OWNERSHIP CONSORTIUM
TISHMAN SPEYER
NEW YORK, NY, USA

ICICI VENTURE
BANGALORE, INDIA

DEVELOPER
TSI VENTURES
BANGALORE, INDIA

DESIGN ARCHITECT
KRUECK & SEXTON ARCHITECTS
CHICAGO, IL, USA

LANDSCAPE ARCHITECT
ANDROPOGON ASSOCIATES
PHILADELPHIA, PA, USA

ASSOCIATE ARCHITECT
CR NARAYANA
BANGALORE, INDIA

CIVIL ENGINEER
TCE CONSULTING ENGINEERS LIMITED
BANGALORE, INDIA

VASTU CONSULTANT
DESIGN LAB
CHENNAI, INDIA

TRAFFIC CONSULTANT
TRANSPORT ADVISORY FORUM
CHENNAI, INDIA

WASTEWATER CONSULTANT
NATURAL SYSTEMS INTERNATIONAL
SANTA FE, NM, USA

ENVIRONMENTAL CONSULTANT
BURO HAPPOLD
NEW YORK, NY, USA

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20 JUNE 2008

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The site presents a number of challenges to the design of a project of this type and scale:

- Situated in a floodplain at the bottom of a watershed
- No frontage on a major public road; difficult or undesirable access from existing roads
- No immediate access to rapid transit, municipal water supply, stormwater, sewage treatment, solid waste nor electrical infrastructure
- High proportion of building footprint needed for program in relationship to site area

However, the site offers several opportunities for the proposed residential development:

- Proximity to Chennai International Airport and major highways
- Proximity to existing and emerging employment centers
- Flat, walkable site
- Low-rise and mid-rise character of the program
- Presence of adequate sub-surface water
- Proximity to potential service workforce
- Good air quality

The program size and its specification of building types and heights reflect an urban rather than suburban development model. This approach is characterized by the close proximity of buildings to one another, intensive use of all available land—both public and private—and a street network with a finely scaled grain. Due to the pressures on the site's available land area, uses will need to be overlapped onto typical urban elements, such as streets and open space.

These qualities are viewed as significant opportunities to shape the project in positive ways. A compact, urban-scaled development promotes non-motorized transportation within the project boundaries and helps create an active community life.

Notwithstanding the 9-story apartments, which are a major component of the program, the overall site density is about 25 units per acre. This is in character with the dense yet horizontal development found in much of Chennai which has avoided the hyper-density of other India cities, such as Mumbai.

Water is the site's greatest challenge. There is either too much during the monsoon or too little during the dry season. The lack of a municipal utility infrastructure for potable, waste and stormwater is an opportunity for the project to consider a more thoughtful and sustainable approach to the retention, consumption and allocation of this, India's most precious and vital resource.

The tropical ecology of the region offers an abundance of plant material and landscape opportunities to site character and identity that can make a memorable and authentic place.

The pressures due to human impact have resulted in degradation and disappearance of native forests in the Chennai region. Most of the forest cover has been removed due to agricultural practices utilized on the site.

The required allocation to Open Space Reserve (OSR) is an opportunity to create an amenity for the project and its neighboring communities, as well as recreate the rich diversity of native forests.

The climate offers the opportunity to encourage and support a style of outdoor living typical to South India. By designing the master plan and the individual buildings for natural ventilation and daylighting, and for mitigating the more severe aspects of both the monsoon and dry seasons, energy demand can be dramatically reduced. From this, a modern, yet recognizable, architecture can flourish.

CHENNAI INDIA

Chennai, formerly known as Madas, is the capital city of the Federal State of Tamil Nadu. The fourth largest metropolitan city in India, the city is located on the Bay of Bengal and is the southeast corner of India's "Golden Quadrilateral" of major cities.

The city stretches 19 km (12 miles) along the Coromandel coast and extends inland about 9 km (6 miles). Situated on a low-lying strip of land, its highest point is only 60m (200ft) above sea level.

As of 2007, Chennai had an estimated metropolitan population of 7.5 million. With a population density in the metropolitan area of 5,922 per km² (2,287 mi²), it is one of the most densely populated cities in the world. As with other cities in India and the developing world, growth is very rapid. Chennai is expected to reach megacity status, with a projected population of over 10 million people, by 2025.

Served by an international airport and two major ports, Chennai is connected to the rest of the country by five national highways and two railway terminals. Each of the sides of the "Golden Quadrilateral" is undergoing a major upgrade to more contemporary road standards.

Chennai's economy has a broad industrial base, including automobile, information technology, manufacturing, healthcare, and financial services. Chennai is also the cultural capital of Tamil Nadu with film-making, dance and music among its many offerings.

The Golden Quadrilateral

Source: Google Earth

REGIONAL CONTEXT

Source: Adapted from Chennai Master Plan

The site is located at the western edge of the Chennai metropolitan region, about 25 km (16 mi) from the historic center. It is well served by the national, regional and metropolitan road network. National Highway (NH) 4, which connects Chennai to Bangalore and to points further west is nearby. The Tiruvallur High Road is located to the north. The metropolitan ring road, which is currently under construction, is located about 1.5 km (1 mi) away.

The Chennai International Airport is located 7 km (4.3 mi) south of Chennai and is slated for a significant expansion and upgrade. A proposed new international airport is in the early planning stages in the Tiruvallur district to the west.

In contrast to the motor and air transport situation, the site is not well served by existing commuter rail and transit corridors. A single bus route utilizes NH 4. There are no plans at this time to serve this sector of the region by rail or bus rapid transit.

Major challenges facing the Chennai metropolitan area are typical of cities undergoing rapid urbanization:

- Water quality and supply
- Traffic congestion
- Air quality
- Lack of open space

NATIONAL HIGHWAY
OUTER RING ROAD
ARTERIAL ROADS
PLANNED ARTERIAL ROADS
SUB-ARTERIAL ROAD
SUBURBAN RAILWAY
RAPID TRANSIT (MRTS)
RAPID TRANSIT PLANNED (MRTS)
IT CORRIDOR
CHENNAI CITY
CHENNAI METROPOLITAN AREA

0m 500m

DISTRICT CONTEXT

The site is located in an established and expanding development corridor, where greenfield development is displacing existing agricultural and light industrial uses. International corporations such as Hyundai have recently constructed manufacturing facilities. Further development of this type is anticipated and actively sought by the state government. A number of private colleges, technical institutes and schools have nearby campuses.

Site characteristics:

- 146.2 acres
- Irregular shaped, particularly at the edges
- Generally flat with few trees
- Tapers toward the south
- Existing dug wells on site
- Slightly higher elevation in northern section
- Former rice paddy, currently used as pasture

TOWNS / VILLAGES
SITE
NH-4 CORRIDOR
RAIL
MAJOR INDUSTRY
SCHOOLS / COLLEGES
WATER BODIES

0 km 5 km

Source: Google Earth

SITE AERIAL

Source: Google Earth

1. Looking North

2. Looking Northwest

3. Looking South

Source: TSI

1. Thurumazhisai Village

2. SIDCO Industrial Estate

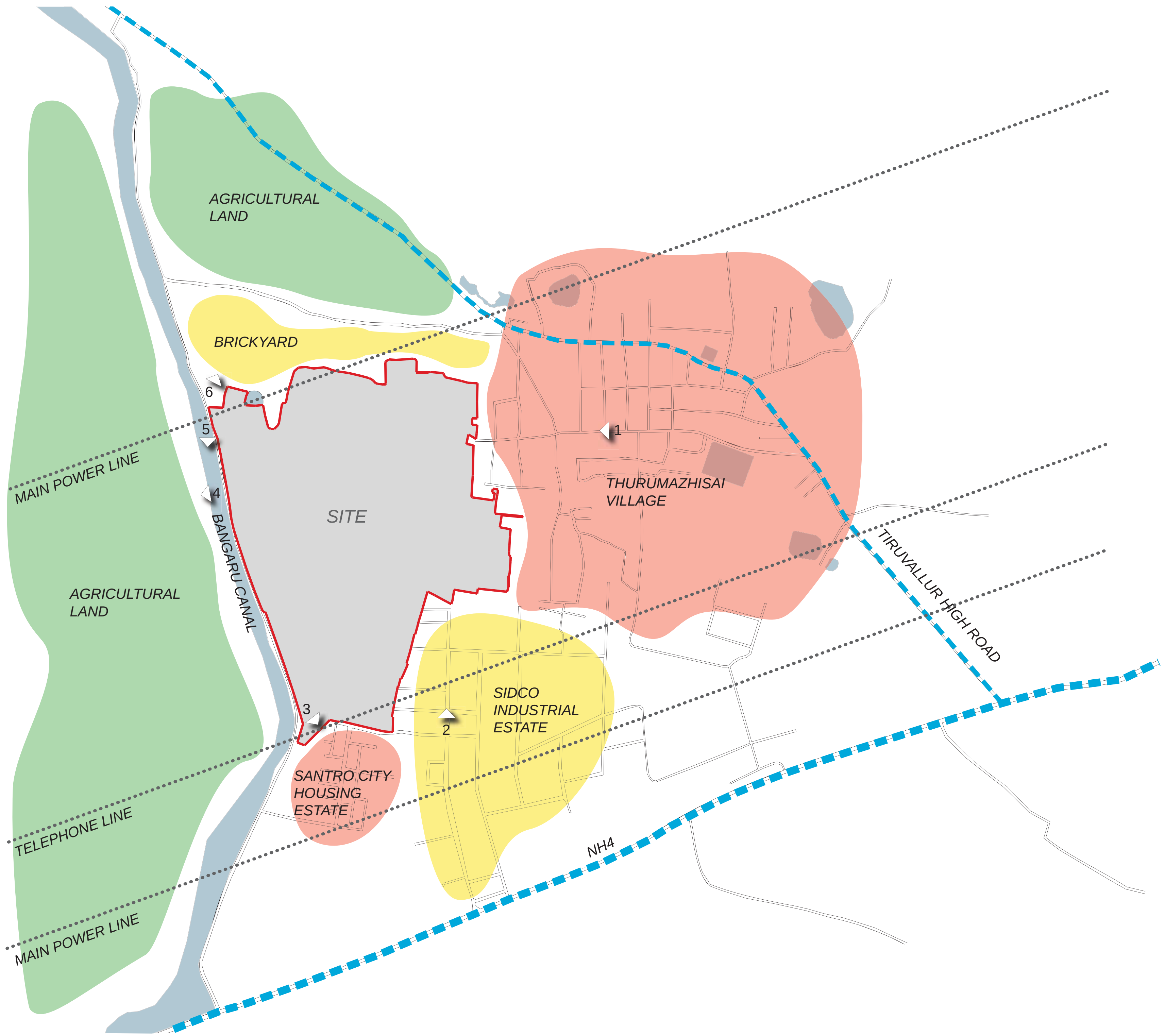
3. Santro City Housing Estate

4. Agricultural Land

5. Bangaru Canal

6. Brickyard

Source: Krueck & Sexton Architects



LAND USE AND ZONING

Neighbors

A variety of land uses directly abut the site. These include a traditional Indian agricultural village, a housing estate of small private homes, brick pits and kilns, and SIDCO, a state-owned, light industrial park. High-tension power lines cross the northern edges of the site and are also visible on adjacent properties to the south.

The character of these neighboring built-up areas, while small in scale (one and two stories), does not present favorable views from the site. However, the agricultural land to the west, which is currently under rice cultivation, offers attractive and sweeping vistas.

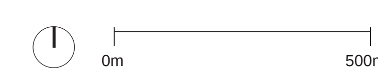
The Bangaru Canal, with its bund road built on a raised levee, is a diversion channel owned and operated by the Public Works Department and clearly defines the western site edge. Canal water level varies considerably, depending on regional flood control needs and ground water height. With improvement of the canal edge and bund road, this element could be a visual landscape asset for the project site.

Site Access

Access to the site is difficult, as it does not have a significant frontage on any major public road. Substantial improvement to the existing roads, in consort with the construction of new roads, is required to provide access to support the project.

Zoning

The site is zoned for residential development. Maximum building height, under the regulation of the Second Chennai Master Plan, is 27 m, assuming a minimum 18m bund road right-of-way. An FAR of 1.5 is available.

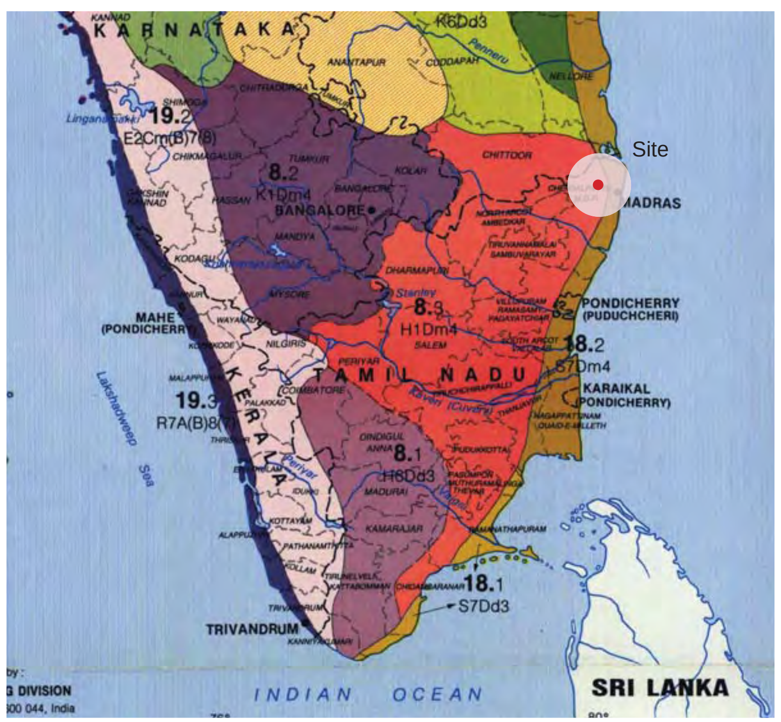


Regional Geology

Chennai is located within the North Tamil Nadu Coastal Plains which are characterized by very deep, cracking clay soils on nearly level, slightly eroded tank-irrigated lands. The Coastal Plains that constitute alluvium deposits are generally considered young in terms of geologic time. The geological formations are characterized by sand, silt, clay, gravel, and other matter deposited by flowing water. Sandstone and siltstone under clayey sand and clay deposits signify presence of good aquifers.

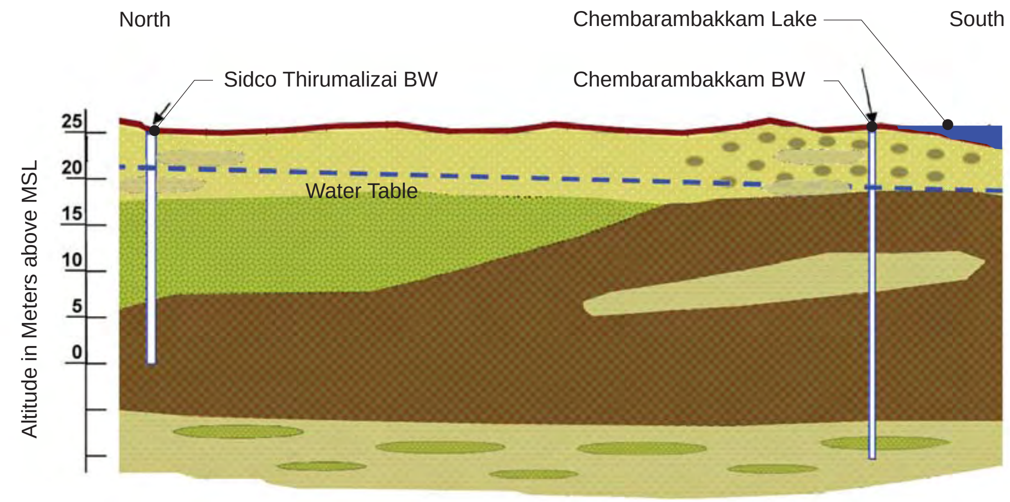
- Occurrence of clayey sand and clay followed by clayey siltstone and shale are indicators of aquifers that may not yield good quality groundwater.

The site is located along the transition between the North Tamil Nadu Coastal Plains and the Tamil Nadu Uplands, with physiographic conditions more closely resembling those found on the Tamil Nadu Coastal Plains.



Source: Tamilnadu Water Supply and Drainage Board

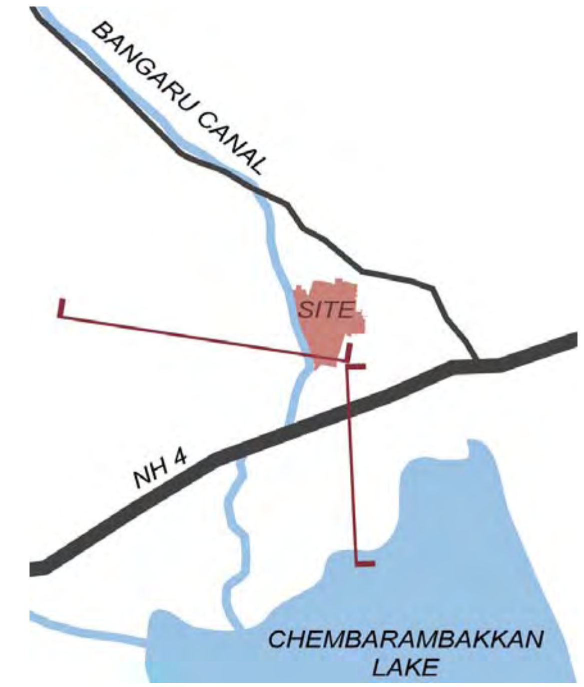
Tamil Nadu Uplands and Plains
North Tamil Nadu Plains (Coastal)
Site



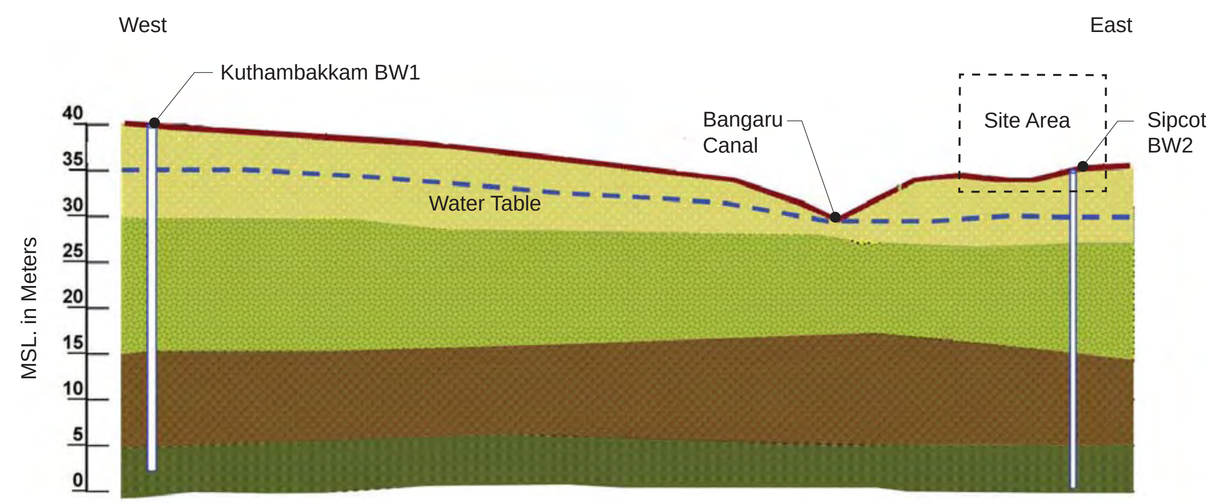
Source: Hydrogeological report by M/S Scientific Ground Water Services

Top soil and silt
Clay
Sand
Sandstone
Laterite, Gravel and Clay
Clayey siltstone and shale

N-S Geological Cross Section between Thinumazhisai and Chembarambakkam



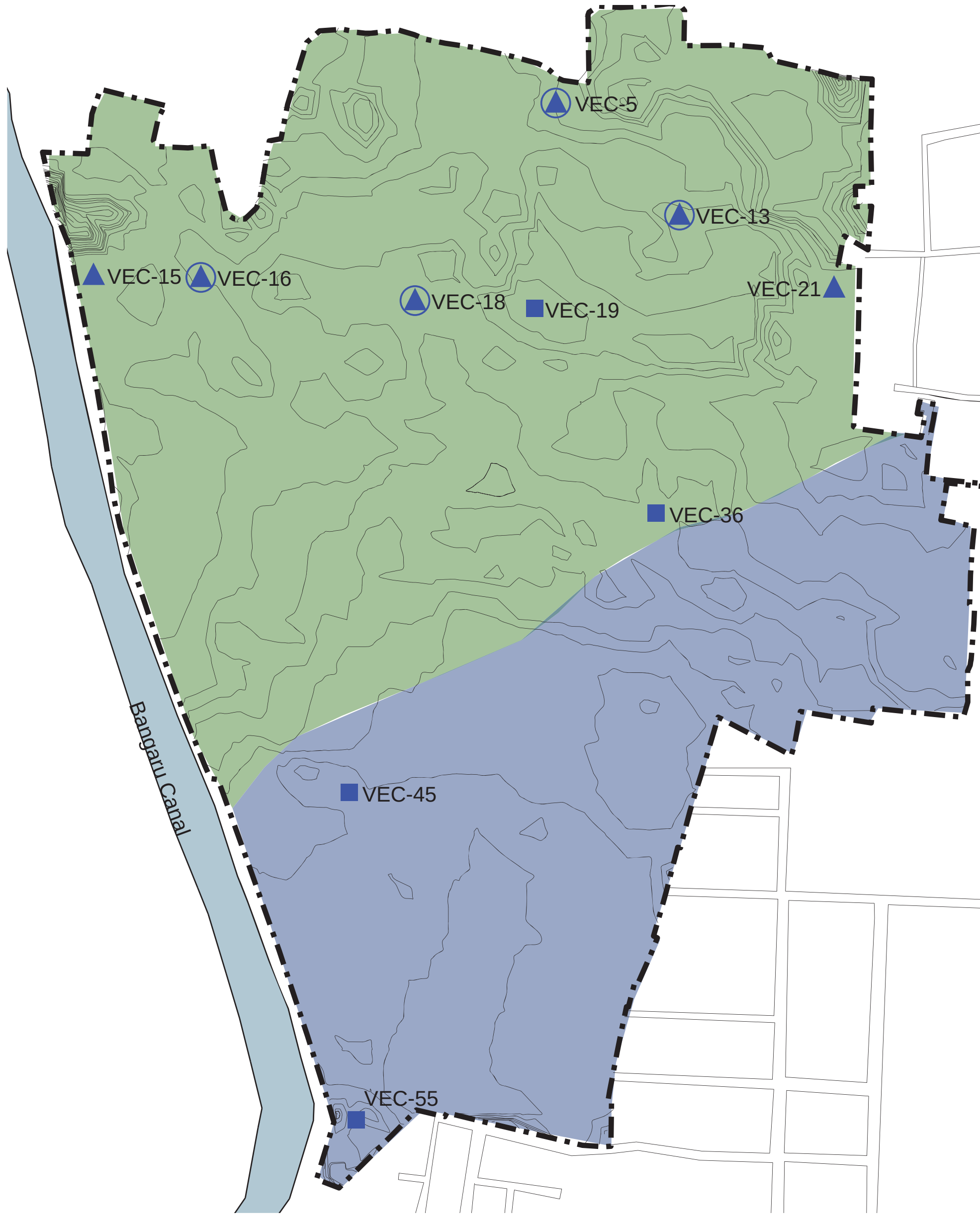
Key Plan



Source: Hydrogeological report by M/S Scientific Ground Water Services

Top soil silt and fine sand
Medium and coarse grained sand
Sandstone and siltstone
Clay and shale

E-W Geological Cross Section between Thirumazhisai and Kuthambakkam

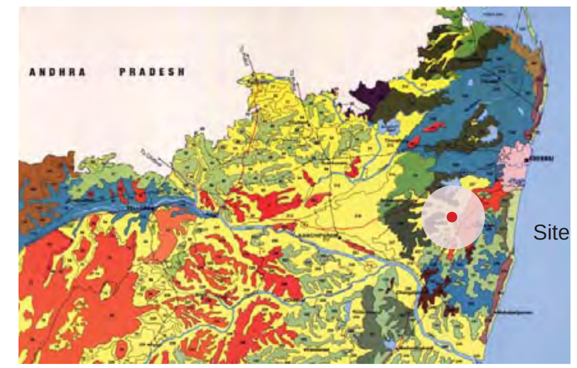


Source: Hydrogeological report by M/S Scientific Ground Water Services

- Top Soil followed by Sand, Clayey Sand, Sand Stone and Shale
- Top Soil followed by Clay, Siltstone and Shale
- Recommeded VEC Locations for Borewells
- Favorable VEC Locations for Borewells
- VEC Locations

0m 350m

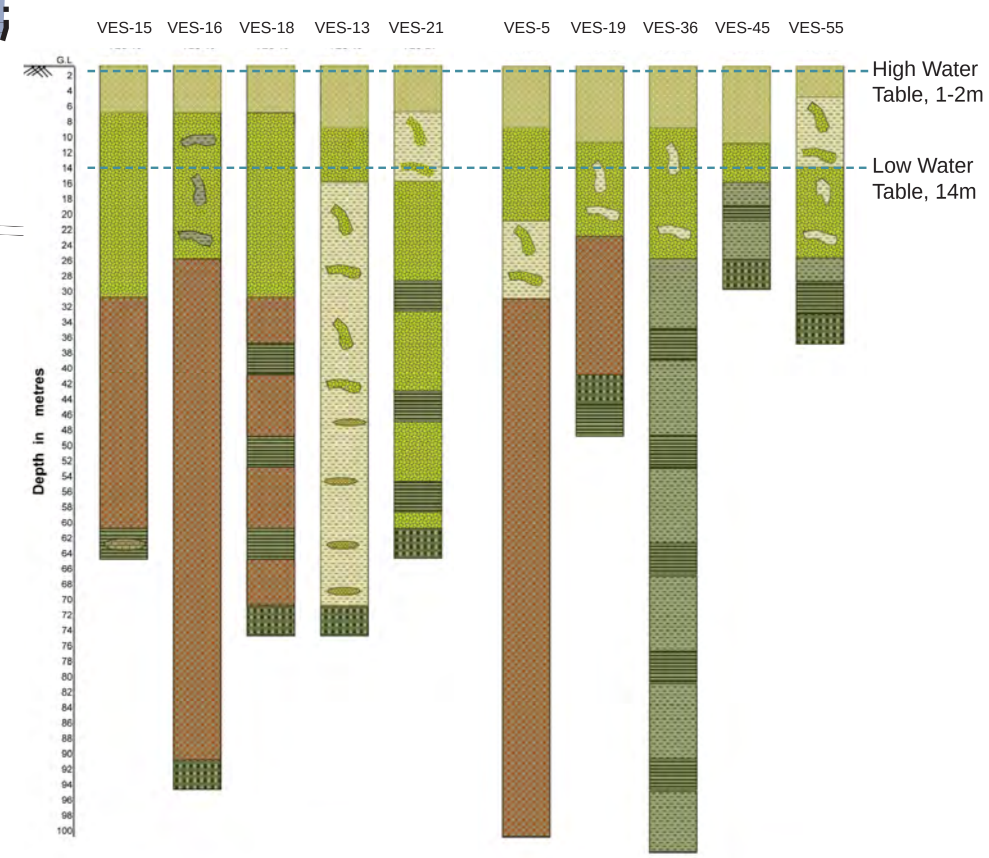
Geological Map of Site



Source: National Bureau of Soil Survey and Land Use Planning

- Alluvial (Coastal)
- Site

Regional Soil Classification



Source: Hydrogeological report by M/S Scientific Ground Water Services

Cross Section along EW from Inferred Lithology

Cross Section along NS from Inferred Lithology

Regional Soil Classification

Alluvial (Coastal) Soils consists of deep (>100 cm), clayey and cracking Coastal and Deltaic alluvium-derived soils with high available water capacity (150-200 mm) and a growing period of 120-150 days.

Site Soil Characteristics

The northern site area is overlain by sandy loam soils while the southern area has soils with high clay content. Clayey soils expand and contract depending on moisture levels. Therefore, during the monsoon seasons, clay expansion effectively seals the ground surface resulting in high levels of runoff. This prevents infiltration and recharge of the aquifer. The water table currently fluctuates between approximately 1 and 4 meters below the surface during monsoon seasons and between 6 and 8 meters during summer months.

- Soil conditions combined with groundwater levels result in water logging in the southern portions of the site.

Due to sub-surface conditions, two types of foundation systems are recommended for all structures:

- Regular piles at 10 m
- Under-reamed piles at 4.2 m

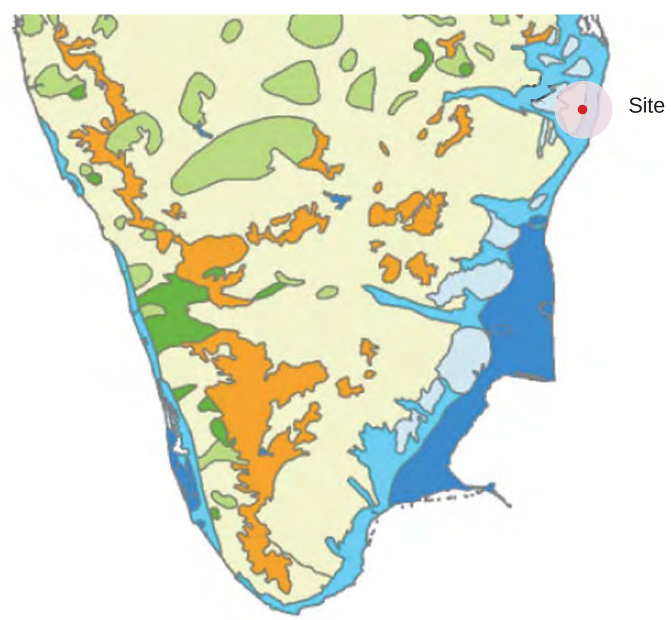
- Top Soil and Silt
- Sand
- Sandstone
- Clay and Shale
- Sand and lenses of sandy clay
- Sandstone and siltstone clayey
- Clayeysand and siltstone
- Sand Clayey siltstone

Regional Hydrogeology

The Chennai region is characterized by rivers, canals and numerous tanks, the closest of which is the Chembarambakkan Lake located directly south of the site.

It is covered by alluvial sediments of river basins, coastal and deltaic tracts that constitute the unconsolidated formations. These are by far the most significant ground water reservoirs. Although the method of development of ground water is primarily through dug wells, borewells and cavity wells, thousands of tube wells have been constructed during last few decades.

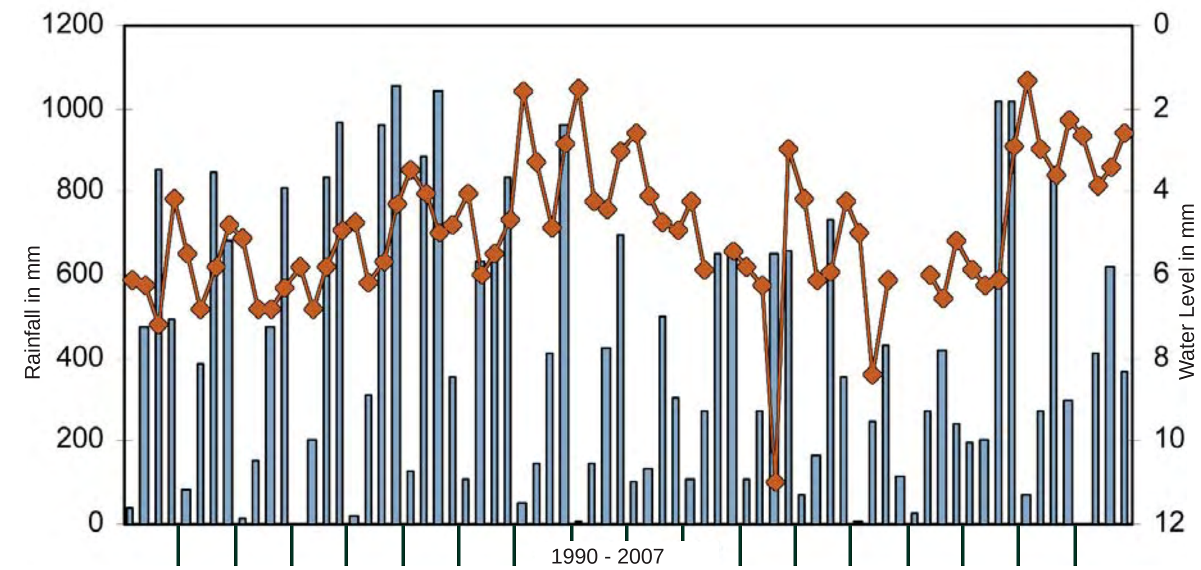
- A significant portion of the project's district is in the "Dark Category" for groundwater development; indicating overdraw can result in saltwater intrusion into the freshwater aquifers



Source: Central Ground Water Board - Ministry of Water Resources - Government of India

- >40 Unconsolidated Formations
- 25-40 Unconsolidated Formations
- 10-25 Unconsolidated Formations
- <10 Unconsolidated Formations
- 1-25 Consolidated / Semi-Consolidated Formations
- 1-10 Consolidated / Semi-Consolidated Formations
- 1-5 Consolidated / Semi-Consolidated Formations
- Hilly Areas

Ground Water Potential

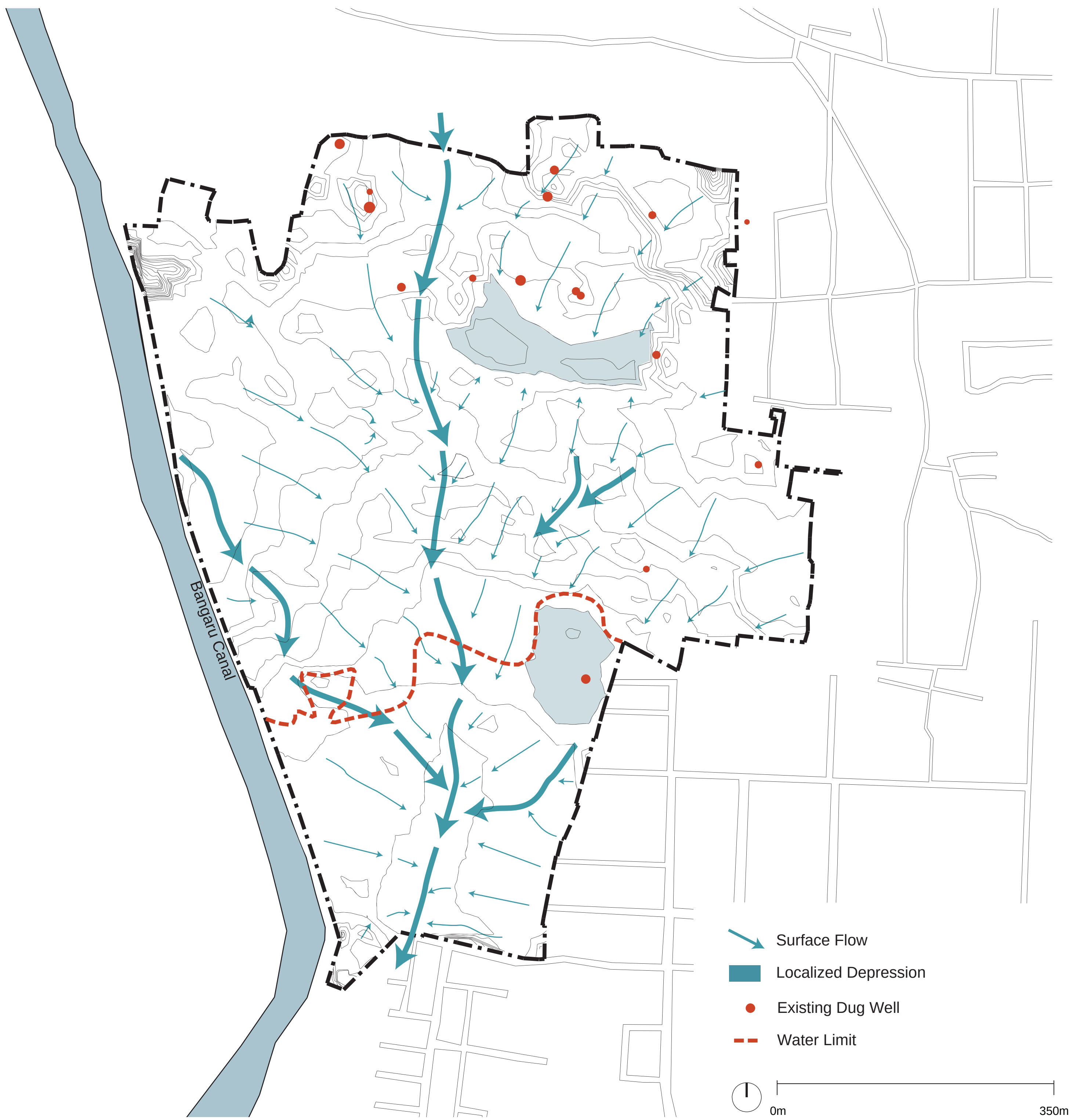


Source: Hydrogeological report by M/S Scinetific Ground Water Services

Water Level vs Rainfall

Local Water Resources

WATERSHEDS & SURFACE HYDROLOGY



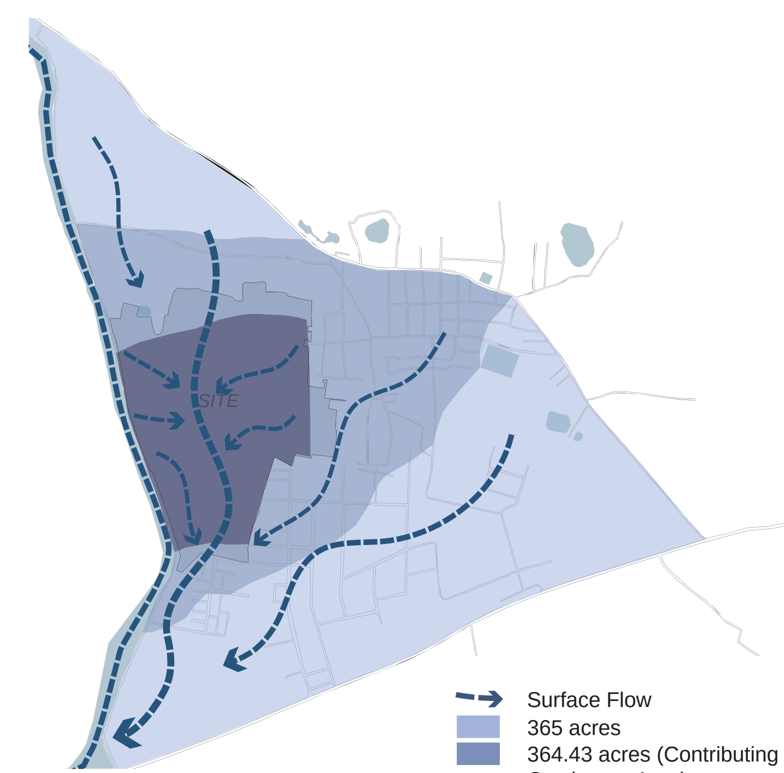
Site Hydrology

The site is in the contributing watershed of Chembarambakkan Lake, which is one of the drinking water resources for Chennai. Any development within this watershed can impact water quality and quantity of the lake. The Bangaru Canal forms the western boundary of the site and connects the Coovum River to Chembarambakkan Lake. NH4 acts as a dam. Low clearance at the NH4 bridge prevents free flow of water from the Bangaru Canal into the lake. The culvert under the existing bund road also acts as a bottleneck. High water levels of the lake have resulted in water back-up in areas south of the site.

- The proposed bund elevation has implications on the drainage and surface flow planning of the site.

The site itself is flat. Elevation ranges between 25m and 28m above mean sea level. There is a slight slope down from the northwest to the southeast and there are also several depressions resulting in the pooling of water during monsoons.

- The flat topography of the site can be a challenge to maintaining surface stormwater flows.



Source: TCE Consulting Engineers Limited, Mumbai

Contributing Watershed

Ecoregion Analysis

The site is located within the Tropical Dry Evergreen ecoregion. This ecosystem has a unique physiognomy in which the forest stays green during the dry periods between the seasonal monsoons. Human impact has taken a heavy toll on the natural habitat of this ecoregion, and more than 95 percent of the ecoregion has been deforested. The remaining forests are scattered, small fragments which are often associated with sacred groves. The majority of the canopy-forming trees have disappeared leaving behind a low forest of tropical dry evergreen scrub.

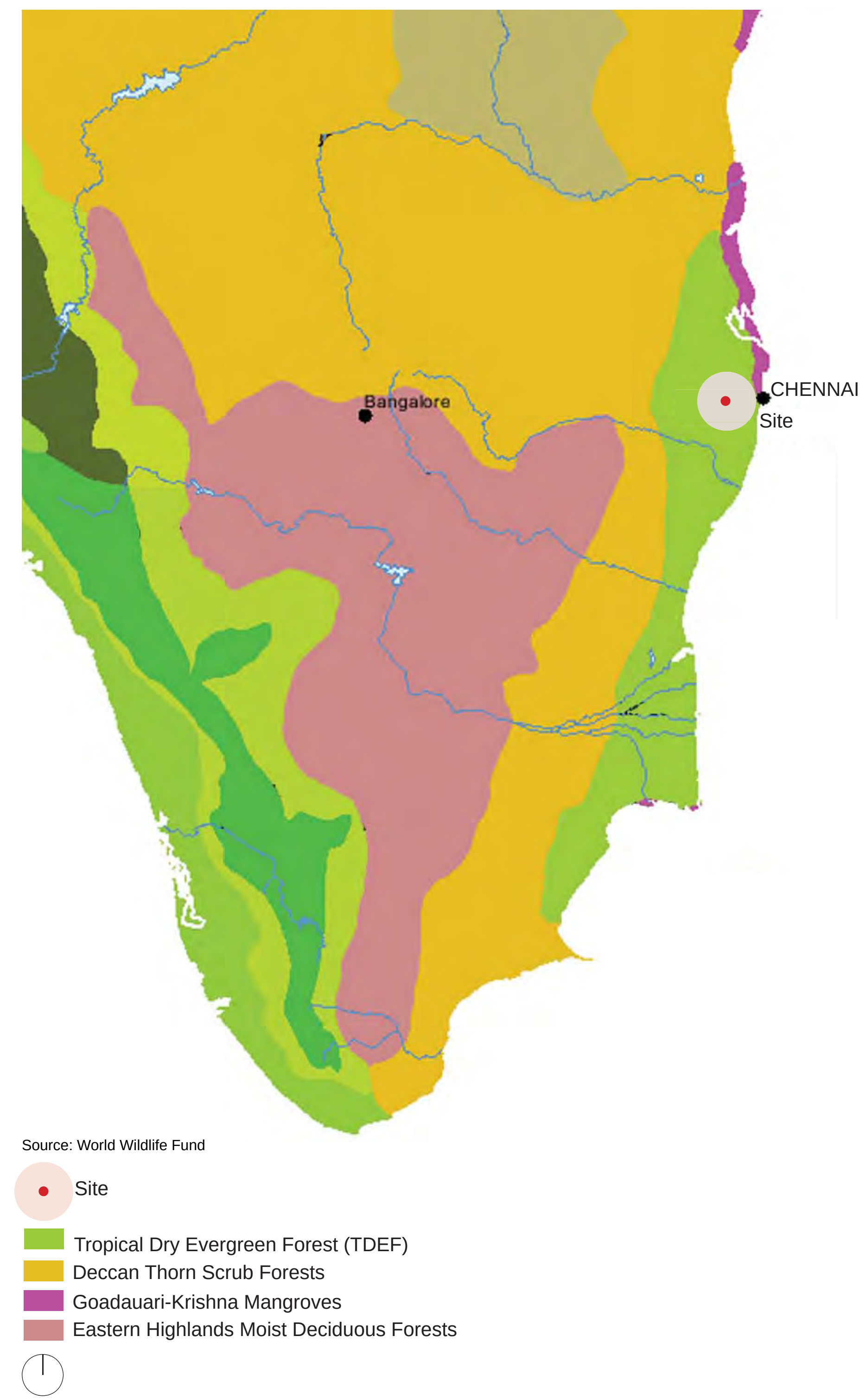
Historically, tropical dry evergreen forests have been extensively harvested for firewood, fodder, medicinal plants, and timber. However, research indicates that dry tropical forests return to their original pre-disturbance condition faster that other tropical forests.

- Regeneration of native forests can have immense benefits for preserving the diversity of species,and timber sources for future generations.

Existing Site Vegetation

The site was historically utilized for agriculture, and currently consists of a vacant field with non-native tree species lining it's perimeter. Seasonal wet depressions supporting vegetation is indicative of the permanent water logged conditions on the site. Water availability and the climatic conditions in the region can support a healthy Tropical Dry Evergreen plant community found in the ecoregion.

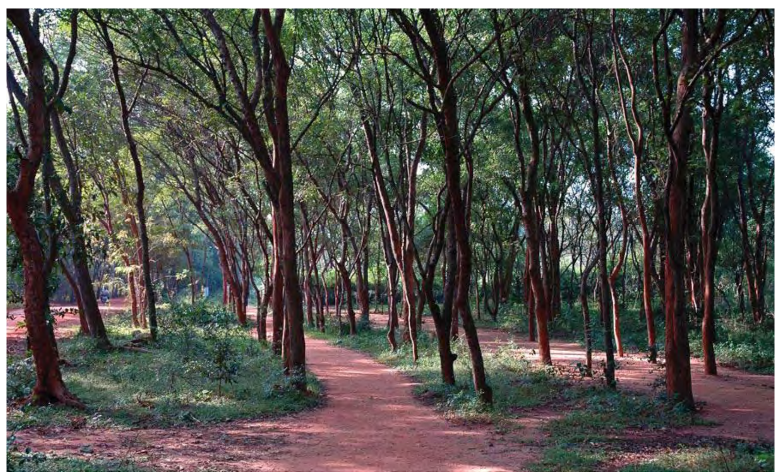
- Diospyros ferrea
- Ziziphus glaberrima
- Calliea cinerea
- Catunaregam spinosa
- Carissa spinarum
- Albiziz amara
- Buchanania lanzan
- Dodonaea viscosa



Ecoregion Map

Existing Site Conditions

Source: Krueck & Sexton Architects



Native Tropical Dry Evergreen Forest Source: http://www.andaman.com

Threats

Like most of the other ecoregions in the Indian Subcontinent, this ecoregion is also subjected to heavy deforestation and grazing pressure from domestic livestock. The stunted scrub vegetation present throughout most of the ecoregion is indicative of many years of grazing practices.

The remnant sal (Shorea robusta) forests are being rapidly lost to podu, or shifting cultivation. Invasion by Prosopsis, a thorny exotic plant that is unpalatable to domestic livestock, is being used extensively in reforestation programs, and will certainly usurp the preferred habitat of the Jerdon's courser (Rawat and Babu 1995).

Rapid Economic Growth, Voracious Energy Demand

As India's economy continues to grow at astonishing rates, so does its demand for energy. Currently the world's fifth biggest energy consumer, India is projected to surpass Japan and Russia to take third place by 2030, behind China and the U.S. Per capita energy consumption rates remain low at 553 kWh per capita, but demand is growing as incomes and living standards rise.

Energy and Carbon

More than half of India's total energy needs and around 70% of India's electricity generation is fueled by coal. Large-scale 'clean' energy alternatives face serious issues. India's civilian nuclear program has regularly fallen behind schedule, and large-scale development of hydroelectric facilities has been stymied by environmental and social concerns. Development of renewable energy sources has progressed, but their use is currently limited. India is firmly on a path to increasing fossil fuel dependency and, hence, increasing carbon emissions.

India Climate Change Impacts

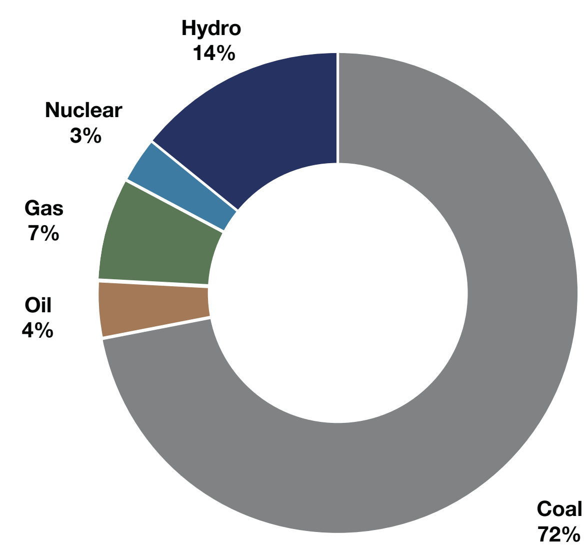
Various climate change studies conducted on India predict that mean temperatures will rise significantly: winter temperatures by as much as 3.2°C (5.8°F) in the 2050's and 4.5°C (8.1°F) by the 2080's; summer temperatures by 2.2°C (4.0°F) in the 2050's and 3.2°C (5.8°F) in the 2080's. Research also indicates India will experience an overall decline in summer rainfall by the 2050's, with a potential increase in extreme monsoon events.

It is expected that climate change will represent an additional stress on ecological and socioeconomic systems already facing tremendous pressures due to rapid urbanization, industrialization and economic growth. Water resource problems in arid and semi-arid regions, shortening of the crop cycle and flooding of deltas and low-lying areas are clear threats. Extreme temperatures and heat spells are common in certain areas, often causing loss of human life. These events are expected to worsen.

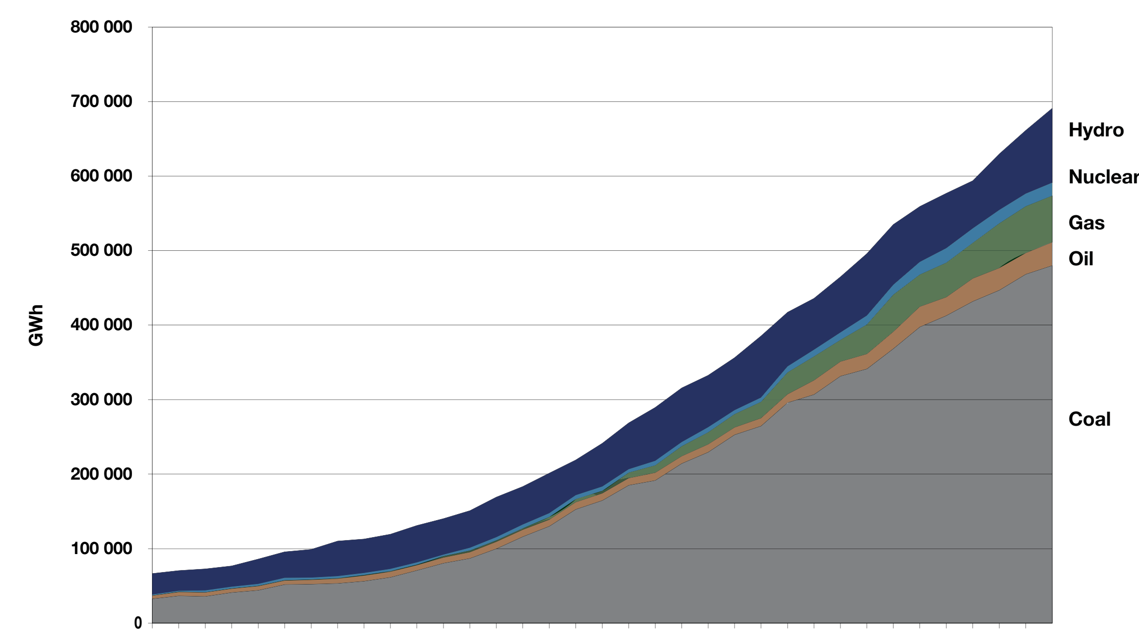
Chennai Climate Change Considerations

Tamil Nadu is considered one of the states in India more vulnerable to potential climate change impacts due to:

- Capacity of existing drainage and potable water systems, in the context of rising sea levels and changes in rainfall patterns
- Effects of heat waves on the populace and economy

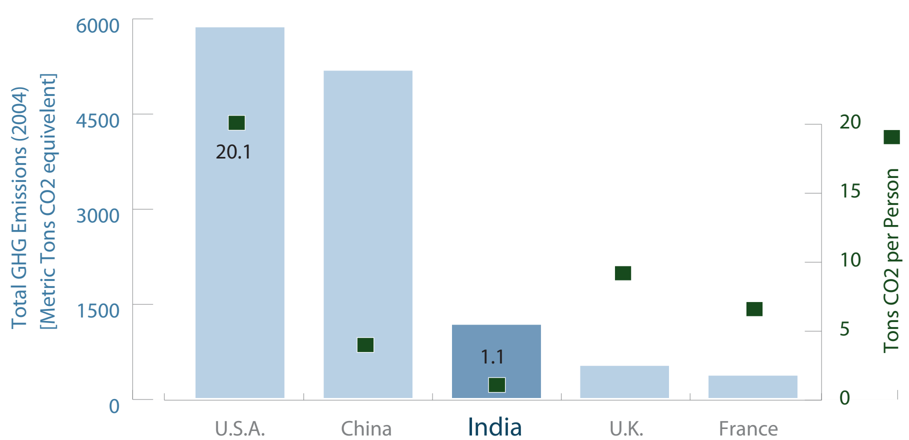


India Estimated Present Day Electricity Generation Breakdown



India Electricity Generation from 1971 to 2005



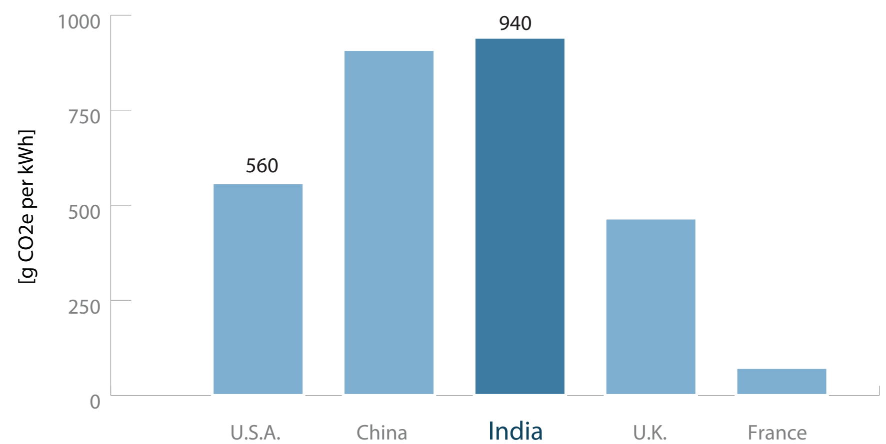



Greenhouse Gas Emissions

The amount of greenhouse gases emitted in particular countries or regions during a particular year can be measured by the overall total and as per capita emissions. The amount of total amount of emissions and by per capita are relatively low but are growing rapidly.

All emissions are expressed in CO^2e (or carbon) equivalents using 100 year global warming potentials found in the IPCC Second Assessment Report (1996).

India represents 5% of the world total greenhouse gas emissions, while the US and China combine for nearly 40%.



Carbon Intensity of Electricity Production

Carbon intensity of electricity production measures carbon emissions [grams] per unit of electricity (kWh) generated. The higher value indicates more fossil fuels are used for electricity generation and less of a renewable mix.

Climate Change Policy

India signed the United Nations Framework Convention on Climate change (UNFCCC) on June 10, 1992 and ratified it on November 1, 1993. It ratified the Kyoto Protocol in on August 26, 2002, but is not legally required to reduce emissions. The Indian government has also initiated the first national communication on sources of greenhouse gas emissions (NATCOM).

Decisions made by India will have an important impact on global climate change. India can set an example of rapid "climate-responsible" growth through commercially available technologies and a commitment to clean energy goals.

Energy Drivers

The energy policies of India are being forged by the following major issues:

- Continued rapid economic growth dependant on reliable energy
- Rising quality of life expectations, making affordable and adequate supply of electricity a necessity
- Limited domestic reserves of fossil fuels, and subsequently, the need to import fuels
- Serious indoor, urban and regional environmental impacts, necessitating demand reduction and cleaner energy solutions

Integrated Energy Policy

Lowering the energy intensity of GDP growth through higher energy efficiency is key to meeting India's energy challenge, ensuring its energy security and reducing future emissions. India's own energy strategy articulated in the Integrated Energy Policy report (2006) and 11th 5-year plan seeks to slow the growth of emissions and at the same time provide access to electricity to the rural poor by augmenting clean and efficient supply of energy, increasing end-use energy efficiency, deepening sectorial reforms and protecting the environment.

Energy Conservation Policy

The Energy Conservation Act 2001 was passed by the Indian Parliament in September 2001 confirming energy conservation as a major policy objective. The Bureau of Energy Efficiency was created to implement the provisions of the Act. As a result, new buildings must follow the Energy Conservation Building Code launched on 28 June 2007.

Energy Conservation Building Code (ECBC)

This code is mandatory for commercial buildings or building complexes in India that have a connected load of 500 kW or greater or a contract demand of 600 kVA or greater. The code is also applicable to all buildings with a conditioned floor area of 1,000 m^2 (10,000 ft^2) or greater. Energy models indicate that ECBC-compliant buildings use 40 to 60% less energy than similar baseline buildings.

Rainfall

Average annual rainfall for Chennai is about 1,300 mm (51 in). The city receives most of its seasonal rainfall from the north-east monsoon, from mid-September to mid-December. January through June are relatively dry months with average monthly rains of less than 100mm (4 in).

Average monthly and annual rainfall patterns are indicated in the adjacent figures. The highest annual rainfall recorded was 2,570 mm (101 in) in 2005.

Site Challenges

The pattern of heavy rainfall during the monsoon period and little rain in other months present particular challenges for the site:

- Stormwater management must respond to intense peak rainfall events of the monsoon
- Maximizing the retention and reuse of rainwater is a priority

Strategies such as rainwater harvesting must be understood in the context of a limited supply capacity during the dry season, when water is at a premium

Chennai Climate Change Impacts

In 2005, heavy rainfall of 420 mm in just 40 hours resulted in the shift of 50,000 people in Chennai to relief centers and the shut-down of the international airport.

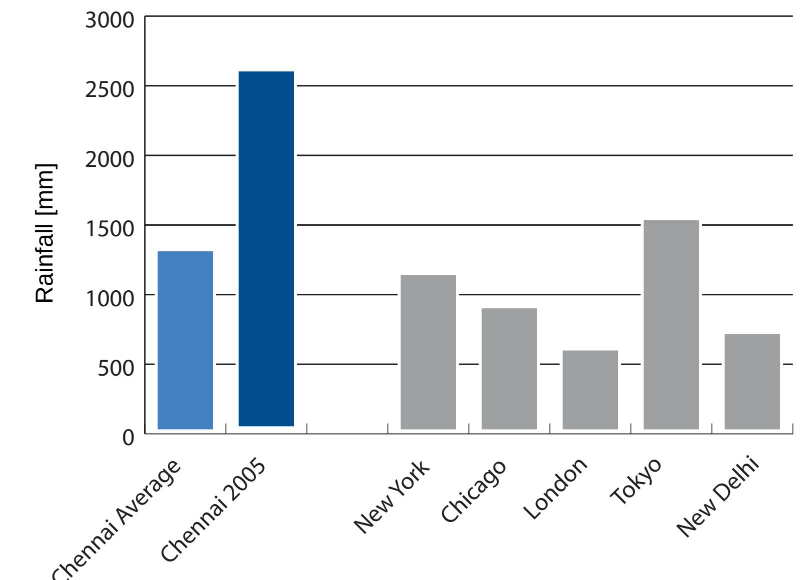
Unfortunately, this magnitude of rainfall event may become more common. Climate change models predict a large-scale increase in monsoon rainfall and cyclonic storms with substantial spatial differences and increases in extreme events. At the same time periods of drought in the dry season are expected to increase in frequency. This reinforces the need to prioritize effective stormwater management and water conservation and reuse strategies.

Design Storm Event

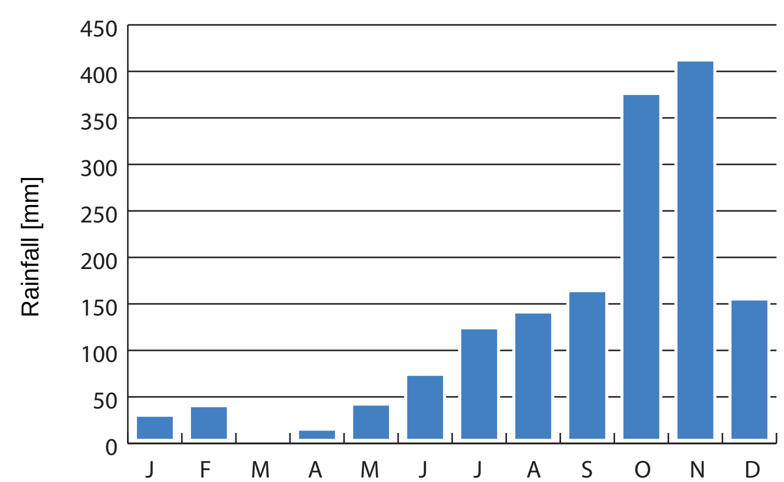
Due to the increasing magnitude of storm events and anticipated impacts of climate change, a conservative design storm event is utilized:

- 80 mm/hr peak storm intensity rain event. This is 14% above the maximum peak intensity of the 2005 monsoon at 70mm/hr and 20% above the normal peak intensity.

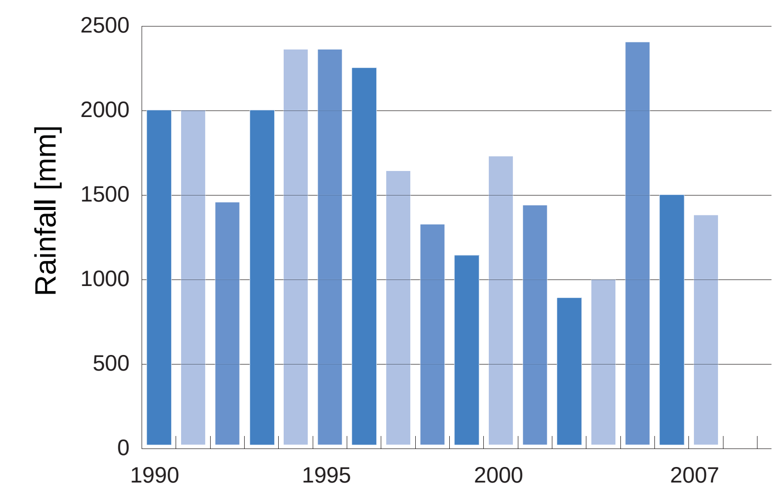


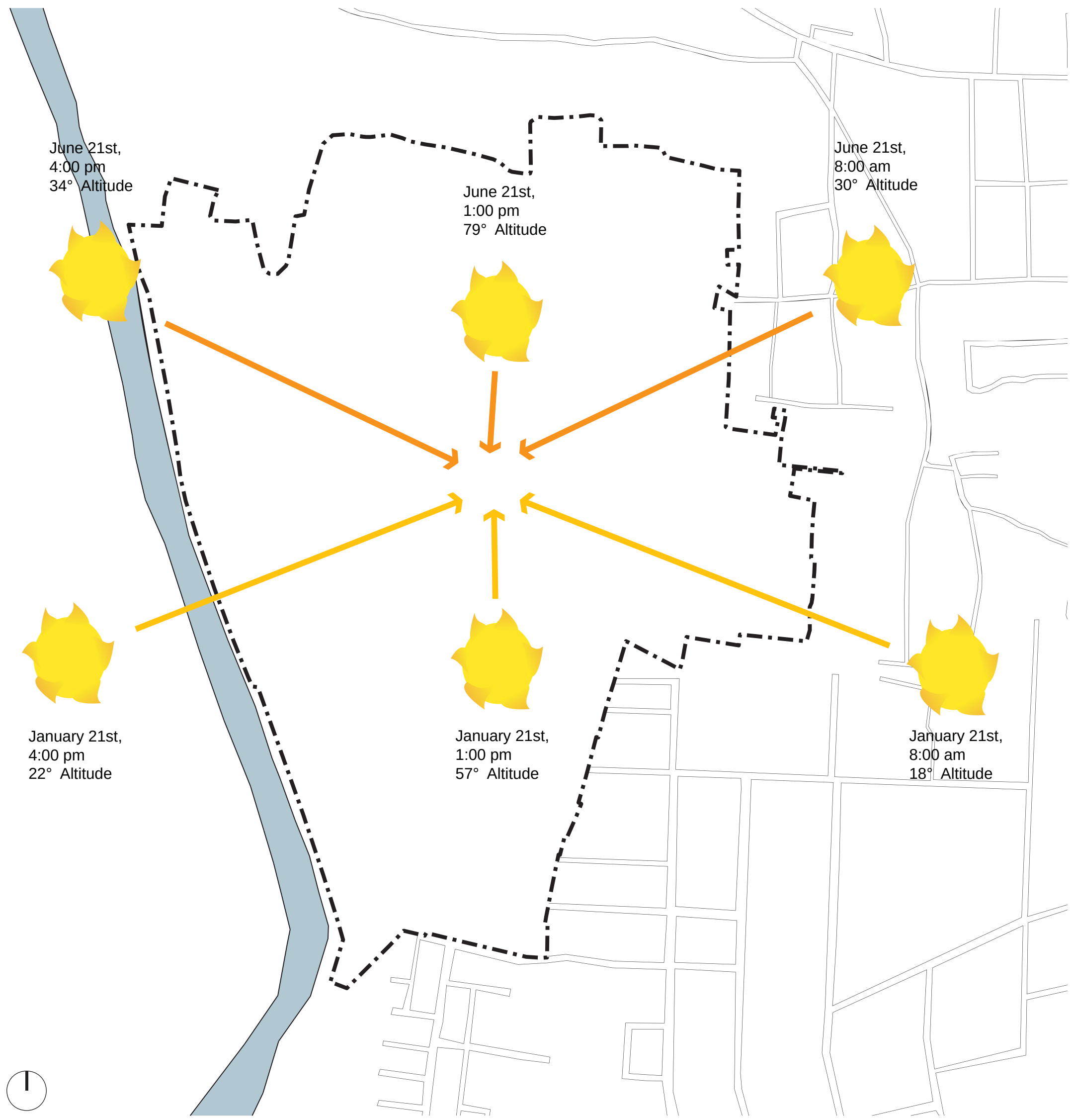
Average Annual Rainfall Comparison



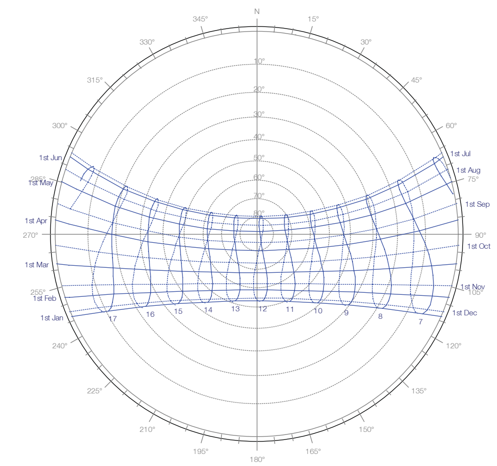
Average Rainfall by Month [mm]



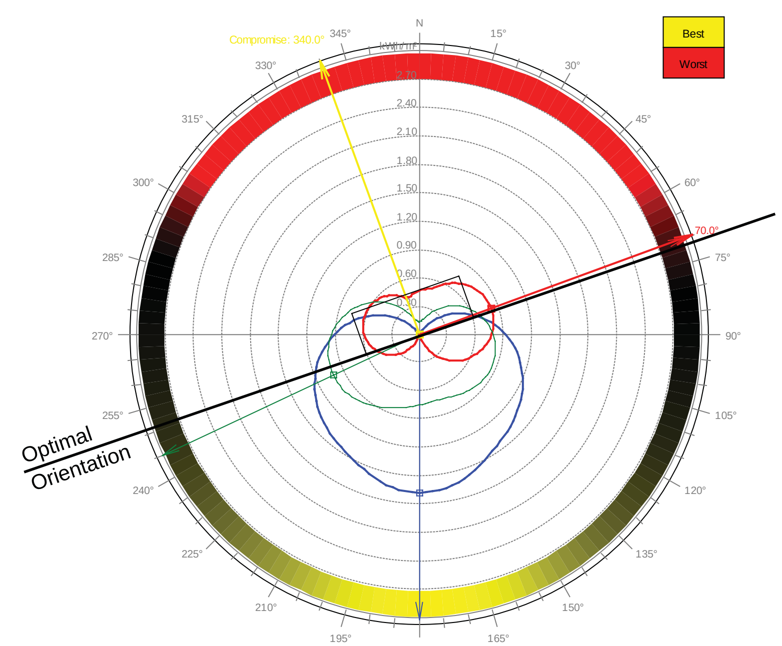
Historical Annual Rainfall



Site Solar Map Source: Buro Happold



Sun Path Diagram Source: Buro Happold



Location: Chennai-Madras, IND
Orientation based on average daily incident radiation on a vertical surface.
Underheated Stress: 0.0
Overheated Stress: 1681.7
Compromise: 340.0°
© Weather Tool

Avg. Daily Radiation at -19.0°
Entire Year: 0.20 kWh/m²
Underheated: 0.00 kWh/m²
Overheated: 0.42 kWh/m²

Annual Average
Underheated Period
Overheated Period

Optimum Orientation Diagram Source: Buro Happold

Temperatures

For the majority of the year, the climate in Chennai is hot and humid. The combination of the position of Chennai on the thermal equator and on the coast prevents any extreme variations in seasonal temperature. Late May through early June is the hottest period of the year; maximum temperatures are between 38–42 °C (100–107 °F). The coolest part of the year is January, with minimum temperatures of around 19–20 °C (66–68 °F).

Building Orientation

The orientation of buildings will have a significant impact on the thermal comfort of the occupants, as well as the energy performance of the buildings. Orientation is the first step in providing the most effective passive solutions. In addition, proper design of shades, overhangs, plantings, and structure will need to be considered at a building and landscape design level.

Chennai is located at 12.6 degrees North latitude; consequently, the majority of the sun will hit the buildings from very high angles—almost directly overhead.

In summer, the hottest sun hits the site from the north and, in the swing seasons, from directly overhead and from the south. These high solar angles are easy to shade with simple horizontal shades

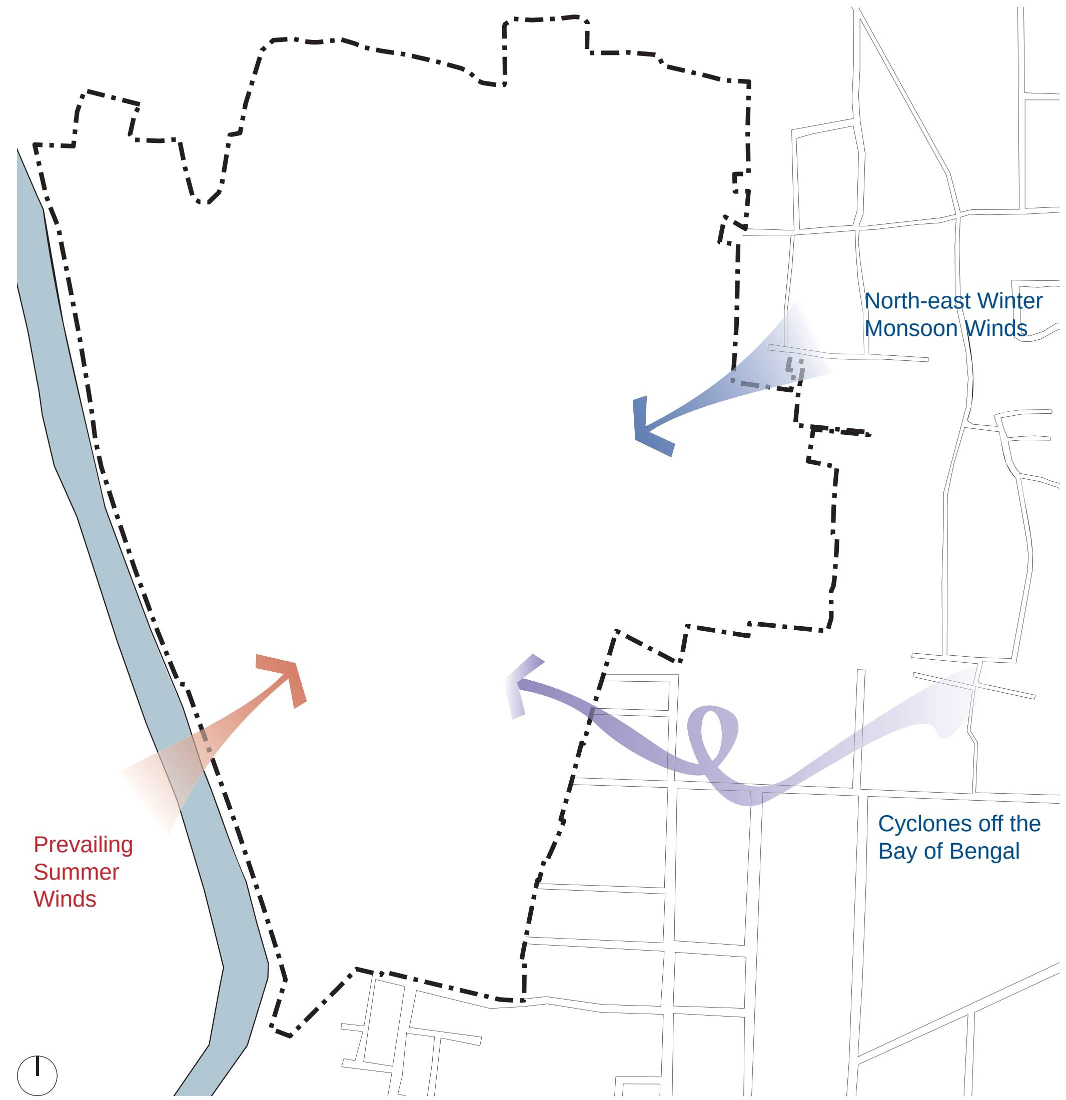
The lower eastern and western sun angles will provide the greatest challenge to shade while providing diffuse natural light for internal lighting. The morning eastern sun is much more pleasant, all year round, then the harsh, westerly afternoon sun.

Thermal inertia of buildings and hardscape will produce radiating heat in the afternoon, adding to the uncomfortable, intense afternoon sun.

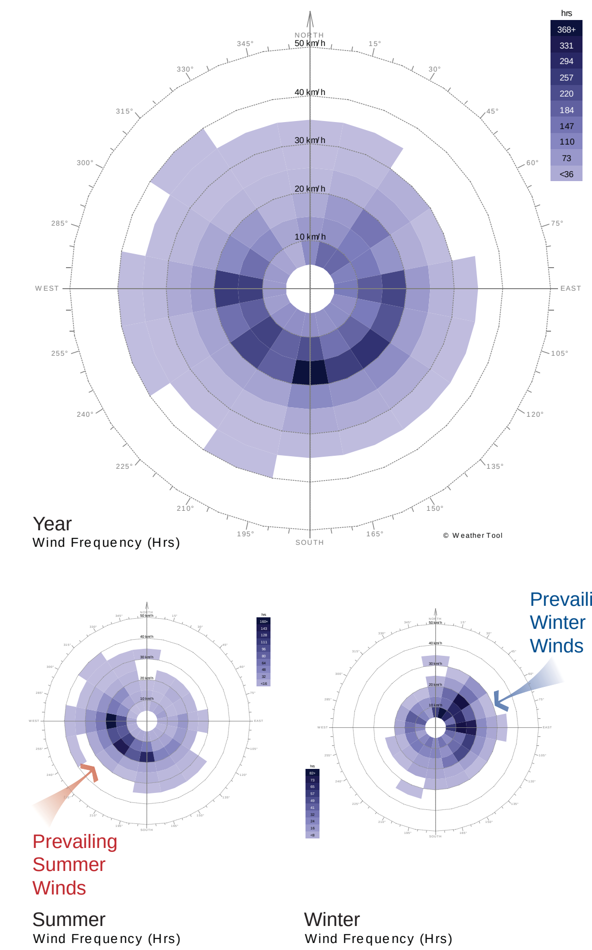
- Optimal orientation is a south facing structure which favors the east.

Wind
The prevailing winds in Chennai are the South-Westerly, between May and September, and the North-Easterly during the rest of the year. Cyclones in the Bay of Bengal occasionally strike the city with devastating effects.

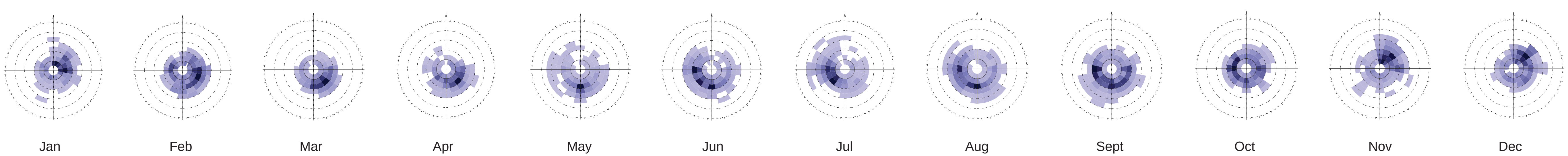
Site Concerns
The direction of prevailing winter and summer winds, plus the potential impact of cyclones, are highlighted in the adjacent figure. While the inland position of the site protects it to some extent from the cyclonic storms, high-speed winds are still likely to impact the site. Protection of the site and the prevention of wind tunnel formation between the buildings using planting and strategic building orientation; positioning and planting should be prioritized.

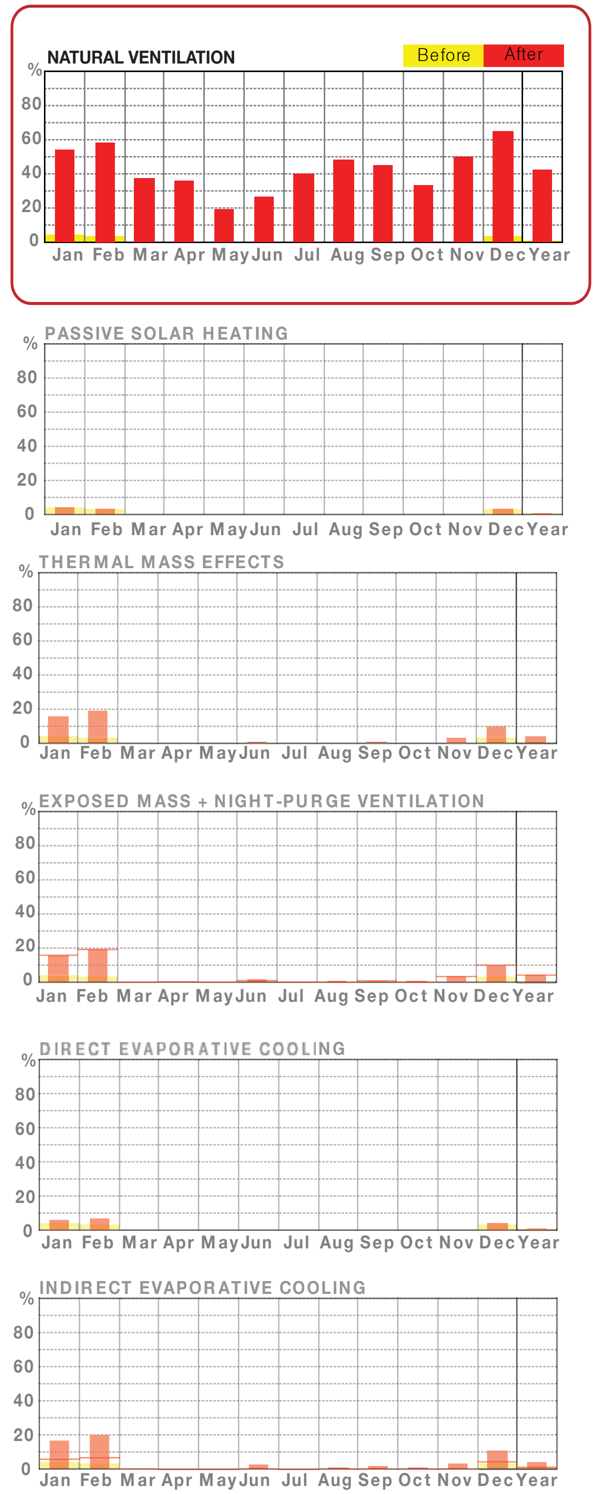


Site Wind Considerations

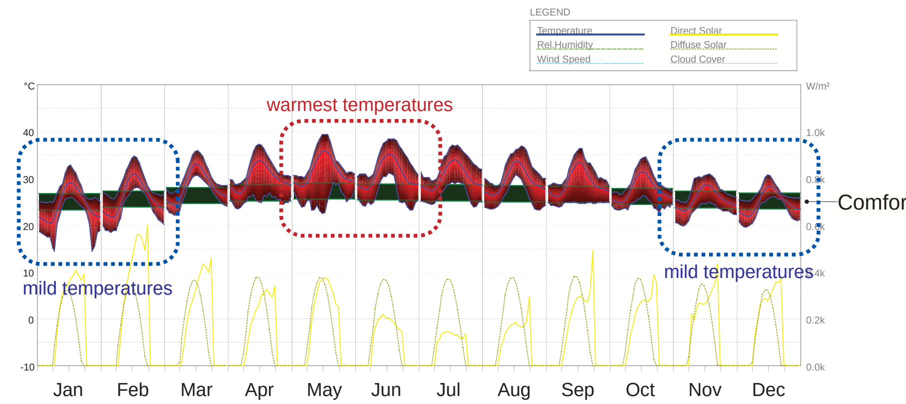


Wind Diagrams



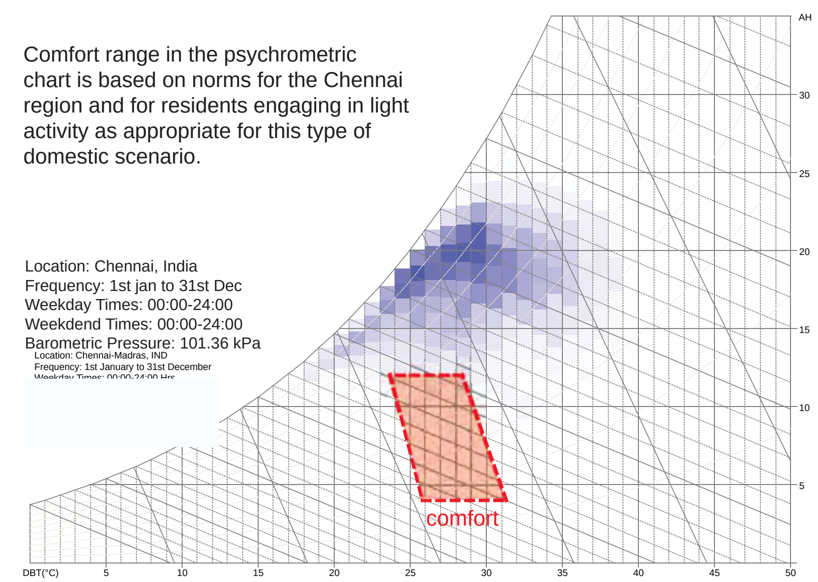


Passive Strategies: Comfort Percentage Improvement

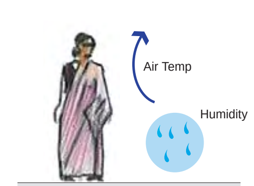


Monthly Dirunal Averages Source: Buro Happold

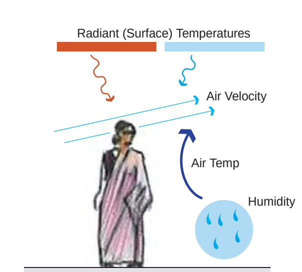
Comfort range in the psychrometric chart is based on norms for the Chennai region and for residents engaging in light activity as appropriate for this type of domestic scenario.



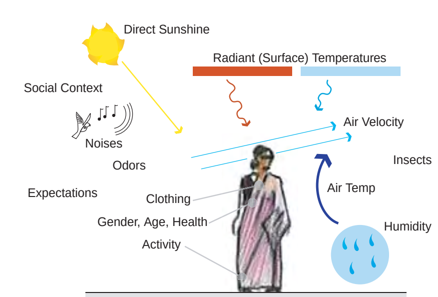
Psychometric Chart Source: Buro Happold



Perception of Comfort



Quantifiable Comfort Variables



Reality of Comfort - Total Environment

Chennai lies near the equator and is a coastal city. This prevents any extreme variation of season temperatures. For most of the year, the weather is hot and humid. May and June are the hottest months, with temperature around 38–42 °C (100–107 °F). November through February is milder, with January being the coolest month. Temperatures in January can reach as low as 9–20 °C (66–68 °F).

Passive Cooling Analysis

Analysis on a range of individual passive design strategies is shown on the left. The y-axis shows the percentage improvements in comfort level (percentage improvement in the time that conditions would be considered comfortable). The majority of strategies bring little additional benefit, largely due to the humid climate. For example, there are only a few days in which evaporative cooling is viable.

- Use of natural ventilation--the opening up of the building whenever overheating occurs to take advantage of cooling breezes--is the option that brings the greatest passive benefits.

External Thermal Comfort

The site, as well as localized wind conditions, will play an important role on the orientation of the buildings; however, these are secondary to solar conditions. Understanding the prevailing winds throughout the year, a site massing that provides turbulence, pressure differences and increased velocities will allow for optimization of naturally ventilation openings, exhausts and fresh air intake.

Other site conditions are important when investigating the orientation of the buildings. Both internal and external roads can incur noise from passing cars, as well as dust and debris, especially during the dry season. Occupants may find it difficult to manage these unfavorable conditions in naturally vented spaces which would tend to increase the use of mechanical cooling systems and, thus, energy use. Proper road, landscape and building designs can mitigate these effects and increase the likelihood that residents will use natural ventilation.

ARCHITECTURAL PROGRAM

TSI provided a program brief which is summarized in the adjacent table. Following a research and programming phase, the design team developed this brief, further adding population, parking, unit diversity, utilities and amenities information. The program is overwhelmingly residential in its area requirements and will be dependent upon off-site retail, schools, public safety and other uses.

The TSI development model requires one fully equipped Clubhouse for each unique residential type—Villa, Townhouse and Apartment. After benchmarking tours of other Indian residential developments and discussions with TSI, the design team developed a Clubhouse and site open space program, consisting of a variety of active and passive recreational uses.

The Second Chennai Master Plan, which will be applicable to the project, requires very high parking ratios by North American suburban standards. With input from TSI, these ratios have been reduced to 1 space per 100 m^2 of residential area per unit. Further reductions of parking counts consistent with marketing objectives are recommended.

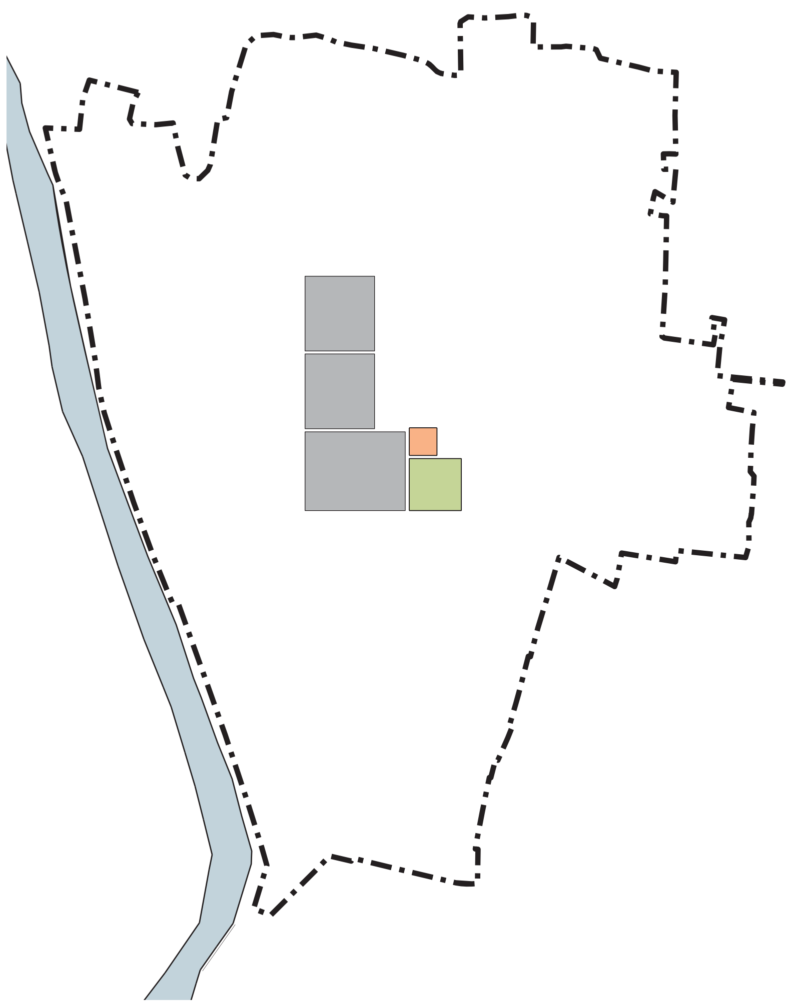
	TSI PROGRAM					DESIGN PROGRAM DEVELOPMENT				
BUILDING OR LAND USE	**UNIT AREA (SF)**[1]	**LOT AREA (SF)**[1]	**NUMBER OF LEVELS**[1,3]	**TOTAL UNITS**[1]	**TOTAL AREA**[1]	**TOTAL SALEABLE AREA**[3]	**RESIDENT POPULATION 5 per Unit**[5]	**TRANSIENT POPULATION 1.5 per Unit**	**PARKING Per Unit**[4]	**TOTAL PARKING REQUIRED**[8]
VILLAS				340	1,000,000	1,068,037	1,700	510		1,020
3-Bedroom type A1	2,000	2,400	2						2	
4-Bedroom type A2	3,000	3,600	2						3	
5-Bedroom type A3	4,000	4,800	2						4	
TOWNHOMES				587	1,170,000	1,209,879	2,935	881		1,468
3-Bedroom type B1	1,450	1,350	2						2	
4-Bedroom type B2	2,350	2,250	2						3	
APARTMENTS				1,400	2,200,000	2,624,128	7,000	2,100		2,800
2-Bedroom type C1	1,200	N/A	9						2	
3-Bedroom type C2	1,600	N/A	9						2	
4-Bedroom type C3	2,100	N/A	9						2	
SUBTOTALS					**4,370,000**			**3,491**		**5,288**
CLUBHOUSE[7]					80,000			100	1/2,000 SF[2]	44
CIVIC AMENITIES & RETAIL[7]					20,000			28	1/2,000 SF[2]	10
UTILITIES[7]					130,000					
TOTALS				**2,327**	**4,600,000**	**4,902,044**	**11,635**	**3,619**		**5,342**

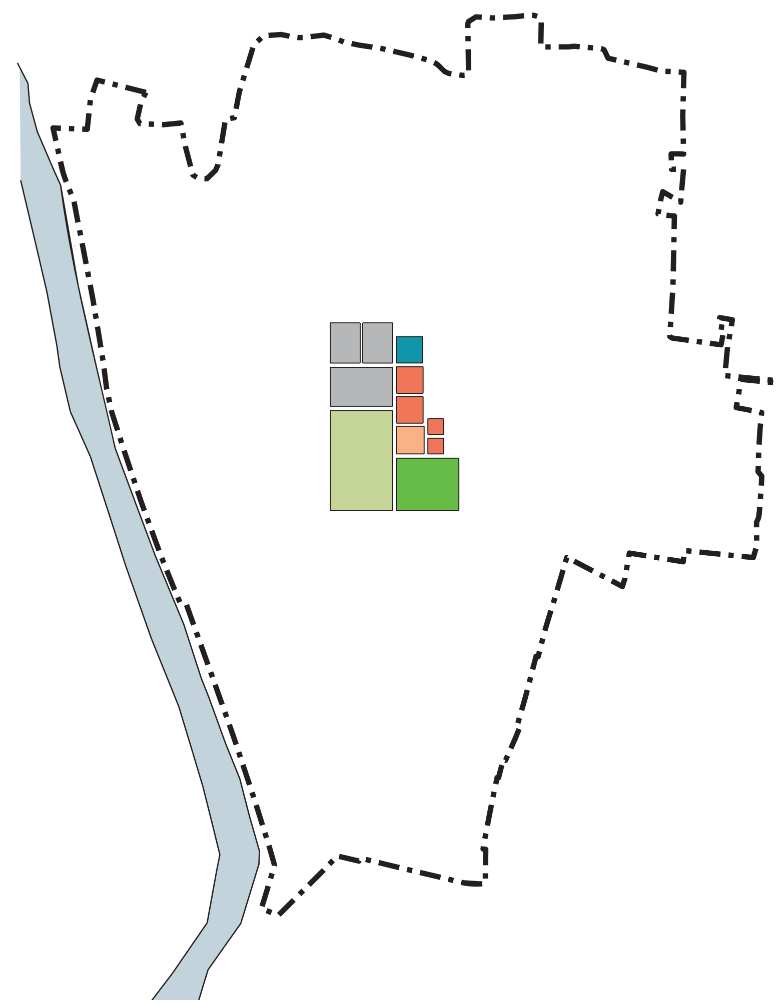
1 Per TSI program mix
2 Per Chennai development code
3 Per TSI design brief
4 Per TSI direction
5 Per TSI & TCE direction
6 Per TCE & K+S direction
7 Per TSI, TCE, & K+S direction
8 Per design team assumption on average unit mix

OPEN SPACE PROGRAM

INITIAL PROPOSED SCENARIO	ACRES
LARGE CLUB HOUSE AREA	2.90
• Include 4 tennis, 2 volleyball, 1 pool, club house, parking	
SMALL CLUB HOUSE AREAS	2.80
• 2 Clubhouses at 1.8 acres	
• Include 2 tennis, 2 volleyball, 1 pool, club house, parking	
1 ACRE PARK	1.00
1 AMPHITHEATER	0.20
3 1-MILE JOGGING PATHS (WITHIN ROAD AND OTHER SITE AREA)	
TOTAL	7.90

DESIGN TEAM PROPOSED SCENARIO	ACRES
LARGE CLUB HOUSE	0.90
SMALL CLUB HOUSES	0.90
• 2 Clubhouses at .45 acres	
1 COMBINATION PLAY FIELD	1.20
1 OUTDOOR POOL	0.25
1 AMPHITHEATER	0.28
2 TENNIS COURTS	0.26
2 VOLLEYBALL COURTS	0.09
SHARED OPEN SPACE	2.30
3.2 MILES OF JOGGING PATHS (WITHIN ROAD AND OTHER SITE AREA)	
TOTAL	6.18





TSI provided an open space and recreation program for the project consisting of three individual clubhouses, each with their own outdoor recreation. During the programming and site test fit phase, the design team developed the net site area required for open space and the recreation program.

- Due to the urban nature of the project and the limited amount of land available, the design team proposes reducing the recreation program to one large and two small clubhouses.

Outdoor sport facilities are shared. A variety of larger social gathering spaces are surrounded with retail. The combination field and the amphitheater can support a host of sport and social activities. This offers an opportunity to encourage development of a walkable community.

To maximize the benefit of the open space for all residents, active programmed recreation activities are located in the Central Open Space. The adjacency to the central water tank offers the added advantage of access to water, views, and improved microclimate.

- Situating community activities at the project's geographical center will create a vibrant town center and conserve land.

India's rapidly growing economy faces the challenge of creating large amounts of new housing for an expanding middle and professional class, and rural populations shifting to urban regions. This rapid growth incurs environmental impacts that must be managed, mitigated and remediated in order to achieve a development model that is environmentally, economically and socially sustainable.

Development at the scale of this project is one of the defining challenges for architecture and urban design in the 21st century. In order to satisfy this growing demand for housing, with its related energy, water and material needs, while conserving and enhancing the environment, sustainable design principles have been integrated into the project's development and design process from the beginning.

Recognizing this challenge and opportunity, Chennai 113 Residential Master Plan aspires to:

- Visionary, innovative development designed, constructed and operated in sustainable manner, resulting in a restorative impact for both man and nature.
- Re-connect people to the environment and build community.
- Use naturally based systems to the maximum extent possible at all levels of the site and its buildings.
- Integrate architecture, landscape and urban design to create a place of enduring beauty, whose aesthetic is timeless and of its place.

Because of the urban character of the Master Plan, site and architectural systems are by necessity—and by design—overlapped with other functions, to preserve land, air, water and energy, to provide aesthetic enjoyment and to communicate the principles of environmental and design stewardship.

The recommendations and goals put forward in this Master Plan are a realistic path to achieving a high quality and sustainable project. The design, environmental, marketing, and social issues presented by the program and site are complex and interlinked; correspondingly the design strategies developed overlap and inform each other, to maximize efficiency and value, balance cost and create joy and delight.

I Site Development & Urban Design

Human Scaled and Human Centered

The project will be centered on an active and vital public realm that prioritizes pedestrian and other non-motorized forms of transit within the development. Future public and private transit opportunities will be designed into the Master Plan. The project looks beyond its property boundaries with open space and streetscape design to create common spaces and linkages with its neighbors, to connect and embed the site in its wider physical and social context.

Integrate Indoor and Outdoor Life

Providing comfortable and attractive spaces for residents and visitors, both internally and externally, is central to creating a sustainable and marketable project. Building orientation, roof and street shading, passive cooling and ventilation strategies will contribute to maximizing comfort at a minimum cost of capital, energy and materials.

II Landscape & Ecology

Integrate Site and Landscape Systems

Using the ecosystem approach, landscape design will restore and manage the site's natural systems of soils, water, plants and animals in a sustainable, integrated manner. Since land is at a premium, open spaces are designed to perform multiple urban design and ecological functions, such as increasing native vegetation diversity, rainwater harvesting, and improving microclimate. Rainfall is collected and reused within the site boundaries to sustain plant communities, while composted organic material will be used to amend soils and nourish vegetation.

Re-Establish Native Plant Communities & Habitats

The project will create native plant communities and re-establish natural wildlife habitats. This re-generative landscape will be self-maintaining, use minimum construction, energy and human capital, and will be more resilient to climate extremes. A multi-layered pattern of forest and woodland communities will help to improve bio-diversity of the flora and fauna and will have benefits outside the project boundaries.

Promote Healthy Lifestyles

The landscape serves as an extension to the experience of living in a South Indian urban community. Attractive and sustainable landscapes will create ecologies that promote healthy, functioning natural systems, provide an inspiring environment, and engage and educate residents by example about sustainability and stewardship. Shaded open areas and gathering spaces, active recreation areas and jogging trails will encourage outdoor life and healthy lifestyles.

III Infrastructure & Systems

Utilize Green Infrastructure

In contrast to technology intensive, high-impact “gray” infrastructure, the Master Plan deploys low-impact “green” technologies based on natural processes, such as stormwater management. These biological complex and technologically simple, systems minimize upfront capital, energy inputs and maintenance costs. Simultaneously, they provide beautiful landscapes that are integrated into the project’s public open space.

Balance Water Demand with Water Scarcity

Water is the site’s most precious resource. Through demand reduction and water efficient fixtures, potable water use will be reduced below 150 liters/person/day. Greywater and blackwater recycling for non-potable uses will further reduce potable water consumption, pumping and treatment. Groundwater withdrawals will be balanced by an equal amount of re-charge to sustain the aquifer supply for future generations.

Integrated Waste Management

The project will implement a central waste collection facility, incorporating India’s traditional excellence in recycling. This facility will process household and other waste, compost the organic component, and ensure that recyclables are processed and reused within the metropolitan area.

IV Building Design & Construction

Authentic Architecture

Using modern principles of design and sustainability, wedded to indigenous and emerging technologies, the project develops an architectural language that is both rooted to its place and forward-looking. This aesthetic is clean, simple, tactile and sophisticated, utilizing Indian (and modern) architecture’s time-honored traditions of proportion, sequence, detail, light and shadow, and creating buildings and places of delight.

Reduce Energy Consumption by 50%

Reduction of energy and associated CO2, is a priority for the project, region and India as a whole. Energy efficient appliances, plug load metering, daylight harvesting, responsive lighting controls, solar hot water, ground water cooling, natural ventilation and owner education are important strategies in reducing energy use by 50%.

V Social Capital

Equity and Access

Design solutions build upon the deeply rooted patterns of daily life in South Indian culture, foremost which is intergenerational living. The project should enable people of different ages and physical ability to live full and complete lives within the community.

Effective Governance

The resident-run association is a key element in ensuring that the project operates in the most sustainable manner possible and that design standards are maintained. Land conveyance from TSI to individual owners is the critical moment when an effective governance structure can be implemented. The development and design team should put into place systems that are practical and intuitive, and engage the association at an early stage to ensure optimum operating conditions.

Goals

The project should re-establish the full range of relationships between natural processes and human activity, by deploying ecological systems in a clear and visible fashion to perform vital site functions. Rather than being hidden from view these systems can be celebrated and given aesthetic, as well as functional value. These include:

- Stormwater infrastructure and open space systems that improve the surface drainage situation in the watershed to mitigate the impacts of urbanization.
- Improving the district's stormwater management by facilitating the movement of stormwater generated by the watershed to the north and east via a diversion channel along the eastern and southern edge of the site.
- Harvesting and managing water that falls within the site boundaries, while reusing rainwater, stormwater, and greywater to maximize both environmental and visual benefits.

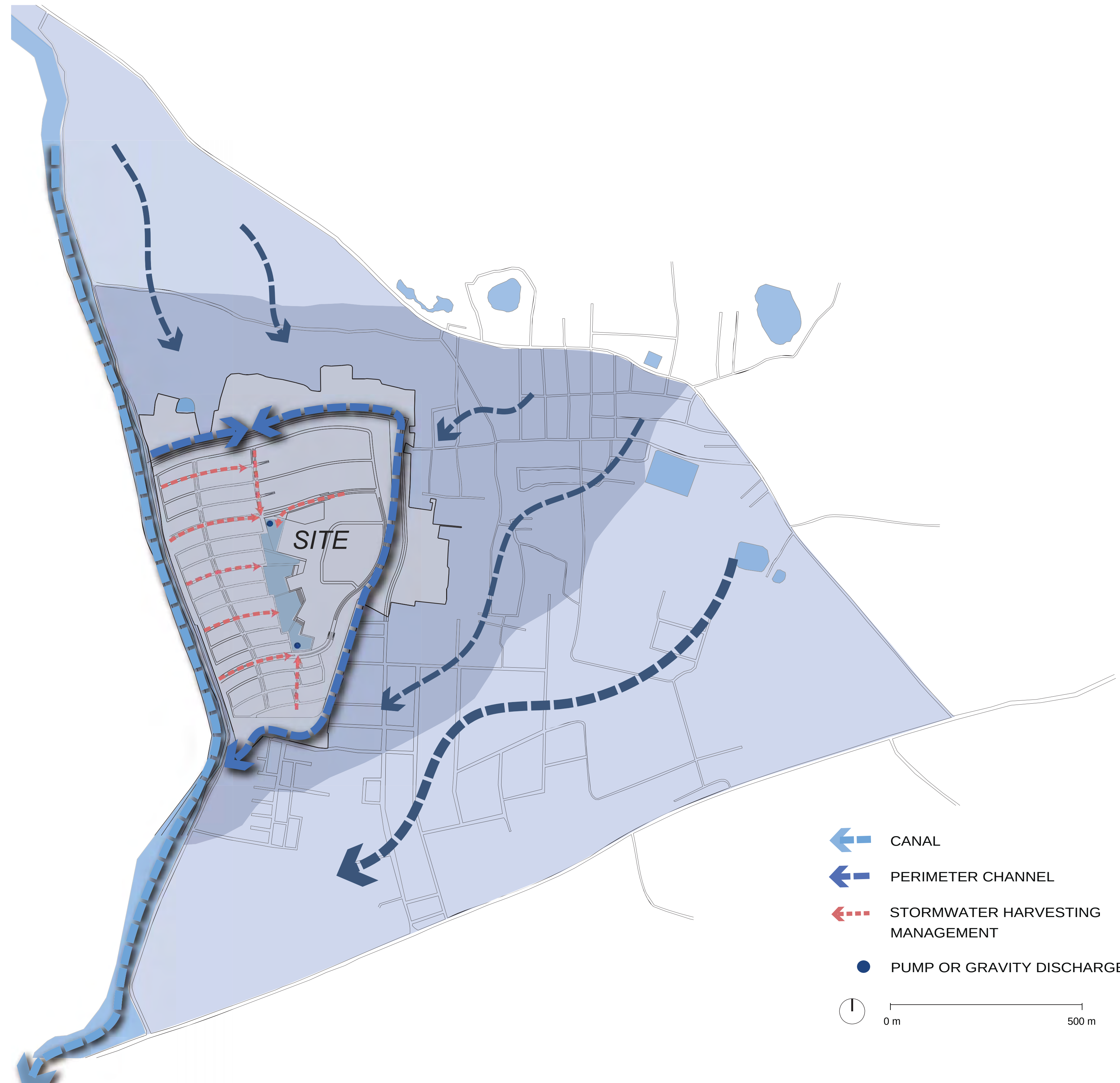
Assumptions

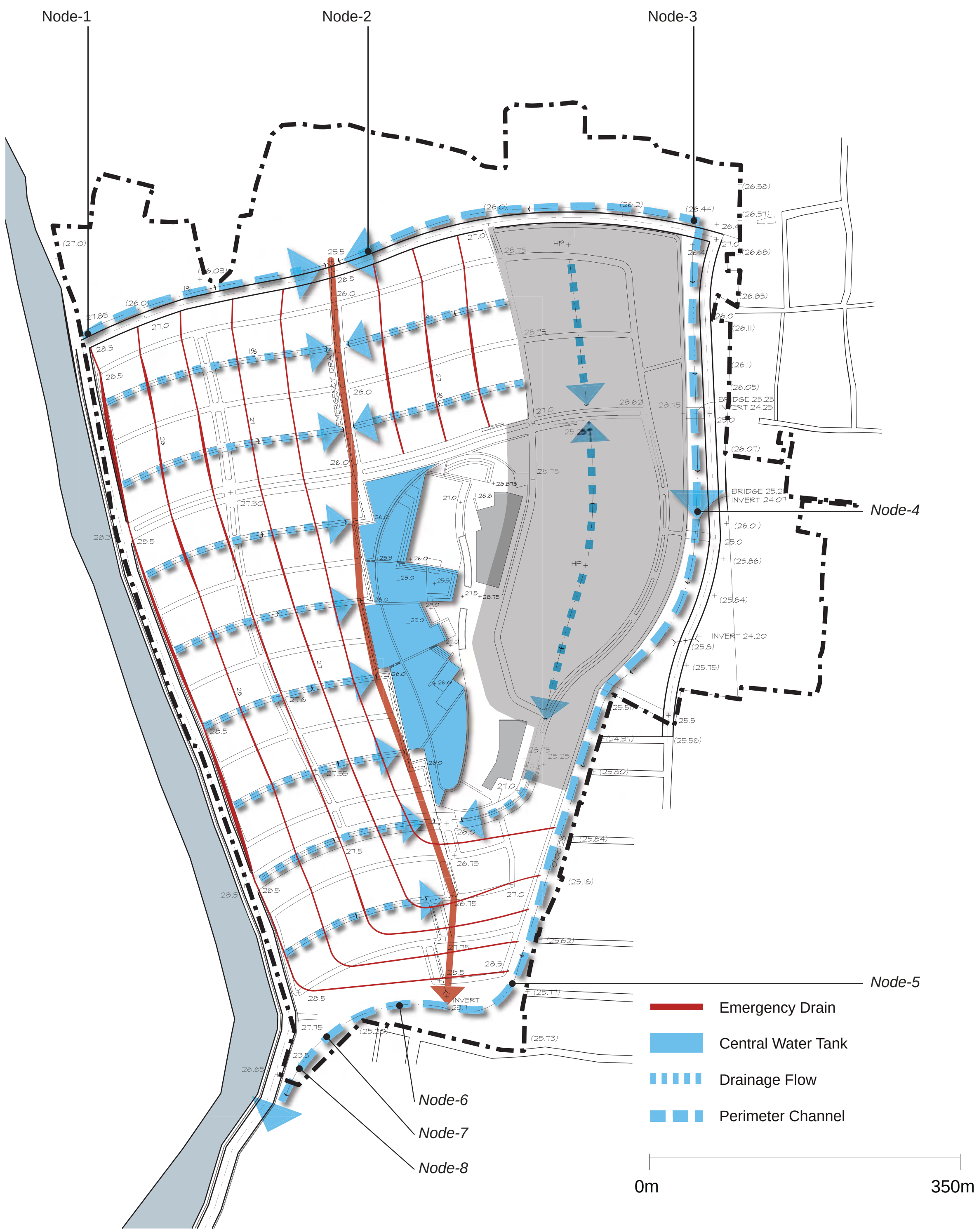
Run off Coefficent	0.4
Rainfall Intensity	80 mm/hr
Outside Catchment	238.69 acres
Previous Owners	20 acres
Poramboke Exchange	5.74 acres
Total Catchment	264.43 acres
Drain Section	Trapezoidal
Free Board considered	0.1 m
Z	1.5
Z_East+South drain	3 (As advised by Andropogon)

Note:
- North Drain is assumed to be steeper, due to space constraints
- East and south drains are wider with side slope of 3H:1V

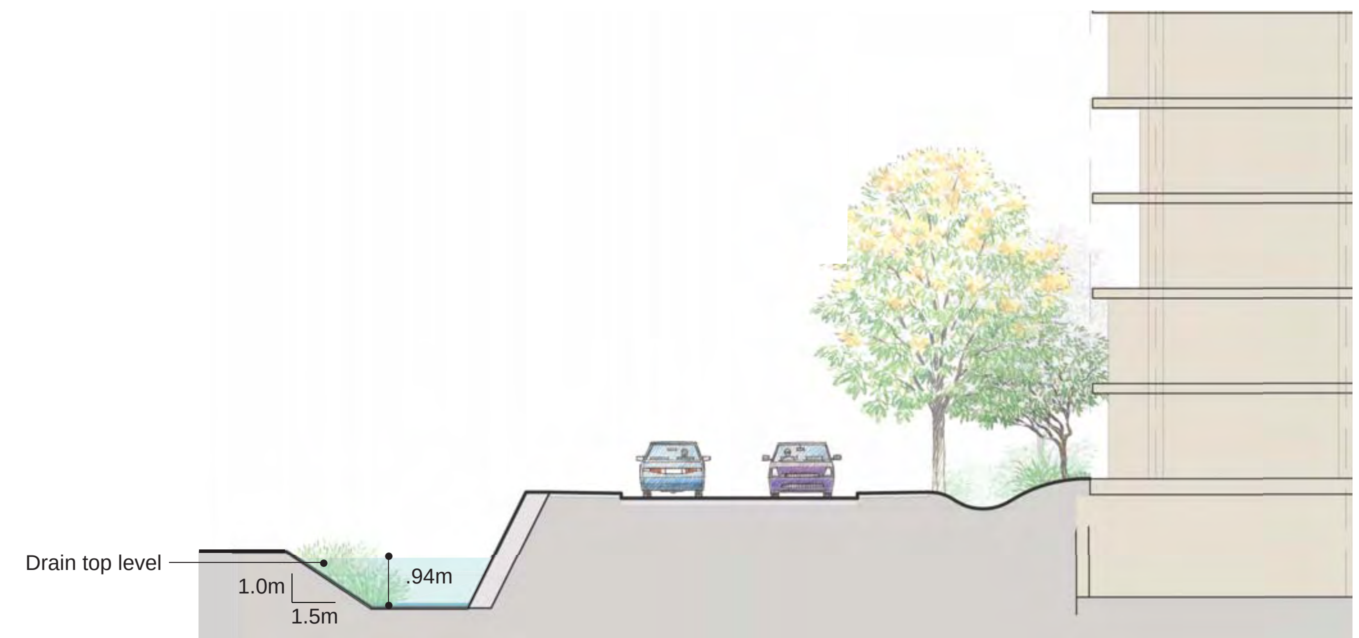
Perimeter Channel								
Drain	Nodes	Length (m)	Catchment Area (acres)	Cumm. Discharge (m3/sec)	Width (m)	Water Depth (m)	Drain Depth (m)	Top width (m)
North	1 to 2	297.20	36.97	1.33	1.40	0.55	0.65	3.36
	2 to 3	404.50	96.39	4.80	2.50	0.94	1.04	5.62
East	3 to 4	302.90	57.47	6.86	12.00	0.53	0.63	15.79
	4 to 5	600.80	48.11	8.60	16.00	0.55	0.65	19.88
South	5 to 6	132.10	12.74	9.05	18.00	0.55	0.65	21.92
	6 to 7	115.10	4.56	9.22	18.00	0.56	0.66	21.96
	7 to 8	65.00	8.19	9.51	20.00	0.55	0.65	23.90

Source: TCE





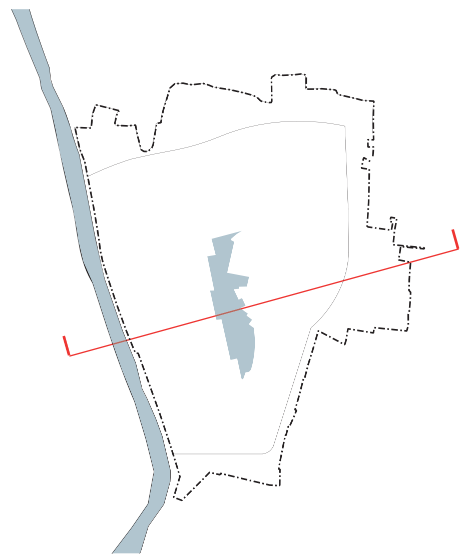
Site Grading Plan



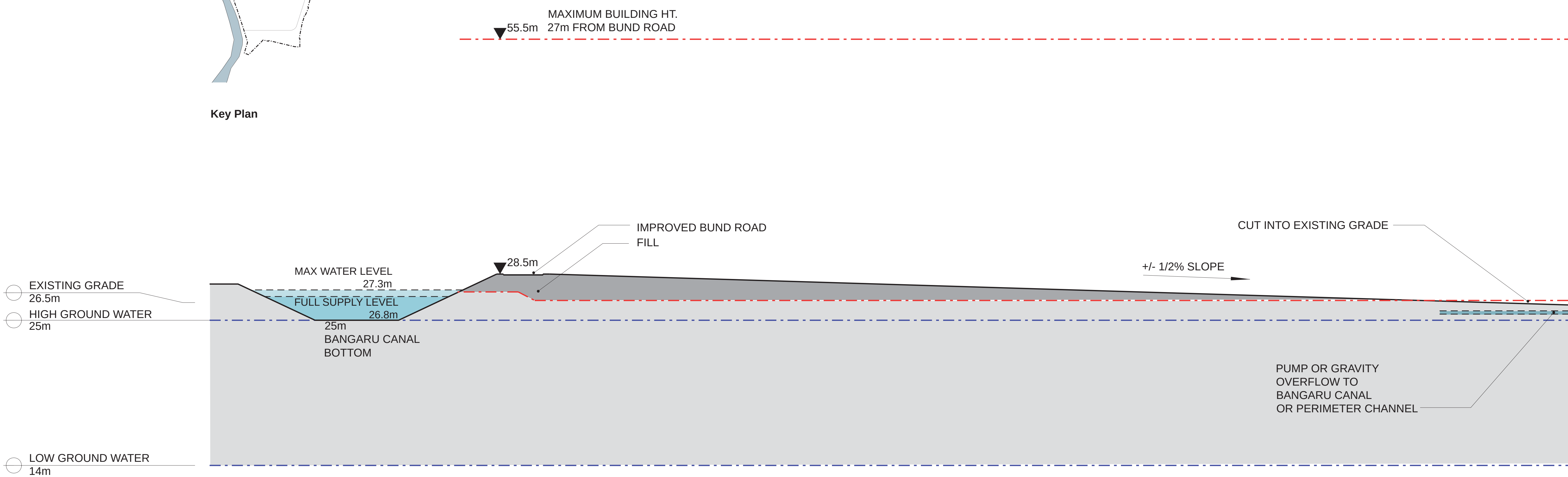
EW District Road
From Node-2 to Node-3

NS District Road
From Node-4 to Node-5

Perimeter Channel Sections



Key Plan



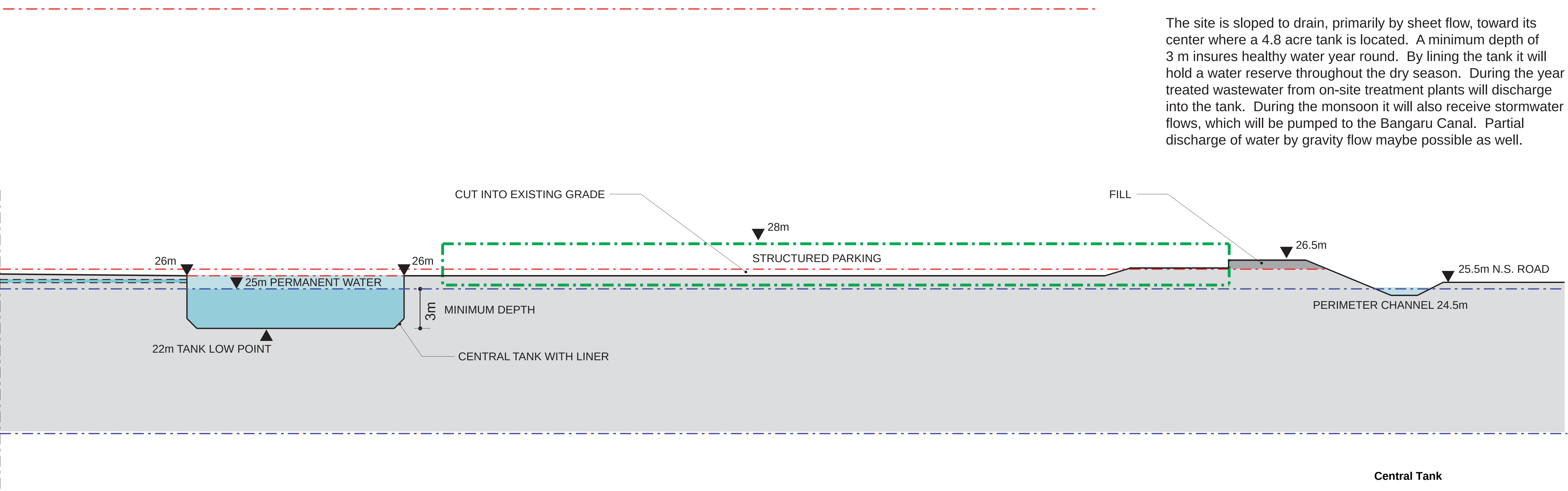
East-West Section
Vertical Scale: 1:300
Horizontal Scale : NA

CONCEPT SITE SECTION

Sectional development of the site works closely with the master plan's overall water strategy. To minimize the expense and transport emissions associated with filling the site above the flood plain, the site is protected from outside flooding by landscaped embankments on all sides.

The raised Bund Road at 28.5m provides protection from the maximum water level in the Bangaru Canal. This elevation is also the reference from which the maximum height of the project's building area is measured. Height of the other embankments is determined by maximum flood elevation of Chembarambakkan Lake at 26.03m.

The site is sloped to drain, primarily by sheet flow, toward its center where a 4.8 acre tank is located. A minimum depth of 3 m insures healthy water year round. By lining the tank it will hold a water reserve throughout the dry season. During the year treated wastewater from on-site treatment plants will discharge into the tank. During the monsoon it will also receive stormwater flows, which will be pumped to the Bangaru Canal. Partial discharge of water by gravity flow maybe possible as well.



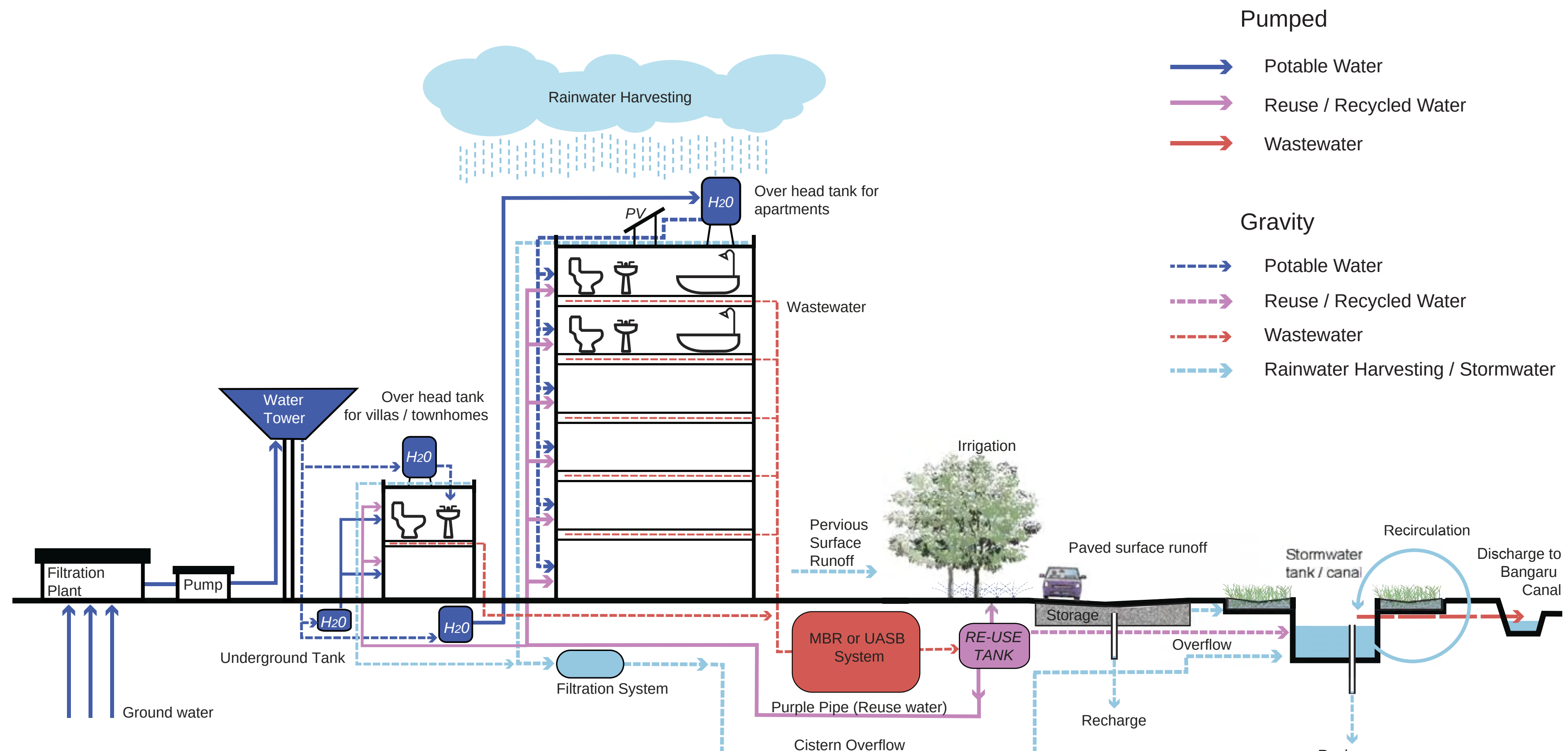
Central Tank	
Surface Area	4.8 Acres
Storage Capacity	58,262 m^3
Storm Event Capacity	26,420 m^3

Goals

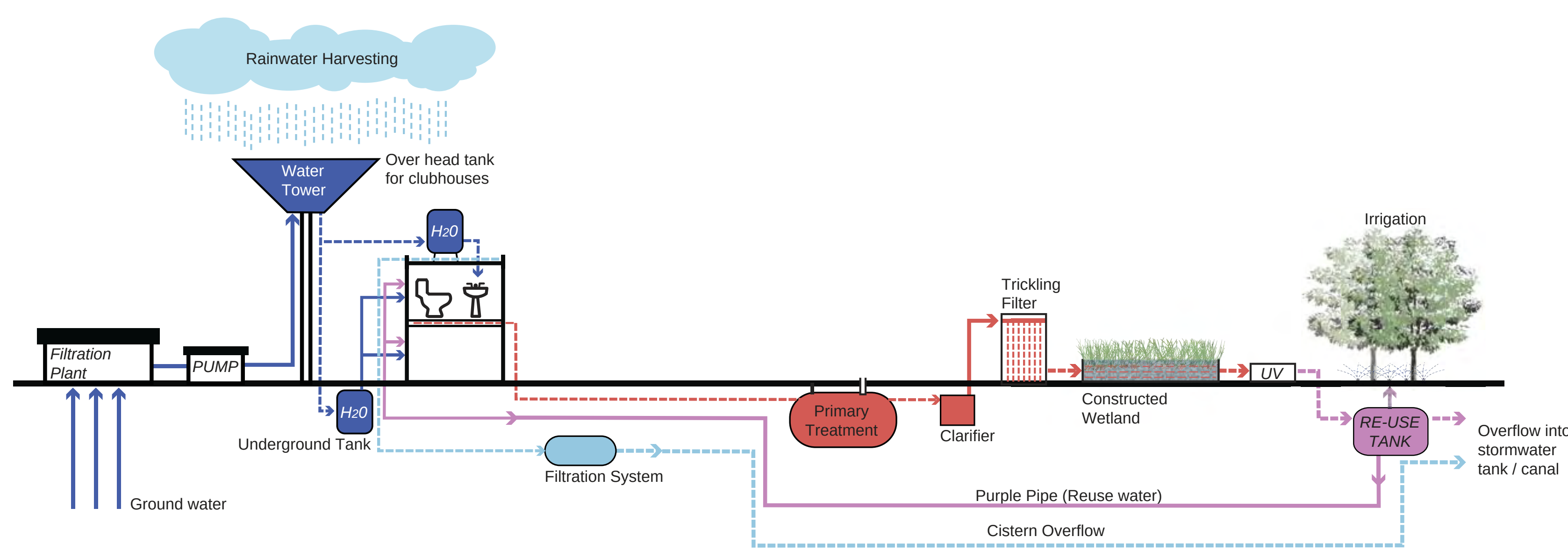
Water is the most critical resource in Chennai. Every drop of water that falls on and resides below the site is treated as a precious resource. Although the monsoons bring substantial rainfall, it is concentrated in few months, while there is water scarcity for majority of the year.

Typically when a site is developed and urbanized, natural systems are buried or destroyed, as when stormwater is conveyed in underground piping or native vegetation is replaced by exotic or invasive species. Overturning this approach, the master plan's watercycle goals include:

- Creating infrastructure systems using Best Management Practices (BMP) that sustain the delicate balance between water supply and demand, improve water quality, reduce stormwater volumes generated by impervious surfaces, and promote aquifer recharge.
- Integrating potable water, stormwater, rainwater harvesting, and reuse systems within the open space of the site while increasing their land use efficiency.
- Reducing potable water consumption through budgeting, water efficient fixtures and irrigation, and implementing a pricing structure to promote conservation.
- Designing stormwater systems to celebrate in aesthetically compelling ways the movement of water through out the project
- Utilizing gravity and low-energy strategies as much as possible to move water within the site and building systems.



Site Water Cycle



Natural Waste Water System

Source: M/S Scientific Ground Water Services

Water Demand

	Total	Villas	Townhomes	Apartments	Clubhouse	Gardening	
Total residential population	10,940	1,605	2,065	7,270	0	0	persons
Total transient population	3,282	482	620	2,181	0	0	persons
Net fresh water demand	1,633,465	182,368	230,248	812,770	408,080	0	liter/day
Net irrigation water demand	184,558	0	0	0	0	184,558	liter/day
Net recycled water demand	811,714	86,670	111,510	392,580	36,396	184,558	liter/day
Gross fresh water demand	1,809,934	202,069	255,122	900,576	452,166	0	liter/day
Gross irrigation water demand	204,496	0	0	0	0	204,496	liter/day
Gross recycled water demand	899,406	96,033	123,557	434,992	40,328	204,496	liter/day
Total gross water demand	**2,709,340**	**298,102**	**378,679**	**1,335,568**	**492,494**	**204,496**	liter/day

Source: TCE

Potable Water

Underlying the northern part of the site are water-bearing aquifer layers, identified by hydro-geological analysis, recommended for the project's drinking water supply. Accessed by bore wells, this water requires treatment to achieve potable standards. Because the district's groundwater resources are at "Critical Stage", water conservation, greywater use and aquifer re-charge are essential to insure the project's aquifer can continue to meet demand.

The project's water balance is based on 150 liter/person/day. Approximately 40% of the project's total water demand can be met by greywater. Water reduction strategies are discussed in a later section.

Best Management Practices (BPM)

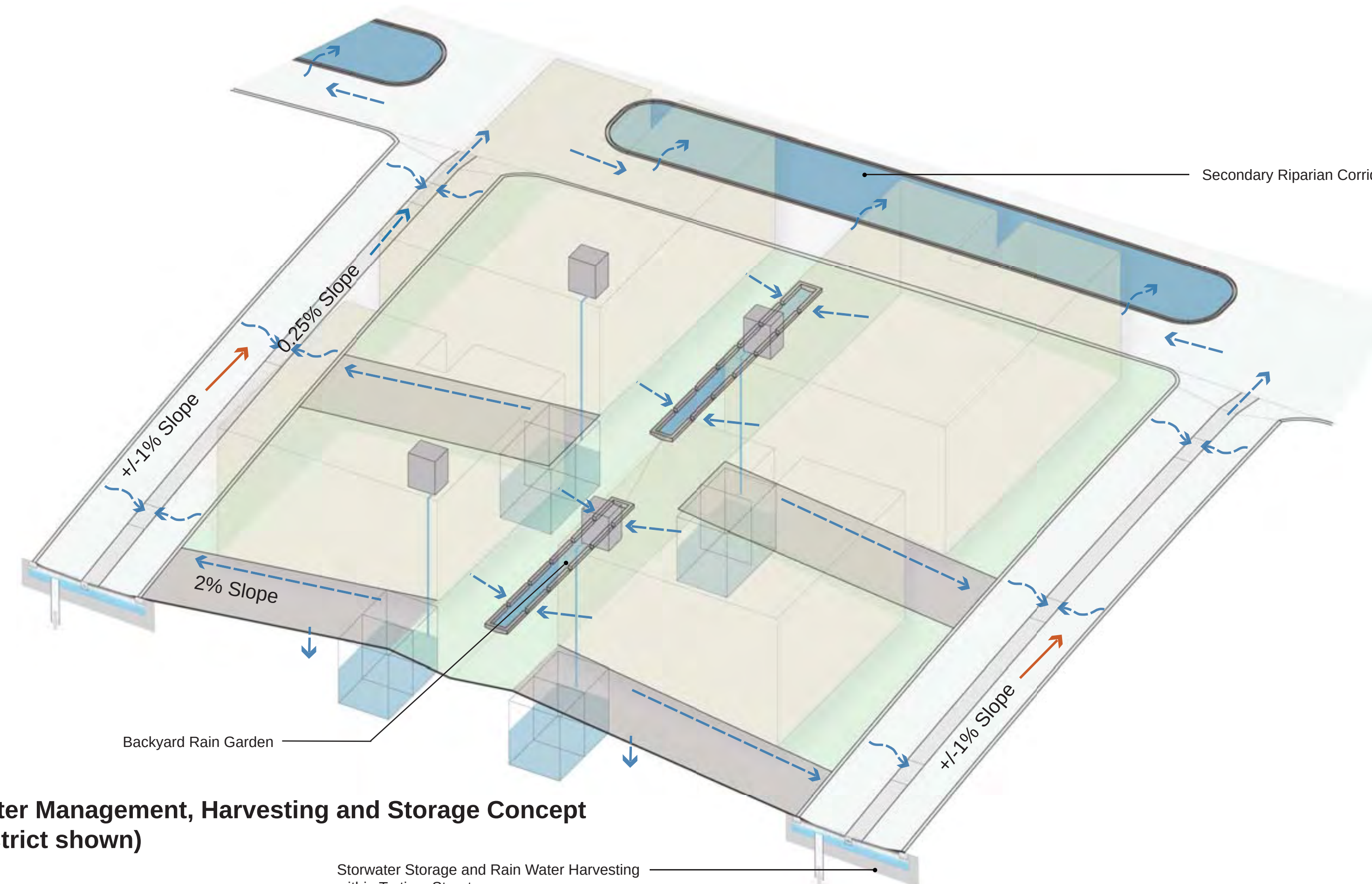
- Rain Gardens, integrated into landscapes, and plazas, will absorb water during intense rainfall. In doing so, the gardens will help prevent flooding, slow runoff, improve water quality, and replenish the water table.
- Bio-Swales slow the movement of stormwater runoff, encourage infiltration, and help remove pollutants. Also, they provide beautiful flowering landscapes, which make visible the flow of water across land.
- Wastewater biological treatment systems within the club house buildings are used to treat wastewater and greywater.
- Permeable pavements are used as infiltration basins. The depth of storage basins are determined by site conditions and percolation rates.
- Roof gardens use light weight engineered soil to reduce structural cost. The engineered soil is capable of storing stormwater, and the roof garden provides additional open space.
- Cisterns are used to store stormwater. They are typically tied to a gutter system to collect roof runoff.

STORMWATER STORAGE & RECHARGE

The master plan's landscape and open spaces are designed to mitigate the impacts of urbanizing the watershed and recapture rain water for aquifer recharge, an important consideration since the project must provide its own drinking water from bore wells. The project approach:

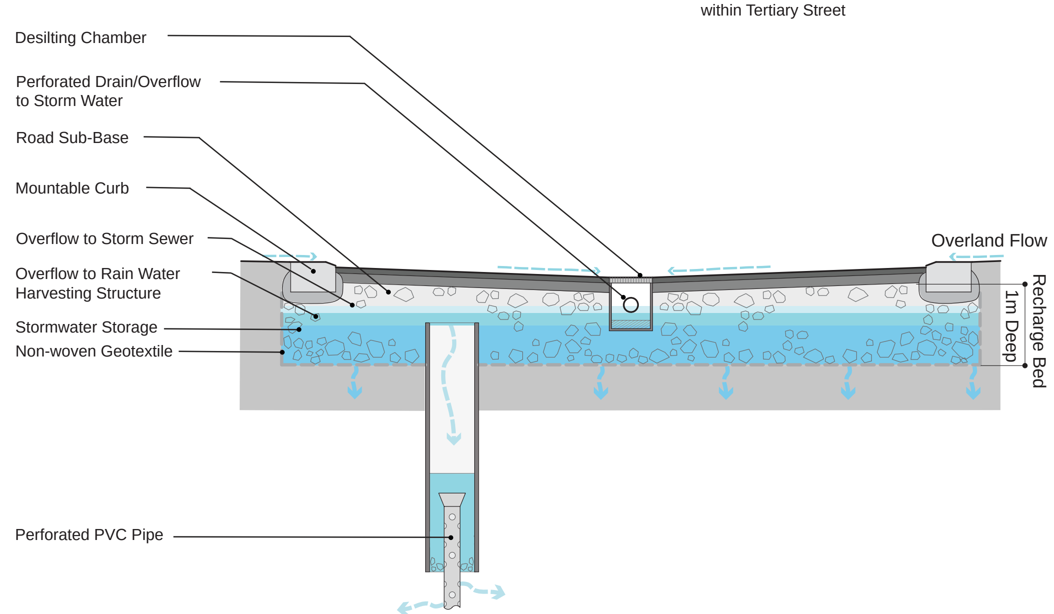
- Replicates the natural hydrologic cycle.
- Infiltrate water into the soil, stores excess runoff in underground storage cisterns / recharge beds, and directs surface flow through stabilized vegetated swales.
- Seeks multiple solutions at different points, rather than a single solution. Distribution of water resources throughout the site will help to sustain site wide ecosystems.
- Integrates rain gardens, swales, cisterns, and underground storage in aggregate stone beds at multiple locations close to where the stormwater is generated.

Roads cover a large proportion of the master plan. Because of poor soil conditions and typical road construction practice, all will need to be constructed on layers of engineered filled. Taking advantage of this situation, the project's tertiary roads are designed as rainwater storage and harvesting structures.

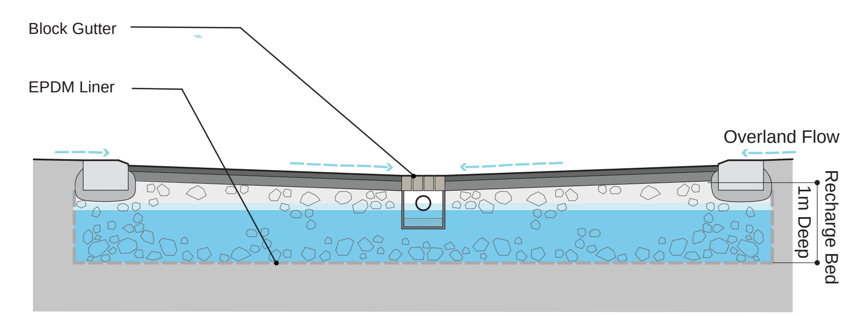


Rain Water Management, Harvesting and Storage Concept (Villa district shown)

Riparian Corridor



Harvesting at Tertiary Street



Storage at Tertiary Street

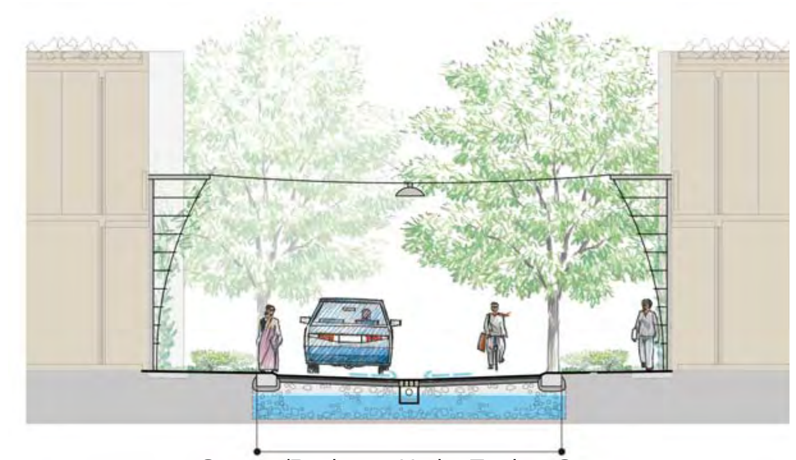
STORMWATER STORAGE & RECHARGE

Source: M/S Scientific Ground Water Services

The hydro-geological study conducted by M/S Scientific Ground Water Services indicates the northern areas of the site are overlain by soils that are suitable for infiltration while the soils in the southern areas are clayey and do not permit infiltration.

Rainwater is harvested using cisterns situated within the plot boundaries of the villas and townhomes, in addition to using storage and infiltration beds and rainwater harvesting structures beneath the roadways. Surface flow is directed through a landscape system of rain gardens in the backyard areas and stabilized vegetated swales.

The tertiary streets are constructed with underground storage in aggregate stone beds which function as rainwater harvesting structures. An overflow system conveys storm runoff away in case of oversaturation. In the southern portions of the site, the aggregate stone beds are used only for storage, as the infiltration may not be possible due to the existing soil structure.



Storage/Recharge Under Tertiary Streets

- RECOMMENDED BOREWELL LOCATIONS
- FAVORABLE BOREWELL LOCATIONS
- STORMWATER STORAGE & INFILTRATION BEDS UNDER ROADWAYS
- STORMWATER STORAGE BEDS UNDER ROADWAYS

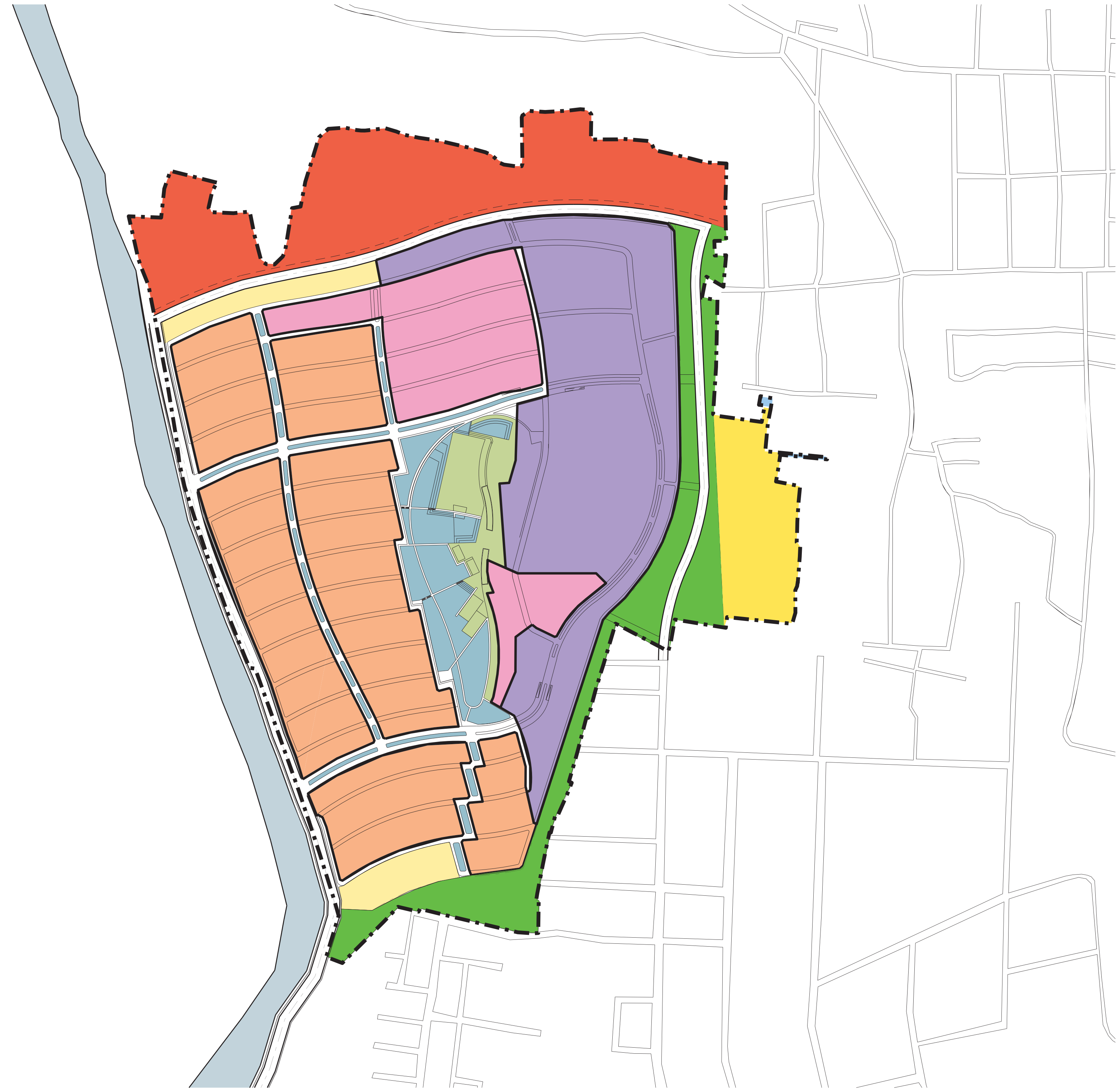
0 km — 350 km

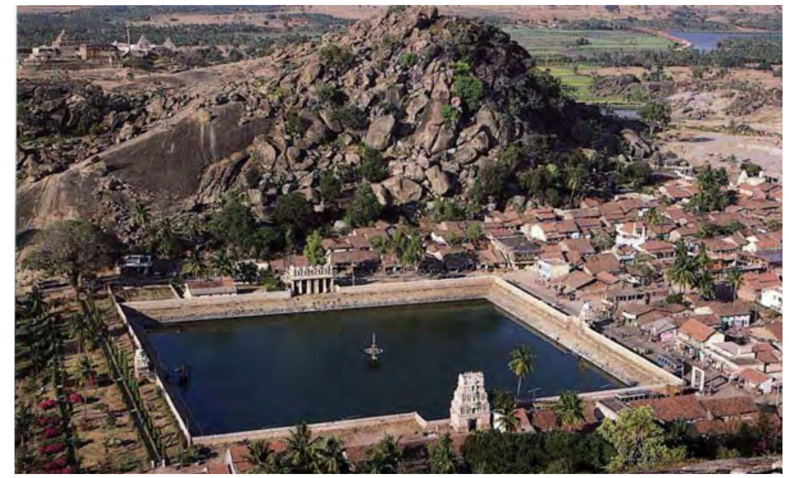
Buildable Site Definition
Modifications to the initial 146.27 acre plot reduces it to 102.76 acres of buildable area available for the project's residential program. These modifications accomplish several inter-related site planning and urban design goals:

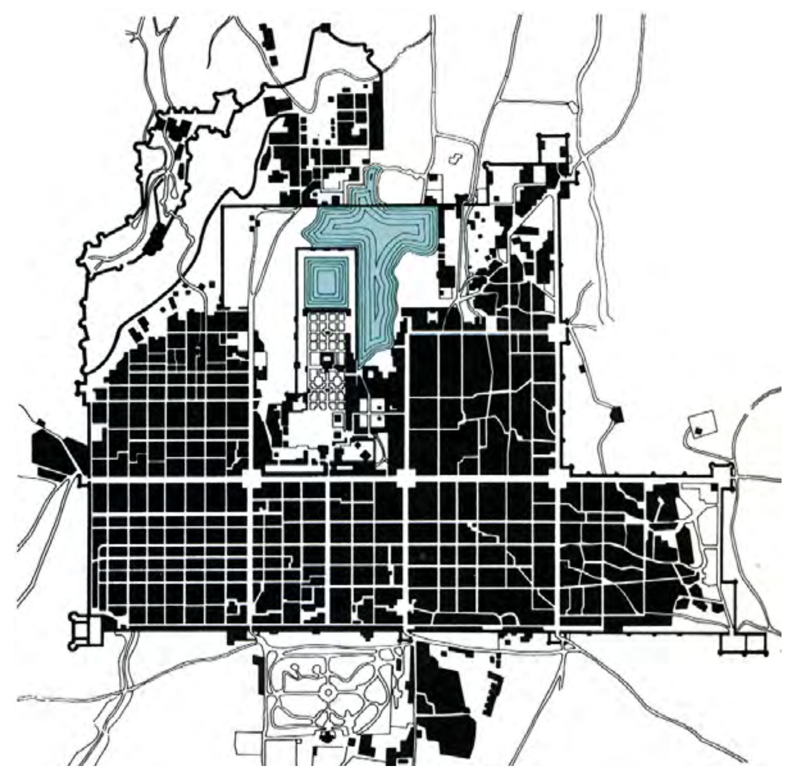
- Create regular site edges for the buildable site area.
- Develop greenbelt buffers for the project and adjacent land uses
- Create an open space and public road network that is an asset to both the project and its neighboring communities
- Utilize open space for district stormwater management, public roads, moderation of heat island effect and recreation uses
- Satisfy contractual obligations to the land's previous owners

	ACRES
TOTAL PLOT AREA	146.27
PORAMBOKE EXCHANGE	5.74
NOT USABLE	0.30
TRANSFER TO PREVIOUS OWNER	20.00
NEW PUBLIC ROADS	6.05
TOTAL NET SITE	**114.18**
10% OPEN SPACE RESERVE (OSR)	11.42
TOTAL BUILDABLE SITE	**102.76**
VILLAS	27.89
TOWNHOMES	9.49
APARTMENTS • Includes indoor clubhouse area	24.92
INTERNAL ROADS	24.92
UTILITIES	3.59
STORMWATER MANAGEMENT	6.74
RECREATION • Includes outdoor clubhouse program	3.74
TOTAL BUILDABLE SITE	**102.76**

0m 350m







Jaipur

LAND AREA ALLOCATION

Urban Concept

The allocation of site uses supports these idea, creating an urban design experience, based on blocks, streets, and open space. The different building types and other site uses are deployed to achieve the following goals:

- Create a connective central open space that is the core of the community
- Maintain distinct identities for each of the three residential types while effectively transitioning between them
- Support the proposed construction phasing
- Foster a pedestrian oriented community

To this end a multi-functional open space is situated at center of the site, with villas occupying the western side and townhouses and apartments predominantly on the east. The open space itself is centered a large water tank, which functions as an aesthetic amenity, stormwater management, public promenade and connection to South India's ancient tradition of water storage and display.

Utility areas are split into two areas to serve the northern and southern sectors of the site. Their location is optimized for prevailing winds to minimize the impact on residents, furthermore, with convenient access to the perimeter roads their operations will minimally impact residents.

DISTRICT ROAD NETWORK

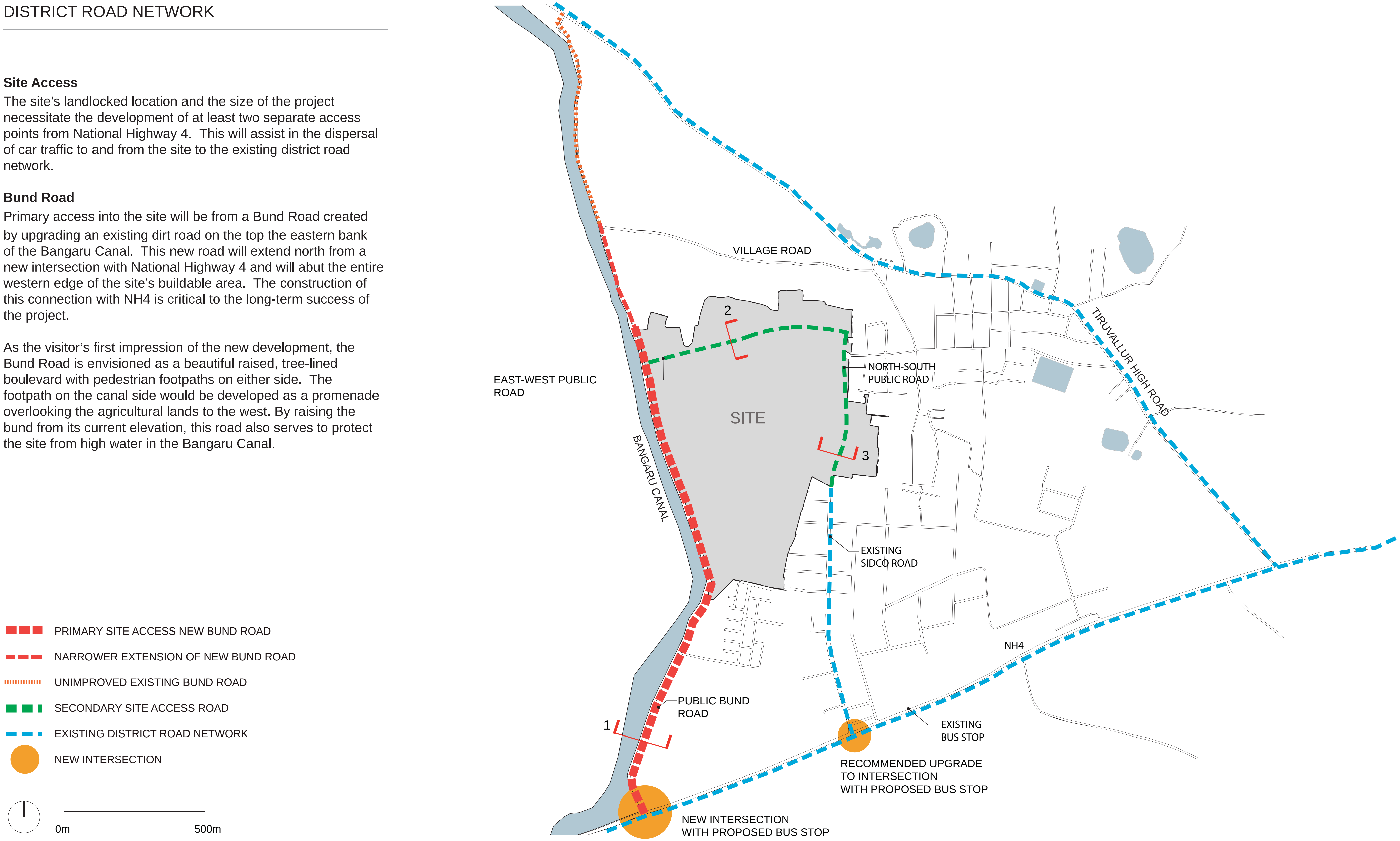
Site Access

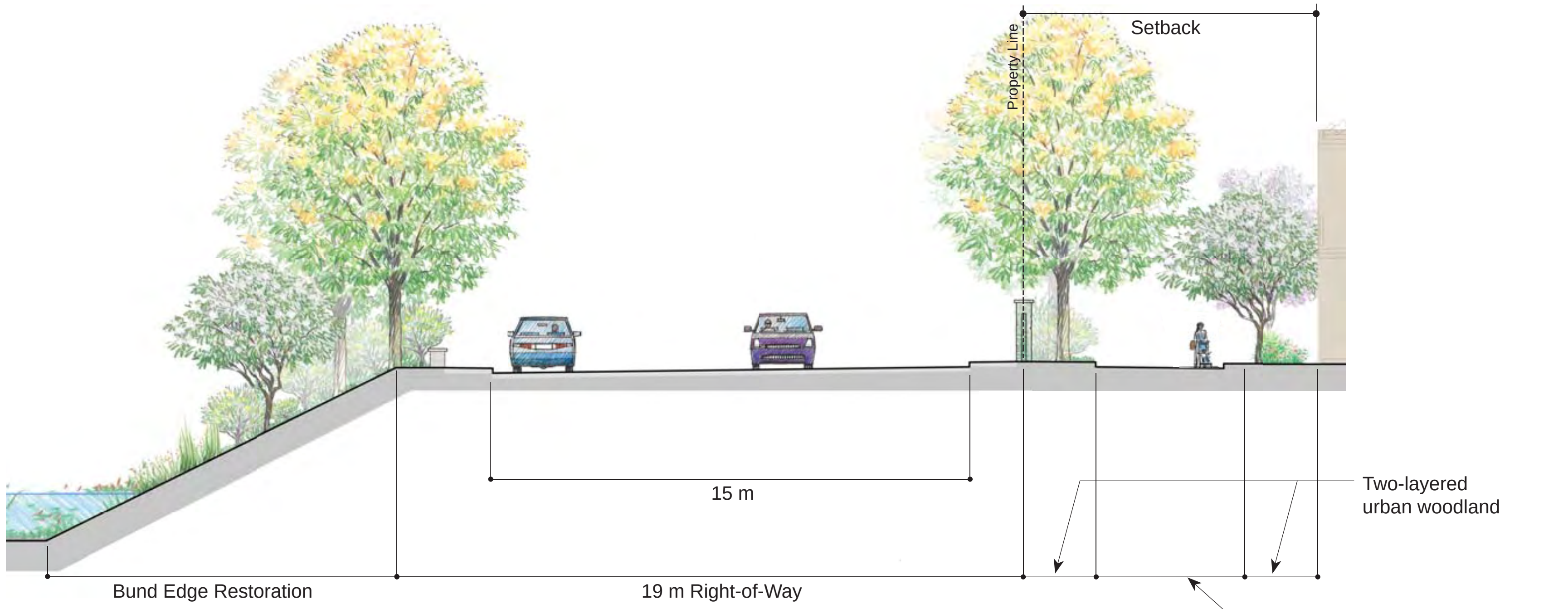
The site's landlocked location and the size of the project necessitate the development of at least two separate access points from National Highway 4. This will assist in the dispersal of car traffic to and from the site to the existing district road network.

Bund Road

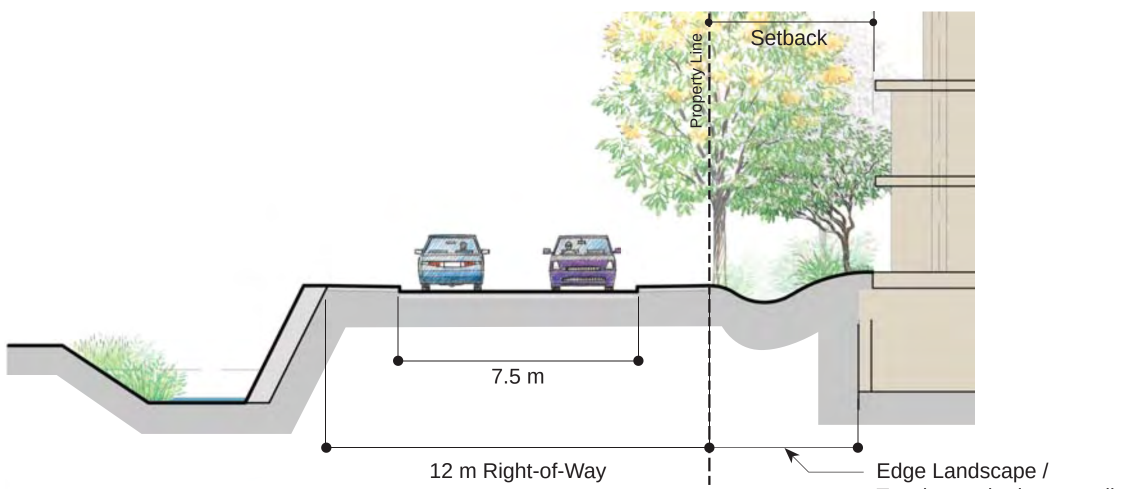
Primary access into the site will be from a Bund Road created by upgrading an existing dirt road on the top the eastern bank of the Bangaru Canal. This new road will extend north from a new intersection with National Highway 4 and will abut the entire western edge of the site's buildable area. The construction of this connection with NH4 is critical to the long-term success of the project.

As the visitor's first impression of the new development, the Bund Road is envisioned as a beautiful raised, tree-lined boulevard with pedestrian footpaths on either side. The footpath on the canal side would be developed as a promenade overlooking the agricultural lands to the west. By raising the bund from its current elevation, this road also serves to protect the site from high water in the Bangaru Canal.

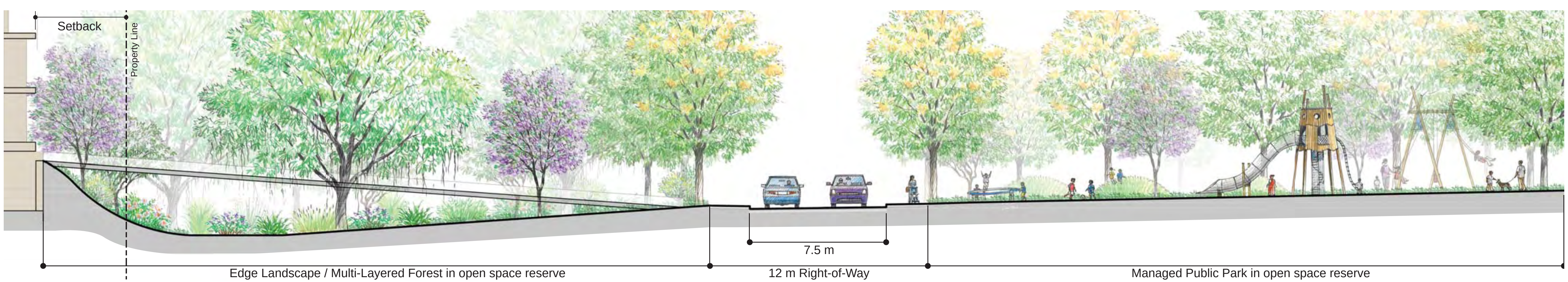




1. Improved Bund Road



2. East-West Public Road



3. North-South Public Road (SIDCO extension)

DISTRICT ROAD NETWORK

Secondary Entry Roads

Secondary site access is provided via the SIDCO Industrial Estate Road. This 24m road narrows to 12m before terminating at the site boundary. This road will be extended north as a 12m public road in Open Space Reserve (OSR) and serve the western edge of the site's buildable area.

A new 12m east-west road will be built at the northern edge of site's buildable area and connect the Bund Road with the extension of the SIDCO Road. This road provides access to the Owner's share, TSI project and allows residents of Thirumazhisai Village to continue accessing agricultural lands to the west of the Bangaru Canal.

Both these roads are tree lined and have footpaths to provide a proper visual frame for the project and connects to neighboring properties. The elevation of the roads from these existing grade helps protect the site from off-site surface run-off.

Public Transit

Currently there is only limited bus service in this district. To facilitate transportation of domestic service workers, reduce vehicle trips and unauthorized parking on perimeter roads, a bus stop is proposed be developed where the Bund Road or SIDCO Road joins NH4.

Goals

The project's internal roads are an urban network that treats land as a precious resource. Consequently, the road sections proposed may be narrower than typical Indian practice. Narrow road sections use less land, calm traffic, cost less to construct and maintain, and are safer for all users. Indian drivers are attuned to closer vehicle proximity and will find these road widths familiar.

Internal roads design achieves several interrelated goals:

- Clear, flexible and safe network for motorists, cyclists and pedestrians
- Supports a pedestrian-oriented development
- Accommodates overlapping uses, such as transportation, stormwater management, micro-climate moderation, recreation and aesthetics
- Enhances the land value of each residential property
- Public space amenity that binds the community together

Entry

Four site entry points are provided:

- Two "front doors" along the Bund Road
- One "back door" along the north-south SIDCO road extension
- One "back door" along the new east/west road

These entries serve motorists, cyclists and pedestrians, and are provided with gatehouses. Service entries for the Apartment buildings are provided along the SIDCO Road extension, and each utility area has direct access to a perimeter road.

PRIMARY ENTRY BOULEVARD
- Two lanes of traffic in each direction
- Central green space and stormwater management

SECONDARY STREET
- One lane of traffic in each direction
- Central green space and stormwater management

TERTIARY STREET
- One lane in each direction

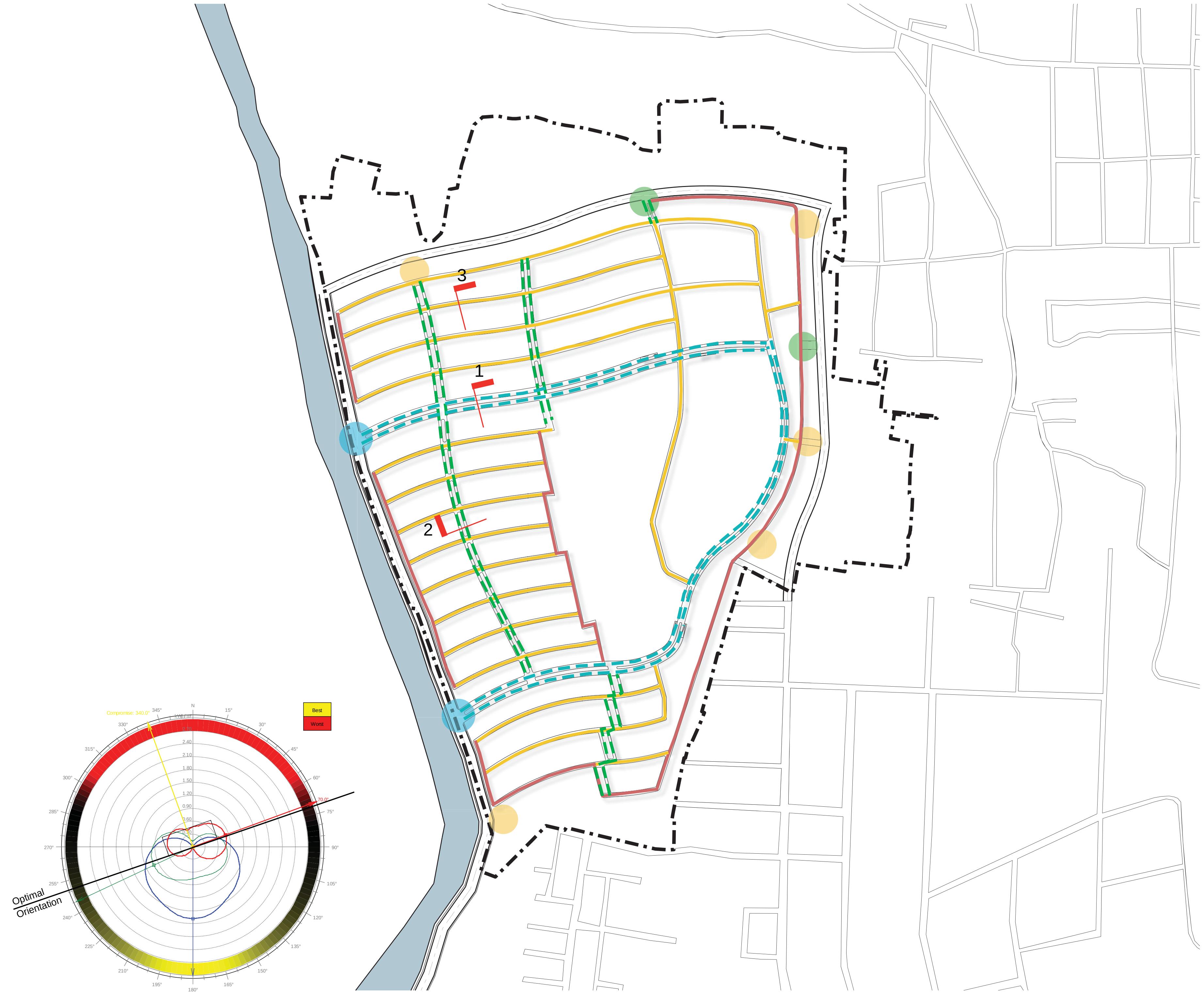
RECREATIONAL / EMERGENCY LANES

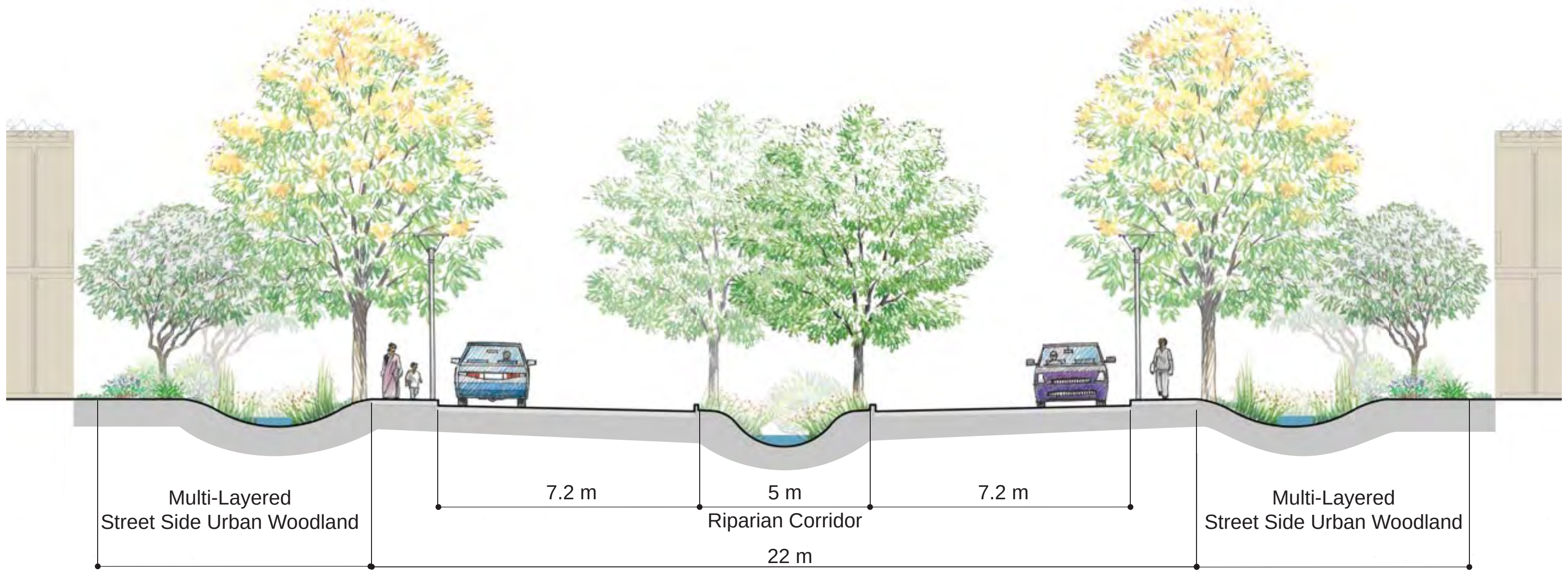
ENTRY

SECONDARY ENTRY

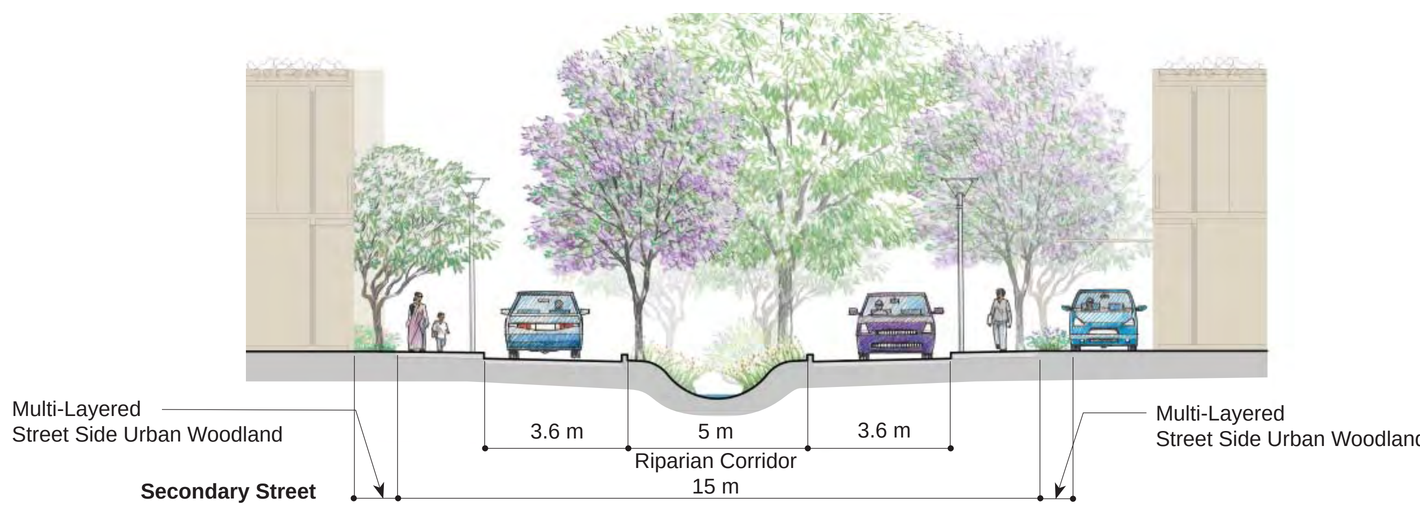
SERVICE ENTRY

0m 350m

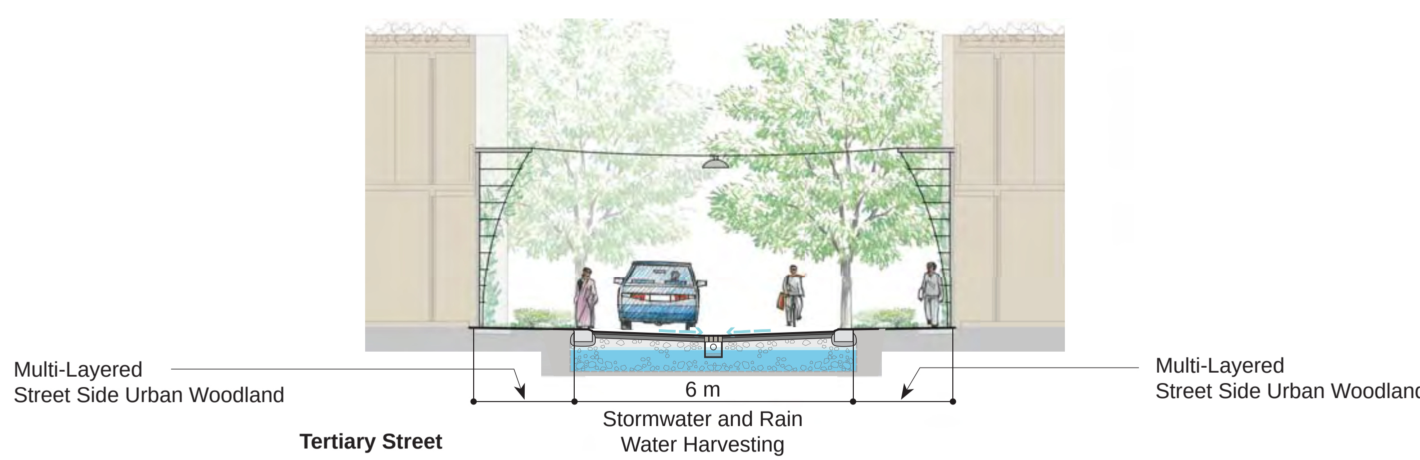




Primary Entry Boulevard



Secondary Street



Tertiary Street

SITE ROAD NETWORK

Network Design

Through the use of gently curving alignments, the street system creates unfolding vistas throughout the project. A clear hierarchy is established, beginning with the entry boulevards which form a connected loop, providing access to each residential district.

Secondary streets branch off to serve each district, while tertiary streets access individual building plots and entries. The tertiary streets, during the middle part of the weekday, will handle very little motor traffic and will become linear parks, using the *woonerf* or “living street” concept, where motorized, cycle and foot traffic co-exist and are balanced.

Recreational lanes connect the ends of tertiary streets to provide walking and running loops for residents and for required emergency vehicle access.

Streetscape Design

At 24.92 acres, the internal streets are the project’s largest amount of public space. Due to the site’s urban concept design and the limited amount of dedicated recreational open space, the streets are designed as an integral part of the site’s public realm. Along these streets, residents will meet each other, stroll, children will play, daily deliveries will be made--in short, the rich mix of activities that make for an active and vital community.

The streets are well landscaped to provide, when mature, a continuous canopy to shade hard surfaces, moderate temperatures in the dry season and provide wildlife habitat.

Woonerf “Living Street”

PARKING

Because of limited site area and high parking ratios, accommodating the program's parking requirement involves a mixture of structured and surface solutions.

Apartments

The overwhelming majority of the project's 4,924 parking spaces are associated with the apartment buildings. To provide the 3,046 apartment car parking spaces within a limited land and building footprint and to avoid excavation into the water table, the apartments are placed on a one-story parking podium, which accommodates resident and visitor cars. Service vehicles and a small amount of visitor and short-term resident parking occurs on roads and vehicle plazas on top of the podium.

Villas

Parking for villa residents is provided in each plot's sideyard setback. Villa visitors and service vehicles park their vehicles on designated mountable curb areas along the tertiary streets.

Townhomes

Parking for townhomes are accomodated with a "stilted" concept at the ground floor of each building. Visitors and service vehicles park their vehicles on designated mountable curb areas along the tertiary streets.

VILLA PARKING
- 1,020 spaces, at grade on each plot

TOWNHOUSE PARKING
- 804 spaces, at grade on each plot

APARTMENT PARKING
- 3,046 spaces, one-storey structured parking
- 24.5 acres impacted area at 350 gross SF per car[1]
- 24.5 acres structured area includes apartment building services

RETAIL AND CLUBHOUSE PARKING
- 54 spaces, one-storey structured parking
- 5 acres impacted area at 350 gross SF per car[1]
- 2.4 acres structured area includes clubhouse services and double height program

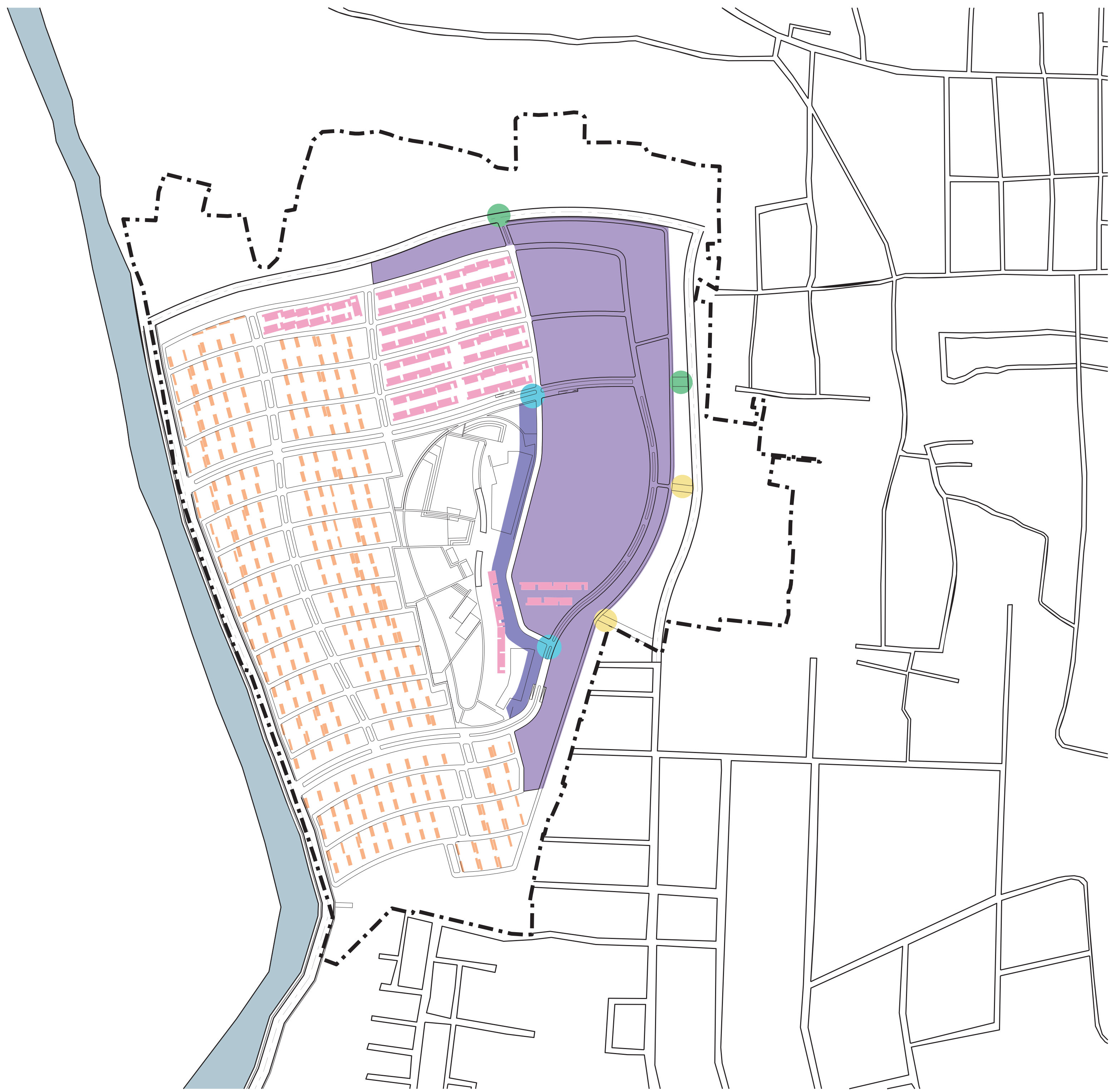
ENTRY

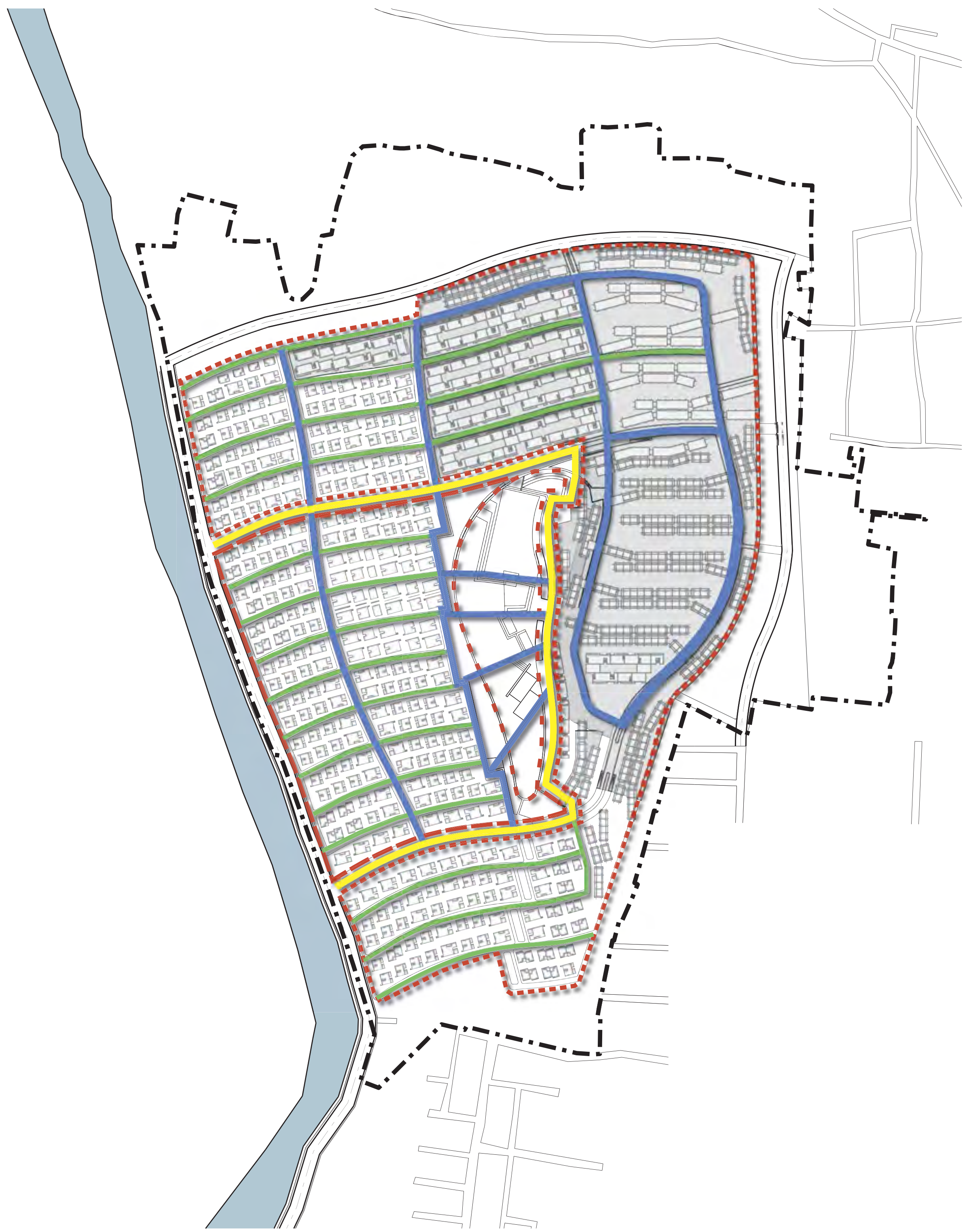
SECONDARY ENTRY

SERVICE ENTRY

1 Additional below slab area will be required for building services. To be further developed during future design phases.

0 m 350 m

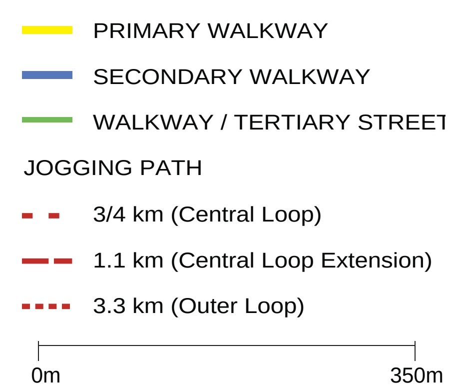




Central Loop

Central Loop Extension

Jogging Path



PEDESTRIAN CIRCULATION

Human Centered

The master plan is designated to encourage pedestrian and other types of nonmotorized transport for 100% of residential trips within the boundaries of the project. An attractive network of pedestrian pathways compliments and at times overlaps the street network to knit the master plan together at a human scale. The network is designed to:

- Reinforce a walkable township that provides opportunities for community interaction at various scales.
- Promote a universally accessible development with an emphasis on pedestrian and child safety, security, and ease of movement
- Encourage a healthy, outdoor lifestyle for all residents.
- Use long life cycle materials that are sourced locally, to weave the different neighborhoods into a cohesive network and contribute towards overall sustainability goals.
- Reduce impervious surfaces within the development in order to reduce storm runoff volumes generated.

Walkway Hierarchy

The primary walkway is 2.4m (8ft) wide and constructed with permeable unit pavers. The secondary walks are 2m (6ft) wide constructed of permeable unit pavers or asphalt with unit paver accents. The tertiary walks are combined with the tertiary streets since there will not be through traffic on these streets. In these low speed zones, the pedestrian will have the right of way and safe zones are provided at each unit driveway locations or at specific nodes where pedestrians can find temporary refuge from occasional vehicle. Jogging and bike paths of varying character and length radiate out from the central open space.

Traffic Calming

Multiple traffic calming techniques like raised tables (elevated cross-walks) in conjunction with surface treatments can be used at pedestrian crossings. These traffic calming techniques can be designed in conjunction with proposed nodes or junctions. Their width and materials would reflect their relative importance in the path hierarchy.

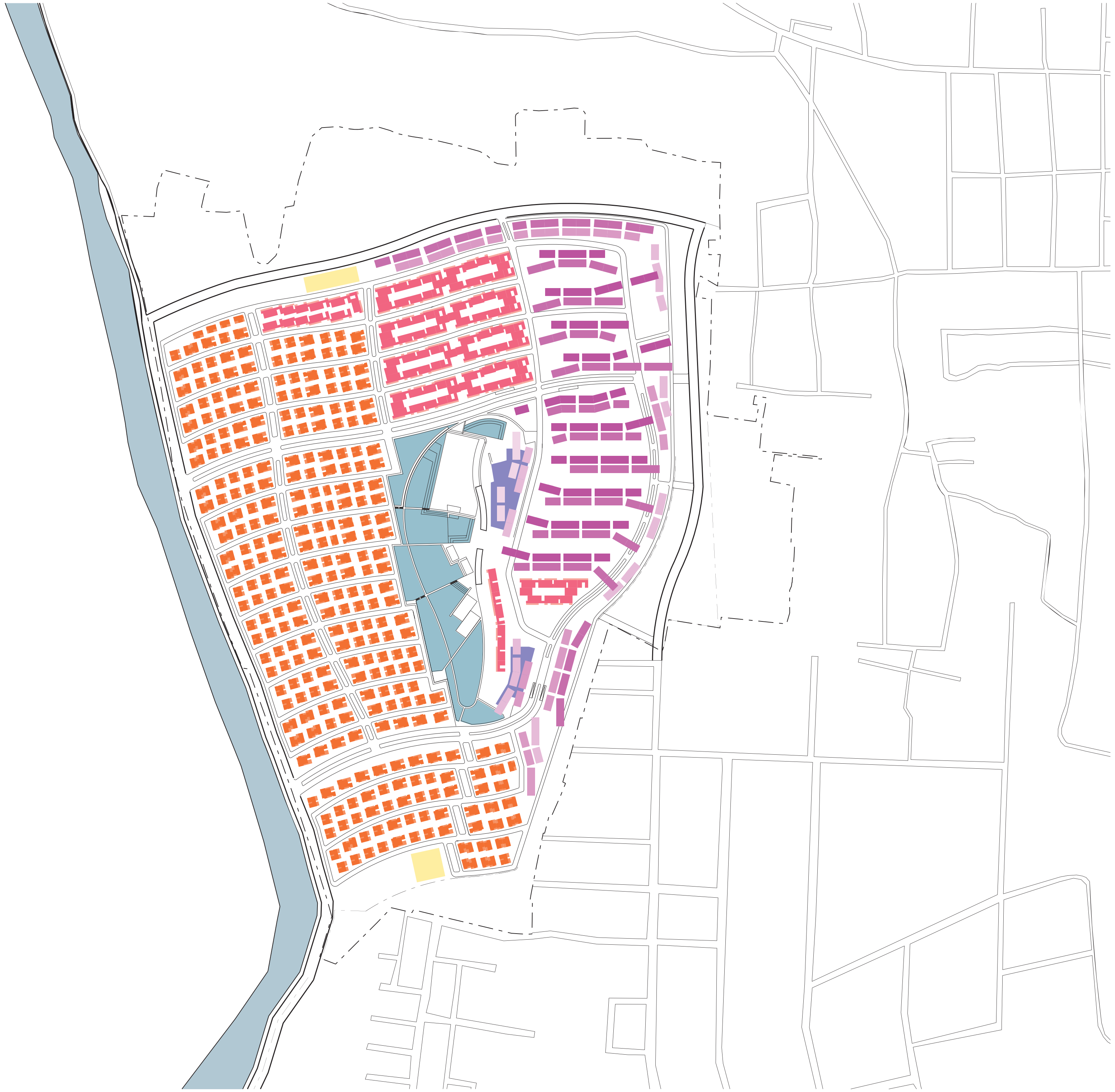
FIGURE GROUND

While the program's floor area ratio (FAR) is a modest 1.1, the footprint coverage of the buildings is high. This is due to the large amount of land area required for Villas and their individual plots. Accepting this constraint:

- Master plan develops an urban pattern of buildings, which fill or mostly fill their plots, thus creating strongly defined streets and open spaces.

Buildings are organized to maximize views, solar-orientation and natural ventilation. The site is more porous and open in the east-west direction, fostering easy pedestrian movement across its short dimension, leading to the central tank and public open spaces. Buildings are also deployed to reinforce the edges of the project site. The northern and eastern edges are more defined, while the western side along the Bund Road is more transparent and screen-like.

Due to land area limitations, setbacks are generally at required minimums, creating spaces between buildings which are narrower than the buildings themselves. These in-between spaces are programmed as multi-use gardens for rainwater harvesting or as parking courts which extend indoors space outward.



VILLAS

TOWNHOMES

APARTMENTS

CLUBHOUSES

RETAIL
- Within ground level of apartments

UTILITIES
- Electrical
- Solid waste managment
- Potable wastewater

0m 350m

ARCHITECTURAL PROGRAM

Initial test fits indicated that the buildable land area and TSI program requirements for the Villas, Townhomes and Apartments, using a 15m maximum height would result in a total area that did not meet proforma requirements.

With input from TSI, the quantity of Villas was maintained at program levels, while the quantities of Townhomes and Apartments were adjusted.

- Master Plan exceeds the TSI program area required with an altered program mix.

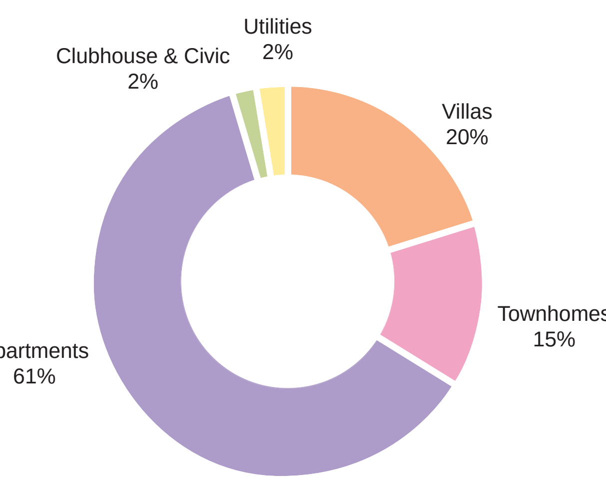
Villa quantity is slightly less. The original TSI program quantity can be attained by providing more of the smaller A1 villas.

Apartments unit quantity was increased to take advantage of the density that is possible using the 27 m height, available under the Second Chennai Master Plan. Using this increased height, the Master Plan incorporates a variety of building heights up to 9-stories.

The Townhomes in the Master Plan are designed as a raised 4-storey duplex building type. This stacked strategy reduces the land area required by the Townhomes, helping to achieve the required space for Utilities, Clubhouses, Water Management and Outdoor Public Spaces.

	TSI PROGRAM			MASTER PLAN							
BUILDING	UNIT SF	TOTAL UNITS	TOTAL AREA	UNIT SF	TOTAL UNITS	TOTAL AREA	RESIDENT POPULATION 5/unit	TRANSIENT POPULATION 1.5/unit	PARKING PER UNIT	TOTAL PARKING	UNDERGROUND PARKING AREA [1]
VILLAS		340	1,000,000		328	1,020,000	1,640	492		1,020	within lot
3-Bedroom type A1	2,000			2,000	72	144,000			2		
4-Bedroom type A2	3,000			3,000	148	444,000			3		
5-Bedroom type A3	4,000			4,000	108	432,000			4		
TOWNHOMES		587	1,170,000		329	763,990	1,645	494		804	within block
3-Bedroom type B1	1,450			See	183	371,850			2		
4-Bedroom type B2	2,350			Page 61	146	392,140			3		
APARTMENTS		1,400	2,200,000		1,523	4,896,096	7,615	2,285		3,046	24.5 acres
2-Bedroom type C1	1,200			See	263	403,490			2		
3-Bedroom type C2	1,600			Page	726	1,427,095			2		
4-Bedroom type C3	2,100			65	534	1,281,521			2		
SUBTOTAL			**4,370,000**			**4,886,096**		**3,271**		**4,870**	**24.5 acres**
CLUBHOUSES			80,000			80,000		100	1/2,000 SF	44	0.4
AMENITIES & RETAIL			20,000			20,000		25	1/2,000 SF	10	0.1
UTILITIES			130,000			130,000					
GRAND TOTAL		**2,327**	**4,600,000**		**2,180**	**5,126,096**	**10,900**	**3,396**		**4,924**	**25.0**

1 350 SF/space; This does not include area for underground building cores or utilities



Master Plan Program Mix

SITE AERIAL

- Site massing reinforces the concept of a compact, walkable community focused on a central open space and water tank

Buildings heights are developed to maximize views, solar-orientation, natural ventilation and reduce wind shadowing. The site is more porous and open in the east-west direction, encouraging pedestrian movement across its short dimension leading to the water and public open spaces.

All three residential districts—Villa, Townhome and Apartment—meet at the central tank. Lower buildings front onto a public promenade which invites residents to move around the tank. The taller apartments step back away from the edges of the open space, reaching their maximum height at the center of their district.

Rising beyond the Villas and Townhomes, the Apartments in con-sort with the Clubhouses and Retail, form the “urban” center of the project. Here, the highest development density and the most varied mix of activities and uses is found.

The two-storey Villas are set among a landscape of tree-lined streets. As the trees mature, views in the direction of the Villas from the taller Townhomes and Apartments will be of an urban forest, rooftop gardens and terraces.

LANDSCAPE STRUCTURE

The master open space structure integrates the natural environment of the project with its built structures. Site scale gateways mark entrances from the Bund Road and establish the identity of the project to the outside of the site. The entry experience extends into the development with additional gateways at civic and residential scales.

Shared spaces can be an effective and attractive project edge and boundary. A programmed park and forested buffer space within the Open Space Reserve can create a functional open space for village residents, and provide much needed relief from the density of the village and new development.

Circulation corridors, like the roadway and pedestrian network are the open space and landscape structure of the project. These corridors are designed as “woodland gardens” that act as landscaped thresholds between the private and public realm. They also integrate stormwater and recharge functions in a visually attractive and elegant manner celebrating vital sustainable principals.

The central open space with its community facilities, recreation, and retail activities is the organizing focus to the civic life of the residents. It is the heart of the project.

- SITE GATEWAY
- ENTRY GATEWAY
- CIVIC GATEWAY
- RESIDENTIAL GATEWAY
- SECONDARY GATEWAY
- STREETSCAPES AND URBAN WOODLANDS
- MANAGED ROOF GARDENS
- CIVIC OPENSPACE
- OPEN SPACE RESERVE (OSR)
- EDGE LANDSCAPE / BUFFER
- ENTRY LANDSCAPE
- RIPARIAN CORRIDOR
- CENTRAL WATER TANK

0m 350m

PLANTING ZONES

The landscape should reflect natural landforms, reinforce the existing hydrologic cycle, reflect cultural traditions, and provide a sustainable amenity for the community. It also provides the setting for the buildings, and defines a hierarchy of spaces for movement, socializing and recreation, while providing significant shading and moderation of the project's micro-climate.

The planting strategy within the different zones re-establishes native plant communities and habitats, responding to the need for open spaces, active as well as passive recreation, and residential unit privacy without creating barriers. Other strategies include:

- Emphasizing plants native to the region. If native plants cannot be used, planting regionally adapted non-invasive plants.
- Landscapes that are self-maintaining and use a minimum of human and energy capital.
- Utilizing sustainable landscape management, including pest management for all public space, and prompting the same practices for private gardens through the township maintenance agency and owner education.

Multi-layered pattern of forest and "urban woodland" communities, with canopy, understory, shrub and groundcover plants native to the region reinforces the major boulevard and entries and streets. A "two layered urban woodland" is developed on streetscapes where the intent of the landscape is to provide a setting for the dwelling as well as provide visual connectivity to the streets. Riparian corridors will establish a lowland plant community.

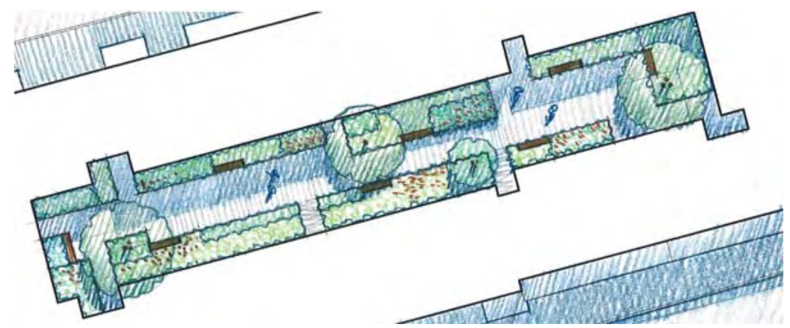
Riparian Corridor

Multi-layered urban woodland and green screen
- variety of plant species
- canopy, understory, shrub, ground cover
- greater use of climber species for green screen
- -• drought tolerant with with minimal irrigation

Multi-layered streetside urban woodland
- provide shade
- seasonal color
- reinforce streetscape rhythm
- drought tolerant

Constructed wetlands
- water loving species
- shade loving species
- continuous water supply

Two-layered streetside urban woodland
- provide shade
- seasonal color
- reinforce streetscape rhythm
- drought tolerant



Two-layered courtyard urban woodland
- screening
- provide shade
- provide gathering space

Managed public garden and park
- provide shade
- seasonal color
- more lush
- year round irrigation

Multi-layered backyard urban woodland
- screening and privacy
- higher density
- provide shade
- provide

Riparian corridor
- water tolerant species
- shade tolerant species
- irrigation in dry season

Multi-layered forest
- variety of plant species
- canopy, understory, shrub, ground cover
- reintroduce tropical dry evergreen forest
- drought tolerant with minimal irrigation

Bund Road Entry

OPEN SPACE RESERVE

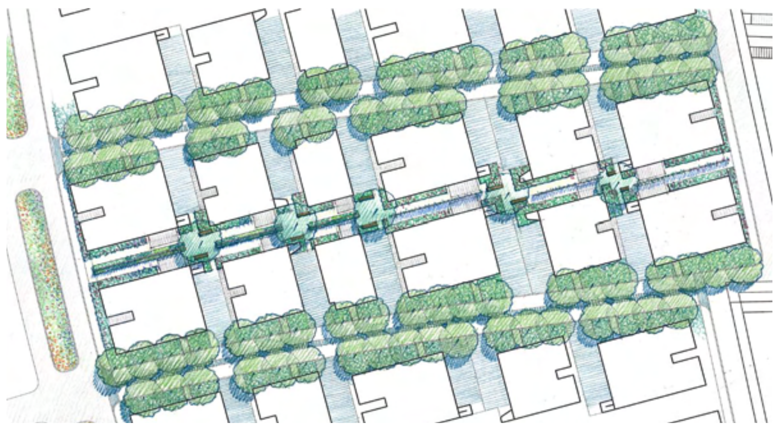
Landscape Character

The landscape reflects integrated planning. While it is important that the development have a healthy native plant community, it is also essential that it look well maintained. A landscape management philosophy of “ordered ecology” is proposed for the development, where environmental stewardship supports a neat and organized aesthetic. Well maintained native plants and careful attention to details, such as curbing or flush stone edges, demonstrate a level of sensitivity and planning.

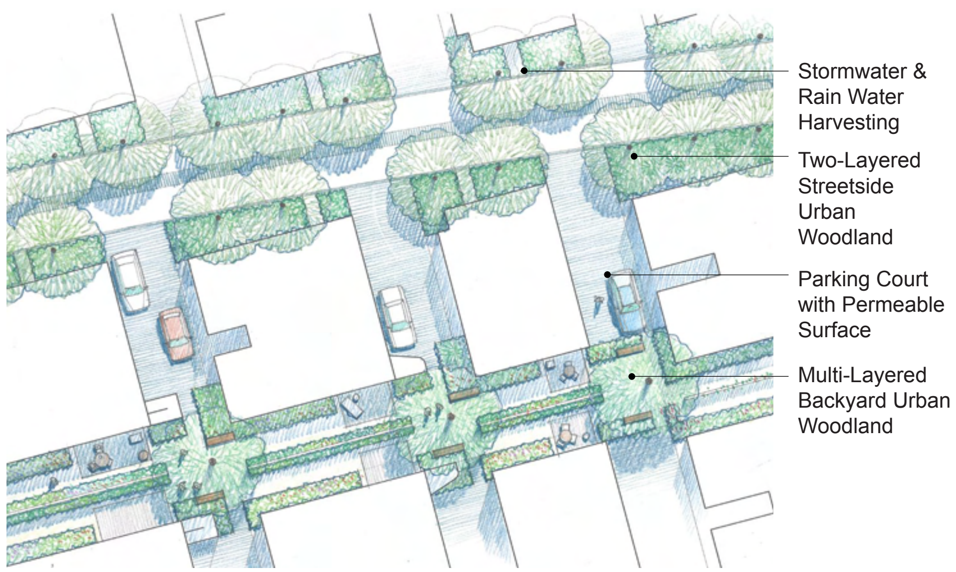
Open Space Reserve

VILLA

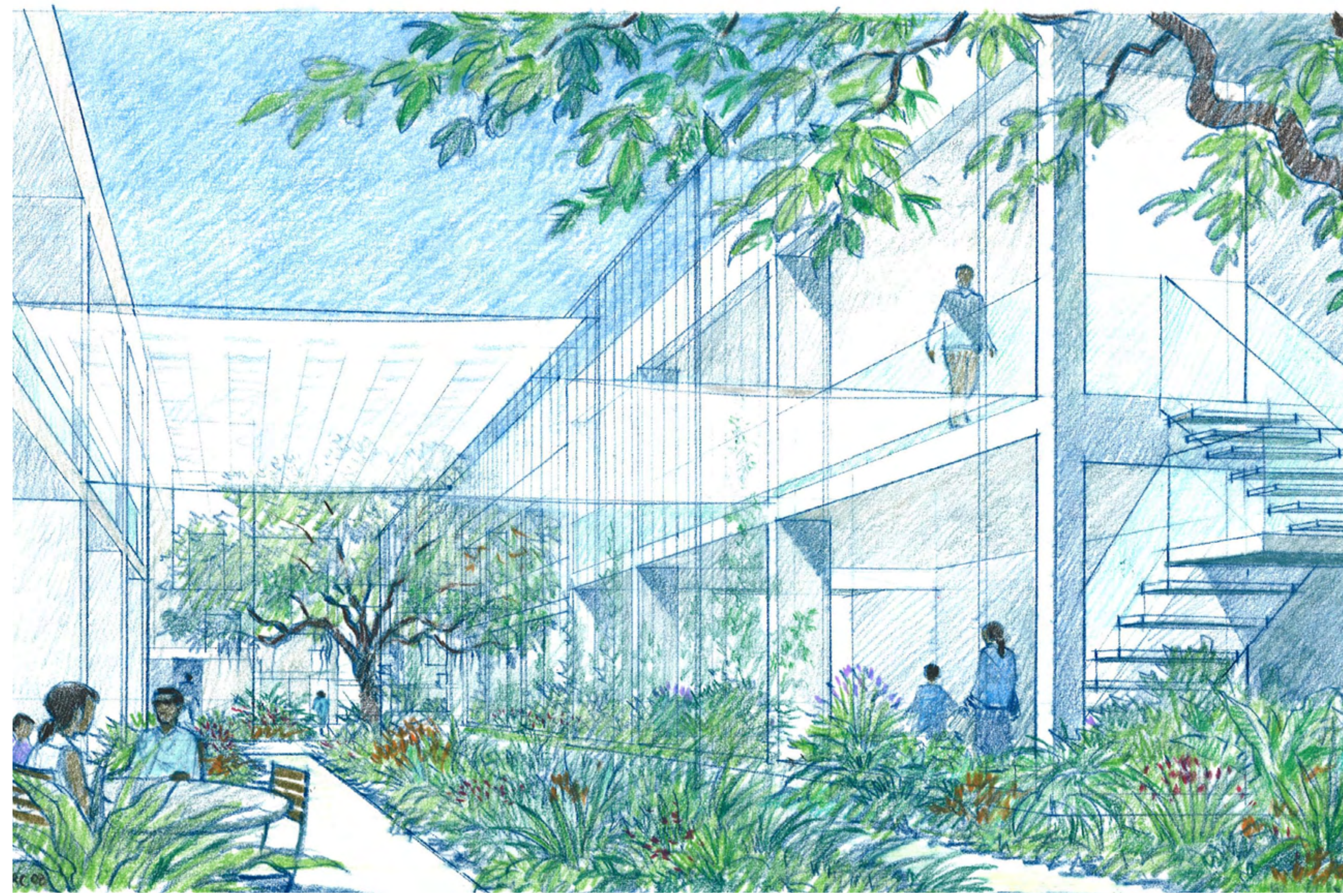
The villa landscape is a fusion of social, spacial and cultural experiences. The entire tertiary streets are raised platforms which slow entering and exiting traffic. An avenue of shade trees defines the boundaries between house and the street. Back yards are extensions of living spaces, and buffer spaces serve as informal neighborhood social nodes, places where families meet, underneath shaded canopies.



Villa Block Plan



Villa Enlargement Plan



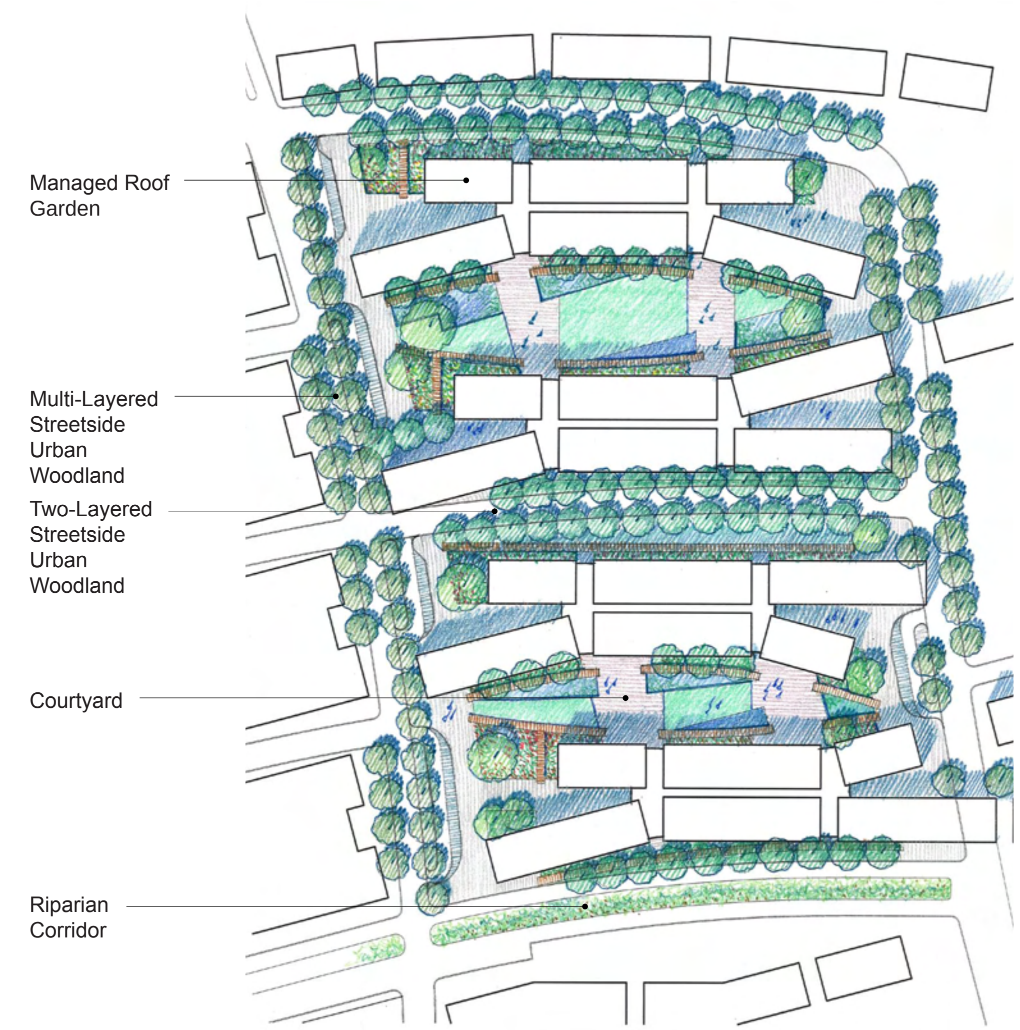
Villa Rear Gardens

APARTMENT

Enclosures of varied scales created by building orientations and layout provide opportunities for active, social, recreational and contemplative uses. The structure can support roof gardens, incorporating a range of landscape types and spaces.

Landscapes at building entries provide focal points and act as threshold gardens, or transition spaces between the private and public realm. Plantings and architectural elements enhance the landscape spaces, while pedestrian oriented circulation corridors link the various spaces.

Apartment Courtyard



Apartment Block

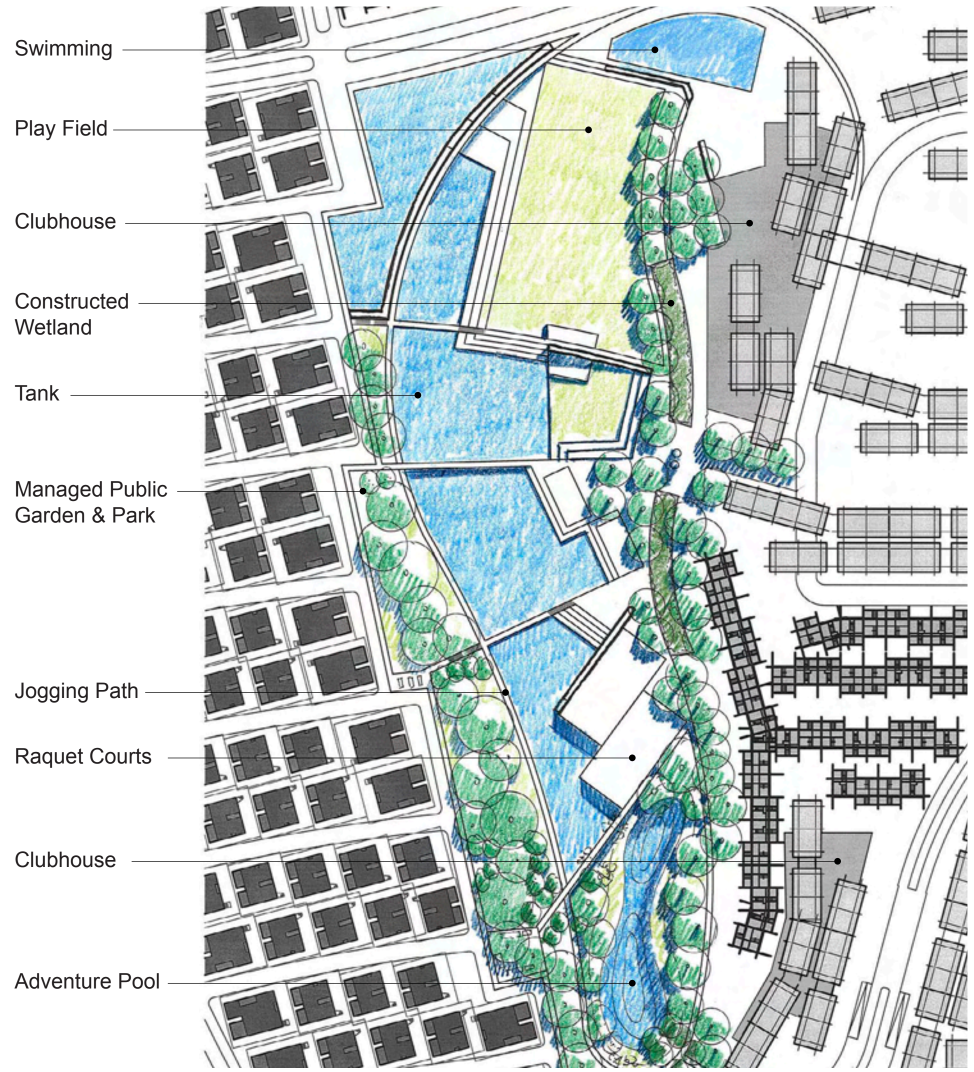
Central Open Space, View Toward Clubhouses

CENTRAL OPEN SPACE

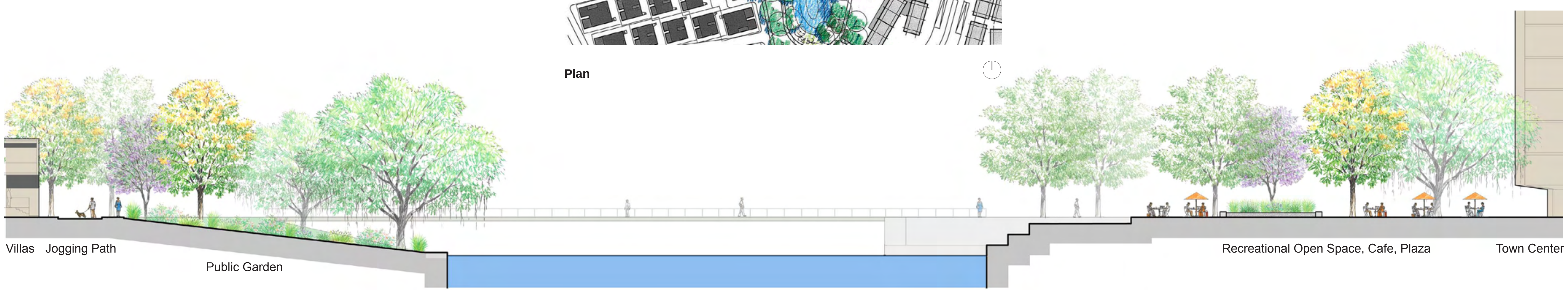
The Central Open Space forms the geographical centre of the development. Recreation, community, and retail facilities are located along the eastern edge. The Central Tank performs the function of a stormwater detention facility, in addition to providing aesthetic and microclimate benefits. Pedestrian walkways and bridges connect the villa and townhome neighborhoods to the clubhouse and recreation facilities.

Architectural elements such as the amphitheater, planters, walls, and plazas, provide opportunities for community interaction and social events. Constructed wetlands located within the public open space integrate the wastewater system of the club houses with landscape elements.

Other recreation facilities such as the jogging path, tennis and volleyball courts, and pools make the central space active and vibrant.



Plan



Section

VILLA DISTRICT

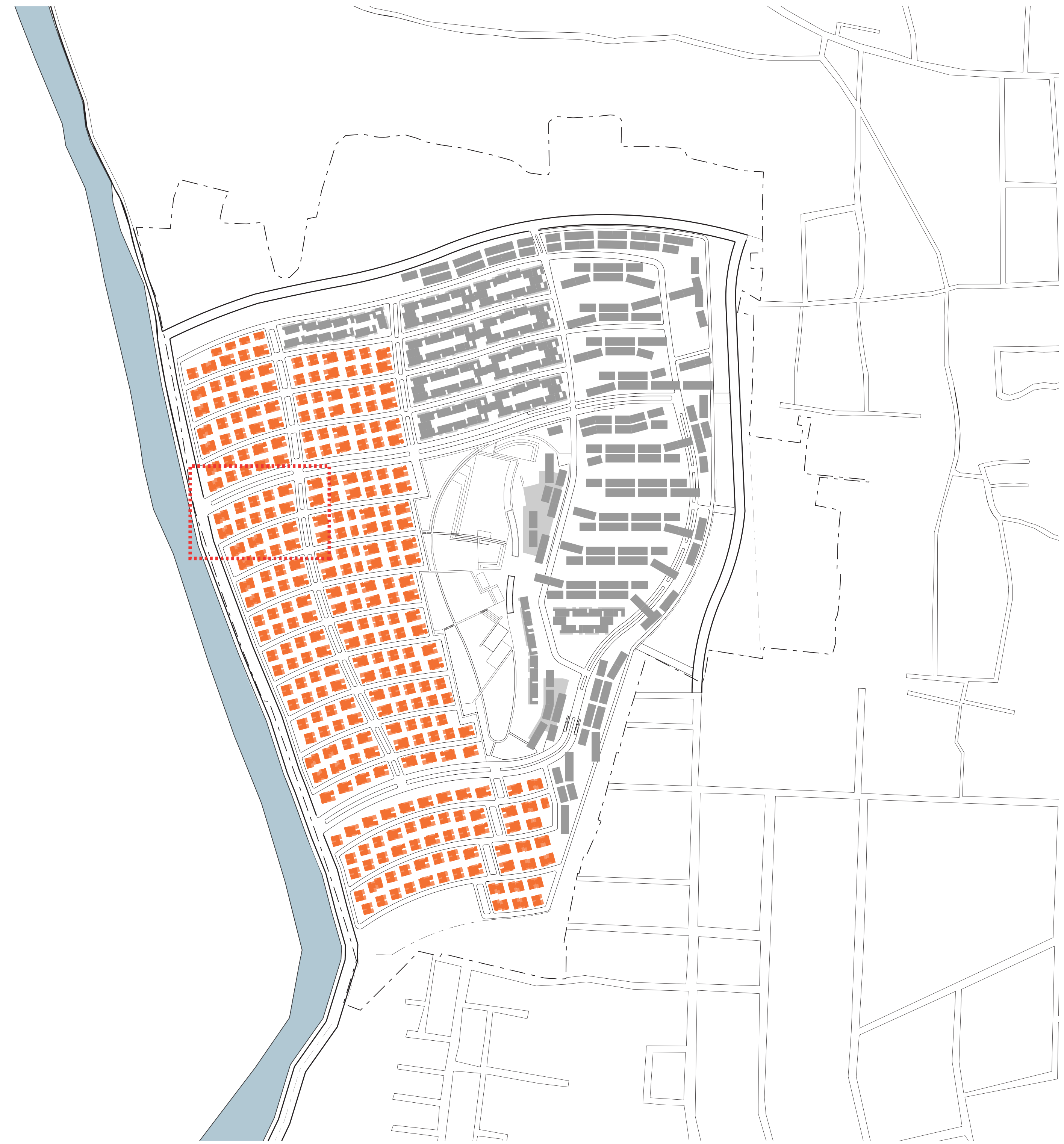
Designed as low-scaled walkable neighborhood with quiet tree-lined streets and small blocks, the Villa District is the Master Plan's lowest density area at 12 units/acre. Despite being single family houses, land is used very efficiently and wisely. The dwellings and their plots form a series of yards and gardens. Cars are parked on permeable pavement in the side yards, which are developed as secure auto courts. In the rear setbacks, intimate family centered gardens extend interior space to the exterior, linking people to nature. Street facades both protect the privacy of the house and create transitional spaces between the public and private realm.

The Villas are two-story buildings with accessible roof gardens. Compact in plan, they are organized to provide lifestyle flexibility in the Indian context, maximize natural light and passive cooling opportunities. Street or garden elevations face either north or south. Exposure to the east and west is minimize and controlled.

	Floors	Units	SF
Building 1 - Three Bedroom A1 Unit	2	72	2,000
Sub Total		72	144,000
Building 2 - Four Bedroom A2 Unit	2	148	3,000
Sub Total		148	444,000
Building 3 - Five Bedroom A3 Unit	2	108	432,000
Sub Total		108	432,000
Grand Total		328	1,020,000

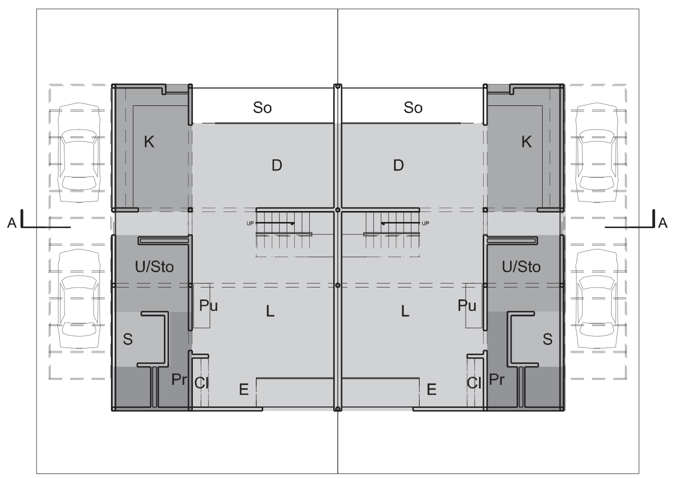
Typical Block Layout

0m 50m

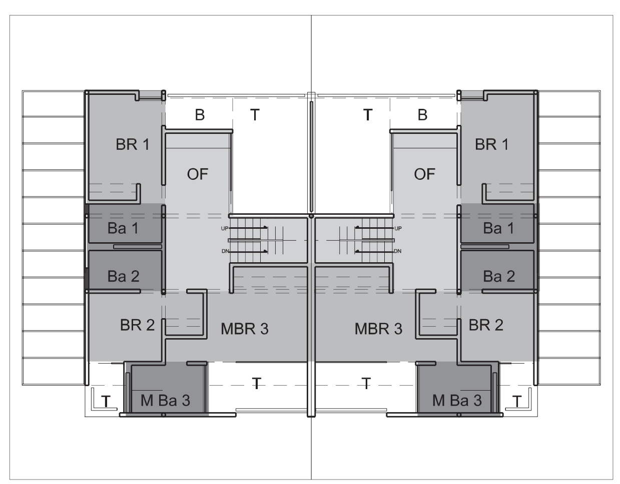


Site Plan Layout

0m 350m

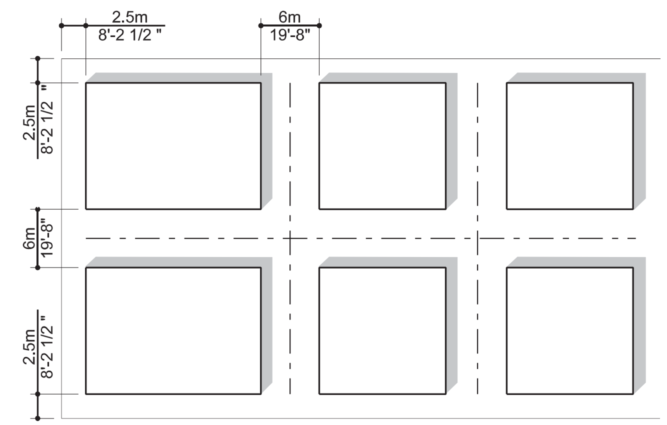


Ground Floor

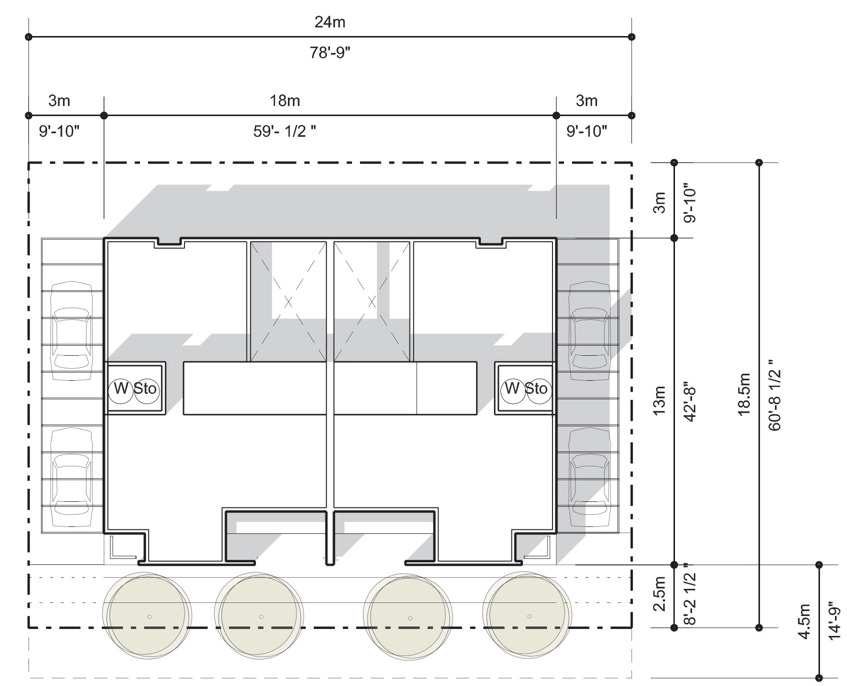


Second Floor

B - Balcony
Ba - Bathroom
BR - Bedroom
Cl - Closet
D - Dining Room
E - Entry
F - Family Room
K - Kitchen
L - Living Room
S - Servants Room
Pr - Powder Room
OF - Office
Pa - Play Area
Pu - Puja
So - Sit Out
T - Terrace
U/Sto - Utilities/Storage
W/Sto - Water Storage Tanks



Villa Block Setbacks



Site Plan

Front Elevation

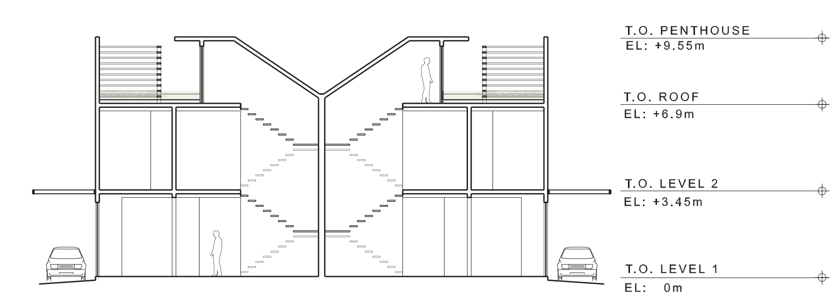
VILLA A-1

"Duplex" concept with shared demising wall.
To increase land efficiency and meet the TSI program's required plot size, the smallest Villas are paired along a common wall. This gives, what would have been a small façade, much more street presence and market appeal.

- Unit owner parking provided in 3m sideyard setback
- Front yard setback is 2.5m from curb, requiring a portion of the front-yard setback to be part of the private street in front of each Villa. This maintains a 6m setback between buildings.

- 4,800 SF lot
- 2 x 2 ,000 SF foot print 50% lot coverage
- 2 x 2,000 SF Villa
- 9.55m tall

TSI Program lot/carpet area ratio	1.2
Designed lot/carpet	1.2
TSI Program Lot Area	2,400 x 2 = 4800 SF
Designed Lot Area	4,800 sf



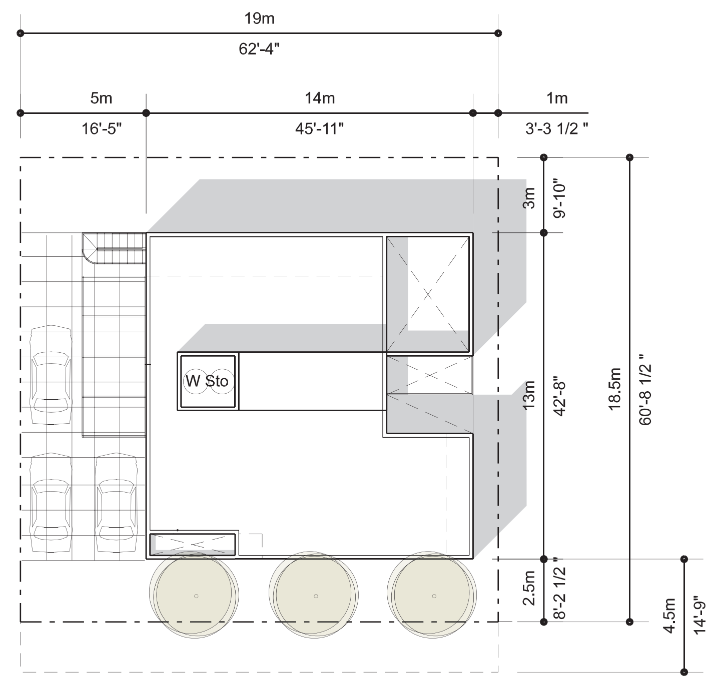
Section A:A

VILLA A-2

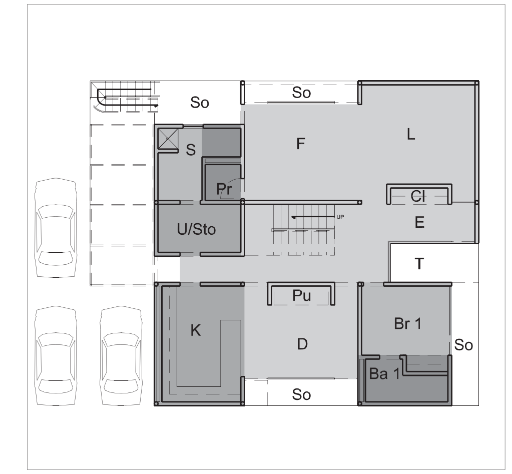
- Unit parking provided in 5m sideyard 1m abutting sideyard provides 6m total sideyard set back distance.
- Guest parking (1 space per unit) provided in side
- Front yard setback is 2.5m from curb, requiring a portion of the front-yard setback to be part of the private street in front of each Villa. This maintains a 6m setback between buildings.

- 3,800 SF lot
- 1,800 SF foot print 47% lot coverage
- 3,000 SF villa
- 9.55m tall

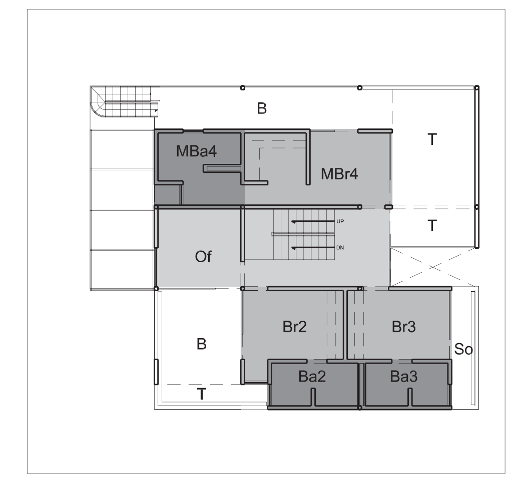
TSI Program lot/carpet area ratio	1.2
Designed lot/carpet	1.27
TSI Program lot area	3,600 SF
Designed lot area	3,800 SF



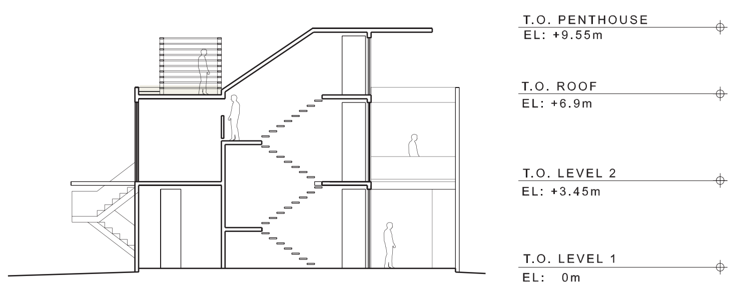
Site Plan



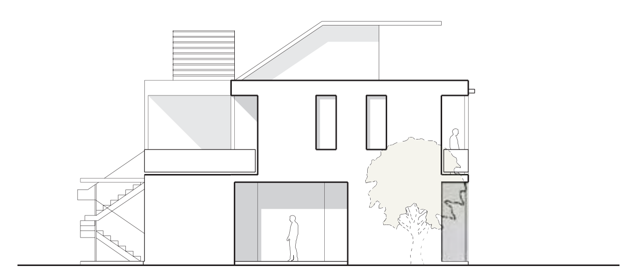
Ground Floor



Second Floor



Section B:B

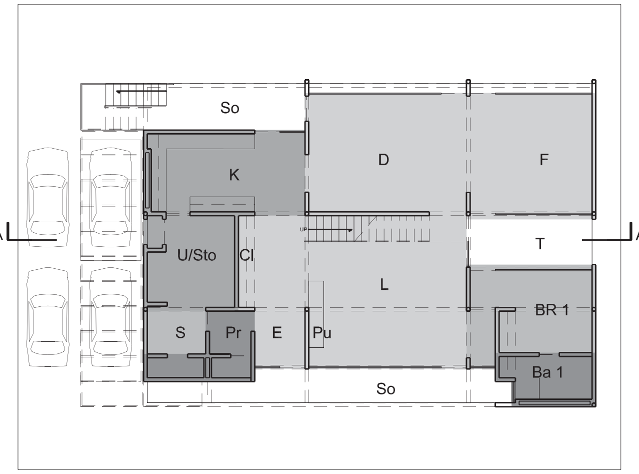


Front Elevation

B - Balcony
Ba - Bathroom
BR - Bedroom
Cl - Closet
D - Dining Room
E - Entry
F - Family Room
K - Kitchen
L - Living Room
S - Servants Room
Pr - Powder Room
OF - Office
Pa - Play Area
Pu - Puja
So - Sit Out
T - Terrace
U/Sto - Utilities/Storage
W/Sto - Water Storage Tanks

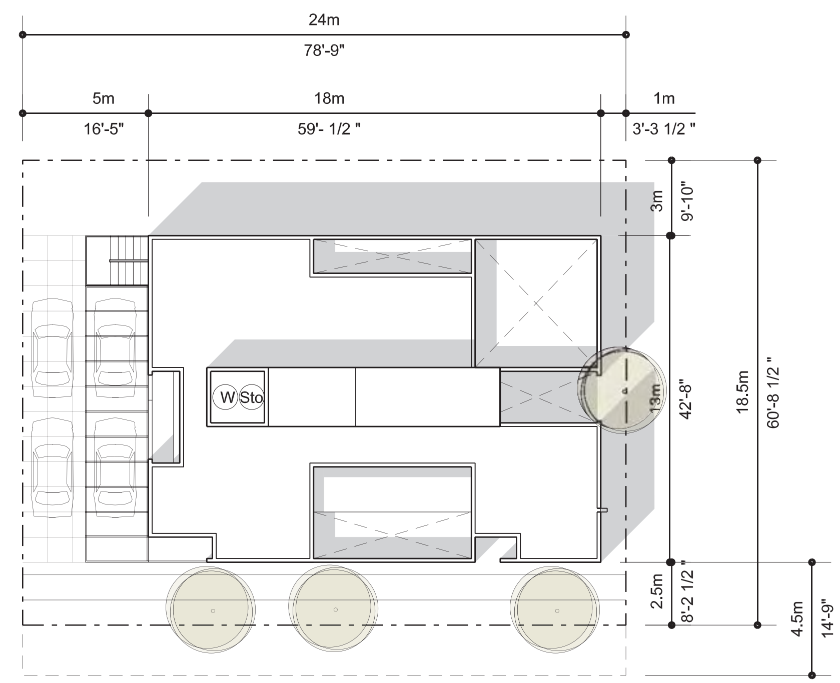
0m 5m

VILLA A-3



Ground Floor

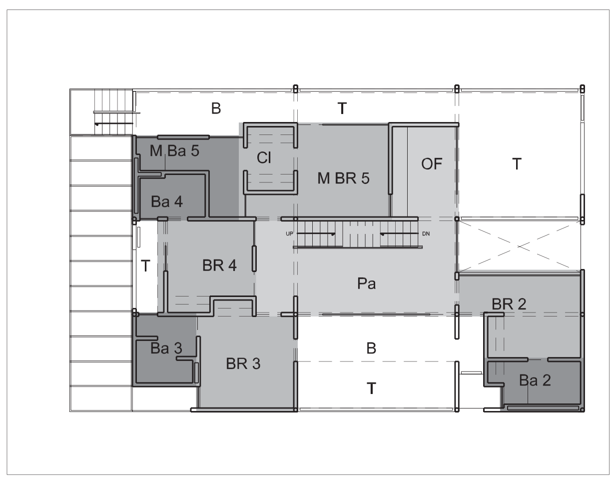
- Unit parking provided in 5m sideyard 1m abutting sideyard provides 6m total sideyard set back distance.
- Guest parking (1 space per unit) provided in side
- Front yard setback is 2.5m from curb, requiring a portion of the front-yard setback to be part of the private street in front of each Villa. This maintains a 6m setback between buildings.



Site Plan

- 4,800 SF lot
- 2,130 SF foot print 44% lot coverage
- 4,000 SF villa
- 9.55m tall

TSI Program lot/carpet area ratio	1.2
Designed lot/carpet	1.2
TSI Program lot area	4,800 sf
Designed lot area	4,800 sf



Second Floor

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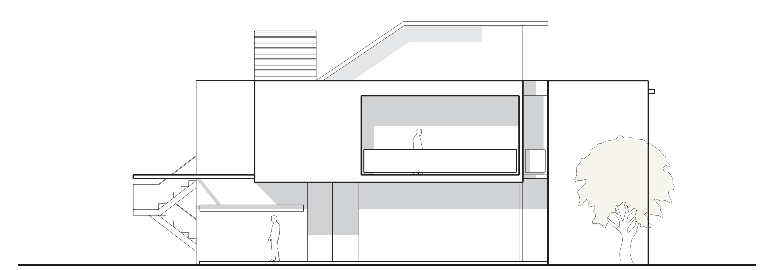
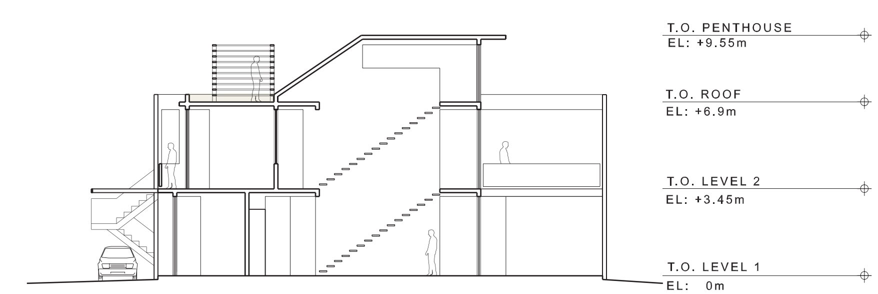


Front Elevation



Section A:A

0m 5m

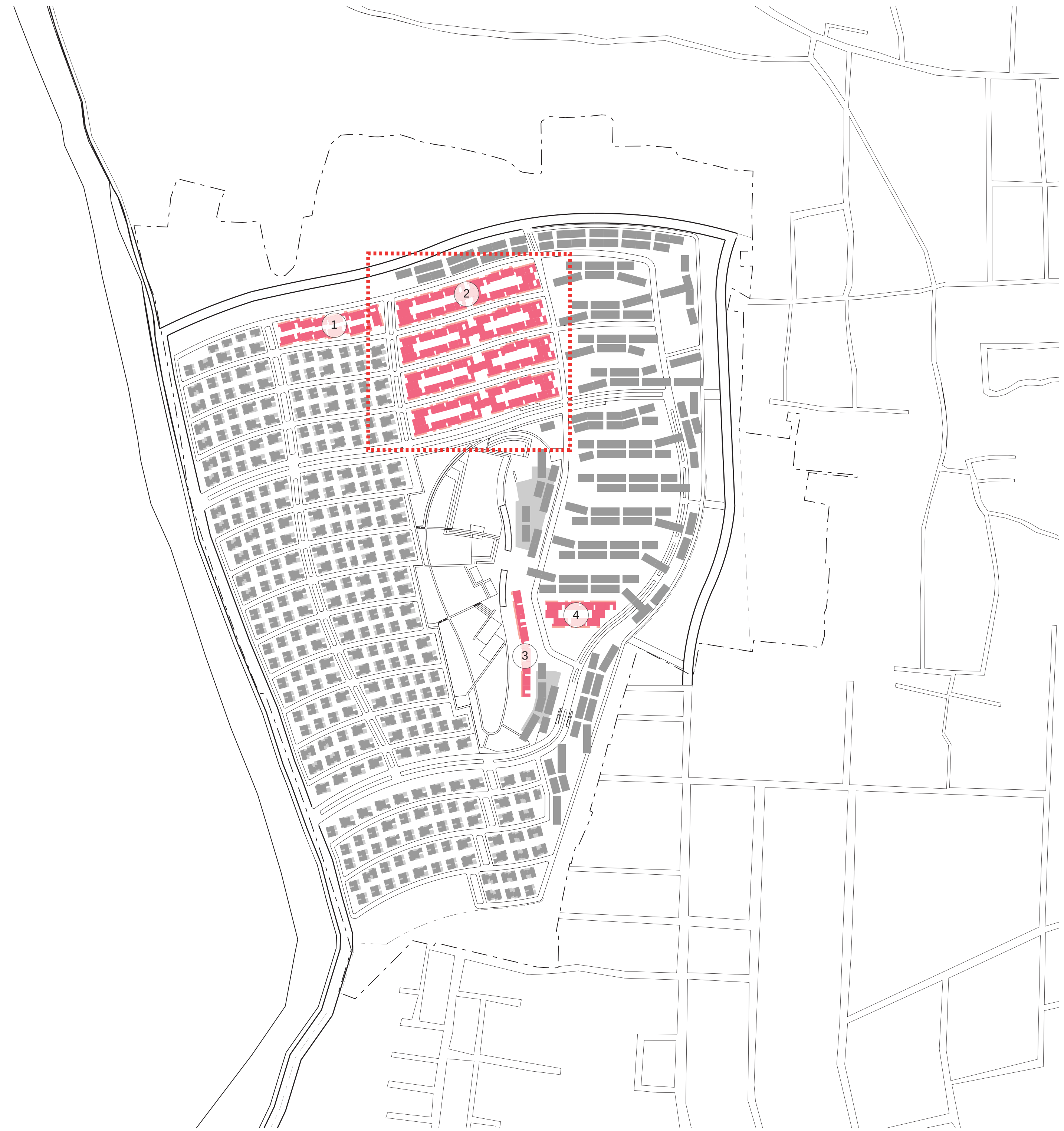
The Master Plan re-defines the Townhome building type from the TSI Program. Rather than two-story attached houses on small individual plots, Townhomes units are stacked duplexes and single level homes, each with a generous elevated garden room and terraces, connecting indoor and outdoor living.

Inspired by a European urban scale, each 5-story Townhome building consists of a series of planning and structural modules, organized around a common landscaped courtyard, which bedroom balconies overlook. The overwhelming majority of the Townhomes, like the Villas, have both a north and south elevation, which provides excellent natural lighting and ventilation

Privacy for the units is maintained by individual elevator and access stairs, which serve at most only two units per floor. Resident parking is discretely accommodated at grade under each building, with the farthest space only 18 m (60 ft) from an elevator. This assures an excusive entry experience for a limited number of units. Guest and service vehicle parking is provided on mountable curbed parking in the streets. Front yard setback is 2.5m requiring a portion of the setback to be part of the private street in front of each Townhome building

Typical Block Layout

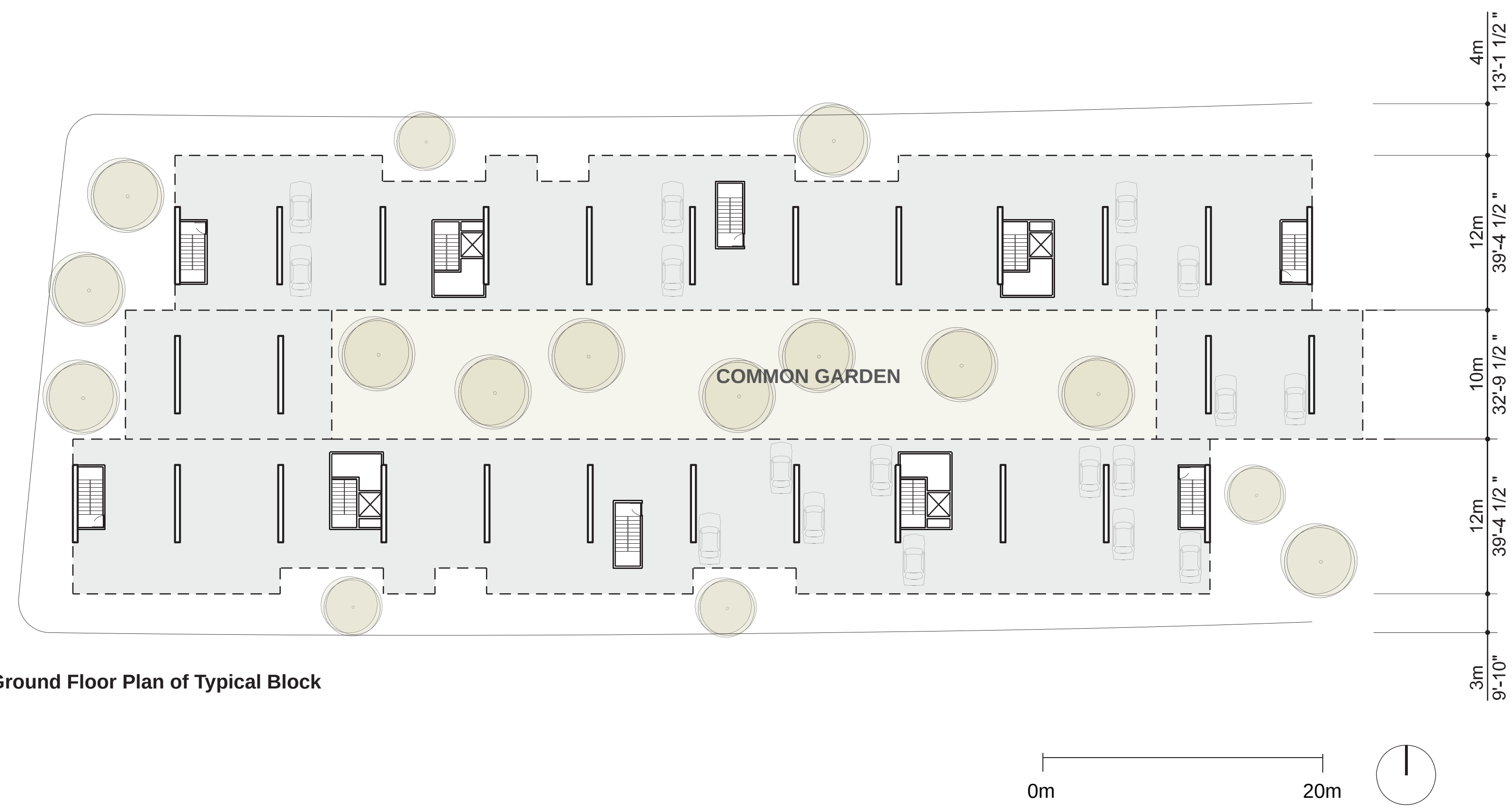
0m 80m



Site Plan Layout

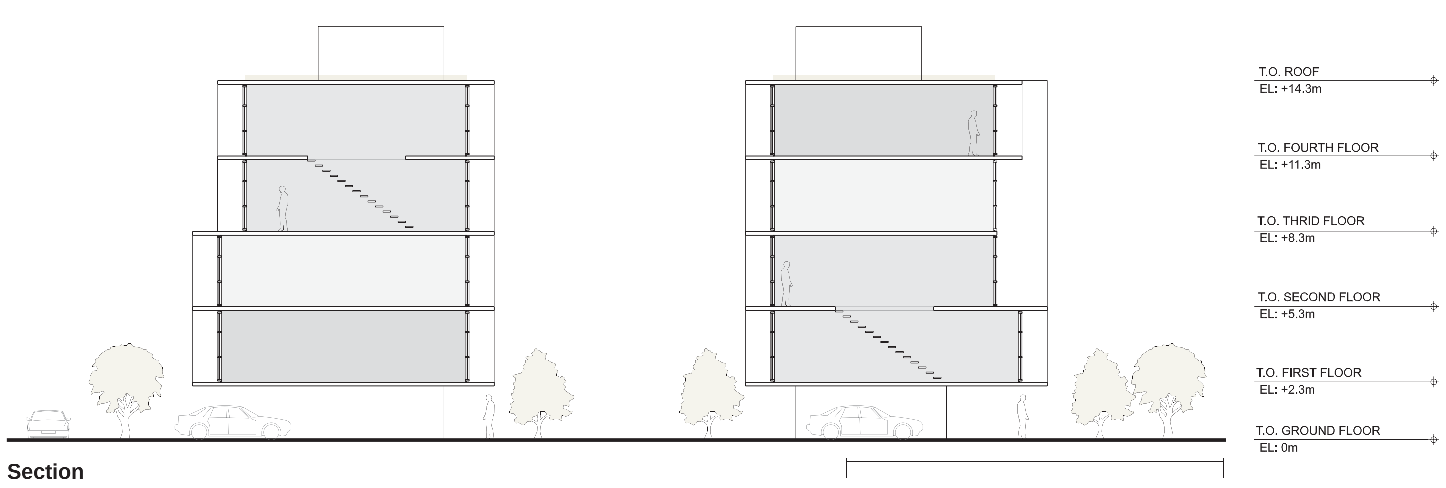
0m 350m

TOWNHOUSE



Ground Floor Plan of Typical Block

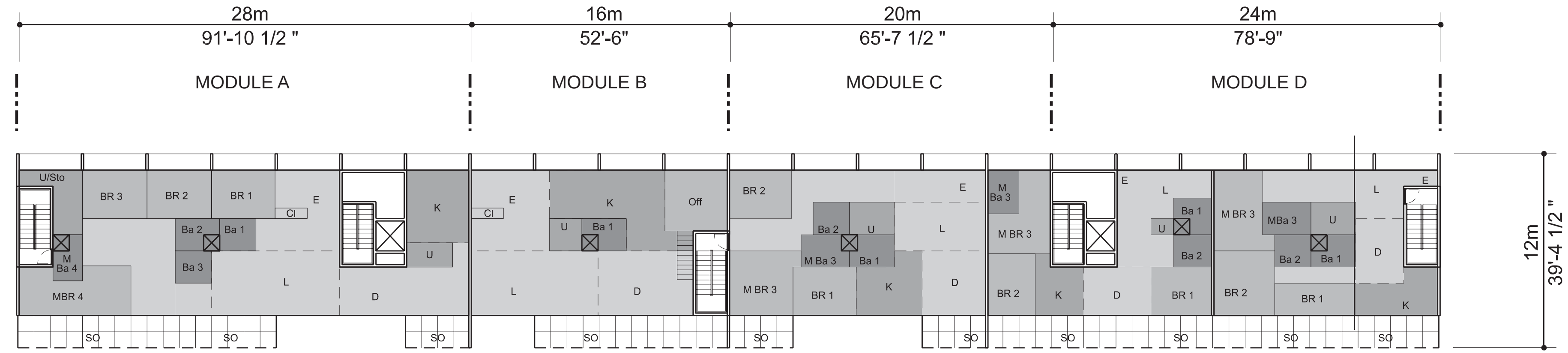
	Units/Module	Quantity	Units	SF	Total SF
Building 1					
Module A	4	7	28	73,010	
Module B	2	2	4	11,520	
Module C	4	2	8	16,442	
Sub Total		11	40		100,972
Building 2					
Module A	4	4	16	41,720	
Module B	2	4	8	23,040	
Module C	4	4	16	32,884	
Module D	5	4	20	40,208	
SubTotal		20	60	137,852	
SubTotal x 4 Buldings		80	240		551,408
Building 3					
Module A	4	1	4	10,430	
Module B	2	1	2	5,760	
Module C	4	2	8	16,442	
Module D	5	2	10	20,104	
Sub Total		6	24		52,736
Building 4					
Module A	4	2	8	20,860	
Module B	2	2	4	11,520	
Module C	2	4	8	16,442	
Module D	5	1	5	10,052	
Sub Total		9	25		58,874
Grand Total		90	329		763,990



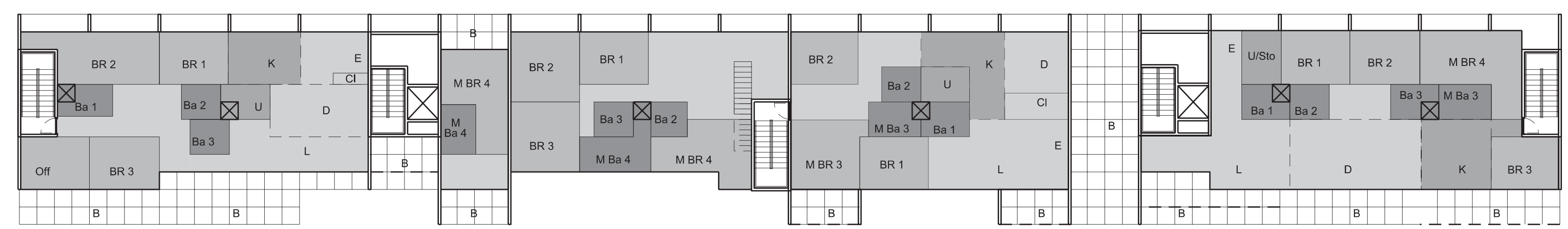
Section

TOWNHOUSE

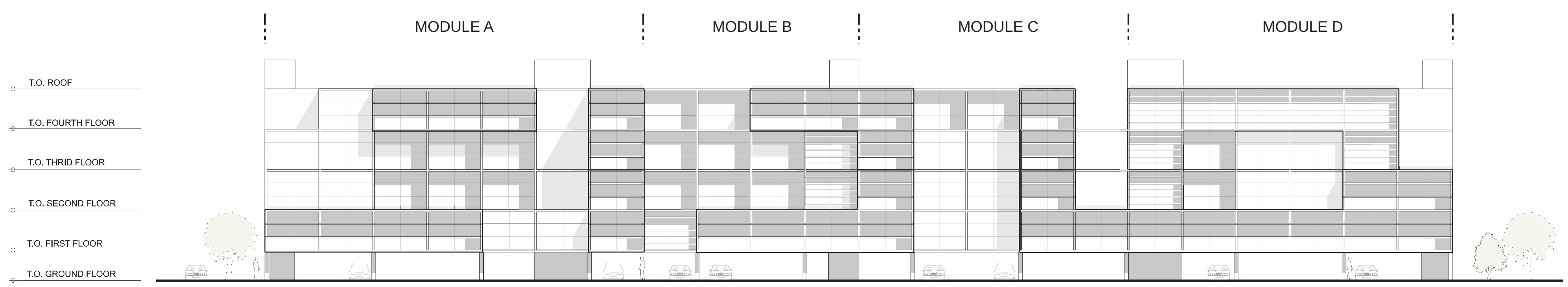
	Type	SF	Total SF
Module A			
First Floor	B-2	2,745	
Second Floor	B-2	2,766	
Third Floor	B-2	2,249	
Fourth Floor	B-2	2,670	
Sub Total			10,430
Module B			
First Floor	B-2 (duplex)	2,789	
Second Floor			
Third Floor	B-2 (duplex)	2,971	
Fourth Floor			
SubTotal			5,760
Module C			
First Floor	B-1	1,711	
Second Floor	B-1	2,195	
Third Floor	B-1	2,195	
Fourth Floor	B-1	2,120	
Sub Total			8,221
Module D			
First Floor	B-1	1,431	
	B-1	1,528	
Second Floor	B-1	2,626	
Third Floor	B-1	2,196	
Fourth Floor	B-1	2,271	
Sub Total			10,052
Grand Total			34,463



First Floor Plan

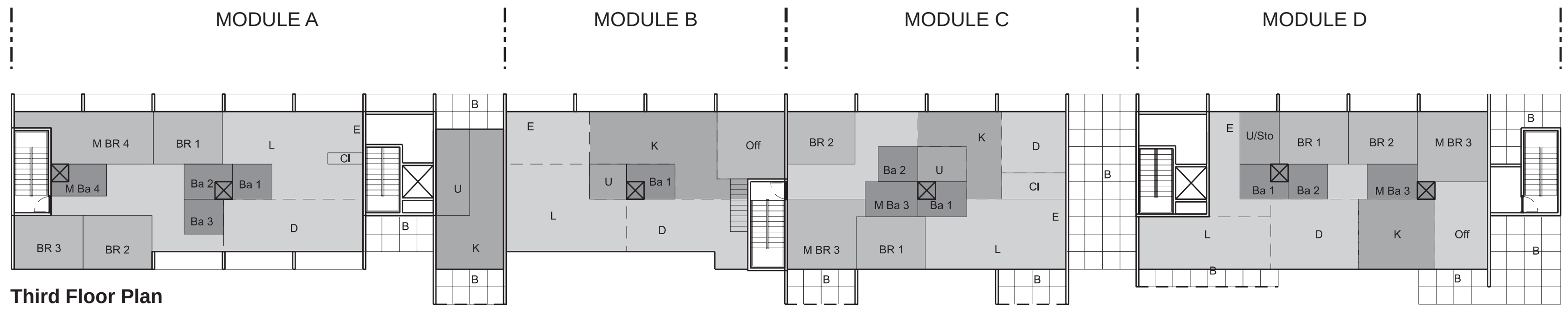


Second Floor Plan



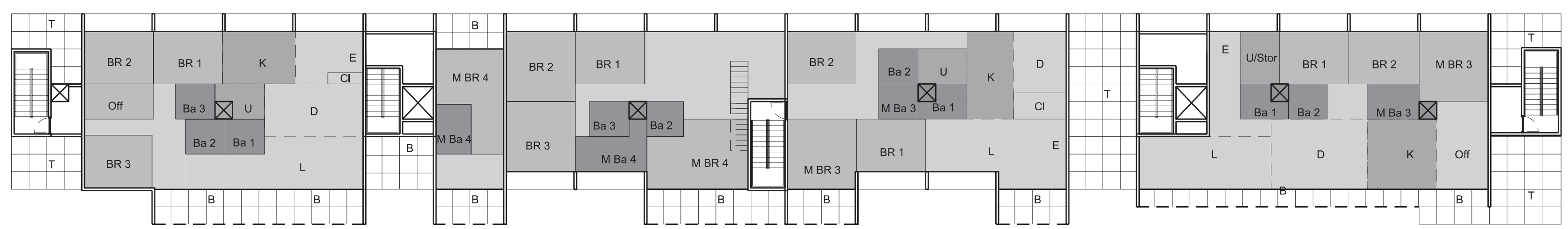
Street Elevation

TOWNHOUSE

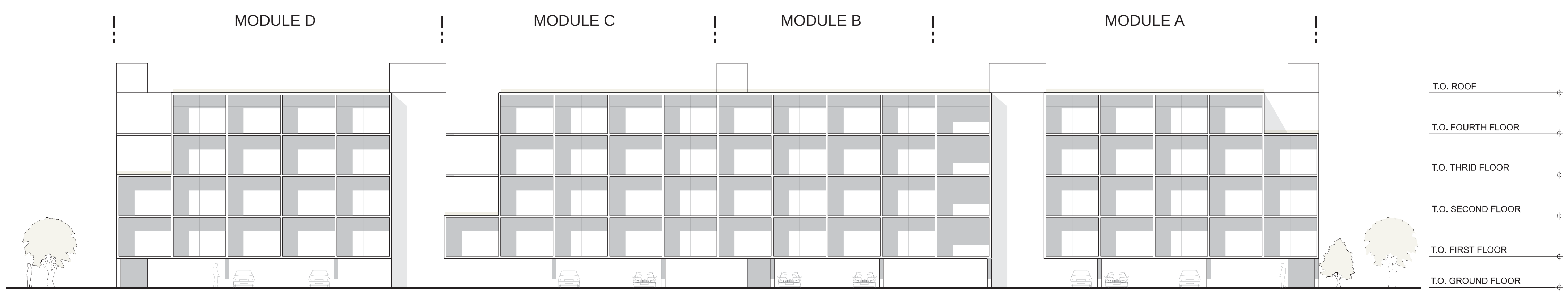


Third Floor Plan

B - Balcony
Ba - Bathroom
BR - Bedroom
Cl - Closet
D - Dining Room
E - Entry
F - Family Room
K - Kitchen
L - Living Room
Off - Office
So - Sit Out
T - Terrace
U/Sto - Utilities/Storage



Fourth Floor Plan



Courtyard Elevation

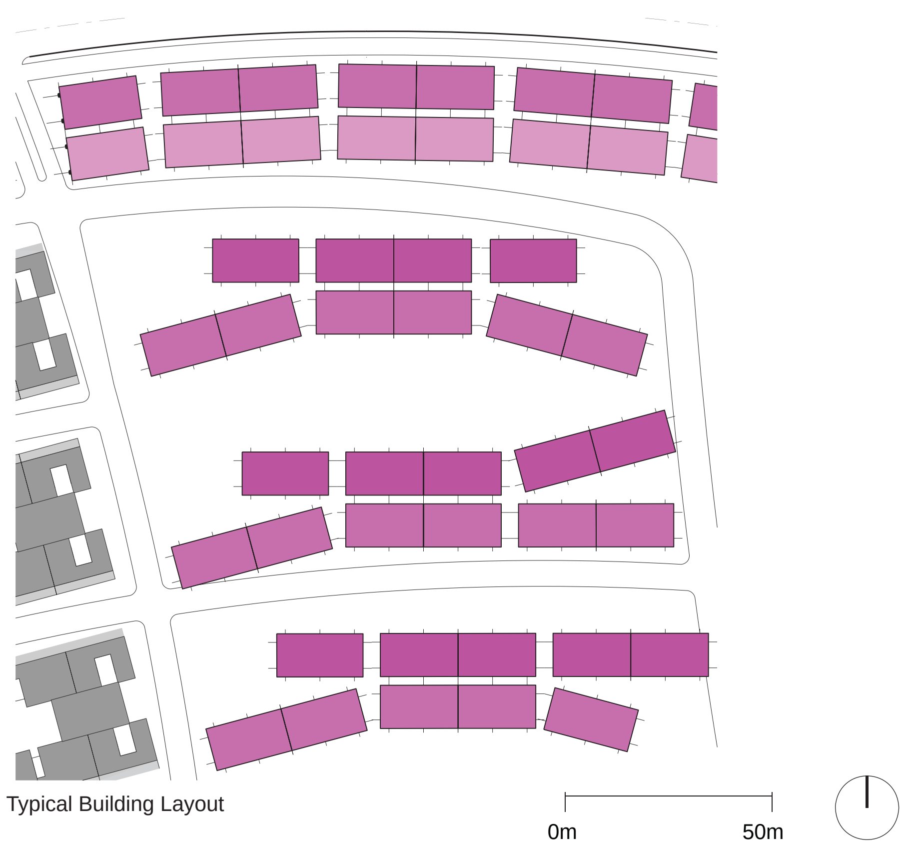
0m 20m

APARTMENT DISTRICT

The Apartment District is designed as a high-density urban neighborhood that provides active streets and quiet landscaped courtyards. Buildings heights between 3 and 9 stories are deployed to create view corridors, roof gardens, foster natural ventilation and variety in the district's massing and skyline silhouette.

Organized on a modular structural and planning concept, the apartment buildings accommodate the TSI program's range of apartment types within an overall architectural language, which unifies the district and allows for the expression of the program's diversity and urban design flexibility. The design very purposefully avoids the repetitive, cookie-cutter solutions appearing all too frequently in Southeast Asia.

Each unit has either three or four exterior exposures, to maximize daylighting, cross-ventilation and passive cooling.



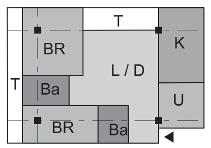
Typical Building Layout

Site Plan Layout

	Floors	Units	SF
Building 1 - Four Bedroom C3 Units			
North Wing	7	56	136,031
South Wing	6	48	116,598
Total		104	252,629
Building 2 - Four Bedroom C3 Units			
North Wing	7	63	149,891
South Wing	6	48	116,598
Total		111	266,489
Building 3 - Four Bedroom C3 Units			
North Wing	9	36	90,531
South Wing	7	46	105,355
Total		82	195,886
Building 4 - Three Bedroom C2 Units			
North Wing	9	45	90,171
South Wing	7	46	88,807
Totals		91	178,978
Building 5 - Two Bedroom C1 Units			
East Wing	4	32	46,808
Total		32	46,808
Building 6 - Two Bedroom C1 Units			
North Wing	9	45	70,380
South Wing	7	46	70,992
Total		91	141,372
Building 7 - Three Bedroom C2 Units			
North Wing	9	61	122,053
South Wing	7	62	120,689
Total		123	242,742
Building 8 Not Used			
Building 9 - Four Bedroom C3 Units			
North Wing	9	61	146,313
South Wing	7	44	106,305
Total		105	252,618
Building 10 - Four Bedroom C3 Units			
East Wing	4	20	48,040
West Wing	3	20	45,668
Total		40	93,708
Building 11 - Three Bedroom C2 Units			
North Wing	9	55	108,875
South Wing	7	45	88,641
Total		100	197,516

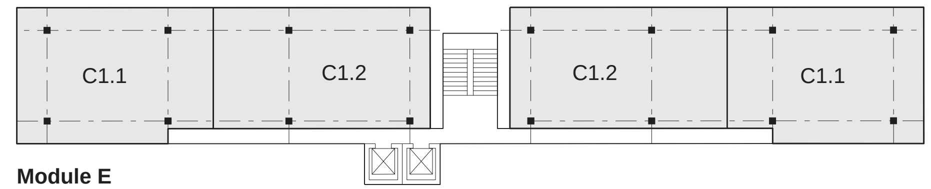
	Floors	Units	SF
Building 12 - Two Bedroom C1 Units			
East Wing	4	12	18,012
West Wing	6	24	38,730
Total		36	56,742
Building 13 - Four Bedroom C3 Units			
North Wing	9	54	132,453
South Wing	7	38	87,738
Total		92	220,191
Building 14 Not Used			
Building 15 - Three Bedroom C2 Units			
North Wing	9	61	120,162
South Wing	7	45	88,501
Total		106	208,663
Building 16 - Two Bedroom C1 Units			
East Wing	4	16	23,404
Total		16	23,404
Building 17 - Three Bedroom C2 Units			
North Wing	9	61	120,162
South Wing	7	45	88,501
Total		106	208,663
Building 18 Not Used			
Building 19 - Three Bedroom C2 Units			
North Wing	9	63	123,552
South Wing	7	47	91,891
Total		110	215,443
Building 20 - Two Bedroom C1 Units			
East Wing	4	16	23,404
Total		16	23,404
Building 21 - Two Bedroom C1 Units			
East Wing	6	18	27,642
West Wing	4	20	31,280
Total		38	58,922
Building 22 - Three Bedroom C2 Units			
East Wing	7	56	107,058
West Wing	5	34	68,032
Total		90	175,090
Building 23 - Two Bedroom C1 Units			
East Wing	6	18	27,018
West Wing	4	16	25,820
Total		34	52,838
Grand Total		**1523**	**3,112,106**

APARTMENT C-1

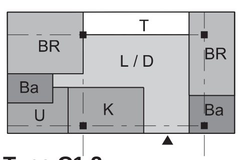


Type C1.1
Outside End Location
- 1,226 SF
- 2 Bedrooms
- 2 Parking spaces in structured parking

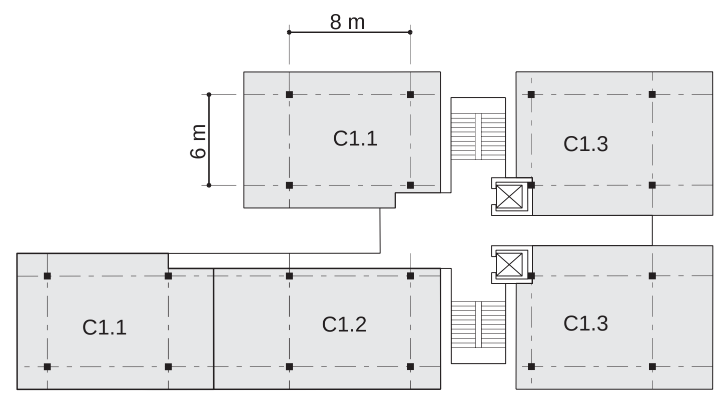
Ba - Bathroom
BR - Bedroom
K/D - Kitchen/Dining Room
L - Living Room
T - Terrace
U - Utilities



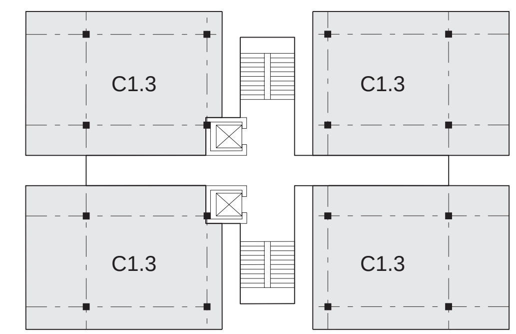
Module E
Net 5,032 SF
Common 819 SF
Gross 5,851 SF
factor = 16.3%



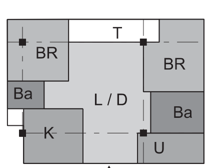
Type C1.2
Inside End Location
- 1,290 SF
- 2 Bedrooms
- 2 Parking spaces in structured parking



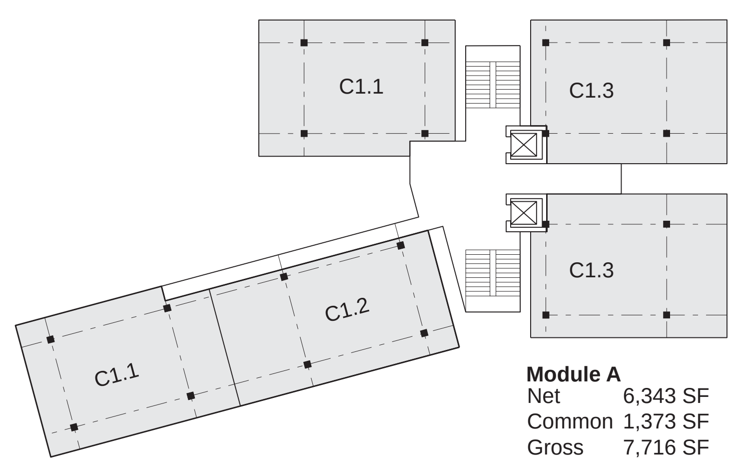
Module C
Net 6,343 SF
Common 1,379 SF
Gross 7,722 SF
factor = 21.7%



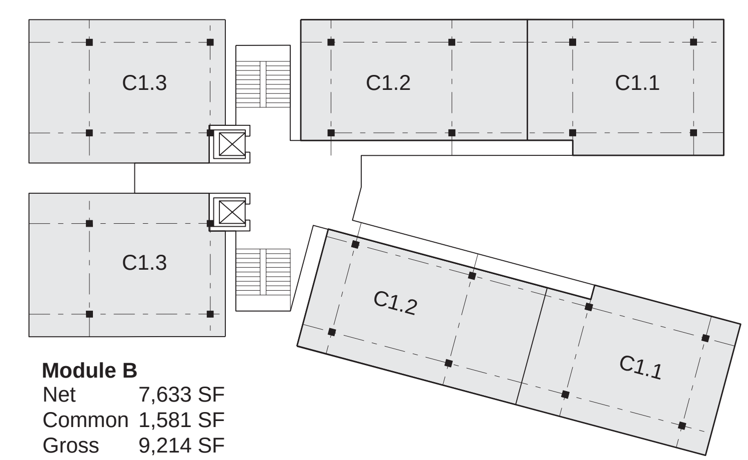
Module D
Net 5,262 SF
Common 1,581 SF
Gross 6,505 SF
factor = 23.6%



Type C1.3
Center Location
- 1,300 SF
- 2 Bedrooms
- 2 Parking spaces in structured parking



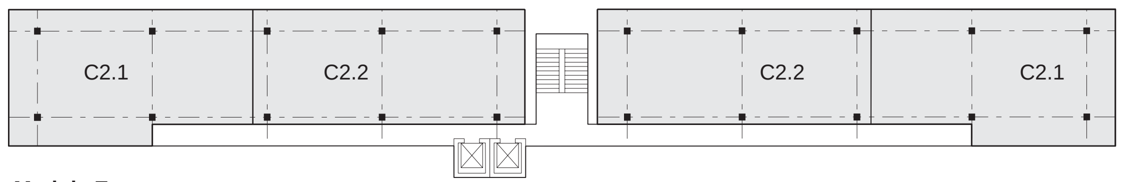
Module A
Net 6,343 SF
Common 1,373 SF
Gross 7,716 SF
factor = 21.6%



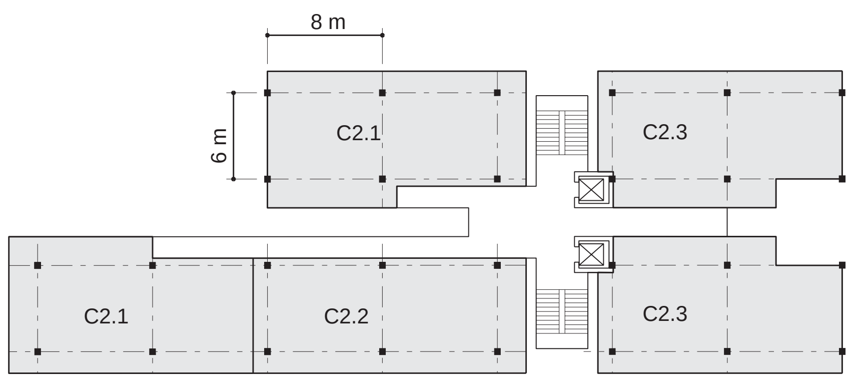
Module B
Net 7,633 SF
Common 1,581 SF
Gross 9,214 SF
factor = 20.7%

0m 10m

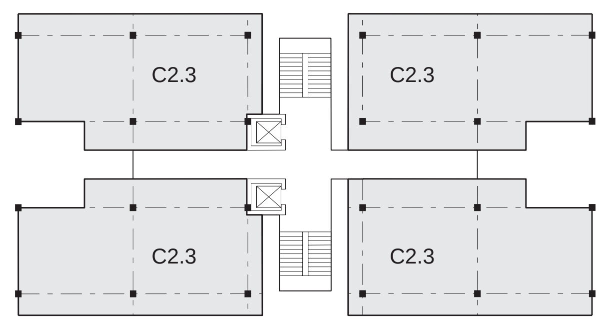
APARTMENT C-2



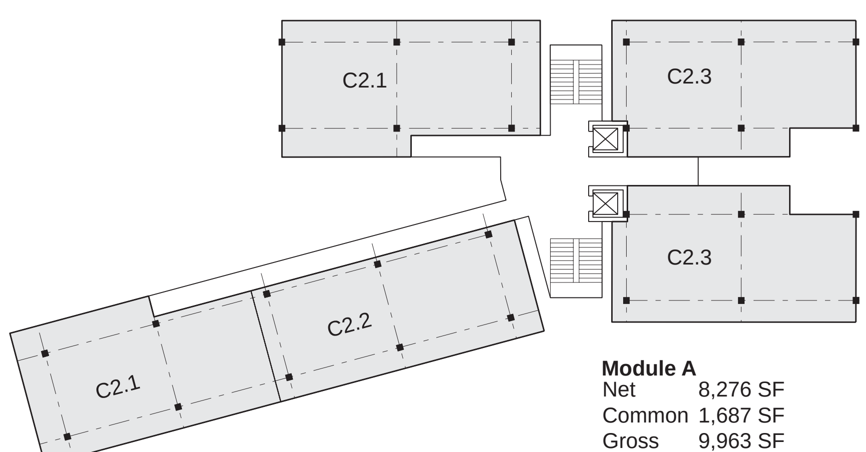
Module E
Net 6,522 SF
Common 1,290 SF
Gross 7,812 SF
factor = 19.8%



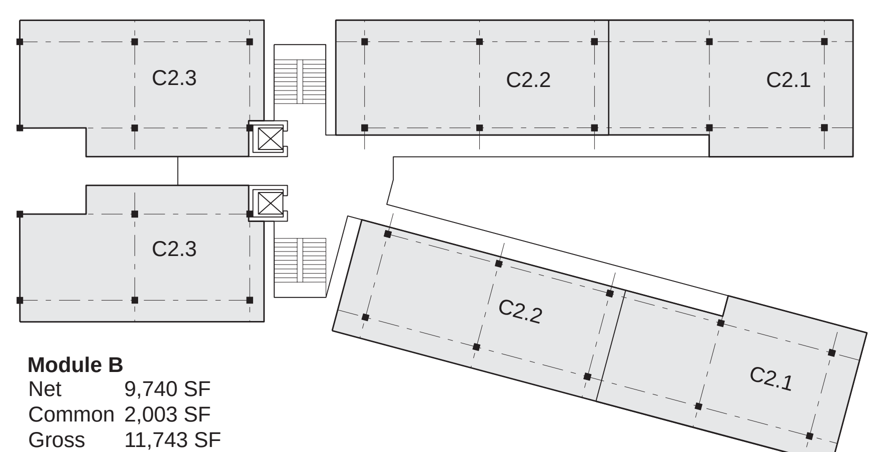
Module C
Net 8,276 SF
Common 1,673 SF
Gross 9,949 SF
factor = 20.2%



Module D
Net 6,490 SF
Common 1,244 SF
Gross 7,734 SF
factor = 19.2%

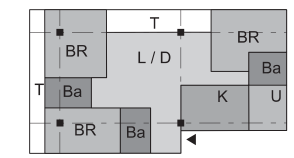


Module A
Net 8,276 SF
Common 1,687 SF
Gross 9,963 SF
factor = 20.4%

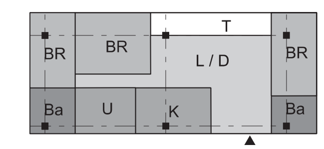


Module B
Net 9,740 SF
Common 2,003 SF
Gross 11,743 SF
factor = 20.6%

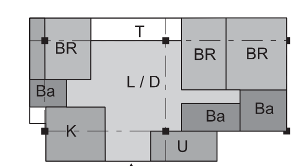
Ba - Bathroom
BR - Bedroom
K/D - Kitchen/Dining Room
L - Living Room
T - Terrace
U - Utilities



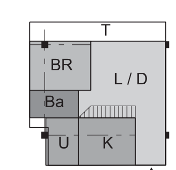
Type C2.1
Outside End Location
- 1,625 SF
- 3 Bedrooms
- 2 Parking spaces in structured parking

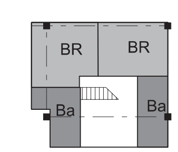


Type C2.2
Inside End Location
- 1,636 SF
- 3 Bedrooms
- 2 Parking spaces in structured parking



Type C2.3
Center Location
- 1,606 SF
- 3 Bedrooms
- 2 Parking spaces in structured parking

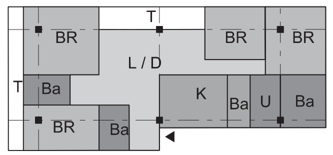




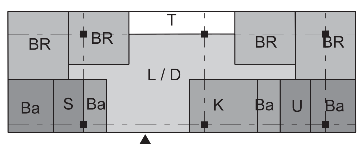
Type C2.4
Center Location
- 1,650 SF
  886 SF - Lower Floor
  764 SF - Upper Floor
- 3 Bedrooms
- 2 Parking spaces in structured parking

0m 10m

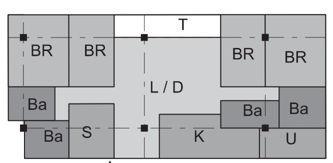
APARTMENT C-3



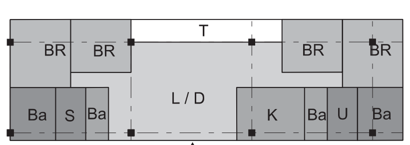
Type C3.1
Outside End Location
• 1,968 SF
• 4 Bedrooms
• 2 Parking spaces in structured parking



Type C3.2
Inside End Location
• 1,980 SF
• 4 Bedrooms
• 2 Parking spaces in structured parking



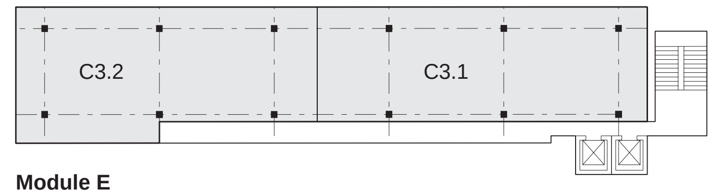
Type C3.3
Center Location
• 2,114 SF
• 4 Bedrooms
• 2 Parking spaces in structured parking



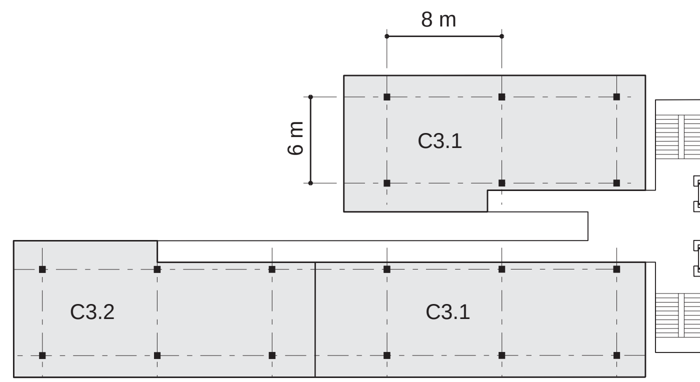
Type C3.4
Inside End Location
• 2,238 SF
• 4 Bedrooms
• 2 Parking spacesin structured parking

0m 10m

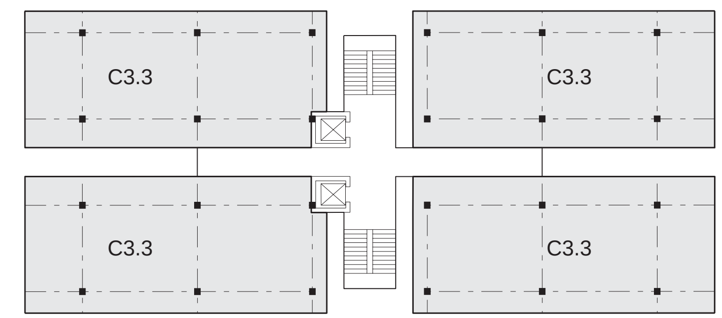
Ba - Bathroom
BR - Bedroom
K/D - Kitchen/Dining Room
L - Living Room
T - Terrace
S - Storage
U - Utilities



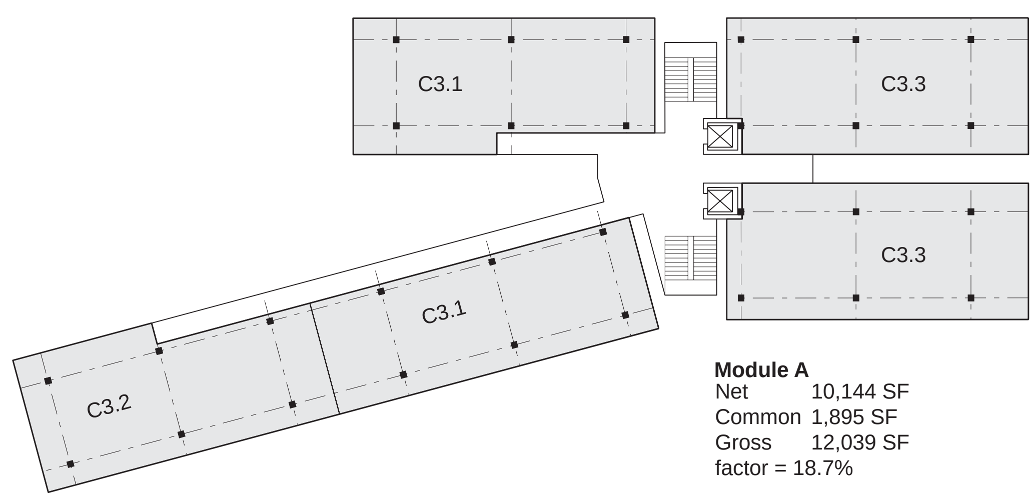
Module E
Net 3,948 SF
Common 947 SF
Gross 4,895 SF
factor = 24.0%



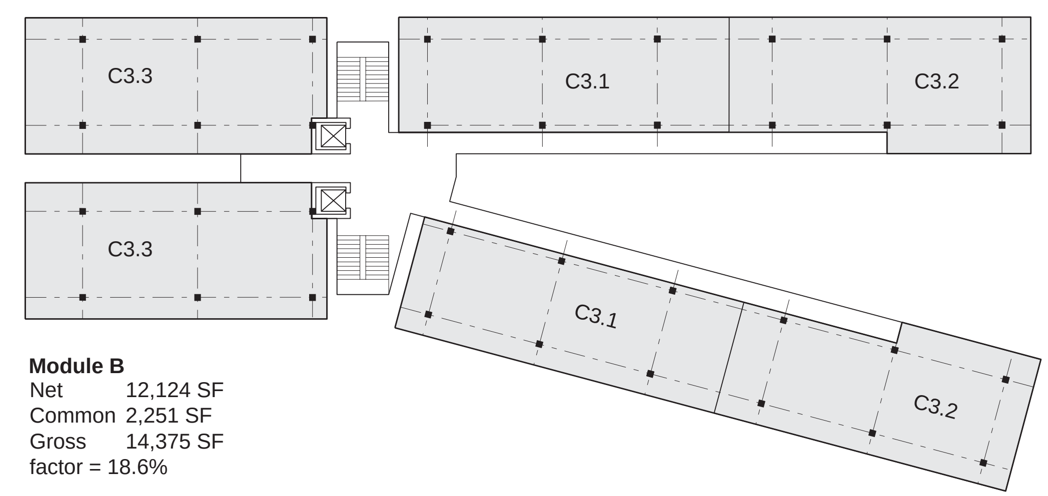
Module C
Net 10,144 SF
Common 1,837 SF
Gross 11,981 SF
factor = 18.1%



Module D
Net 8,516 SF
Common 1,244 SF
Gross 9,760 SF
factor = 14.6%

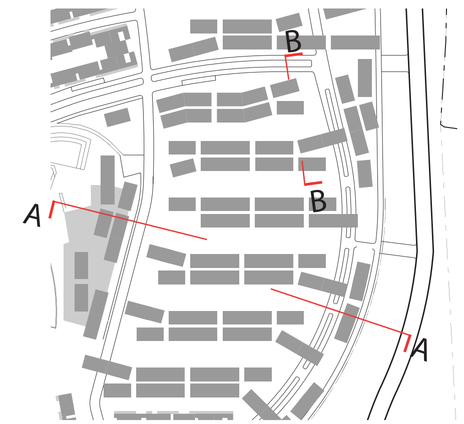


Module A
Net 10,144 SF
Common 1,895 SF
Gross 12,039 SF
factor = 18.7%



Module B
Net 12,124 SF
Common 2,251 SF
Gross 14,375 SF
factor = 18.6%

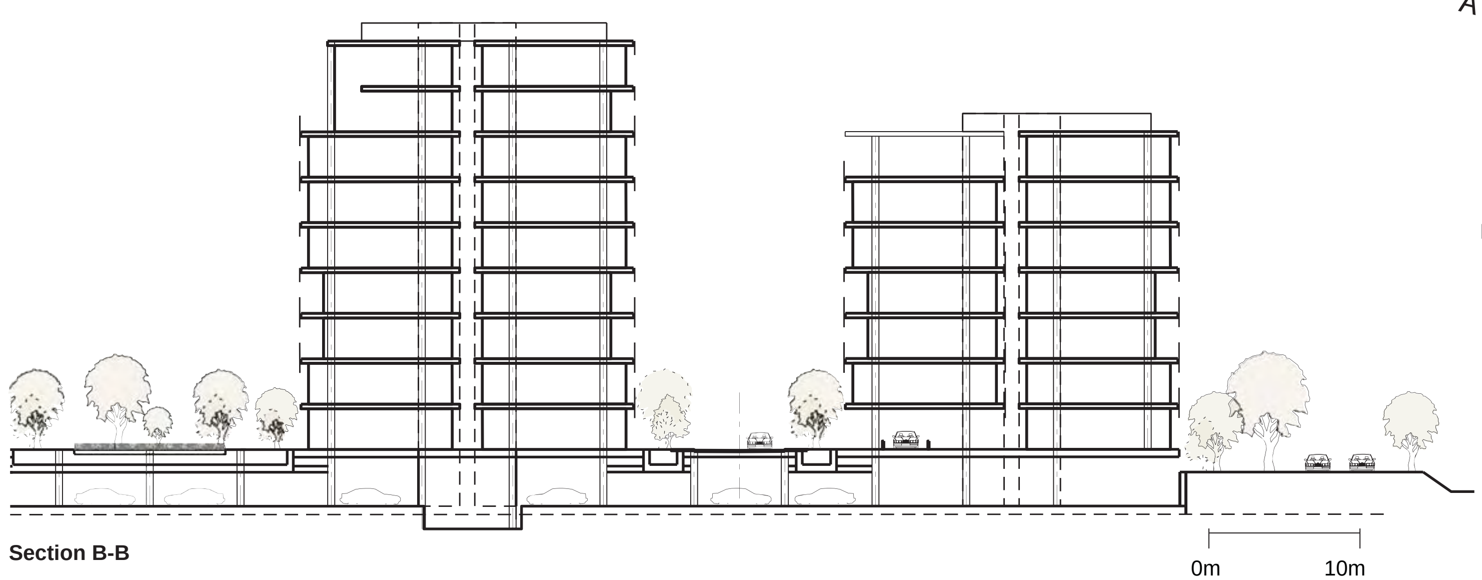
APARTMENTS



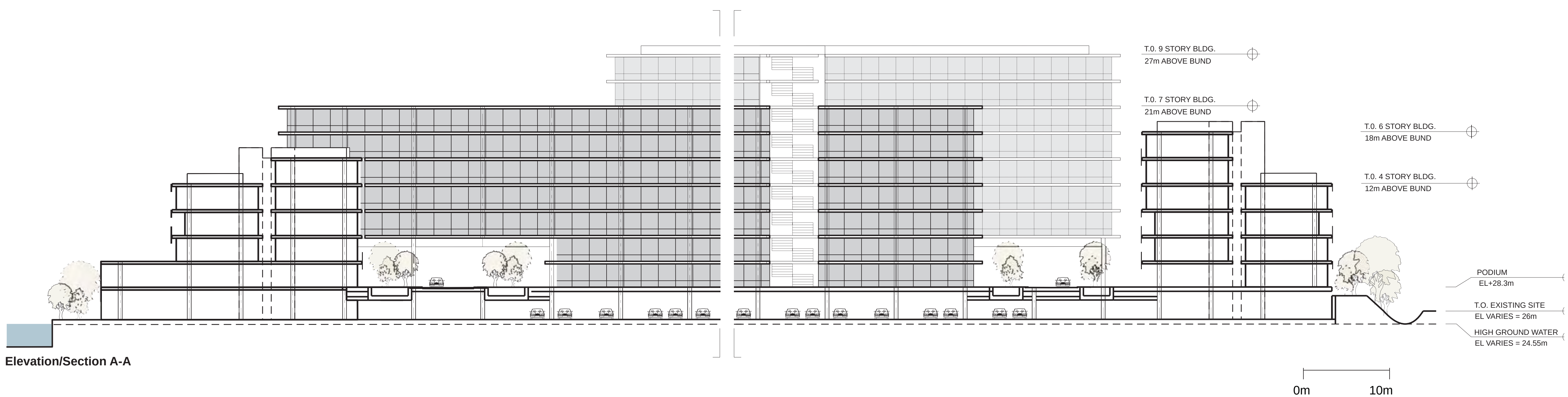
Key Plan

A one-story podium constructed approximately at existing grade contains resident and visitor parking, as well as space for building services such as, generators, pump rooms and transformers. It designed for natural ventilation and supports at its top level planting beds for trees and landscaping.

The variety of building heights creates layering of the facades planes adding variety and scale. This strategy has the additional benefit of increasing the number of more desirable and therefore higher value units. In a response to the project's land constraints, the main roads of Apartment District penetrate through the buildings to recapture land back for residential units, and at the same time weave together architecture and urban space. Stepping back along the western edge of the central open space, the Apartments engage the public character of the landscape and provide space at their lower two levels for the Clubhouses.



Section B-B



Elevation/Section A-A

ENERGY CONSUMPTION COMPARISON

Energy Analysis

The first step in analyzing energy conservation measures (ECM) in buildings begins with establishing a baseline model or benchmark of energy use to which to compare. Several sources exist in the industry to provide benchmarking data for energy use in commercial buildings but much fewer for residential buildings. Finding documented energy performance in India is a challenge which forces the implementation of conversions for climate types from other known data locations.

There are other challenges as well. Difficulty lies in understanding the use of space, the true number of occupants in each dwelling and the social issues that drive the use of that space. Also, final energy consumption is very much a factor of the use of the space and the awareness of the occupant on his or her impact on energy reductions. For example, a large family of “high-tech” members (lots of computers and gadgets) that prefers a mechanically cooled apartment in swing seasons versus a more “traditional” family with very few plug loads, who is never home and almost never operates their mechanical cooling systems.

Talking to local Indian people on their social manners, customs, resource conservation awareness and need for modern appurtenances is the best way to begin to understand the energy picture of the Chennai 113 site.

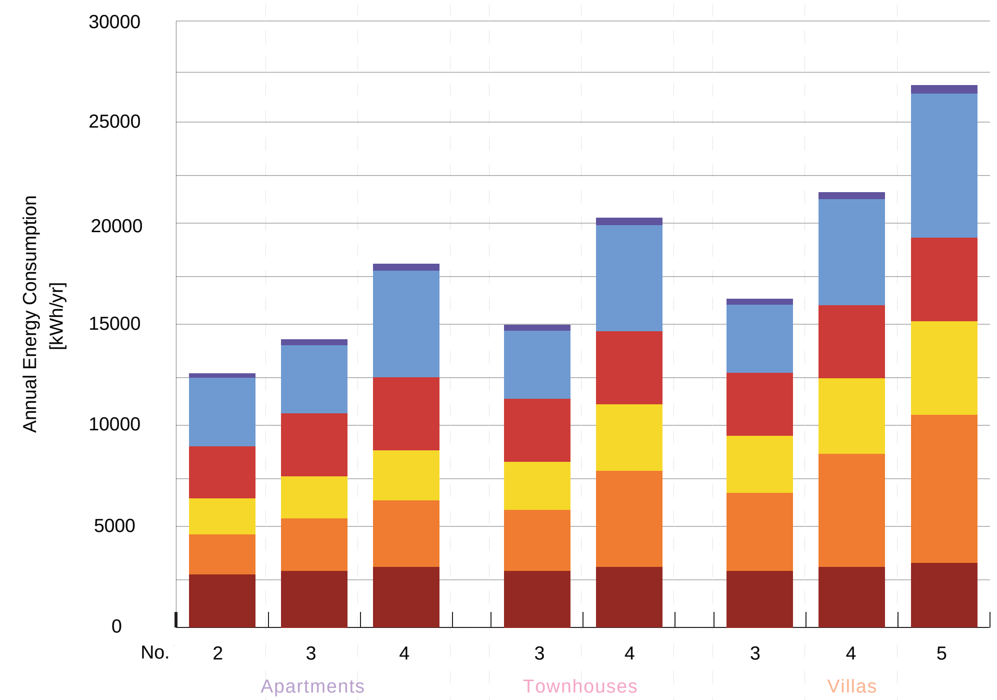
Energy Use Benchmarks

Two tools helped in this evaluation:

- ASHRAE 90.2, Standard for Energy-Efficient Design of New Low-Rise Residential Buildings
- National Renewable Energy Laboratory Conference Paper entitled “Development of an Energy Savings Benchmark for All Residential End-Uses” Preprint (NREL/CP-550-35917), August 2004 by R. Hendron et. al.

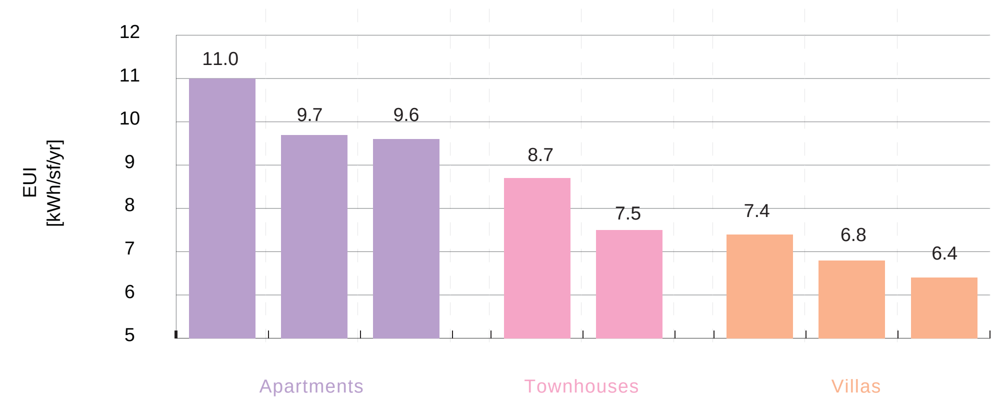
Energy Consumption (kWh/yr by end use)

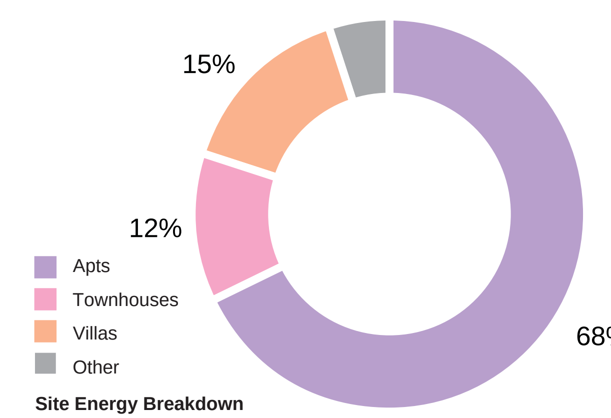
		Apartments			Townhouses		Villas		
	Nbr	2	3	4	3	4	3	4	5
	FFA	1,200	1,550	1,970	1,800	2,850	2,300	3,350	4,400
Appliances		2,609	2,800	2,991	2,800	2,991	2,800	2,991	3,182
Plug Loads		2,004	2,589	3,290	3,006	4,760	3,841	5,595	7,348
Lighting		1,765	2,095	2,481	2,395	3,285	2,845	3,735	4,625
Hot Water		2,583	3,099	3,615	3,099	3,615	3,099	3,615	4,131
Space Cooling		3,375	3,375	5,250	3,375	5,250	3,375	5,250	7,125
Exhaust		243	297	351	297	351	297	351	405
TOTAL:	[kWh/yr]	12,579	14,254	17,977	14,972	20,251	16,257	21,536	26,815



Energy Use Intensity (kWh/sf/yr)

	Apartments			Townhouses		Villas		
[kWh/sf/yr]	10.5	9.2	9.1	8.3	7.1	7.1	6.4	6.1
Safety 15%								



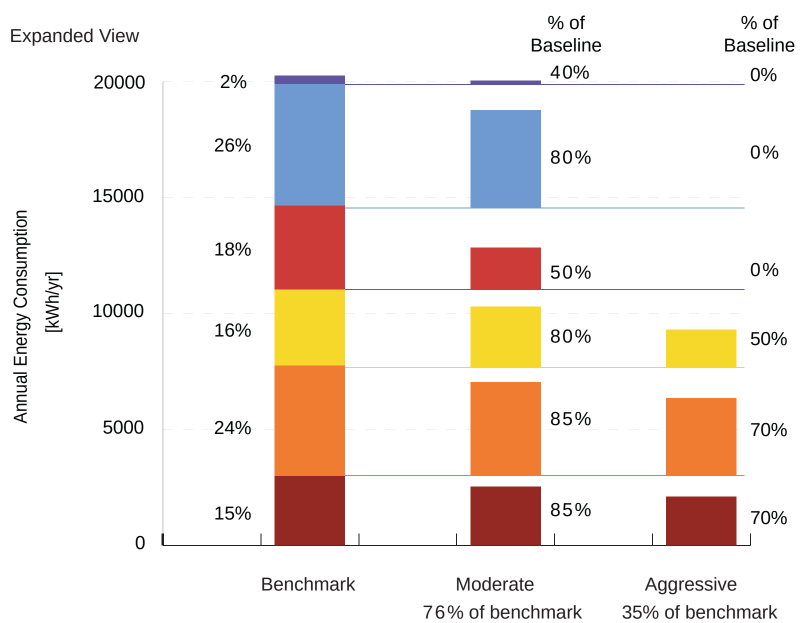


Site Energy Breakdown

	C1	C2	C3
Total Area	502044	1218120	1372368
[kWh / sf]	11.0	9.7	9.6
[kBtu / sf]	37.6	33.0	32.7
Total MBtu/yr	18,860	40,150	44,900

45000

	Benchmark Business as Usual	Moderate Good Practice	Aggressive Exemplar Performance
Appliances	2,991	2,542	2,093
Plug Loads	4,760	4,045	3,331
Lighting	3,285	2,628	1,642
Hot Water	3,615	1,807	0
Space Cooling	5,250	4,200	0
Exhaust	351	150	0
TOTAL: [kWh/yr]	20,251	15,373	7,068



This analysis assumes that cooking facilities are electric rather than propane.

Space Cooling

Moderate

1. Envelope improvements, shading
2. Minimal size of split unit requirements
3. Not splits allowed in some rooms

Aggressive

4. Central condenser water systems
5. No mini-splits allowed

Exhaust

Moderate

1. Kitchen Exhaust only
2. Fans on timers / occ. sensors

Aggressive

3. No exhaust systems (operable windows)

Appliances

Moderate

1. Energy Star Equivalent Appliances
2. Peak Load shedding
3. Clothes lines

Aggressive

4. Only BEE 5 Star Appliances

ENERGY IS LIFE
B E E
CONSERVE IT

Plug Loads

Moderate

1. Off-peak shedding
2. Timers
3. Energy Star equipment

Aggressive

4. Plug load metering
5. Incentives

Hot Water

Moderate

1. Tempered water systems
2. No dishwashers?
3. Central laundry rooms

Aggressive

4. Solar Hot Water Systems
5. No hot water systems

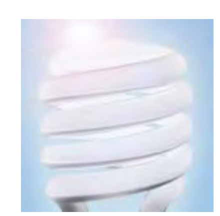
Lighting

Moderate

1. Skylights
2. High Performance Lighting
3. Dimmers / Timers
4. Minimal Site Lighting

Aggressive

5. Occupancy Sensors / Timers
6. Wind Powered Site Lighting.
7. Aggressive Skylights



Energy Conservation Oppurunities

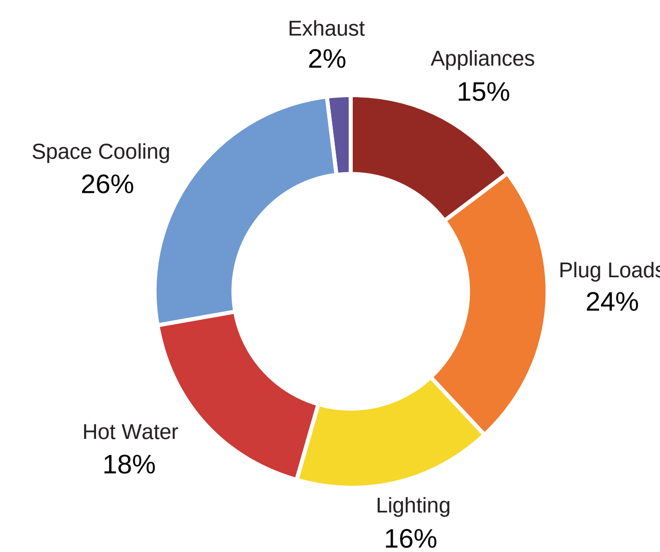
Once benchmarking has been completed and assumptions agreed upon, the next step is to propose energy conservation opportunities (ECMs).

These ECMs are categorized by end use; moderate and aggressive opportunities are highlighted here. These end uses will be further explored throughout this report.

As previous figures will attest, end use will differ from dwelling type (Villa, Townhome, Apartment) based on size and population. Equal discrepancies may be seen, however, between equally sized and populated dwellings due to the building's orientation, massing and operability, the awareness of the end-users and the general energy-intensity of the appliances and plugged devices in the home.

For example, one four-bedroom Townhome example was taken as a benchmark to explore moderate and aggressive ECMs. Assumptions were made on the energy reductions that each ECM would achieve, and graphs plot the outcome.

- Aggressive ECMs can yield a 35% energy use compared to a similar baseline dwelling. These ECM's take into account end-users and a relaxation of thermal comfort.
- This reduction includes no exhaust systems or active cooling systems (all natural ventilation), solar hot water, and very aggressive reductions in lighting demand.



Benchmark Energy Breakdown

COOLING

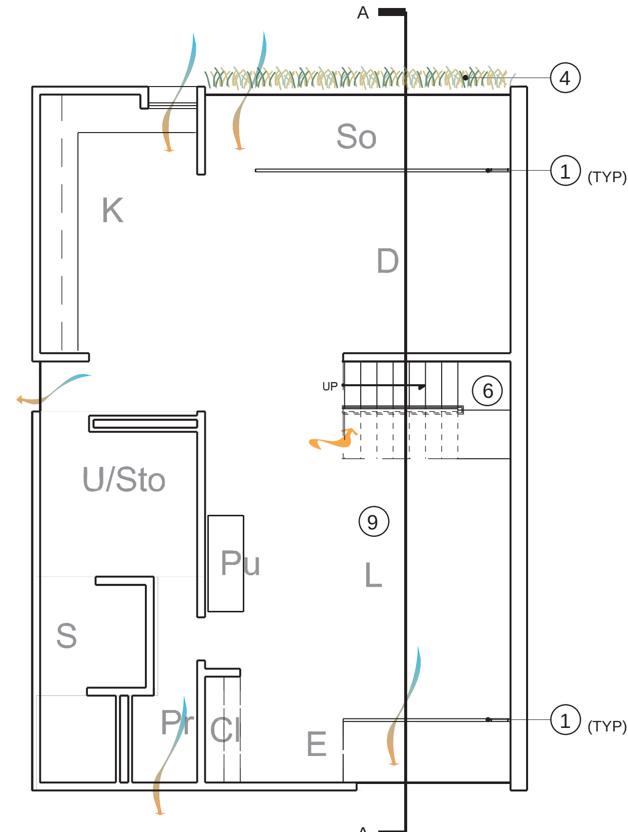
Passive Strategies - Cooling
To minimize the use of mechanical cooling devices, the project must optimize, through as many conditions as possible, natural ventilation strategies.

Site-wide, central mechanical cooling strategies have been suggested for their high energy efficiencies and lower energy consumption rather than individual “mini-splits” or through wall units. If these systems are not implemented, and the owners are subsequently required to install local conditioning systems of their own choosing, then the need for passive strategies to offset the inefficiency of those systems is paramount.

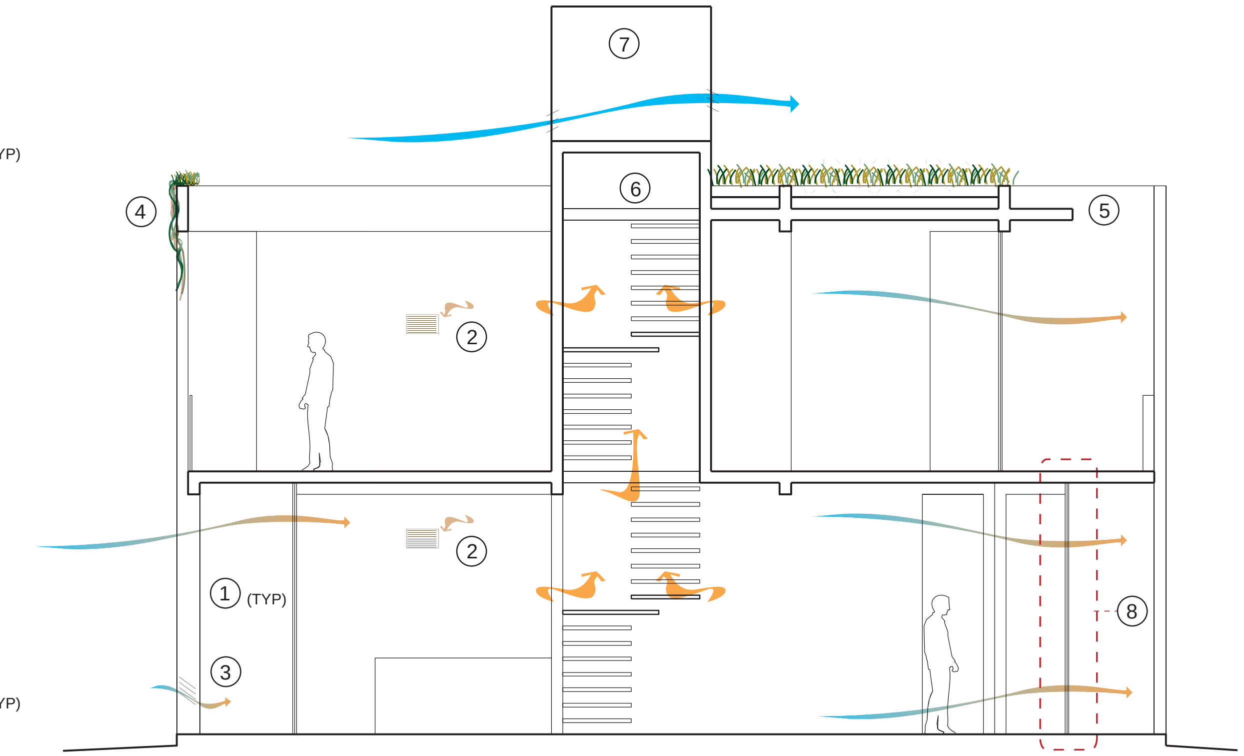
Active Strategies - Ventilation
Forced air systems, utilizing a fan system to aid in the natural ventilation of the space is the next step of low-energy strategies. These systems will be installed by the owner, and are provided with the base building design.

Active ventilation for odor control can serve as cooling devices, creating negative pressure zones that help to aid in natural ventilation. These active systems also help to increase indoor air quality by removing any contaminants, germs and odors, however, they require proper maintenance to be effective and will consume energy, although a small percentage of the building totals.

- Passive ventilation strategies are proposed for all residential building types.



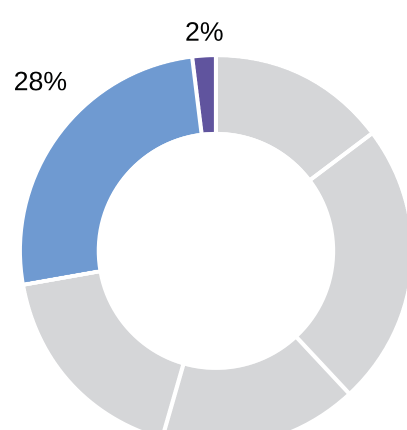
Partial Floor Plan



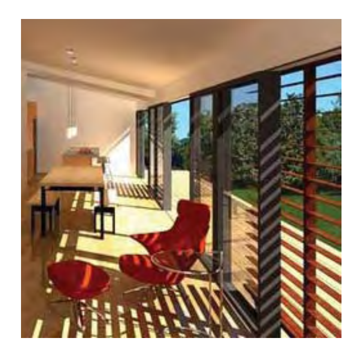
Section A-A

KEYED NOTES

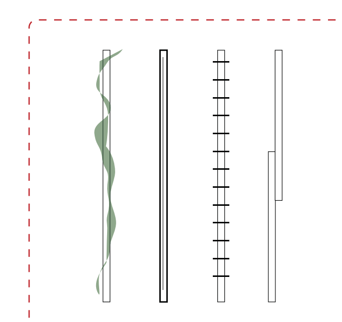
1. Operable Windows and Sliding Doors. User Controlled Environments
2. Local exhausts or openings for Toilets and Kitchens
3. Trickle vents
4. Plantings, screens and light filters
5. Overhangs (w/ or w/o plantings)
6. Light and Air wells to aid in Natural Ventilation
7. Air scoops or venturi vents on roof
8. Operable Facade Options with Varying porosity
9. Open Floor plans to aid in through-venting



Cooling and Ventilation



The design should provide multiple ranges of user interface, for example sliding screens, so that the expternal facade cab be created in a number of ways.

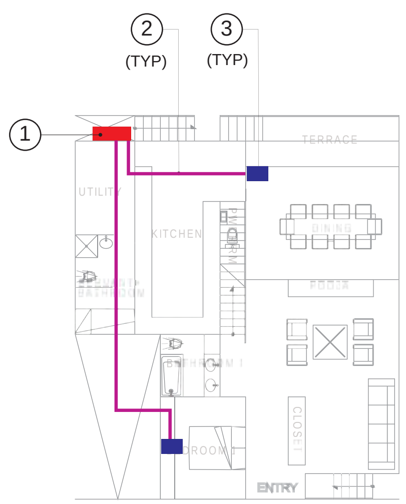


Facade Opportunities
Large vertical sliding lattice, protective solid coverings, vertical and horizontal sliding barriers

Townhomes and Villas Active Cooling Schemes

Baseline System
The norm in Chennai is to provide residential units without central conditioning systems. The owner is responsible for providing their own system, typically a "mini-split" system.

This system rejects the heat from an outdoor condensing unit and distributes refrigerant, usually ozone depleting R22, to indoor evaporator sections.



Partial Floor Plan

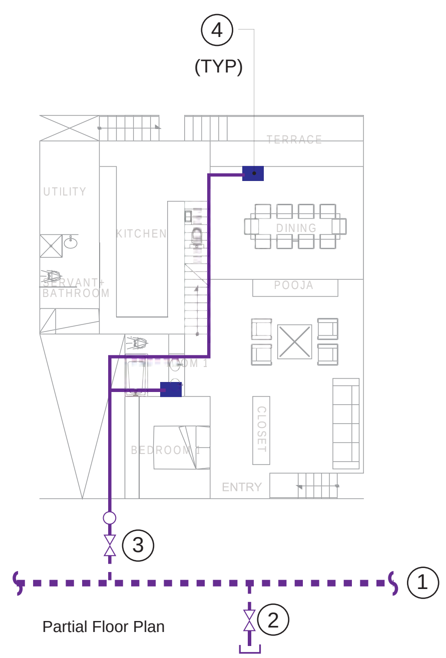
KEYED NOTES

1. Exterior condensing unit of mini-split system (tenant installed)
2. Interior evaporator sections of mini-split system (tenant installed)
3. refrigerant piping (tenant installed)

High Energy Consuming Mini-split systems

Option A
A central condenser water loop, using the site's abundant ground water is an alternative to the mini-split system.

Ground water would be distributed to each dwelling and apartment where tenants would be responsible for installing internal Packaged Terminal Air Conditioning (PTACs).



Partial Floor Plan

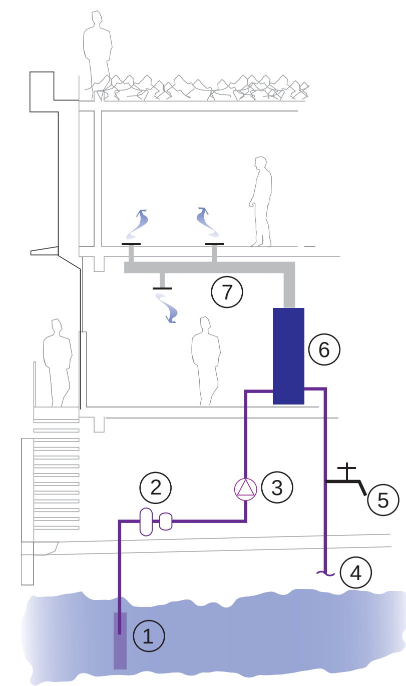
KEYED NOTES

1. Main distributed condenser (ground) water, pumped and filtered from central source
2. Taps to owners and tenants for future fit out and ownership of systems
3. Valves, metered and secondary filters
4. Internal PTAC (packaged terminal air conditioner) with compressor

Internal Packaged Terminal Air Conditioner

Option B
In lieu of a central distributed condenser water system, a more local systems could be implemented. Small personal ground wells, located beneath the site or in the yard, could pull, filter and distribute ground water to a central heat pump system.

There are variations of options A and B, which consist of a ducted scheme in Option A, and a non-ducted scheme of Option B.



Partial Section

KEYED NOTES

1. Individual or ganged wells at townhomes and villas (w/ filter)
2. Valves, filters, appurtenances in accessible location
3. Small inline circulation pump
4. Recharge of ground aquifer
5. Filtered ground water can be used as non-potable after it's been used for heat rejection
6. Indoor water-to-air heat pump with economizer coils
7. Distribution duct work and diffusers

Internal Water-to-Air Heat-pump Systems

Active Strategies - Cooling

Shown are two main options for mechanical on site cooling. Options A and B have several variations and should be explored.

Due to the harsh solar gains, and high temperatures in Chennai, most tenants will require some level of mechanical cooling. The building envelope should be optimized to provide a high performance thermal and moisture barrier to minimize losses when mechanical cooling is required.

Minimizing the use of these systems is dependant on the user. Creating awareness of the energy consumption of these systems will help to reduce the overall site energy consumption.

Due an abundance of site ground water, there is an excellent opportunity to use this water as either chilled water or a means of rejecting the heat of refrigeration of local systems.

- Due to an abundance of site ground water, there is an opportunity to use this water as either chilled water or as a means of rejecting the heat of refrigeration of local systems.

COOLING: APARTMENTS

Baseline System Advantages

- Control by unit and by room
- Electric load placed on individual meter
- No basebuilding infrastructure
- Ease of retrofit and adoption
- Potential for low energy use

Disadvantages

- Average efficiencies
- Large energy use over whole building and site
- Many condensing units on facade and balconies causing unsightly clutter
- Small units often contain high ODP (ozone depleting potential) and GWP (greenhouse gas potential) refrigerants such as R-22.

Option A & B

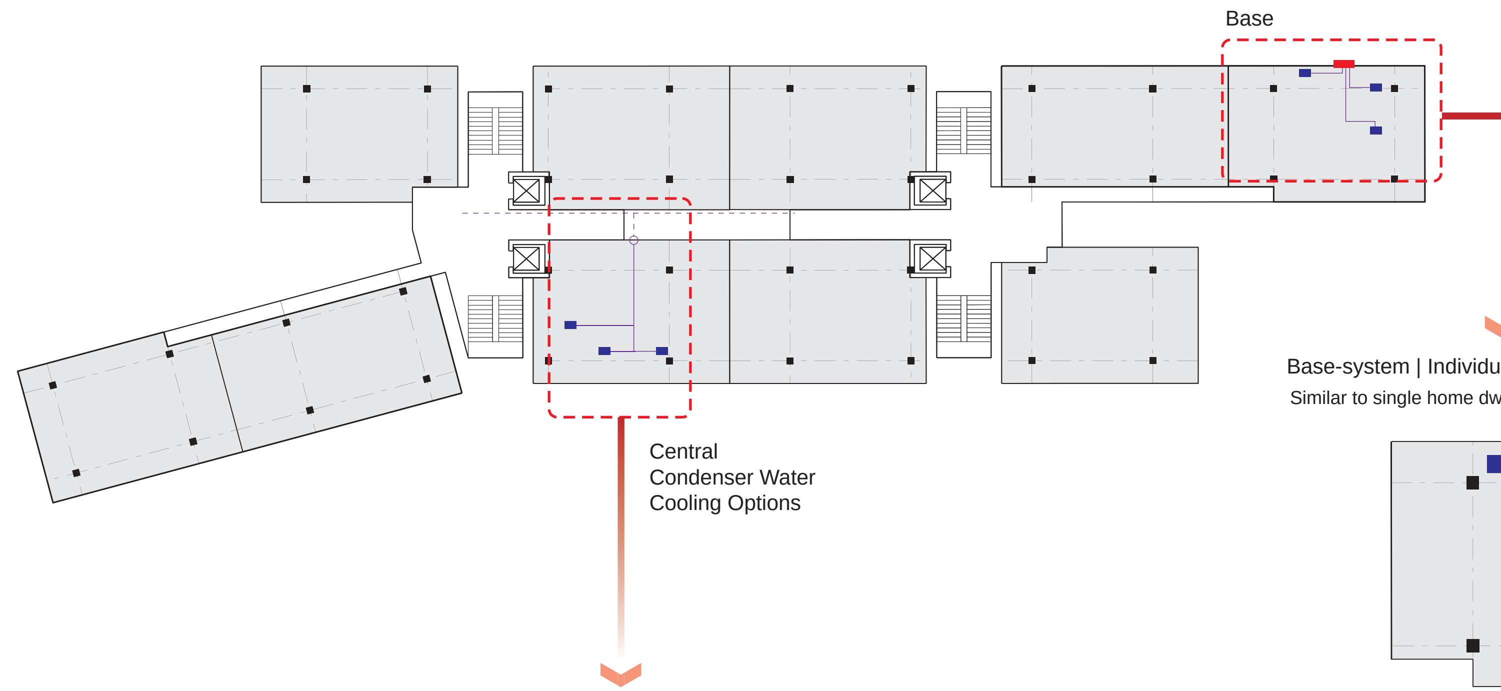
An alternative to mini-split systems is a distributed condenser water system for the Apartment buildings. The diagram shows a main located in the corridor with valving and metered stubs in each apartment. Tenants can choose to fit-out their apartment with DX air conditioning systems.

Advantages

- Control by unit, and by room
- Electric load can be placed on individual meter
- Ease of retrofit and adoption
- Potential for low energy use
- No external condensing units
- Opportunity to use system for hot-water production

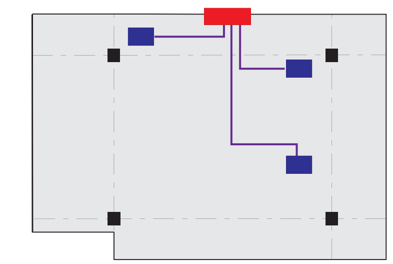
Disadvantages

- Greater efficiencies over entire building, but systems might be used longer, proving greater energy use.
- Some base building infrastructure for owner / operator
- Maintenance of central systems by owner / operator
- Electric load placed on individual meter

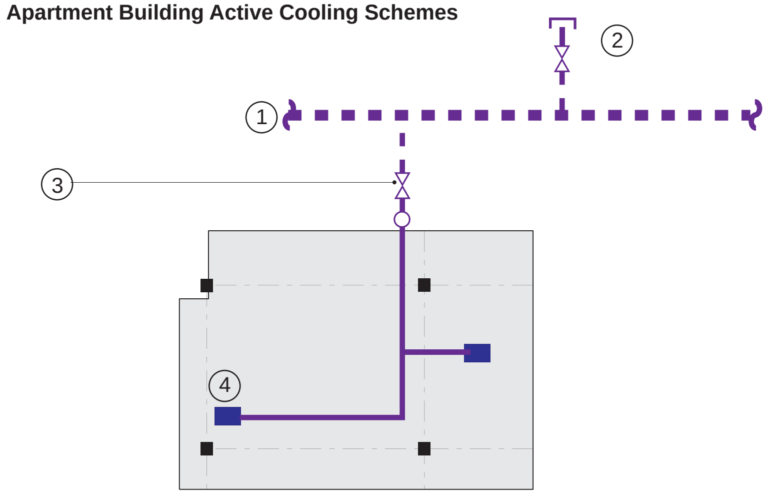


Base-system | Individual Multi-split Systems

Similar to single home dwellings



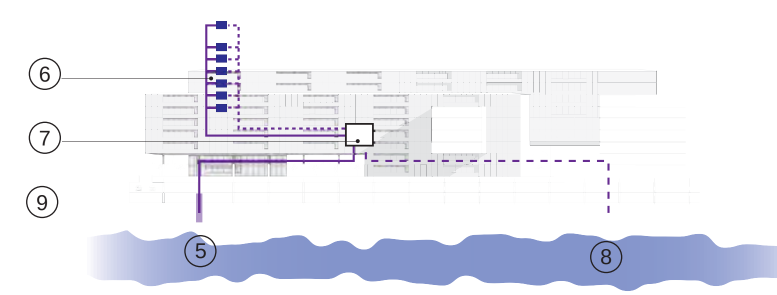
Apartment Building Active Cooling Schemes



Option | Base-building condenser water

Condenser Water Systems

Due to the great excess of site water, it is possible to provide an open well, open loop geoexchange system.



KEYED NOTES

1. Main distributed condenser (ground) water, run through corridors or in vertical risers
2. Taps to owners and tenants for future fit out and ownership of systems
3. Valves, metered and secondary filters
4. Internal PTAC (packaged terminal air conditioner) with compressor
5. Alternative, Option B could be implemented. This is a central heat-pump with ducted supply to each space
6. Individual or ganged wells (w/ filter)
7. Pump Room Valves, filters, appurtenances in accessible location
8. Ground water distribution to heat pumps or PTACs
9. Recharge of ground aquifer
10. Underground Aquifer

APPLIANCES & PLUG LOADS

Occupancy Sensors

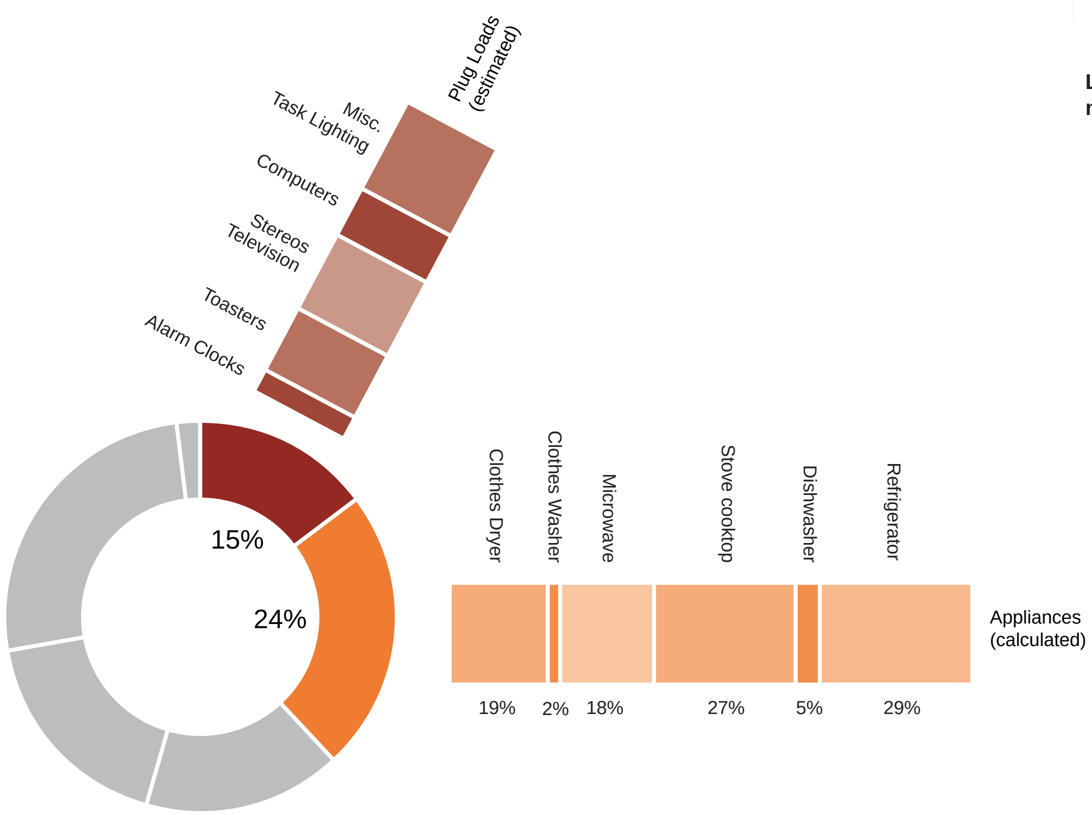
Local timers

Owner Manuals and Association By-Laws

High Efficiency Appliances

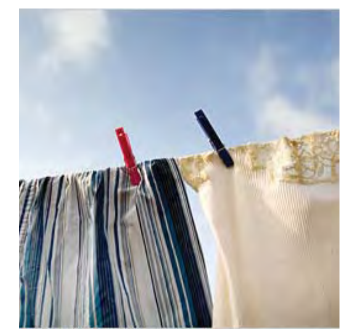
Solar Powered Chargers

Breakdown of Plug and Appliance Loads

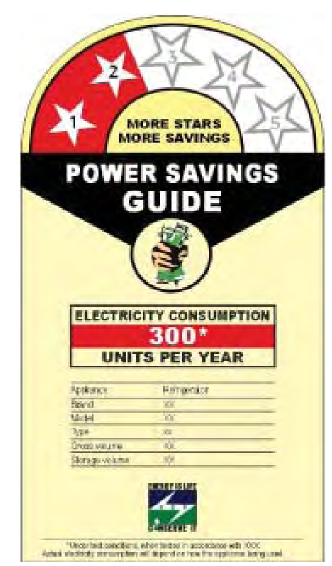


Breakdown of Plug and Appliance Loads

Low energy fans to promote natural ventilation strategies



Encourage Clothes Lines and Air Drying racks



Power Savings Guide through BEE "More Stars, More Savings"

One of the largest consumers of energy use in a residence, and the most difficult to control for designers, are plug loads. In the baseline estimate for a typical dwelling in Chennai, 40 percent of the energy consumed is associated with appliances and plug loads.

Plug loads are the energy associated with devices literally plugged into an outlet. These include televisions, computers, stereos, hair dryers and task lighting. Appliances, which are included within this category, include refrigerators, dishwashers, stove cook-tops, microwaves and clothes washer and dryers. The stoves in the project will be propane, but for this analysis, an electric stove-top was assumed.

There are several technological ways to address this problem. Installing energy efficient appliances is a start. Plug loads, because they are more user driven, can be provided with timers, occupancy sensors and even peak-load shedding, which shuts off non-critical appliances during peak load periods.

Many of the appliances considered as plug-loads are not 'base-building' appliances; i.e. the owner will purchase and install after occupancy.

- As part of governance structure of the development regulations should be placed on unit owners to mandate efficiencies for appliances through association's by-laws. •The Indian Bureau of Energy Efficiency (BEE) will be used as a benchmark, which is similar to EnergyStar in the US.

Specifying efficient appliances and providing levels of controllably are an important step, but the single biggest opportunity for reduction is in user behavior. An educated, and responsible, owner could have 10% of plugload energy use as a less aware owner who uses many plugged devices.

DOMESTIC HOT WATER

Culturally, many Indian families do not expect to have domestic "hot water" when they turn the faucet. Tempered, or even cold water, is acceptable for many uses that other parts of the world would consider only "hot water" operations. Hand-washing, house cleaning, clothes and dishwashing can all be used with tempered or warm water in lieu of hot water.

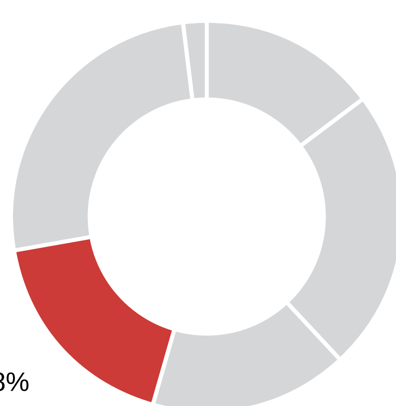
Showering is the main activity that demands hot water in the Chennai climate. Even with showering and bathing, Indians typically accept a lower hot water temperature than other parts of the world. This flexible thermal range for hot water is a critical first step in reducing the demand. The baseline percentage of energy used in hot water is estimated at 10%.

There are several ways to reduce the hot water demand and energy use; however, the best solution for this site is a solar strategy.

- Solar hot water production can minimize the need for electric consumption for hot water delivery to near zero.

An aggressive solution would provide only solar hot water systems which would only provide hot water in times of sun. A more traditional solar hot water scheme would provide internal solar heated coils in an electric heated tank for a "hybrid" strategy, as shown in the diagram. The use of these technologies is increasingly familiar in India.

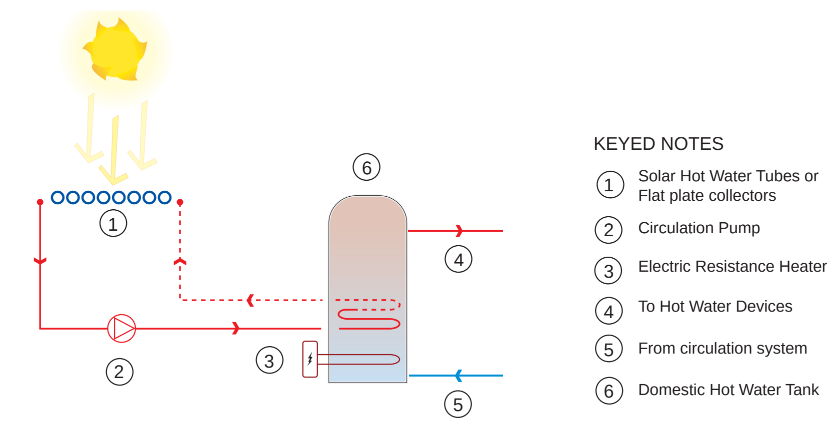
This system can function for Townhomes and Villas, as well as in a more ganged solution for Apartments.



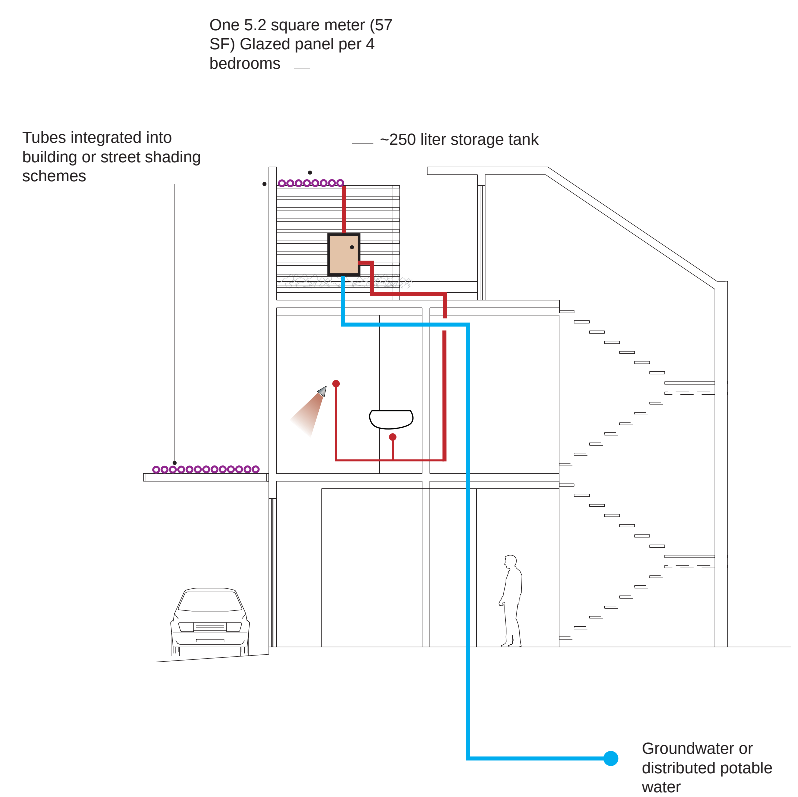
Domestic Hot Water

Solar tubes located on roof, protected from occupants. Chennai's installation would be more closely to horizontal, due to the high solar angles

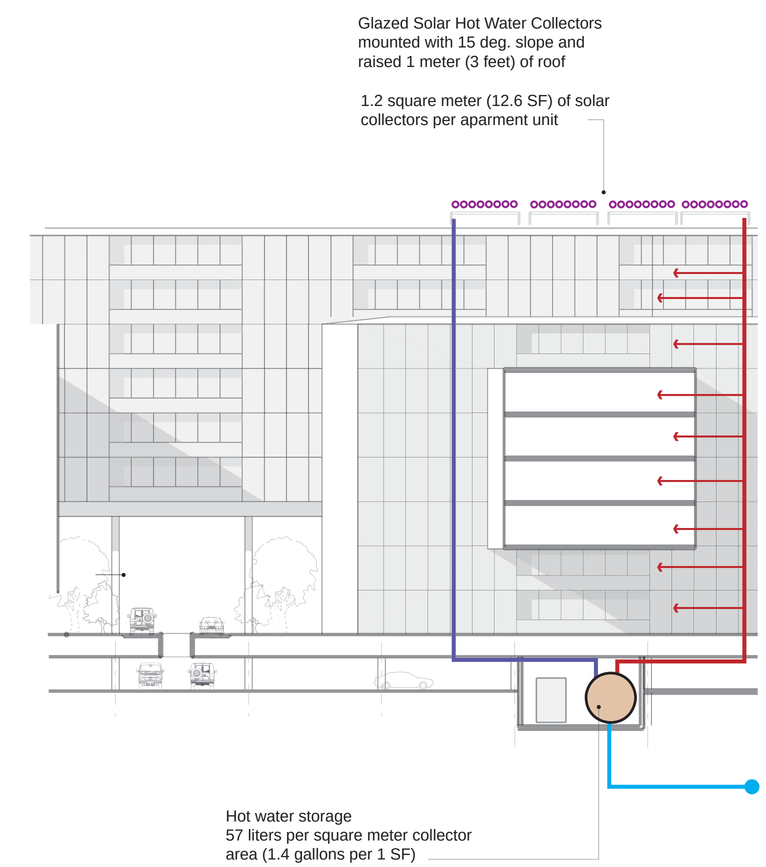
Flat plate solar collectors as alternative to evacuated tubes



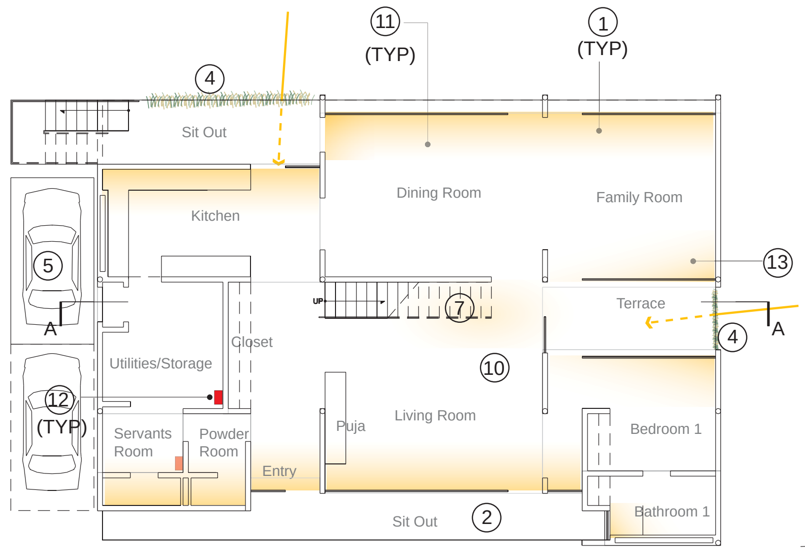
Solar Hot Water Schematic

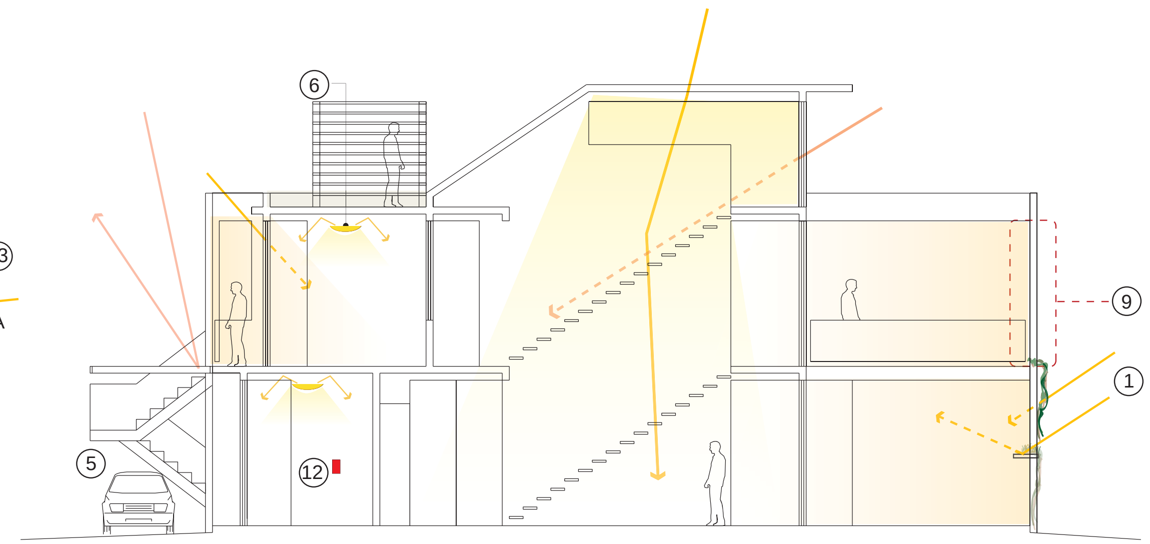


Single Family Dwelling Solar Hot Water Scheme



Apartment Building Solar Hot Water Scheme

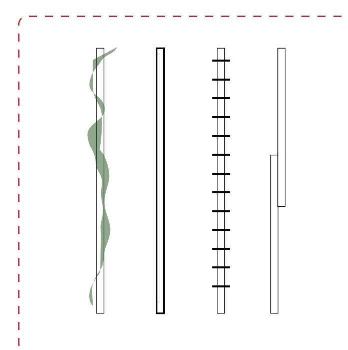




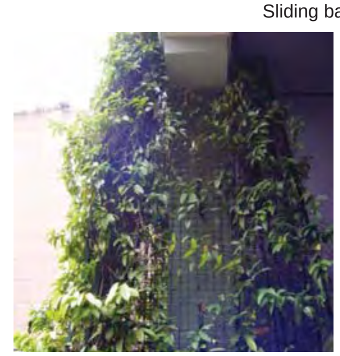
Section A-A

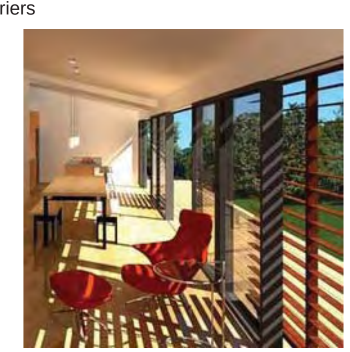
KEYED NOTES

1. South Facing Light Shelves
2. Haveli-structure with overhangs to protect from high sun angles
3. Solar Tubes to serve unlit interior spaces
4. Plantings, screens and light filters
5. Naturally Lit, Naturally Vented Garages
6. High-performance internal lighting
7. Light and Air wells to aid in daylighting
8. Rain-proof transparent skylights
9. Operable Facade Options with Varying transparencies
10. Open Floor plans for deep light penetration
11. User controlled interior shades and blinds
12. Occupancy Sensors, timers and dimmers throughout
13. Control of west and eastern sun



9. **Facade Opportunities**
Large Vertical sliding lattice
protective solid coverings
Vertical and Horizontal
Sliding barriers





LIGHTING

Passive Strategies

Daylighting is the most effective energy reduction strategy associated with lighting on the project. Optimizing the orientation of the buildings and their façade design to allow for diffuse, indirect light and minimize glare is critical.

- Design all dwellings to utilize zero artificial light during the daylight hours.

Open floor plans that allow views of naturally lit areas prevent the need for artificial light. Solid privacy partitions can be equipped with high glass to allow natural light to deeply penetrate. During peak energy load periods, such as early morning and evening, natural lighting schemes are optimized. For interior areas that are not exposed to an exterior façade, skylights, light tubes, and interior light wells can deflect light deep into the plan and section.

Success depends on informed homeowners who understand the daylight strategies provided and utilize them to the fullest.

Active Strategies

When lighting is required, at night time and at particular times of the day, lighting power densities are reduced and the lighting efficiency is optimized. High-efficiency, low-mercury compact fluorescent lamps will be utilized throughout the project. Smart controls will be provided where required, such as timers, dimmers, occupancy sensors and daylight set-back.

Landscape and facade lighting will be reduced to 50% of ASHREA/IESNA 90.1-2007 and exterior areas will not exceed by 80%. Local small scale solar powered lighting strategies will be explored.

Context
India's population and economic growth is increasing demand for water; because of this trend, water availability has dropped over 60% per year for the last fifty years and is still decreasing.

Almost 70% of the surface water resources and a growing number of the groundwater aquifers in India have become contaminated by biological and toxic pollutants. Salt infiltration is further taxing water resources. Currently, groundwater from aquifers accounts for over 80% of the rural domestic water supply and 45% of the irrigation water supply.

Demand Reduction
Sustainable development requires that aquifer depletion be minimized through reduced consumption. The target daily indoor water use for the project is 150 liters per capita. This compares to the daily US average of 226 liters per capita. Because municipal potable water is not available to the site, the project will be 100% dependent on its aquifer for potable water. Reductions beyond this target benchmark should be explored.

The most cost effective strategy to reduce water consumption is to reduce demand. The following analysis uses three water schemes for comparison to identify the potential savings available through demand reduction:

Table 1: A series of assumptions lead to three water strategies:

- Benchmark
- Moderate
- Aggressive

The Benchmark scheme consists of the cheapest available technology that meets building code.

Table 2: Assumptions in Table 1 are applied to a typical project unit and household. Water consumption is calculated by a water use model for each of the three schemes, and data is provided per type of use.

Figure 3: Comparison of savings provided by each scheme. For comparison, US standards of consumption are included.

Compared to the Benchmark scenario:

- Moderate water conservation strategy can reduce demand by 33% or 100 liters / person / day.
- Aggressive strategy can reduce demand by up to 60% or 71 liters/ person/ day.

Once demand has been minimized, further analysis of potable and non-potable water consumption will lead to additional savings in potable water consumption through water recycling and graywater treatment systems.

Greywater collection and treatment will provide recycled water for toilet flushing, road and car washing, and irrigation. Rainwater harvesting and recycling for non-potable uses could also contribute to water conservation. Further potential savings of 40% on total water demand is feasible. Reducing water demand means reduced pumping, electricity use and stress on the aquifer.

	Benchmark	Moderate	Aggressive
Kitchen Sinks	Cheapest Available Fixtures and Appliances	Low-flow faucets	High efficient aerated faucets
Water closets		Single flush, low flow WCs	Dual-flush, tank type gravity-feed toilets
Sinks		Low-flow faucets	High efficient aerated faucets
Showers/ Baths		Low-flow showerheads	Flow control, aerated showerheads
Clothes washer		Front-loading washers	Ultra-efficient washer (50 liters/ wash)
Dishwasher		EnergyStar Equivalent (13 liters/ wash)	Ultra-efficient Dishwasher (9 liters/ wash)
Car washing		No change.	No change.
Leaks		Leak detection systems for sinks	Leak detection systems for toilets
Irrigation		Reduce amount of turf grass on-site and use xeriscaping	Eliminate the use of a permanent irrigation system

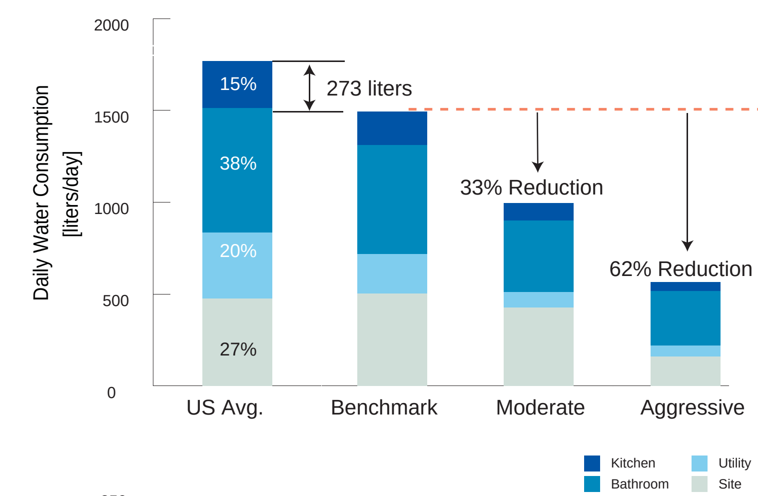
Table 1: Demand Reduction Technologies

		US Average *assumes 5.7 occupants	Benchmark *per typical dwelling	Moderate	Aggressive
Kitchen		257			
	Sinks		162	81	41
	Dishwasher		23	13	9
Bathroom		676			
	Water Closets		331	176	121
	Sink		45	22	11
	Showers		216	189	162
Utility		359			
	Laundry		140	49	41
	Other Domestic Use		76	38	19
Site		476			
	Irrigation		377	333	122
	Car Washing		54	54	22
	Leaks		71	38	16
Total (liters/day/ typical dwelling)		1767	1495	998	564

Table 2: Water Demand Reduction Calculations

- Increasing levels of affluence do not necessarily lead to proportional increases in domestic water consumption.

The Netherlands is an affluent, industrialized country with plentiful water supply, yet consumption levels are at a modest 132 liter/person/day. Singapore, a developed Asian country, in a climate similar to Chennai uses slightly over 100 liter/person/day, consistent with the Moderate water strategy.



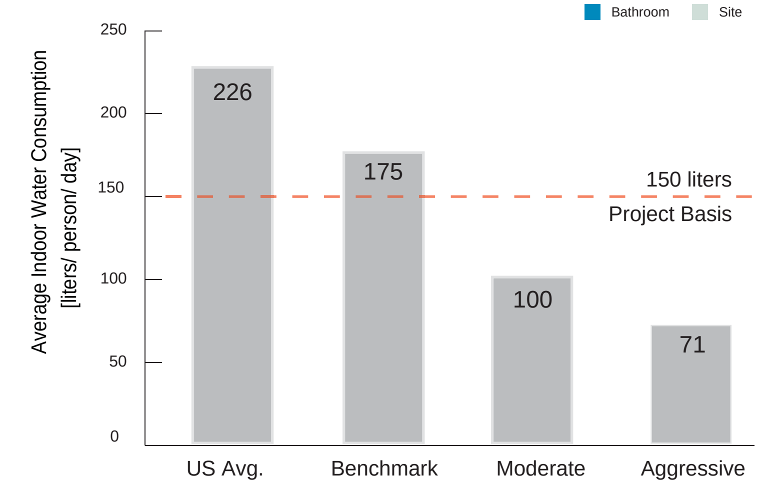
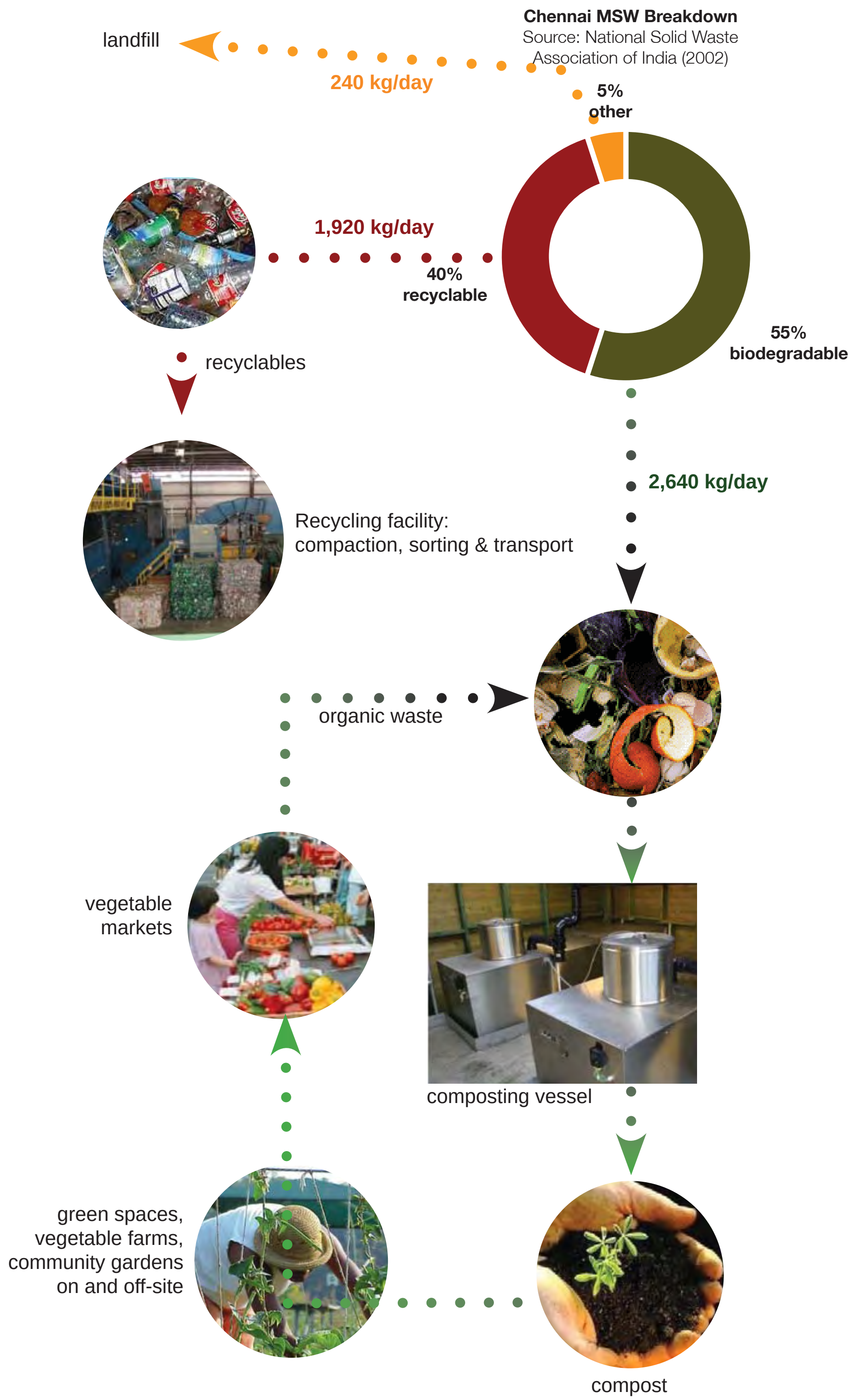
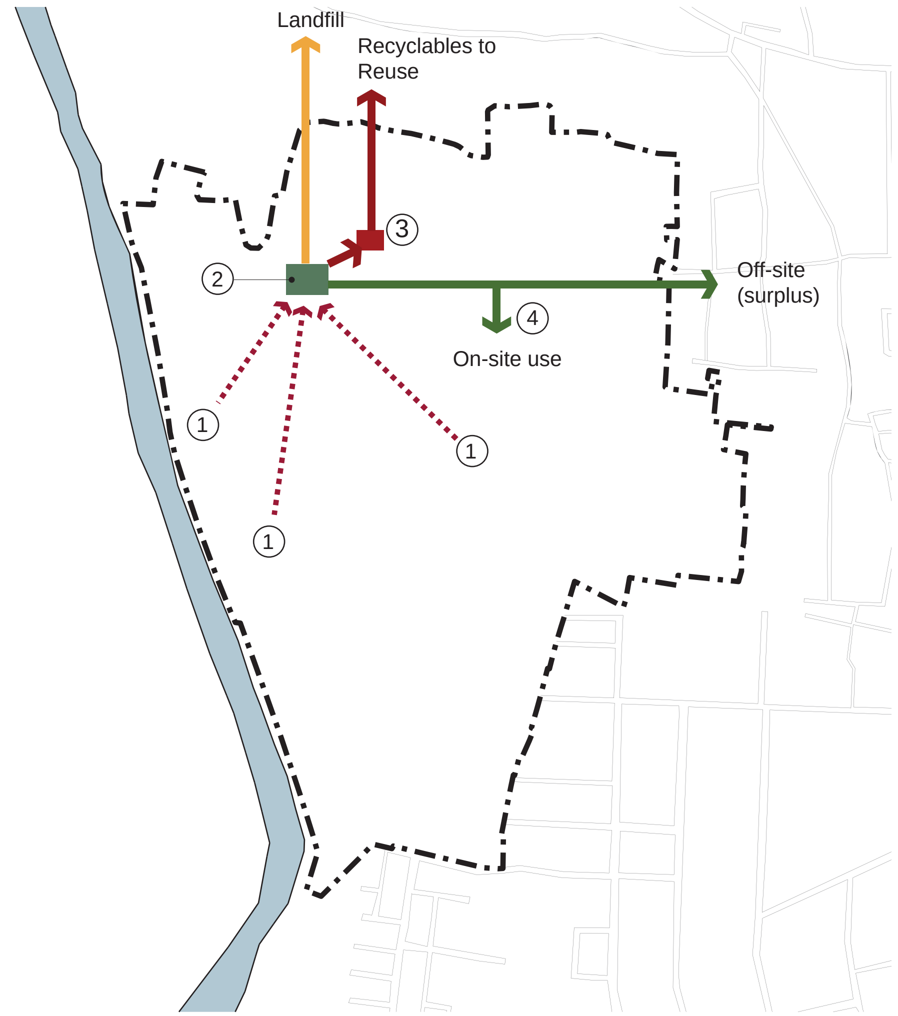


Figure 3: Water Demand Reduction - Scheme Comparison





1 Waste collected at building level and from public spaces and transported to Central Collection Facility

2 Central Collection Facility (On-site) Sorting & Organics Composting

3 Recycling Facility (Off-site)

4 Compost to green spaces, vegetable gardens and community gardens

Context

Municipal solid waste generation in Chennai is 1.1lbs/person/day. This waste consists of 55% biodegradable matter by weight. Because of the high organics component, there is a high moisture content and, therefore, a minimal need for compaction.

Waste Management Priorities

An integrated waste management strategy is a critical component to the sustainability of the project. This strategy should:

- Prevent unsightly areas and unpleasant odors
- Reduce the site storage area needed for waste
- Reduce number of truck trips and energy required for waste transport
- Reduce maintenance needs and hauling costs
- Divert as much organic waste as possible from landfills and prevent associated GHG emissions
- Recover recyclable material

Waste Strategy

- Waste is collected at buildings and from public spaces using hand-carts and light waste collection vehicles and is transported to a Central Collection Facility
- Waste is sorted into biodegradeable, recyclable and other components
- Organic waste is composted at the Central Facility using in-vessel composting or batch composting
- Compost is used for on-site green spaces and gardens and for off-site agriculture
- Recyclables are taken to an off-site recycling facility
- Non-organic and non-recyclable waste streams are transported off-site to a municipal landfill

Processing and use of composting on-site significantly reduces the number of truck trips that would be required per day to take waste to the municipal dumping grounds and, subsequently, the associated energy and emissions.

The facility size depends of the system selected. If the facility is 100% on-site and includes an in-vessel system, space requirements may be in the order of 2,000 m^2. Vehicular access is required, and siting should take into account turning space and minimal disturbance to residents. Use of a public recycling facility would reduce space requirements.

ROOF SYSTEMS

The roofs offers one of the greatest thermal comforts and environmental opportunities in the project.

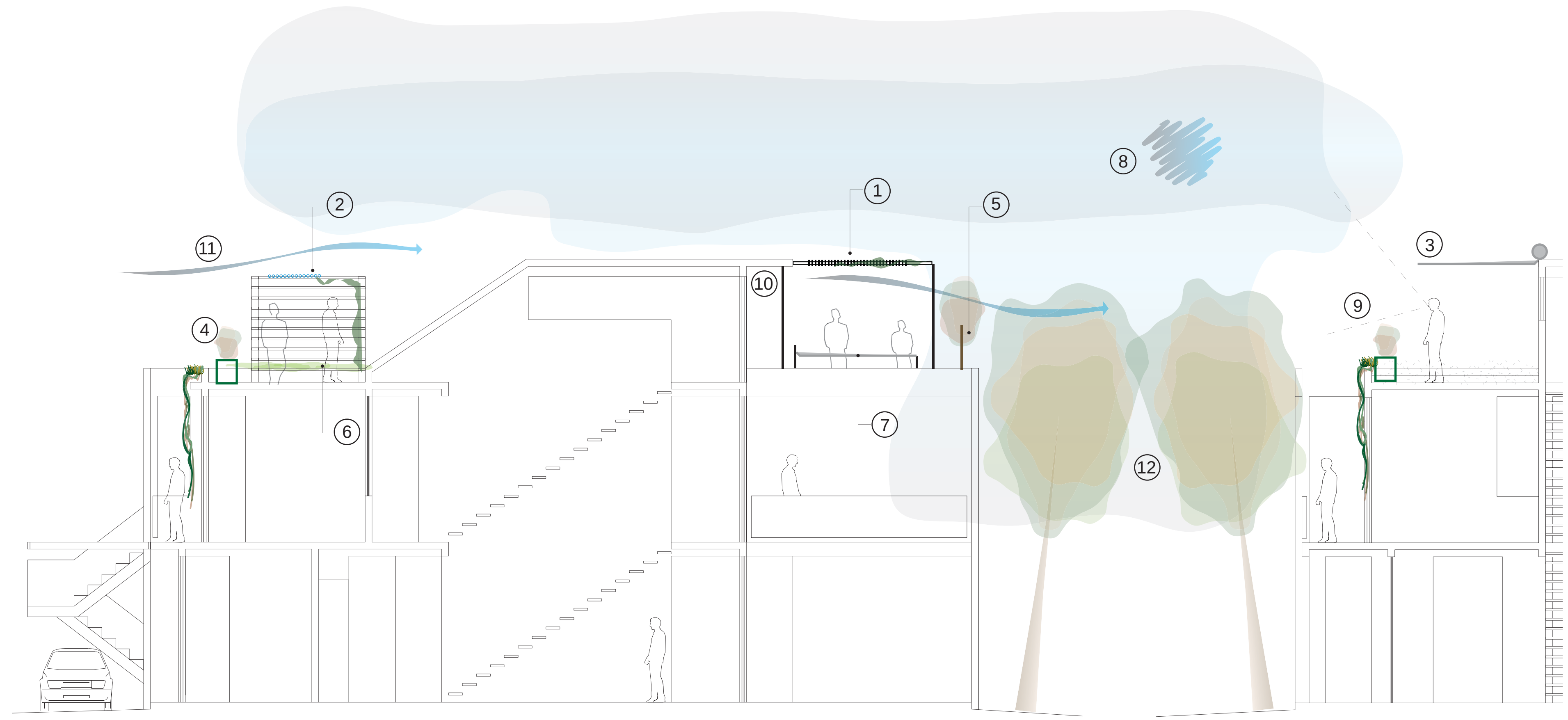
The master plan's streets and its buildings are oriented to encourage the pleasant breezes and the views of the project and its surroundings.

Roofs create a different outdoor space than the ground floor and upper level terraces. A combination of intimate, private, shaded spaces and open, exposed viewing terraces, gardens, and shelters can provide a diversity of experiences on each roof. Cool night breezes will help remove what little thermal heat is stored on the light colored roofs to create a pleasant passively cooled space.

Commuters leave in the morning and return in the evening, leaving a sparsely occupied space during the daytime hours. At day, occupants seek shelter in the cool shaded streets and private tertiary streets throughout the site. At night, the roofs come alive.

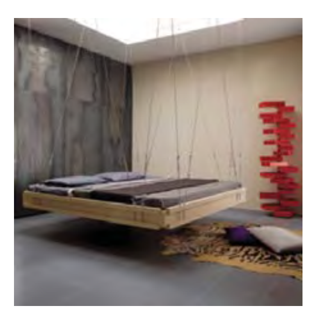
Through views of the landscape, the development and the city in the distance, a new link is created with community, sky, and nature.

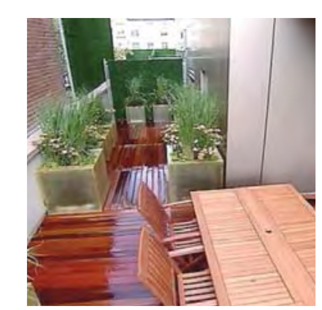
The township, when mature, will literally be one continuous garden, with the street trees linking the ground to the roof landscape. This dense lush environment, invites local habitat. Green roofs, planters, and vertical plantings help to capture and retain rain water before it hits the ground, providing environmental functionality, in tandem with a pleasant experience and increased property values.

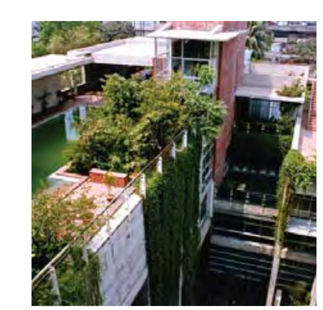


KEYED NOTES

1. Shading Structures w/ vegetation (permanent)
2. Solar Hot Water integrated Into shading device
3. Retractable canvas cover
4. Movable planters
5. Permanent Privacy Planters
6. Green Roofs (Combination of occupied, unoccupied, intensive & extensive
7. Permanent weather-proof furniture (day and night beds, shaded chairs)
8. Connectivity to sky, particularly, comfortable evening and night views
9. Linkage to neighbors and community
10. Shaded structure for daytime occupancy
11. Cool nighttime breezes make the roof the most comfortable area in Chennai at night
12. Full grown street landscape provide shade and privacy to roof areas, as well as filtering noise and airborne debris







INFRASTRUCTURE

A primary loop of underground utilities serves the project from two zones at the north and south of the site. This location insures that their operations and structures do not impact residents. The utility zones do not have public access, but are provided with service entries from the perimeter roads. Landscaping, walls and other strategies will screen views into these areas.

- Infrastructure buildings are low, unobtrusive structures no higher than the two-story Villas.
- Water towers, at approximately 20 m high, are positioned as urban design elements terminating the vistas of major streets.
- Treated wastewater discharges to the central tank via Riparian Corridors.
- Clubhouses utilize a natural wastewater treatment system as a demonstration project of low-impact, low-energy green infrastructure.
- Routing of main electrical distribution into the site is from SIDCO to minimize visual impact of overhead lines and retain maximum development value.

Location and size of all utility structures and routing is approximate and requires confirmation at the next level of project development. Design approach for stormwater management is described in Section 2.1 Water Strategy.

UTILITY ZONES

UNDERGROUND UTILITIES ROUTING
PRIMARY
SECONDARY

ELECTRICAL SUB-STATIONS
- 1-4 Villas
- 5-7 Townhouses
- 8-12 Apartments

EXISTING OVERHEAD UTILITIES

TREATED WASTEWATER DISCHARGE

WASTEWATER PUMP STATIONS

WASTEWATER CONSTRUCTED WETLANDS

0m 350m