HOUSING FOR MARRIED STUDENTS AT M.I.T

HOUSING FOR MARRIED STUDENTS AT M.I.T.

A thesis report submitted in partial fulfillment of the requirements for the degree Bachelor of Architecture.

Massachusetts Institute of Technology
23 May 1955

Marilyn Fraser

Lawrence B. Anderson
Head of Department

FOREWORD

Housing large numbers of people economically and satisfactorily is a problem which demands a strong, positive solution which is realistic concerning costs without sacrificing quality of design. It is a problem whose solution must be based on an understanding of the residents' lives and needs, an acceptance of the economic situation of the client, and a realization of the meaning of housing in a social structure. Here, a unique aspect of housing is studied for a group of young married students at M.I.T.

ACKNOWLEDGEMENTS

I wish to acknowledge with gratitude Professor Beckwith, Dean Belluschi, Professor Gelotte, and Professor McNulty for their generous and valuable assistance in the preparation of this thesis.

I also wish to express my appreciation to these and the many other members of the staff of the Department of Architecture and Planning with whom I have enjoyed such rewarding contact during my years of study at M.I.T.

23 May 1955

Pietro Belluschi, Dean
Dept. of Architecture and Planning
Massachusetts Institute of Technology
Cambridge, Massachusetts

Dear Dean Belluschi:

I submit this thesis study in partial fulfillment of the requirements for the degree Bachelor of Architecture from M.I.T.

Respectfully,

CONTENTS

INTRODUCTION

M.I.T. is presently facing the problem of providing new housing for its married students to replace the existing Westgate development.

Westgate and Westgate West are temporary wooden buildings which were built in 1946 to meet the needs of the great influx of married veteran students and their families. The development is a combination of single family one story units numbering one hundred and of seventeen navy barracks housing ten families each. The total number of dwelling units is two hundred seventy.

The existing buildings are no longer acceptable as housing for the married student group. They are poorly insulated and heated. They are noisy, have inadequate kitchen and bath facilities, and are lacking in sufficient wiring to meet tenant demands. They are highly susceptible to fire. The community as a whole is estheticly unsatisfactory because of the lack of landscaping and the drab grey color of the structures.

From the Institute's point of view, the project is extremely wasteful of land. It is spread over an

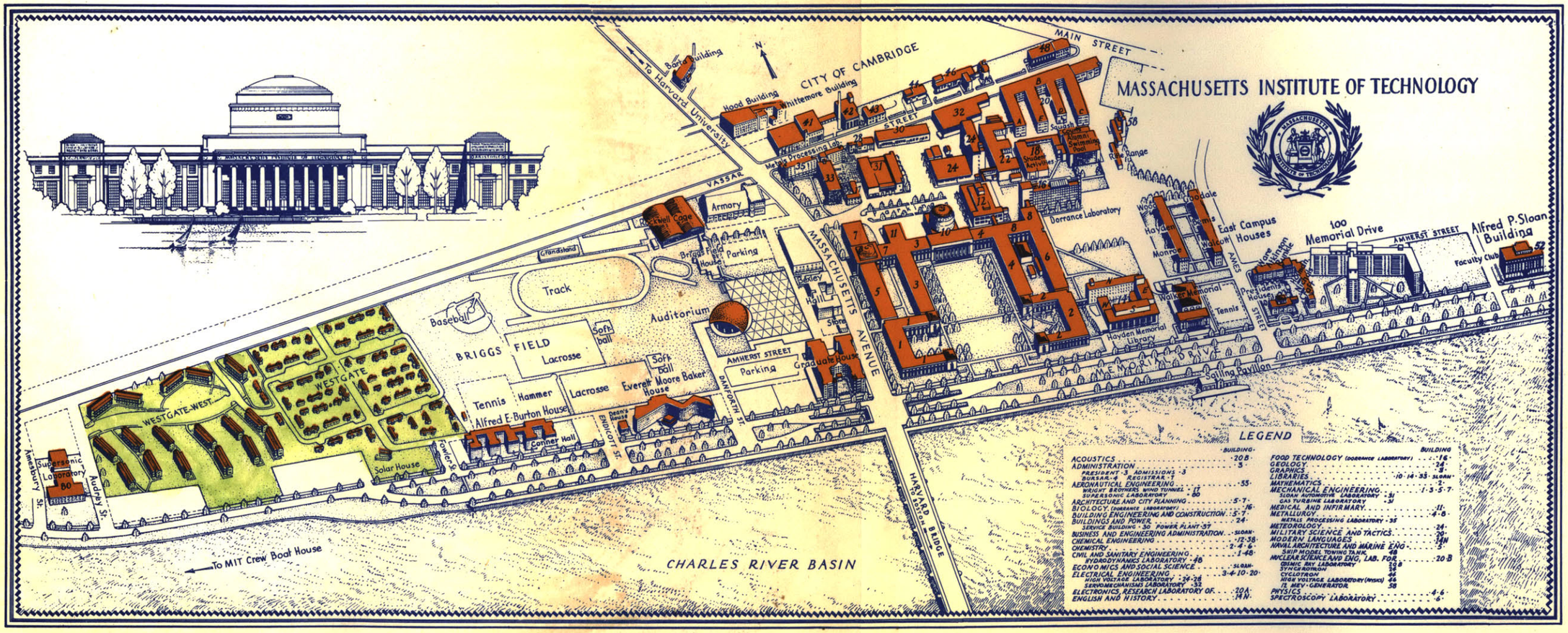
area of 900,000 square feet with a very low density. The residents appreciate their use of land, but M.I.T. needs to use it more efficiently for additional athletic fields and parking for the main educational buildings.

Since M.I.T. assumes the responsibility of offering housing for its students, this aspect of its program is now of considerable importance in view of the fact that twenty percent of the student body is married.

AERIAL SKETCH SHOWING

LOCATION AND EXTENT OF

PRESENT WESTGATE SITE



REQUIREMENTS FOR PROGRAMMING

If a new housing development is to be provided, then certain basic programming information is necessary. It is necessary to know how many units the Institute is willing to build immediately and what the types and costs of the units should be. Financial, rental, and management policies must be stated. The long range situation must be considered, including trends of the number of married students and the size and composition of their families. There must be a description of the tenants of the units clarifying their educational background, special interests, work habits, and social activity preferences. The percentage of families with cars must be set. It must be determined what and how many private, semi-private, and public utilities and services are required. A site should be fixed; its soil characteristics, existing utilities, and general surroundings should be known. Finally, the stipulations of the Cambridge Building Code must be consulted.

PROGRAM

According to Dean Frederick G. Fasset and Vice President-Treasurer John J. Snyder, the Institute is prepared to supply about three hundred dwelling units at the present time. As the result of a survey of Westgate with 46% ceverage in January, 1955, Dean Fasset recommends that the following distribution of unit types be included.

0 bedroom..... 0

1 bedroom.....85

2 bedroom....200

3 bedroom.....15

He further suggests the possibility of building only two-bedroom apartments, making some of the excess rooms available to adjacent families with more children and leaving others as study rooms. Treasurer Snyder proposes another distribution.

0 bedroom.....40

1 bedroom.....80

2 bedroom....160

3 bedroom.....20

Based on a personal survey with 41% coverage in December 1954, this distribution is suggested since it was found that about 40% of the families have no

children, 38% have one child, 17% have two, and 5% have three children.

0 bedroom.....0

1 bedroom...120

2 bedroom...165

3 bedroom....15

An average of the distributions results in an initial program.

0 bedroom....40

1 bedroom....80

2 bedroom...160

3 bedroom....20

The allowable construction cost per room (based on Treasurer Snyder's financial and rental policy as presented below) is to be about $1760 per room. This figure treats living-kitchen-bath as 1½ rooms and public circulation and service areas as included in the cost per room.

The financial and rental policy of the Institute on this project is set down by Mr. Snyder.

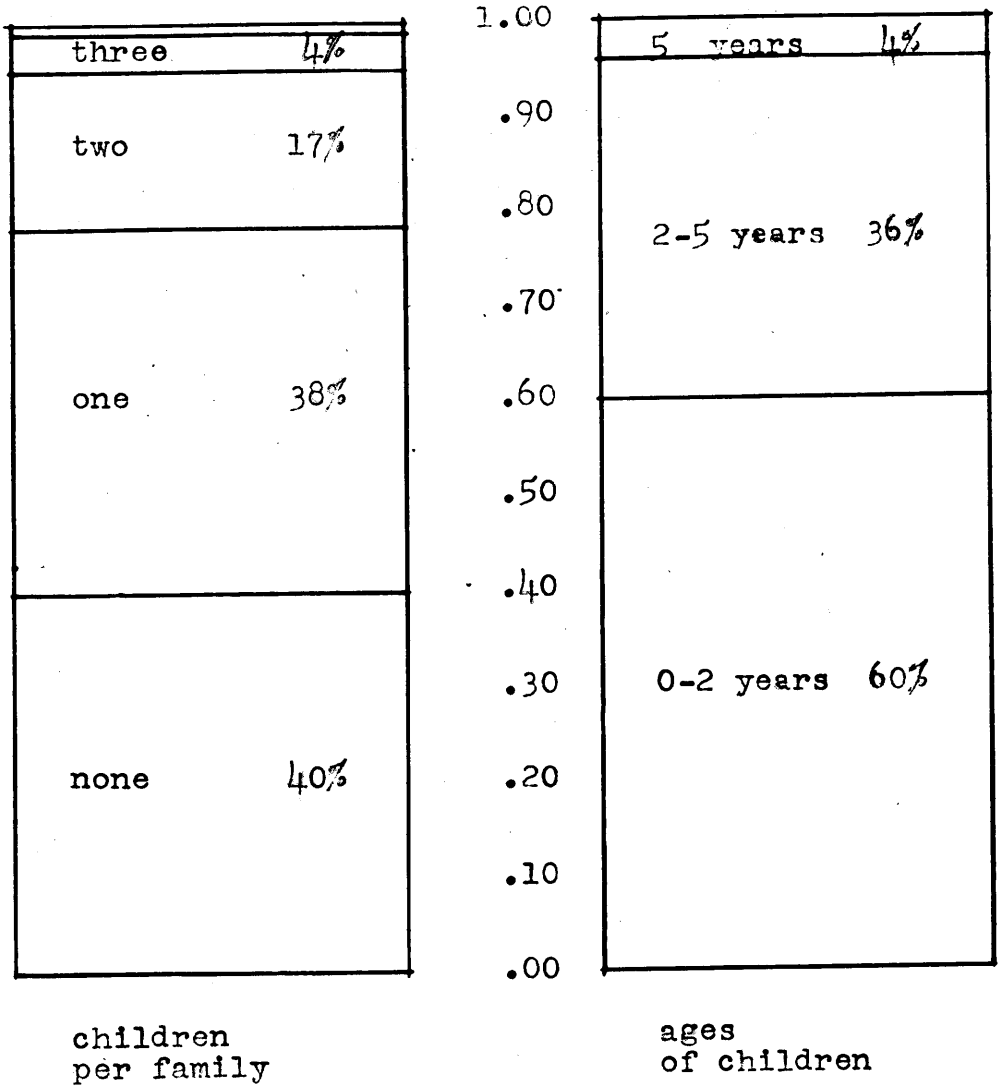
> "I have reviewed operating costs including real estate taxes along with financing charges and it is clear that under favorable conditions gross rentals must be about 17% of the original investment to meet these charges in total... if we took as a goal

> $30 per room per month, gross rentals would be $273,000 for 910 rooms and this gives a construction cost of $1, 600,000 which is a little more than $1,760 per room".

As mentioned above this estimate treats living-kitchen-bath as 1.5 rooms and includes all public areas in th-e rentable space category. This statement is acceptad as law for present purposes, but might be altered if a subsidy such as described in Appendix C were obtained.

Dean Fasset states the managerial policy by advising the residence of two faculty couples and a student resident manager. There should be no need for other resident officials or caretakers.

The long term trend for the proportion of married students is difficult to project, but it has shown a steady increase to the present size of one in five. Dean Fasset believes that the figure is likely to increase or at least maintain itself because of the tendency of younger students, in addition to the graduate and veteran students, to be married. Veterans have been playing a decreasing part in the Westgate tenancy. The percent has dropped from 100% to 57%. Now, 75% of the Westgaters are grad students. This indicates that the tenants, instead of being



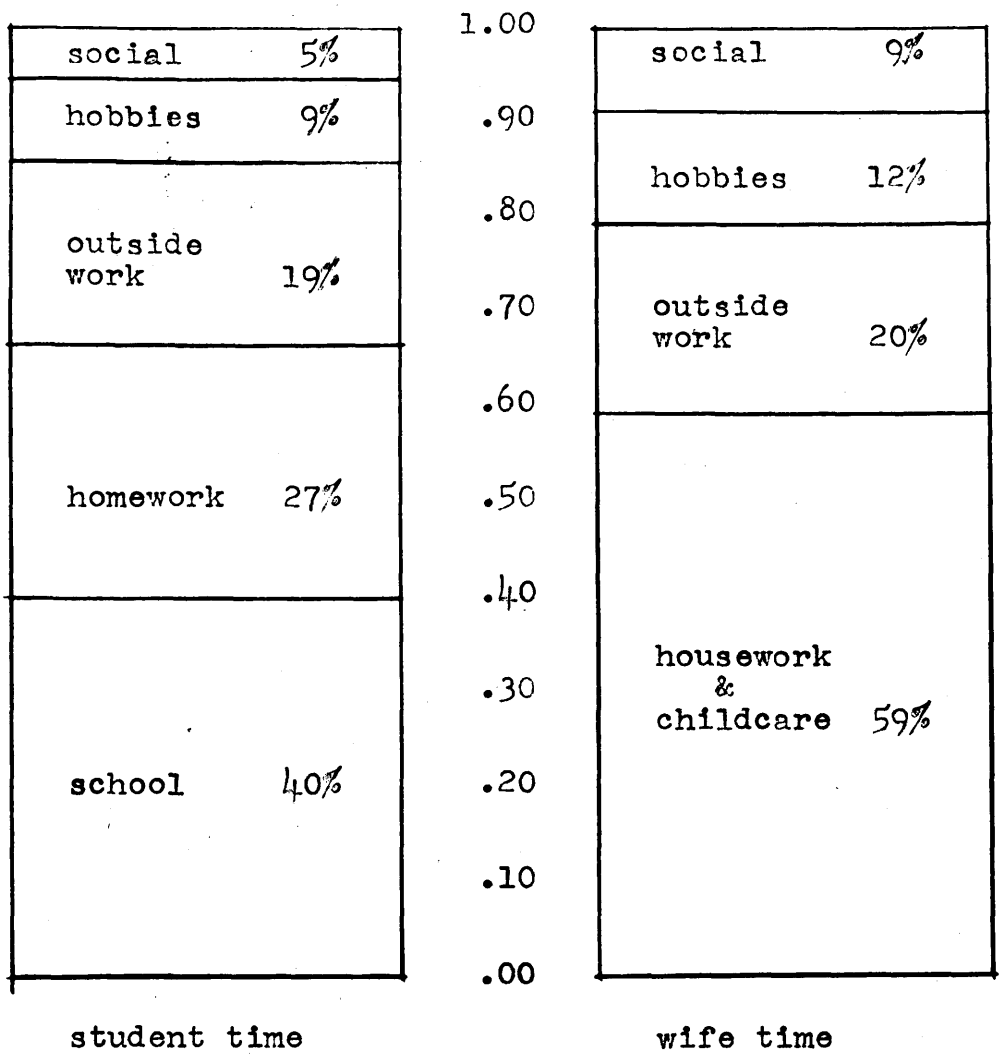
CHILD POPULATION

WESTGATE SURVEY RESULTS

veterans (72% with children) with accumulated large families, are mostly graduate students who were married after college graduation and are just starting family life or are undergraduates who have small families (45% with children). A trend, verified by observation, might be projected for smaller families with fewer and younger children. If, however, this proved to be incorrect because of grad students having more children or because the number of veterans began to increase, then some provision should be made for such larger families.

The survey shows that 60% of the children are 0-2 years, 36% are 2-5 years, and 4% are 5 or more years old.

The survey shows that the students are 75% graduate, 25% undergraduate. The wives are 100% high school trained, 83% have post high school schooling, and 10% have done graduate work. The average student spends 35 hours per week in school, 24 hours on home studies. He works at a paying job for 17 hours. He devotes 7.5 hours to special interests and 4.5 hours to social activities. The wife spends 53 hours per week on housekeeping and childcare, 19 hours a paying job, 11 hours on special interests, and 7.5 hours for social activities. The special interests are largely quiet pursuits which require



TIME ALLOTMENT TO ACTIVITIES

WESTGATE SURVEY RESULTS

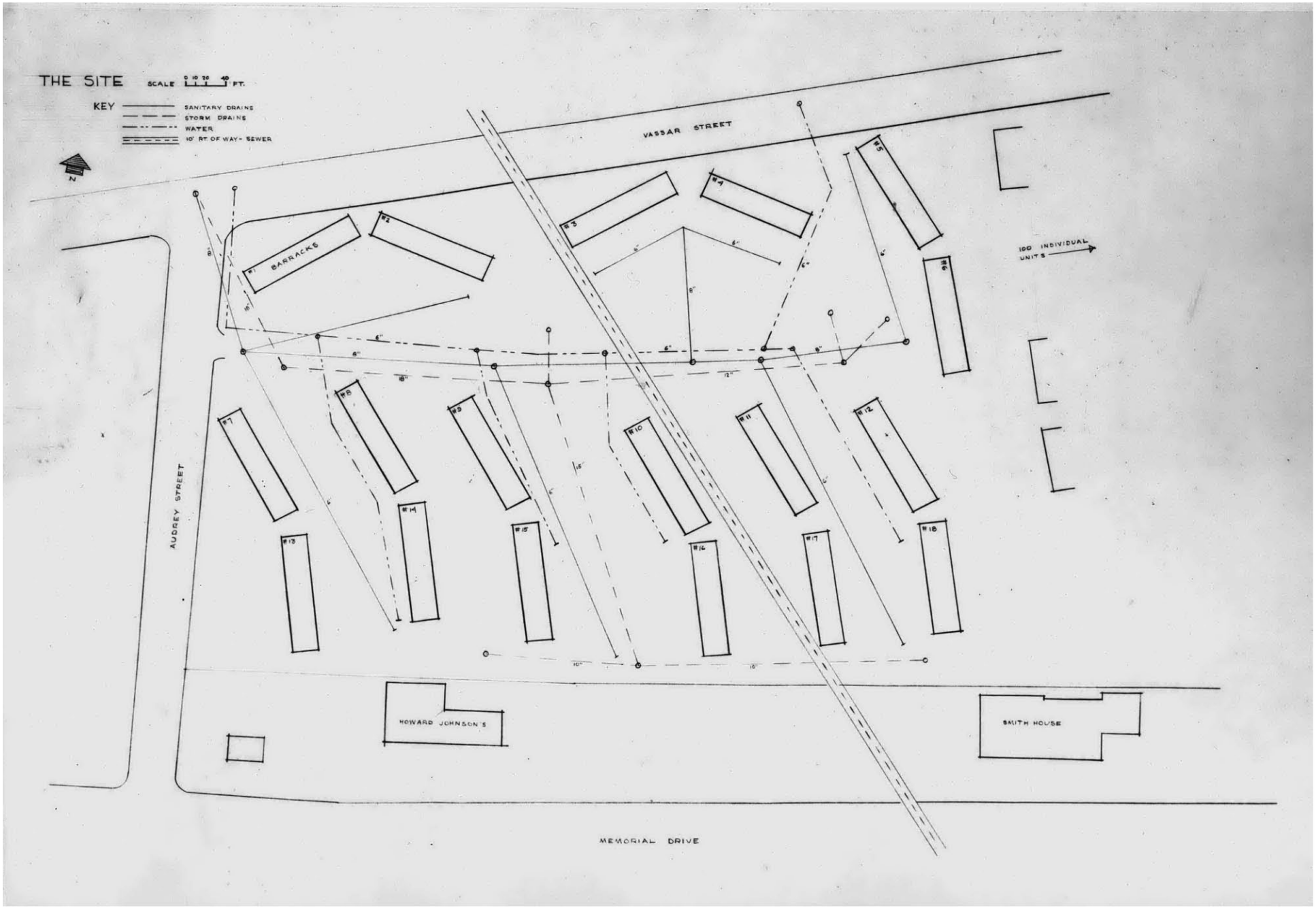
no special planning in the apartments or vigorous sports which could take place at the M.I.T. athletic facilities. Several are musical. This strengthens the need for acoustical isolation of apartments. Social activities take place in small parties and casual visiting, in organized M.I.T. groups, in outside entertainment, or in Westgate movies and association meetings.

The following services and utilities are necessary. Privately, the tenants require heat, ventilation, natural and artificial light, sink, refrigerator, range, bathtub (preferred over present shower for washing babies), water closet, lavatory, space for washing machine, kitchen-dining storage, and space for living, food preparation and consumption, study, sleeping, washing, and excreting. Semi-privately or publicly they need horizontal and vertical circulation, lighting, trash and garbage disposal, fire alarm and extinguishing apparatus, bulk storage, and (based on present usage) laundry, nursery, play yard, and community room.
85% of the residents require parking space.

The site recommended for the housing study by Dean Belluschi was an area at the far end of the athletic fields. (See Alternate Proposal, Appendix F).
It was left without an exact eastern boundary or

area restriction but was to be limited to as small an area as possible and to be designed with regard to future uses of adjacent land. Three boundaries of the site include Vassar Street on the north, Audrey Street on the west, The Howard Johnson and Smith House lot lines on the south (after six years their leases will expire and the southern boundary will be Memorial Drive). A ten foot right of way runs diagonally across the field and underground utilities exist as shown in site plan. The ground surface is flat with sub-surface characteristics extrapolated from borings made on nearby property as in the diagram of Appendix D .

The site surroundings include: to the north, a warehouse service street and one-story warehouses; to the west, a service street, a two story warehouse, the supersonic lab, and a view of the Charles; to the south, temporary restaurants, high-speed pleasure vehicle Memorial Drive, and a view of the Charles and the Boston skyline; to the east, athletic fields, dormitories, the student activity center, and the main buildings of M.I.T. All are shown on the sketch-map.


THE SITE
SCALE 0 10 20 40 FT.
KEY
SANITARY DRAINS
STORM DRAINS
WATER
10' RT OF WAY - SEWER
N
VASSAR STREET
#1 BARRACKS
#2
#3
#4
#5
#6
100 INDIVIDUAL UNITS
#7
#8
#9
#10
#11
#12
#13
#14
#15
#16
#17
#18
AUDREY STREET
HOWARD JOHNSON'S
SMITH HOUSE
MEMORIAL DRIVE

DESIGN APPROACH

A general design approach is formulated by the designer.

The design problem involved here is housing for married students and their families. The residents are a nearly homogenous group. They are all young. The husbands are studying related subjects at one school. The educational backgrounds are similar. The study habits, special interests, and social patterns are like. The greatest difference of character exists between couples with no children and those with. Among the couples without children, many of the wives hold paying jobs during the day. Among the families with children, there are common interests for wives in their youngsters, all within an age range of five years.

These basic facts would seem to indicate, and they are checked by present experience, that the tenants form numerous intimate friendships within the opportunity framework determined by the project design. Such friendships are highly desirable and they, in combination with the fine community spirit, are generally conceded to be responsible for the high degree of satisfaction with the existing devel-

opment, despite its other shortcomings.

Two goals of the design are to maximize the opportunity for individual friendship factor and to promote a vital community feeling.

The Institute is typified by grey, massive buildings and intensely serious adult pursuits. The housing community should be in strong contrast. It should offer opportunity for privacy and relaxation at an intimate scale and should have an element of lightness, gaity, and youth.

A large portion of the population is comprised of children. The project should be pleasant and stimulating as an environment for them and convenient for their parents' care of them.

A desirable characteristic of a large housing development is an encouragement of personal interest and pride in the individual units as well as in the whole development. Personal interest and pride should be effected by the design of the project.

Students in the project are managing on limited budgets during their period of education for satisfying, useful lives. The design should be honest in its expression of economy of means while striving for the fullest esthetic satisfaction possible.

The project should fulfill the needs of the residents not only as individuals and as a specific living group but also should recognize their status as M.I.T. students by making a real contribution to the Institute campus.

The Institute is sympathetic to the requirements of the group and the physical campus, but its important role in this problem is that of financing the development. Thus, the design should consider equally the dual clients--the actual residents and those interes-ts supplying the means necessary for realization.

The Institute financial policy must be extremely tight. Here, again, the necessity for economy is paramount.

The structural system of the project must be used to its fullest advantage. All materials involved should be inexpensive, but of a good durable quality with low maintenance requirements. The elements of design should be standard units. Construction should be simplified and standardized. The method should be as easy and quick as possible to reduce labor costs.

Land, which is at a premium on the chosen site, should be used sparingly and efficiently.

The result should be a design which has a low original

cost and needs a minimum of maintenance and supervision.

The design is an economical housing project. It might be considered as being housing for the students and economical for the Institute, but such a view is misleading. Economy is important to the students if the housing is to be truly successful for them. A high quality of housing is necessary for the Institute if their financial investment is to be sound. Thus, there can be no conflict of interests in the project. Quality cannot be sacrificed to low cost or the result will be cheapness. Economy cannot be sacrificed to indulgence or the result will be waste.

Finally, the solution must offer a long range development program which will meet future housing needs, beyond these three hundred units, with a well integrated residen-tial community.

PROGRAM ADJUSTMENT

A specific program adjustment is proposed for the purpose of achieving economical and esthetic goals.

The distribution of dwelling units may be simplified while complying with the fundamental requirements of the program. If 40% of the families are childless, then they can be accommodated by either 0 or 1 bedroom apartments. In a projedt where the husbands must spend 24 hours per week on home studies, it is very desirable to make provision for a separation of areas for study and other, mutually disturbing, activities. More important, if there are only 300 apartments provided and priority is given to families with children, then it is conceivable that the 40% figure might decrease markedly. This also agrees with the trend toward more but smaller families with children. The 0 bedroom apartments would be a real hardship for a family of three, if only an inconvenience for a family of two. Thus, primarily to allow for maximum flexibility in family characteristics, the studio apartment might well be eliminated. (Compare with Dean Fasset's distribution proposal)

Now, 60% of the families have children. 90% of these

have one or two children. Such families would be well accommodated in a two bedroom apartment. While those families with three children would find life difficult, it could be managed. Since the trend is toward more but smaller families with children, it seems ill-advised to become involved with larger apartments for a dwindling 5% of the families unless there is good indication of a change from that present direction.

The argument is that, since M.I.T. is concerned on a large scale with families of 0, 1, or 2 children and that these may be housed adequately in 1 and 2 bedroom apartments, the Institute should focus its immediate attention on 1 and 2 bedroom apartments.

A new distribution of 180 2-bedroom units and 120 1-bedroom units meets the fundamental requirements of the program.

PHYSICAL DESCRIPTION OF SOLUTION

This solution proposes a single high rise, 311 unit elevator apartment block oriented north-south in the long dimension and east-west in its fen-estration. It is set on a slightly excavated tray to include twelve stories within the 100 foot height restriction in the Cambridge zoning ordinance. The building is separated into two sections by a vertical service block containing a double elevator system, a stairway, and an incinerator chute. One section holds 192 2-bedroom apartments. The other section contains 119 1-bedroom apartments. The two sections are linked by an open balcony corridor on the eastern leeward side with a closed stairway at each end. Each apartment is a simple rectangular slot which is long and narrow, having through ventilation from east to west. The apartments are zoned by the bathroom block into living and sleeping areas in the case of the one bedroom apartment and into adult and child areas in the case of the two bedroom apartment. On the ground floor, the two end apartments are allocated to the two resident faculty couples. Two apartments at the entry to the vertical service block are assigned to the student manager as living

quarters and office.

Additional community functions are inexpensively included on a concourse between parking and entry, in the tunnel foundation, or on the roof. Parking is provided in a double level system. One area is slightly excavated with the other on a deck above. The capacity is 250 cars. There is some additional parking for visitors and service on ground level near the main entry.

The project is located on the far end of the playing fields with its automobile access from Vassar Street. The parking deck is parallel to Audrey Street and is linked with the parallel building by the covered concourse. The total developed area is about 130,000 square feet, or 14% of the existing coverage.

The building structure is reinforced concrete. The uniformly narrow apartments are enclosed with 6" structural bearing walls and continuous floor slabs spanning 11 feet clear with a thickness of 4.5". The 6" walls meet the 4.5 hour fire law; the 4.5" slabs meet the 2.5 hour fire law for class I buildings. The structural walls also provide wind bracing for the tall building.

The method of erection is to place a floor slab, use

that surface for pouring the wall slabs horizontally before tilting into place (thus saving one half of the cost for wall formwork based on form-contact area). Each wall is to have reinforcing bars which extend to tie into the next floor slab for lateral stability. The forms may be used repeatedly since all apartments are identical except for variation in length.

The foundations are longitudinal reinforced concrete beams extending to the depth of the coarse sand and gravel strata and they spread the load over a thick floor slab which completes a waterproof tunnel for service lines and bulk storage.

The exposed ends of the building are the standard 6" bearing walls which may be faced with 4" cinder block for reduced heat transmission.

The open ends of the apartments are rectangles 8x 11 feet. They are fitted with pre-fabricated welded steel frames which hold the entry door, Hope's projecting windows, glass wall panels, and translucent honeycomb plastic-coated panels. The 624 steel frames are identical with only the inserted panels, window, and door units differing on east and west exposures.

The roof is a standard 4.5" slab with a built-up

cover insulation of 1" corkboard and composition roofing.

The walking surface on the exterior corridors is trowelled with mastic to reduce noise. The corridors are caged from floor to ceiling with steel mesh. The corridor is cantilevered 5 feet.

The stairwells are reinforced concrete bearing walls on three sides and are accessable through steel frame glass doors. The Grossman standard steel stairs are supported on reinforded concrete landing beams.

The two elevators are Otis passenger geared traction type carrying 2000# at 200 fpm. They have slow speed power doors and collective control.

The incinerator chute serves each floor and feeds to the Goden Model 505 incinerator in the basement service tunnel.

Each function in the central utility core is cased in 6" concrete walls. The whole block is surrounded by cantilevered beams and access landings.

The suggested flat slab, glass wall roof structure is supported on lally columns and houses laundry with coin operated machines and a community room.

The interior of each apartment is exposed concrete

painted white on the ceiling and light shades of grey, buff, yellow, etc. on most of the walls to aid illumination by high interflectances. The floors are covered with light weight linoleum. The linoleum is trimmed from 12 to 11 feet in width and cemented to the floor slab.

The interior partitions enclosing the bathroom are of translucent honeycomb plastic-coated panels mounted in light steel framework. A similar steel frame defines the section of the apartment containing the kitchen unit and may be used as a curtain track and a support for shelving.

Each apartment includes a free standing kitchen unit composed of a counter top electric refrigerator, a single bowl sink, and a four burner electric range with oven. The plumbing stacks are free standing and exposed.

The bathroom holds a Sitz tub, a lavatory, and a water closet. The interior bathrooms receive mechanical ventilation by a Fasco model 847 wall fan leading to the ventilating duct which is double loaded on each floor. The plumbing stacks rise in the common shaft between two apartments and are reached by access panels on each level. The ventilating duct, plumbing stacks, and emergency fire exit

are provided for by a thickened floor slab around.

The second fire exit is a vertical system extending through the height of the building. It consists of counter-weighted up-sliding self-closing metal clad fire panels which may be released by breaking a seal, setting off an alarm in the central office.

The district heating uses steam from the main Institute line in a one pipe overhead distribution system. The apartments have finned radiators at east and west ends. All risers are insulated and exposed and free standing within the apartment.

The electric wiring carries around the circumference of each unit in a National Electric all steel plug-in strip set 10" above the floor with outlets every few feet.

Kitchen storage is built in under the counter and above in open shelves, but other types of storage are available in inexpensive prefabricated packages, ready to be assembled by the tenant to meet his requirements.

The concourse structure is of flat slab concrete on lally columns and the nursery is defined with curtain walls of glass and plastic-coated honeycomb panels. Heating and plumbing lines are carried out under the

concourse to the nursery shelter.

The parking deck is reinforced concrete columns and slab. The sides are surrounded with opaque screening.

For structural, acoustic, illumination, heating, ventilation, and plumbing calculations, see Appendix E.

The site development is held to a minimum by concentrating a focus on the west side which is strongly defined by the building and the parking deck and divided by the concourse area. Automobiles are brought in from Vassar Street and led into the parking deck for residents or to the concourse for visitors and service. Trees are used as a screen for Vassar Street and low shrubs separate the drive from the sunken tray immediately outside the 1-bedroom apartments. The concourse houses the nursery, so that the southern space between the building and the parking deck becomes a play yard with easy control. There are low shrubs as a nominal separation between it and the apartments but since all of the units overlooking the play yard are of families with children, little separation is necessary. Some additional trees are used to enforce the division of areas at the concourse and to define the end of the play yard near the present Howard Johnson line.

The east side of the building relies on open space and

view for its success, although again there is an excavated tray with planting to indicate the beginning of the building.

COST ESTIMATE

The cost of the unfinished structure is calculated on the basis of the cost per unit measure of material plus installation. *

Concrete in cubic yards @ $20 per cubic yard

Floor slabs

(2 br)	11.5x 16x 42x 4.875 =	1410 cu.yd.
(1 br)	11.5x 10x 34x 4.875 =	705
(strs)	3x 50 x 4.875 =	27
(lobby)	334x 4.875x 13 =	60

Bearing walls

(2 br)	17x 37x ½x 96 =	1120
(1 br)	11x 29x ½x 96 =	570
(strs)	3x 33x ½x 110 =	200
(lobby)	24x ½x 112 =	50

Beams

(balc)	1.5x 336 =	505
(lobby)	7x 1.5x 13 =	136
(lobby)	3x 2x 13 =	78
	TOTAL =	5,581.5 cu.yd.
	Cost =	$111,500.00

* Cost estimates are rough figures obtained from Fuller Construction Company.

Formwork contact area in sq.ft. @ $ .60 per sq.ft.

Floor slabs

(2 br) 11.5x 16x 42x 13	=	100,000 sq.ft.
(1 br) 11.5x 10x 34x 13	=	50,800
(strs) 3x 50x 13	=	1,950
(lobby) 334x 13	=	4,340

Bearing walls

(2 br) 17x 37x 96	=	60,500
(1 br) 11x 29x 96	=	30,600
(strs) 3x 33x 110	=	10,899
(lobby) 24x 112	=	2,700

Beams

(balc) 1.5x 5x 336	=	2,510
(lobby) 7x 1.5x 5x 13	=	682
3x 1.5x 7x 13	=	410
TOTAL	=	261,383 sq.ft.
Cost	=	$ 156,500.00

Steel in tons @ $ 220 per ton

Slabs

(2 br) 13x 185x 40x .67	=	32.1 tons
(1 br) 13x 115x 32x .67	=	16.1
(balc, lobby, strs) 13x 6x 400x 1.04	=	15.9
(beams) 15x 466	=	3.5

Walls

110 (360 319 80)	=	56.5
TOTAL	=	124.1 tons
Cost	=	$27,300.00

Foundation

Concrete

300x 10x 4.5' = 500 cu.yd

300x 30x 1.0' = 370

TOTAL = 870 cu.yd.

Cost = $ 17,400.00

Formwork

300x 10 = 3000 sq.ft.

300x 30 = 9000 sq.ft.

TOTAL = 12,000 sq.ft.

Cost = $ 7,200.00

TOTAL FOR UNFINISHED STRUCTURE = $ 319,900.00

Additional known expenses:

Cranes (3) @ $150 per day, 37 days @ 100 cu.yd. Per day = $ 16,600.00

Cinder block facing (4"0)

13,200 sq.ft. @ .55 per sq.ft. = $ 7,260.00

Linoleum

14,112 sq.yd @ $2.50 per sq.yd. = 35,300.00

Incinerator (metal installation) = 250.00

Elevators (2) = 50,000.00

Stairs, steel, (3) @ $3,000 = 9,000.00

Wall, glass 40,000 sq.ft. @$2.5/sqft = 100,000.00

panels 20,000 sq.ft. @$3/sqft = 60,000.00

Additional guessed expenses (based on Eastgate breakdown):

Plumbing	=	$ 225,000.00
Heating	=	100,000
Electrical	=	175,000
Painting -	=	40,000
Partitions(bath)	=	60,000
Storage unit (prefab)	=	10,000
Kitchen equipt.	=	100,000
Roofing	=	20,000

Pure guesswork:

Excavation and pumping	=	30,000

TOTAL ESTIMATED EXPENSE BY BREAKDOWN- $ 1,658,000

The following checks are made on blanket sq.ft. and cu.ft. figures given by Fuller Construction using the Eastgate costs plus 20% for increase in building costs in last seven years minus an allowance for the economies inherent in the design.

141,000 sq.ft. @ $12 per sq.ft.	=	$ 1,695,000
1,290,000 cu.ft. @ $ 1.50 per cu.ft.	=	$ 1,940,000

If the apartment building is now taken into consideration, it is found that the design provides 312 units with a distribution of 192 2-br and 120 1-br. One unit is given to the resident manager as an office s-o

there are 311 rentable units. Taking Mr. Snyder's figure of $30 per room per month, the following return is achieved:

192 (2 br) @ $ 105 per mo. x 12 mos.	=	$241,920
119 (1 br) @ $ 75 per mo. x 12 mos.	=	107,100
TOTAL	=	$ 349,020

Taking $349,020 as 17% construction cost, the allowable construction cost is $ 2,053,333 .

The estimated costs run below this figure. If, in reality, such savings were effected, then three courses might be considered:

1. The extra community facilities such as laundry, nursery, and parking could be included without additional charge. (The original idea was to charge special use-rents on these items or to have Westgate Association dues which would pay for their inclusion.)
2. More space could be allotted to each apartment.
3. Rents could be reduced.

If the construction costs equal the budget figure, then the community facilities on the roof, concourse, and parking deck could be added later when the Institute wished, or could be supported by voluntary tenant financial support.

QUALITATIVE DESCRIPTION OF SOLUTION

The single high-rise building conserves land, achieves a fine view and breezes, and eliminates tedious stair climbing.

The acceptance of the open corridor system depends on the homogeneity of the group. Since the living-working areas are open to community view, the project attempts to create openess for as much opportunity for social intercourse as possible during the day. The families with children are in one section so th-at mothers may conveniently wheel baby carriages on the balconies as if they were suburban sidewalks. The mothers may meet friends there or stop to chat with neighbors. The young children can safely play along the balcony under supervision of the mothers working inside. Residents will pass there in the open on their way to and from classes with more incentive to speak than in a dim interior corridor.

Privacy can be obtained in each apartment with a minimum amount of curtain, since each apartment has a frontage of only eleven feet. From the point of view looking for fire safety, the open corridor is good. It is an economical way of providing circula-

tion space because it requires little additional structure and wall; besides mere circulation area, offering many of the advantages of private balconies.

The balcony should make each floor a social unit. The fact that both sections meet at the central elevator core and that all floors funnel through the ground level entry and concourse, should build a strong community feeling.

The apartment planning is economical because the narrow dimensions shorten the length of circulation runs. Each apartment is long and narrow and effects a protective, intimate scale while gaining natural isolation of interior areas by distance rather than by numerous partitions. Because the bathroom block is the only permanent partition, the space is easily comprehensible as a whole. The bathroom is like a piece of furniture in the complete unit. The light steel frames, set perpendicularly to the length of the apartment, create an organizing rhythm in the space which eases the problem of arrangement, division, and use. The do-it-yourself storage units also encourage a personal interest in the apartment as well as saving labor costs for the Institute and offering a maximum of flexibility. The structural party walls give good acoustical isolation, satisfy

fire requirements, and give wind bracing with no duplication of effort. The deep, closely packed apartments reduce the over-all building heating load.

There are two strong community focal points, the roof and the entry concourse. The roof, if it contains the laundry and the community recreation room, will be a group headquarters remote from the outside world. The concourse will be the transition from the outside world, with parking and nursery school. It will be the meeting place before and after entering outside activities.

The project attempts to achieve a gay, youthful spirit with its extrovert exposure of all activities, a community feeling with its emphasis on open circulation feeding from individual units to a single central core, an expression of economy in its strict living slot pattern, skeleton circulation, and packaged vertical services.

It enhances the Institute's aims of economy of structure and land with its esthetic contribution to the campus as a backdrop to the new student activity center around the auditorium and as a space definition giving containment and scale to the west campus expanse of land.

FUTURE DEVELOPMENT

The possibility for further development of the area is encouraged by limiting this compact project to the northwest corner of the land. When the restaurants' leases expire in six years, their riveredge southern exposed land could be used for low housing, particularly for the few families with three or more children (who were given less attention in this first step). They will be related to the portion of this building which houses the families with children and may use an extended play yard and enlarged parking garage.

There might also be more housing on the north boundary for fraternities or for families with no children, thus closing off Vassar Street and forming a residential courtyard at the end of the campus.

APPENDICES

INSTITUTE PROGRAM

C O P Y

FROM: MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Cambridge 39, Massachusetts

Joseph J. Snyder
Vice-President and Treasurer

July 7, 1954

Dean Pietro Belluschi
c/o American Academy
via Angelo Masina
Rome, Italy

Dear Pietro:

Earlier you inquired about the number of units we would need as a first step in building for married students and the distribution of these units by 0 -1 -2 -3 bedrooms. Westgate and Westgate West together come to a total of 270 units and in part because of the very low rents, these facilities fail to meet the demand. Eastgate, by the way, has 260 apartments. Three hundred units would be a reasonable starting point in my judgment and I would expect it to prove to be somewhat on the low side. At any rate, we could, in a first step of this magnitude, house 10% more married students than we can now accommodate at the Institute.

220 units in Westgate and Westgate West have two bedrooms and 50 are single bedrooms. In Eastgate, there are 28 apartments with no bedrooms, 95 with one, 108 with two and29 with three bedrooms. This may be useful to you as a guide.

I have reviewed operating costs including real estate taxes along with financing charges and it is clear that under favorable conditions gross rentals must be about 17% of the original investment to meet these charges in total.

A two bedroom unit in Westgate including heating but not electricity or telephone rents for about $75 per month and the single bedroom units for $60 per month on the same basis. The units in Eastgate with no bedrooms carry a rental range of $65 to $90 - one bedroom $125 to $165 - two bedrooms $130 - $ 190 and three bedrooms $175 to $225.

Projecting a 300 unit building and taking the distribution and rental schedule shown below as simply a place to start rather than a fixed reference mark, we can produce the

gross rentals of $337,200 -

0 bedroom units	40 @ $70 x 12 mo.	$33,600/yr
1 bedroom	80 @ $85 x 12 mo.	81,600/yr
2 bedrooms	160 @ $100 x 12 mo.	192,000/yr
3 bedrooms	20 @ $125 x 12 mo.	30,000/yr
		$ 337,200/yr

If the 0 bedroom is taken at 1.5 rooms inall, the one bedroom at 2.5 rooms, the 2 bedroom as 3.5 rooms and the 3 bedroom as 4.5, the total in the building would be equivalent to 910 rooms. The average rental per room would be about $37 per room. This is a very substantial increase over the present Westgate rental scale and is probably too high for our students. $75 per month for a two bedroom unit Westgate is about $21.50 per room as I estimate it.

Taking rentals at 100% occupancy of $337,200 and specifying that these rentals must be 17% of the original investment gives a construction cost of $1,980,000. With 910 rooms equivalent, this cost is $2,180 per room. If we took as a goal $30 per room per month, gross rentals would be $273,000 for 910 rooms and this gives a construction cost of $1,600,000 which is a little more than $1,760 per room.

The foregoing figures must be greatly refined before they will be of any great use to you in planning the building. Perhaps the estimates here will serve to illustrate the character of the financial problem at least.

With all good wishes -

Sincerely,

s/Joseph Snyder

JJS:nc

C O P Y

FROM: MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Cambridge 39, Massachusetts

Office of the Dean of Students December 1, 1954

Dr. Pietro Belluschi
Dean of the School of Architecture
7-233, M.I.T.

Dear Pietro:

I have been held up by one thing after another since that pleasant conversation in the infirmary some weeks ago and hence am only now getting opportunity to set down some ideas which, I hope, may be helpful in the studies for a new Westgate. Whether the new village consists of one ten-story elevator apartment building or of a number of more economical three-story units, I have a feeling that the following items should be considered:

Incinerators with access doors and chutes available conveniently to each group of six families are highly desirable. They cost far less than electric pigs and they take care of trash as well as garbage. The mere fact that many of the young housewives use paper diapers endorses the incinerator, to my mind.

There should be a system of easily interchangeable locks on the front doors of the suites. Whether the interchangeable cylinders which are used at 100 Memorial Drive would do, I don't know. In a multiple dwelling the ability to change locks without trouble is very desirable as a preventitive to sneak-thieves and as a way of maintaining security when, as often happens, the quitting tenants take their keys with them when they move.

In the planning of bathrooms it is important to remember that the population of infants and small children is bound to be fairly high, and the only way that a baby can be given a bath in a shower is for its mother to get into the shower, too. The Sitz bath idea which you discussed with me has a lot to recommend it.

My observation of the semi-furnished units in Westgate West leads me to the strong conviction that in the new village the units should be unfurnished. This menas, I think, that if it is economically feasible, there should be as much built in shelving and drawer space as possible. This provision ties in the the necessity in the units for as much storage and closet space as can be wangled.

A

If we are talking of a walk-up group of buildings, I think it is important that considerable effort be spent on making the staircases easy. They are easy if they run at a reasonable pitch and if they have as few twists and switchbacks as possible. I must go on record as saying that whatever ill things he may have done, Brigham Young in the so-called Lion House in Salt Lake City set a mark for all architects to shoot at in the design of his staircases.

If the new village is a ten-story apartment house, there would have to be a baby carriage garage somewhere in the ground floor. If a number of smaller buildings are contemplated, say six units using one entry, it may be that the ground floor entry hall can be planned to accommodate the necessary.

The plan should take into account the desirability of space in the basement for automatic laundry machines and drying facilities. At Westgate West at present there are large numbers of outdoor clothes lines which are feasible enough when the land is as wastefully used as it is used in the present village. If we have three hundred families in a ten-story building, the clothes line becomes impossible unless deliberate use of a portion of the basement for the air drying of laundry is made. Such a use may be hard to justify, and the provision of coin-operated drying machines may be regarded as necessary.

Whether an effort should be made in the new village--ten-story or several three-stories-- to accommodate a nursery school, I do not know. The present school is a boon to the present community. I would leave this a moot question, but I would have no doubt whatever about the very great desirablity of providing in the plan suitable accommodations for two resident faculty couples. If the building is a single ten-story unit, there should be a faculty resident in either end, and a hand-picked married resident manager in the middle. He should handle the whole business of applications, assignments, leases, and terminations. His would be an uneasy task at best, but I think it would be eased substantially--were he also a resident of the village.

Because of the spreading high-fidelity addiction, the partitions between apartments and the floors separating the apartments should be as nearly sound-proof as possible. Devotion to music is a beautiful attribute of all people, young or old. In a multiple building filled up with young people, it produces very nearly as much nuisance as do cats, dogs, and firearms.

The roofs of practically all our dormitories are a network

OF WIRES AND ANTENNAS. If we are to build a multiple dwelling to take care of Westgate, and if economics allow, some kind of master antenna system into which residents may plug radios and television sets is, I think, a very desirable adjunct.

These are a few notions. I shall continue to mull the matter over, and may I hope burden you with another letter later.

With all good wishes,

Very truly yours,

F. G. Fassett, Jr.
Associate Dean

FGF:k

SURVEY OF WESTGATE AND WESTGATE WEST

It is necessary to provide the most economical and minimum housing which will meet the needs and desires of this group as well as those common facilities which will encourage a well serviced and socially satisfying community.

To determine the nature of the client, a questionnaire was prepared to be sent to all residents requesting both specific and general information about their interests, activities, families, and their reactions to the present housing. The information accumulated by the survey should be of great assistance in programming the new project.

Included is a copy of the letter of explanation and questionnaire which were mailed (along with a typed return envelope) in a hand addressed commercial envelope to the residents early in December. Also included is a tabulation of the results.

There is no attempt made here to draw conclusions. The results are intended to serve as useful guides during the process of programming and design.

Headquarters
Department of Architecture
M.I.T.
December, 1954

Dear Westgate Resident:

As a senior in the Department of Architecture, I am doing my thesis on a housing development to accommodate the married students of M.I.T.

For the purpose of clarifying the nature of the design project, it would be a great help to me if you would furnsih me with the information requested on this brief questionnaire.

I shall appreciate it very much if you will return the completed page to me some time during this week. Thank you very much.

Sincerely.

Marilyn Fraser

B

QUESTIONNAIRE TO ALL RESIDENTS OF WESTGATE

Student - Are you a veteran?_____
What is your educational background (including high School)?

School	Years	Degree	Major

How many hours do you allot per week to
Studies? _____
Outside work? _____
Special interest (hobbies, sports)?

Interest	Hours

Social activities? _____

Wife ---- What is your educational background (including high school)?

School	Years	Degree	Major

How many hours per week do you allot to
Housekeeping and child-care? _____
Outside work? _____
Special interests (hobbies, sports)?

Interest	Hours

Social activities? _____

Children - How many children do you have? _____
What are their ages? _____

Car ----- Do you use a car? _____

Comments - Do you have sufficient space?_____
Do you have adequate facilities; private? _____
If not, what would you like? _____
Do you have adequate facilities; community? _____
If not, what would you like? _____
(co-op nursery, community center)

Feelings about present project:

TABULATION OF RESULTS

number of questionnaires mailed 260

answered 107

project coverage 41%

student questions

are you a veteran?

yes 60

no 47

what is your educational background?

high school graduate	107
M.I.T. undergraduate school	48
technical major at other college	65
liberal arts major at other college	5
M.I.T. graduate	79
other graduate school	12

how many hours do you allot per week to studies?

not including classes (average)	23.5
including classes (average)	59

how many hours per week do you allot to outside work?

average of those holding jobs	17

how many hours per week do you allot to special interests?

average	7.5

how many hours a week do you allot to social activities?

average	4.5

wife questions

what is your educational background?

through ninth grade	1
high school training	106
post high-school	89
liberal arts major at college	38
technical major at college	25
junior college	4
career training	26
graduate school	11

how many hours a week do you allot to housekeeping and child care?

average	53

how many hours a week do you allot to outside work?

average of those holding jobs	35
average of project	19

how many hours a week do you allot to special interests?

average	11

how many hours a week do you allot to social activities?

average	7.5

children

how many children do you have?

what are their ages?

no children		43
one child		40
(0-2 yrs)	28	
(2-5yrs)	11	
(5+ yrs)	1	
two children		18
2 (0-2 yrs)	6	
1 (0-2 yrs), & 1 (2-5 yrs)	10	
2 (2-5 yrs)	2	
three children		5
2 (0-2 yrs), 1 (2-5 yrs)	1	
1 (0-2 yrs), 2 (2-5 yrs)	3	
1 (0-2 yrs), 1 (2-5 yrs), 1 (5+ yrs)	1	
four children		1
1 (0-2 yrs), 1 (2-5 yrs), 2 (5+ yrs)	1	

car

do you use a car?

yes	90
no	17

general comments

do you have enough space?

yes	68
no	39

do you have adequate facilities?

yes	29
no	78

do you have adequate community facilities?

yes	64
no	43

what are your feelings about the present project?

mostly favorable	77
all unfavorable	29
no comment	9

SPECIAL INTERESTS

topic	# students	# wives	total # people
reading	23	31	54
photography	19	3	22
outdoor sports	16	3	19
hiking	2	1	3
sailing	5	1	6
skiing	6	3	9
tennis	3	4	7
aviation	2	0	2
rugby	1	0	1
track	1	0	1
swimming	2	8	10
hockey	1	0	1
golf	2	1	3
fishing	2	0	2
indoor sports	1	2	3
squash	7	1	8
basketball	3	0	3
bowling	1	1	2
pistol	1	1	2
carpentry	9	0	9
electronics	2	0	2
mechanics	5	0	5

SPECIAL INTERESTS (continued)

topic	# students	# wives	total # people
puttering	1	0	1
model trains	2	0	2
ceramics	1	1	2
radio-tv	5	1	6
music	11	10	21
singing	1	2	3
instrumental	3	2	5
correspondence	1	2	3
stamps	2	1	3
art	1	8	9
weather	1	0	1
tropical fish	1	0	1
gardening	2	0	2
dramatics	1	2	3
scoutmaster	1	1	2
sewing etc.	0	26	26
ballet	0	2	2
none	19	25	44

SOCIAL ACTIVITIES

topic	# students	# wives	total # people
school activities	9	1	10
home entertaining	4	6	10
neighbors	5	6	11
church	7	13	20
Westgate	1	3	4
bridge	7	13	20
"out"	1	1	2
movies	3	1	4
concerts	2	0	2
parties	3	3	6
dances	3	3	6
faculty club	2	1	3
fraternity	2	0	2
professional	2	0	2
Dames	0	23	23
Matrons	0	1	1
Newcomers	0	2	2
barrack coffee	0	1	1
none	33	38	71

COMMENTS

mentioned	# times
poor heating system and insulation	55
bad acoustic conditions	28
inadequate storage space	24
outside storage desirable	1
toy storage desirable	5
doorless closets difficult	4
bedroom too small	4
bathroom too small	4
should allow for washing machines	5
bath tub desirable	14
kitchen too small	22
better stove with thermostat desirable	20
better refrigerator desirable	17
better sink desirable	5
kitchen should be better hidden	1
wiring inadequate	2
air-conditioning needed	1
more drying space needed	3
parking provision needed	8
rubbish disposal system inadequate	5
laundry improvement desirable	11

COMMENTS (continued)

mentioned	# times
nursery desirable	6
nursery not desirable	1
keep play areas	8
workshop needed	1
community stores desirable	16
rec hall should be improved	14
structures unsound	22
drab exteriors	12
landscaping necessary	7
site unpleasant	4
transportation needed	5
like Westgate privacy	10
no privacy in Westgate West	8
like one floor	1
like private land	2
appreciate low rent	20
rent too high	5
rent must stay low	6

FEDERAL SUBSIDY

REMARKS BY
COMMISSIONER OF THE COMMUNITY FACILITIES ADMINISTRATION
JOHN C. HAZELTINE
BEFORE THE ANNUAL MEETING OF THE SOUTHERN ASSOCIATION
OF COLLEGE AND UNIVERSITY BUSINESS OFFICERS
AT THE ROOSEVELT HOTEL, NEW ORLEANS, on FRIDAY
APRIL 1, 1955

I would like to tell you a little about our team, which is captained by Albert M. Cole as Administrator of the Housing and Home Finance Agency, the permanent Federal Agency established to carry out the principal housing and home finance functions of the Federal Government. These functions are carried out through six constituent agencies,--the Home Loan Bank Board, Federal National Mortgage Association, the Federal Housing Administration, the Public Housing Administration, the Urban Renewal Administration, and the Community Facilities Administration, which I head as Commissioner. Each of these administrations has a precise field in the overall plan of Federal assistance toward home ownership and assistance to housing and redevelopment authorities and to local communities and their institutions in carrying out the National Housing Policy as declared by the Congress.

The Community Facilities Administration, which is my particular responsibility, administers a variety of programs of Federal assistance for related community development. Here I would like to go into some detail.

Under agreement with the Commissioner of Education, we are supervising all construction of school facilities for which Federal aid is being provided through the Office of Education. This includes non-Federal in certain areas where there has been a heavy impact of Federal activities, Federal schools on Federal property, and Indian schools. All of these projects, when completed, are operated by local school districts--if their services are available.

We make public facility loans to state and local governments to finance the construction of needed public works. We have been making loans and grants to local governments for the construction of community facilities in critical defense housing areas. This program, however, is almost completed.

We are making advances to state and local governments for a reserve of planned public works and liquidating former programs of similar nature. We are liquidating programs of loans to Alaska Housing and to prefabricating concerns.

C

Last, but far from least, we are administering the College Housing Program, under which loans are made to colleges and universities for the construction of housing for students and faculty. I have a slight suspicion that it is because of that particular program that I have been invited to speak to you today.

It is clear that the college housing program is intended to extend to the college and university campus the philosophy expressed in the Congressional declaration of National Housing Policy. Acting on the rather sound assumption that students and faculty members are citizens too, the goal of a decent home and suitable living environment for them certainly contributes to the growth, wealth and security of the Nation. While we do not think of college campuses in terms of slums and blighted areas, those of us who like to call a spade a spade must admit that a rickety, highly combustible, frame barracks, which has already served two useful lives for G.I.'s, one on an Army base and one on your campus, has many of the characteristics of a slum dwelling.

Unfortunately, we have seen application after application filed in our offices in which the applicant boasters his justification of need with the statement that the new dormitory is required to replace the temporary barracks which have become unsafe and expensive to maintain. The loan is made, the new building is erected and filled with students. Then we find that the old building is not torn down, and can't be, because enrollments have gone up and it too is again filled with students. It gives us the feeling, which many of you must have, that as far as satisfying the housing needs of the colleges and universities, we are slipping behind in face of the enrollment already on hand. In fact, one estimate has been made that the whole $300 million authorized for the College Housing Program will provide for only the net replacement of the temporary buildings constructed during the G.I."bulge" and can make little appreciable contribution to the total housing requirements for the higher enrollments ahead.

It is clear, I think, that it is going to take all the resources available on every side, loans both public and private, donations and appropriations to make a real dent in this problem. I think, too, that the colleges and universities are going to have to adjust their sights further in the direction of self-liquidating projects. As your other resources become exhausted, as the net income from your debt-free buildings is encumbered, you are going to have to seek a self-liquidating solution to

the financial equation. Let's see what the elements to that equation are.

The most important element is cost per bed. You and your architect are going to have to rethink your requirements. You are going to have to study what the Branch Agricultural College of Utah has been able to do for $1250 a bed, what the University of Maryland has done for $1750 a bed, and what Cornell University has done for $2400 a bed. None of these are ideal, perhaps, and you will be quick to recognize their shortcomings. They do, however, represent careful efforts to meet minimum requirements. Some of the shortcomings of these particular projects can be overcome by the addition of only a few hundred dollars per bed. They are significant to you, therefore, as starting points in an effort to tailor your facilities to the requirements of the other essential factors of the equation, the amortization terms and the rentals which are feasible for you to charge. Our offices are available to advise you on weighing these different factors, but with no intent to influence you or your architect in designing the type of building which you believe is appropriate for your students and your campus.

I hesitate to talk very much about rentals, first because they are your business, and secondly because the College Housing Program was intended to help you provide facilities without the imposition of high rentals on your students. Few if any suggestions have been made by any of our offices concerning higher rentals to your institutions. However, I must point out that you should bring a degree of realism to the problem and face up candidly to the extent to which you are consciously or unconsciously subsidizing the room and board of those of your students who are living in college-owned facilities.

Neither do I wish to go into technical details of the amortization terms of the College Housing Program. Looking about the room I can see George Baughman, Clarence Schepps and Frank Peterson, to mention only a few who know the technical details of financing under the College Housing Program much better than I do. Suffice it for me to say that it is a hard nut to crack, one which takes patient negotiation and careful planning. Our Regional Offices stand ready to help you in your planning and to share with you their experiences with other institutions in your region.

I would like to close these remarks with the same words Mr. Cole used in ending his article in the Architectural Record. "I believe that the College Housing

Program furnishes an opportunity for institutions of higher learning to analyze their needs, to crystallize their plans and to develop economically sound projects with assurance of reasonable financing."

I want to assure you that we are fully appreciative of your problem as business officers in solving the serious housing situations on your campuses. Thank you.

SITE CHARACTERISTICS

(Soil Structure)

TRACING - BORINGS by GOW DIVISION RAYMOND

ON ADJACENT PROPERTY AT MEMORIAL DRIVE & AUDREY STREET

#1-4 6 JULY 1946

#5-13 17 MARCH 1947

ELEVATIONS REFER TO CAMBRIDGE CITY BASE

RIGHT COLUMN = # BLOWS TO DRIVE PIPE 1 FT., 140# FALLING 30"

KEY

WATER LINE w.l

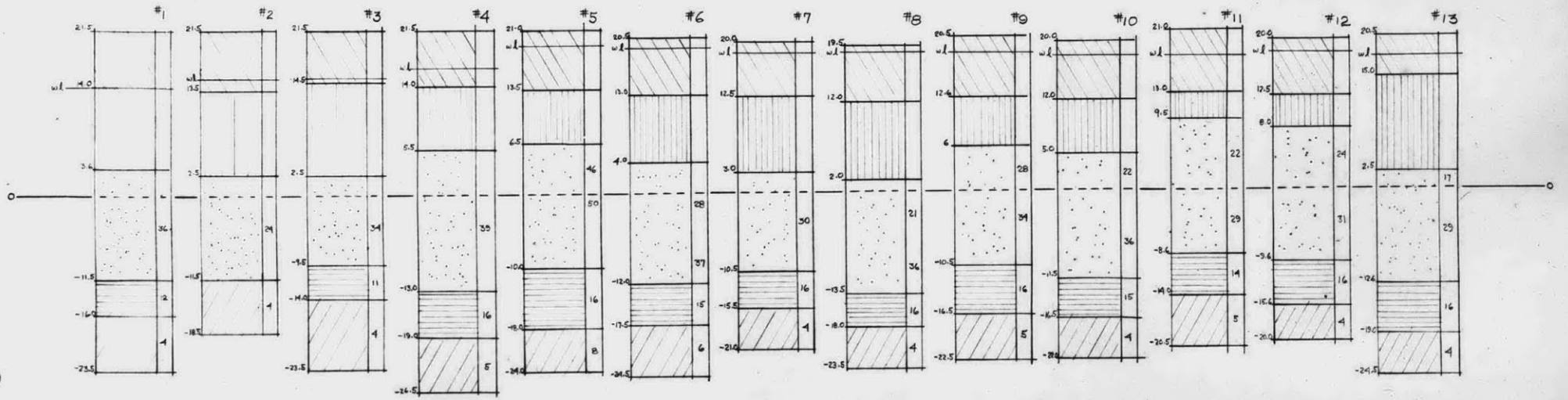
FILL

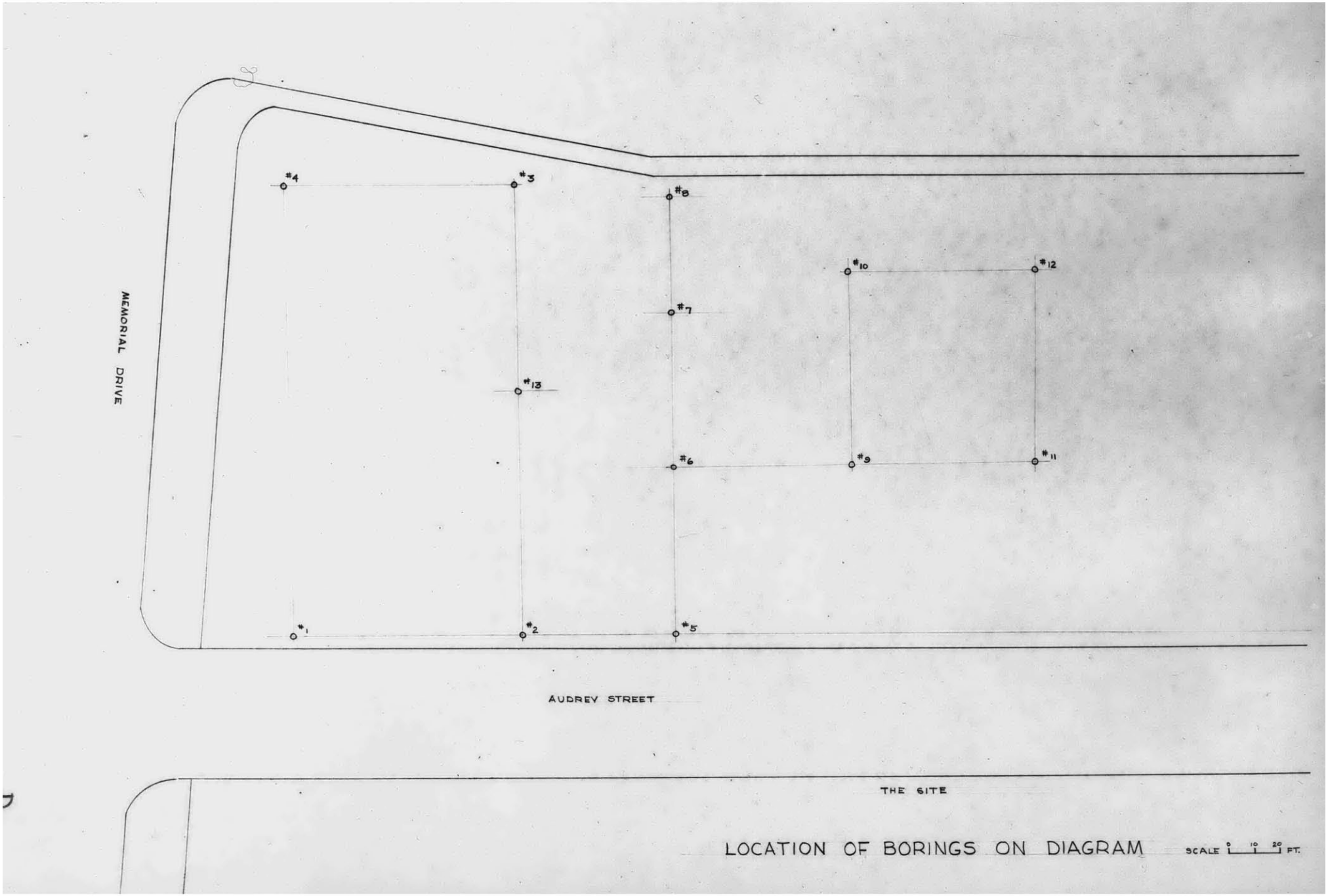
SILT & PEET

HARD COARSE SAND & GRAVEL

HARD YELLOW CLAY

SOFT BLUE CLAY





LOCATION OF BORINGS ON DIAGRAM

SCALE 0 10 20 FT.

STRUCTURAL ANALYSIS

Slabs

span = 11' $\quad f'_c = 2000$ psi

n = 12 $\quad f_c = 800$ psi

$f_s = 20{,}000$ psi

$$M = \frac{f_c}{2} \times b \left(\frac{3}{8}d\right)\left(\frac{7}{8}d\right)$$

Apartments

dead load = $56\#/ft^2$
live load = 40

total = $96\#/ft^2$

$$M = \frac{96 \times 121}{10} = \frac{wl^2}{10} \text{(Continuous end span)} = 1.16k'$$

$$d^2 = \frac{M \times 2 \times 64}{b \times 21 \times f_c} = \frac{1.16 \times 24 \times 64}{12 \times 21 \times .8} = 8.84 \text{ in}^2$$

d = 3"

$$A_s = \frac{1.16 \times 12}{20 \times 3.5} = .2\text{in}^2$$ use $\frac{1}{2}$ o 11" oc.

weight = $.67\#/ft^2$

Balcony

dead load = $56\#/ft^2$
live load = $100\#/ft^2$

total = $156\#/ft^2$

$$M = \frac{156 \times 121}{10} = 1.89 \text{ k'}$$

$$d^2 = \frac{1.89 \times 24 \times 64}{12 \times 21 \times .8} = 14.4 \text{ in}^2$$

d = 3.75 in

$A_s = \frac{M_r}{f_s \text{ arm}} = \frac{1.89 \times 12}{20 \times 3.5} = .325 \text{ in}^2/\text{ft}$

use $\frac{5}{8}\phi$ 11" oc.

weight = 1.04 #/ft^2

Walls (steel only, for thickness, see below)

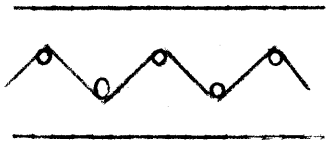
concrete = 72 in^2 /ft

steel = .0025 A_s = .0025 x 72 = .18 in^2/ft

use 5-- $\frac{1}{4}\phi$ /ft area/ft = .25in^2

weight/ft^2 wall = .85# plus ties

weight/ft^2 wall = 1.0#



Balcony Beam

dead load = 50#/ft^2 (slab) arm = 2.5'

25#/ft (beam)

live load = 100#/ft^2

M = 2.5 (150"/ft^2 x 55 ft^2 plus 25#/ft x 5 ft)

= 21.5 k'

$d^2 = \frac{21.5 \times 24 \times 64}{6 \times 21 \times .8} = 327 \text{ in}^2$

d = 18 in. at inside (alternately use steel in compression)

Foundations and First floor bearing walls

dead load

concrete = 5,581.5 cu.yd. @ 4050#/cuyd = 11,300 tons

steel = 124.1 tons

live load areas per floor

(2 br)	6,500 ft^2	@ 40#/ft^2	= 130 tons
(1 br)	3,190	@ 40	= 64
(publ)	2,045	@100	= 102
total	11,735 ft^2		= 296 tons/fl.

live load reductions

roof=	11,735	x 30#/ft^2		= 176 tons
fl. 12	296	tons x 100%		= 296
11	296	100		= 296
10	296	90		= 266.4
9	296	80		= 236.8
8	296	70		= 207.2
7	296	60		= 177.5
6	296	55		= 162.5
5	296	50		= 148
4				148
3				148
2				148
1		50		148

total = 2,558.4 tons

total dead plus live load = 13,982.5 tons

First floor walls

load = $\frac{2,558.4 \text{ tons}}{11,735 \text{ sq.ft.}}$ = .218 ton/sq.ft.

each linear foot of wall carries 11 ft^2, or

2.4 tons on 72 in^2 -- strength C of 2000psi

Foundations

load = 13,982.5 tons or 27,965,000 #

length about 300 feet (plus)

giving 46.6 tons or 93,217 # per linear foot

bearing capacity is 2000 psi or 288,000 #/ft^2

therefore, area required is

.324 ft^2 per linear foot or 4" thickness

but with two walls as beams, only 2" thickness

considering hydrostatic pressure and buckling, thicken foundation beams to strengthen and make watertight as service tunnel

Bearing on soil

support on coarse sand and gravel strata

compressive strength = 5 tons / ft^2

area required = 9.3 ft^2 per linear foot of building

or

on each side = 4.65 ft^2 per linear ft.

Stability

$\frac{\text{moment of overturn}}{\text{moment of stability}}$ less than, or equal to $\frac{2}{3}$

wind pressures

building height o--40' = 10#/ft^2

40--80' = 15#/ft^2

80-100' = 20#/ft^2

M_{ov} = pressure x area x arm (about leeward edge)

= 10 x 12,000x 90 plus 15x 12,000x 60
plus 20x 6,000x 90

= 24,000,000 #'

M_{st} = building weight x .5 building thickness

= 27,965,000 x 15

= 420,000,000 #'

$\frac{M_{ov}}{M_{st}} = \frac{24,000,000}{420,000,000}$ is less than $\frac{2}{3}$ O.K.

ACOUSTICAL CHARACTERISTICS

Desirable decibel reduction between apartments

= 40--50 db

Desirable decibel reduction between living areas

= 45--50 db

The 6" party walls give a reduction of about 47 db

The 4.5" slabs give a reduction of 42 db (uncovered--

a greater reduction with addition of linoleum)

(Values from "Architectural Acoustics", Article I, Bolt, Richard and Newman, Robert, Figures 3 & 4.)

Reverberation Time

material	coefficient of absorption at 512 cps
concrete	.015
linoleum	.05
glass	.027
carpet	.20
drapes	.10

item	units of absorption
chair (upholstered)	3
bed	18

Living area of 1 br apt Volume = 1410 ft^3

walls & ceiling =	432 ft^2	@ .015	= 6.5
linolem floor	176	.05	= 8.8
glass	88	.027	= 2.4
carpet	54	.20	=10.8
drapes	88	.10	= 8.8
chairs	(3)		= 9.0

unfurnished a = 20, 05

Sabine formula = $T = \frac{.05\ V}{a} = \frac{.05 \times 1410}{20.05}$

T = 3.44 seconds

furnished a = 39.85

$T = \frac{.05\ 1410}{39.85}$ = 1.77 seconds (quite high)

Living-bedroom area of 2-br apt Volume = 2110 ft^3

unfurnished a = 24.82

$T = \frac{.05 \times 2110}{24.82}$ = 4.25 seconds

furnished a = 70.36

$T = \frac{.05 \times 2110}{70.36}$ = 1.43 seconds

These values are high but were figured with minimum furnishings;

1-br apt -- carpet 9'x6', window drapes, 3 chairs

2-br apt -- 2 carpets, window drapes, room dividing drapes, 3 chairs, bed

It is probable that any unit would be more absorptive because of additional furnishings.

NATURAL ILLUMINATION

Critical point is interior kitchen counter, 4 m. from window.

Recommended luminous pharosage for close work = 100 $\frac{lu.}{m^2}$.

window is 1.5 m. above counter
section L is 1 m. to side left
section R is 2.3 m to side right

L $\beta = \tan^{-1} \frac{2.3}{4} = 30^\circ$ R $\beta = \tan^{-1} \frac{1}{4} = 14^\circ$

$\gamma = \tan^{-1} \frac{1.5}{4} = 20.5^\circ$ $\gamma = \tan^{-1} \frac{1.5}{4} = 20.5^\circ$

$\frac{D_y}{H} = .015$ $\frac{D_y}{H} = .005$

transmission of glass is .8

H (overcast) = 5000 helios (of sky)
H (clear) =10000 helios

Overcast day

Luminous pharosage = $H \times \tau \times \frac{D_y}{H}$

$= 5000 \times .8 \times .015 = 60 \text{ lu/m}^2$

with interflections (ρ_2 - .8, ρ_3 - .5)

$$D = D \frac{\rho_2}{1-\rho_3 \rho_2}$$

$$D = 60 \frac{.8}{1-.5\ .8} = \underline{80 \text{ lu/m}^2}$$

Clear day

$D = 10{,}000 \times .8 \times .015 = 120 \text{ lu/m}^2$

with interflections,

$$D = 120 \frac{.8}{1 - .5\ .8} = \underline{160\ lu/m^2}$$

On a clear day, the kitchen is 160% as bright as the recommended value for close work. On overcast days, it is 80% of the recommended value. Most kitchen work is not close work, so that the figures seem satisfactory.

PLUMBING AND MECHANICAL VENTILATION

fixture units per bathroom = 8

fixture units per stack = 92

required soil stack size = 4" d.

length of vent = 110'

required vent size = 3" d.

fixture units per kitchen = 4 (including washing machine)

fixture units per stack =48

required waste stack size = 3" d.

length of vent = 110'

required vent size = 2.5" d.

bathroom mechanical ventilation

one air change per 5 minutes in use (Cambridge Bldg. Code)

volume per bathroom = 280 ft^3

volume per minute = 56 ft^3

fan capacity $\geq$ 56 cfm

rooms per duct = 24

volume per minute = 1340 cfm

required duct size = 14" d.

or equivalent rectangular duct 10" x 17"

HEATING CALCULATIONS

Inside design temperature = 70° F.
Outside design temperature = -18+ 13 = -5° F.
Average wind velocity = 15 mph

Total Building

heated building volume - 1,027,000 cu.ft.

glass area = 45,500 sq.ft.
panel area = 15,170
end walls = 13,350
roof area = 10,190

window crack (worst side) = 11,850 ft.

U values

U_g = 1.13

U_{pan} = .4

U_{wall} = .65

U_{roof} = .34

Infiltration constant = $c_{pa}\ q_i\ d_a = C_i$

= .24 x 39 x .086 = .81

$H = U\ A\ (t_i - t_o)$

H_g = 1,13 (45,500)(75) = 3,860,000 Btu/hr.

H_{pan} = .4 (15,170((75) = 456,000

H_{wall} = .65 (13,350)(75) = 650,000

H_{roof} = .34 (10,190)(75) = 260,000

H_i = .81 (11,850)(75) = 720,000

Total hourly loss = 5,946,000 Btu

One Interior Apartment of 242 Interior Apartments

A_g = 132 sq.ft. U_g = 1.13

A_{pan} = 44 U_{pan} = .4

L_{crk} = 38 ft. C_i = .81

H_g - 1.13 x 132 x 75 = 11,200 Btu/hr

H_{pan} - .4 x 44 x 75 = 1,320

H_i - .81 x 38 x 75 = 2,510

total hourly loss = 15,030 Btu

(assuming there will be no appreciable heat transfer to adjacent apartment)

One Exterior Apartment of 70 Exterior Apartments

242 (15,030 Btu) + 70 (x Btu) = 5,946,000 Btu

70 x = 2316

x = 33,100

total hourly loss - 33,100 Btu

Radiators

Using finned tube radiators, $1\frac{1}{4}$ " d. with a rating of 4.25 sq.ft. per linear foot and a radiation of 240 Btu/sq.ft. for steam, the interior apartments need a total length of radiator of 16.5 feet. These will be placed at the two exposed ends.

The exterior apartments will need twice this length unless more insulation is applied to the building itself.

ALTERNATE PROPOSAL

One solution to the problem of housing married students is to destroy the wooden structures and to build a new high-rise apartment block on very little land at the far end of West campus.

There are two strong drawbacks to pursuing this tack. One is the long range development difficulties involved in providing future expansion of the housing facilities. Once a new building or group of buildings is completed, it will be difficult to re-acquire for more housing the land newly freed for other uses. The demand for housing is almost certain to increase. The percentage of married students at M.I.T. has already reached 20% and shows no sign of decelerating. The far end of West campus may be too restricting to cope with future needs.

Another serious handicap to the new building scheme is the economic policy of the M.I.T. Treasurer, Mr. Snyder. He must receive 17% of the original construction cost in rents each year. Since rents must be kept at least as low as $30 per room, the resulting space for occupancy is necessarily extremely low in view of present construction costs. The serious doubts as to whether offering such minimum space is a respectable gesture on the Institute's part or even a wise financial venture, plus

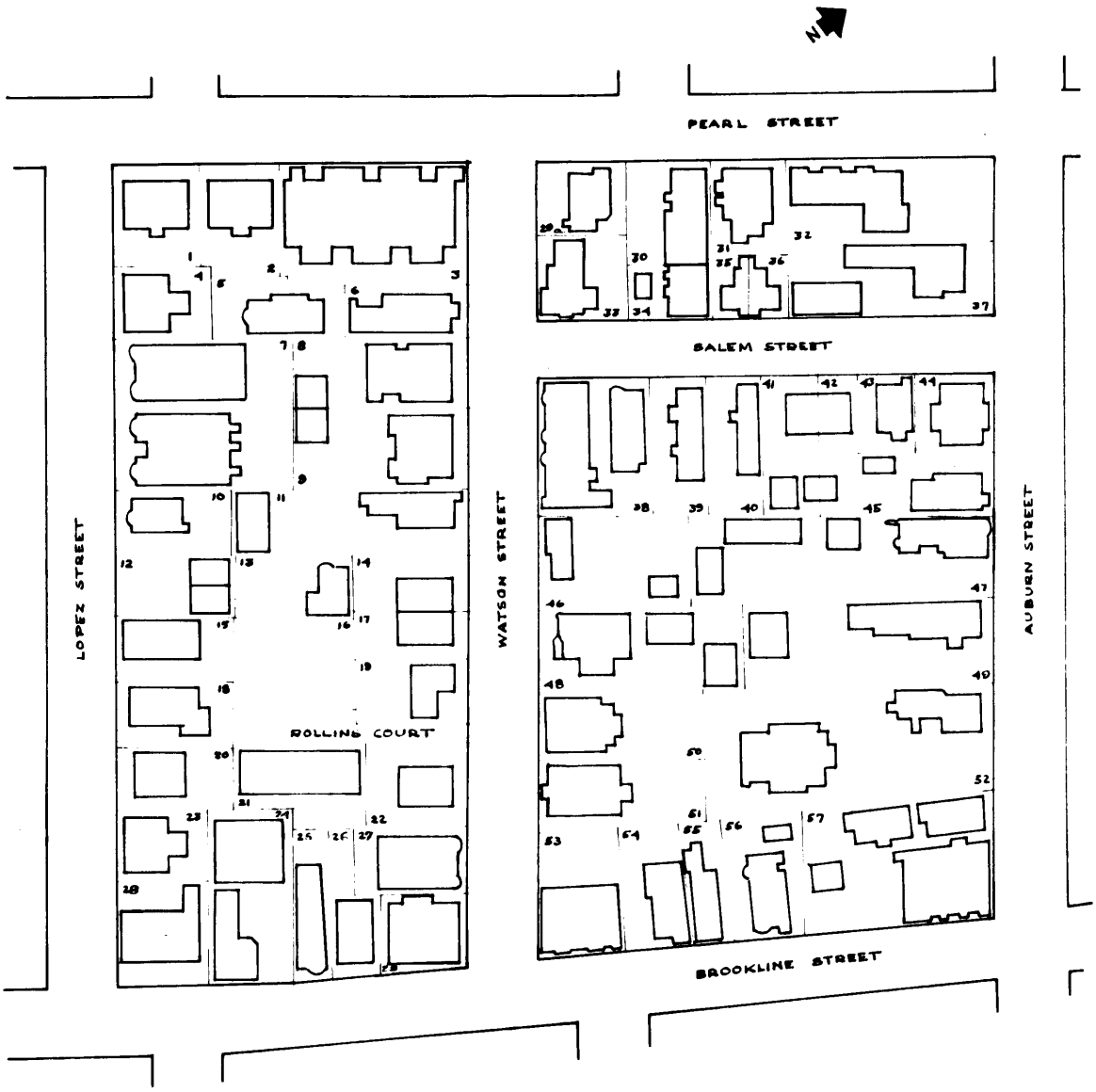
the previously mentioned expansion problem, lead to the search for some other solution to the housing problem.

A possible direction toward meeting the present and future needs is to acquire more land which would allow for a real community development with low units, less expensive to build and more suitable for families with young children. Another possibility is to buy existing buildings in a given area from individual owners and to renovate these for student use.

Professors Adams and Kelly of the City Planning department indicated that there is a committee composed of representatives from M.I.T., Harvard, and the city of Cambridge which is interested in mutual co-operation in redeveloping areas of Cambridge to benefit all three institutions. Although they have not started serious work yet, they were able to suggest some areas which are ripe for redevelopment. Two which seemed to be of interest to M.I.T. were at Green and Franklin Streets at the far end of Central Square, and Brookline and Pearl Streets across the railroad tracks from M.I.T.'s present Westgate development. The former had the advantage of being close to Harvard Square and the prospect of being tied in with further Harvard expansion. It was a considerable distance from Tech, however, and would probably require students to take the MTA to school. The latter was within walking distance, but was separated by a strong and unassailable

industrial belt from M.I.T. and was in a low-class city residential section. Even so, it seemed to be the more promising of the two, if the idea could be accepted that proximity of housing and industry is not *per se* an undesirable thing and that a co-existence of population characteristics could lead to reciprocal advantages and education to both classes of residents.

A representative area of two blocks was selected from the section, close to M.I.T., which Mark Fortune, of the Cambridge Planning Board, said stood a good chance of being condemned for redevelopment purposes. If this were to be done, then the land could be acquired by Tech at its own value, without existing buildings. The two blocks could be treated as one larger block, gaining the area of the present street for developing and increasing the flexibility of new building arrangement. These two blocks would then give an area of 200,424 square feet. These are not held as the final answer--more blocks could be acquired--but they are used as a sample of the conditions of that entire section. The diagram shows the two-block area and the table gives the results of investigation at the assessor's office of assessed land values. The Palmer Real Estate Agency estimated that the market value would be about 150% of the assessed valuation; so that it seems safe to assume that in the event of a redevelopment project, M.I.T. might acquire the land at this cost, at most


N
PEARL STREET
LOPEZ STREET
WATSON STREET
AUBURN STREET
SALEM STREET
BROOKLINE STREET
ROLLINS COURT

LOT NUMBER	ASSESSOR'S NO.	LAND AREA #	ASS. LAND VALUE	ASS. BLDG. VALUE	TOTAL ASS. VALUE	13% ASS LAND	15% ASS. BLDG	18% ASS. TOTAL	20% ASS. TOTAL
1	66	2724	1700	4800	6500	2250	7200	9750	13 000
2	173	2900	1800	3500	5300	2700	5250	7950	10 600
3	172	7462	4500	13800	18300	6750	29700	36450	36 600
4	88	2350	800	3900	4700	1200	5850	7050	9400
5	174	2325	700	1800	2500	1050	2700	3750	5000
6	69	2050	900	3600	4500	1350	5400	6750	9000
7	87	8650	2200	12 000	14200	3300	18000	21300	28400
8	180	4180	1500	4300	5800	2250	6450	8700	11600
9	179	4470	1600	4200	5800	2400	6300	8700	11600
10	86	2275	700	1800	2500	1050	2700	3750	5000
11	167	5047	1500	2400	3900	2250	3600	5850	7800
12	85	2369	800	2300	3100	1200	3450	4650	6200
13	168	3146	800	2500	3300	1200	3750	4950	6600
14	97	1758	700	1100	1800	1050	1650	2700	3600
15	84	2493	700	2300	3000	1050	3450	4500	6000
16	169	4698	1000	——	1000	1500	——	1500	2000
17	98	1778	700	1100	1800	1050	1650	2700	3600
18	83	2584	800	3000	3800	1200	4500	5700	7600
19	76	2430	1000	2500	3500	1500	3750	5250	7000
20	82	2419	700	1700	2400	1050	2550	3600	4800
21	170	4486	1000	3500	4500	1500	5250	6750	9000
22	171	2971	1200	3400	4600	1800	5100	6900	9200
23	155	2037	600	2900	3500	900	4350	5250	7000
24	80	4645	1900	5000	6900	2850	7500	10350	13800
25	89	1866	800	3600	4400	1200	5400	6600	8800
26	90	1809	1000	3600	4600	1500	5400	6900	9200
27	92	2340	1000	5000	6000	1500	7500	9000	12 000
28	156	3216	1500	3000	4500	2250	4500	6750	9000
29	91	2112	1200	8300	9500	1800	12450	14250	19000
30	2	2788	1700	3900	5600	2550	5850	8400	11200
31	3-4	1305	1600	2900	4500	2400	4350	6750	9000

32	5	5175	4400	6900	11300	6600	10350	16950	22 600
33	9	2647	1200	2400	3600	1800	3600	5400	7200
34	8	1551	500	2000	2500	750	3000	3750	5000
35	7A	675	200	1300	1500	300	1950	2250	3000
36	7	675	200	1300	1501	300	1950	2250	3000
37	6	5194	1900	4500	6400	2850	6750	9600	12 800
38	93	5082	2100	8400	10500	3150	12600	15750	21 000
39	94	2320	1000	2300	3300	1500	3450	4950	6 600
40	12	2560	700	2900	3600	1050	4850	5400	7200
41	13	2400	700	1300	2001	1050	1950	3000	4 000
42	14	2000	600	800	1400	900	1200	2100	2 800
43	15	1417	500	1700	2200	750	2550	3300	4400
44	16	1936	1000	2400	3400	1500	3600	5100	6 800
45	17	2597	1200	2100	3300	1800	3150	4950	6 600
46	29	4748	1900	1100	3000	2850	1650	4500	6 000
47	18	8500	2600	3800	6400	3900	5700	9600	12 800
48	28	5925	1900	5900	7800	2850	8850	11700	15 600
49	19	7056	2400	5500	7900	3600	8250	11850	15 800
50	27	3981	1400	4600	6000	2100	6900	9000	12 000
51	26	3862	1400	2100	3500	2100	3150	5250	7 000
52	20	11258	5300	3900	7200	4930	5850	10780	14400
53	25	3348	1500	9900	11400	2250	14850	17100	22800
54	24	2624	1200	3300	4500	1800	5950	7750	9600
55	23	1584	700	2300	3000	1050	3950	5000	6000
56	22	3016	1400	3100	4500	2100	4650	6750	9000
57	21	7945	3600	10400	14000	5400	15600	21000	28000
29A	1	2000	1300	1500	2800	1950	2250	4200	5600
TOTALS		199,749	$ 79,420	$ 215,400	$294,820	$ 119,000	$ 313,000	$432,000	$589,640

F

This study cannot weigh the advantages and costs of acquiring this additional land against the disadvantages and lack of new expense of using presently owned land, nor can it deal with the city's social and economic problems arising from the displacement of the estimated 100 families which now live in the area under consideration. It can only present what the assessed value of the new land is and what its probable cost would be; it can point out the increased flexibility and long-range possibilities for expansion and improvement of the housing program.

If a redevelopment project did not occur, then M.I.T. might instead start to buy the properties of the present owners from them as individuals. M.I.T. could then renovate the better structures and dispose of the more blighted ones, replacing them according to a plan for preserving a reasonable amount of open space. If, due to high construction costs, low buildings on more land were the best course, additional land might be acquired.

It is impossible to estimate what buildings are worth renovating without inspecting their interiors one by one. From the exterior, it looks as though close to half of the structures are reasonably sound. These are principally two or three-story wooden apartment houses. Renovating is a tricky business in which nothing can be predicted with certainty. The office of Sam Nissenbaum

has found, after many such jobs in Cambridge, that the older buildings are often built in violation of the present building code and are faulty at an unexpected point which may be expensively discovered only by breaking into walls or testing foundations. Still, it most cases, they claim to be able to tell which buildings are worth while for renovation purposes.

The table lists the assessed valuation of all of the buildings in the two blocks on the diagram. If the owners were not so anxious to sell to M.I.T. as the city might be to see a redevelopment project, then the 150% figure might be too low. It is listed in the table at that figure, as well as at 200%, which was the figure estimated by Mark Fortune.

The Registry of Deeds records a sale of the property on Lopez Street, Lot #18, in 1953 at a figure of $4,125. This is 110% of the assessed valuation. The property on Lopez Street, Lot#20, was mortgaged in 1952 at $5,900, or 245%. These examples give little clue to the situation as it would exist. Evidently, each property would be a problem in itself.

The area studied could be developed as a start toward housing the increasing number of married atudents at M.I.T. Such a direction would lead eventually to a real residential community which achieved a richness through combining both old and new building, fostered a wide range of social experience for the students, permitted expansion

and flexibility, and located the families more conveniently to shopping, entertainment, and transportation facilities, and, if not closer to M.I.T. itself, not too far distant to be out of walking range.

Its long-run economy for M.I.T. has not been clearly demonstrated, but this study is a preliminary step in an investigation which might well be a wise direction for M.I.T. to consider.

If such a building as designed in the thesis project were to be completed and found to be an inadequate solution to the total problem, then this other course could be adopted, abandoning the new structure to use by graduate or upper-class students in two and three-student suites. Then, a circle of West campus would be made with dorms and the new building would reduce Institute expenses in dormitory dining halls and janitor service.

BIBLIOGRAPHY

Bolt, Richard H. and Robert B. Newman, Architectural Acoustics.

"Boston Builds Balconies," Architectural Forum, May, 1951.

Ehlers, Victor M. and Ernest W. Steel, Municipal and Rural Sanitation, New York, McGraw-Hill Book Company, Inc., 1950.

Festinger, Schacter, and Back, Social Pressures in Informal Groups, New York, Harper and Brothers, 1950.

Kennedy, Robert Woods, The House, New York, Rheinhold Publishing Corp., 1953.

Moon, Parry and Domina Spencer, Lighting Design, Cambridge, Addison-Wesley Press, Inc., 1948.

Sabine, Hale J., Less Noise, Better Hearing, Chicago, Celotex Corporation, 1941.

Severns, William H. and Julian R. Fellows, Heating, Ventilating, and Air-Conditioning Fundamentals, New York, John Wiley and Sons, Inc., 1950.