-56. Grading of a typical head wall.

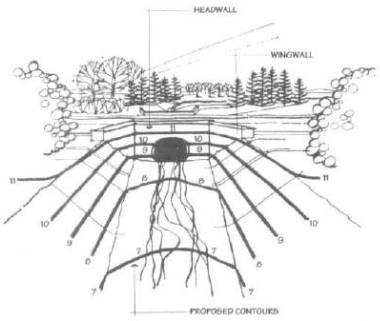


Figure 320-57. Grading criteria for slopes.

Culverts and Headwalls:

The grading scheme and the design of the headwall for a culvert must be totally integrated.

STAIRS AND RAMPS:

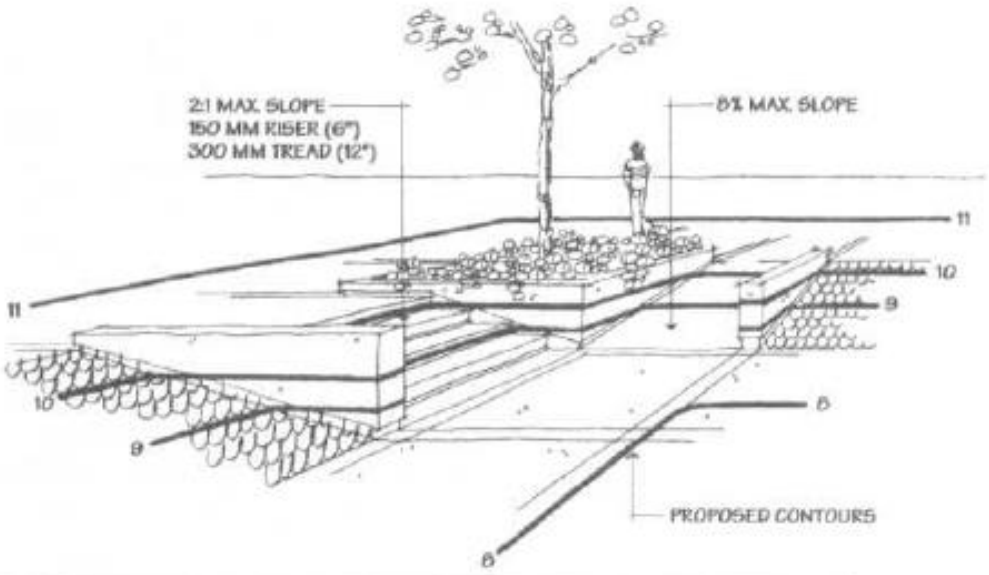


Figure 320-58. Grading of stairs and ramps. *Note that tread/riser ratios greater than 2:1 are advisable whenever possible.*

GRADING AROUND EXISTING TREES

Should be managed with great care, using one or more of the following techniques:

- **To avoid grading, cutting, or filling above the root zone of a tree.**
- **If filling around an existing tree cannot be avoided, then the tree must be protected**
- **to create a flat area and at the same time**

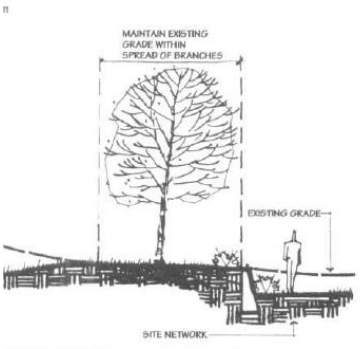
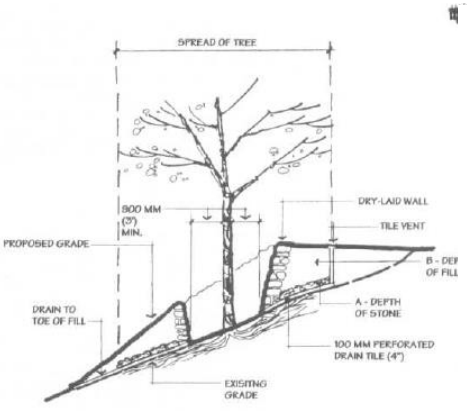


Figure 320-59. Grading near existing trees.



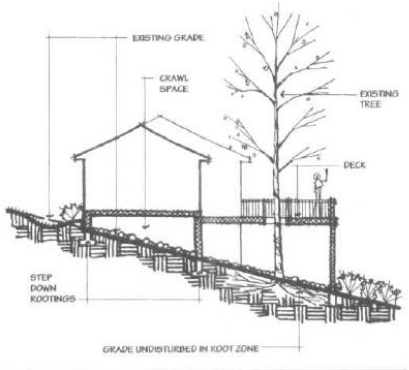


Figure 320-62. Crawl space and decking near existing trees.

SOIL SLIPPAGE:

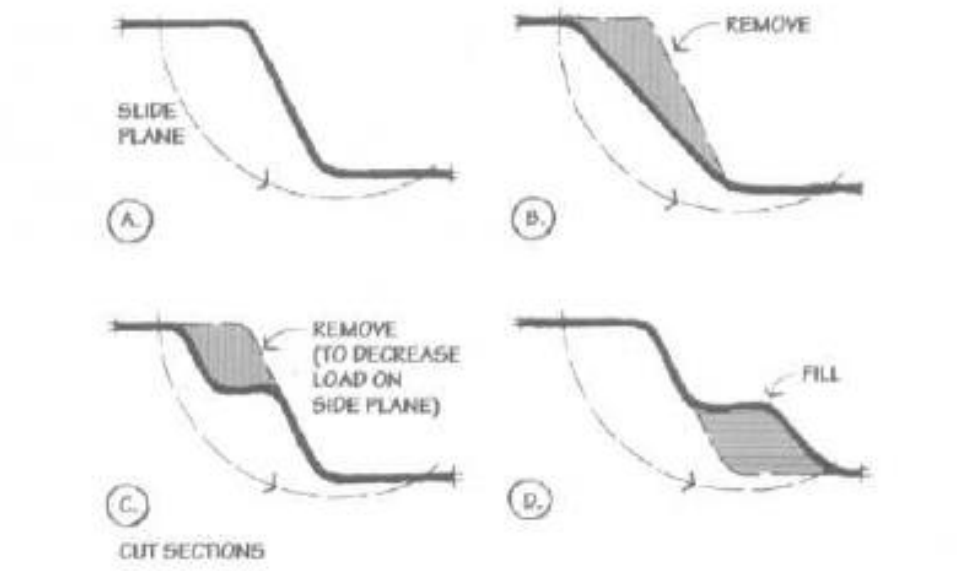


Figure 320-66. Stabilization techniques for cuts on hillsides.

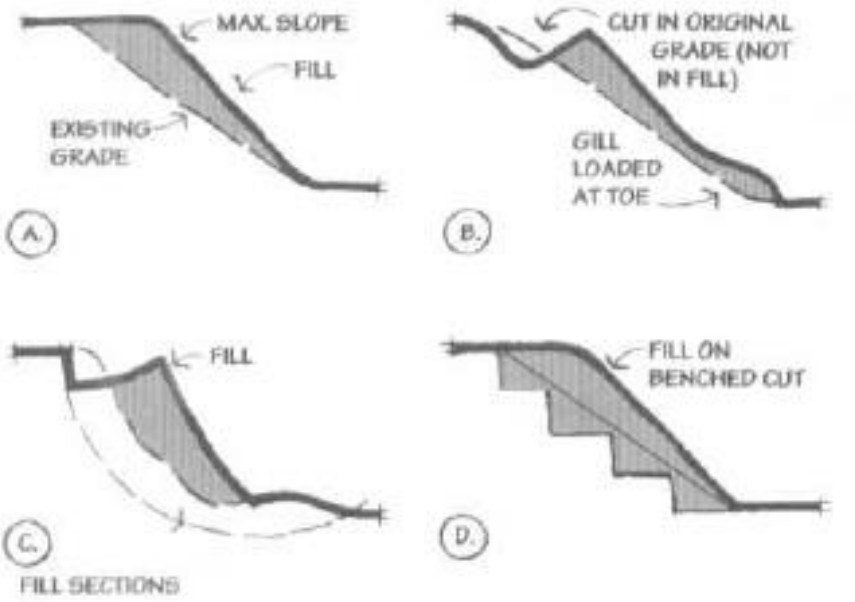


Figure 320-67. Stabilization techniques for fills on hill sides.

Erosion Control by Grading.

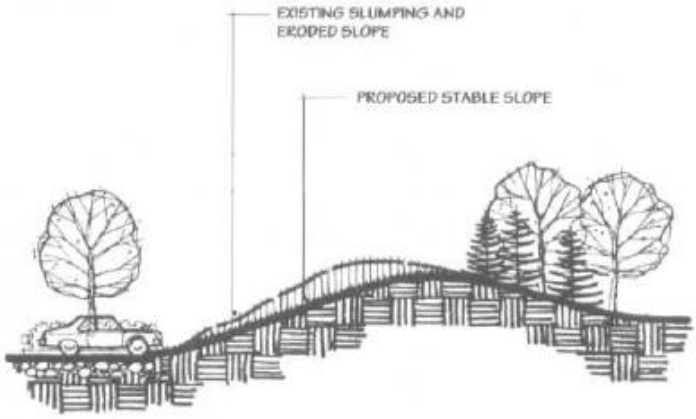


Figure 320-64. Erosion control by reducing gradient of slopes.

GRADING OF PARKING AREAS

The minimum and maximum gradients required for vehicular access and parking areas are often the major determinants for the grading plan of a site .

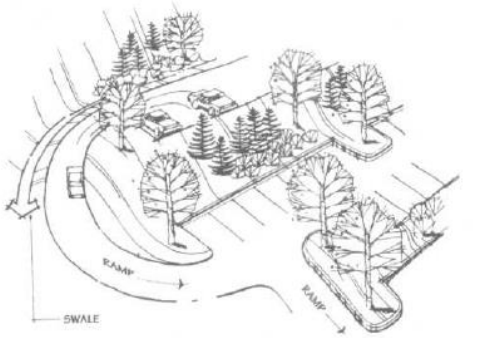


Figure 320-68. Example of a stepped-down parking area.

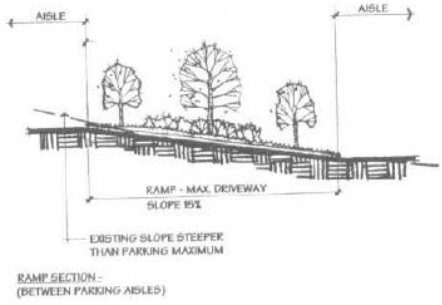


Figure 320-69. Example of a ramp section between parking aisles.

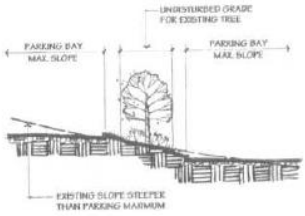


Figure 320-70. Example of an island section between parking bays.

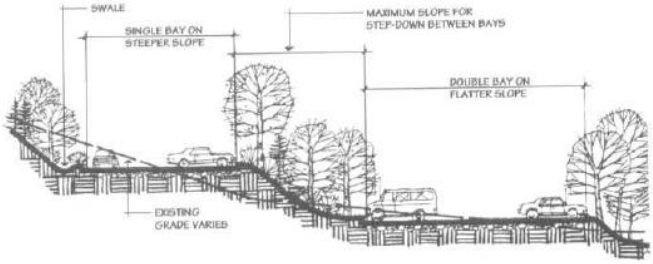
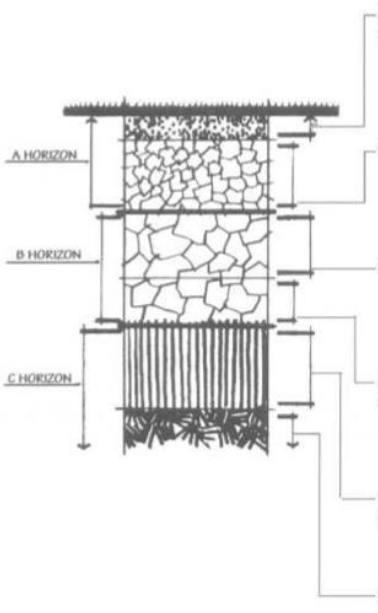


Figure 320-71. Combined single and double parking bays to adapt to steep slope.

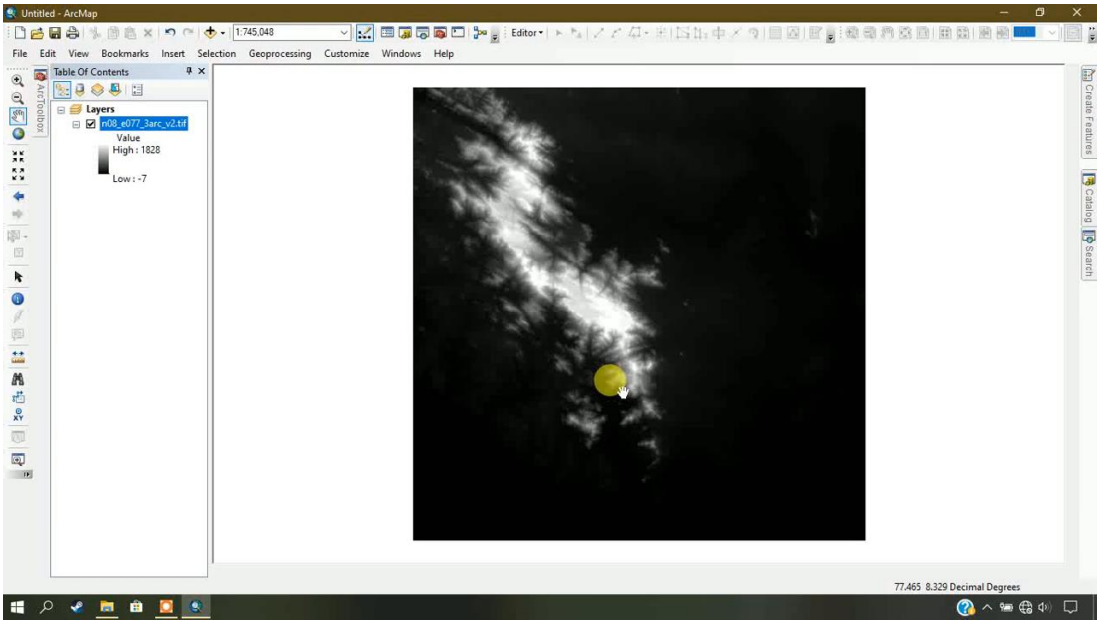


	TYPICAL RANGE	DESCRIPTION	HOW TO USE
SURFACE SOIL	150-600 mm (6"-24")	Dark gray colored - high organic matter, high biotic activity,abundant roots, commonly leached.	Should be stripped from construction site, stockpiled for backfill in planting areas - not suitable for fill under construction.
SUBSURFACE	150-600 mm (6"-24")	Moderately dark — many roots, moderate organic matter, commonly leached.	May be used as fill under topsoil and may respond to compaction under some construc-tion.
SUBSOIL	150-2 400 mm (6"-8')	Below plow depth - brown or reddish colored - more clay than surface, fewer roots.	Not desirable for plant growth but may make good compacted subsurface for con-struction.*
LOWER SUBSOIL	150-2 400 mm (6"-8')	More yellowish and less clay - fewer roots than subsoil, less aeration than above	Not desirable for plant growth but may make good compacted subsurface for con struction.*
PARENT MATERIAL		Unconsolidated - slightly weathered rocky mass from which soil develops. No biotic activity, . few roots	Good base course material when properly placed and compacted for construction.
BEDROCK		Consolidated rock.	

*Depends upon soil quality and type of construction anticipated.

Figure 320-77. Typical soil profile. *A soil horizon is a significant layer of soil that has distinct characteristics produced by soil*

CONTOURS WITH ARC GIS



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SCHOOL OF BUILDING AND MANAGEMENT

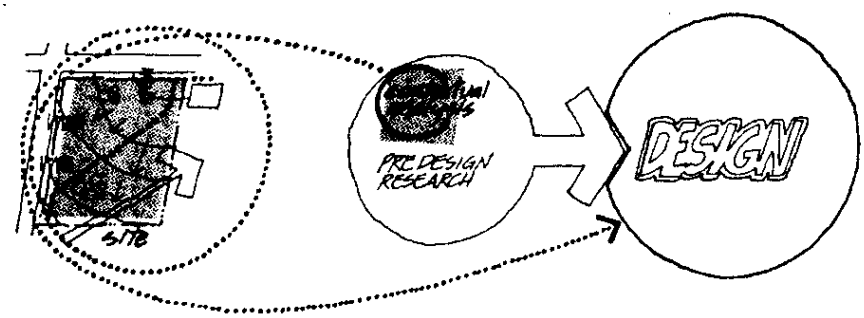
DEPARTMENT OF ARCHITECTURE

UNIT – III – Site Design and Site Development – SAR1203

SITE CONTEXT - CONTEXTUAL ANALYSIS

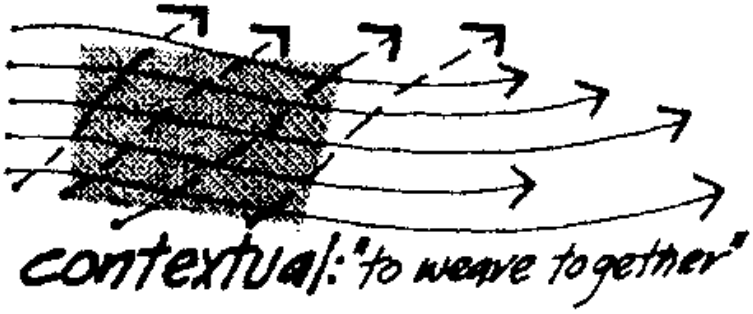
PRE-DESIGN RESEARCH

The major role of contextual analysis design is that of informing us about our site prior to beginning our design concepts so that our early thinking about building can incorporate meaningful responses to external conditions.

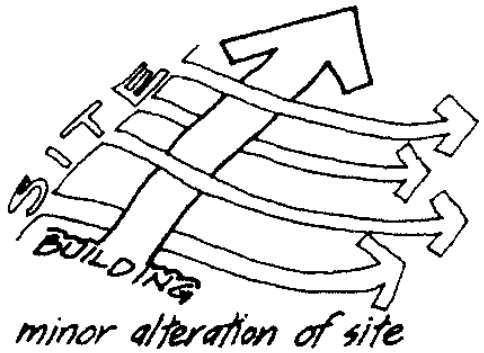


Site Context

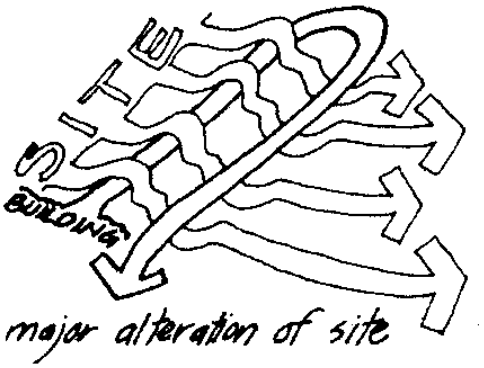
Site Context is defined as the "whole situation, background or environment relevant to the site". The derivation of the word context means to "weave together." - Weaving together various aspects of the site.



Weaving as a concept applied to the placement of building will always include some alterations of the existing conditions. What is important is to make these decisions deliberately and thoughtfully so that the effects of our building on the site are not accidental. Weather attempting to go with the site or to contrast the site, early thinking is pivotal in terms of producing a successful project.



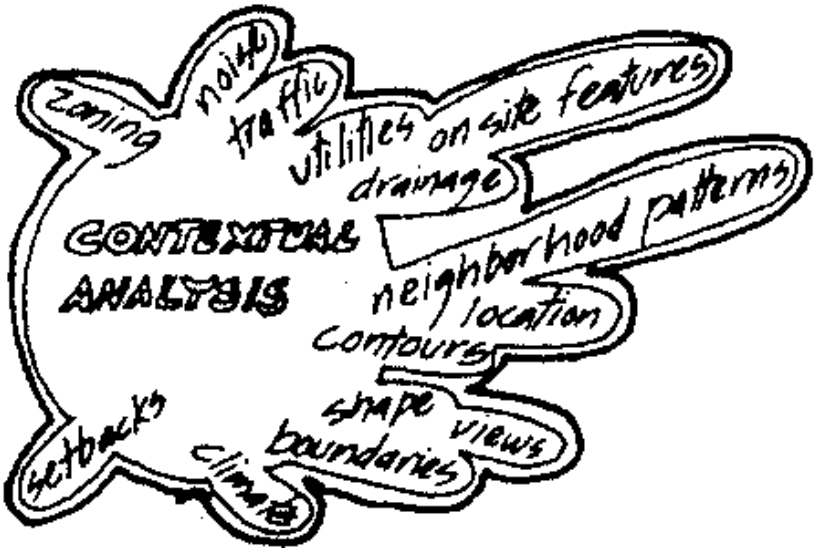
minor alteration of site



major alteration of site

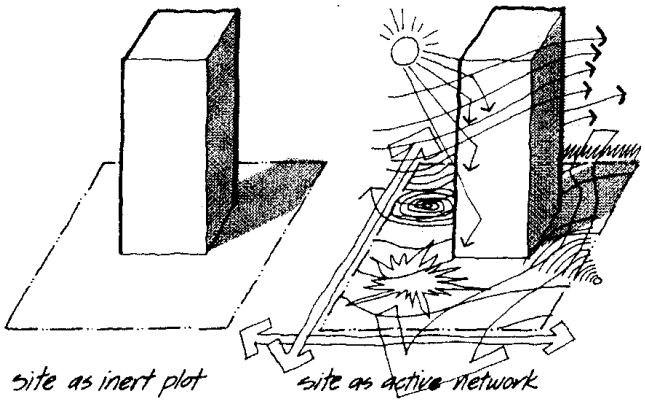
Contextual analysis of site- Factors

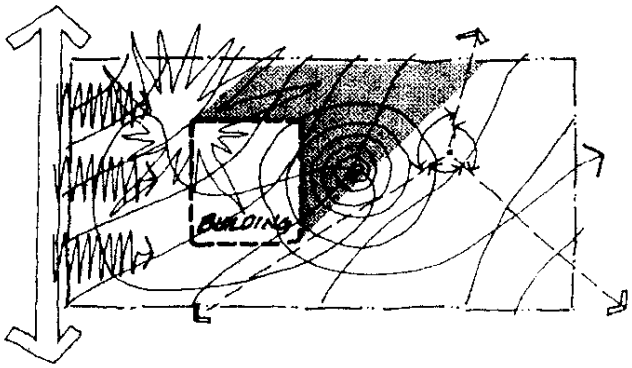
- **Site location**
- **Size**
- **Shape**
- **Contours**
- **Drainage patterns**
- **Zoning**
- **Set backs**
- **Utilities**
- **Significant on site factors**
- **Surrounding traffic**
- **Neighborhood patterns**
- **Views to and from the site**
- **climate**



Contextual analysis - Site as active networks

We should always remember that site is never inert but is an ongoing set of very active networks that are intertwined in complex relations.



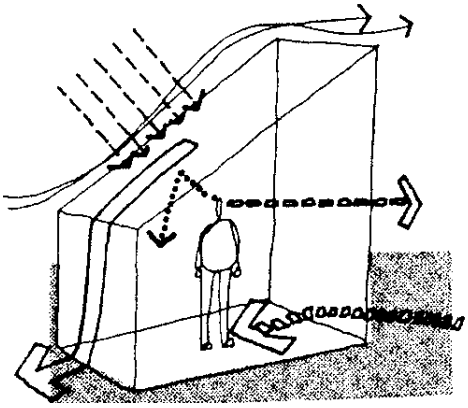


We are about to place our building within this active network . It seem reasonable to assume that if we are to integrate design our gracefully into this network without destroying

the positive aspects then we must first make ourselves aware of the nature of the networks through contextual analysis.

Consequence triangle

Model for understanding contextual networks and contextual analysis. The consequence triangle focuses on the simulation of the completed and occupied building is based on the hypothesis that it is not the design or the building itself which is our ultimate responsibility as designers but the prediction and delivery of a set of consequences or effects that have been deemed positive and possible.



Three actors of the consequence

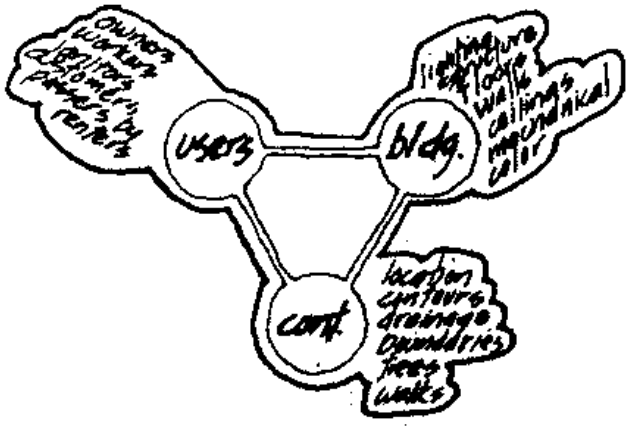
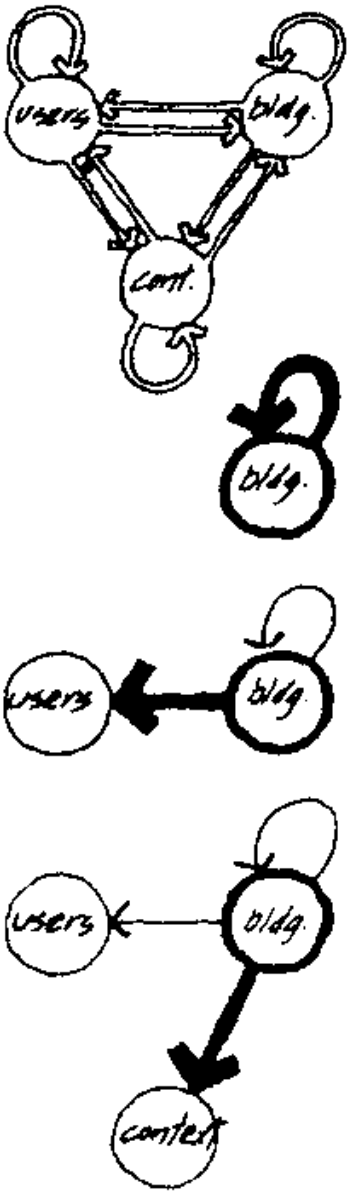


Diagram - Set the three protagonists at the corners of the triangle and draw the lines representing impacts from each of them to the others and to themselves.



<u>Impacts of building on itself, users and context</u>

Building on building -

- **Air conditioning system causes changes in material, lighting and furniture because of the temperature and humidity differential.**
- **Fenestrations causes changes in material lighting and furniture due to the admittance of sunlight.**
- **Furniture location causes changes in the flooring material due to placement in the space.**

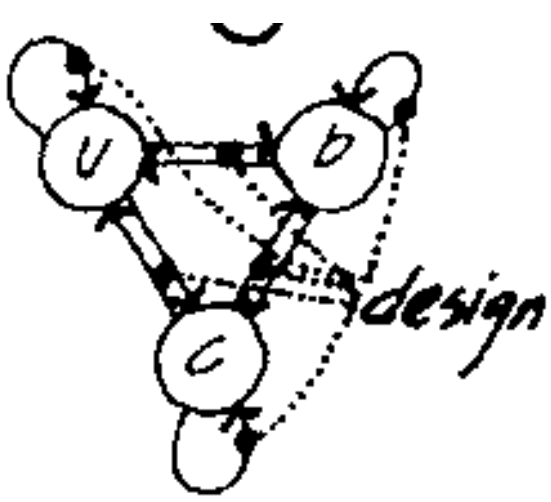
Building on User –

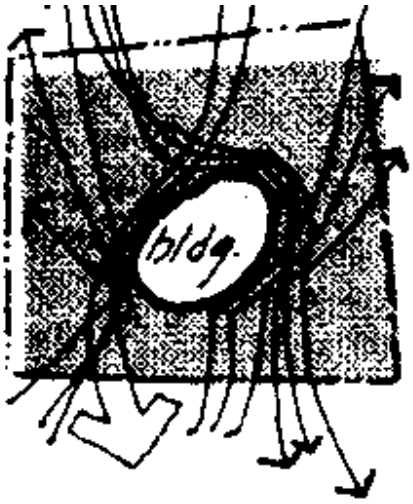
- **environmental effects on attitude**
- **productivity**
- **efficiency**
- **sense of worth and well being**
- **staff turnover**
- **level of learning**
- **sales volume**

and other aspects of human behavior.

Building on Context –

- **alteration of wind pattern**
- **contours and drainage patterns**
- **surface absorption of rainfall**
- **exiting foliage**
- **shadow patterns**
- **sunlight reflection off windows**
- **Sound reflections off building surfaces.**
- **To complete the model the same has to be performed for users and context. Then we will see that each of the three causes changes in the other two and is changed by the other two. The network is in constant motion for the life of the building.**
- **It behooves us to not only know something about the compositional characters of buildings, people and contexts but also about how they affect themselves and each other.**
- **The implanting of our building on the site will always result in remodeling of the site . Our goal should always be to leave our site better than we found it.**





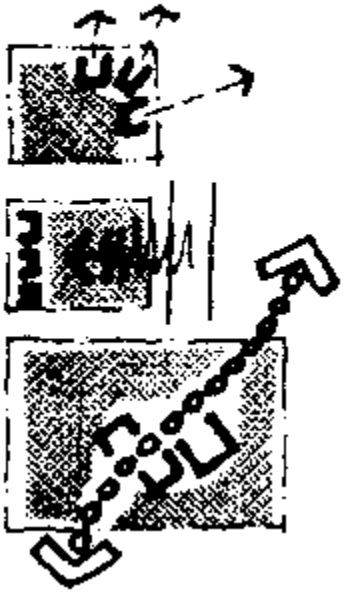
Outcomes of contextual analysis

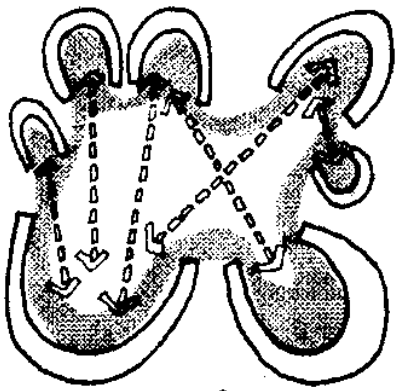
Some examples of situations that might cause a space or activity to be placed in the scheme due to external linkages to context are presented below.

Activities requiring or desiring a view.

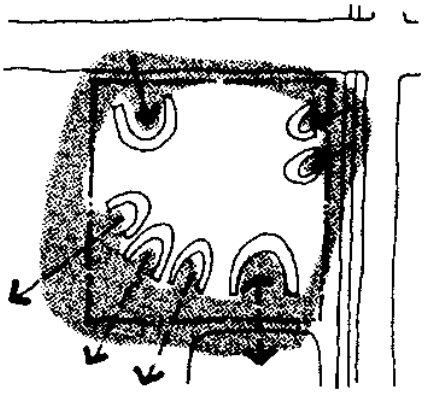
Activities that should be zoned away from noise.

Activities that should strongly relate to on site pedestrian circulation patterns.





placement of spaces due to internal functional relationships



placement of spaces due to relation to external context

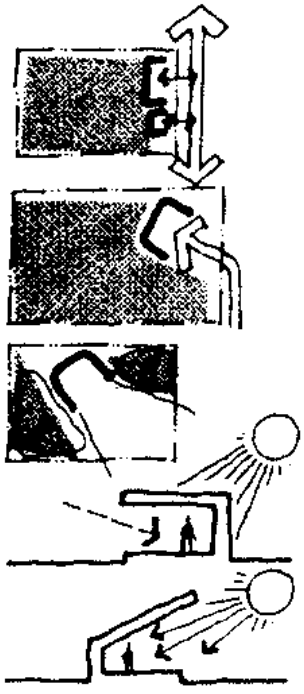
Operations needing access to delivery and pick-up vehicles.

Building entry located to relate to primary approach direction.

Zoning of parking areas away from view lines to building.

Activities needing indirect natural lighting.

Activities needing direct sunlight.



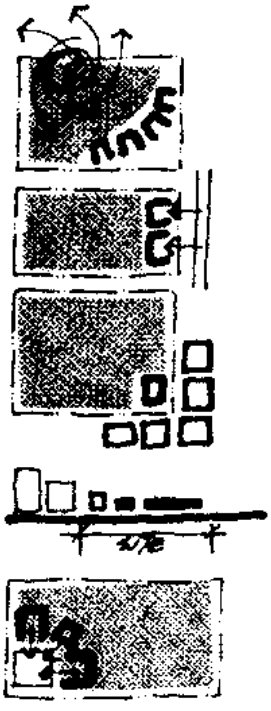
Operations needing shelter from high activity zones.

Activities needing direct access for vehicles.

Integration of form with surrounding contextual images.

Relationship of spaces to existing scale and geometric patterns.

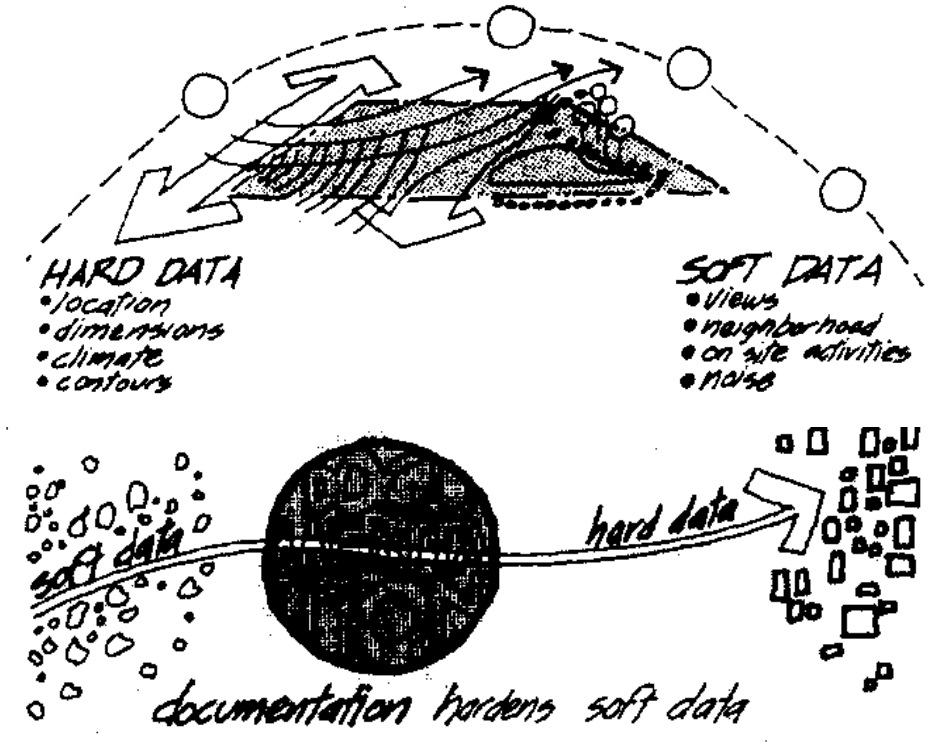
Spaces needing their own controlled exterior environment.



22

Kinds of information collected for contextual analysis

The facts about our site will always include both hard and soft data.



Hard data usually relate to physical site factors and involve no judgments about their existence or nature

- **Site location**
- **Dimensions**
- **Contours**
- **On site features**
- **Climate**
- **Soft data**

Soft data may involve value judgments for contextual analysis

Deals primarily with the sensory and human aspects of the site that are not quantitative such as -

- **Good and bad views from the site**
- **Best approach direction to the site in terms of view**
- **Existence of odors and extent to which they are annoying**

- **Presence of existing on-site human activities and their value(informal playground, gathering spot, neighborhood fairs and festivals)**
- **Types of noises and the extent to which they are disruptive**

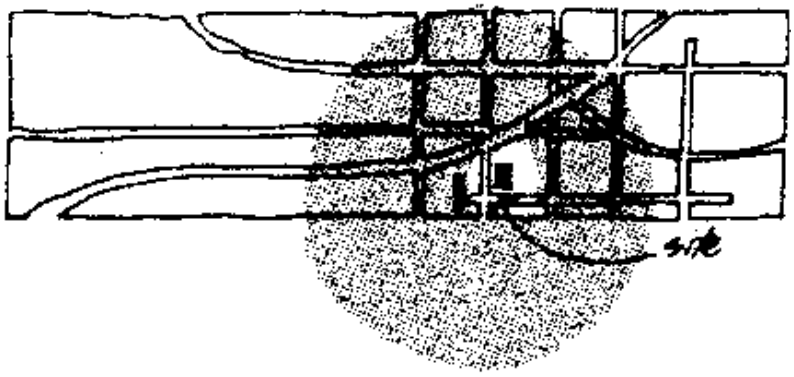
Factors influencing the site - Hard data maps

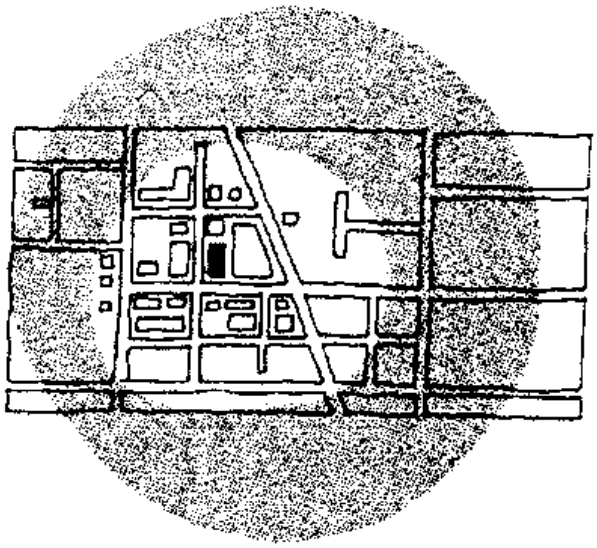
<u>Location -</u>

Site map and city map showing location of site in relation to city as a whole. City maps also show distances and travel lines to related functions in other parts of the city.

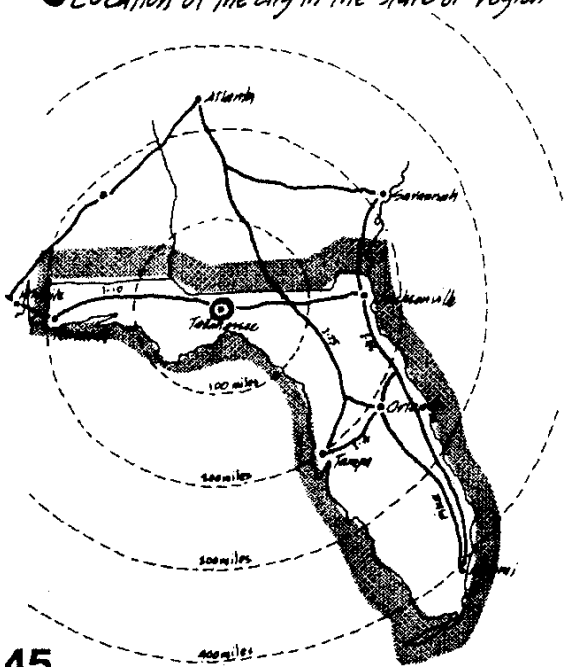
<u>Neighborhood context -</u>

Immediate surroundings as well as three to four blocks beyond the site boundary. Existing and projected uses. Buildings zones and any other conditions that may have an impact on our project.

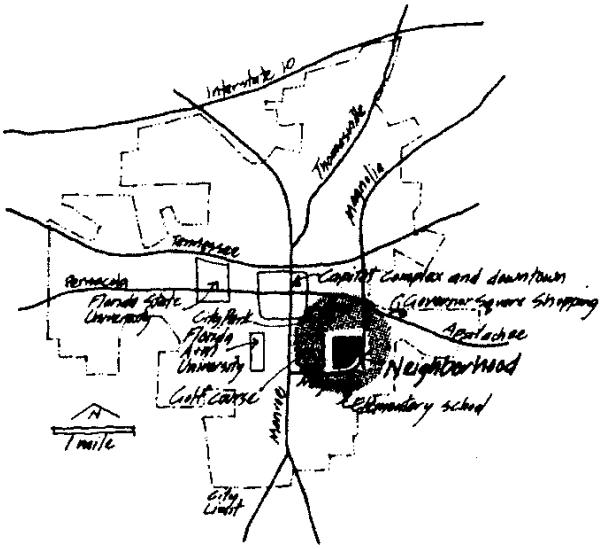




● Location of the city in the state or region



● Location of the neighborhood in the city



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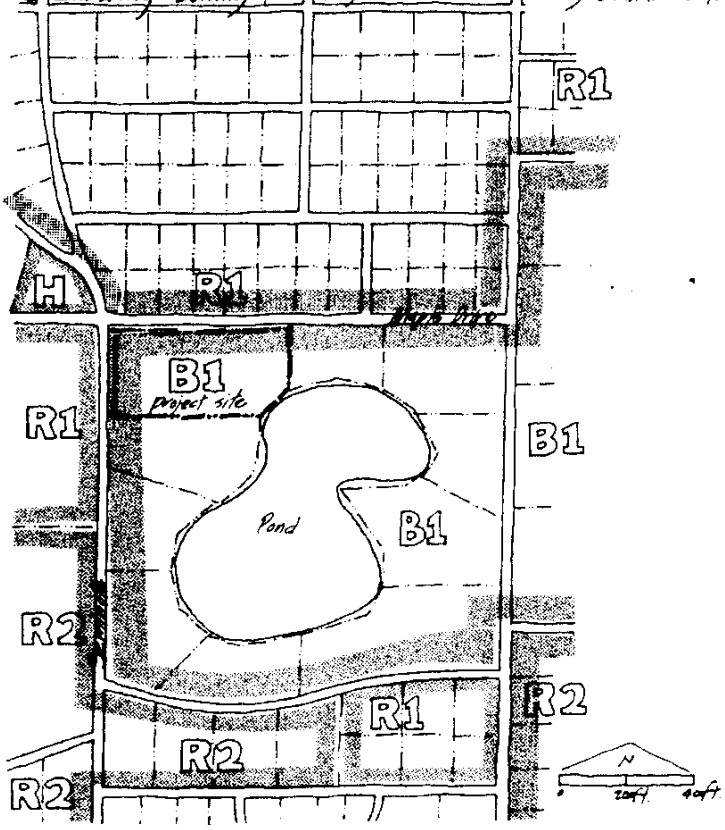
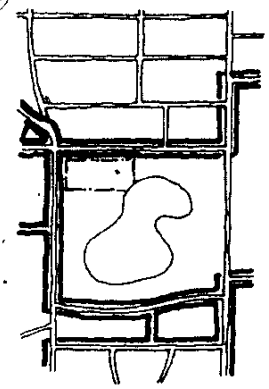
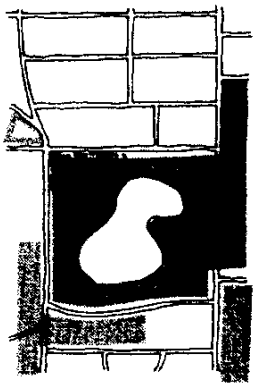
Neighborhood Context

● Existing zoning (see City of Tallahassee Zoning Ordinance for details)







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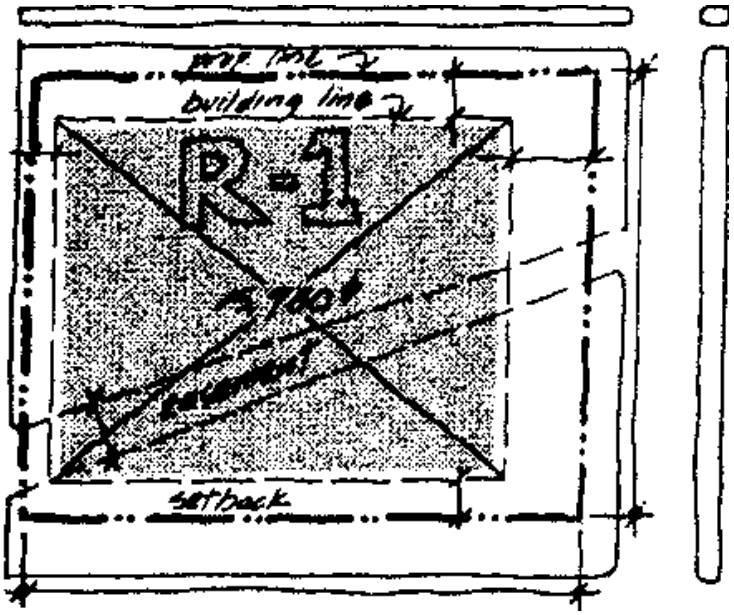
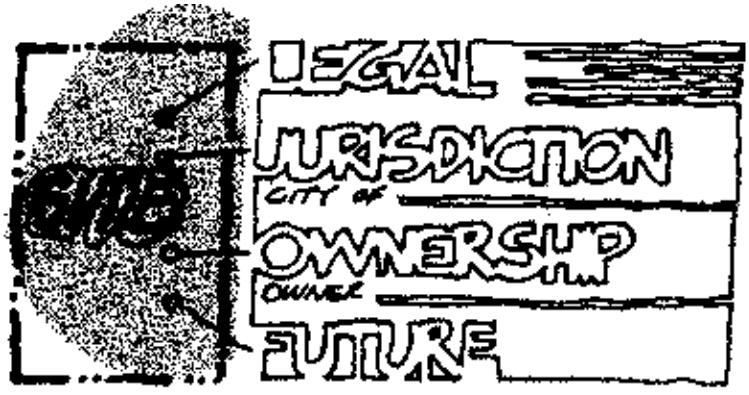
SITE AND ZONING -

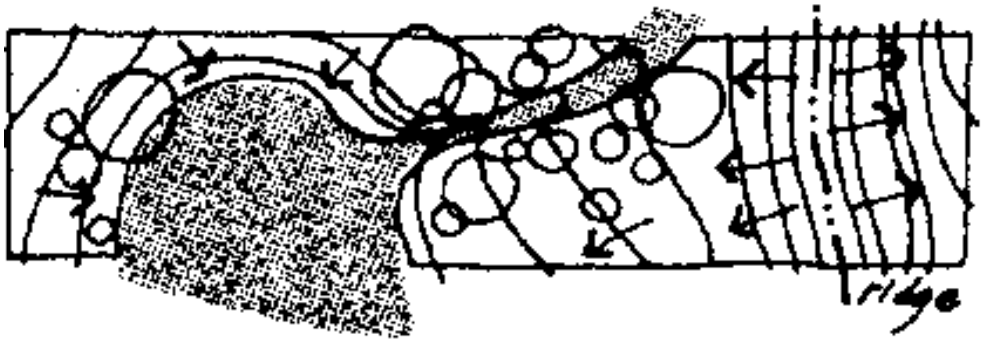
- **Documents all the aspects of site including**
- **Boundaries**
- **Location**
- **Present zoning classification with all its dimensional implications - setbacks, height restrictions, parking formulas, allowed uses and buildable area.**
- **Legal – this presents**
- **legal description of property**
- **Covenants**
- **Restrictions**
- **Present ownership**
- **Governmental jurisdiction**
- **Any future projections that may influence the project**





NATURAL PHYSICAL FEATURES-

- **Documents on aspects of site including**
- **Contours**
- **Drainage patterns**
- **Soil type and bearing capacity**
- **Trees**
- **Rocks**
- **Ridges, peaks and valleys**
- **Water bodies**



MAN MADE FEATURES –

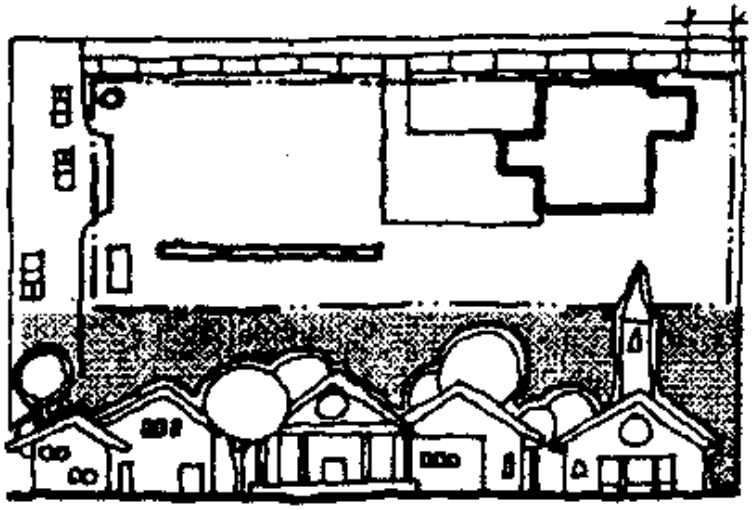
Documents on and off site conditions

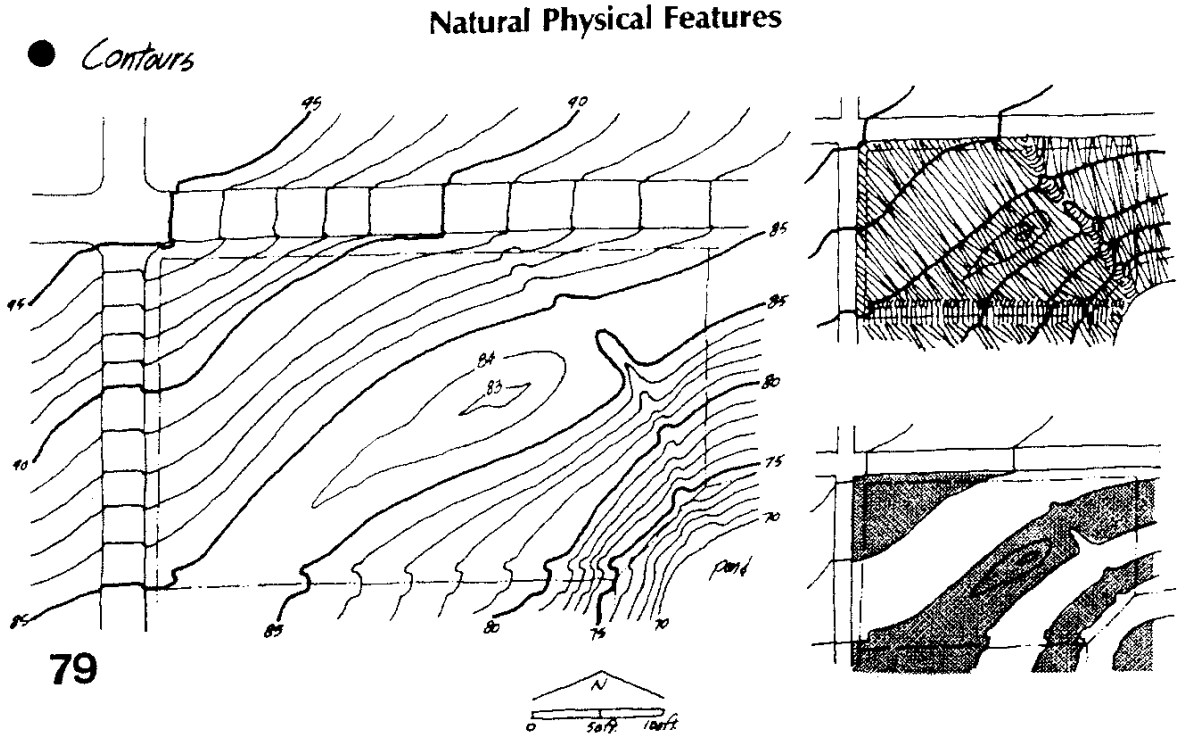
- **Buildings**
- **Walls**
- **drives and Curbs**
- **Hydrants**
- **Power poles**

Surrounding built character

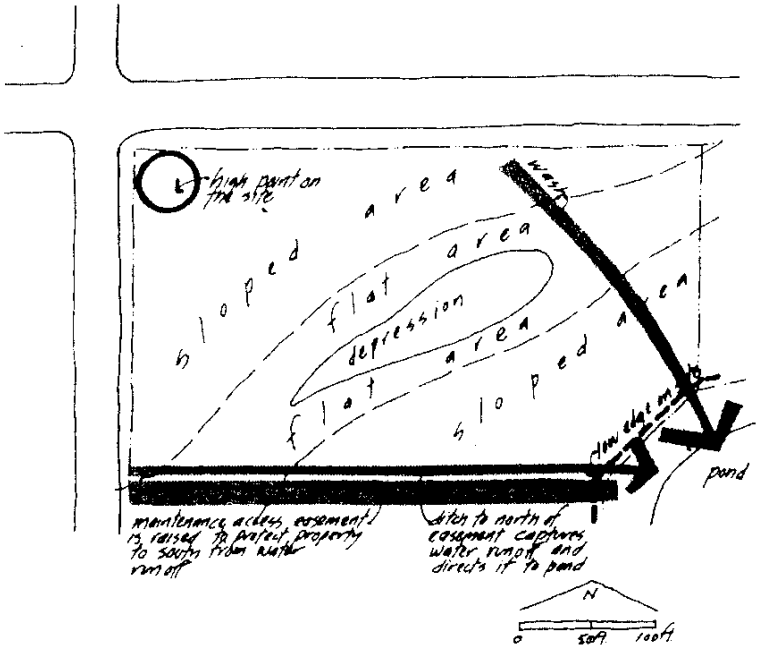
- **Built and unbulit**
- **scale and roof forms**
- **fenestration patterns**
- **set backs**
- **materials and colours,**

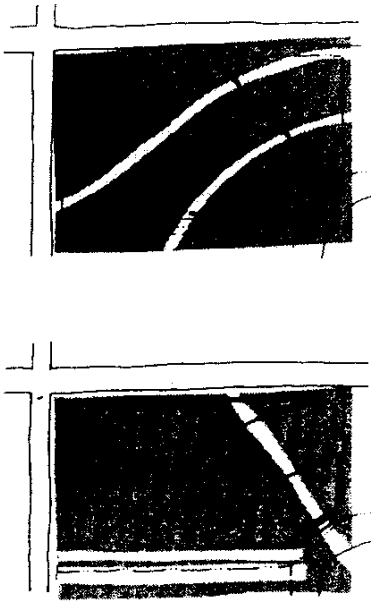
- **open spaces**
- **visual axis**
- **paving patterns**
- **landscaping materials and patterns**
- **wall forms, accessories and details**





● Major land features





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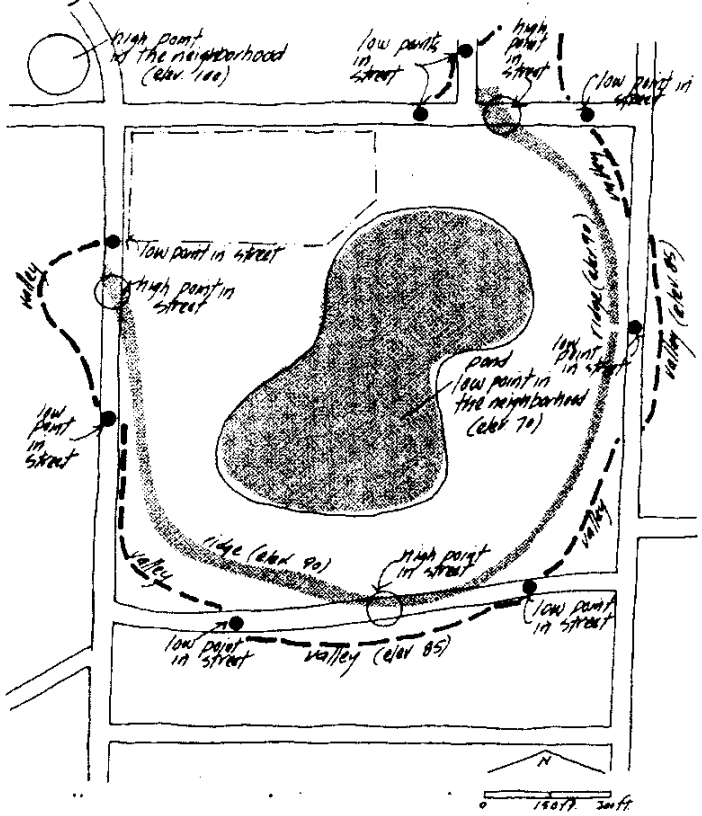
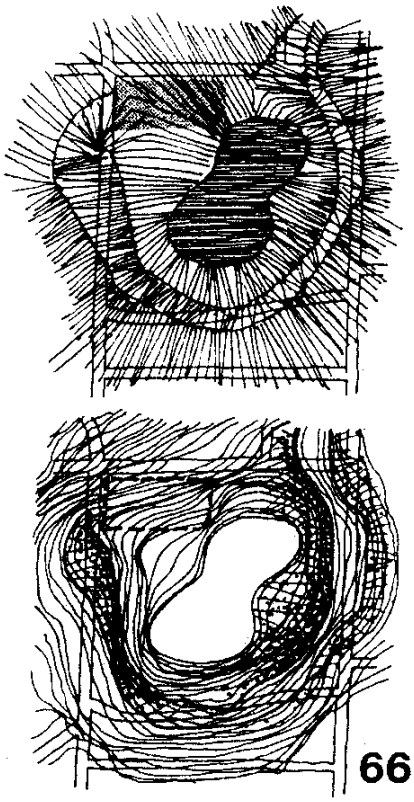
● Major land features

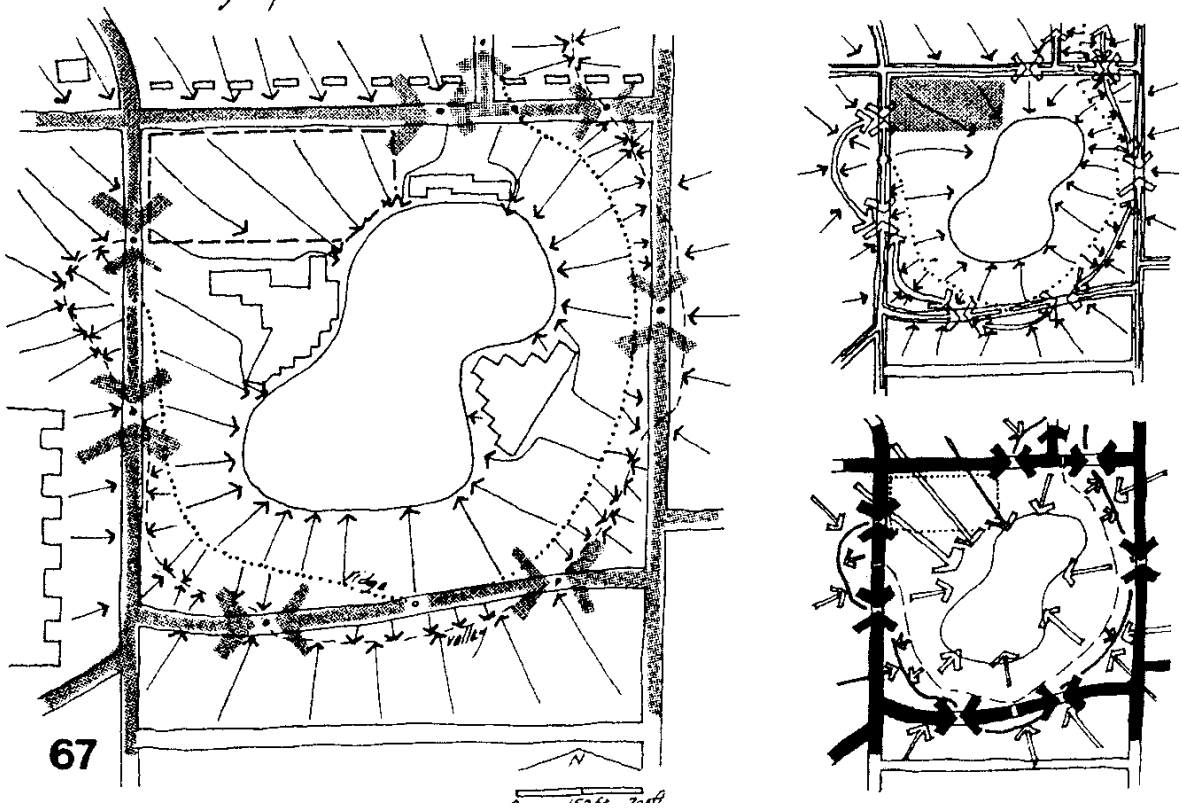




66

5

● Surface drainage patterns



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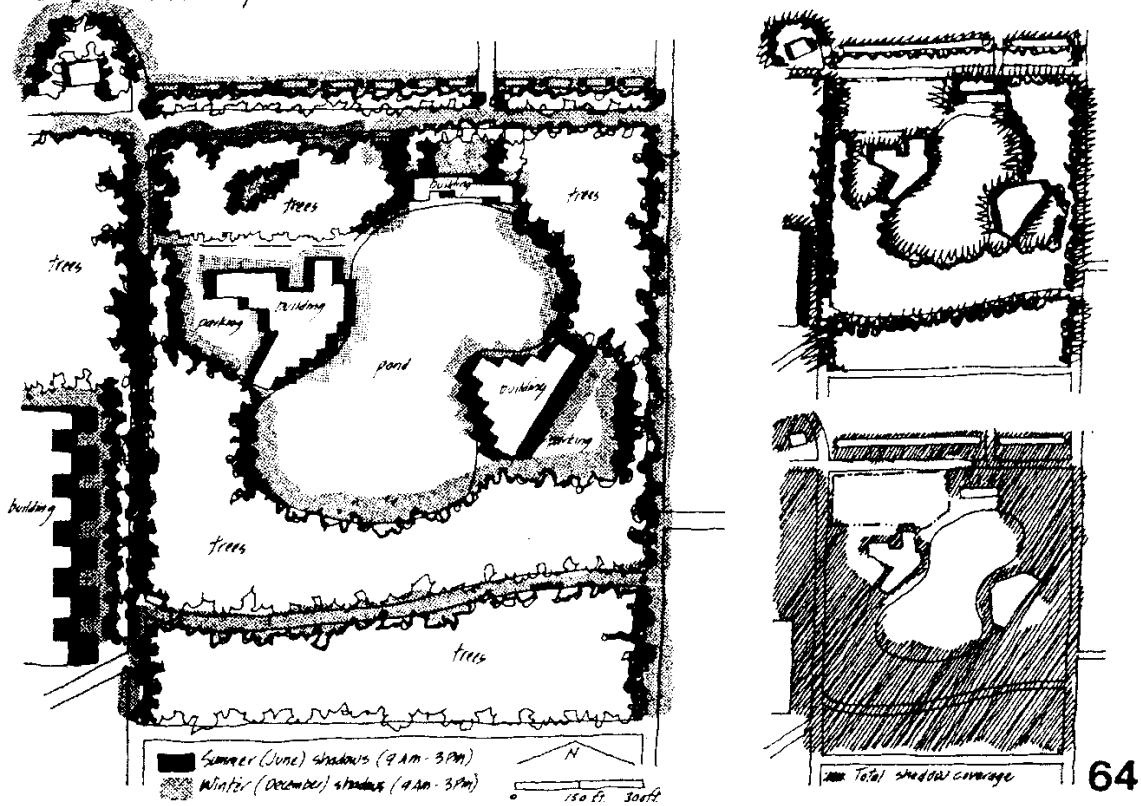
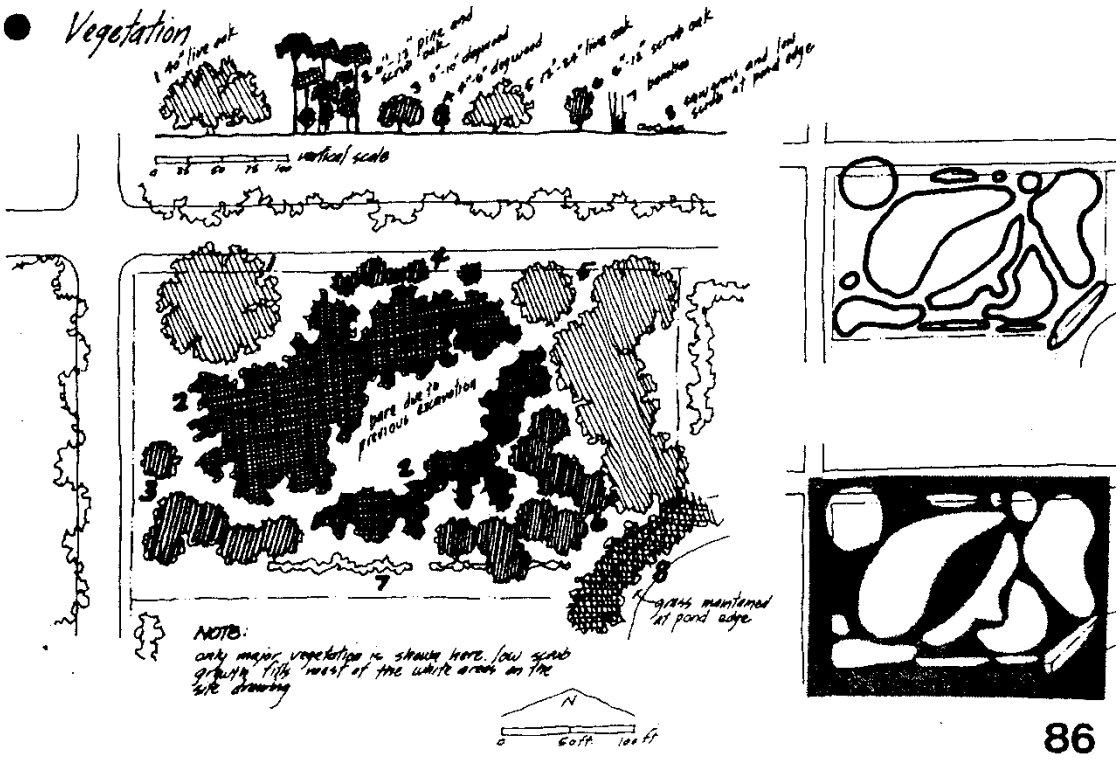
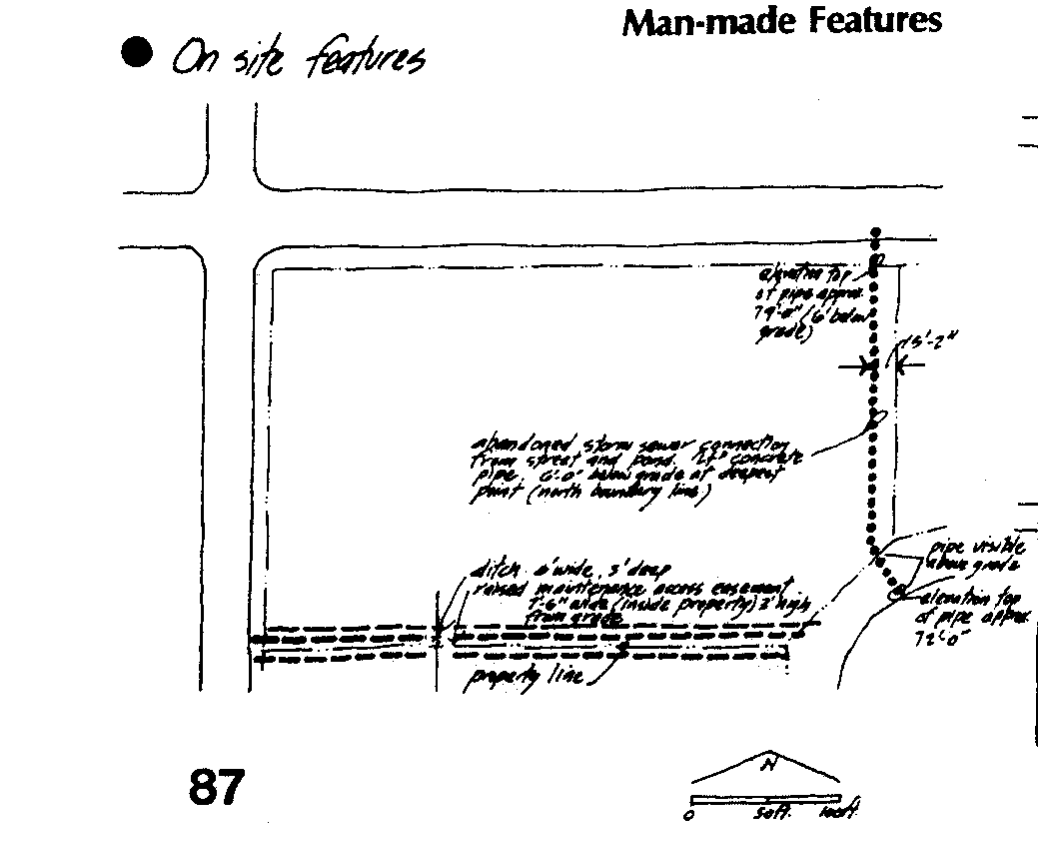
● Sun-shadow patterns



64


Vegetation
vertical scale
grass maintained at pond edge
NOTE:
only major vegetation is shown here. low scrub growth left west of the white areas on the site drawing
N
0 60ft 100ft

86


Man-made Features
On site features
elevation top of pipe approx 79'-0" (6' below grade)
15'-2"
abandoned storm sewer connection from street and pond. 12" concrete pipe. 6'-0" below grade at deepest point (north boundary line)
pipe visible above grade
elevation top of pipe approx 72'-0"
ditch 6' wide, 3' deep
raised maintenance access easement 7'-6" wide (inside property) 2' high from grade
property line
N
0 50ft. 100ft.

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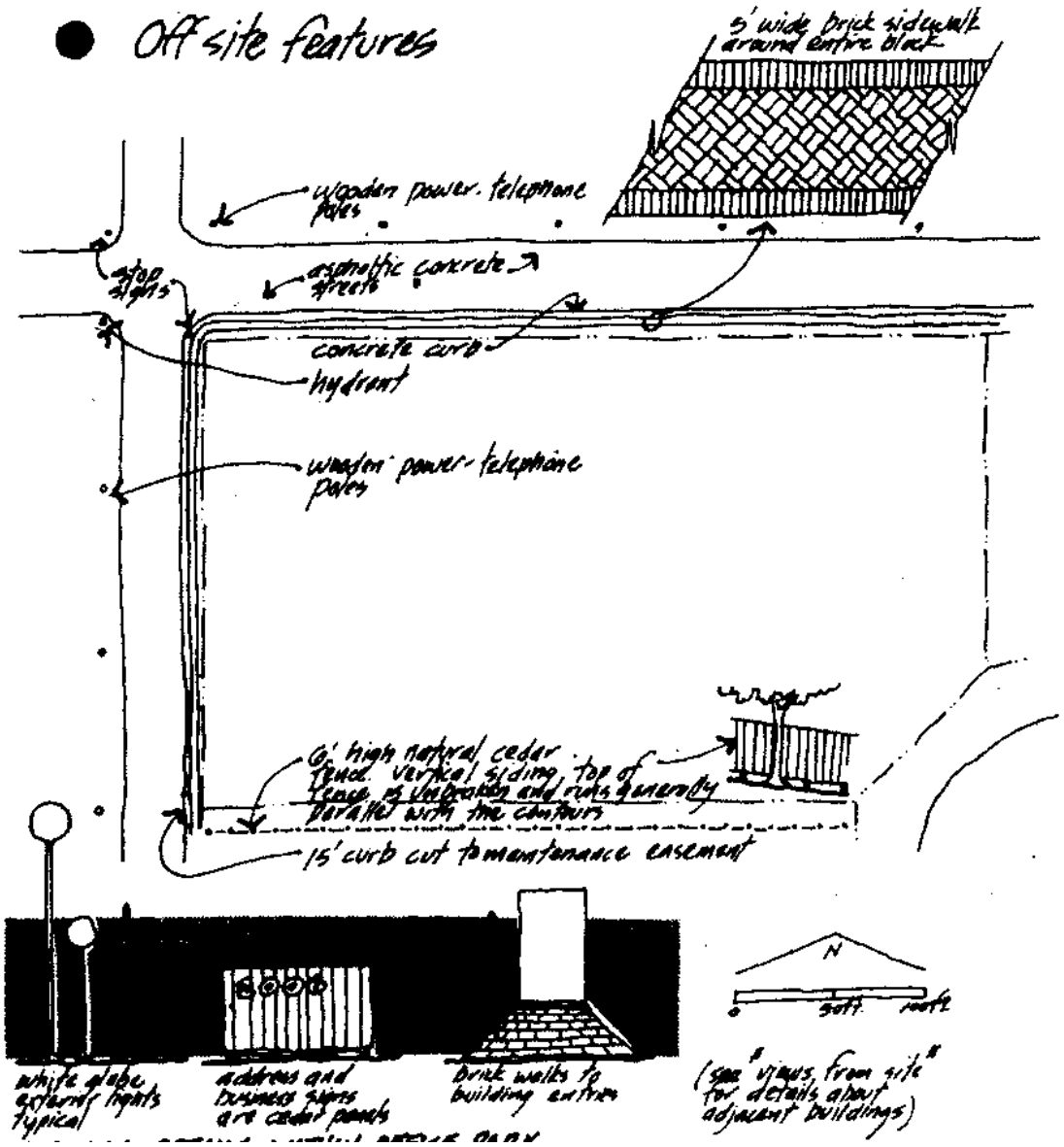
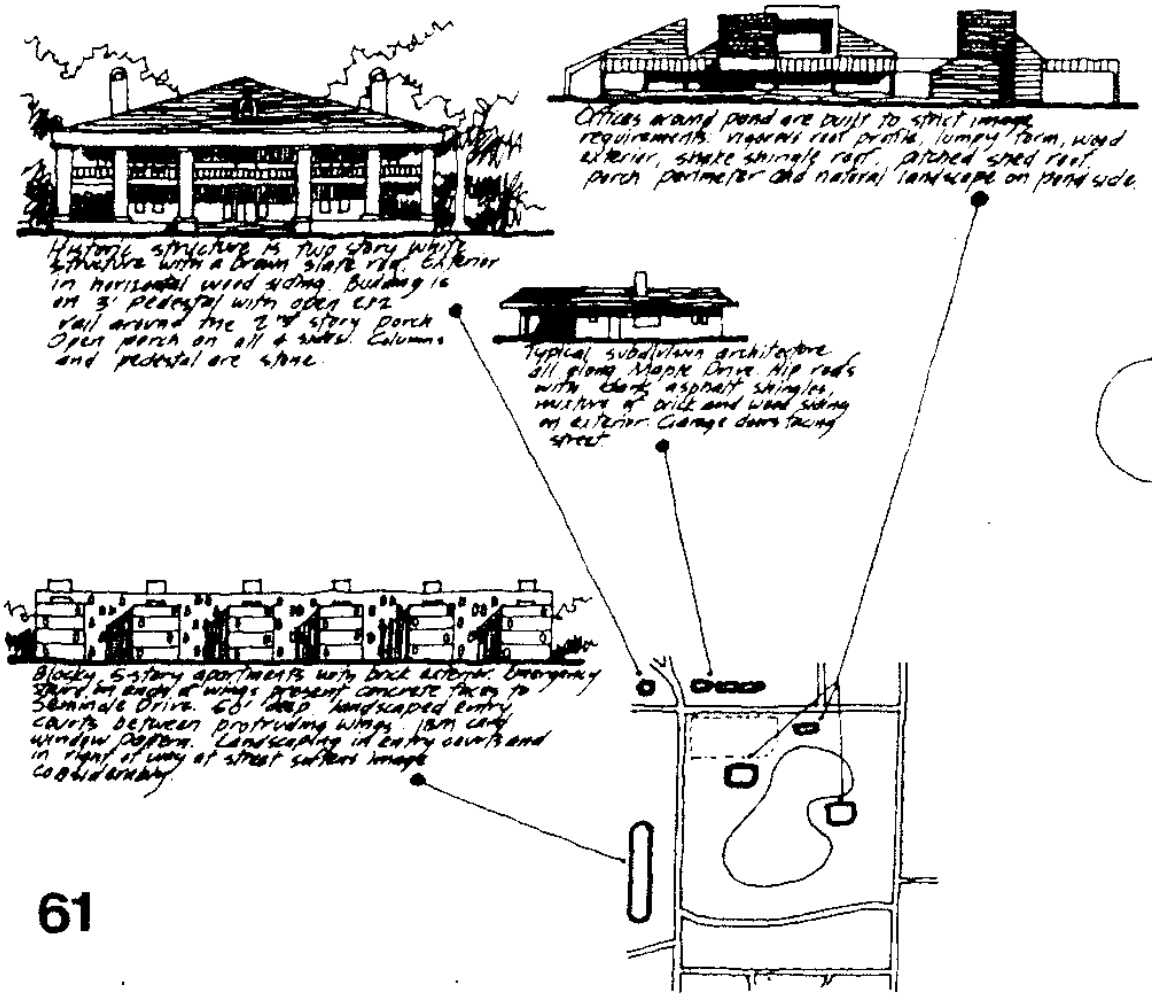
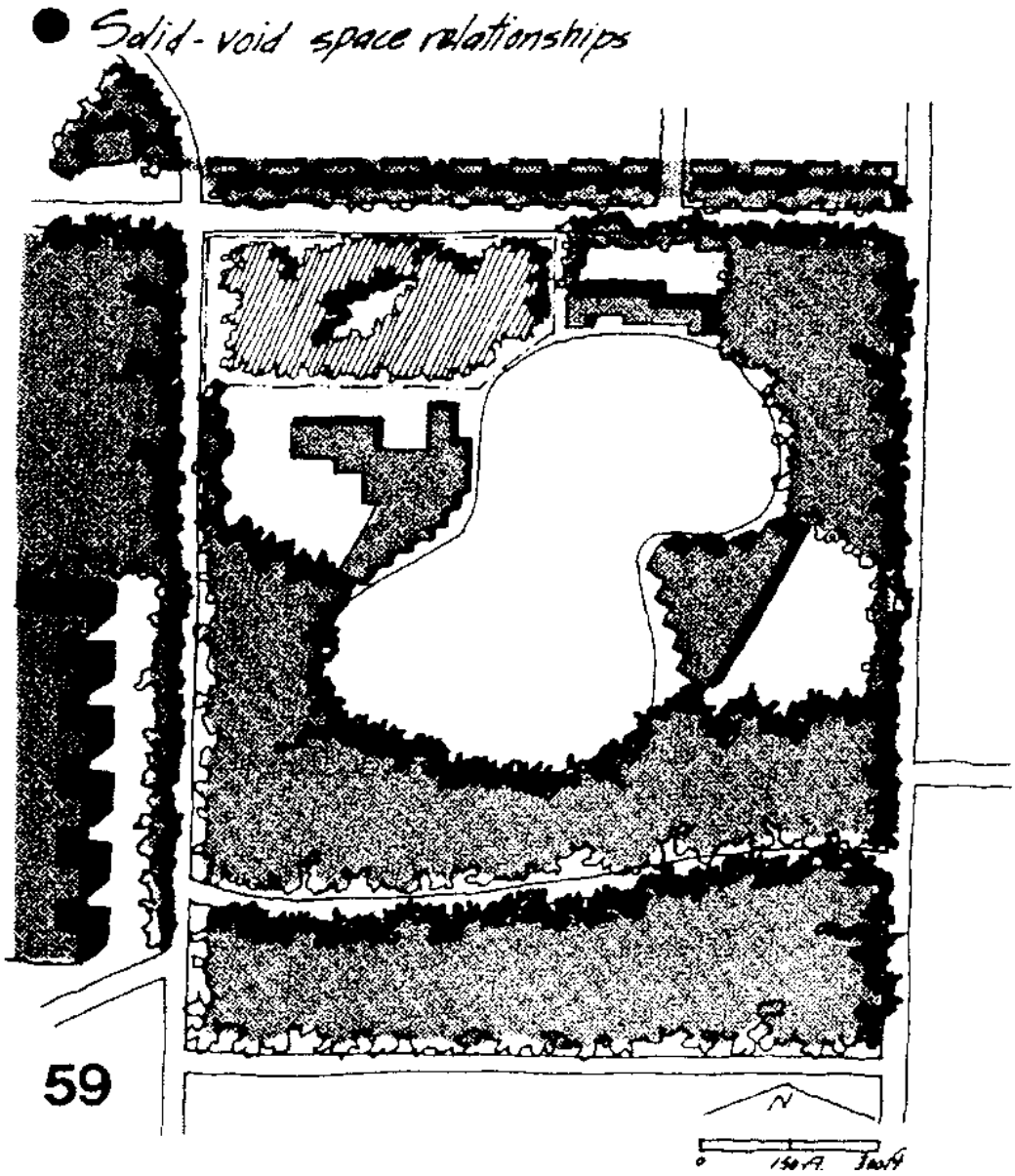

Off site features
5' wide brick sidewalk around entire block
wooden power, telephone poles
stop signs
asphaltic concrete streets
concrete curb
hydrant
wooden power-telephone poles
6' high natural cedar fence. Vertical siding, top of fence as vegetation and rises generally parallel with the contours
15' curb cut to maintenance easement
white globe exterior lights typical
address and business signs are cedar panels
brick walks to building entries
N
(see "views from site" for details about adjacent buildings)

● Significant architectural patterns





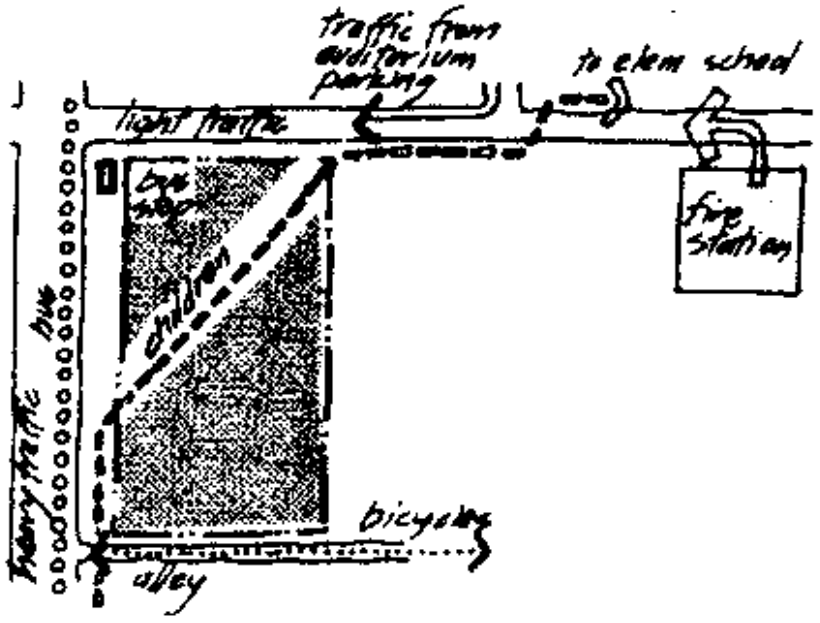
CIRCULATION -

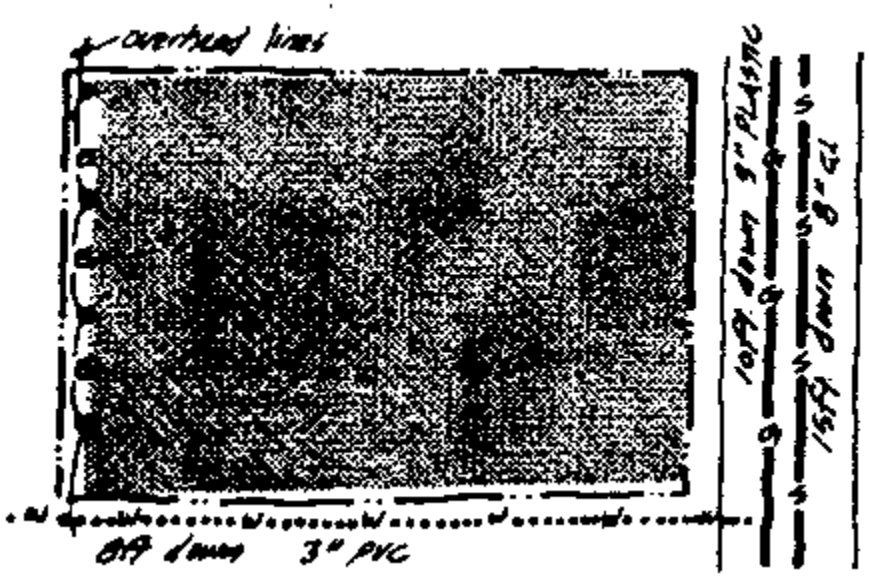
- **Documents aspects of site including**
- **Vehicular and pedestrian movement and patterns**
- **Duration and peak loads for surrounding vehicular and pedestrian movement**
- **Bus stops**
- **Site access**
- **Traffic generators**
- **Service truck access and intermittent traffic (fire truck and concerts at near by auditorium)**
- **Future projections of traffic**

UTILITIES -

Documents type, capacity, material depth and location of all utilities on, adjacent to, and near the site

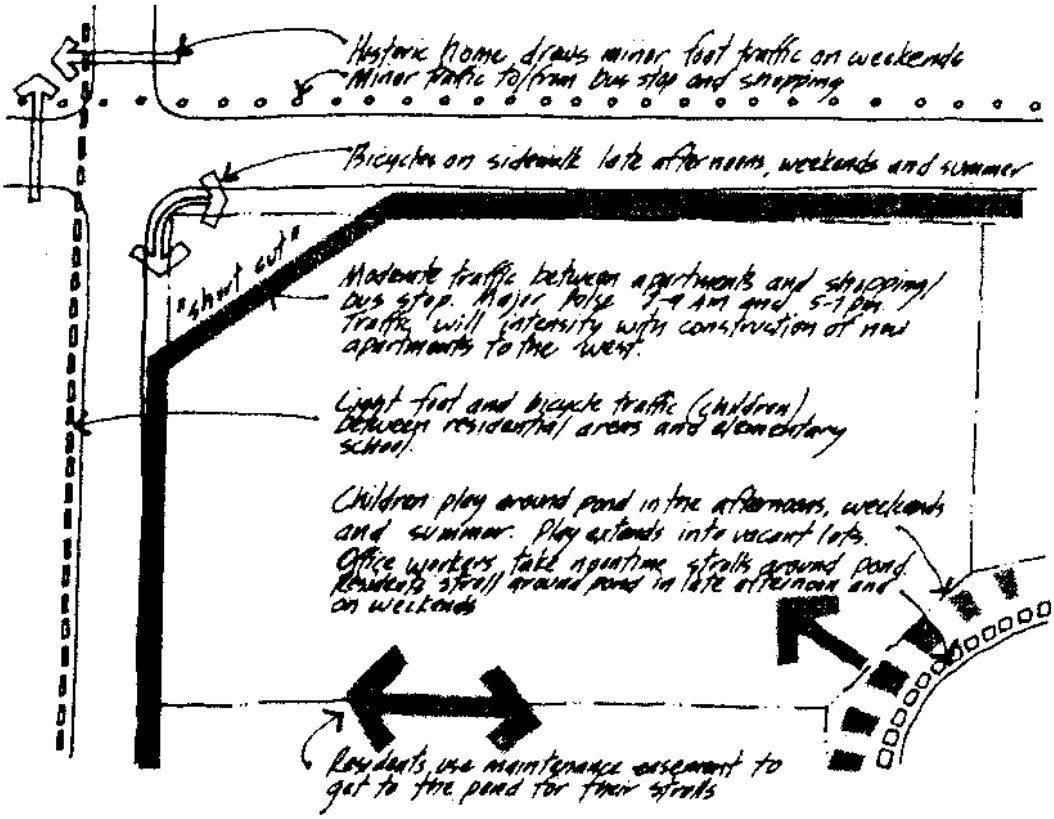
- **Electricity**
- **Sewer**
- **Water**
- **Telephone**





Circulation

● Pedestrian



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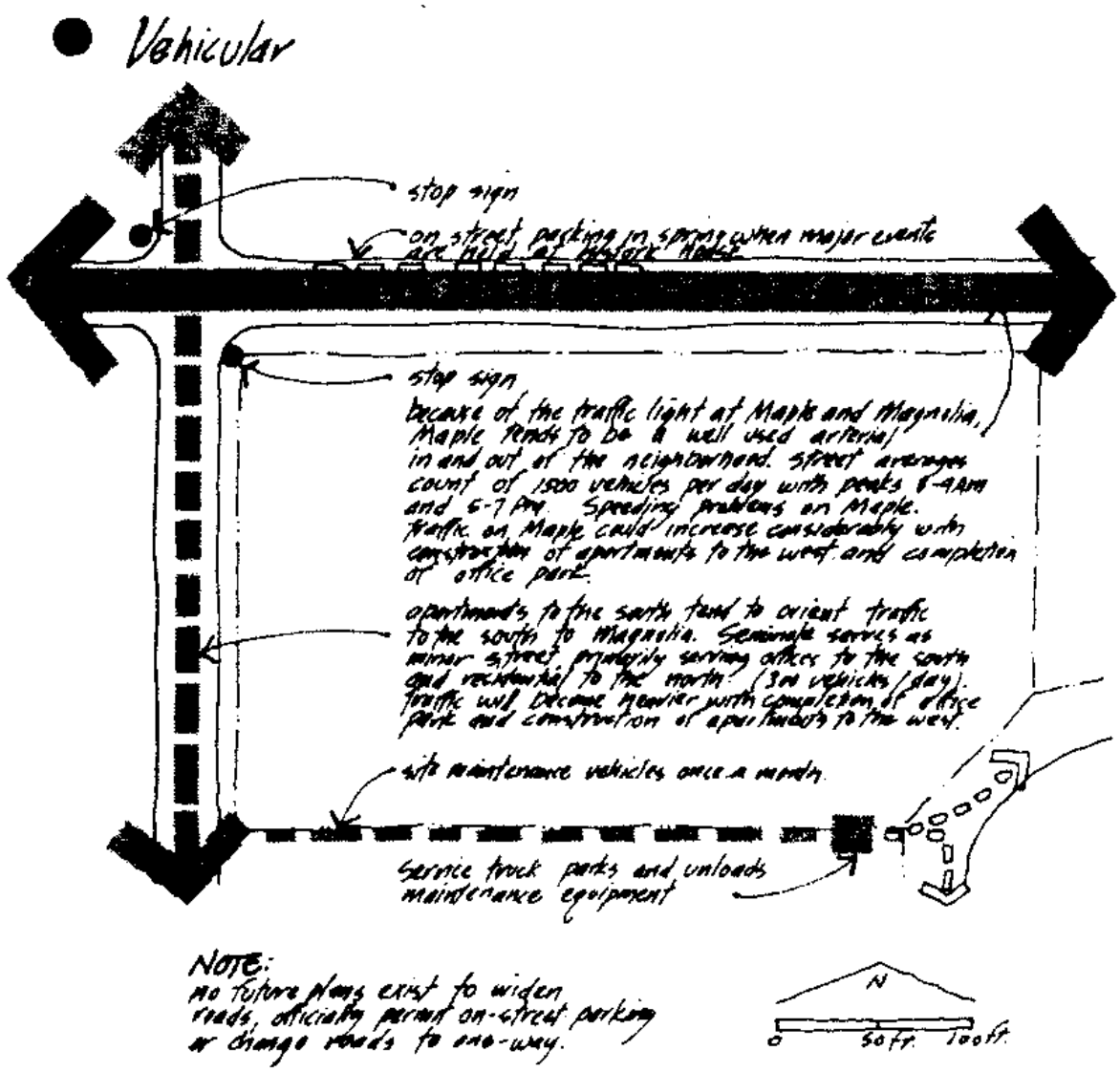
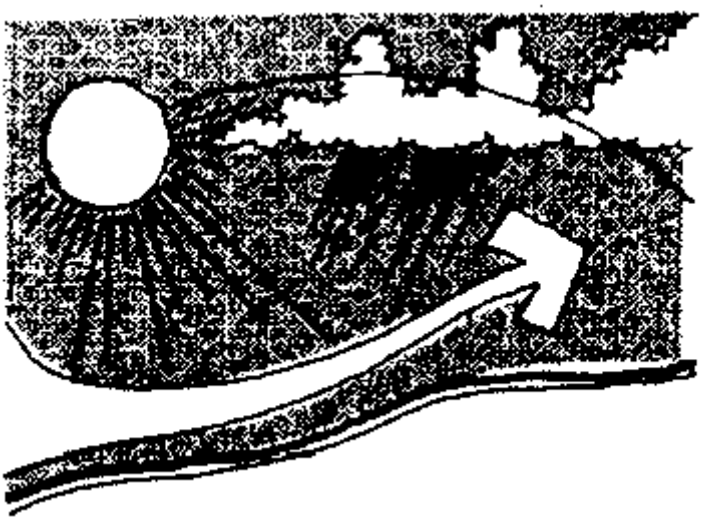


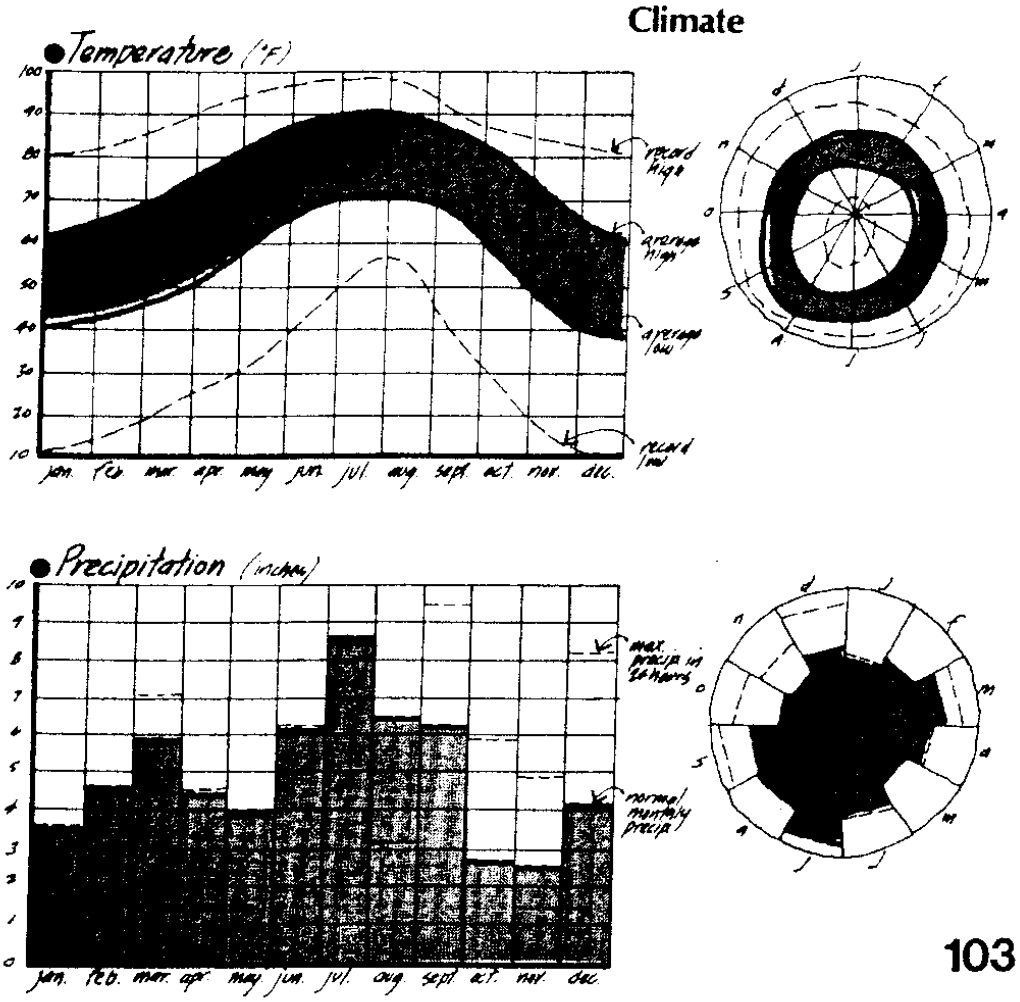
CLIMATE -

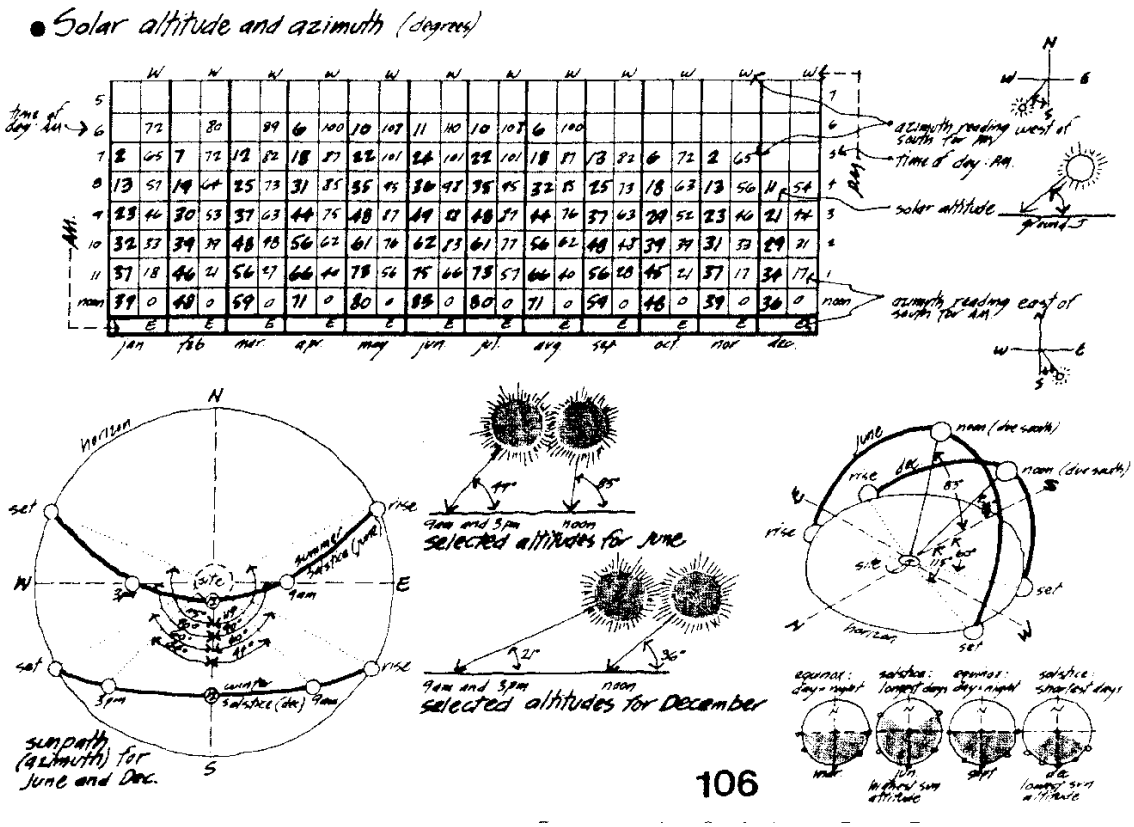
Presents all the pertinent climate conditions such as

- **Rainfall**
- **Humidity**
- **Temperature variations over the months of the year**
- **Prevailing wind directions**
- **Sun path and vertical sun angles**
- **Potential natural catastrophes**

Micro climatic conditions





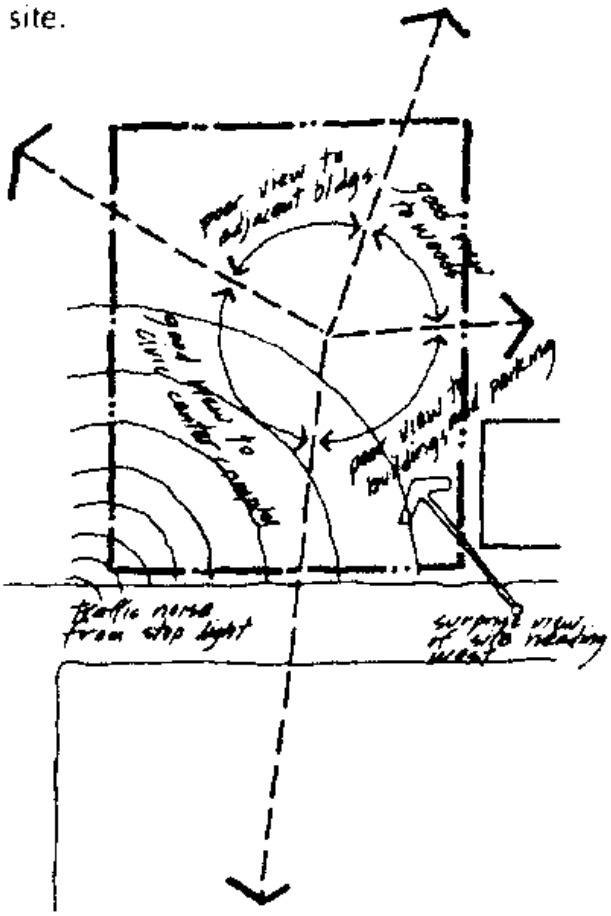


Factors influencing the site - Soft data maps

SENSORY – documents the visual and tactile aspects of site. Views to and from the site. Existence of odors and noise and extent to which they are annoying. Human and cultural-analysis of surrounding neighborhood in terms of cultural ,psychological, behavioral. Sociological aspects.

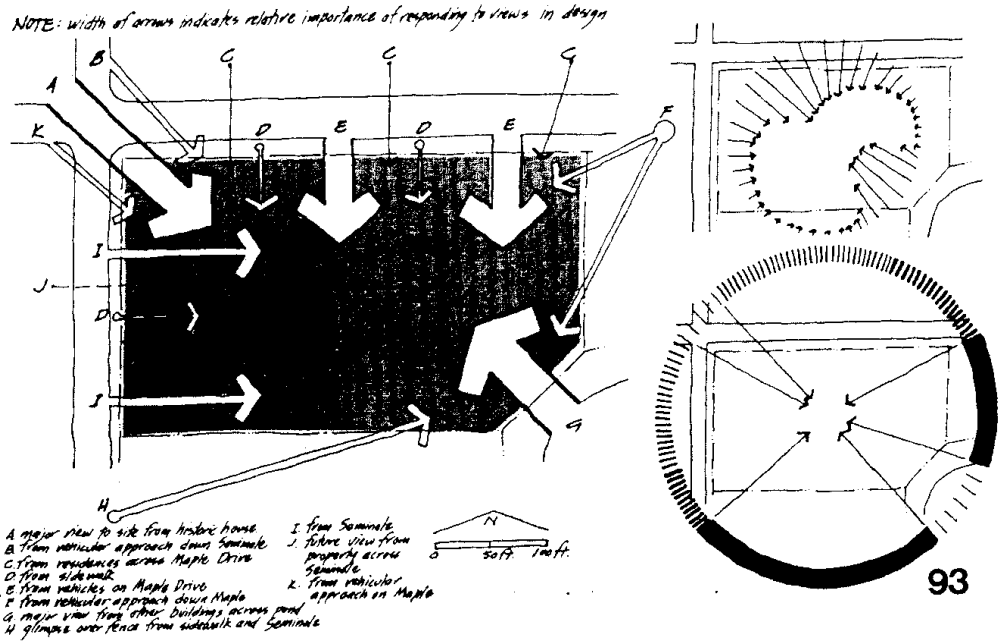
Involves the study of

- **Population**
- **Age**
- **Ethnic patterns**
- **Values**
- **Income**
- **Family structure**
- **Informal activities in the neighborhood**
- **Festivals**
- **Parades or craft fairs**
- **Vandalism and crime patterns**

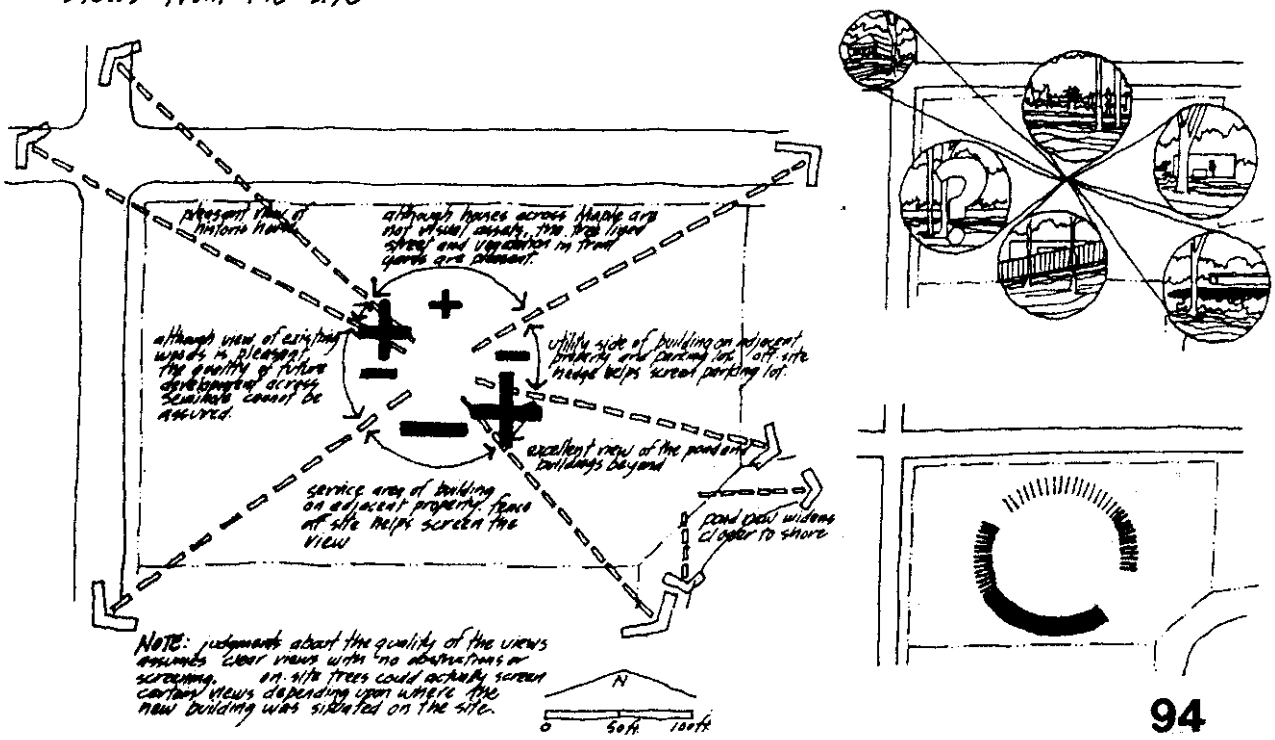


Sensory

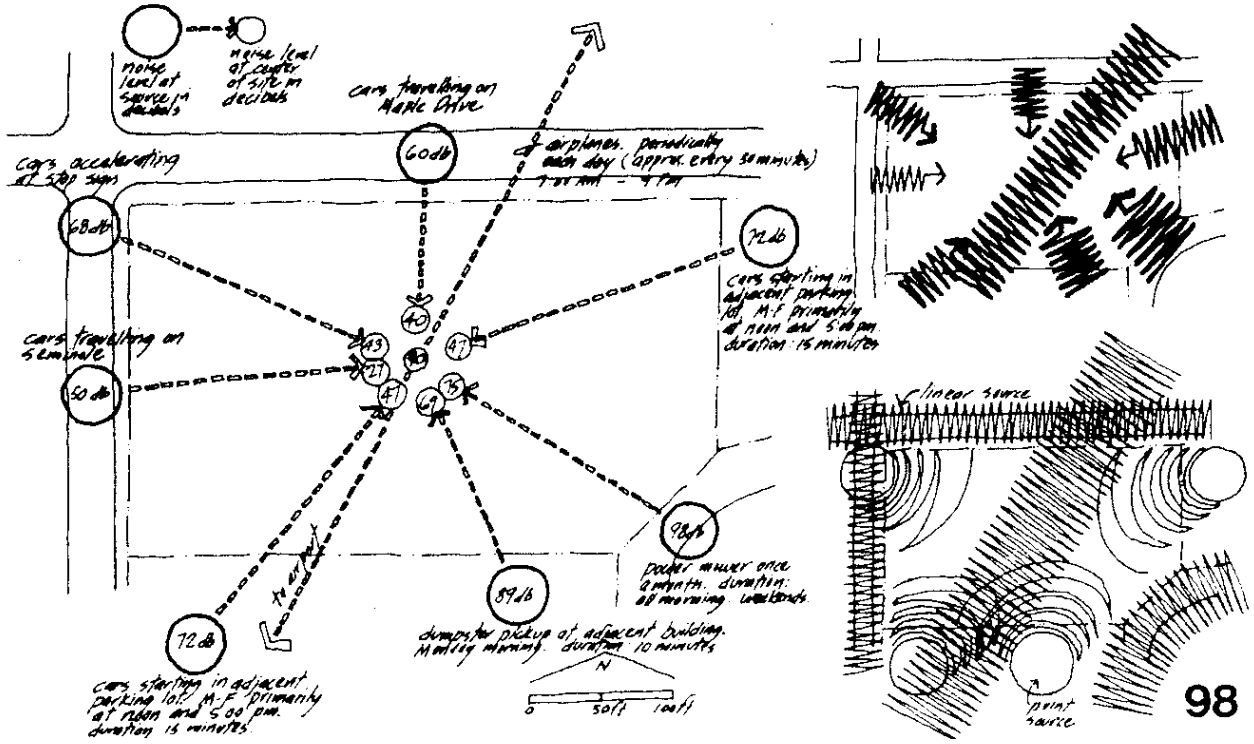
- *Views into the site*



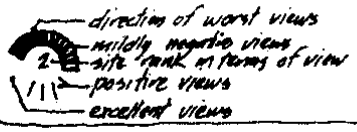
● Views from the site

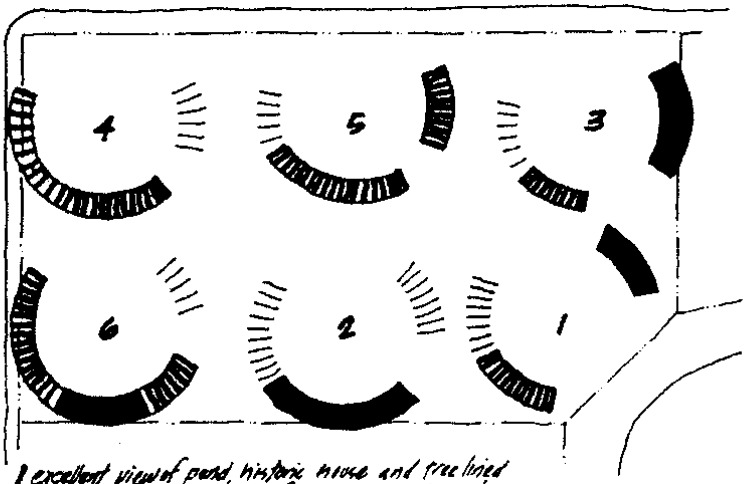


● Noise



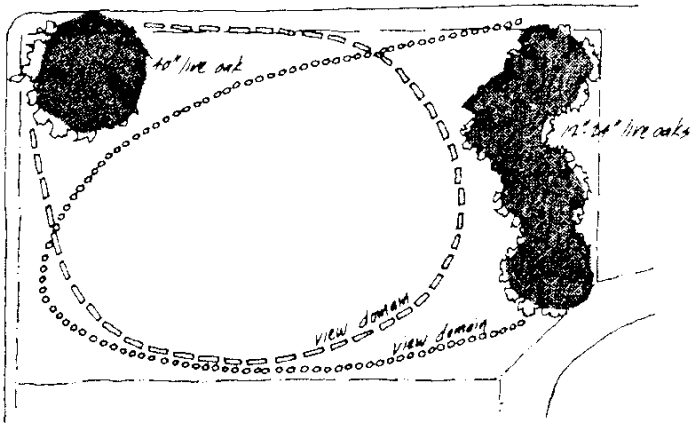
● View quality from various site positions

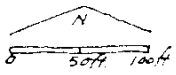




1 excellent view of pond, historic house and tree lined Maple Drive. proximity to fence screens adjacent building to south.
2 except for view to south, good views in all directions. restricted view of pond.
3 good view down the pond and proximity to tree lined Maple Drive.
4 good view of historic house & Maple Drive. pinched view of the pond due to buildings.
5 high elevation presents view of service yard to south.
6 good view direction restricted to north east. pinched view of pond and historic house.

● Points of interest on site



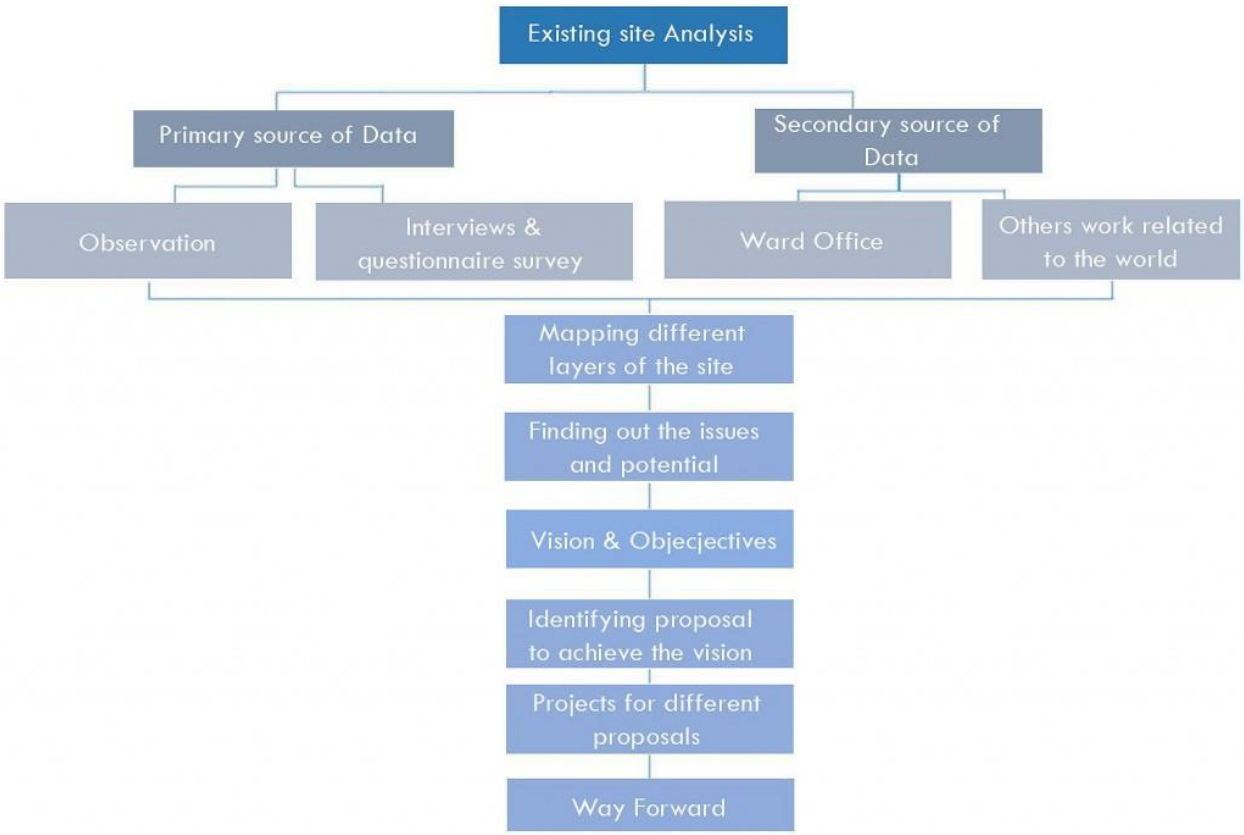


Master Plan

A Master Plan is the long term perspective plan for guiding the sustainable planned development of the city. This document lays down the planning guidelines, policies, and development code and space requirements for various socio-economic activities supporting the city population during the plan period. It is also the basis for all infrastructure requirements.

The Master Plan can identify:

- **suitable locations for commercial, housing and mixed-use development**
- **locations where the city should increase density, use redevelopment, or intervene in other ways;**
- **opportunities to extend and/or improve open space, recreational areas, and civic facilities;**
- **strategies from increasing economic development;**
- **environmental, historic and cultural resources that need conservation;**
- **strategies for solving congestion and improving transit services.**



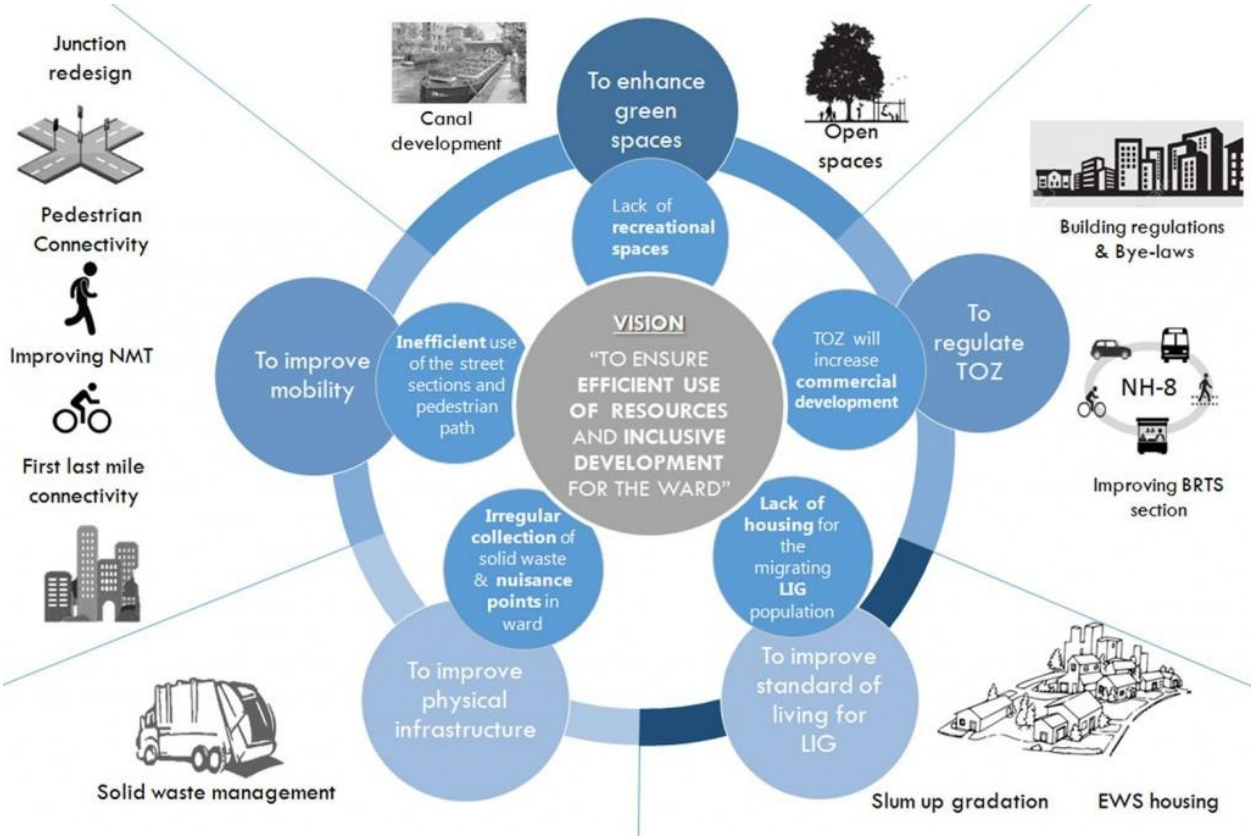
Nine elements of master planning – documents and plans

1. **Goals and Policies**

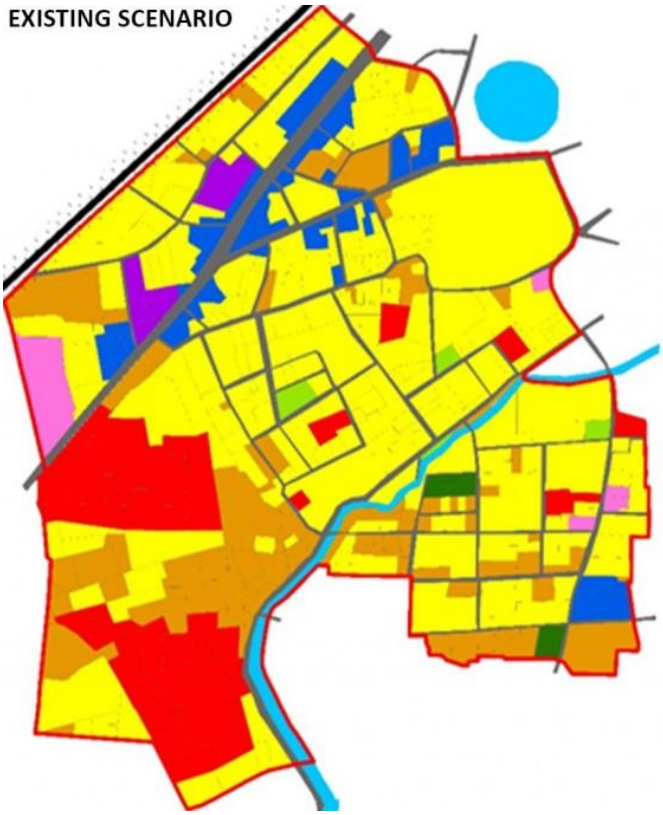
The desires and wishes of the community about what kind of place it wants to be and how it wants to improve its quality of life. Looks at the direction the community wants to head in. Should be developed at the beginning of the process with public input.

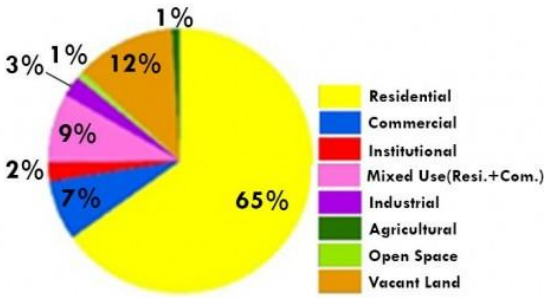
2. **Land Use maps**

Looks at the pattern of land use in the community, including public and private land, and protected lands. Projects the full build-out condition to assess the need for redirection of future land use. Identifies ideal areas for development to meet future needs as determined by the other plan elements.



EXISTING SCENARIO





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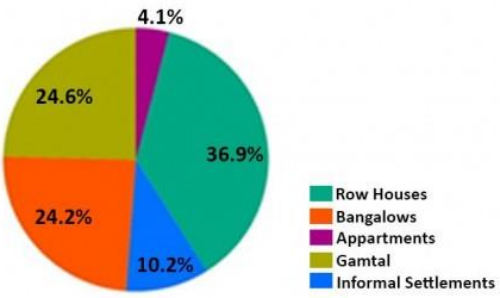
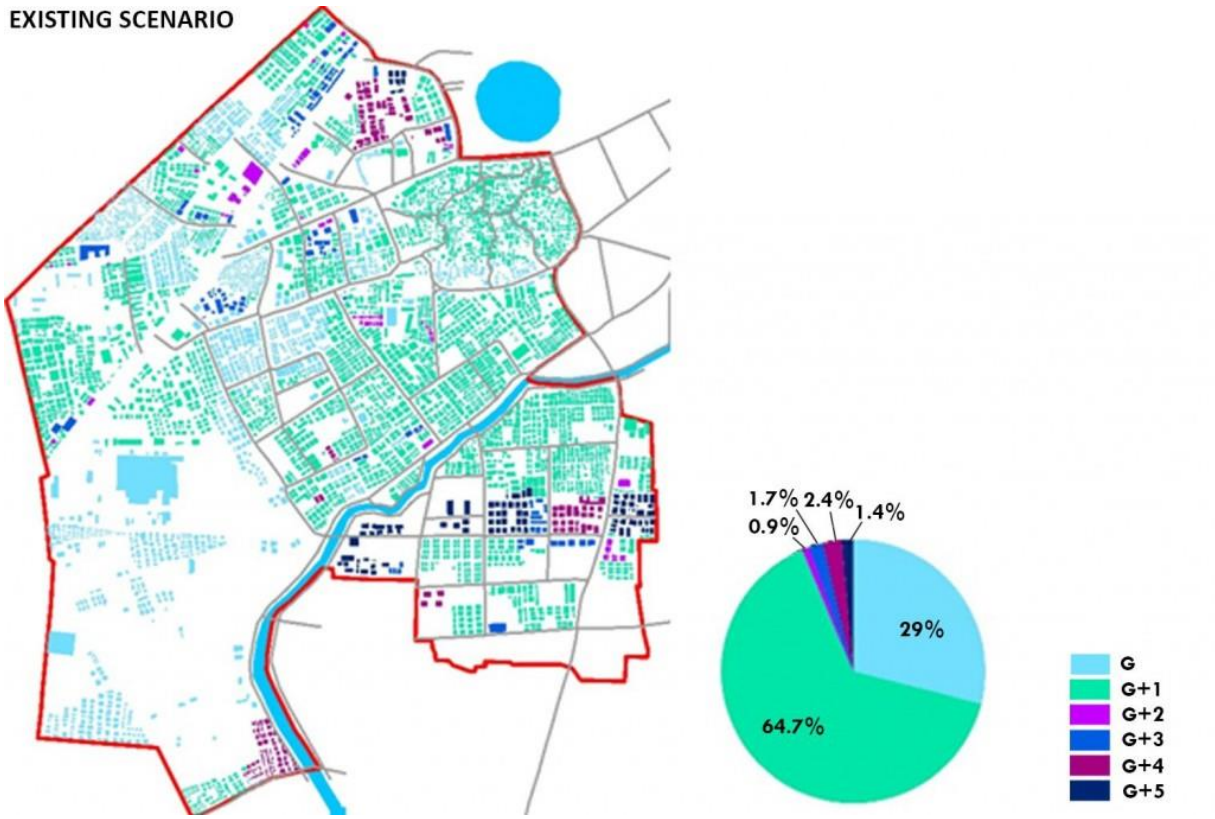


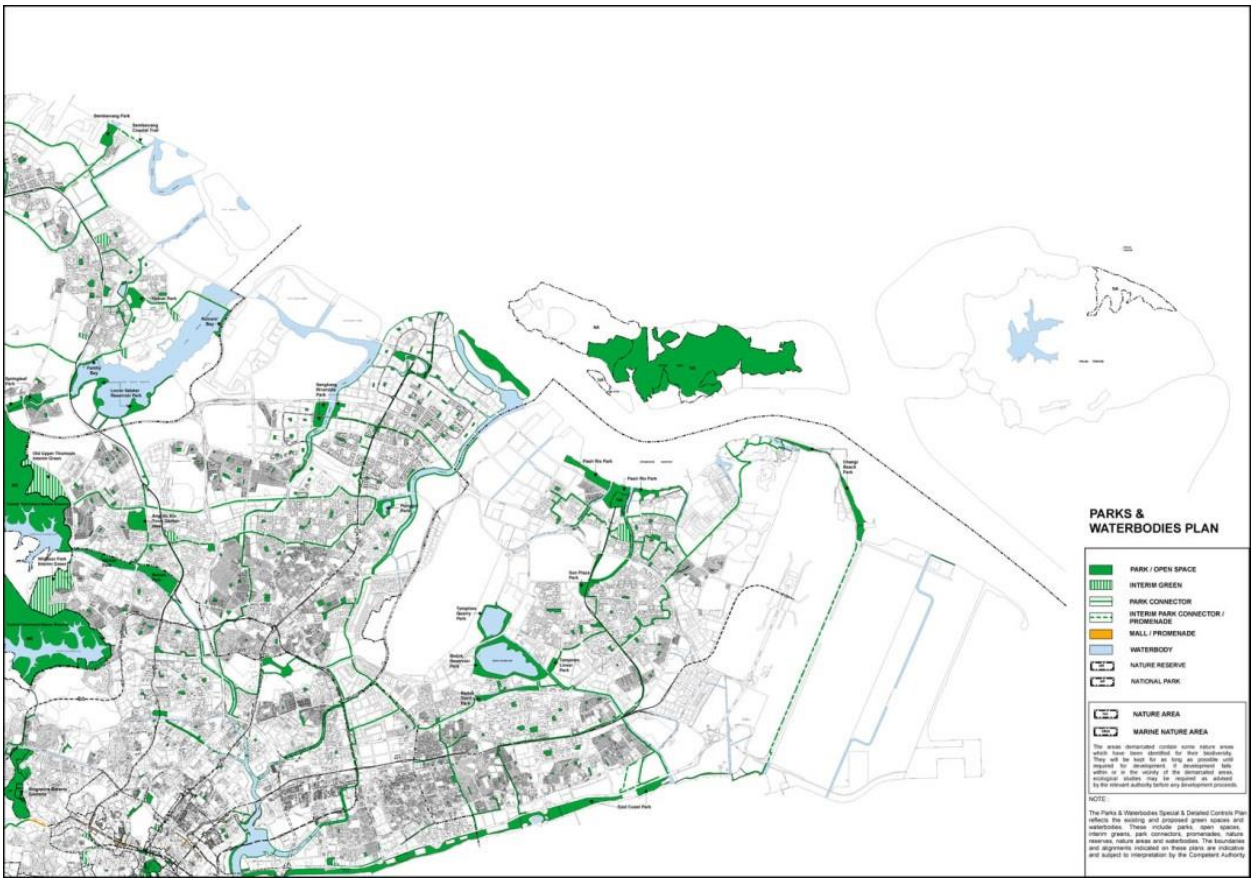


3. **Natural Resources maps**

Identifies land and water resources and cultural and historic resources whose preservation is important in maintaining natural resources and the character of the community. Develop strategies to protect and manage the natural and historic resources that enhance the attractiveness of the town.

4. **Open Space and Recreation maps**

Assesses the future recreational needs of the community in planning for the maintenance and expansion of existing areas, and the construction of new facilities. Recommends techniques to better protect and manage the current open space network and identifies future land acquisitions to meet active and passive recreational demand.



5. **Service and Facilities maps**

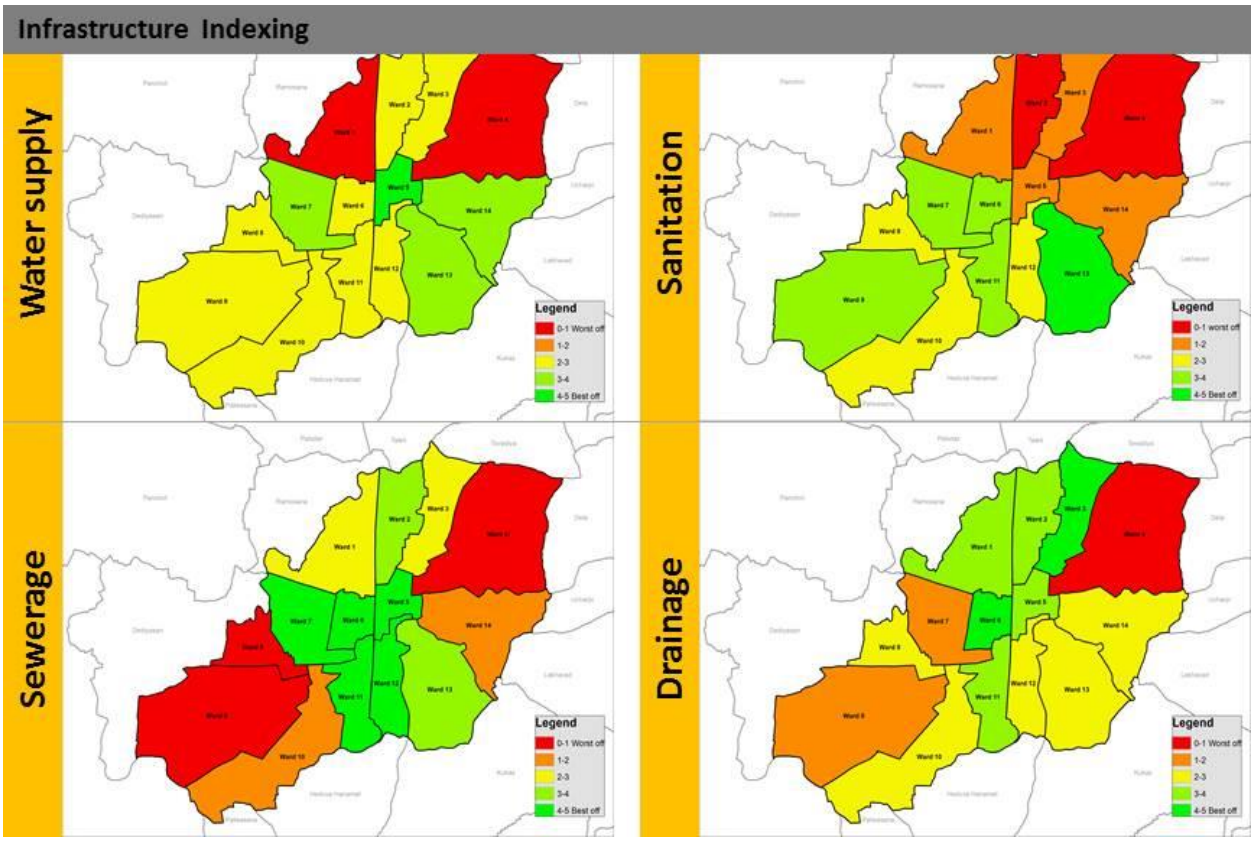
Identifies the availability and status of public services, including education, public safety, water and sewer, energy, and other utilities. Looks at future growth and calculates the increased need for the provision of municipal services and facilities in planning for their expansion. Investigates the current delivery of municipal services and identifies best management practices and cost-efficient techniques to be implemented.

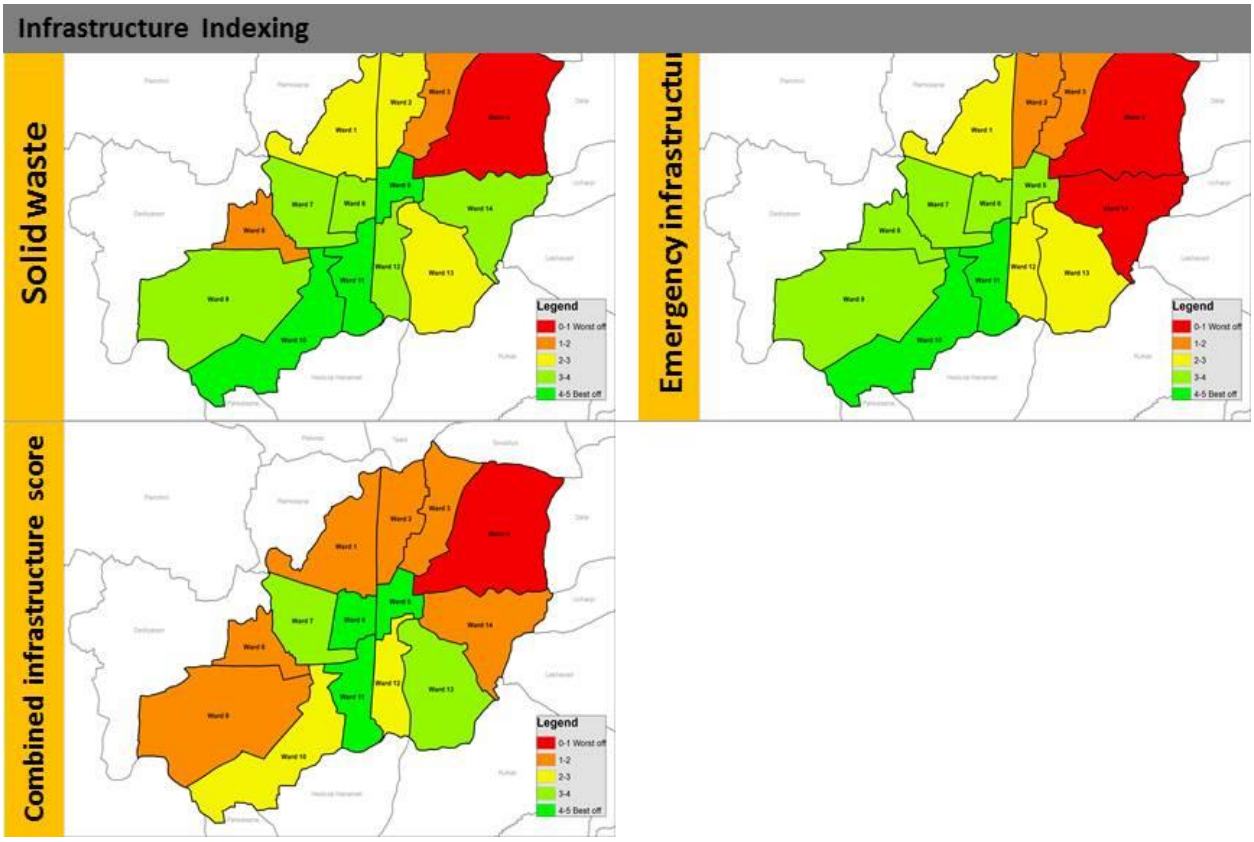
6. **Transportation and Circulation maps**

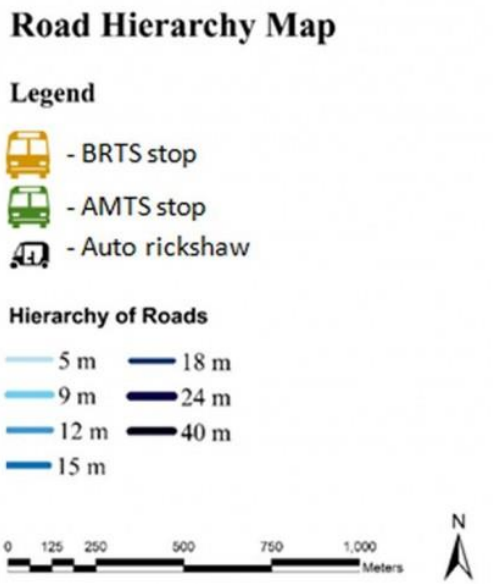
Identifies existing and potential roadway problems by looking at circulation and parking patterns, developing strategies for improvement. Identifies available alternative transportation options and considers how their future development may help alleviate congestion.

7. **Economic Development**

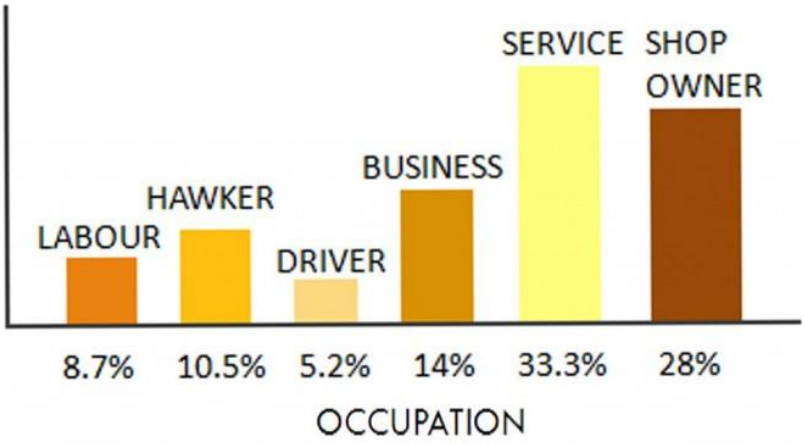
Determines the strengths and weaknesses of the labor force and market sectors in the local economy in planning for new business and development. Looks at other businesses and industry location factors in identifying improvements to be made to stimulate desired economic development.


Infrastructure Indexing
Water supply
Sanitation
Sewerage
Drainage
Legend
0-1 Worst off
1-2
2-3
3-4
4-5 Best off


Infrastructure Indexing
Solid waste
Emergency infrastructu
Combined infrastructure score
Legend
0-1 Worst off
1-2
2-3
3-4
4-5 Best off



AREA	3.57 km^2
DENSITY	308 person/ha
POPULATION	109922
NO. OF H.H	23919
ZONE	R1

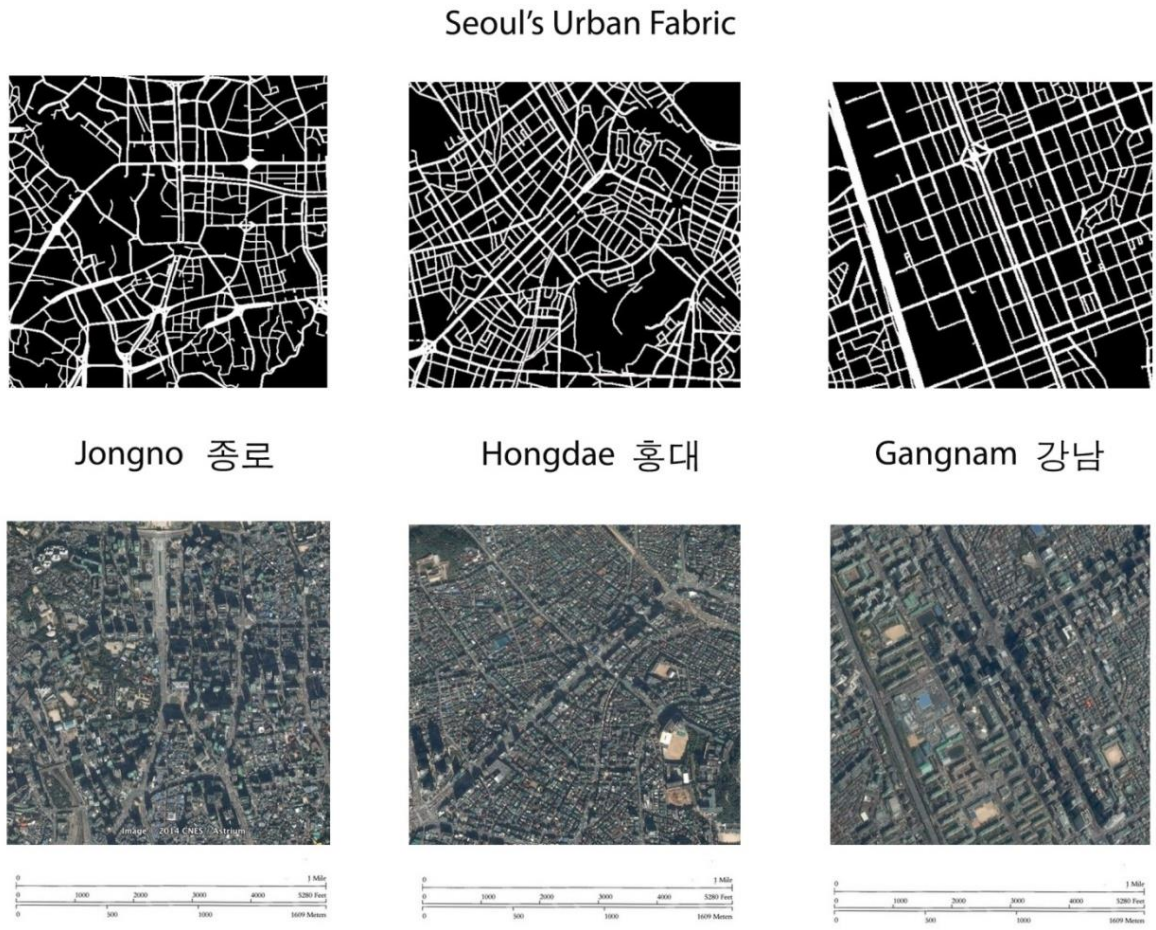


8. Implementation

Suggests strategies to be accomplished by the town to achieve the goals the community set forth at the beginning of the planning process taking into consideration what the community has and what it desires. Describes available funding sources and technical assistance to help the community put parts of the plan into practice. May include recommendations for zoning amendments, identification of responsible parties (including different municipal boards or departments), and priorities.

<u>Built and Un-built – figure and ground study</u>

A figure-ground diagram is a two-dimensional map of an urban space that shows the relationship between built and un-built space. It is used in analysis of urban design and planning. The figure ground plan organizes the primary urban landscape components - plots, streets, constructed spaces, and open spaces into a diagram of solid and void.



The figure-ground theory of urban design and urban morphology is based upon the use of figure ground studies. This helps to define the voids between the buildings, and to emphasize their existence as defined objects in their own rights: spaces that are as much a

part of the design as the buildings whose exteriors define them. It relates the amount of "figure" to the amount of "ground". Helps to approach urban design as a manipulation of that relationship, as well as being a manipulation of the geometric shapes within the diagram. It illustrates a mass-to-void relationship analysis and identifies a "fabric" of urban structures.

Eg. If building mass (solid) is greater than or proportionate to the open space (void), spatial continuity is achieved through street walls and articulated public spaces, creating a mixed-use urban environment that fosters pedestrian activity. If building mass is much lesser than open spaced, then buildings become disconnected, and voids lack spatial definition, often becoming surface parking.

https://www.researchgate.net/publication/297650940_Role_of_Built_Environment_on_Factors_Affecting_Outdoor_Thermal_Comfort_-_A_Case_of_T_Nagar_Chennai_India

A figure ground diagram of Washington DC. Image: Mayr & Mayr

https://www.citymetric.com/horizons/figure-ground-diagrams-tell-stories-about-cities-2359

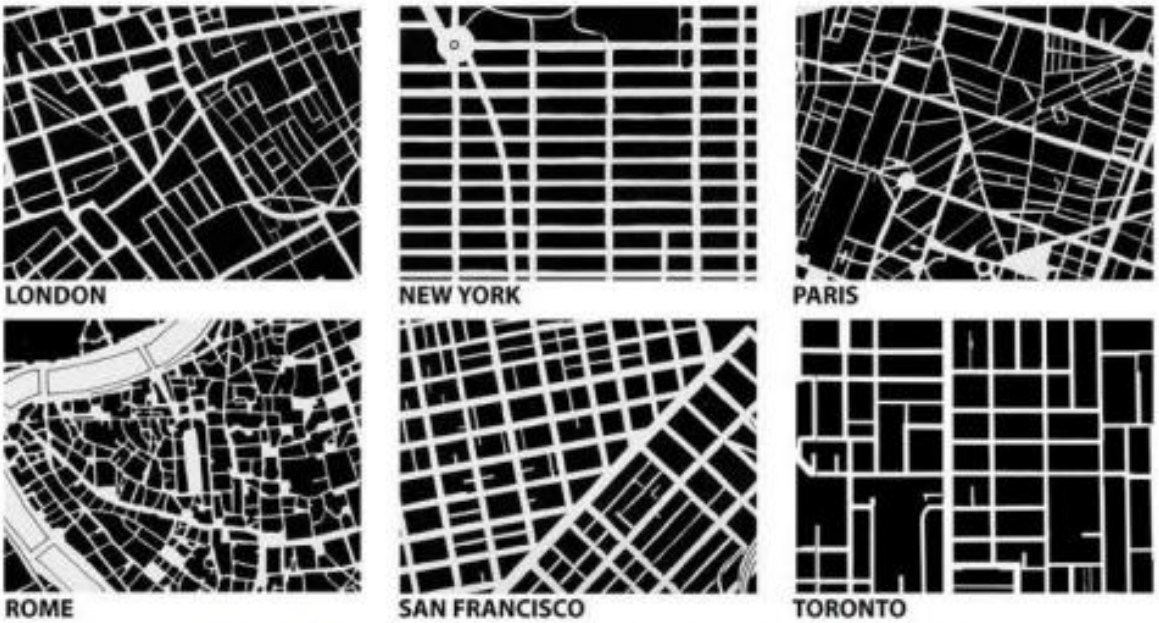
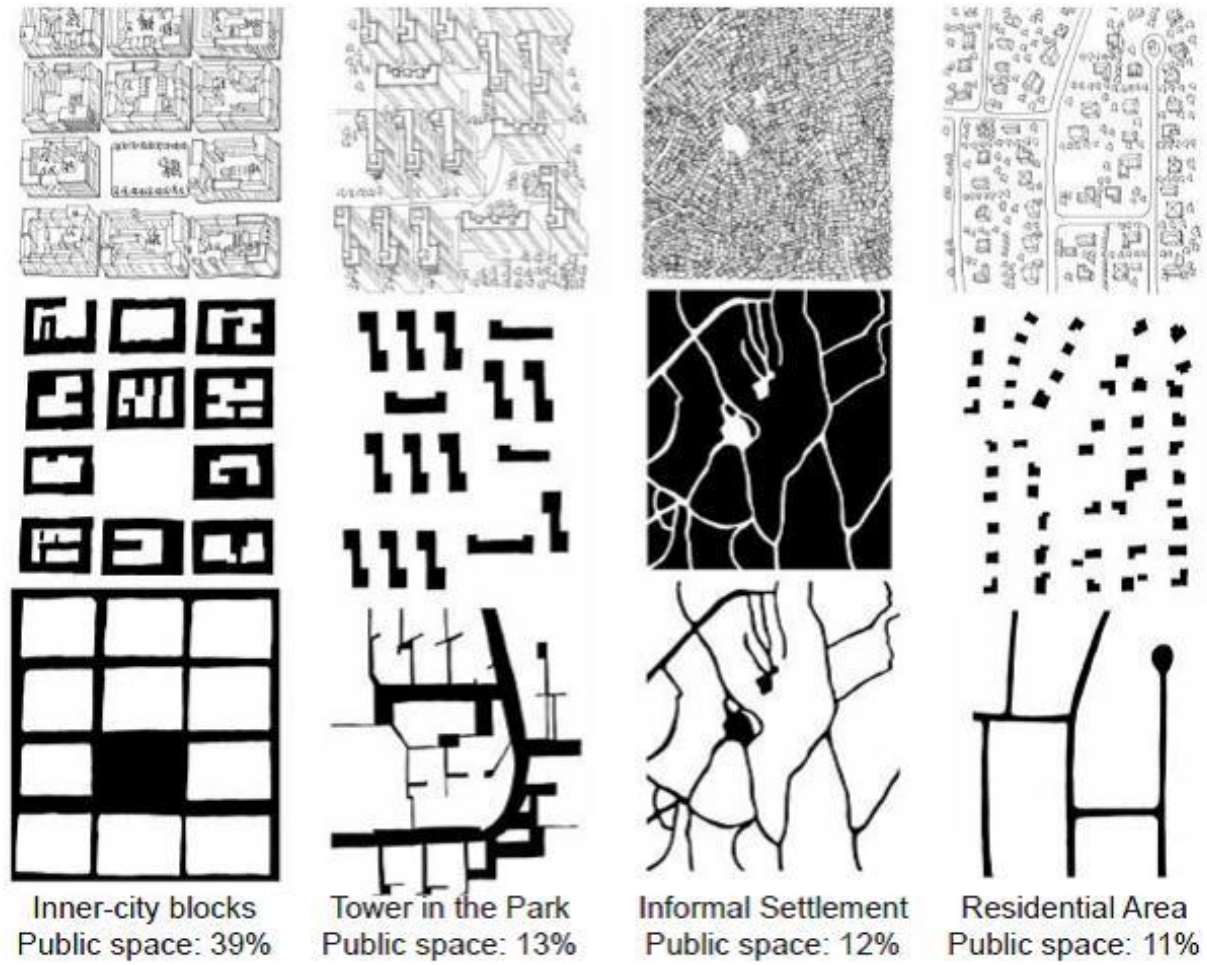
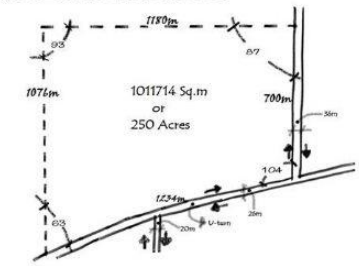


Figure 2: Figure-ground maps of major cities in the world
Source: Trancik (1986)

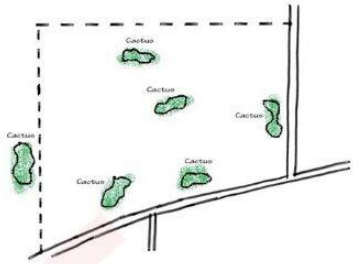


Source: Habitat III Issue Papers - #11 Public Space

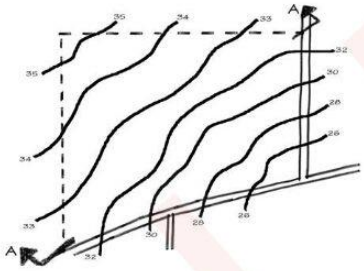
SITE ANALYSIS

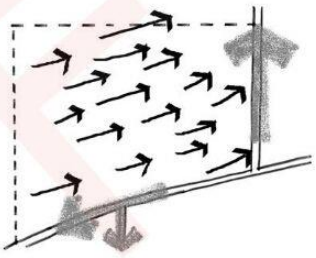


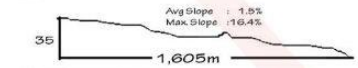
1. SITE DIMENSIONS



2. VEGETATION ON SITE

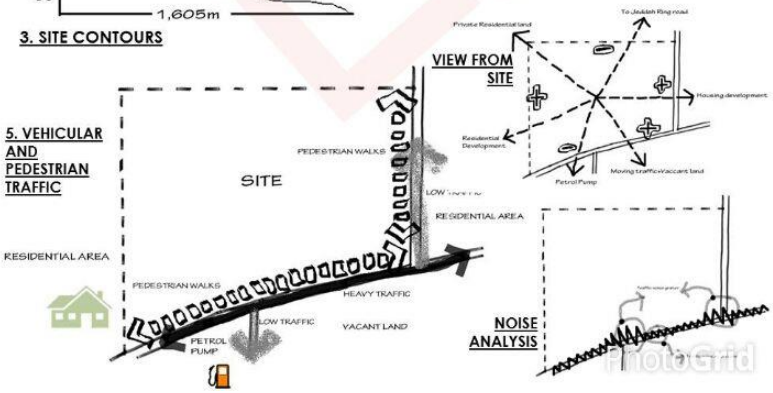


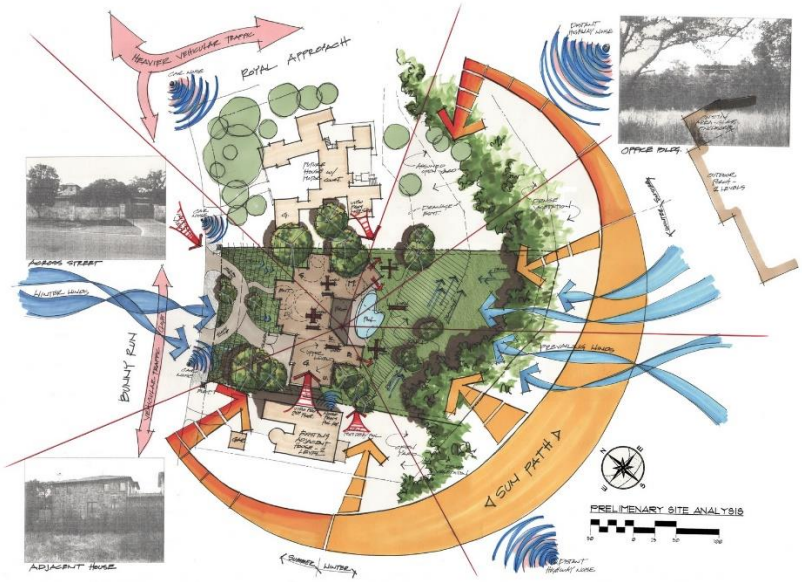


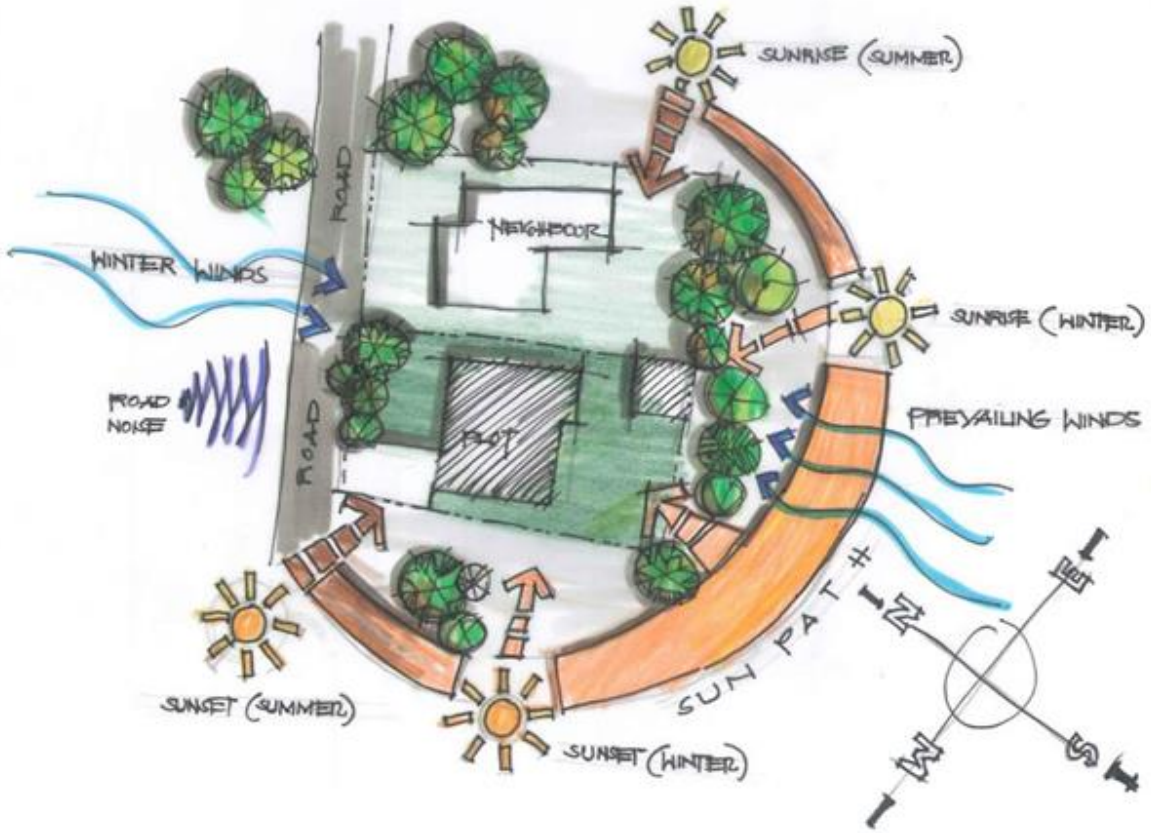


3. SITE CONTOURS

4. SITE DRAINAGE






SUNRISE (SUMMER)
ROAD
NEIGHBOUR
WINTER WINDS
SUNRISE (WINTER)
ROAD NOISE
ROAD
PLOT
PREVAILING WINDS
SUN PATH
SUNSET (SUMMER)
SUNSET (WINTER)
E
N
W
S

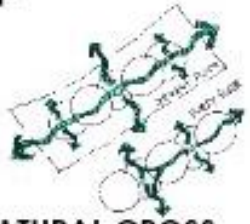
DESIGN CONCEPT ANALYSIS

CONCEPT

Circular shapes to mimic tree branches with the ecosystem and connectivity of a rainforest.

CENTRE POINT

The atrium lobby acts as the center point and gateway to the building.

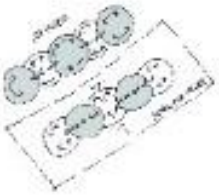


NATURAL CROSS VENTILATION

The atrium lobby acts as the center point and gatewayto the building.

VEHICLE CIRCULATION

Sensible vehicle circulation and parking.



INTERNAL CIRCULATION

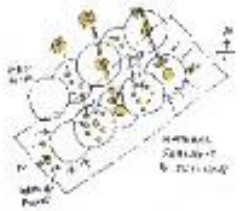
Human internal circulation.

SEPERATION

Dividing public and private areas with the lobby as the connecter.

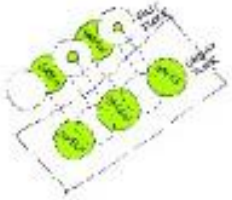
WIND DIRECTION

Analysis of Malaysia's weather data shows high occurrence of cool wind from North and North-West.



DAYLIGHT

Harvesting daylight from the façade and roof skylights.



GREEN AREA

Abundant green area integration.

SOLID & VOID

Alternating solid and void areas.

INTEGRATION

Connecting outdoor and indoor by alternating spaces.

SATHYABAMA
INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)
Accredited "A" Grade by NAAC | 12B Status by UGC | Approved by AICTE
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SCHOOL OF BUILDING AND MANAGEMENT

DEPARTMENT OF ARCHITECTURE

UNIT – IV – Case Studies – SAR1203

TERI – THE ENERGY AND RESOURCES INSTITUTE AT BANGALORE

Introduction

TERI, Bangalore is among south India's first energy efficient and environmentally sustainable campuses. It houses work spaces for the staff, conference rooms, a library, a laboratory and a guest house. Dining and recreation facilities are shared between the offices and the guest house. It has the potential to serve as a model for future development in similar geographical and climatic conditions.

TERI campus at Bangalore

Project Details

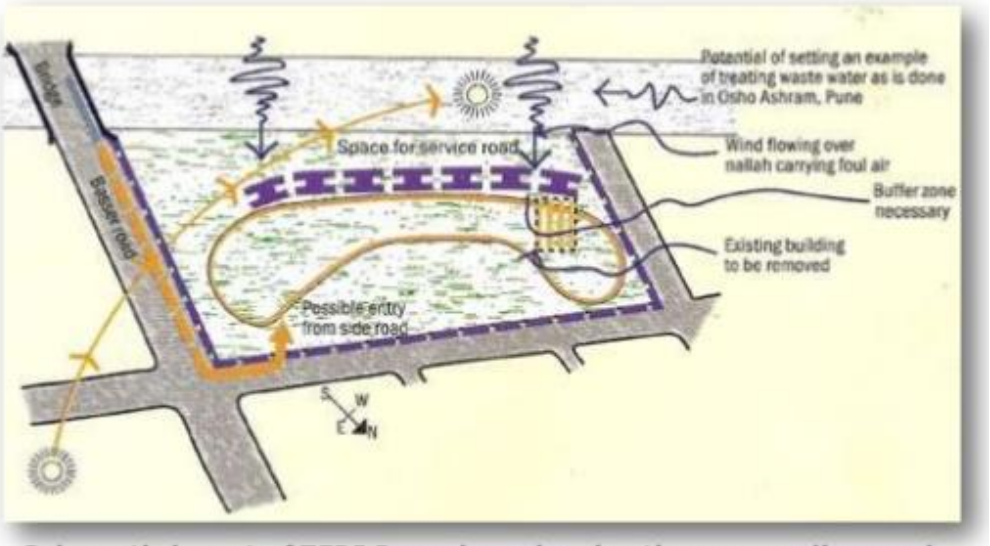
Name of the project	**The Energy and Resources Institute (TERI), Southern Regional Centre, Bangalore**
Client	**TERI**
Architect	**Ar.Sanjay Mohe**
Climate	**Moderate**
Completion Year	**1990**
Type of Building	**Institutional**
Total No. of Floors	**G+2**
Built-up-Area	**26,663 Sq.Ft**

The design displays a dexterous interplay of five basic natural elements – Sun, Air, Earth, Water and Sky – with the built form, to meet the requirement of Thermal, Visual and Aural comfort.

1. **<u>Location, Orientation & Climate</u>**

The site is located at Domlur, about 3 km from the Bangalore airport. It is a long and narrow site with roads on the eastern and northern sides, the former being the major road. The western side has an open ground and on the southern side is an open drain about 9 m

wide. The buildings are aligned along the east-west axis and entry into the site is from the road on the northern side which is relatively less busy.



Schematic layout of TERI Bangalore showing the surrounding roads and the drain.

The office block is kept towards the east, close to the main road for high visibility and the guest house is located towards the quieter western side. In a moderate climate zone like Bangalore where temperatures are not very high, a good ventilation system can easily provide comfortable living conditions.

The office blocks are placed towards the main road while the guest house is located on the quieter west side.

2. Natural Features

Positive and Negatives:

The drain on the southern side is a major feature which influences the design. Wind coming from the south over the drain brings in the foul smell into the site.

Open drain on the southern edge of TERI Bangalore

3. **Architectural Design**

This energy efficient complex is designed to provide all round comfort for the users. The building opens to the north to take maximum advantage of glare-free light. Continuations of skylight spaces carry natural light into the building.

Abundant natural light is available in the work spaces.

Adequate natural lighting and ventilation is provided through an optimized combination of solar passive design, energy efficient equipment, renewable sources of energy and materials with low embodied energy. The condition of the drain is proposed to be improved into a pleasant landscaped element by using plants that absorb impurities as well as with the help of basic filtration and aeration. This being an ideal long-tern solution would be a major civic project. The architecture responds to the present site conditions but the building can eventually open up towards the drain when it turns clean.

A fresh environment is maintained inside the building

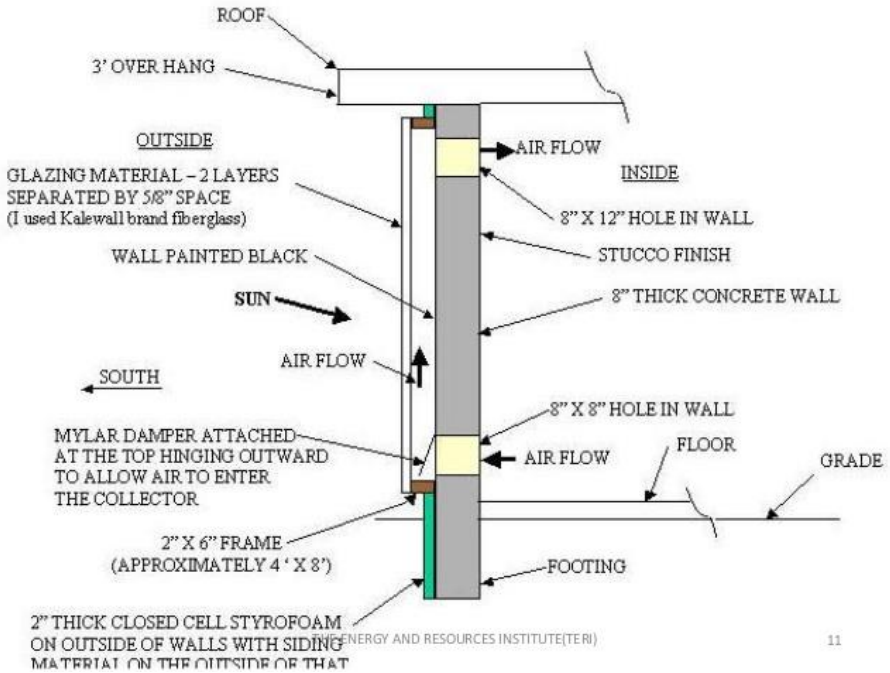
A cavity wall on the southern side insulates the building from solar heat gain. The ground disturbed due to the building is replaced on the rooftop to form terrace gardens at various levels. These gardens along with earth berms provide good heat insulation and moderates fluctuations in temperature.

Locally available 'kadappa' stone used to clad the southern wall

Trombe walls help in insulating the hostels

4. Materials & Appliances

As use of local materials reduces the energy consumed in their transportation, local materials and materials with low-embodied energy have been used wherever possible. The southern wall, for instance, is clad in local 'kadappa' stone. Energy-efficient lighting devices like CFL lights have also been used.



Rooftop gardens are also beneficial in reducing rain runoff. A roof garden can delay run off; reduce the rate and volume of run off. Plants have the ability to reduce the overall heat absorption of the building which then reduces energy consumption.

5. **Day lighting**

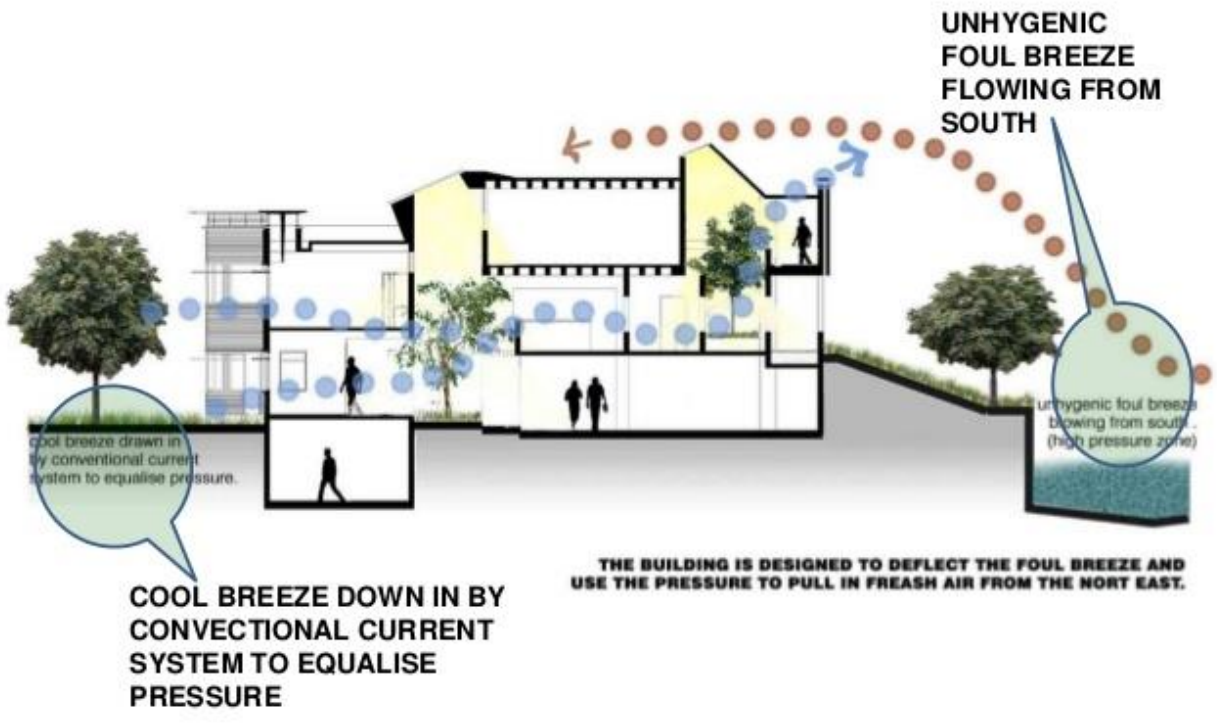
Openings have been designed such that requirement of artificial lighting is minimal throughout the day when the building is under maximum usage. By creating atrium spaces with skylights, the section of the building is such that natural light enters into the interiors of the building, considerably reducing the dependence on artificial lighting.

Abundant natural light inside due to intelligently designed fenestrations

6. **Ventilation**

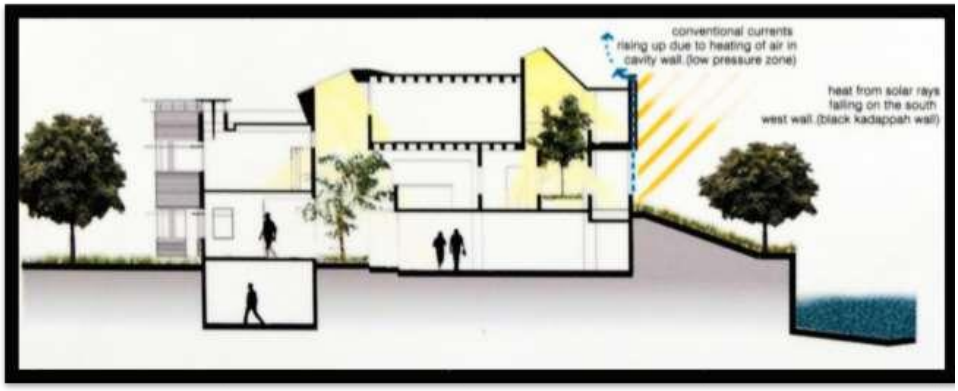
A blank wall towards the south (facing the drain) allows the breeze to flow over the building. This creates a negative pressure which pulls fresh air from the north into the building. The sections are designed such that hot air rises to the top and make the building breathe. Air in the cavity in the south wall on the south creates negative pressure, thereby enhancing the convection currents in the building.

Section showing natural light penetrating deep into the building through skylights and fenestrations.

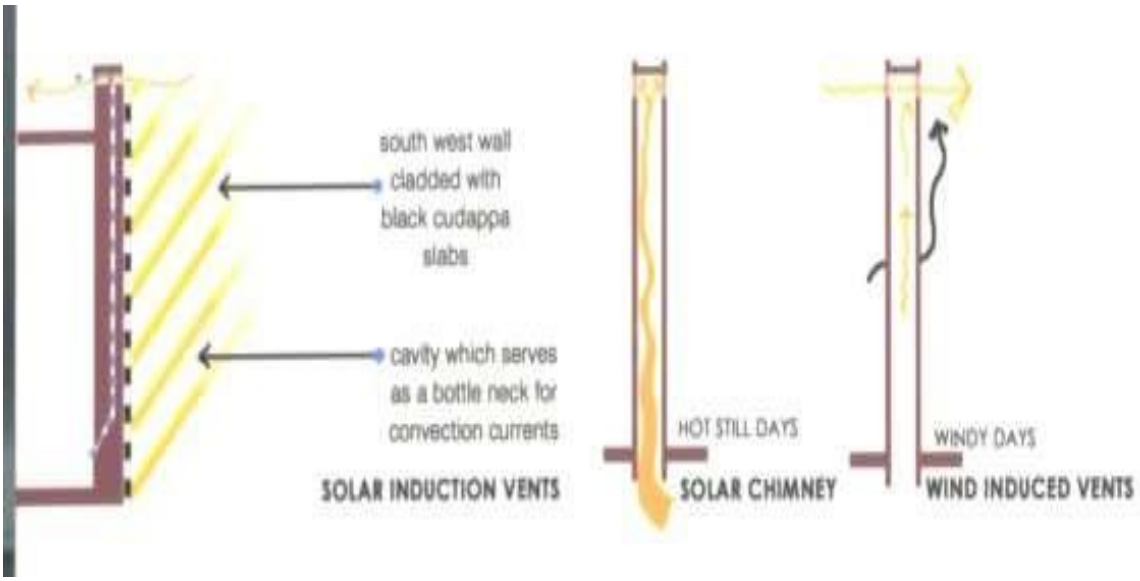


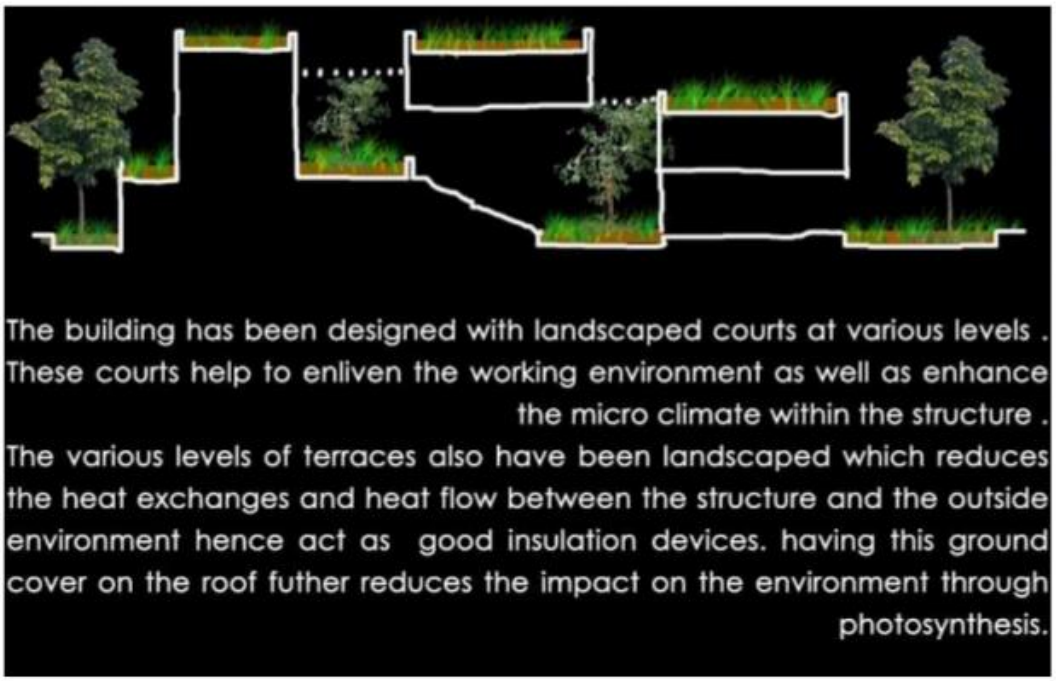
ON THE SOUTH IS AN ABSORPTIVE DOUBLE WALL WITH A CAVITY, WHICH

1. **PROVIDES INSULATION FROM THE SOUTHERN SUN &**
2. **HEATS UP THE AIR WITHIN**



The working of the system is very simple. The sun's rays heat the black south wall increasing the temperature of the immediate environment around. This causes the air in the cavity to rise upwards naturally. These convectional currents are blown away by the winds blowing south to north. This creates a vacuum at the at the top core structure. To fill this vacuum, air from inside is drawn up. This system of hot air rising and drawing in of cool fresh air is a continuous process.





The building has been designed with landscaped courts at various levels . These courts help to enliven the working environment as well as enhance the micro climate within the structure .
The various levels of terraces also have been landscaped which reduces the heat exchanges and heat flow between the structure and the outside environment hence act as good insulation devices. having this ground cover on the roof futher reduces the impact on the environment through photosynthesis.

7. **Renewable Energy**

A 5-kw peak solar photovoltaic system integrated with the roof skylights provides day-light and also generates electricity. A solar water heating system meets the hot water requirements of the kitchen and the guest rooms. Other energy conservation systems include an effective waste and water management system, a centralized uninterrupted power supply, and a kitchen that reduces internal heat.

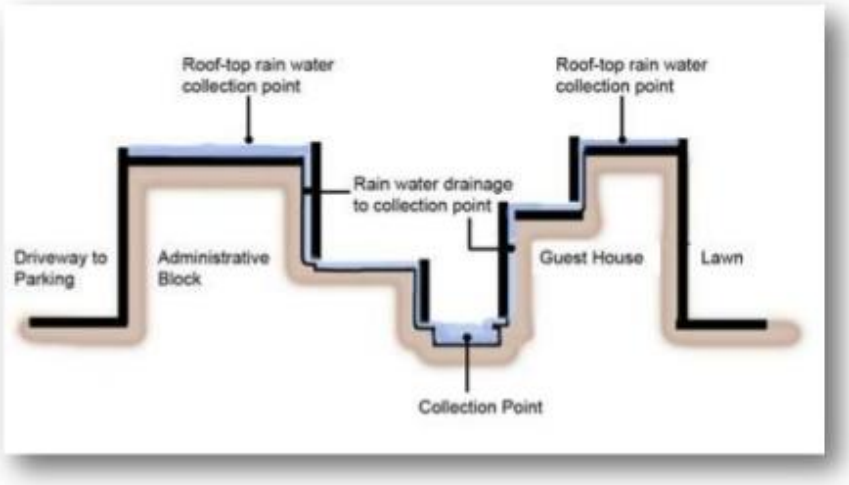
Solar Photovoltaic integrated with the roof provide natural light and electricity

Solar water heaters which meet the hot-water requirements of the campus

8. **Water Management**

An efficient rainwater harvesting system preserves water to the maximum possible extent. Water run-off from the roofs and from the paved area is collected and stored in a

collection sump below the amphitheater. This water is used for various purposes including landscaping and flushing toilets.



Schematic section of the building showing the rain water harvesting system

9. Post Construction

The monthly energy consumption is about Rs.30,000 for the entire complex. This works out to be around Rs. 1.12 per square foot which is about one-tenth of a conventional building with air conditioning in Bangalore, thus proving the energy-efficiency of the complex. As and when the drain to the south gets cleaned, the complex can also open out towards it. This would provide the complex with its own water-front.