# NEW GROUND: SUPPORT STRUCTURE FOR HUMAN HABITATS

by

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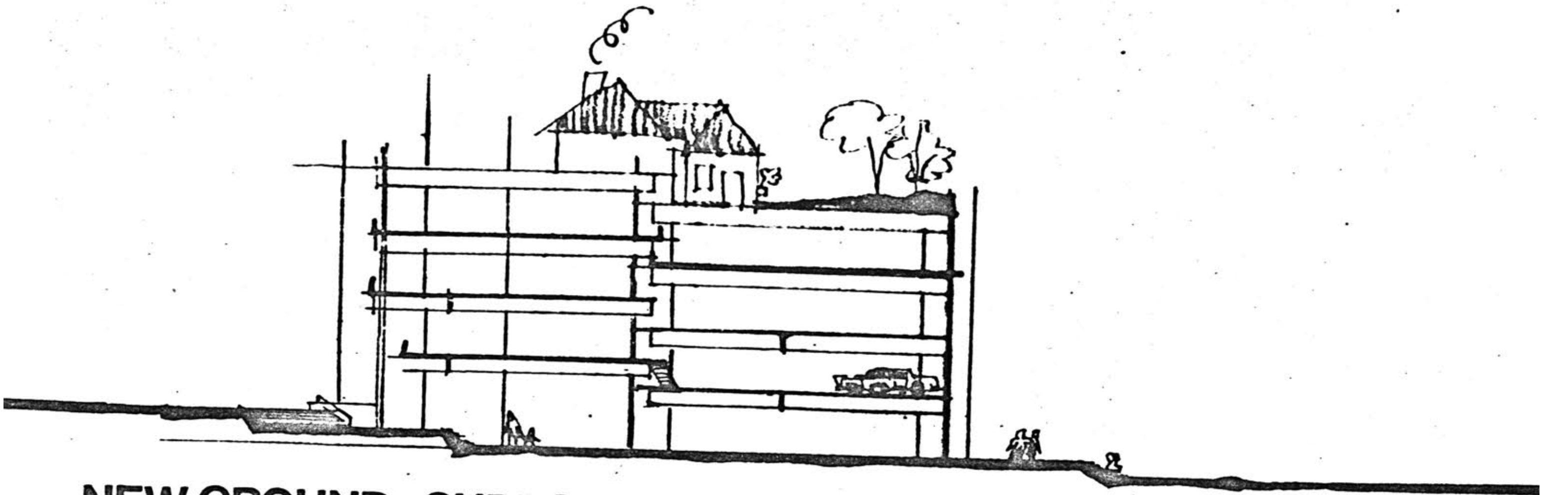

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# Preface

Because of my interests and training, I am biased toward investigations of built form solutions: dwellings themselves and not public policies, economic strategies, materials or methods research and the like. This thesis places a heavy emphasis on the ability people should have to control some of the architectural and physical aspects of their homes. I have not dealt with many issues--such as neighborhood quality, employment opportunity and economic power--around which many of the problems of housing arise. I have asked who will make decisions about housing needs and housing quality. I have prepared a preliminary design for housing on an urban site using an approach I believe will ultimately affect the broader issues as well.

My thanks go to Doloras Hayden and Douglas Mahone for the help they gave me during the formative stages of this thesis, and to my wife, Missy, without whose total support and assistance I could never have accomplished what I have.

Charles J. Michal

May 10, 1974

ABSTRACT: NEW GROUND: SUPPORT STRUCTURES FOR HUMAN HABITATS

Charles J.J. Michal, Jr.

Submitted to the Department of Architecture on May 10, 1974 in partial fulfillment of the requirements for the degree of Master of Architecture.

The design of multifamily housing, especially subsidized mass-housing, has historically been based on the needs of individuals as determined by social roles. These social roles are indentified with socio-economic indicators such as economic status, race and age. This abstraction of the typical user results in caricatures, and housing designed for such caricatures does not meet individual, personal needs.

As the profession realizes that the traditional design program is inadequate, alternative approaches to housing design are being suggested and tried. Two different attitudes are seen in these approaches. The first is to rely more and more on the expert, professional interpretation of people's real needs and on increased control of the physical environment in order to provide optimum environments for human development. The second attitude relies instead on the participation of people themselves in order to create physical environments that correspond to people's expectations as well as their needs. Because participation implies consent, and individual responsibility and power are desirable social goals, this second attitude is seen as the most desirable to take toward housing design.

The architectural problem that arises is how to allow for and encourage independent form decisions in medium and high density housing. A potential solution to this problem was suggested by Habraken (1961) to be "support structures", interpreted by this author to be a three-dimensional configuration of building sites, mechanical services and circulation patterns, within which individuals build or have built their own dwellings.

The support structure concept is developed and examined in a preliminary design for 160 units of housing on 4 acres in the Boston metropolitan area. The 11 sheets of drawings include the site design, the structural system design, and plans and sections of the support structure in two forms -- a terraced walk-up form and a medium-rise, elevator form.

The thesis concludes that the support structure is a valid and promising idea for urban housing, deserving further study and [hopefully] implementation.

Thesis Supervisor: Dolores Hayden
Title: Assistant Professor

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# List of Drawings

# Introduction

For the last two years, I have been both fascinated and frustrated by the manner in which mass-housing is produced. I have come to believe that the way in which housing is designed for people who are unknown to the bureaucrats, planners, developers, and architects ensures that such housing will never be anything more than "perfect barracks."[1] The design of mass-housing, which is based on "shopping lists" of residential requirements compiled through the statistical abstraction of people, never acknowledges the right to define personal housing needs for oneself. The attitude that professionals must make all decisions about the environment perpetuates this manner of housing design.[2]

Running counter to this attitude is the conviction that when individuals participate in the design, production, and management of their own housing the resulting environment is qualitatively better. Of the many means that have been proposed to enable and encourage this participation in the dwelling process, the idea of "support structures" introduced by Habraken in 1961 is particularly relevant to the urban situation. This thesis identifies some of the primary attributes of support structures and examines the architectural consequences of the concept with a preliminary design for a support structure of 160 dwellings on 4 acres in the Boston metropolitan area.

# 1 - The Man of Straw

The design of housing centers around the question, "What is a dwelling?" This question is answered with supreme confidence or in sheer desperation everytime a place is built in which people are meant to live. The answers tend to reflect the motivations of the people involved. The building industry sees the house primarily as a product and a source of jobs. The banking and financial circles look at housing as an investment opportunity or as a fiscal policy tool.

Architects generally view the ideal home as a living environment that has been "custom-designed" around the specific needs, wants and desires of one or more persons. Its success is dependent upon the client's ability to articulate, the architect's skill in interpreting, the community's propensity to interfere and the limitations of the site, time, money and materials.

This definition of the home assumes direct communication between the designer and the individual users. When these lines of communication are stretched or distorted, for instance by cultural differences, designs based on this definition are usually less successful. Obviously, when there is no communication between architect and user, the definition must change. When third parties serve as clients, the architect relies on the design program with its lists of user needs and residential functions.

The architect Vitruvius, writing in the first quarter of the first century A.D., set a pattern for these design programs. After discussing the appropriate proportions and proper exposures of various rooms in the house, he went on to explain that the rooms should be suited to the social class of the user:

> Men of everyday fortune do not need entrance courts, tablina, or atriums built in grand style because such men are more apt to discharge their social obligations by going around to others than to have others come to them.
>
> For capitalists and farmers of the revenue, somewhat comfortable and showy apartments must be constructed, secure against robbery; for advocates and public speakers, handsomer and more roomy, to accommodate meetings; for men of rank who, from holding offices and magistracies, have social obligations to their fellow citizens, lofty entrance courts in regal style, and spacious atriums and peristyles, with plantations and walks of some extent in them, appropriate to their dignity. They need also libraries, picture gallaries, and basilicas, finished in a style similar to that of great public buildings, since public councils as well as private law suits and hearings before arbitrators are very often held in the houses of such men.
>
> If, therefore, houses are planned on these principles to suit different classes of persons, as prescribed in my first book, under the subject of Propriety, there will be no room for criticism; for they will be arranged with convenience and perfection to suit every purpose.[3]

These programs are the professional's working definition of housing. Common to all these programs are three elements. 1)The housing needs of people are assessed according to their role in society. 2)These needs are accommodated by the provision of spaces for particular activities. 3)The design of these spaces is based on dimensional and aesthetic criteria.

This characteristic form of the design program has changed little over the years. As science has improved, other standards concerning acoustical transmission, thermal performance and the like, have been added to criteria such as Palladio's prescription that "loggias, for the most part, are not to be made less than ten feet wide, nor more than twenty."[4] Instead of rooms for particular purposes, writers now speak of "environmental resources" for "behavioral circuits."[5] The element that has changed the least is the first -- the use of social roles as guides to housing needs.

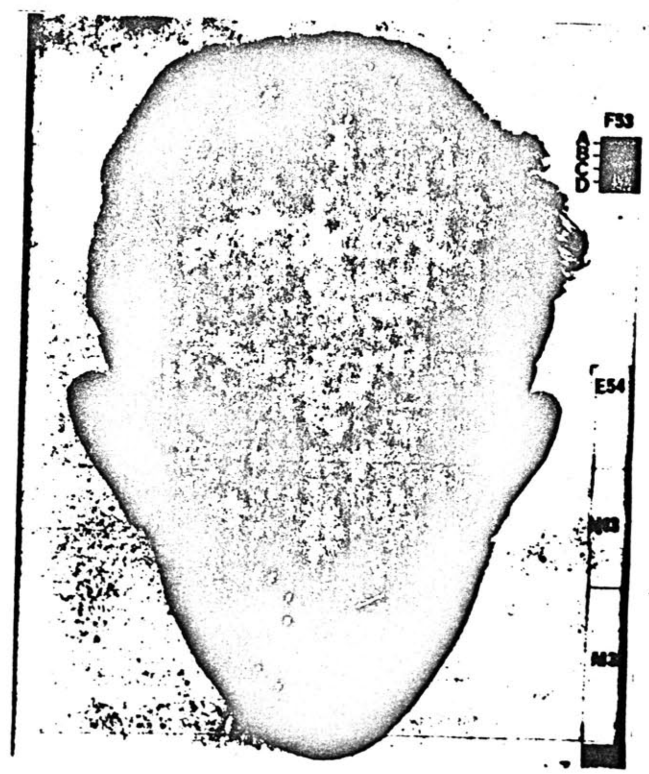
The professional's use of the social role is explained this way:

> In the traditional formulations of the social sciences, the role is considered to be the smallest unit in the social system, as one way of organizing what a person does and placing him in a system of social and interpersonal interaction. The approach in sociology and political science is to join many kinds of roles into substructures of society by abstracting from persons.
>
> The role a person "plays" abstracts him from what he is and does in concrete and specific terms. In all the behavioral detail that makes up a working day in a working environment, the "role of the executive" is different from "what an executive does." The concept of role has given the designers of physical things the idea that roles are people.[6]

The design and production of mass-housing relies heavily on this concept of roles as people. In order to define the social roles (read people) governments and the professions use socio-economic indicators. When, for example, Peter the Great moved Russia's capital to St. Petersburg in 1714, he ordered architectects "to draw up plans which should take into account the income and social position of the householders. Accordingly, plans were made out for modest houses -- for 'soldiers, carpenters, and workers of the lower classes' -- and for houses for the wealthy and the noblemen."[7] And our own history of public housing is one of repeated attempts to isolate deserving groups with socio-economic indicators -- whether they be economic status or occupation or more current ones such as education, ethnic status, age, sex and family status.

These indicators serve to catagorize typical users whose housing needs are to be met. These typical users are composites of bits and pieces of real lives, in the way a police photo-montage is a composite of partial photographs of real faces. They are gross caricatures stuffed with statistical straw.

The typical user as a statistical abstract.



## 2- On Attitudes and Alternatives

The problems with the traditional approach to housing design are being acknowledged within the professions. The model of the design program based on the socio-economic classification of users and their needs is in disrepute. In the search for alternatives, two opposing attitudes can be seen.

The first of these is a predictable outgrowth of our culture's contemporary dependence on expertise and professionalism. It is a continuation of public housing's legacy of paternalism. The primary characteristic of proposals exhibiting this attitude is the total exclusion of the public from the processes of decision-making and implementation.

In order to improve the programmatic definitions of housing, writers are calling for an interdisciplinary approach to the identification of human needs and human expectations.[8] The involvement of professionals in the behavioral sciences--psychology, sociology and anthropology--is sought. It is suggested that "optimum" environmental conditions for human behavior can be created through the application of knowledge gained from "unobtrusive monitoring of behavior in its setting."[9]

These methods are especially attractive to planners when combined with the industrialized building industry's potential to become a large-scale, systems oriented "shelter industry."[10] Such an industry would be responsible for the provision, maintenance and replacement of all the resources considered necessary for community life. Those resources could include public utilities, housing, communications, transportation--even recreation, education and medical care. The tremendous scale of operations and the top-down control, backed by the latest research in the behavioral sciences, would permit a very high level of efficiency, from the system's point of view.

Nowhere in this alternative is there any evidence that the people for whom the environment is being "optimized" have any part to play other than as passive consumers and as data sources. Real participation, which has been defined as existing when people "join in determining how information is shared, goals and policies set, tax resources are allocated, programs are operated and benifits are parcelled out,"[11] has no place in this view of how housing needs might be met.

Nor is it likely that the individual will be able to exert any control over the environment when professionals are spurred on by editorial calls for a "responsible architecture" in which the "full responsibilities of the architect should include not just <u>what</u> gets built, where and how, but also <u>why</u> and <u>whether</u>."[12] Without some other attitude toward architecture we might well come to a brave new world long before 1984.

The second attitude embraces participatory design methods and responsive building technologies. This attitude is part of a larger rebellion against the manipulation of individuals by institutions, whether they be public or private. More and more people are going out of their way to acquire their own educations, find their own inspirations, and shape their own environments. The trend is away from centralized authority and towards personal autonomy and power.

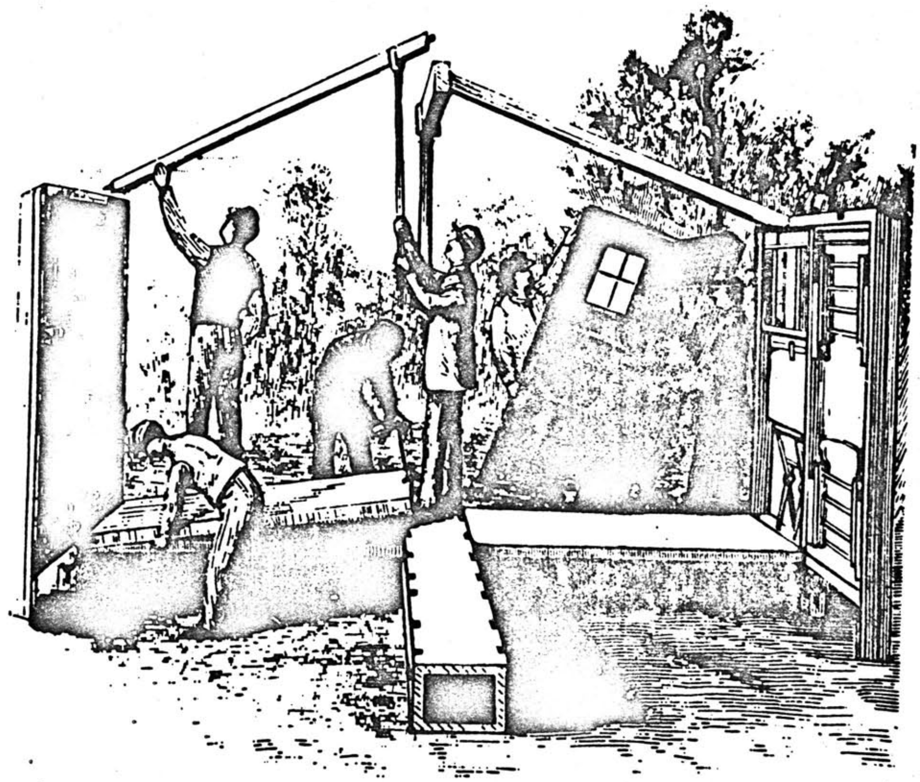
The argument for user participation in the housing process has a logical as well as moral basis. The dwelling environment will more likely reflect the needs and wants of an individual if he or she can take an active part in its design. Participatory methods that have been tried have shown that people have definite ideas about their homes and the changes and improvements that could be made therein, and that they can communicate these ideas in a variey of ways, particularly through model manipulation and gaming techniques.[13] It is also clear that people can and will plan and build their own homes if they are given the opportunity and means to do so.[14] Furthermore, it can be argued that experience of controlling and shaping the physical environment endows it with existential meaning for the individual.

Although people have been housing themselves far longer than professionals have been involved in the field, their freedom to do so is being threatened by the attitudes and trends previously mentioned. The tools and programs that would preserve this "freedom to build" are just beginning to be explored.

The legal and economic arrangements that would support individual decision-making on urban sites within the public infrastructure might be based on models such as the Sites and Services program [15] and the Urban Homestead Act.[16] The now familiar condominium is an obvious model for the equitable distribution of jointly incurred costs.

The industrialized building industry, instead of contributing to the trend toward standardization and centralized control, could be directed toward the manufacture and distribution of small-scale housing components and the dissemination of information in support of individual building efforts.[17] Directed research efforts might produce innovations in foundation systems, structure and enclosure systems, water and waste systems and energy systems that would make it easier to build, thereby increasing individual autonomy.[18]

Work also needs to be done on the architectural problem of incorporating independent decision-making about dwelling form into the context of the medium and high density urban site. The most promising idea I have found regarding this problem is Habraken's concept of a "support structure", which he defined as a "construction that allows for the provision of dwellings which can be built, altered, and taken down, independently of others."[19] In order to further this idea, which I believe takes the right attitude toward people and housing, I have prepared a preliminary design for a support structure on an urban site at a density of approximately 40 families per net residential acre.



Industrialized building methods can make it easier for individuals to build, thereby increasing personal autonomy. (Ducker's Portable Barrack and Field Hospital, 1886. From A Crack in the Rear View Window.)

# 3-Support Structures

Habraken's original definition of the support structure, while powerful as an idea, offers little in the way of design guidelines. His subsequent efforts as director of the S.A.R. (Stichten Architecten Research) in Holland have gone toward the development of a particular design methodology utilizing "zones" and "margins" within a modular co-ordination system. (See Plan, 3, 1970.) Little else has been published regarding the architectural design problems of providing freedom to build at urban densities.[20] The Community Projects Laboratory at M.I.T. has contributed the idea of zones outside the boundaries of the primary dwelling in which public functions as well as individual unit expansion could take place.[21]

In order to find a workable starting point for the preliminary design effort I undertook, I found it useful to look briefly at the traditionally successful rowhouse and city street combination.

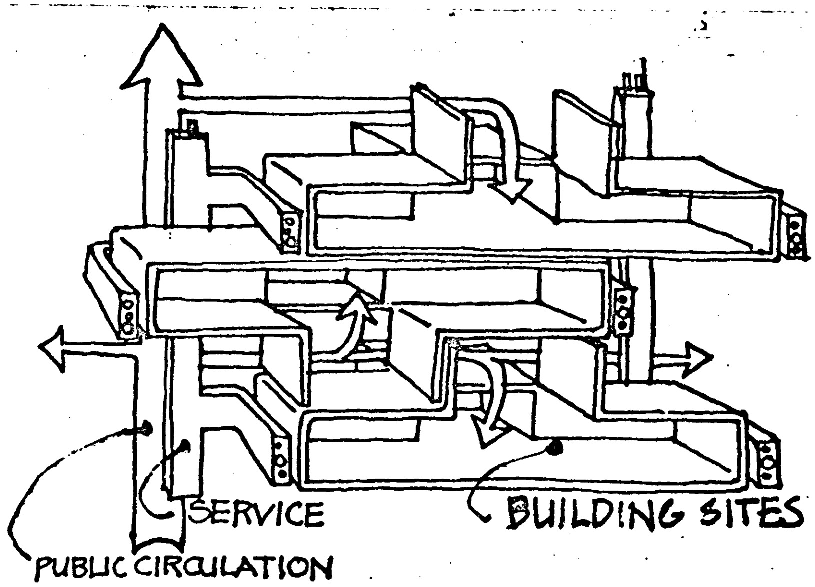
These house were built for speculative development or for individual owners in areas like Boston's Back Bay or South End. Each rowhouse was initially constructed as a one-family unit. In either case, what was and could be built was determined in large measure by a pre-existing structure. This structure was not primarily physical, but many parts of it had form and dimension.

The component parts of this structure included a pattern of public ways, with alleys paralleling streets, and a overlying network of services, accessible from below the street and from the alley. In between the public ways the land was divided into sites, each site having a front and a back. With the exception of the corner lots, each site had two other sites directly adjacent. Brick party walls seperating individual sites prevented the spread of fire and provided visual and acoustical privacy as well as structural support for roofs and floors. The spacing of the party walls was influence by the structural spans considered economically feasible. The maximum height of buildings constructed on these sites was fixed by zoning law. Within controlled volume, individuals could build pretty much what they wished, subject to other levels of control such as minimum setbacks and maximum bay window protrusions, and the dictates of fashion.

The structure controlling the development of the rowhouses can be regarded as a support structure that consisted of a two-dimensional circulation and service network and a series of three-dimensional building sites defined by zoning laws and the repetitive, vertical structural elements.

This analogy permits Habraken's definition to be re-written in a more descriptive form: A support structure is a construction that provides individual building sites and a network of services and circulation in a three-dimensional form, within which individuals can build, modify, expand and demolish their own homes, subject to an appropriate level of public control in the form of zoning laws.

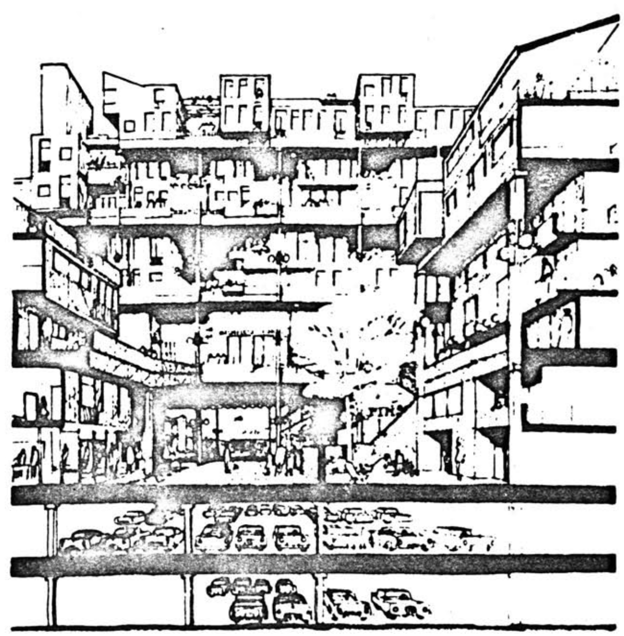
This re-written definition identifies two features of the support structure--the individual building sites and the service network--that most determine what building freedoms individuals will have. Consequently these two features or components of the support structure are the most important ones to examine in a preliminary design study.




The basic characteristics of the building sites within the support structure (Hereafter referred to as unit-sites.) are the gross area of the sites, the minimum vertical and horizontal dimensions of the sites, the number of sides on which individual sites are open to fresh air and natural light and the plan shape of the sites.

The plan shape (narrow rectangular, square, etc.) and the number of sides on which a unit-site has access to air and light together determine the relationships that are possible amoung the internal dwelling spaces. The number of discrete spaces possible across one side of a unit-site is determined more by the minimum width of the side rather than by the total area of the site. Total site area clearly affects the design freedoms the individual dweller will have. More space is always considered an improvement.

The extent of the service network and the ease with which individuals can expand it or change it is an important part of the support structure. The extent of the network is judged not only by the total number of access points but also by the tributary area that can be served. The ease with which the service network can be manipulated is related to the degree of independence the services for one unit-site have from the rest of the support structure. If, in order to change a service in one dwelling, it is necessary to tear out a ceiling in another, then the individual's freedom to build is unecessarily restricted.



Townland's Operation Breakthrough proposal: "synthetc land" and modular infill housing.

# 4-Preliminary Design

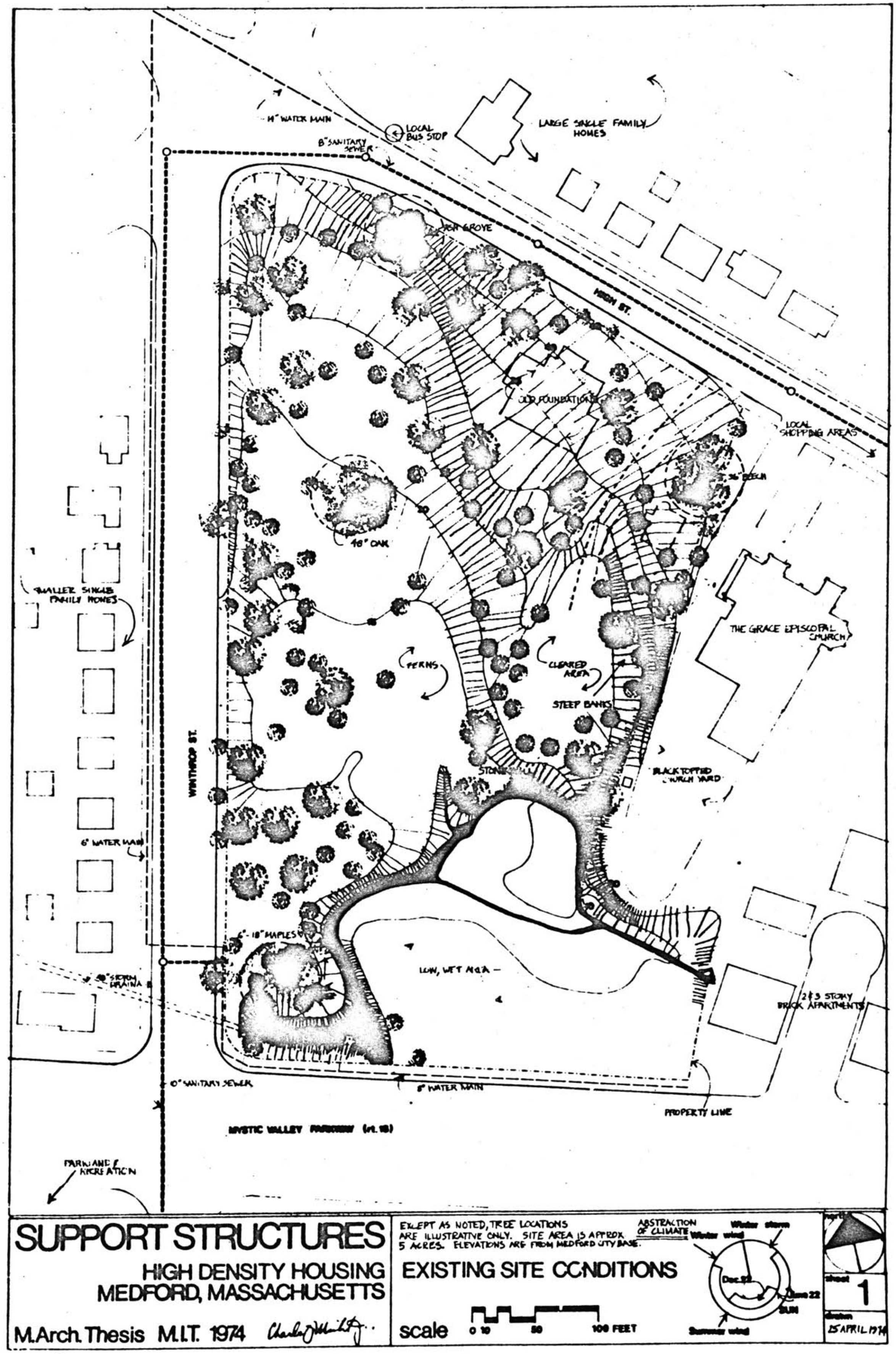
The site for which I have designed this support structure is located in Medford, Massachusetts on the edge of a neighborhood of single-family homes. It is zoned for multi-family use. In 1972, the site was planned for development at a density of 40-45 families per net residential area using three-story walkup apartments.

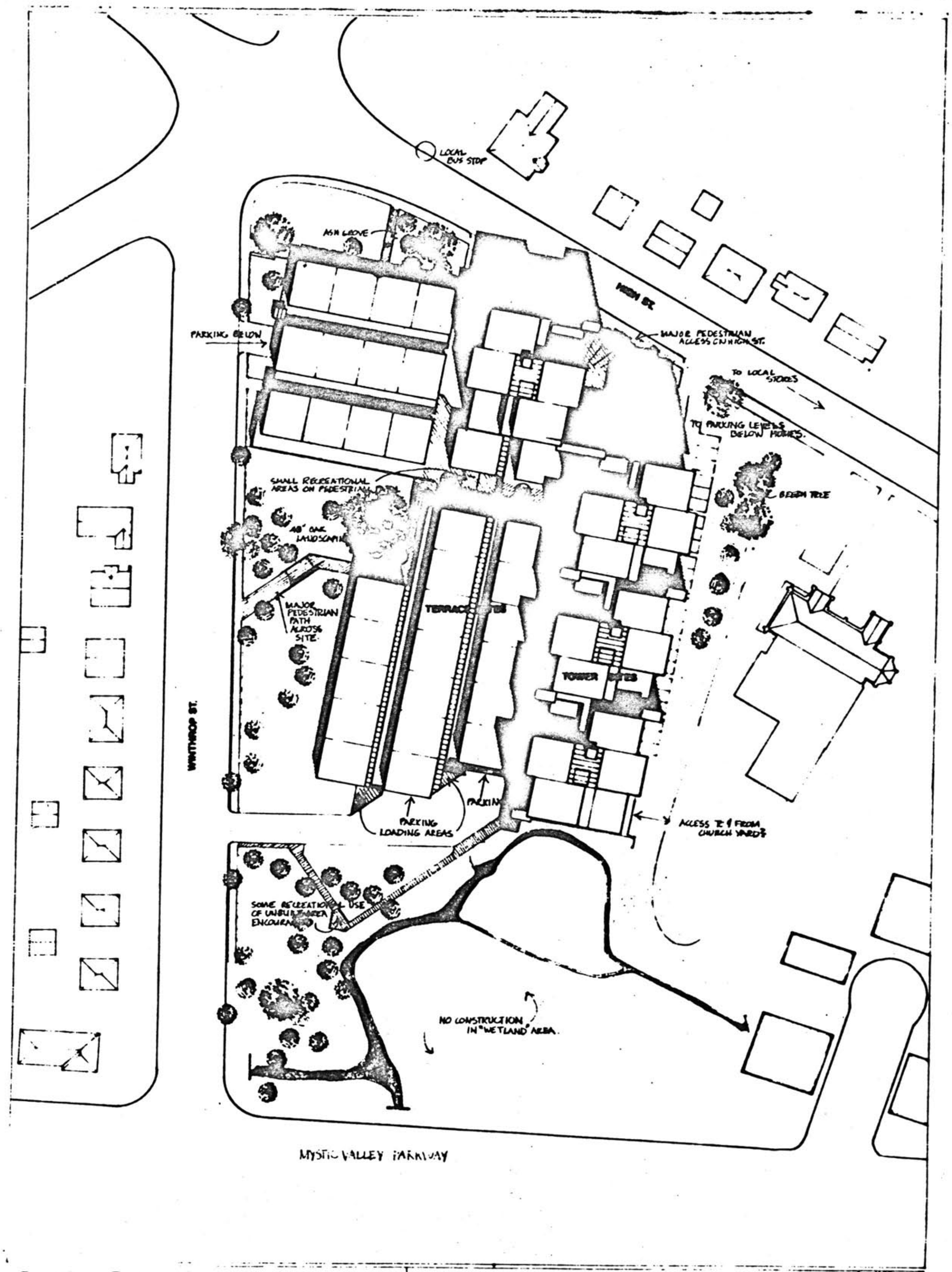
## EXISTING SITE CONDITIONS

The site is bounded on the north and west by residential streets (High and Winthrop, respectively) and on the south by the Mystic Valley Parkway. The parkway is Route 16 and connects with Interstate 93. During rush hours, heavy traffic effectively isolates the site and the neighborhood from the recreational fields and open spaces along the Mystic River directly to the south.

Directly to the east of the site is the Grace Episcopal Church fronting on High Street, and a three-story apartment group fronting on Route 16. Further up High Street are local stores and offices, a library, a catholic school, and other non-residential properties.

The total area of the irregularly shaped site is approximately five acres. The longest frontage, on Winthrop Street is 665 feet. The site slopes generally to the southwest from High Street and from the church yard with a total


LARGE SINGLE FAMILY HOMES
LOCAL BUS STOP
8" SANITARY SEWER
HIGH ST.
OLD FOUNDATION
LOCAL SHOPPING AREAS
36" BEECH
40" OAK
SMALLER SINGLE FAMILY HOMES
THE GRACE EPISCOPAL CHURCH
FERNS
CLEARED AREA
STEEP BANKS
WINTHROP ST.
BLACKTOPPED CHURCH YARD
6" WATER MAIN
18" MAPLES
LOW, WET AREA
2 & 3 STORY BRICK APARTMENTS
10" SANITARY SEWER
8" WATER MAIN
PROPERTY LINE
MYSTIC VALLEY PARKWAY (rt. 16)
PARKLAND & RECREATION
SUPPORT STRUCTURES
HIGH DENSITY HOUSING
MEDFORD, MASSACHUSETTS
M.Arch. Thesis M.I.T. 1974
EXCEPT AS NOTED, TREE LOCATIONS ARE ILLUSTRATIVE ONLY. SITE AREA IS APPROX 5 ACRES. ELEVATIONS ARE FROM MEDFORD CITY BASE.
EXISTING SITE CONDITIONS
ABSTRACTION OF CLIMATE
scale
0 10 50 100 FEET
SUN
1
25 APRIL 1974




# SUPPORT STRUCTURES

HIGH DENSITY HOUSING
MEDFORD, MASSACHUSETTS

M.Arch. Thesis M.I.T. 1974

CIRCLED NUMBERS ARE ELEVATIONS OF MAIN RESIDENTIAL LEVELS. SHADOWS AFFECT.. THOSE EXPECTED AROUND NOON ON MARCH 21ST OR SEPTEMBER 23RD.

## SITE ORGANIZATION

scale 0 10 50 100 FEET

north

sheet 2

drawn 25 APRIL 1974

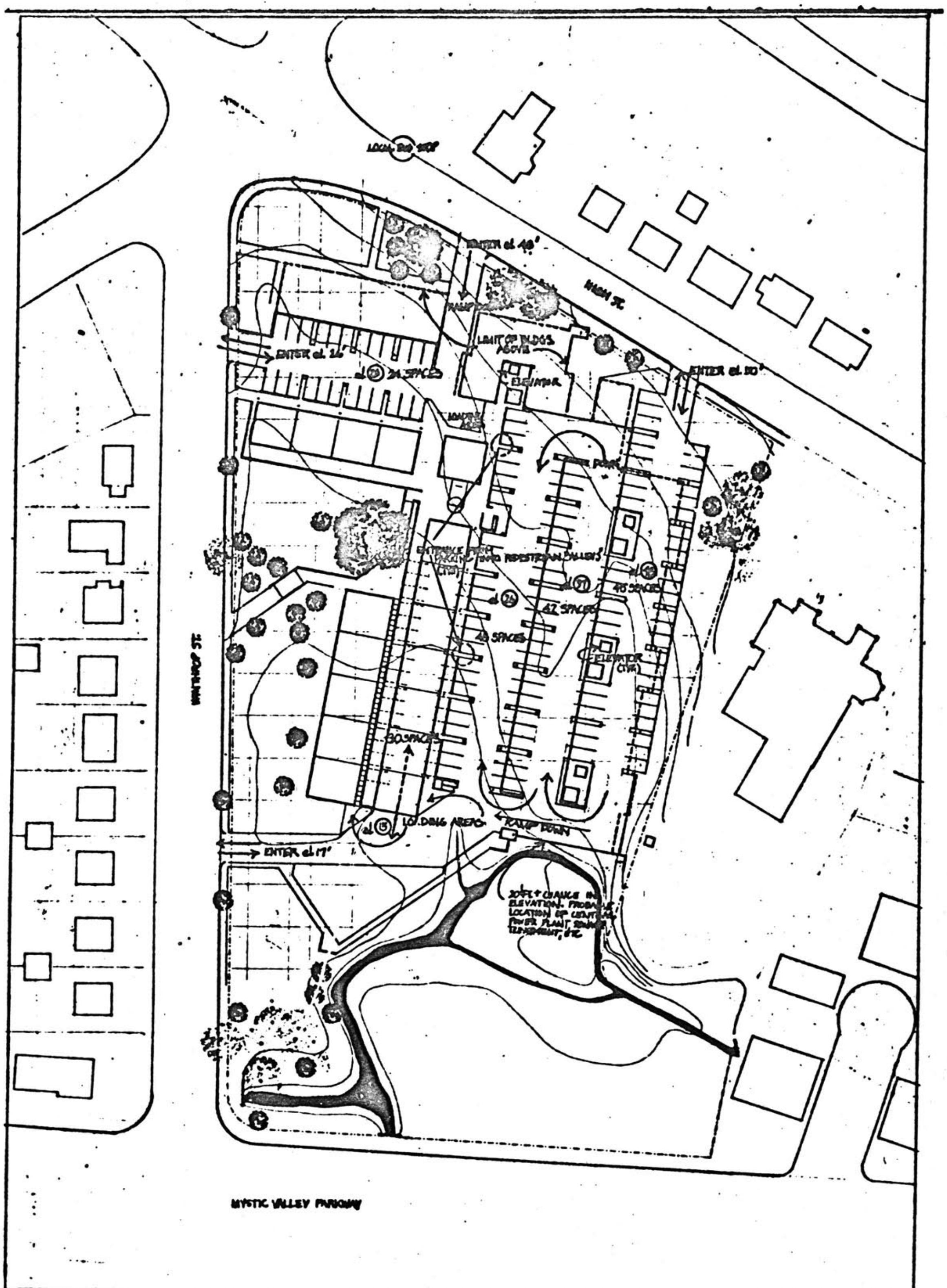
change in elevation of 40 feet. The lowest point on the site, five feet below the level of Route 16, is a stream that runs through the southern quarter of the site. This stream is part of a storm drainage and runoff system that feeds the Mystic River. The low wet area surrounding the stream is not considered a usable part of the site for building purposes. The site is covered with trees, including fine examples of Oak, Beech, and Ash.

My organization of the site was influenced by writers such as Bernard Rudolfsky and Jane Jacobs. Consciously, I wanted to save as many of the trees as I could, to minimize the visual impact of the new construction on the neighborhood, to keep part of the site attractive and useful to everybody in the neighborhood, I wanted to build in such a way that people would be aware of the sloping nature of the original site,and to place and position new construction so that sunlight was part of every dwellers home-life and shadows were not cast on houses in the neighborhood.

Naturally, these intentions and the demands of construction lead to contradictions, and tradeoffs were made.

## SITE ORGANIZATION

In the final site organization, 112 unit-sites are arranged in four six-story towers, and 30 unit-sites are grouped in terraced rows over terraced parking levels. (The 30 terrace sites can, if desired, be converted to duplexes.) Between 142 and 172 dwellings are possible with this support




# SUPPORT STRUCTURES

HIGH DENSITY HOUSING
MEDFORD, MASSACHUSETTS

M.Arch. Thesis M.I.T. 1974

**PARKING for 190 cars**

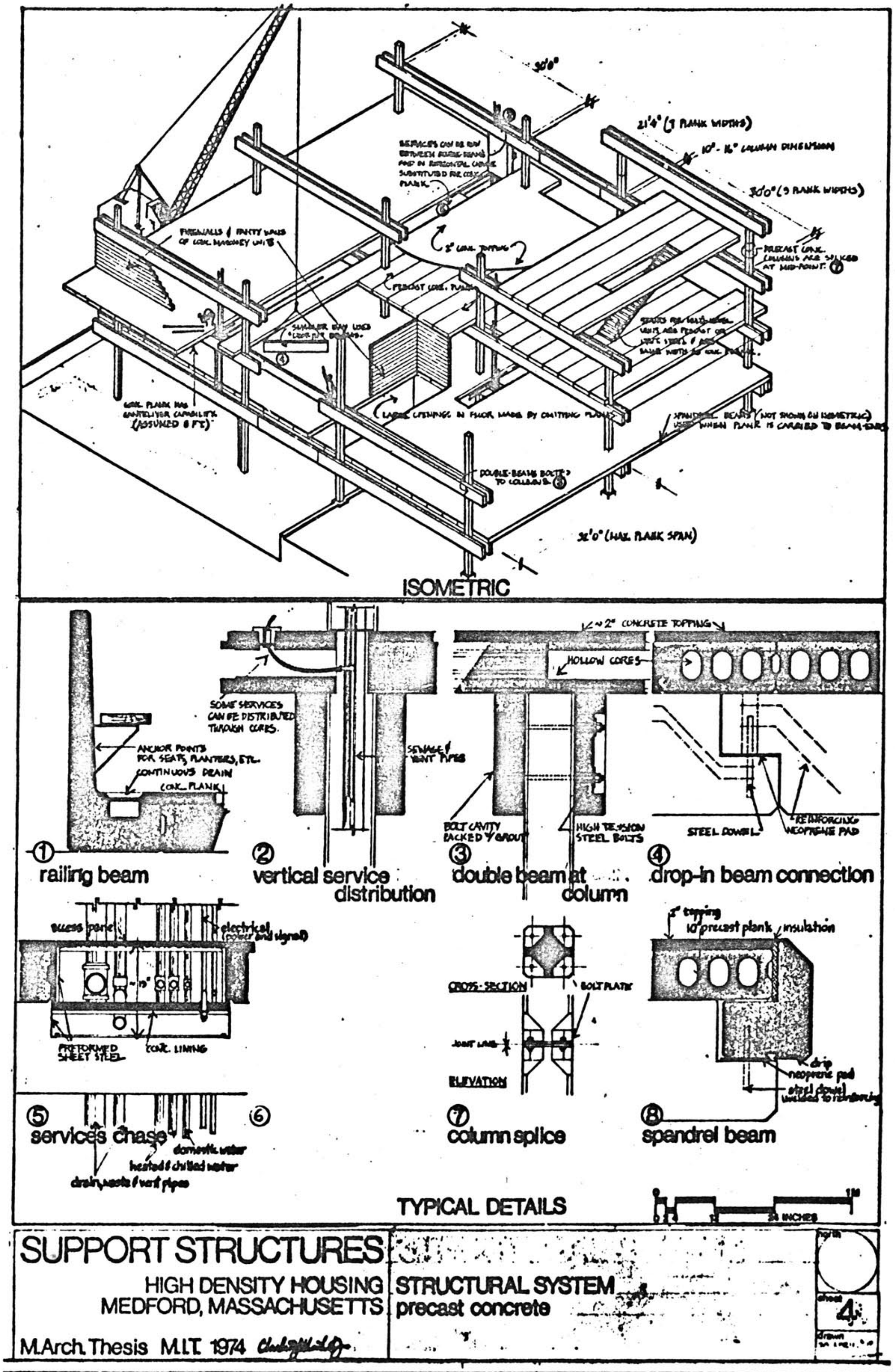
sheet 3

structure and parking is provided for a maximum of 190 cars. The developed area is just over 4 acres. The net residential density is between 35 and 43 D.U. per acre.

The terrace sites face south and west and the tower sites face east and west. The four towers are placed high along the eastern lot line. Their shadows will fall across the terrace sites in the morning and the church yard in the evening. In the middle of the day, during winter, shadows from the towers will reach across High Street. The northernmost tower is displaced westward in order to "open up" the corner of the site and provide a long view of the church from the western end of High Street. Bridges connect this tower to the group of three towers at the third and sixth levels - levels which have continuous internal "streets".

The re-entrant angle formed by the displacement of the northern tower provides space for several shops or community facilities and marks the upper end (elevation 48) of a major pedestrian street that passes under the connecting tower bridges and down ramps through terrace sites to a "vest pocket park" planned around a 48" diameter Oak tree (elevation 17) and out to Winthrop Street. A second street runs south along the western edges of the towers (elevation 48), across a driveway, and down into the undeveloped part of the site. This second street is bordered by six unit-sites that might be developed as professional offices, small stores and the like.

Three entrances to the tower elevator lobbies are


ISOMETRIC
30'0" (MAX. PLANK SPAN)
~2" CONCRETE TOPPING
HOLLOW CORES
SOME SERVICES CAN BE DISTRIBUTED THROUGH CORES.
SEWAGE & VENT PIPES
ANCHOR POINTS FOR SEATS, PLANTERS, ETC.
CONTINUOUS DRAIN
CONC. PLANK
BOLT CAVITY PACKED W/ GROUT
HIGH TENSION STEEL BOLTS
STEEL DOWEL
REINFORCING
NEOPRENE PAD
① railing beam
② vertical service distribution
③ double beam at column
④ drop-in beam connection
access panel
electrical (power and signal)
PREFORMED SHEET STEEL
CONC. LINING
CROSS-SECTION
BOLT PLATE
JOINT LINE
ELEVATION
2" topping
10" precast plank
insulation
drip
neoprene pad
steel dowel
⑤ services chase
⑥
⑦ column splice
⑧ spandrel beam
domestic water
heated & chilled water
drain, waste & vent pipes
TYPICAL DETAILS
24 INCHES
SUPPORT STRUCTURES
HIGH DENSITY HOUSING
MEDFORD, MASSACHUSETTS
M.Arch. Thesis M.I.T. 1974
STRUCTURAL SYSTEM
precast concrete
north
sheet
4
drawn

spaced 100 feet apart along the second street. To the west of this street, the three rows of terrace sites are separated by sheltered pedestrian "alleys" at elevations of 37 feet, 26 feet, and 15 feet. These alleys intersect the first street running across the site in the northeast-southwest direction. At elevation 26, this street joins with the first of three other rows of terrace sites that step up the hill to High Street. Between these three rows and the northern tower is a driveway for the parking below the terrace sites and the loading dock at the base of the tower. Finally, a driveway at the northeast corner of the site and another running across the southern edge of the development connect the terraced parking levels with High Street and Winthrop Street.

STRUCTURAL SYSTEM

The structural system developed during the design of this support structure is a precast concrete column, beam and plank system. The choice of prefabrication acknowledges the expanding influence of industrialized building methods. Precast concrete, as a material, was chosen over steel because it combines structure, fireproofing and finish surface in one product. Steel, when fireproofed economically, as with sprayed mineral fibers, does not provide a usable finish surface. The choice of columns and beams over bearing walls makes it easier for both the initial designer and subsequent users to control the location and size of spaces.

The precast hollow core concrete plank used in the design of this support structure is representative of standardized products available in the market. Each plank is 40 inches wide (approximately 1 meter) and 10 inches deep. When laid with a 2 inch concrete topping, these planks make a floor or roof system that has a dead load of 75 psf and can span 38 feet under a live load of 100 psf. Because the steel reinforcing is only placed in the bottom of the plank, it has a minimal cantilver capability. This particular plank has a bottom surface that is smooth enough and precise enough to serve as a finished ceiling. The hollow cores running parallel to the direction of span could be used for builtin ductwork for the circulation of conditioned air. Metal underfloor ducts for wiring can be buried in the concrete fill if it is a minimum of 2½ inches thick.

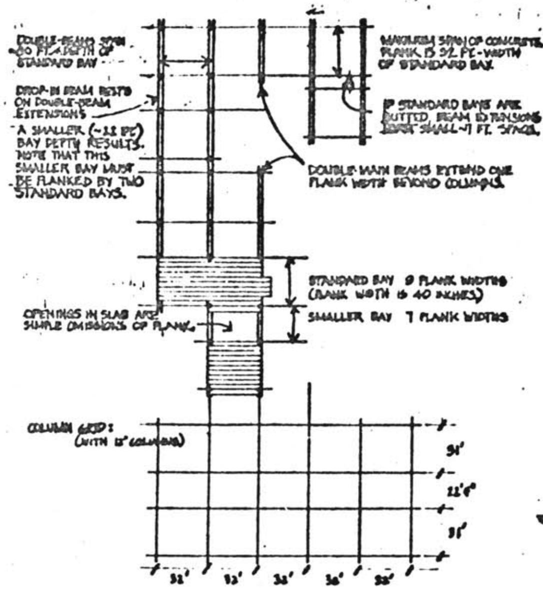
A special floor section made of steel is used instead of a plank, where major service runs are to be located. (detail 5.) As wide as the plank and a little deeper, this special section forms a chase or "utility trench" in the floor of each unit-site. Removable panels flush with the finish floor provide access to the chase. Capped services (potable water, waste piping, electricity, heated and chilled water, etc.) are provided at the ends of the chases along the column lines. These services can be extended along the trench by individuals building on the unit-site.

The precast beams used in this design have two special features. They are used in pairs and extend approximately one plank width past the supporting columns. High tension bolts effectively clamp the columns between the paired beams, with the column acting as a spacer between them. (detail 3.) The combination of beams and columns creates a long slot through which services and utilities can be passed. The paired beams provide bearing for the precast plank on both sides of any vertical chase constructed around the slot. When the hollow cores of the plank are combined with this slot and the floor chase, a simple but effective distribution system for most services is created. (detail 2.)

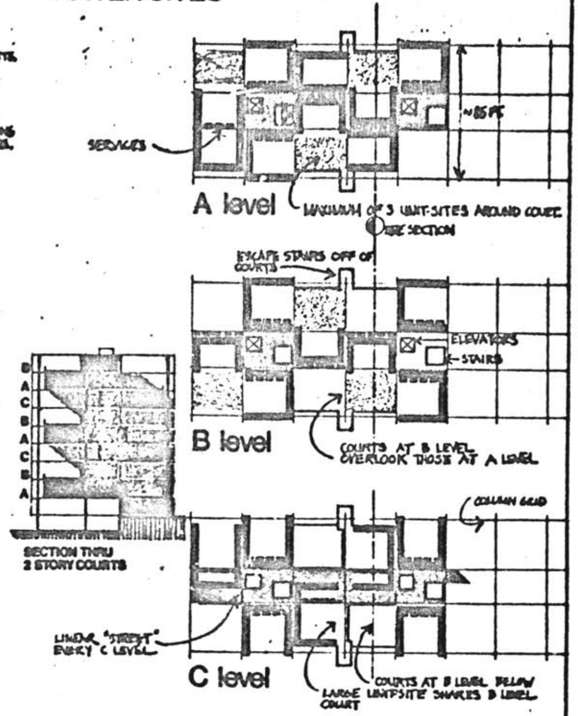
The extension of the beam past the column connection point creates a usable slab area that is larger than the bay area of the columns. This is desirable since column spacing tends to be dictated by dimensional requirements of inflexible uses such as automobile parking. This extension of the primary beams also allows a simple dowel connection to be made to drop-in beams which form a secondary bay. A system of drop-in beams, although is causes the number of spans to be odd, allows the beam to column connections to be simpler and the structural span of the beams to be less than the column spacing. Properly designed, this structural system causes the separate, pin-connected beams to behave like one continuous beam over several supports. If this effective continuity is achieved, all the beams can be smaller than would otherwise be required.

Columns for this structural system are square section

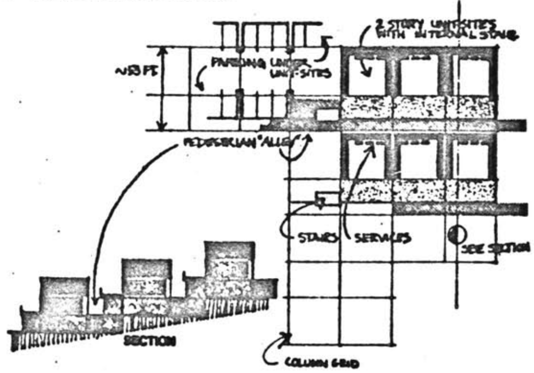
## STRUCTURAL GRID



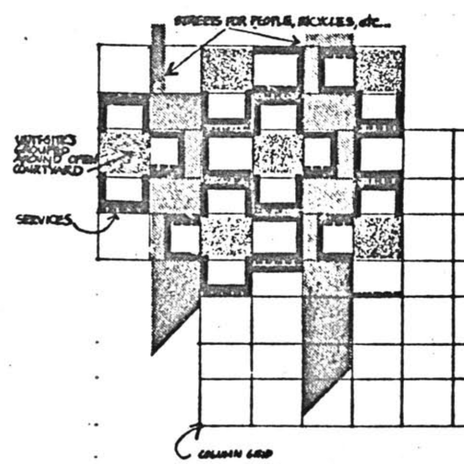

## TOWER SITES




## TERRACE SITES




## COURTYARD SITES




# SUPPORT STRUCTURES

HIGH DENSITY HOUSING
MEDFORD, MASSACHUSETTS

M.Arch. Thesis M.I.T. 1974

DIAGRAMS OF UNIT-SITE GROUPINGS
developed with STRUCTURAL GRID

key: UNIT-SITE, PRIVATE OUTDOORS, PUBLIC, SERVICE RUNS, ELEVATOR, STAIR

sheet 5

drawn 24 APRIL 1974

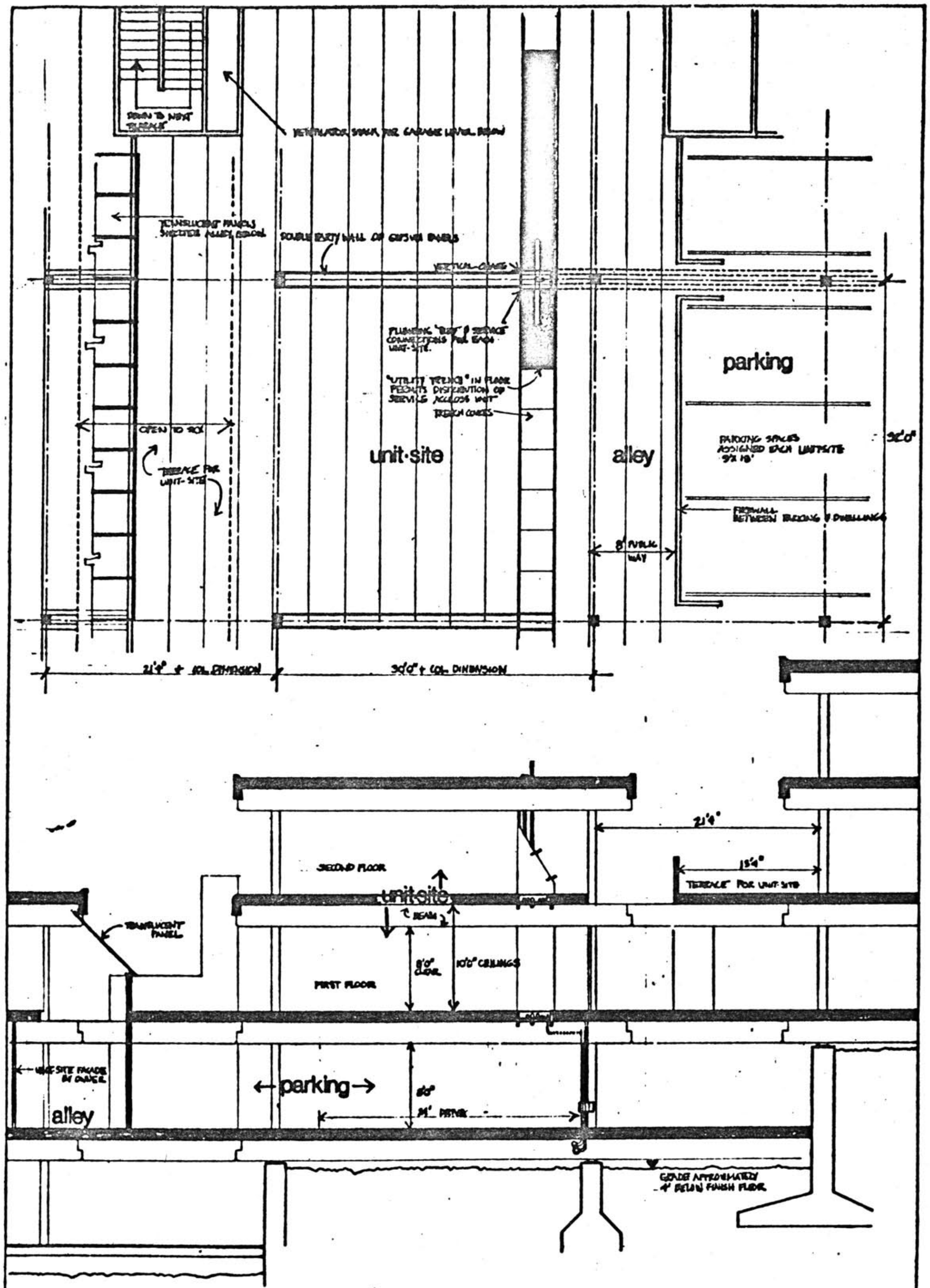
precast concrete cast with sleeves to receive the beam bolts. For structures three or less stories high, the columns would be continuous. Splices should occur at the midpoint of the column between floors if the column beam joint is developed as a moment connection. (detail 7.)

Two additional precast elements are used in this design. The railing beam combines a balcony rail with a floor section half the width of the regular plank. (detail 1.) Outdoor lighting, benches and surface drains can be cast into this special section. The spandrel beam is used to stiffen the edge of the plank at the end of the main beam. (detail 8.) The same connection detail used for the drop-in beams is used for the spandrel beam. This element also forms a protective detail for the top joint of infill walls and an attachment point for temporary scaffolding used during the construction of individual dwellings.

This structural and service system can be used to create different groupings of unit-sites.

## UNIT-SITE GROUPINGS

Three types of unit-site groupings were developed. The type identified as "courtyard sites" was not incorporated into the site design. The other two types are "terrace sites" and "tower sites". Because the services are distributed vertically between paired beams and horizontally to individual sites through the floor chases parallel to the plank span, the unit-sites logically correspond with bays created by the




# SUPPORT STRUCTURES

HIGH DENSITY HOUSING
MEDFORD, MASSACHUSETTS

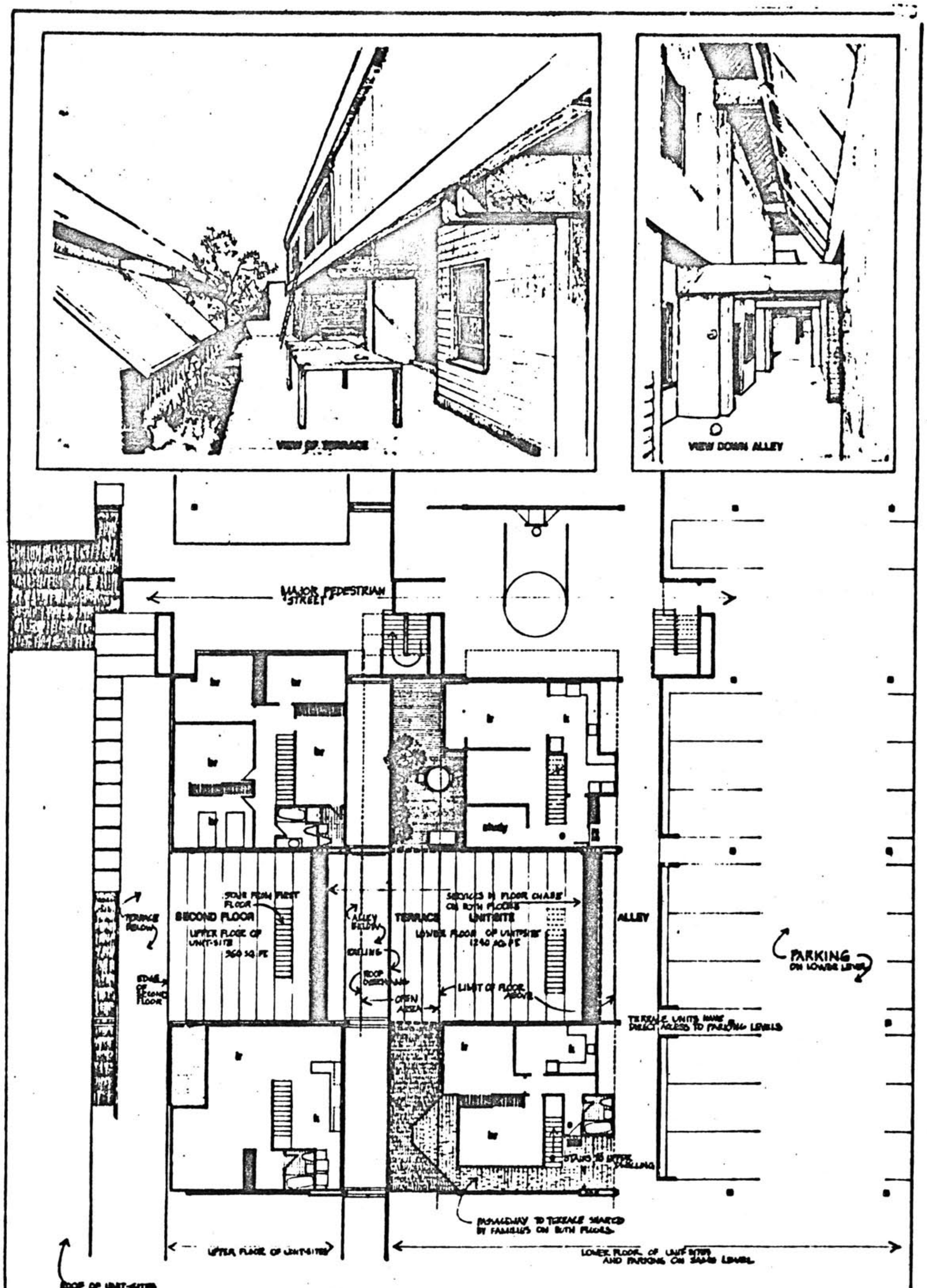
M.Arch. Thesis M.I.T. 1974

TERRACE SITES
DETAIL of structure

scale 0 1 2 5 10 15 FEET

north

sheet 6




# SUPPORT STRUCTURES

HIGH DENSITY HOUSING
MEDFORD, MASSACHUSETTS

M.Arch. Thesis M.I.T. 1974

TERRACE SITES
TYPICAL PLANS & VIEWS

scale 0 5 10 25 FEET

sheet 7

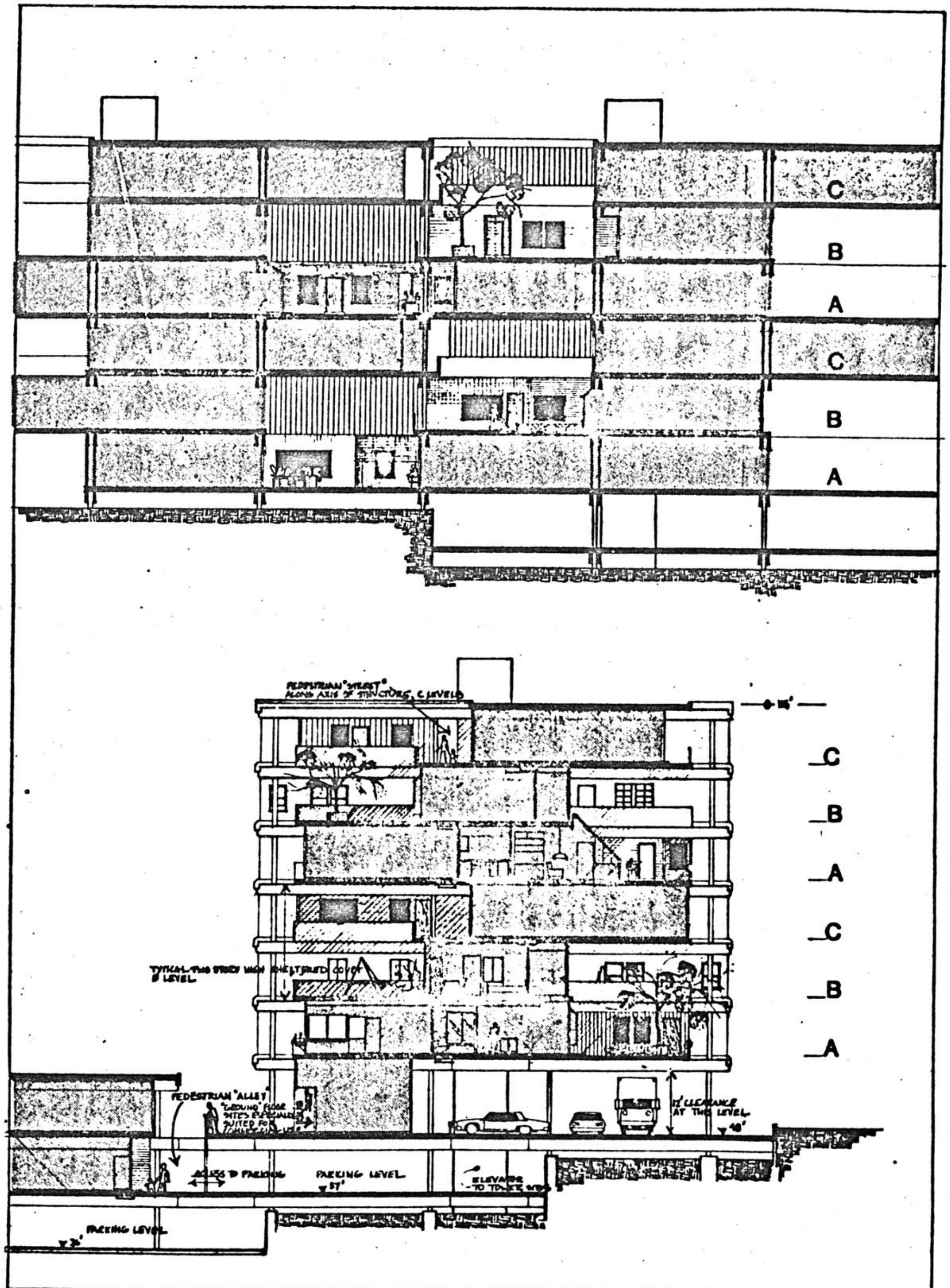
drawn

structural grid. Since the columns--which are spaced 32 feet apart in the direction of the plank span--alternate between 22 feet 4 inches and 30 feet apart, there are two bay sizes. Both of these bay sizes can be altered, either by extending planks beyond the beams or omitting them altogether.

TERRACE SITES

The terrace sites use the larger bays of the support structure for dwelling spaces and the smaller bays for private outdoor spaces and pedestrian walkways. These unit-sites, separated by party walls, are arranged in rows. Each site has a first and second floor connected by a prefabricated staircase. Below the first floor of the unit-sites, the support structure provides parking. Because of the stepped configuration of these sites, the parking below one row of unit-sites is on the same level as the first floors of the next row of sites. The parking spaces assigned to individual unit-sites can be reached by a hose or extension cord run from within the dwelling.

The transition between the parking and the unit-sites on the same level is through a pedestrian alley running parallel to the rows of sites. This alley is 8 feet wide between the face of the garage wall and the property line of the sites. It is sheltered during winter by translucent screens that can be removed during summer. Zoning regulations would be used to encourage the building of setbacks and articulated facades at the first floor of each unit-site. The




# SUPPORT STRUCTURES

HIGH DENSITY HOUSING
MEDFORD, MASSACHUSETTS

M.Arch. Thesis M.I.T. 1974

TOWER SITES
TYPICAL SECTIONS through courts

scale

north

sheet 8

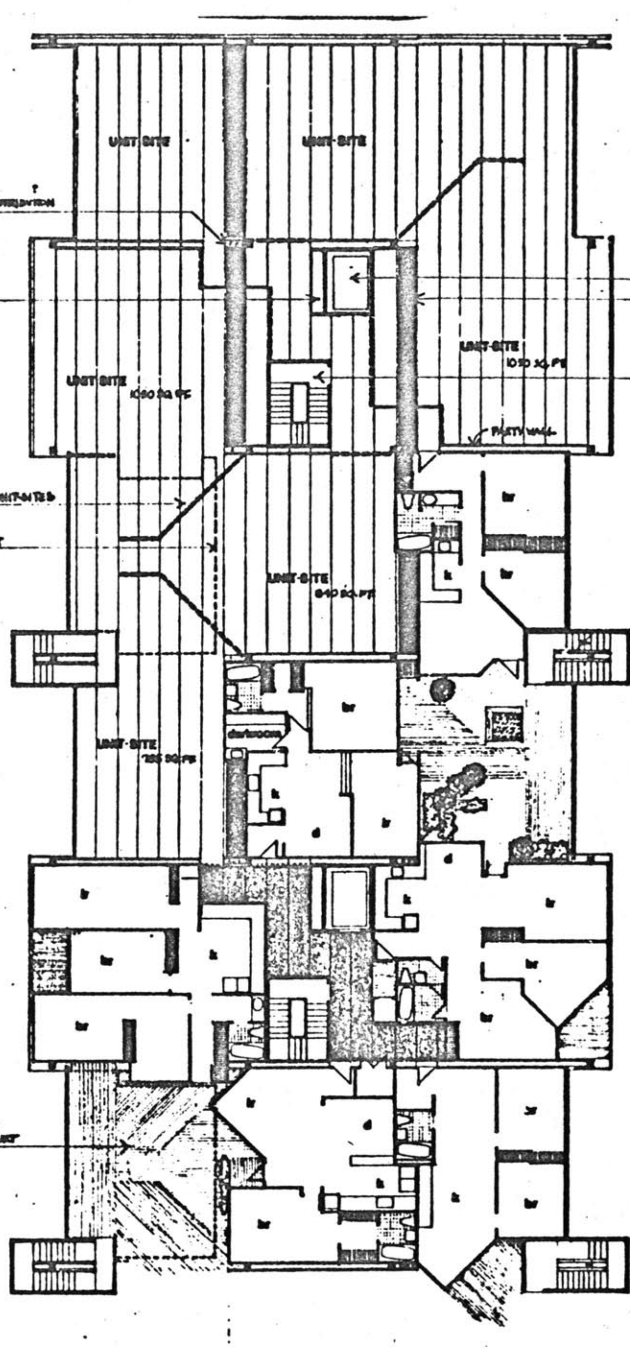
drawn

intention is that the resulting small spaces and the semi-sheltered nature of the alley would provide pleasant play areas for young children. The location of the service chase near this end of the unit-sites enables kitchens to be built from which easy supervision of the alley would be possible. (See "view down alley", page 28.) On the other side of the unit-sites, the extension of the first floor level creates 13 foot deep by 32 foot wide terraces for each site. These terraces are overlooked by the second floor of each unit-site and in turn overlook the alley serving the next row of unit-sites. (See "view of terrace", page 28.)

These terrace sites are large. Including the area of the outdoor terrace, the gross area of each site is 2200 square feet. With natural light and fresh air available on two exterior faces, these sites can easily support four-bedroom dwellings. Additionally, the prefabricated stair can be used as an entry stair to a seperate one-bedroom apartment on the second floor, so that two small dwellings are possible on each unit-site.

TOWER SITES

The tower sites are grouped in a complex three-dimensional way around large open bays called courts. These courts, two stories--21 feet--high and about 800 square feet in area, are open on one side to the climate. The courts are intended to serve as shared "backyards" to the individual unit-sites. They are large enough to grow small trees in,




# SUPPORT STRUCTURES

HIGH DENSITY HOUSING
MEDFORD, MASSACHUSETTS

M.Arch. Thesis M.I.T. 1974

UNIT-SITES ON LEVEL A ARE GROUPED IN THREES AROUND 2-STORY HIGH COURTS.
1 & 2 BEDROOM FLOORPLANS SHOWN AS ILLUSTRATIONS ONLY

## TOWER SITES
## PLAN of LEVEL A

scale 0 5 10 25 FEET

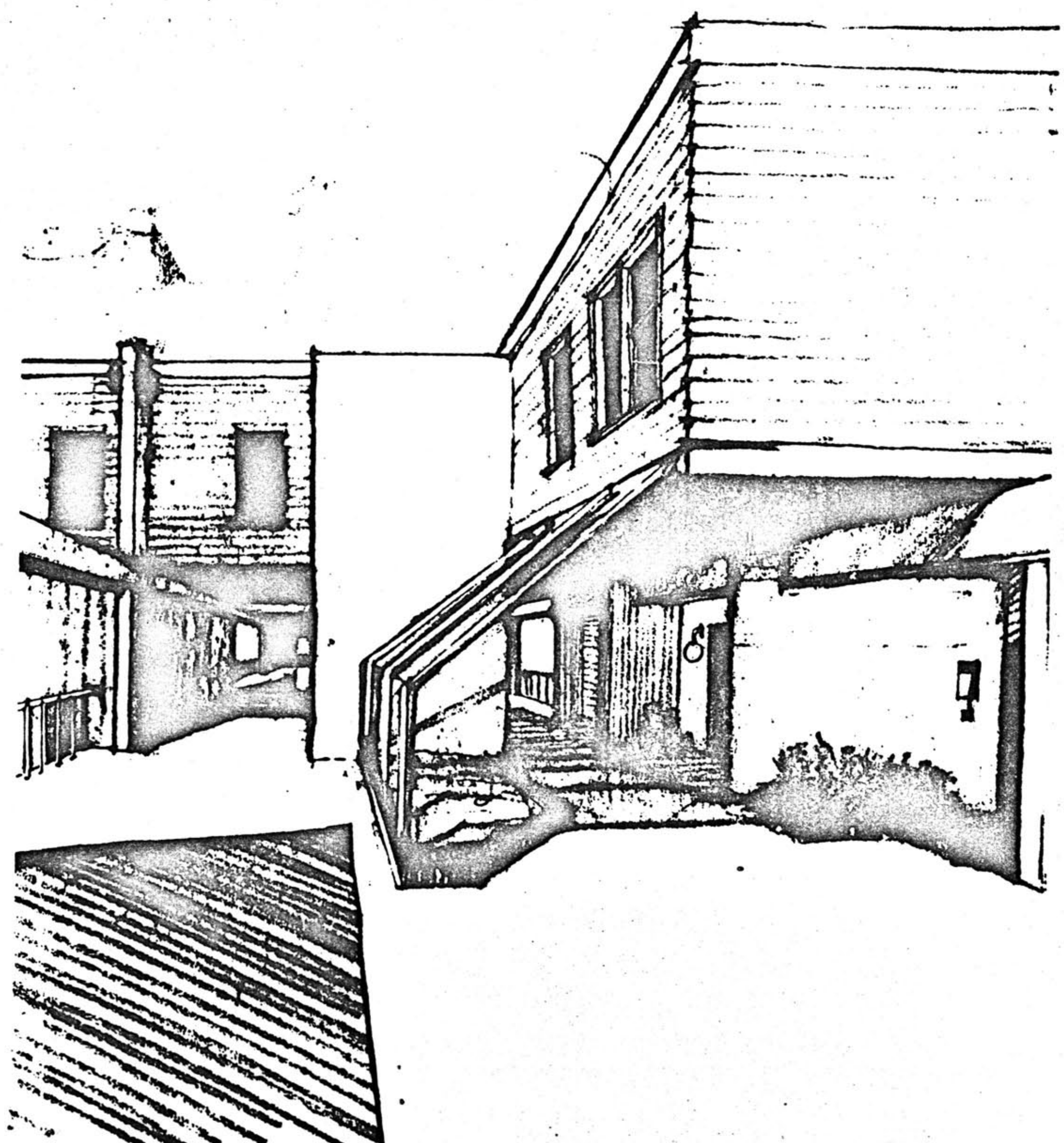
sheet 9

and to set up childrens' swings or practice basketball nets in. The two-story courts also provide dwellings that would otherwise have only one exterior face with two--one into the courts and the standard one on the outer wall. When the tower sites are grouped in slab form, as is intended, each two-story court partially borders on a second. This adjacency provides people inside the courts with visual distances on the order of 60 feet within the support structure.

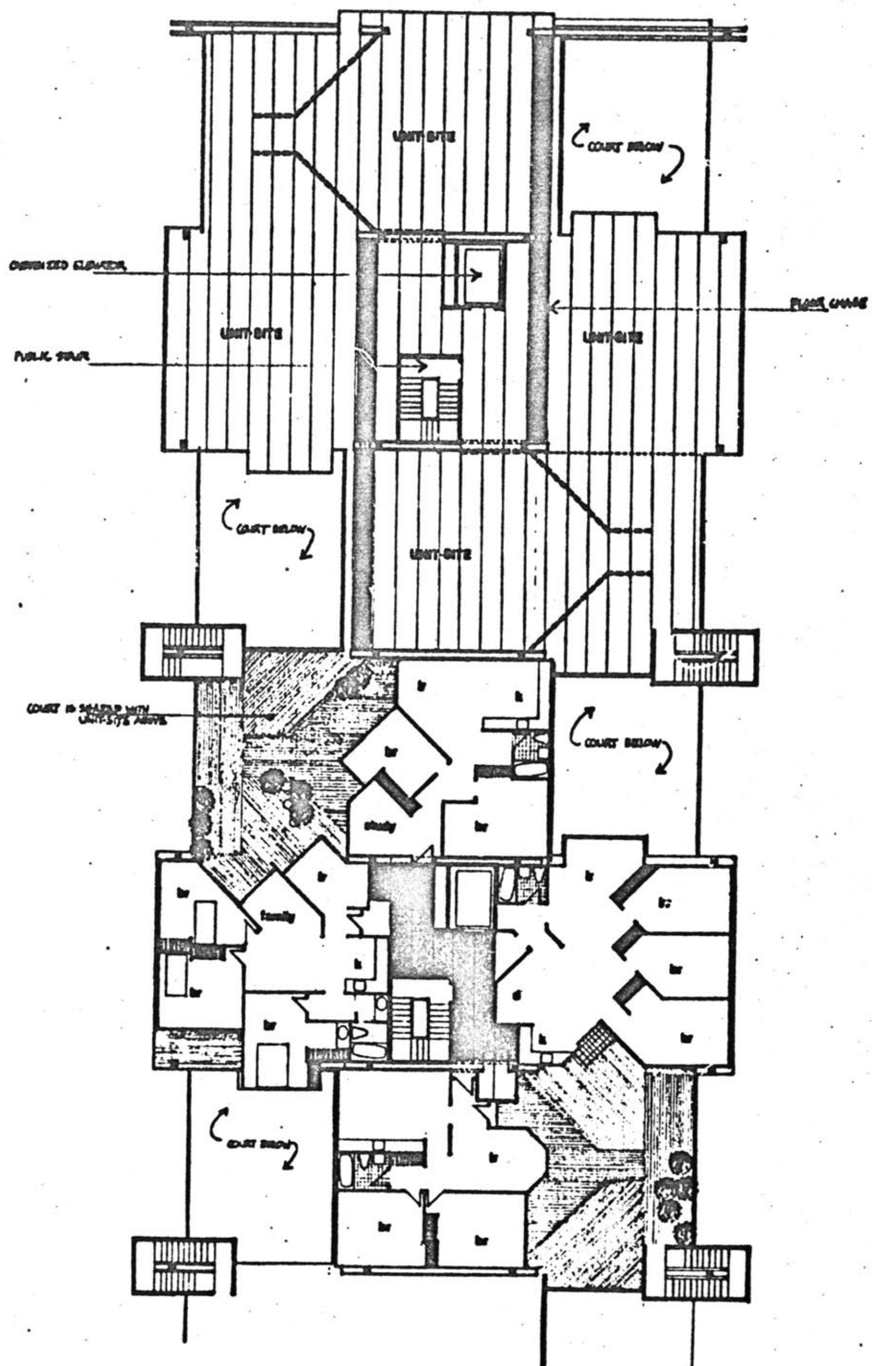
The individual towers are built up by stacking three-level clumps of fourteen unit-sites and four courts each. The levels A, B, and C in each clump are groups of nine structural bays with the central bay used for elevators, stairs and selected services. Of the twenty-seven bays that make up each clump, eight large bays --about one-third the volume and one-fifth the slab area--are devoted to the two story courts. The towers built up with these clumps are butted to make a slab form. On every C level the circulation then takes on the character of an internal street; alternately passing through elevator lobbies and out overlooking the two-story courts.

LEVEL A

On the A level, six unit-sites are grouped around each circulation core. When the tower groups are combined in the preferred slab form, three unit-sites are grouped around each two-story court. Of these three, the one that



Sketch of possible street view when Level C is used as a rooftop level. (See also page 37.)




# SUPPORT STRUCTURES

HIGH DENSITY HOUSING
MEDFORD, MASSACHUSETTS

M.Arch. Thesis M.I.T. 1974

TOWER SITES
PLAN of LEVEL B

scale 0 5 10 25 FEET

north

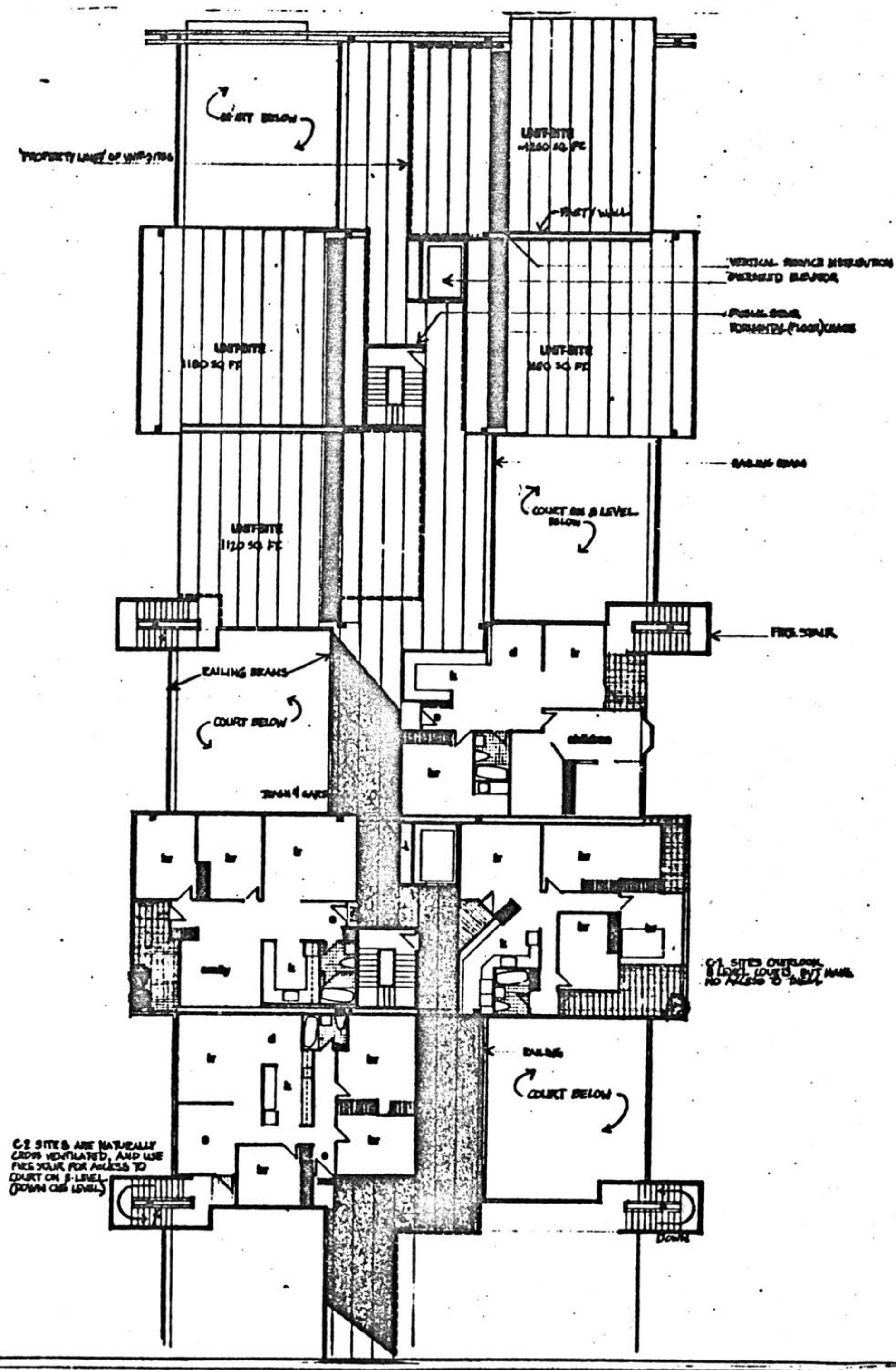
sheet 10

is the least flexible in terms of potential dwelling layout is the one occupying the center small bay of the support structure. This site of 840 square feet will probably be developed like a large one-bedroom apartment in a normal high-rise slab building.

The other two sites sharing the court are open on two sides--the court side and the external face of the support structure. The larger site is directly adjacent to the circulation core, and shares some of the area of the central structural bay. With a gross area just over 1000 square feet and two exterior faces, this site can support two and three-bedroom dwellings. The smallest site of the three is only 785 square feet in area, but because it has two exterior faces, it can support small two-bedroom dwellings.

LEVEL B

The upper half of the two-story courts on the A level occupy two of the support structure bays on the B level. The four unit-sites on the B level look into the lower courts and also open onto their own court spaces. This increases the number of sides on which dwellings built on these sites have access to air and light. The sites in the center small support structure bay can therefore be developed as two-bedroom dwellings, and the large sites adjacent to the circulation core can easily support large three-bedroom dwellings. The court these sites share is




# SUPPORT STRUCTURES

HIGH DENSITY HOUSING
MEDFORD, MASSACHUSETTS

M.Arch. Thesis M.I.T. 1974

## TOWER SITES
## PLAN of LEVEL C

scale 0 5 10 25 FEET

sheet 11

drawn April 26, 1974

open on one side to the upper half of the A level court below, and is connected by an exterior stair to a unit-site on Level C above.

LEVEL C

There are four unit-sites grouped around each circulation core on Level C. Two of these occupy large structural bays on the external face of the support structure directly adjacent to the elevators and stairs. These sites overlook the court on the B level below, but do not have physical access to any court spaces. Therefore dwellings built on these sites are likely to be similar to large corner apartments in high-rise towers, with balconies serving for outdoor space.

The remaining two sites on this level share the use of the two-story courts on Level B below. They open not only on the court below and the exterior face of the support structure, but also onto the extended circulation pattern on this level. This pattern forms a continuous street 10 feet wide running the length of the support structure. Where it passes these last two sites it is essentially a gallery overlooking the two-story courts of Level B. Spaces built within dwellings sited along this gallery will have open views across the top half of the B level courts.

Level C is intended to be the roof level of the support structure as well as an intermediate level. When used as a roof level, the street aspect of this level will be greatly enhanced. (See illustration page 34.)

# 5-Conclusion

I feel that this preliminary examination of the support structure concept and it potential for providing greater dwelling freedoms to people and architectural variety to urban housing shows that it is indeed a valid one. I hope that this thesis encourages others to look at the whole range of problems related to support structures, from flexible plumbing and "scotch tape" wiring, to the economic and social changes they might cause. I am encouraged myself to continue to explore the idea. What will come of both the idea and my interest remains to be seen.

# footnotes

[1] N. J. Habraken's term for housing designed without direct knowledge of the users. Habraken's Supports: An Alternative to Mass Housing was the precipitating agent for this thesis.

[2] Robert Goodman's After the Planners uses the history of urban renewal to illustrate the manner in which the professions traditionally decide for people what they are capable of deciding for themselves.

[3] Vitruvius, Book II.

[4] Andrea Palladio, Four Books of Architecture, Bk I, chap. xxi. New York, Dover Publications, 1965.

[5] Constance Perin, With Man In Mind, An Interdisciplinary Prospectus for Environmental Design, pp. 77-100, passim.

[6] Perin, p. 77.

[7] Mihail Iljin, "Building to Order in Russia," in History of the House, ed. by Ettore Camesasca, p. 248.

[8] For example, Constance Perin.

[9] Henry Sanoff, "Behavior Settings in Residential Environments," Journal Of Architectural Education, XXV (Fall, 1971), 95-97.

[10] As described by Richard Bender, A Crack in the Rear View Mirror. pp. 143-150.

[11] Shery Arnstein, "A Ladder of Citizen Participation," Journal of the American Institute of Planners.

[12] John M. Dixon, "Towards a Responsible Architecture," Progressive Architecture, January 1974, 51.

[13]Community Projects Laboratory, Toward Participatory Dwelling Design: Process and Product, p. 7.

[14]William Grindley, Hans Harms, and others, Freedom to Build.

[15]W.C. Grindley and R. Merrill, Sites and Services: The Experience and the Potential, unpublished report (1970).

[16]James H. Davis, "The Urban Homestead Act: A Proposal for America's Cities.

[17]Bender, p. 163.

[18]Ian Donald Terner, "Technology and Autonomy," in Freedom to Build, pp. 199-237.

[19]Habraken, p. 59.

[20]Habraken's philosophy and methods have appeared in Britain under the name of PSSHAK--primary support structures and housing assembly kits. RIBA Journal, No. 10, October 1971.

[21]Community Projects Laboratory, pp. 63-64.

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