

PROTOTYPE DEVELOPMENTS FOR LOW-INCOME
URBAN SETTLEMENTS ON HILL SITES
IN GUATEMALA CITY, GUATEMALA

by

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Signature of author.....

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PROTOTYPE DEVELOPMENTS FOR LOW-INCOME URBAN SETTLEMENTS

ON HILL SITES IN GUATEMALA CITY, GUATEMALA

by

Fernando Ruiz

This study attempts to explore the possibilities of utilizing hill sites for the development of urban low-income settlements. Its main objective has been to evolve a subdivision pattern that could be applied to the gently sloping areas in the ravines surrounding Guatemala City, Guatemala. In its preparation, data from a squatter area called La Limonada have been used.

This study has concentrated on the aspects of land subdivision and circulation only.

Lawrence B. Anderson, Dean
School of Architecture and Planning
Massachusetts Institute of Technology
Cambridge, Massachusetts

June 28, 1968

Dear Dean Anderson:

In partial fulfillment of the requirements for the degree of
Master of Architecture, I hereby submit this thesis entitled Prototype
Developments for Low-Income Urban Settlements on Hill Sites in Guatemala
City, Guatemala.

Respectfully,

/ Fernando Ruiz /

PROTOTYPE DEVELOPMENTS FOR LOW-INCOME URBAN
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PROGRAM

The program was to select a hillside and design an urban development for 5000 to 10,000 low-income people, with emphasis on land subdivision and circulation.

CONTEXT

Guatemala City is located in the highland area of south central Guatemala at an altitude of 1500 meters above sea level and within a valley of varied topographical characteristics. The flat area occupied by the city itself is surrounded by deep and continuous ravines on three of its sides, a condition that was believed to absorb the shocks of earthquakes when the capital was established there in 1773 but which now has virtually blocked the normal growth of the city to the north, east, and west. Available land lies beyond the ravines, but, unfortunately, there is no direct access to it. The city has roughly 12% of the country's population and over 50% of the nation's urban population. Its rate of growth is 4.9% annually, and latest estimates place its population above the half million mark.

The layout of the city is basically the traditional gridiron pattern of the Latin American cities, with its central plaza, rectangular blocks, and streets oriented toward the four cardinal points. This pattern used on most of the flat areas and on some gently sloping ones

stops at the borderlines of the ravines which, thus far, have remained undeveloped, even though they are located very close to the city.

The population explosion of the last decades plus the strong centralization of activities in Guatemala City have created a strong demand for urban land. This demand has forced people of the lower income groups to turn to the ravines in search of a piece of land on which to erect their dwellings. Unable to pay the high prices typical of the standard developments, they have begun to squat along the gentler slopes of the ravines, thus creating overcrowding and related problems.

According to the population census of 1965, it can be estimated that more than 55,000 people, roughly 11% of the city's population, live in marginal areas in unhealthful conditions without services and utilities. These areas are constantly growing at an estimated rate of 10% per year. If this problem is not given a prompt and appropriate solution, Guatemala City will soon be surrounded by unsightly, unhealthful, and almost incurable squatter settlements.

Thus far, the squatters have invaded public land claiming only that they go to the ravines because they are located close to their places of employment and because there they pay neither rent nor taxes. To explore what can be done economically on hillside sites to alleviate the land problems of this kind of people has been the main objective of this thesis. For its preparation, data from one of these areas -- La Limonada -- has been utilized.

LIMITATIONS

This exercise has not taken into account the aspects of staging, growth, land tenure control, and flexibility of land use, for its main purpose has been to search for a subdivision pattern for hillsites which would utilize the permissible maximum of land and would create rectangular lots of minimum size and a circulation system that could be both efficient and economical.

The maximum useful slope has been set at 30% inclination after studying several cross sections of the ravines in La Limonada and other similar areas and after noting that squatters do not utilize steeper slopes, for these require the use of appropriate supporting structures well beyond their economic capabilities.

ASSUMPTIONS

1) This project would be carried out without any kind of subsidy, its autofinancing being possible through:

- a) minimal cost of initial development
- b) selling of the land on a low monthly installment basis over a long period of time in order to make it available to low-income families.

By minimal cost of development is meant:

- a) subdivision of the land according to a feasible and economical plan
- b) the supplying of potable water through stand pipes located at strategic points

- c) provision of storm drainage systems and macadam or a similar type of surface treatment for the entire circulation system.

The subsequent development and improvement of the project would take place through a joint effort of community action and municipal assistance. The contrasting experiences offered by government low cost housing projects in Venezuela or Peru and the Barriadas Populares of Lima, Peru are irrefutable proof of the success of genuine self-help projects. With this precedent in mind, this thesis supports the idea of offering a minimum of land improvements at the outset of an urban development of this type, while backing it up with a good plan that would encourage continuous development and improvements on behalf of the inhabitants themselves. It is a fact that in this kind of development the people are able to build their shelters by themselves with relative high economy and efficiency. Their effort contributes in high degree to the stabilization and evolution of each family and, in turn, of the community itself.

- 2) Each family would be able to set aside 5% of their total income for its investment in a piece of land.
- 3) Fifteen years have been assumed a reasonable period of time for each family to pay for their land.
- 4) Transportation expenses can make up a high percentage of the poor people's budget. One way of minimizing this expense is by offering them land as close as possible to the city or potential

sources of employment. With this consideration in mind, it has been assumed that the site selected for the project is still farm land available at a relatively low cost.

5) Since the developed land would be sold in installments, a charge of 25% is assumed to cover the interest of the capital utilized and other expenses of the operation.

6) The cost of land per square meter has been assumed to be as follows:

raw land	\$1.00
<u>cost of development</u>	<u>1.50-</u>
total cost of saleable land	\$2.50 per square meter

7) People with similar social and economic characteristics, as in La Limonada, would constitute a potential market for project of the kind developed here.

DEVELOPMENT OF DESIGN CRITERIA AND CONCEPT

This exercise has been developed according to the following steps:

- a) Research, study, and interpretation of the collected information with emphasis on its social and economic aspects.
- b) Study of some urban parameters existing in Guatemala City, in order to select an appropriate site for the project.

- c) Development of a solution for this project, concentrating mainly on the aspects of land subdivision and circulation.

The following tables represent some relevant social and economic data from La Limonada:

Income distribution in \$/family/year

Income (\$)	% families
0 to 60	6.8
60 120	11.5
120 240	13.8
240 360	17.1
360 480	18.8
480 600	12.9
600 720	2.8
720 840	6.3
840 960	3.5
960 1080	2.4
1080 1200	1.7
1200 1320	0.8
1320 1440	0.4
1440 1560	0.4
1560 1680	0.4
1680 1800	0.4
1800 up	0.4

100.0%

(This information indicates that roughly 35% of the families living there have incomes above the \$480 a year level.)

Capability to pay in \$/month/family

\$	% families
00.00 to 0.50	19.3
0.50 0.99	0.6
1.00 4.99	14.4

Capability to pay in \$/month/family (continued)

\$	% families
5.00 to 9.99	44.5
10.00 14.99	16.3
15.00 19.99	3.0
20.00 up	1.8

(The assumption of saving 5% of their income for land investment is reasonable for people of this group.)

Age groups

age	% population
0 to 4	17.1
5 9	16.7
10 14	14.2
15 19	11.3
20 24	7.0
25 29	6.7
30 34	6.2
35 39	6.8
40 44	4.0
45 49	4.5
50 54	1.9
55 59	1.1
60 64	1.2
65 69	0.1
70 74	0.1

(The young population group is very high. The group between 0 and 14 years [school age] accounts for 48% of the total population.)

No. of people per dwelling

0 to	1	1%
2	4	23%
5	9	70%
10	14	6%

(For calculation purposes an average of 6 members per family has been adopted.)

Vehicle ownership

None at all	160
motorcycle	1
bicycle	22
cart	1
automobile	1

Sample of 185
families surveyed

(The car-family ratio is extremely low. On street parking has been considered sufficient.)

SITE SELECTION

In order to study the urban parameters relevant to this problem, the following maps were prepared:

- a) Overall pattern of ravines surrounding the city.

From the drainage standpoint, the city is divided into two watersheds: north and south. This consideration automatically eliminated the possibility of using the ravines to the south of the city, since no sewage

treatment plant or municipal sewer system exists for this area, and city regulations strictly forbid the dumping of city wastes into the creeks and rivers draining to the south.

- b) Income levels distribution. This map helped to locate possible sites within the low income areas and to concentrate the search upon the rapidly expanding part of the city to the north of the Pan American Highway western branch.
- c) Main circulation system of the city. This map helped to pick up a site without access problems and close to existing transportation routes.
- d) Land use pattern of the city. This map was useful in locating a site within a residential zone but also close to commercial and industrial areas.

With the help of these maps, the final selection fell upon a piece of land marked on the map of the city as "Finca El Incienso," a sort of peninsula surrounded by ravines on more than 80% of its periphery, and with a good access road passing right in front of the property.

According to the sources of reference at hand, the site is still farm land with a gently sloping area on its center part that, for practical purposes, can be considered flat. Spreading away from this area, the rest of the property gradually slopes toward the ravines, reaching in

some spots inclinations of more than 100%. The study of the topography of the site and the limitations of using slopes up to 30% inclination helped to narrow down the area considered suitable for the subdivision.

ACCESS AND CIRCULATION

The highway leading to Colonia Bethania and the western boundary of the site run parallel along approximately 500 meters. This fact offers the possibility of connecting penetration streets in one or two points along this distance.

The study of the dimensions of the land, roughly 600 meters wide by 1000 meters long, which give the land a sort of elongated shape, the topographical characteristics of the site, and its clear definition of the flat and hillside areas are all strong suggestions of the need for having a common and transitional element between these two distinct areas. Such an element can be translated into a peripheral artery that could deliver and collect the traffic to and from all points of the site.

Furthermore, a circumferential road also offers the choice for reaching any point from two different directions and through a continuous flow of traffic with no dead ends. This arrangement is appropriate for the functioning of bus routes, main public transportation system in Guatemala City. Bus stops along this major circulation route would generate points of commercial activity, thus acting as a

link between the neighborhoods on the flat and hillside areas.

This main road has been given a right-of-way of 24 meters, considering that four moving lanes and two more for on-street parking plus wide walkways on each side would handle all of the traffic generated by the community. This wide avenue is intended to counter-balance the narrow character of the pedestrian streets leading to it.

In order to minimize grading costs, the main street develops primarily over the flat area of the site, following the contours in some parts and the lines of minimum slope in others. This layout, in turn, offers the possibility of having a broken and interesting visual sequence that sharply balances the uniformity of the lots fronting on it.

The secondary circulation system connects with the peripheral road at three widely spaced points, allowing for a more fluid and uninterrupted traffic flow. One cross-connection between the two branches of the circumferential road has been provided at the narrow part of the flat area, expecting that intense commercial activity could take place along this street. To reinforce the character of this street, the market place has been located in this area.

The second system branches off from the main road, in order to bring access to areas further down the hillside to the north and east of the site. Here again the criterion for its layout has been to follow the contours whenever possible and along lines of slope of no

more than 10% inclination. Its right-of-way has been set at 15 meters, considering that two moving lanes and two for on-street parking plus walkways on each side would be enough for handling the traffic of those areas. When necessary, short cul-de-sacs with a diameter not less than 30 meters have been provided, in order to keep the more distant lots not further than 100 meters from the vehicular circulation system. To build roads on hillsides is expensive. Therefore, minimum cost of construction and maximum efficiency have been the controlling factors for establishing the alignment of the secondary circulation system.

Streets for vehicular circulation demand appropriate space, paving, alignment, etc., which increase the cost of any development. The reduction of its overall length plus the fact that vehicular access to every house is not necessary are two factors that go together in keeping low the cost of development. Therefore, most of the access problem to the lots can be solved by using pedestrian streets of limited width. In order to allow for the occasional access of service vehicles in case of emergency, fire, etc., the right-of-way for these streets has been set at 6 meters.

LAND SUBDIVISION

The first question on this aspect is the determination of lot sizes. It is a fact that what people can get is, in most cases, directly

related to their income and purchasing capabilities. Therefore, the starting point is to find out how much land these people can buy with their limited incomes.

A rough estimate of the minimum expenses required nowadays in Guatemala City to cover the needs of a typical family of six members of the social group here considered is as follows:

Food	\$20.00
Transportation	4.75
Utilities	5.00
Clothing	5.00
Medicines, emergencies, etc.	5.00
<hr/>	
Total per month	\$39.75
Total per year	\$480.00

(This figure has been adopted as the minimum subsistence level.)

The net amount of money capitalized at the end of the 15 year period and under the assumptions described above would be:

$$\$480 \times 5\% \times 15 \text{ years} \times 75\% = \$270.00$$

The area of land that could be purchased at \$2.50 per square meter would be: $\frac{\$270}{\$2.50} = 108$ square meters

This area, in turn, satisfies the minimum area requirements of the AID Proposed Minimum Standards for Permanent Low Cost Housing.

In order to lower the cost of streets and utility lines per lot, the frontage must be minimized and the depth maximized. The above mentioned AID Standards propose a minimum frontage of 6 meters, which

is a common front dimension used in urban developments throughout Latin America, for it is also equivalent to the size of two rooms three meters wide. Accepting this dimension as the minimum frontage for lots of this development, the required depth would be: $\frac{108}{6} = 18$ meters. This gives a depth/width ratio of 3:1.

The module adopted for the subdivision has been 3 meters, thereby making the lot dimensions multiples of this module, with the further consideration that corner lots require 50% more width to compensate for its being serviced by two street. Lots fronting streets for vehicular circulation should also be given more depth to cover the possibility of having shops or small stores at their fronts.

The adopted plot sizes then are:

Interior lots	6 x 18 meters
Interior corner lots	9 x 18 meters
Lots fronting principle streets	6 x 24 meters
Corner lots on principle streets	9 x 24 meters

ORGANIZATIONAL PATTERN OF THE LOTS

The most economical way of developing undulating hillsites is to allow both the roads and the dwellings to follow the contours. The roads will then have minimum slopes, cuts, and fills with the least disturbance to the configuration of the land. These conditions should provide the design initiative and not preconceived geometric patterns. But whatever pattern is evolved must be the result of organizing the individual lots.

The most effecient geometric shape for small lots is rectangular,

with width/depth ratios of between 1:3 and 1:5. This shape is easy to lay out, utilize, and maintain. Economically speaking, it permits the fullest utilization of commercial building components, which are generally produced in rectangular shapes as well. Therefore, avoiding trapezoidal, triangular, and curved shapes is desirable.

The best way for placing rectangular lots on hillsides is to orient them with the long axis parallel to the contours. In this fashion the short dimension will be parallel to the slope of the hill, thus minimizing cuts and fills and avoiding the stepping of the dwelling foundations later on. Problems of drainage and the connection of public utility lines ~~is~~^{are} also more easy to solve in this way.

The problem is that the rigidity of rectangular lots conflicts with the freedom of direction of the contours, especially when trying to organize groups of parallel lots on heavy, undulating terrain. Thus, the search for a system for placing rectangular lots on a hillside that accepts this conflict and controls it became one of the major objectives of this thesis.

The question was how to provide compactness and, at the same time, capability for directional changes to a group of rectangular shapes. Two different directions could be followed in searching for the solution of this conflict.

- a) To ease the restriction of conserving the rectangularity of the shape and, thus, introduce some change of direction

on one of the sides. For practical considerations, the front of the lots must be kept at right or nearly right angle relationship to the other two parallel sides. The only alternative left is to absorb the change of angularity at the back of the lot. This possibility seems to work well for small angular changes but becomes quite cumbersome when dealing with sharp changes of direction.

- b) The other alternative is to handle groups of rectangular lots as units with the space around them absorbing the change of direction. This possibility allows for the organization of blocks along horizontal strips that follow the contours as much as possible. The blocks will then take the shape of a truncated pyramid, which means varying the depth of the lots according to their distance from the center of the curve. In the scheme here presented, the depths vary from 18 to 24 meters maximum. The tapering of the wedge shaped blocks plus the restriction of keeping the front of the lots perpendicular to the other sides gives the opportunity of introducing spacial variation to the pedestrian streets.

The street in Latin America is more than a circulation path; it is mainly a place of intensive social interaction where people gather

at certain spots to chat, play, sing in groups -- in a word, to have fun for a while. The design chosen helps to encourage this attitude, since the alternation of narrow and wide spaces along the pedestrian streets facilitates the formation of such spots. Furthermore, playgrounds, fountains, small public courts, etc. could be developed in these spaces, thus helping to create points of identification for each neighborhood.

The lots must be organized in groups, in order to maximize the use of the land and for the economy and efficiency of the public utility lines. The parallelism of groups of lots, in turn, provides a sense of order and purpose. The groups will be sought to be placed primarily on parts of the hillsides that offer possibilities of accepting a great number of lots but sparing the flatter parts for open spaces of more intensive use.

The preservation of groups of small lots susceptible to being integrated and converted into a larger single one could be a means of adjusting the development to future land use needs.

Block units made up of lots parallel to the contours allow for future growth down the hillsides, but how far they can go depends upon the slope of the hill and also upon the development of the system of access roads.

LAND RESERVE

One form of land reserve suitable to this type of development

could be an agricultural belt that would work as a barrier between the developed areas and the rest of the ravines, preventing its misuse.

This land reserve could be owned either by the municipality or by some form of neighbors' cooperative, which would control it according to the needs and pressures of the locality.

Psychologically, this fringe would produce in its users a sense of purpose, a source of income, and a need for a property to take care of. Economically, the rent obtained from the leasing of this land could be reinvested in the development of the settlement. For the users this land reserve could represent sources of income, since orchards, gardens, corn plantations, or any other type of crop typical of the area could be taken care of easily by unskilled workers. Plots on this agricultural belt would be leased to inhabitants of the community only.

OTHER LAND USES

Other land reserved for more intensive use other than housing is the area fronting the main highway to Colonia Bethania. It is felt that light industry is prone to develop along this artery, thus providing more sources of jobs to the population of the area.

The main open space at the center of the flat area has been designed to function as a spinal cord. Two elementary schools function as terminus of this open space intended to be the main generator of social interaction and most important pedestrian route of the development.

Being inside the area formed by the main circulation system, this path is safe for pedestrian circulation, especially children walking to school. Some minor commercial activities might take place along this path, thus helping to attract more people to this space.

AREAS AND DENSITIES

Total area of lots	20.36 Ha.	(52%)
Schools	1.86 "	
Nurseries	0.37 "	
Chapels	0.12 "	
Market	0.10 "	(6.3%)
Industrial	2.47 "	
Parks and open space	1.70 "	(4.3%)
Circulation	12.13 "	(31%)
 Total area developed	 39.11 Ha.	 100%
No. of lots		1508
No. of people	1508 x 6 =	9048
Net density	$\frac{9048}{20.36}$	= 445 people/ Ha.
Gross density	$\frac{9048}{39.11}$	= 265 people/ Ha.

CONCLUSIONS

Hillside developments require a different approach and treatment from that of developments on level terrain. The conditions existing in each case are totally different in most of the cases. People who go to live on hillsides do not expect and should not be forced to have the same type of environment that exists in the flatlands. Regular layouts are possible on level areas because the most logical way of grouping rectangular lots is by placing them at right angles to each other, but on sloping land the character of the surface becomes dominant, and, therefore, the freedom to impose formal patterns is restricted. If the contours are then respected the resulting pattern will be loose and informal. Each terrain will then produce a pattern of its own.

Public acceptance of hillside developments will be obtained when the following factors are attained:

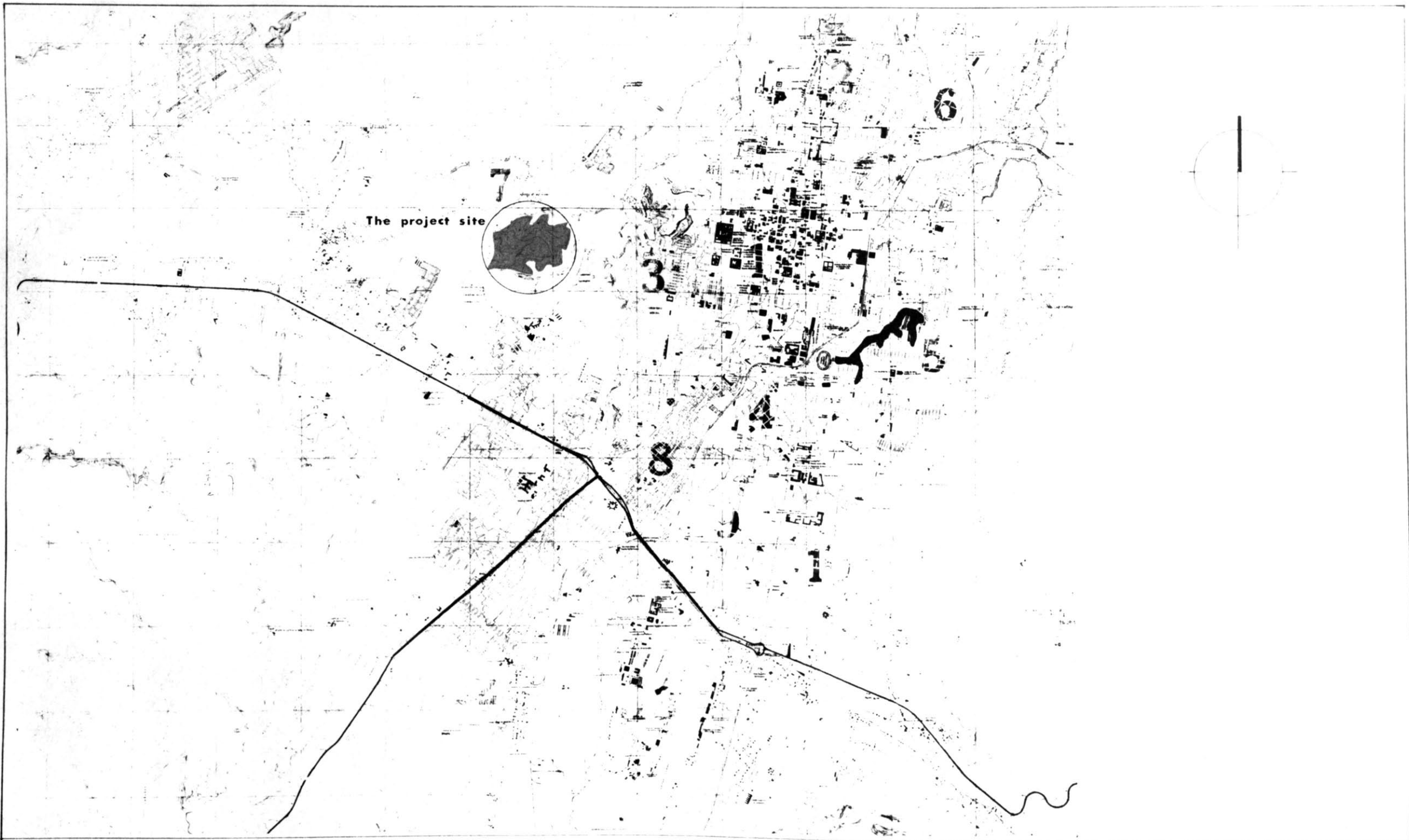
- a) Lower land unit cost due to:
 - i) Low raw land cost
 - ii) Less earth moving cost
 - iii) Less utility footage cost
 - iv) Less street cost
- b) Attractive preservation of the hillscape
- c) Usable open land provided for the recreational use of all

Not all of the area available in the ravines should be developed. Steep, difficult land should be left untouched for its scenic beauty. On the other hand, very gently sloping land should be set aside for parks and community facilities. Outstanding natural features, such as dominant points, natural rock outcroppings, desirable vegetation should be left inviolate.

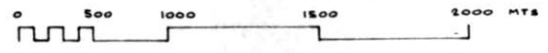
With a little bit of planning and imagination the ravines surrounding Guatemala City could be developed and, thus, incorporate those areas into the urban environment. The precedent offered by the squatters' actions cannot be ignored, for they are proof of the potential offered by the ravines and land resources for the housing needs of the Guatemalan low income groups.

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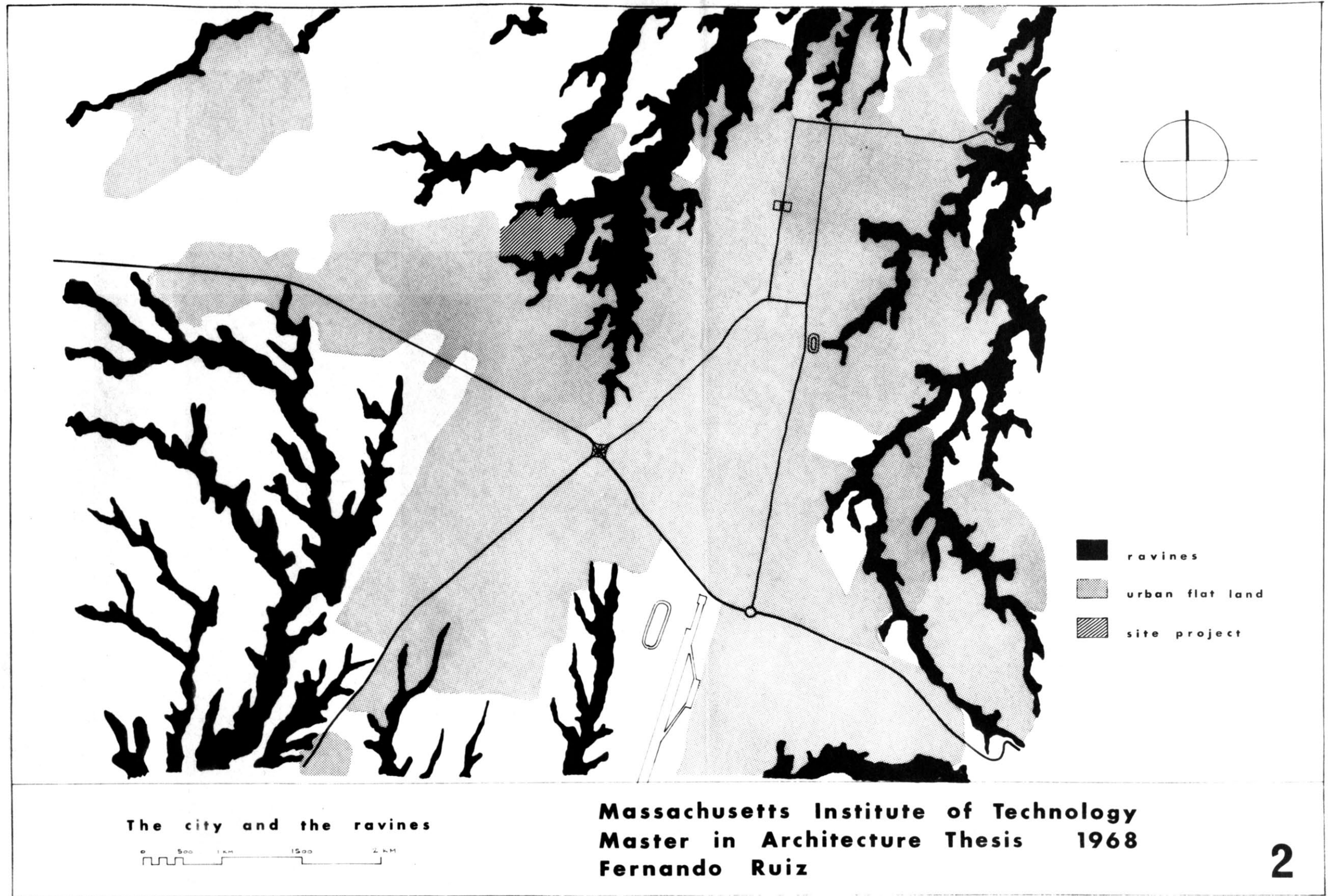
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Map of Guatemala City



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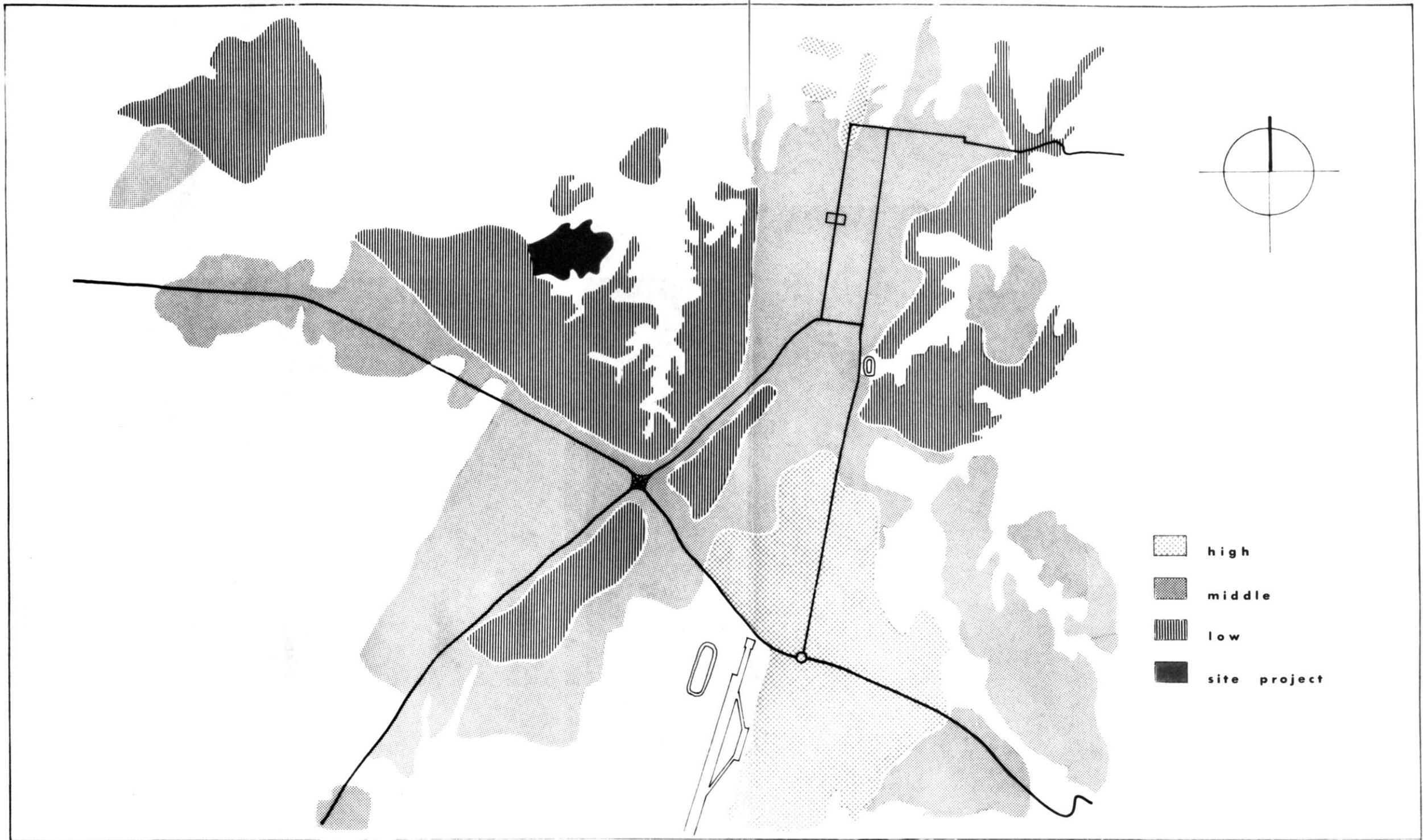




Land use pattern



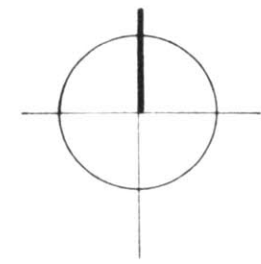
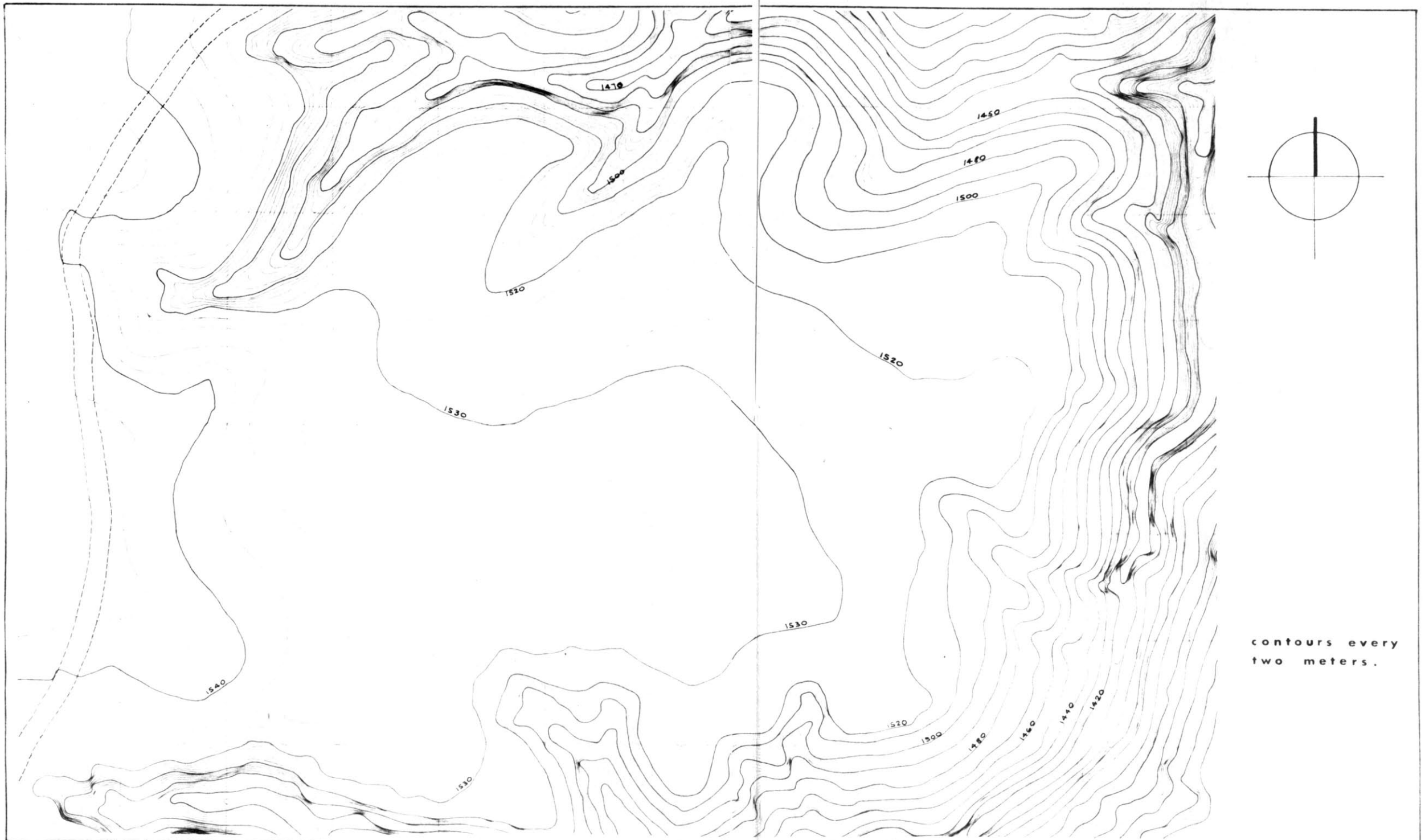
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Income levels distribution



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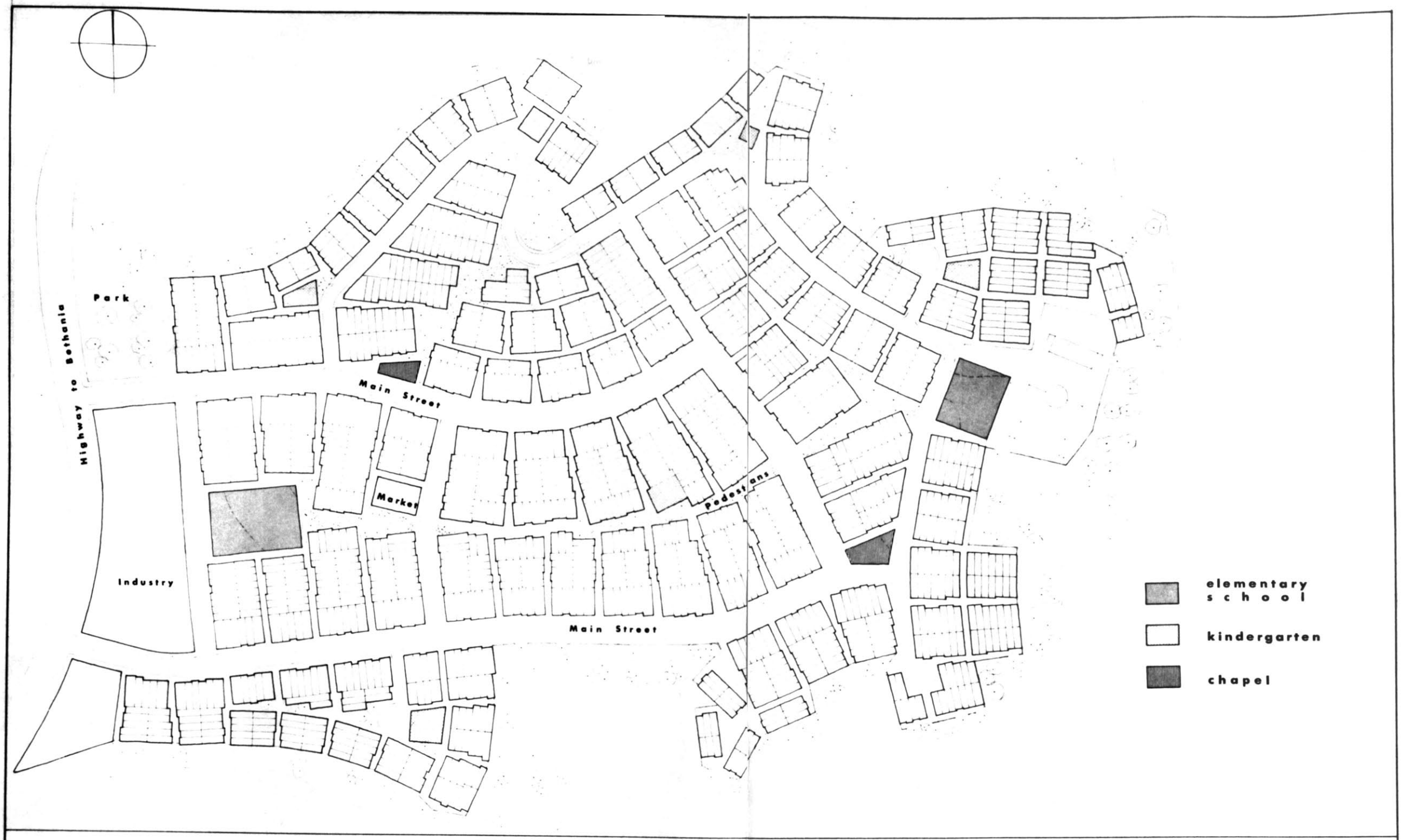


contours every
two meters.

The project site



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Land subdivision plan



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