Title
Sun and Light for Downtown San Francisco

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SUN AND LIGHT FOR
DOWNTOWN SAN FRANCISCO

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ENVIRONMENTAL SIMULATION LABORATORY

Institute of Urban and Regional Development
College of Environmental Design

This study was funded in part by a grant from the Wallace Alexander Gerbode Foundation and the San Francisco Department of City Planning.

Dedication

This report is dedicated to the memory of Donald Appleyard who was a friend and mentor to all of us, and who spent his working life measuring those qualities in the urban environment that affect the daily lives of people.

Acknowledgments

We would like to thank Dean Macris and George Williams and the staff of the San Francisco Department of City Planning for their help in the preparation of this report. In particular we would like to acknowledge the work of Richard Hedman, whose ideas on street scale and building form have influenced our thinking on those subjects. We would also like to thank the members of the San Francisco Planning Commission and its president, Toby Rosenblatt, for their continued support and encouragement. Our thanks also go to Edward Arens for reviewing this report, to Kevin Gilson for many of the photographs shown in this report and to William Grey for his help in developing graphic material.

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The Urban Design Plan, adopted as part of the 1972 Master Plan, is now 11 years old. However, its success in preserving sun and light in public open space has been at best limited. Many downtown highrise buildings, in blatant contradiction to this policy, now shade their own and neighboring public open space.

There are three reasons for this. First, incentive zoning as a means of regulating both the quality and quantity of open space in downtown San Francisco has to all intents and purposes failed. In a classic trade-off between increased development rights and the provision of public amenities, the amount of additional floor space was clearly defined. However, guidelines governing the location, size, and orientation of public plazas, urban gardens and sidewalk arcades was left unspecified. As a result, even when provided as a part of new development, public space is often useless and ill designed.

Secondly, current height zoning does not take into consideration sun access criteria for public open space. To ensure sunlight in downtown parks and plazas it is necessary to depart from the practice of defining allowable building heights by contour lines. Sun access profile planes and "solar fans," defined by cut off angles projected upwards from street level, are recommended as a means of achieving sun access for parks, plazas, squares and sidewalks. These solar zoning techniques and the guidelines they produce are detailed on pages 49-89 of this report.

Thirdly, shadow diagrams contained in Environmental Impact Reports analyzing the impacts of proposed new buildings are in many cases inaccurate and misleading. Decisions are therefore often made on information that is faulty. At the time highrise buildings are reviewed, little attention is given to the accuracy of shadow diagrams. After the building is completed, however, the public is surprised to discover the loss of yet another sunny place.

The use of a city street or park is directly related to the amount of sun and light it receives and the degree of thermal comfort people experience in a particular outdoor environment. The economic and social viability of an area can therefore be threatened when sun and light are prevented from reaching street level during critical use hours of the day. This report recognizes the development imperatives at work in downtown San Francisco. However, the report argues that the application of sun access criteria is particularly important when evaluating and regulating proposed development in the immediate vicinity of significant public open space to safeguard the continued use and function of that space. Methodological techniques provided in this report make possible the rapid and accurate assessment of impacts generated by highrise development. Sun access criteria developed in the report can therefore be used to balance community need against development potential while not overly constraining development options. The report adopts an "area specific" approach to urban design in defining sun access criteria as an important tool in assessing the full impact of urban growth and in guiding the future development of the city.

Introduction

It is not uncommon for residents, visitors, and office workers in San Francisco to remark on the city's cold, windy and foggy climate. During six months of the year, from March to September, cool daytime temperatures of between 45° and 69°F are recorded 53 percent of the time. In the summer, fog rolls over the hills of the city, rarely burning off before 12 noon and often returning around 4 PM. During summer months winds in the city can create uncomfortable conditions for pedestrians. Windspeeds of 25 miles per hour, common in July, force people to lean into the wind while walking.

San Franciscans depend on sunshine to add warmth to their city. The San Francisco Urban Design Plan of 1972 reflects this concern.

> Buildings to the south, east and west of parks and plazas should be limited in height or effectively oriented so as not to prevent the penetration of sunlight to such parks and plazas.

Model of San Francisco housed in the Environmental Simulation Laboratory at UC Berkeley

Summary

This report recognizes the variety of urban character and scale extant in downtown San Francisco as an important frame of reference for the way in which the city is seen and experienced both culturally and historically. The report provides a state-of-the-art analysis of sun access criteria for downtown streets and public open space and develops recommendations designed to protect and maintain the city's unique character.

BACKGROUND

The San Francisco Department of City Planning is currently preparing a new downtown zoning ordinance and a new downtown open space plan that represents a major departure from the incentive zoning policies of the past. Under consideration are policies that identify thermal comfort in outdoor space, an issue of critical concern in the development of new outdoor space and in the protection of existing open space.

Over the past year the Environmental Simulation Laboratory at UC Berkeley has assisted the Department of City Planning in this work. Studies at the laboratory have focused on two major design issues that directly impact the downtown area: street scale and sun access criteria. A study will be conducted this summer that will address a third related design issue, the mitigation of high street level winds caused by highrise development. New urban design guidelines outlined in this report, based on ensuring thermal comfort in outdoor space, have been developed and tested by the Laboratory. This report provides an account of that research effort.

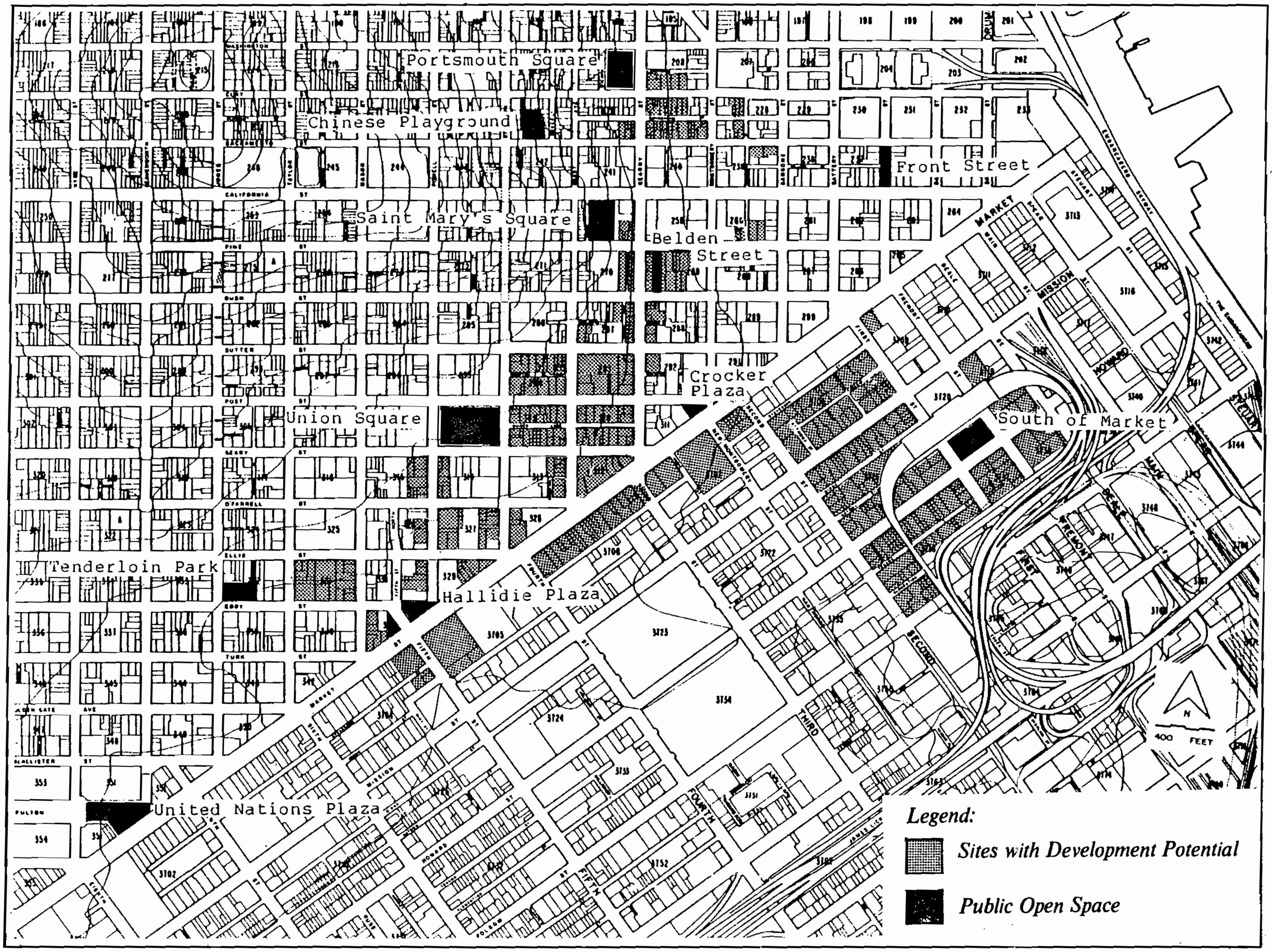
Downtown areas encompassed by the study included critical sites with a strong development potential for highrise office development adjacent to important public open space. These sites were mapped in all downtown districts C3O, C3S, C3R, and C3G (Map 1). The study also mapped two proposed sites for new open space in the South of Market and the Tenderloin. The study differentiates between public sidewalks and parks and plazas used at lunchtime, and neighborhood open space at the edge of the Financial District (Map 2). Special emphasis is given to the Retail District between Market Street and Sutter Street, Powell Street and Kearny Street. In this area sidewalks and all public open space have been included for sun access consideration (Map 3).

Based on these studies urban design guidelines governing future urban growth have been developed. A discussion of urban scale together with an analysis of urban environmental factors and the methodology used in these studies along with a dicussion of the results they generated, form the body of this report. The major recommendations of the study are summarized below:

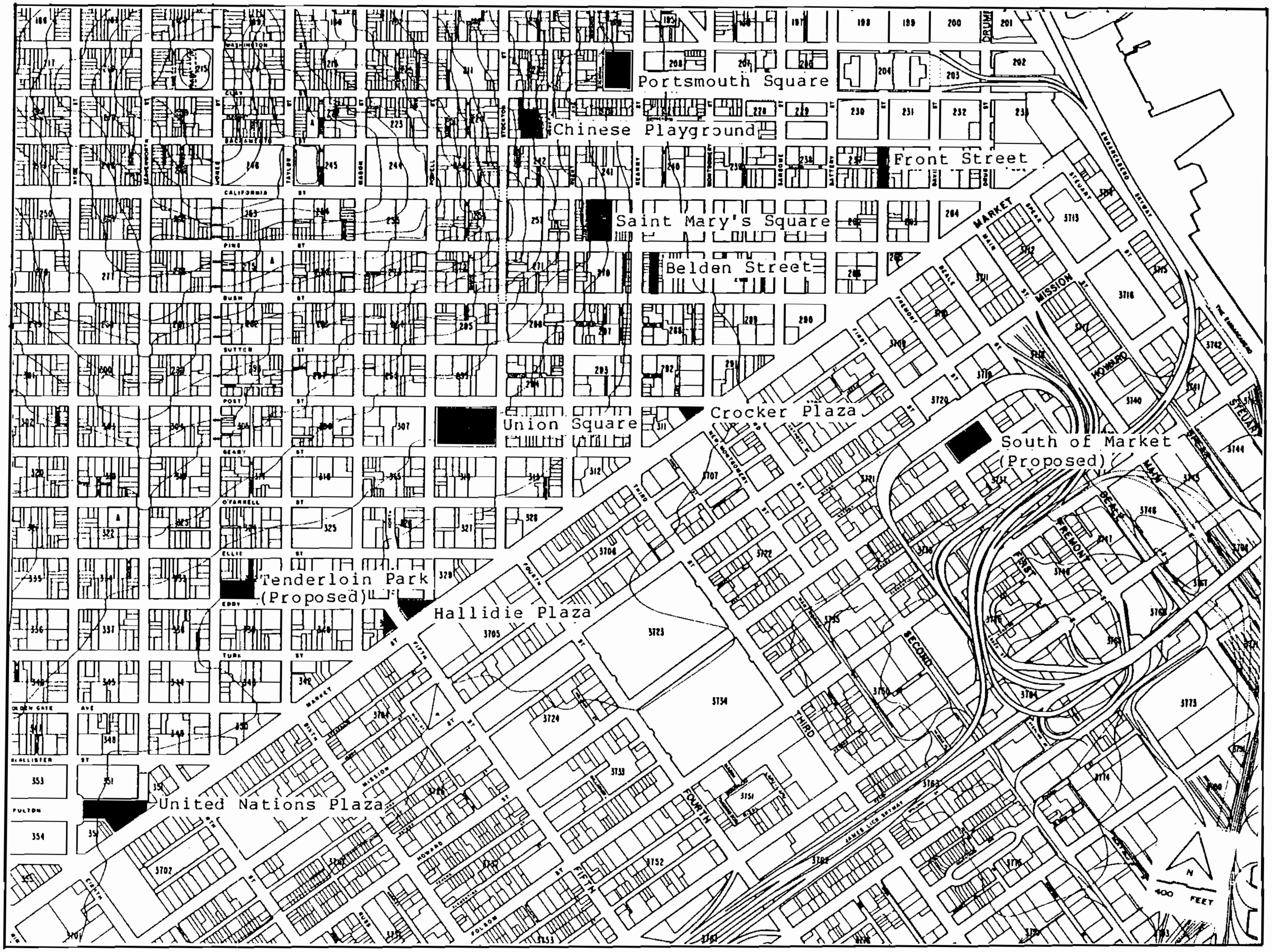
RECOMMENDATIONS FOR THE RETAIL DISTRICT

Streets in the Retail District, like Grant Avenue, Sutter Street, and Post Street, are remarkable for their scale and cohesiveness. Existing building heights along these retail streets allow for sun access for at least six months of the year. This characteristic enhances the quality of the district and makes strolling along its sidewalks a comfortable and pleasant experience. For the Retail District this report makes the following policy recommendations.

1. Preserve the scale and character of existing retail streets and require that future development respect existing predominant street wall heights and setbacks. Development above the street wall should sufficiently separate the street wall from the tower portion of a building.



Map 1 - Sites with high development potential in proximity to downtown open space. The map shows existing structures utilizing between 25% and 60% of their development potential.
Source: Department of City Planning, January 1982.



Map 2 - Downtown public open space considered for sun access criteria.

Map 3 - Downtown sidewalks considered for sun access criteria.

2. EAST-WEST STREETS

New development along east-west streets in the Retail District should conform to sun access guidelines that leave the sidewalk on the northside of the street in the sun at lunchtime, between the hours of 11:00 AM and 2:00 PM, for at least six months of the year. On the south side of the street the street wall height of new development should be determined by a 50° profile angle measured from the curb line of the opposite sidewalk. The street wall height of new development on the north side of the street should be built at the property line to a height not greater than one and a half times the width of the street and not less than a height equivalent to the width of the street.

3. NORTH-SOUTH STREETS

New development along north-south streets in the Retail District should be guided by sun access guidelines that provide sun to alternate sidewalks at lunchtime, between the hours of 11:00 AM and 1:00 PM, for 12 months of the year. On the west side of the street the street the street wall height of new development should be determined by a 50° profile angle measured from the curb line of the opposite sidewalk. The street wall height of new development on the east side of the street should be built at the property line to a height not greater than one and a half times the width of the street and not less than a height equivalent to the width of the street.

RECOMMENDATION FOR DOWNTOWN PARKS, PLAZAS, AND SQUARES

A major goal of the new downtown plan is "that new development not so congest existing downtown open space and recreation space that there will be inadequate places for quite relaxation in the open air and sunshine or for more active recreational pursuits." This study recommends that urban design policies for public open space be based on the degree of thermal comfort people experience in open space. Street scale, sun access criteria and wind mitigation are important factors in the level of comfort experienced. The main policy to protect open space has already been adopted by the City Planning Commission.

> Buildings to the south, east and west of parks and plazas should be limited in height or effectively oriented so as not to prevent the penetration of sunlight to such parks and plazas.
>
> Urban Design Plan 1972

To ensure the implementation of this policy this study recommends that specific sun access criteria for downtown open space, outlined on pages 65-89 of this report, be made mandatory.

Environmental Factors

The following section details those factors that influence the way in which the urban environment is both seen and experienced at street level. These factors include thermal comfort, sun access criteria, wind mitigation, and street scale.

THERMAL COMFORT

Thermal comfort in environmental terms can be defined fairly explicitly. It depends on two basic factors: temperature and humidity. The shaded area in Fig. 1 indicates the comfort zone for people at rest wearing casual clothing. The black dot outside the comfort zone indicates the average day time temperature and humidity in San Francisco from March to September. A third variable that influences thermal comfort is the availability of direct sunlight. On a cool day in San Francisco people feel comfortable when sun radiation is high. The comfort zone can then be placed at a lower temperature (Fig. 2). A fourth variable is wind. On a cool day a wind speed of 7 miles per hour will make people feel uncomfortable unless direct sunlight is present. Only direct sunlight at street level can lower the comfort zone and bring city parks and open space in the downtown area within comfortable limits.

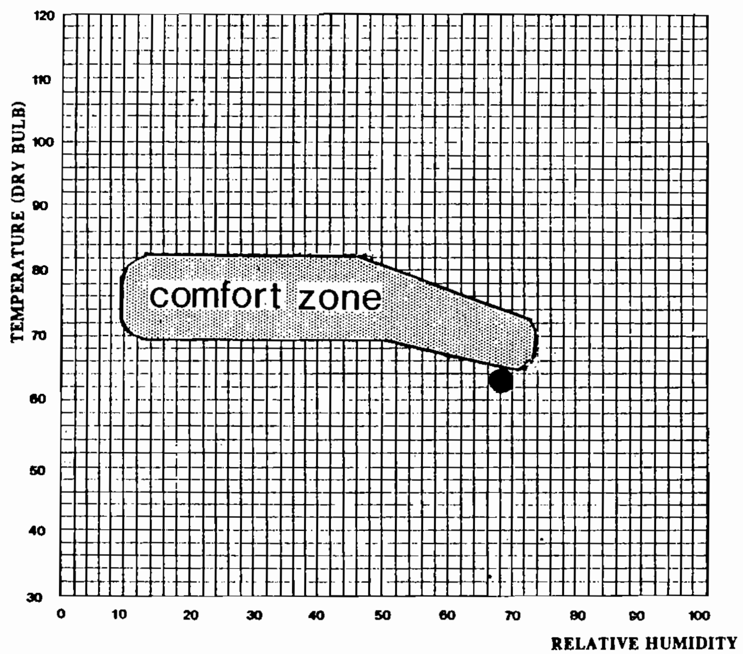


Fig. 1 - Comfort zone diagram.

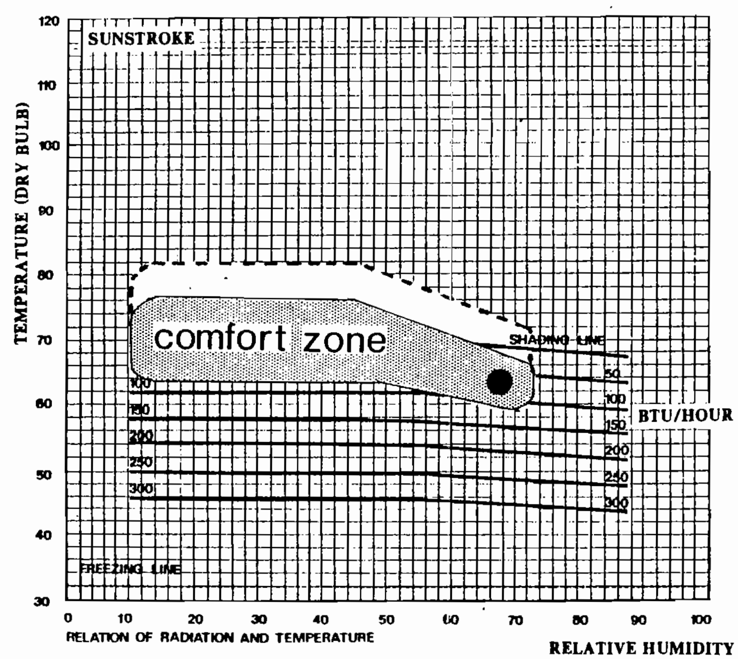


Fig. 2 - Comfort zone influenced by solar radiation.

Source: Victor Olgyay, Design with Climate

Recorded as a percentage of the total amount available throughout the summer the sun shines on San Francisco only 63% of the time. This fact, together with the above illustrations, help explain why sun access criteria is important in San Francisco's cool climate and why direct sunlight can help provide open space that is useful and pleasant. The importance of preventing public sidewalks, parks, squares, and plazas from being overshadowed by new highrise buildings should therefore be a major urban design goal in the development of the downtown plan.

SUN ACCESS CRITERIA

Sun access criteria developed in this report are designed to allow the sun to reach actively used city streets and public parks during critical use times. We have made on-site observations in a number of city parks and plazas that require sun access througnout the day to ensure their active use by neighborhood residents, office workers, and visitors to the city. Most often, the critical time identified for a particular street, park, or plaza is associated with the lunchtime activities that occur in that place from about 11:00 AM to 2:00 PM.

Sun access criteria, and the sun profile planes they generate, synthesize the daily and seasonal movement of the sun. The sun profile planes modify and shape the development envelopes generated under traditional height zoning regulations. Building envelopes defined by sun access criteria establish the largest possible development volume for a given location that will not cast a shadow on adjacent open space or public sidewalks during critical hours of public use.

Design elements that must be taken into account when developing sun access criteria for a particular street, park, or plaza consist of the street wall height, the maximum building height, a cut off angle and sun profile plane that this angle generates. (See page 51 for definitions of these terms.) Applied in a manner similar to that of existing zoning controls, sun access criteria adjusts and shapes development volumes, but need not constrain the development of a site below its economic potential.

Sun access criteria defined in this report attempt to reconcile new urban design guidelines with existing urban conditions in downtown San Francisco. The existing street scale of the city and its urban character are respected and preserved by site specific criteria which directly relate the size, shape, and orientation, of a particular location or street to its urban context. The resulting sun profile planes and solar fans generated by sun access criteria, give rise to development envelopes and overall building forms that will help sustain a cohesive urban streetscape.

WIND MITIGATION

Given San Francisco's cool climate the prevalence of strong winds on city streets can seriously diminish the use public open space. High wind levels can create unpleasant and at times extremely uncomfortable conditions in downtown San Francisco (see Table 1). The strongest winds at street level often occur at the base of very tall buildings induced by the downward deflection of upper air movement caused by the height and mass of a building. This condition is particularly noticeable when the traditional street scale and street wall height of city streets has been ignored in the design of a building. The sheer west facing wall of the Bank of America tower along Kearny Street attests to this condition. Wind gusts about this building at street level, even on relatively calm days, can be alarming.

Wind speed in public open space is also increased when channeled through partially enclosed space or narrow gaps between buildings. Public plazas and parks designed without sufficient landscape screening can also generate winds beyond acceptable levels of comfort and, where high rise development predominates, wind impacts can be severe. The task of maintaining the urban character of San Francisco and guiding its development therefore requires that comprehensive wind studies be conducted in the initial design phase of proposed high rise development.

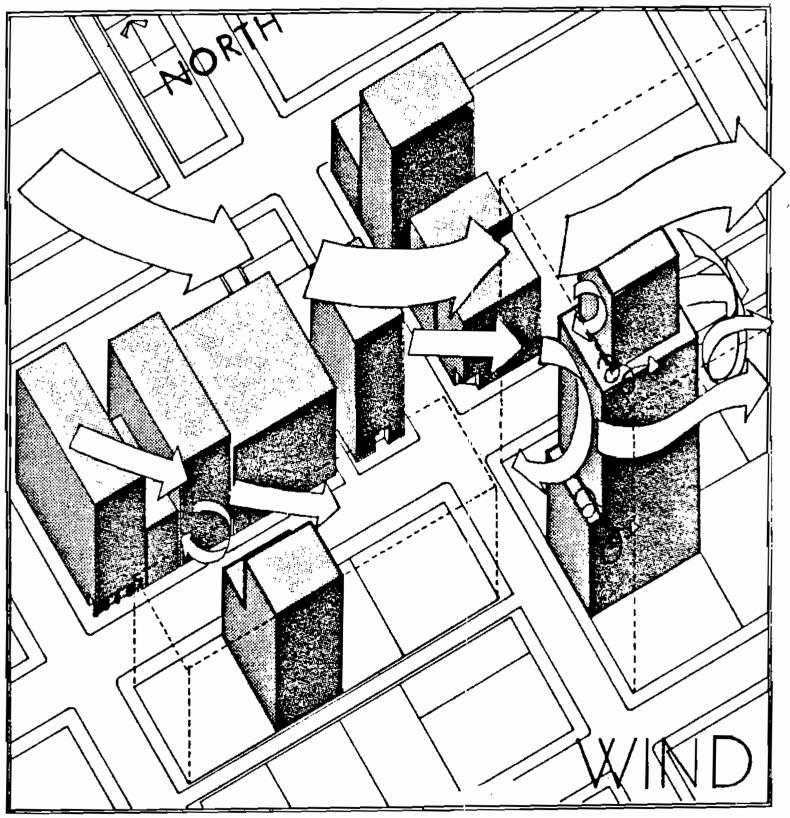


Fig. 3 - Building setbacks can be used to divert strong down winds and safeguard the street level environment.

Such studies will be possible in the newly designed wind tunnel in the College of Environmental Design, UC Berkeley. In this facility the complex flow of air movement about a structure can be

TABLE 1--Wind Effects

Standard equivalent mean wind speed, in miles per hour.

Wind speed (1)	Effects observed or deduced (2)
0	Calm, no noticeable wind
	Wind felt on face
4.4	Clothing flaps [5]
8.8	Newspaper reading becomes difficult (1)
13.2	Hair disarranged [5], dust and paper raised, rain and sleet driven (1)
17.6	Control of walking begins to be impaired
	Violent flapping of clothes [5], progress into wind slightly slowed
22.0	Umbrella used with difficulty
26.4	Blown sideways [2], inconvenience felt walking into wind, hair blown straight
	Difficult to walk steadily, appreciably slowed into wind [10]
	Noise on ears unpleasant
30.8	Generally impedes progress
	Almost halted into wind, uncontrolled tottering downwind [10]
35.2	Difficulty with balance in gusts [2]
	Unbalanced, grabbing at supports [2]
41.8	People blown over in gusts [3]
48.4	Cannot stand [3]

Source: Edward Arens, Designing for an Acceptable Wind Environment.

analyzed using scale models of proposed development projects set in their specific urban context. Information gained from studying individual projects can be used in initial massing studies to help minimize possible wind generation and also assist in the development of urban design criteria for specific areas of the city. Alternate stepping and tiering configurations for individual development projects can be examined and guidelines established can be developed for critical areas of the city subject to high wind conditions.

Although future wind mitigation studies are essential in order to develop more refined criteria, the maintenance of street wall heights compatible with those already found in the downtown area is crucial in preventing the generation of high wind levels and in preserving the city's urban character and street scale.

STREET SCALE

The design concept presented in this report calls for a visual and perceptual separation of the street wall plane from the tower wall plane. The former relates to the public human scale of the city street, the latter to the larger civic scale of the city's design, and a proper and clear distinction between the two is recommended if San Francisco is to retain its unique urban character.

The existing street scale of downtown San Francisco, with the noted exception of certain areas in the Business District, is determined in large measure by the compatibility of adjoining building facades that align both sides of a city

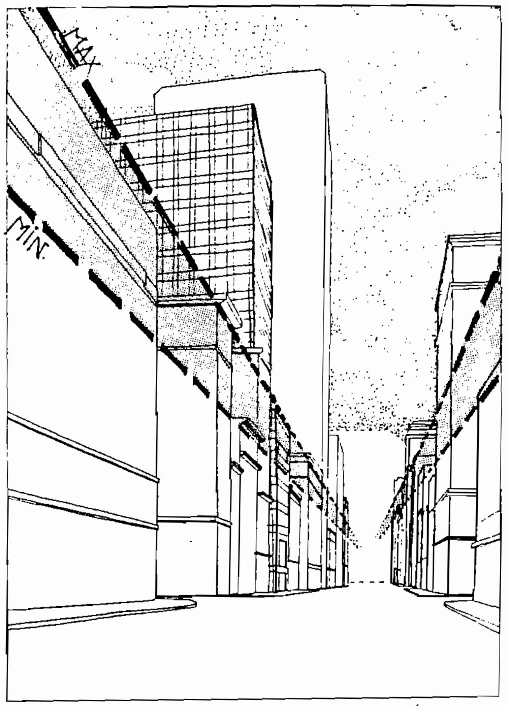


Fig. 4 - Street wall height range, 1:1 to 1:15. Recent buildings and some proposed structures do not respect the predominant street wall height.

street. This compatibility is keyed to the pedestrian use of the street, the architectural character of its building, and perhaps most importantly to a more or less uniform street wall height.

The street wall height is established in most cases by the cornice (or belt) line of adjoining buildings set at a height proportional to the width of the street. More often than not the ratio of street wall height to street width ranges between 1:1 and 1:1.5 and rarely exceeds 1:2. (Fig. 4).

In order not to disturb street scale taller buildings may occur above the street wall height but only when set back from the street frontage line. The street wall height acts as an organizing principle framing individual development along the street, allowing the street to be "read" as an entity.

Urban Design Guidelines

This section of the report defines urban design guidelines for downtown streets, sidewalks, and public open space.

SUN ACCESS GUIDELINES FOR STREETS

Streets in downtown San Francisco are laid out according to two basic patterns known respectively as the Jeffersonian and Spanish grid. Market Street is the dividing line between these two street grids which relate to two different traditions of urban development. Streets south of Market are oriented northeast-southwest, and southeast-northwest in accordance with Spanish colonial law. North of Market, the Jeffersonian tradition prevails and streets are aligned with the cardinal points of the compass running north-south and east-west. This pattern of street orientation gives rise to four basic street types in San Francisco; two of these types are north of Market and two south of Market. However, when alley ways are taken into account, eight basic street types emerge. Along east-west streets in the Retail District present conditions allow sun access for six months of the year during most of the day (Fig. 5).

In the manual section of this report illustrations of these various street types are provided. These illustrations also define building typologies keyed to specific street types. In its essentials, a building typology is generated by taking two factors into account: sun access criteria, and street type. The basic form giver of a building typology is the sun profile plane (see Fig. 6). Development on a specific site must take place without penetrating this plane, which is established by a "cut off angle." Any development that projects beyond the sun profile plane will prevent the sun from reaching the sidewalk at lunchtime for a given number of months in the year.

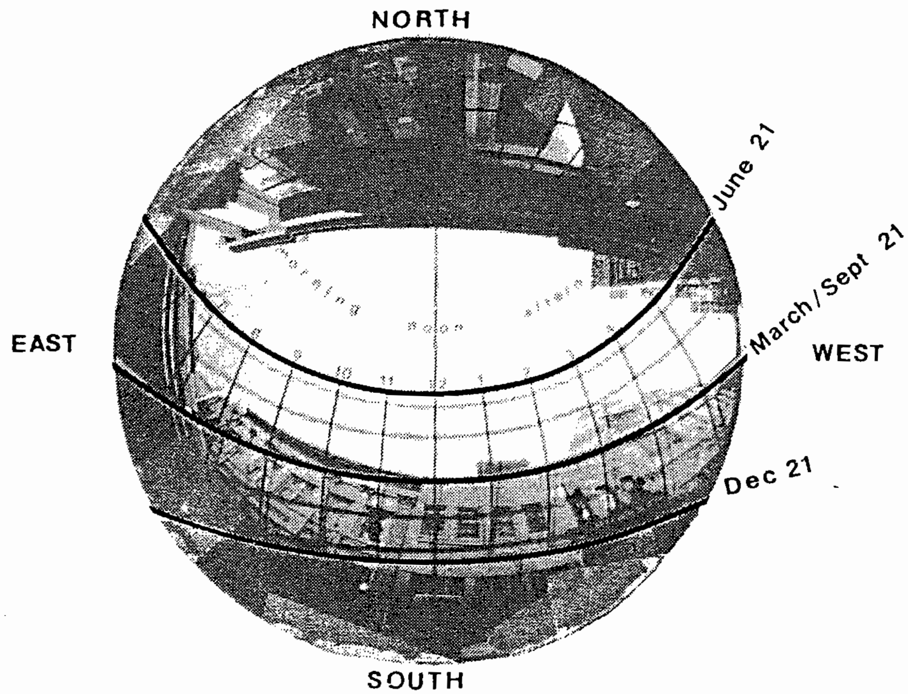
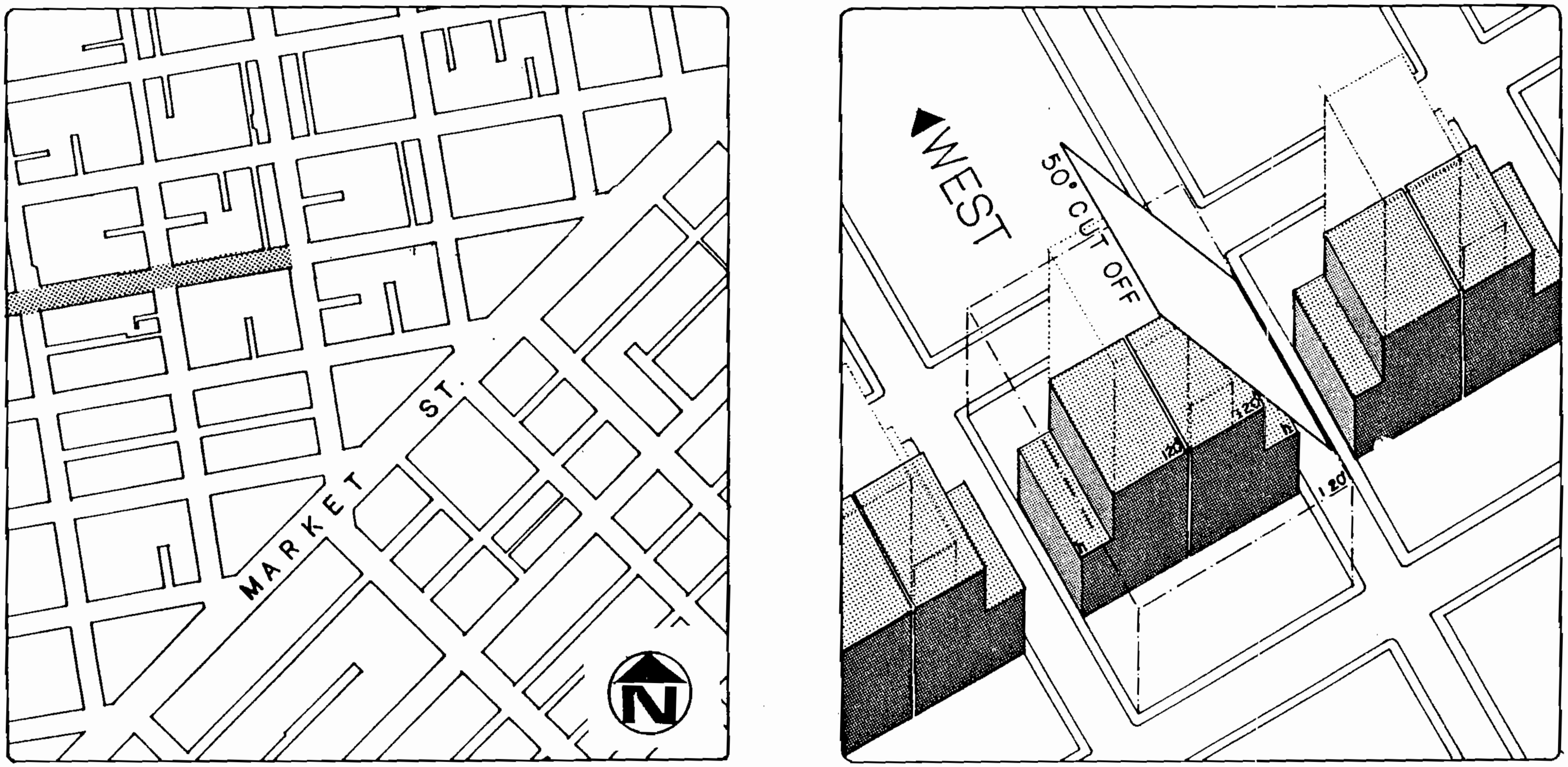


Fig. 5 - Fish-eye taken along Commercial Street. The curved line closest to the circle's center represents the path of the sun for June 21, the next continuous line indicates the path for March and September 21. Existing building height along the south side of the street coincides with the March/September curve indicating the street receives sun for six months of the year from March to September.

NORTH OF MARKET : EAST - WEST RETAIL DISTRICT



ORIENTATION : 81° WEST OF TRUE SOUTH

CRITICAL SIDE OF STREET :
for SUN ACCESS ; NORTH (Sidewalk)
for DEVELOPMENT ; SOUTH

CRITICAL TIME : from 11:00 am, Mar./Sept.

CUT OFF ANGLE : 50°

MAXIMUM STREET WALL HEIGHT IN FEET (h)

Street	
BUSH	65'
SUTTER	66'
POST	66'
GEARY	65'
O'FARRELL	66'
ELLIS	68'

Fig. 6 - Solar access for streets -- sun profile plane for retail east-west streets.

Guidelines in this report consist of a location map showing the basic orientation and configuration of a street type and an isometric sketch of a typical building for this street type. Below each illustration sun access criteria for each street type are specified.

On some streets where the feasibility of sun access at street level is precluded by either existing development, and/or street orientation, a sun profile plane governing potential development has not been recommended.

SUN ACCESS CRITERIA FOR PARKS, PLAZAS, AND SQUARES

To preserve sun access for downtown parks, plazas, squares and lunchtime malls, criteria have been developed for Portsmouth Square, St. Mary's Square, Hallidie Plaza, Belden Street, the Chinese Playground, Crocker Plaza, Front Street Mall, United Nations Plaza, Union Square, two parks in the Tenderloin, and a park proposed for the South of Market area. Maps and tables delineating sun access requirements for these spaces are contained on pages 65-89 of this report. Portsmouth Square has been chosen to illustrate the methodology used in establishing these guidelines.

Portsmouth Square, on the west side of Kearny Street, occupies an historic and strategically important site at the interface of the Business District and Chinatown. The square is intensely used by the Chinese community. Each morning people practice Tai-Chi and martial arts in the square and later in the day the square becomes a gathering place for the entire community. Portsmouth Square is one of the few open spaces found in Chinatown and the amount of sun it receives is one of the reasons why it is actively used. Under existing conditions the square receives generous sun light throughout the day for the entire year. But new highrise buildings, currently proposed on Montgomery Street, will restrict sunlight from reaching the square during the morning. At present areas east and south of the square are zoned for height limits that range from 300' to 500'. In certain places these height limits are in conflict with solar access criteria. As downtown development pressure increases developers may build-out to existing limits with the result that sunlight will be cut off from the square during the morning hours.

Sun access criteria for public open space, based on the concept of the solar window, is designed to allow sun in Portsmouth Square from 8 AM to 4 PM each day for at least six months in the year (Fig. 7). A "solar fan" has been developed with a geometry, shape, orientation, and inclination keyed to:

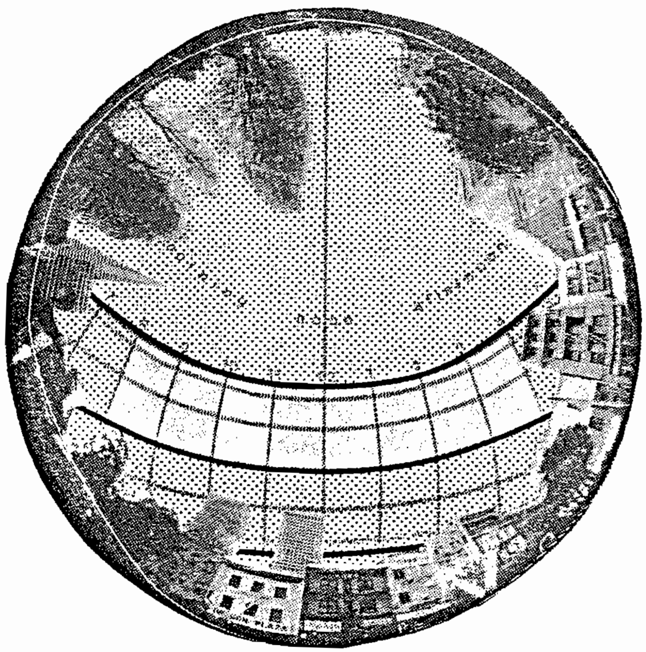
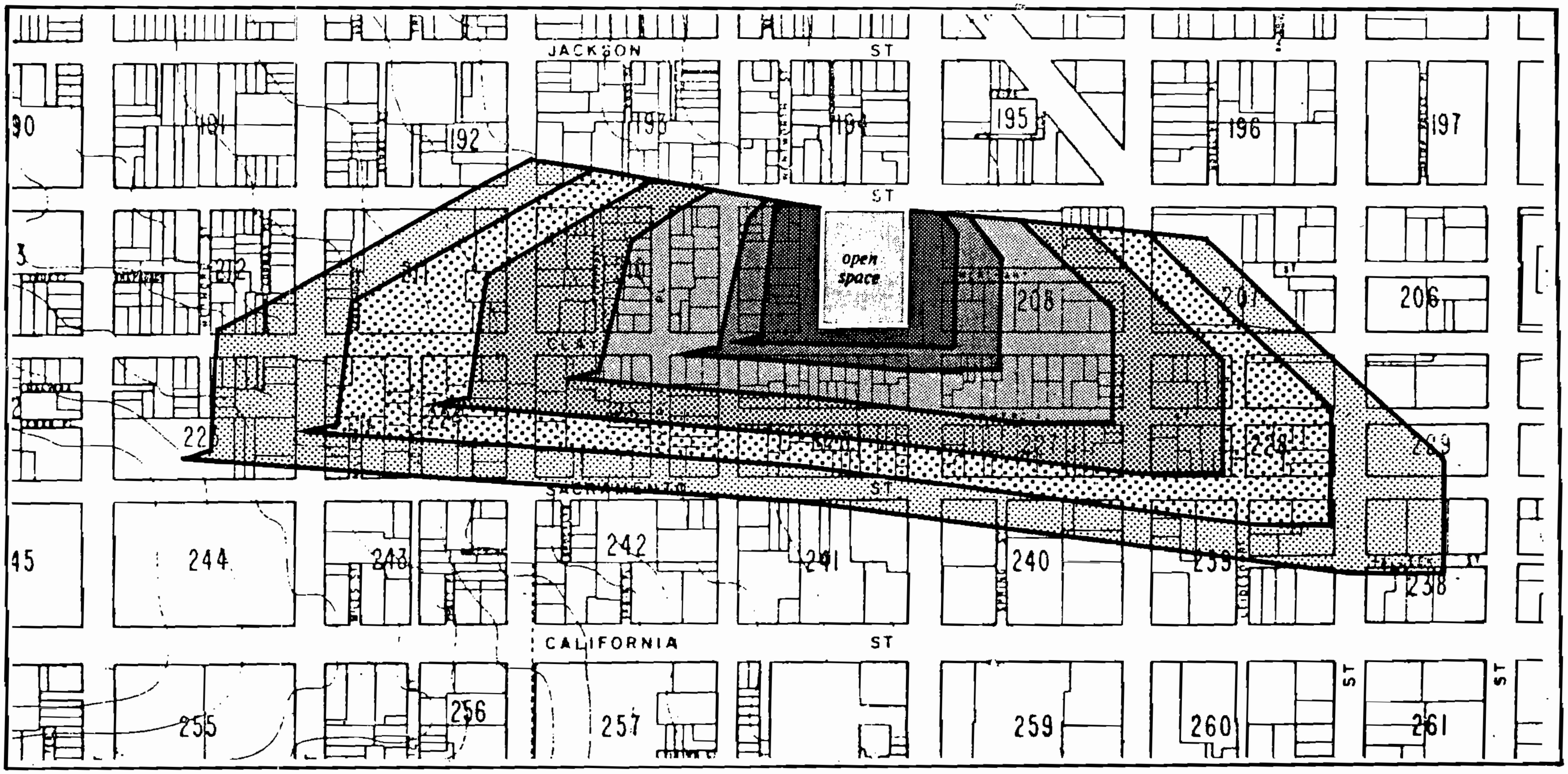


Fig. 7 - Fish-eye photograph taken at Portsmouth Square illustrates the solar window concept. The curved line closest to the circle's center represents the path of the sun for June, the next continuous line the sun's path for March and September 21. The light area between these two lines represents a solar window allowing sunlight to reach the square for 6 months of the year between 8:00 AM and 4:00 PM.

- the daily and seasonal path of the sun
- topographic features surrounding the square
- existing buildings around the square
- the shape and size of the square
- the orientation of the square with respect to true south.

The resulting three dimensional "solar fan" slopes upward and outward from the square. Drawn on a map and sectioned into height zones determined by the sun's altitude angle, the solar fan shown on page 32 illustrates the applicability of solar zoning for height and bulk control in the vicinity of the square (Fig. 8). However, to accurately represent existing conditions in Portsmouth Square, two other factors must be taken into account: existing buildings that obstruct sun access and existing height zoning. Existing buildings, and those under construction, that will prevent sun from reaching the square are shown in Fig. 9. Taking these constraints into account, the resulting "solar fan" is shown in Figure 10. Combining the information contained in Figure 10 with existing height limits, areas of conflict can be identified and recommendations that lower existing height limits to accommodate solar access requirements can be made. This information is recorded in Figure 11 which shows recommended changes in height for building in the vicinity of the square.

PORTSMOUTH SQUARE SOLAR FAN



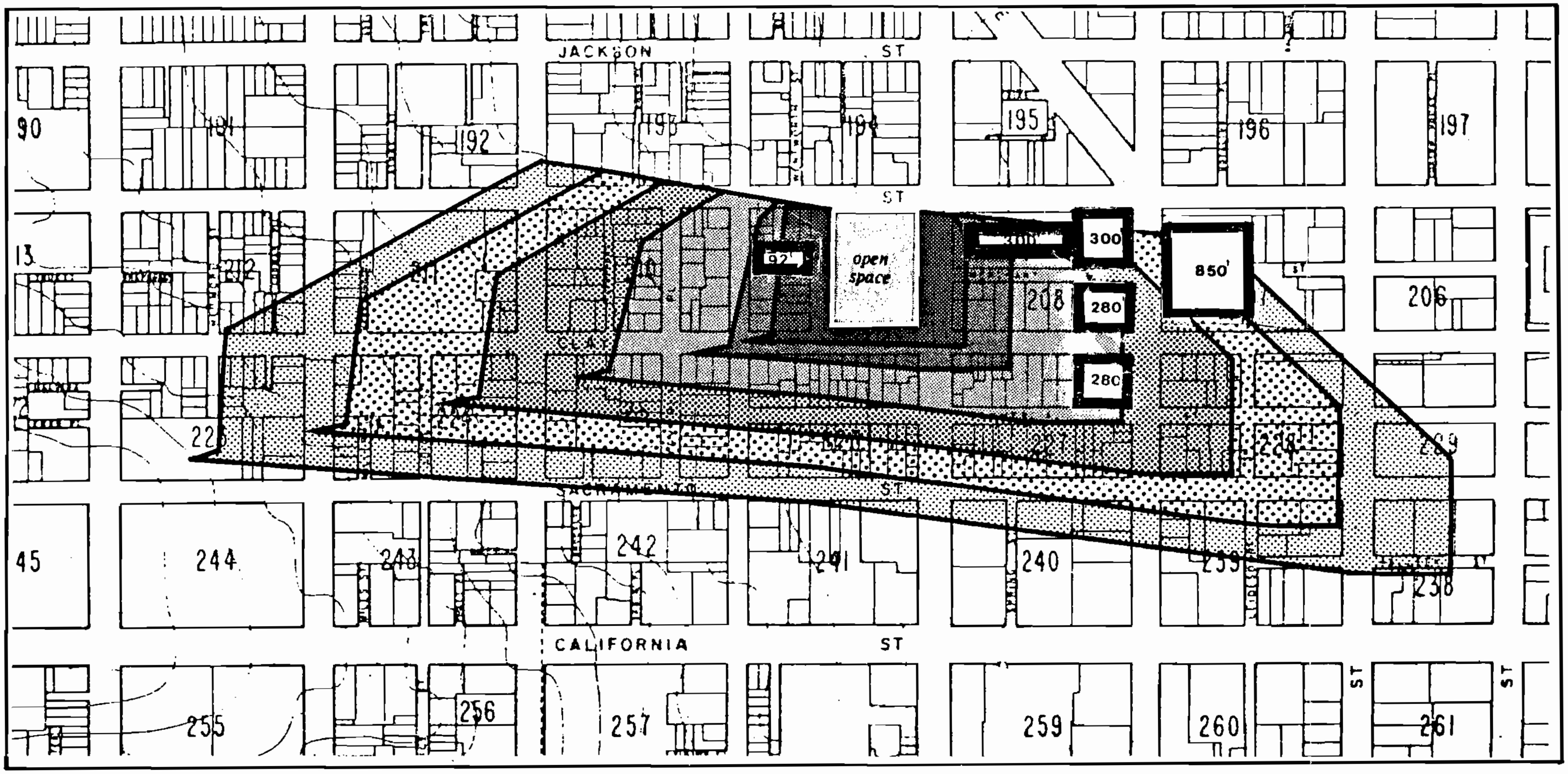
CRITICAL TIME: 8:00 a.m. to 4:00 p.m. (Standard Time)
9:00 a.m. to 5:00 p.m. (Daylight Savings)

CRITICAL MONTHS: March 21st. to Sept. 21st.

50 FEET
80 FEET
100 FEET
200 FEET
300 FEET
400 FEET
OPEN SPACE
300 FEET

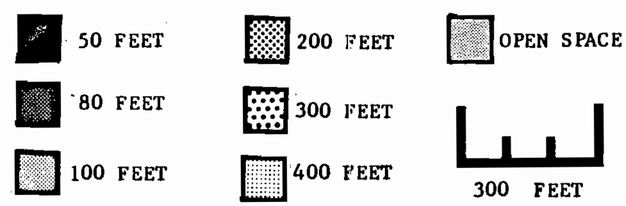
Fig. ⌄ The different tones indicate height zones, which will not obstruct solar access to the square during the critical time of the day for six months of the year.

PORTSMOUTH SQUARE SOLAR FAN



CRITICAL TIME: 8:00 a.m. to 4:00 p.m. (Standard Time)
9:00 a.m. to 5:00 p.m. (Daylight Savings)

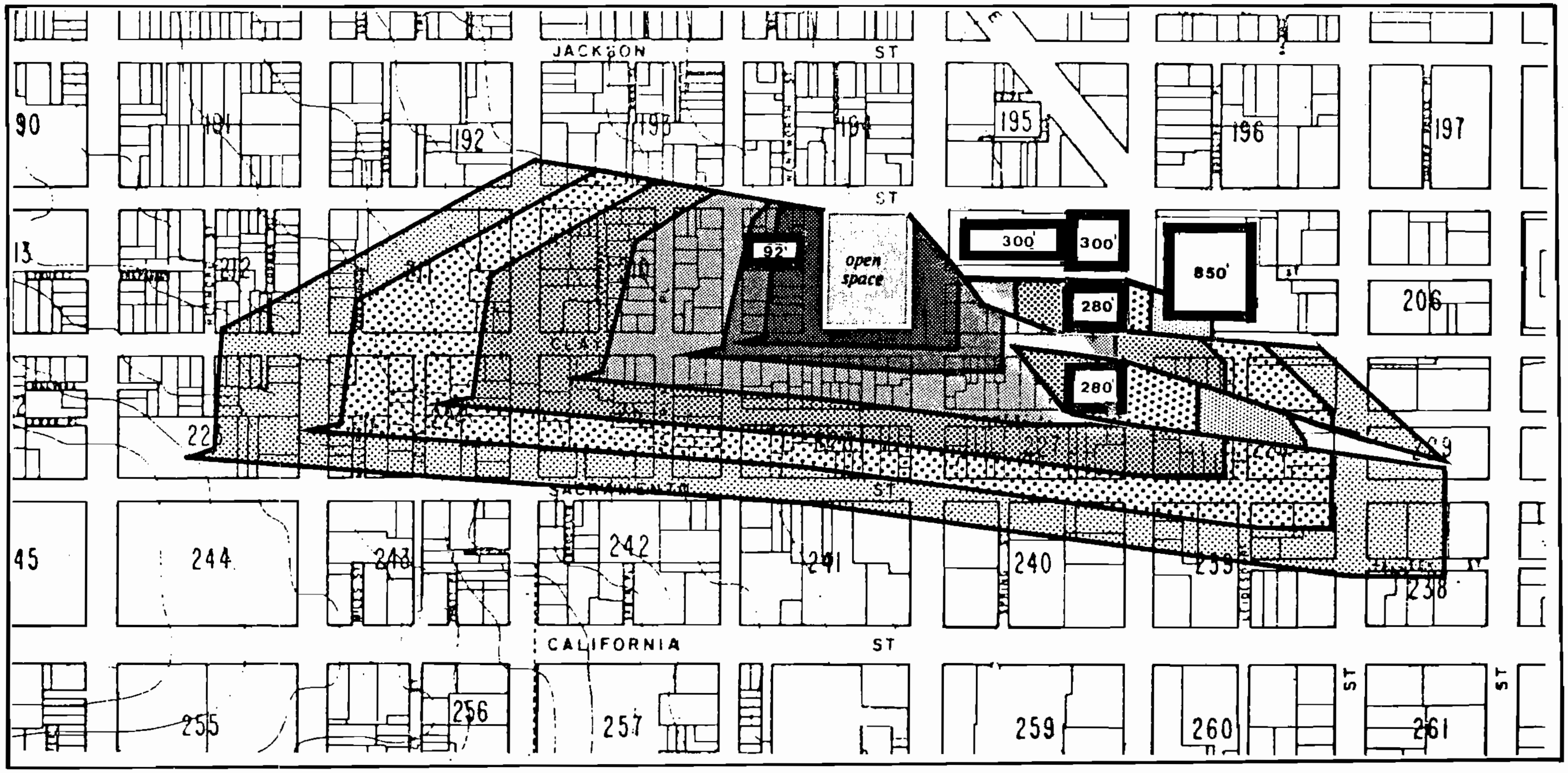
CRITICAL MONTHS: March 21st. to Sept. 21st.



Buildings in conflict with Solar Fan.

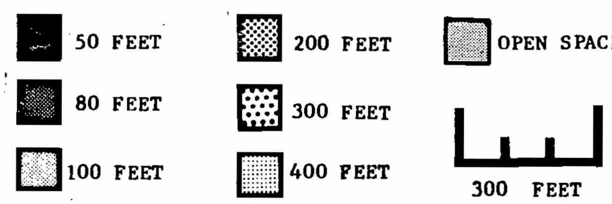
Fig. 9 - Existing buildings that obstruct sunlight from reaching the square. They indicate a conflict between allowable buildings heights and building heights defined by the "Solar Fan."

PORTSMOUTH SQUARE SOLAR FAN



CRITICAL TIME: 8:00 a.m. to 4:00 p.m. (Standard Time)
9:00 a.m. to 5:00 p.m. (Daylight Savings)

CRITICAL MONTHS: March 21st. to Sept. 21st.

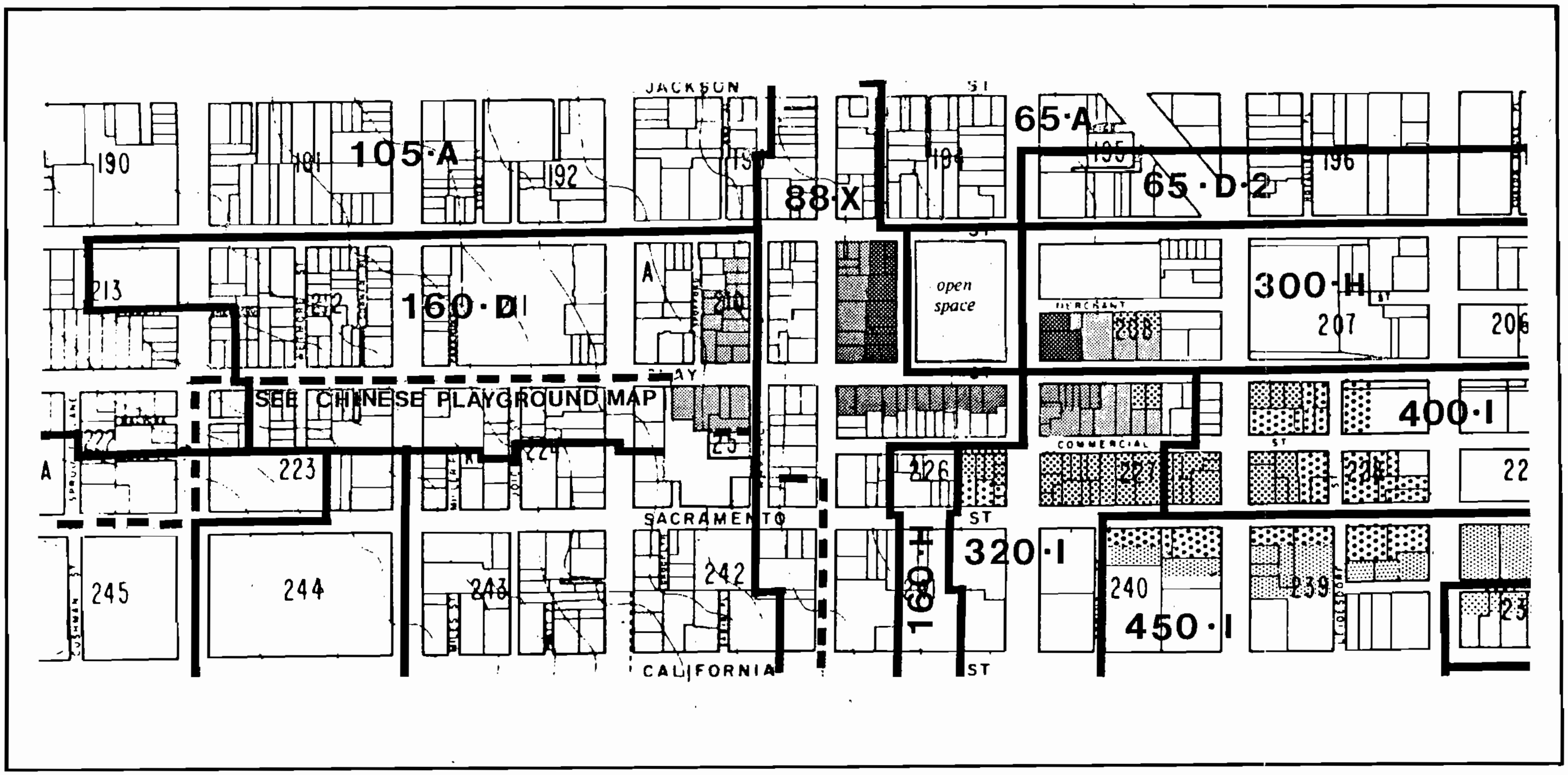


Buildings in conflict with Solar Fan.

Fig. 10 - The final modified solar fan takes into consideration buildings which obstruct solar access.

PORTSMOUTH SQUARE

PROPOSED SUN ACCESS ZONING COMPARED WITH EXISTING HEIGHT LIMITS



CRITICAL TIME: 8:00 a.m. to 4:00 p.m. (Standard Time)
9:00 a.m. to 5:00 p.m. (Daylight Savings)

CRITICAL MONTHS: March 21st. to Sept. 21st.

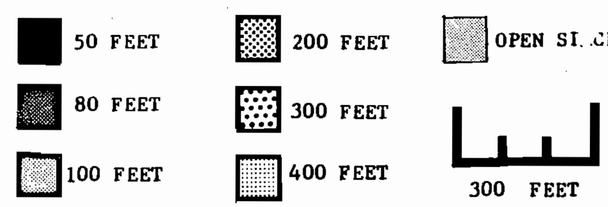


Fig. 11 - The map indicates sites where allowable existing building heights are in conflict with building heights of the solar fan.

STREET WALL HEIGHT

In San Francisco's Retail District existing street wall heights and heights determined by sun access criteria are often compatible within a range of one or two stories. Given this range, when sun access criteria governs street wall height the scale of city streets will not be disrupted. Figures 12 13, and 14 illustrate this compatibility.

Under the most constrained conditions a 50° cut-off angle, measured at the curb line of the opposite sidewalk, will allow a street wall height of 65 to 74 feet on the south side of east-west streets and the west side of north-south streets, depending on the width of the street (Fig. 12). A 70° cut-off angle for the east side of north-south streets would permit a taller street wall height along this side of the street, but street scale considerations call for a street wall height within a range of 1:1 to 1:1.5 of the street width. Street scale considerations also determine a street wall height for new development on the north side of east-west streets and the east side of north-south streets of between one to one and one to one and a half the width of the street(Fig.13).

Wind conditions in San Francisco also call for the maintenance of street wall heights in the Retail District. Prevailing winds in the city are from the northwest and the west, and strong winds between 13 and 24 miles per hour are recorded 48% of the time during summer

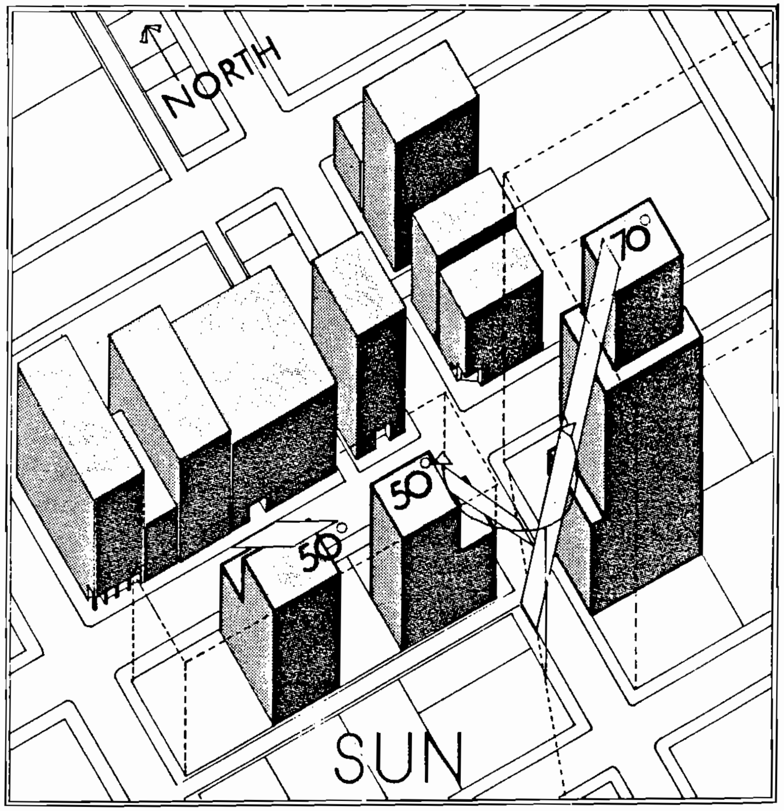


Fig. 12 - Sun profile planes provide sun at street level during lunchtime hours for at least six months of the year along East-West streets and twelve months of the year along North-South streets. On the south side of East-West streets and the west side of North-South streets a cut-off angle of 50° determines street wall heights compatible with street scale considerations.

months. To prevent strong downwinds from reaching sidewalk level the tiering of high-rise development is recommended. Setbacks above the street wall height and at the mid- and upper-tower portions of buildings will disrupt downwinds and

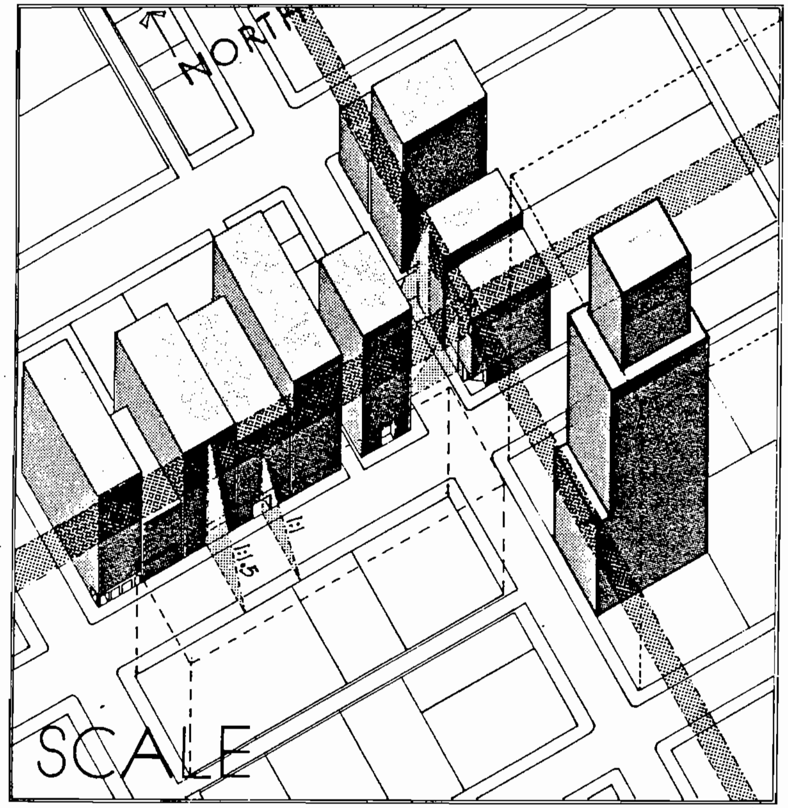


Fig. 13 - Street wall heights for both East-West and North-South streets in the Retail District fall within a range of 1:1 and 1:1.5 of street width. The tower portions of buildings rising above the street wall height to the maximum height limit can be accommodated along these streets provided sufficient setbacks are maintained.

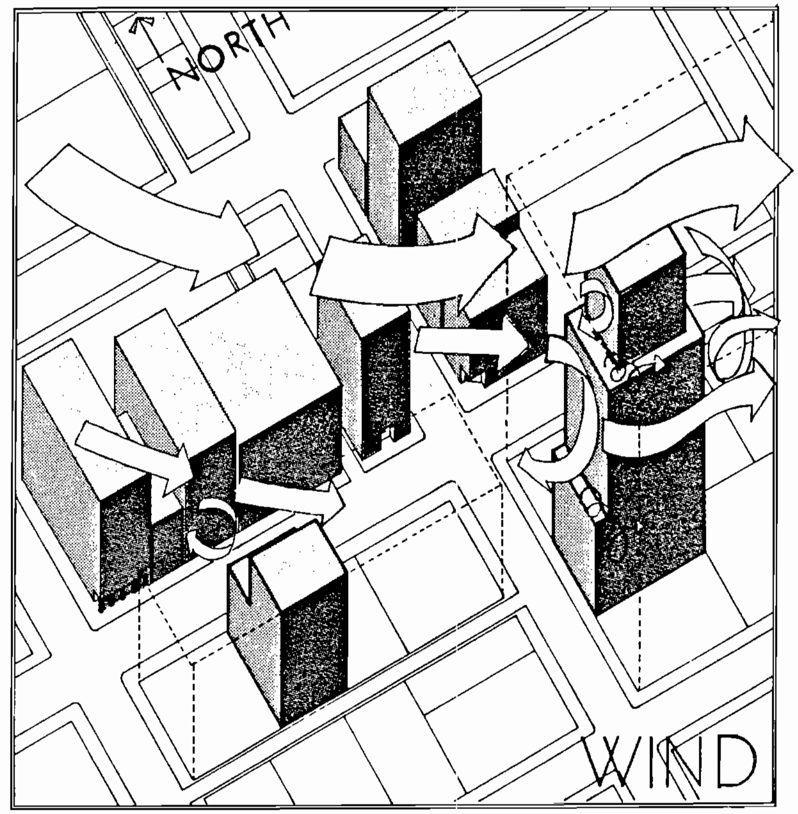


Fig. 14 - Prevalent winds in San Francisco are from the North-West and West. Air flows are deflected downward by highrise buildings and turbulance can be created at street level if tiering configurations and street wall heights are not maintained.

prevent turbulence at street level(Fig.14). Guidelines for street wall heights outlined above illustrate a set of interdependent relationships that exist between sun access, street scale, and wind conditions in downtown San Francisco. Tiering configurations and building setbacks that arise out of these guidelines reinforce and supplement bulk control recommendations previously set forth in Guiding Downtown Development, June 1982.

Street Scale Considerations for North-South Streets in the Retail District.

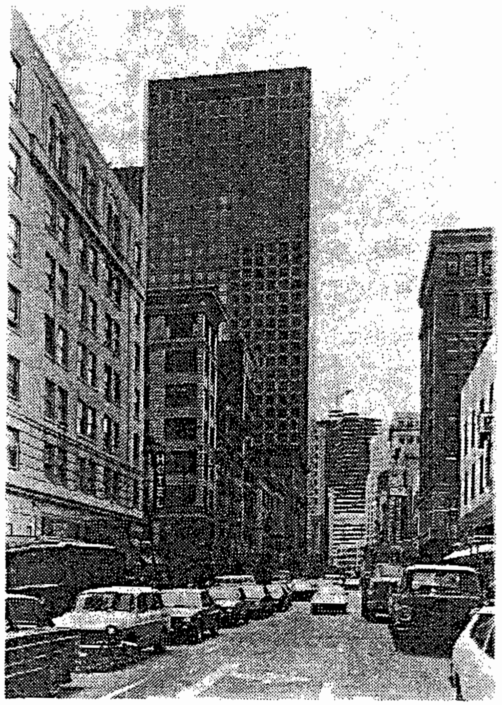
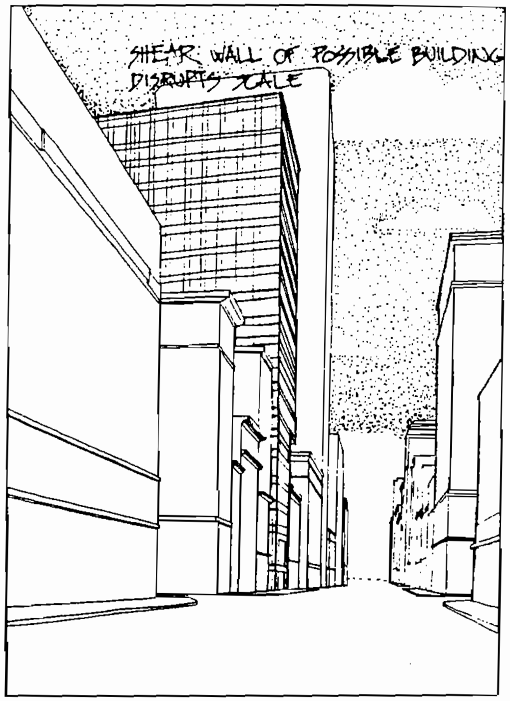
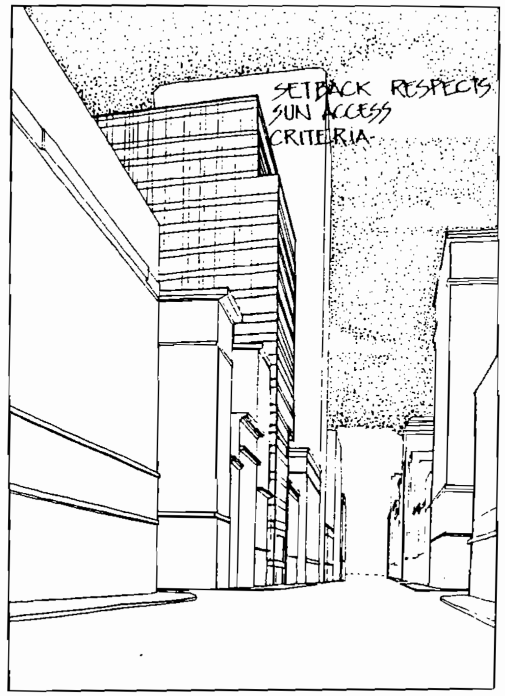


Fig. 15 - Kearny St.; existing conditions

Fig. 16 - Kearny St.; sketch showing existing street scale

On the east side of the street the 70° sun access plane requires a set-back at a building height of *170* feet. Street scale considerations argue for a set-back at a building height of 70 to 80 feet, in keeping with the established street wall height. (For recommended set-back dimensions see page 42.) On the West side of the street, sun access and street scale considerations call for the same street wall height.





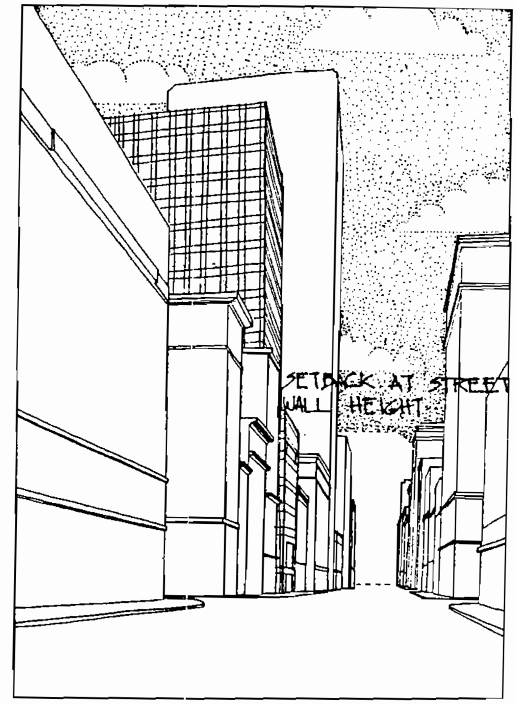


Fig. 17 - Building possible under current regulations

Fig. 18 & 19 - These two different setbacks conform to sun access criteria, however, only the sketch shown in Fig 19 respects street scale.

Street Scale Considerations for East-West Streets in the Retail District.

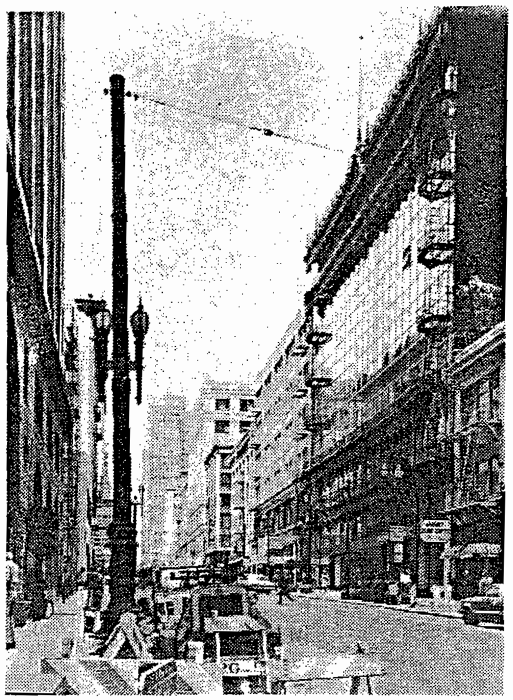
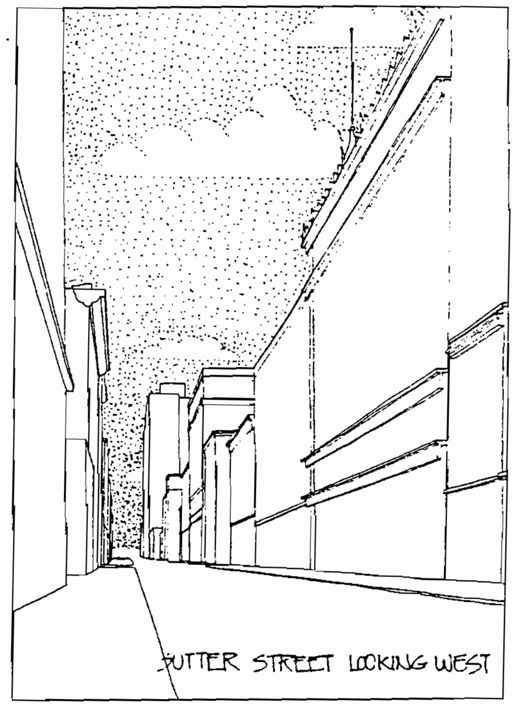


Fig. 20 - Sutter St.; existing conditions



South North

Fig. 21 - Sutter St.; sketch showing existing street scale

The North side of the street is not governed by sun access criteria. Street scale considerations argue for a street wall height of approximately 85 feet in keeping with the existing street wall height.

On the South side of the street sun access and street scale considerations call for the same street wall height within a range of one to two stories.

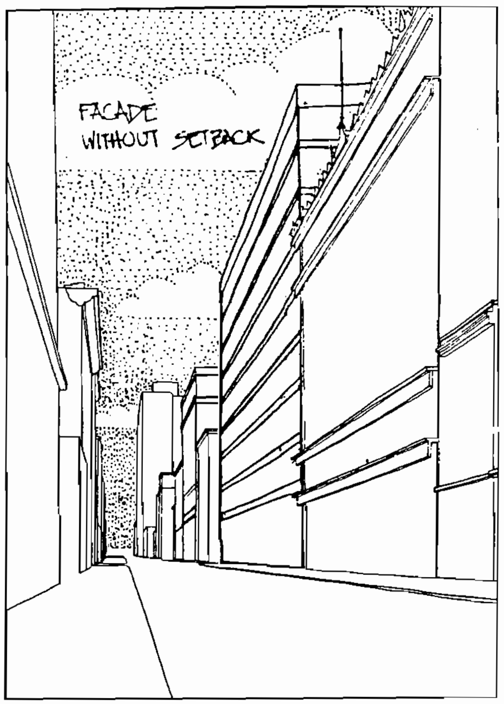


Fig. 22 - Building possible under current regulations

Fig. 23 - Street wall height range

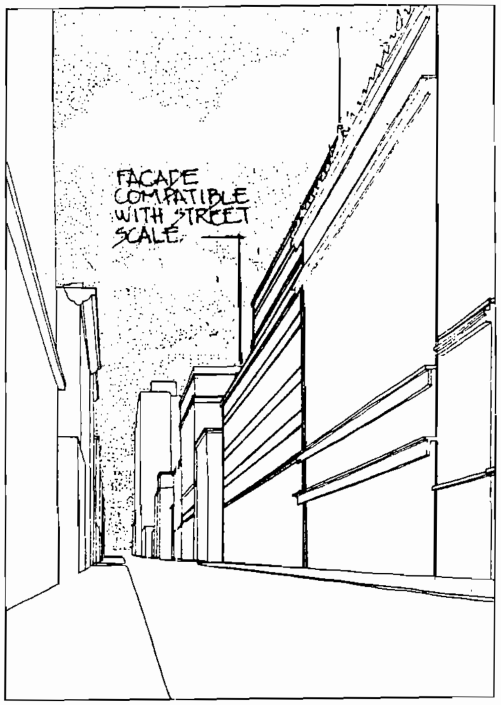


Fig. 24 - Facade that respects scale

The following set of illustrations provide an analysis of different setback dimensions and facade heights related to existing street scale. Factors taken into account include street widths and existing street wall height.

Proposed height limits along this street in the Retail District allow a nine story building to be built at the property line. However on most retail streets a building of this height would disrupt the existing street scale. The illustrations shown below indicate that facade height equivalent to six or seven stories, built at the property line, is compatible with the existing street wall height. The remaining two or three upper stories of the building need to be setback an appropriate distance. By maintaining the street wall height and appropriate set back dimension the upper portion of the building will not be perceived as part of the street wall. In consequence street scale can be preserved.

In each of the illustrations the facade height, tower height, and setback dimension varies reflecting different building configurations:

FIG. 25	street wall height:	7 st.
	upper portion:	2 st.
	setback dimension:	10 ft.
FIG. 26	street wall height:	6 st.
	upper portion:	3 st.
	setback dimension:	10 ft.
FIG. 27	street wall height:	7 st.
	upper portion:	2 st.
	setback dimension:	20 ft.
FIG. 28	street wall height:	6 st.
	upper portion:	3 st.
	setback dimension:	20 ft.

Based on the conditions outlined above, Table 2 shows recommended setback dimensions keyed to street width and street wall height.

TABLE 2

SETBACK DIMENSION (in feet)

Height of Street Facade \ Street Width	64'-67'	68'-71'	72'-75'	76'-80'
5 stories	18	20	22	24
6 stories	14	16	18	20
7 stories	10	12	14	16
8 stories	8	10	12	14
9 stories	6	8	10	12

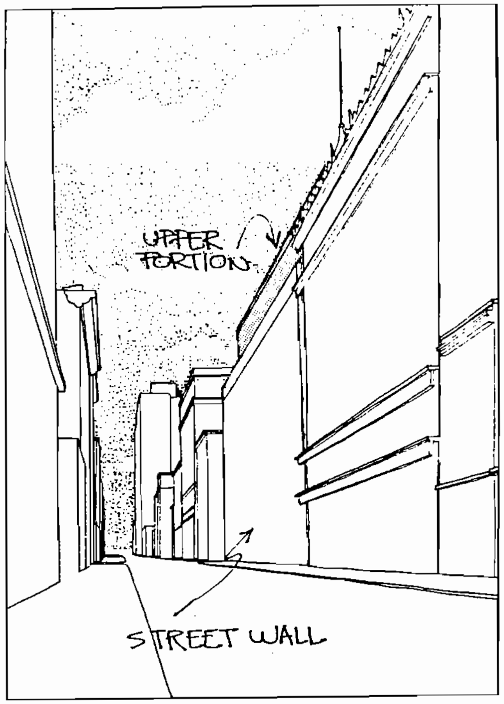


Fig. 25

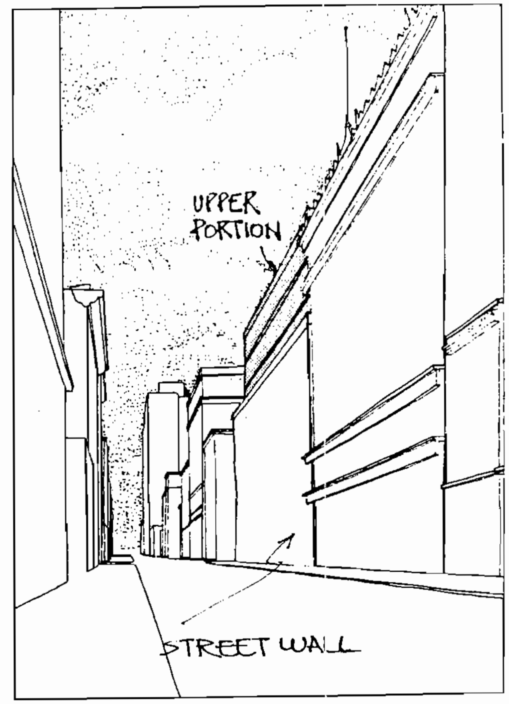


Fig. 26

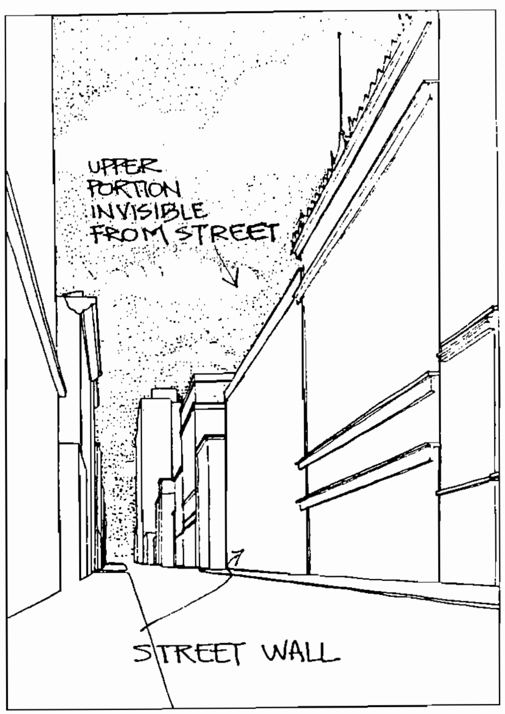
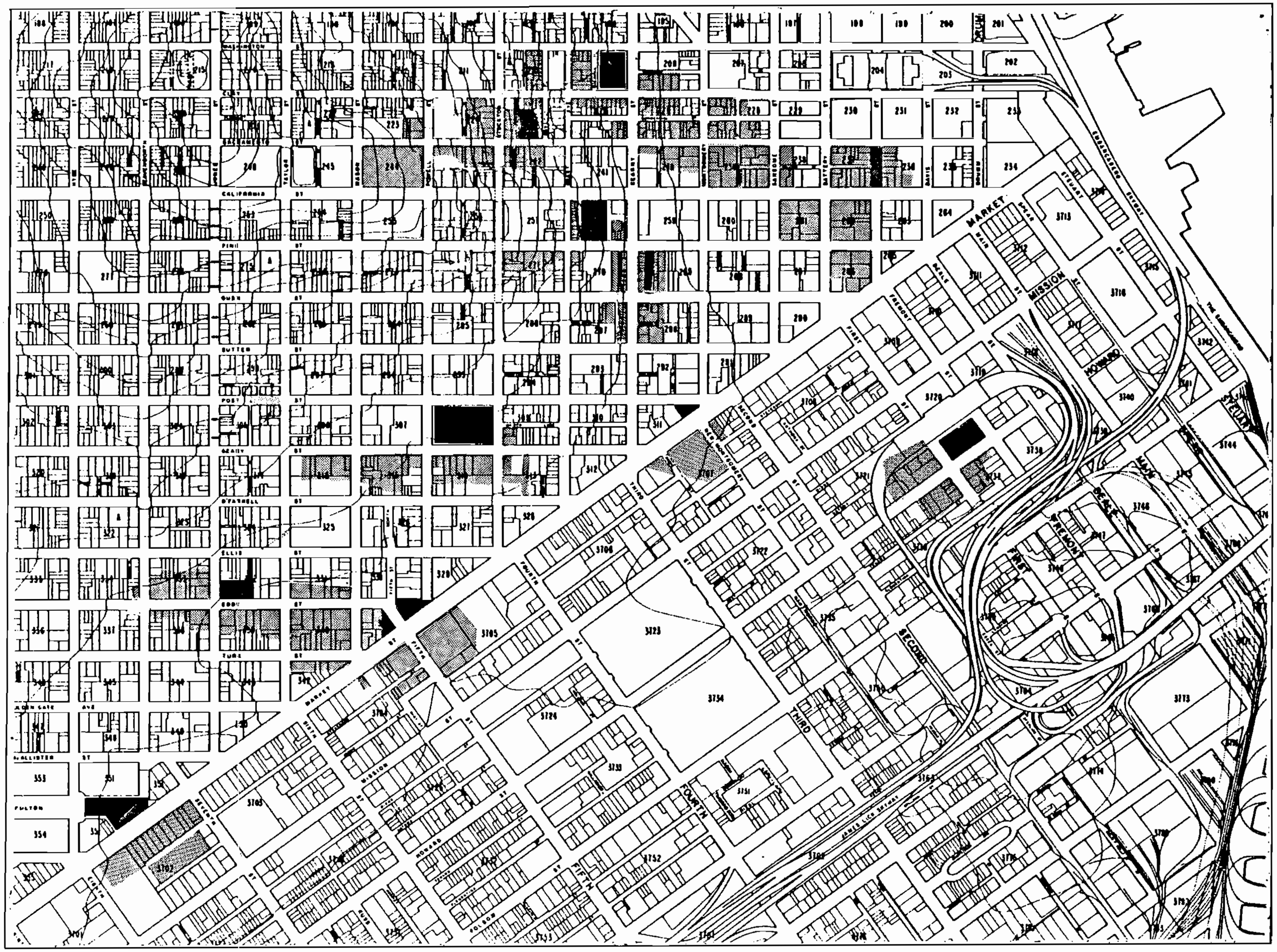


Fig. 27

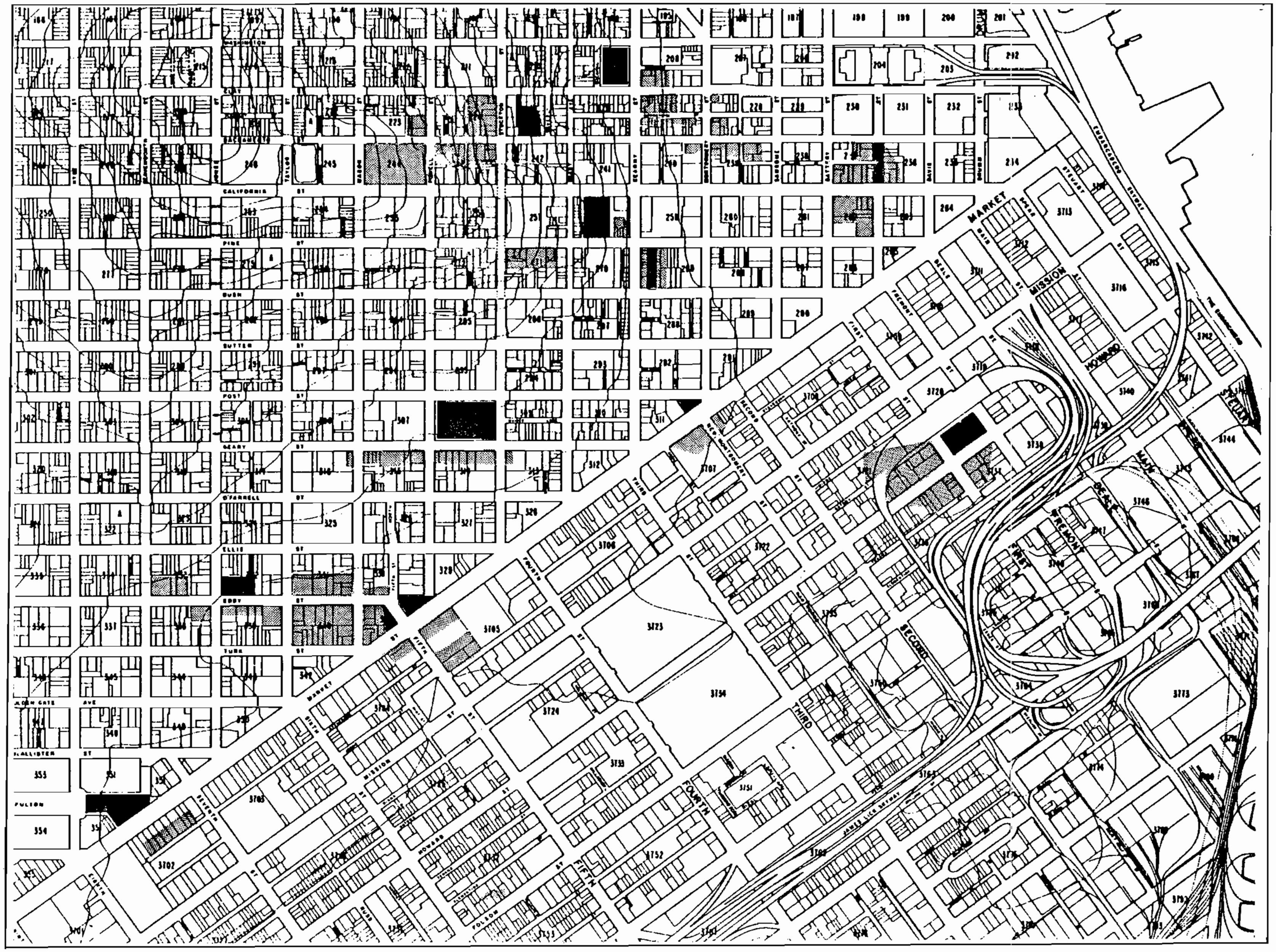
Fig. 28

Fig. 29 - Existing height zones developed in the 1972 urban design plan define a downtown hill.

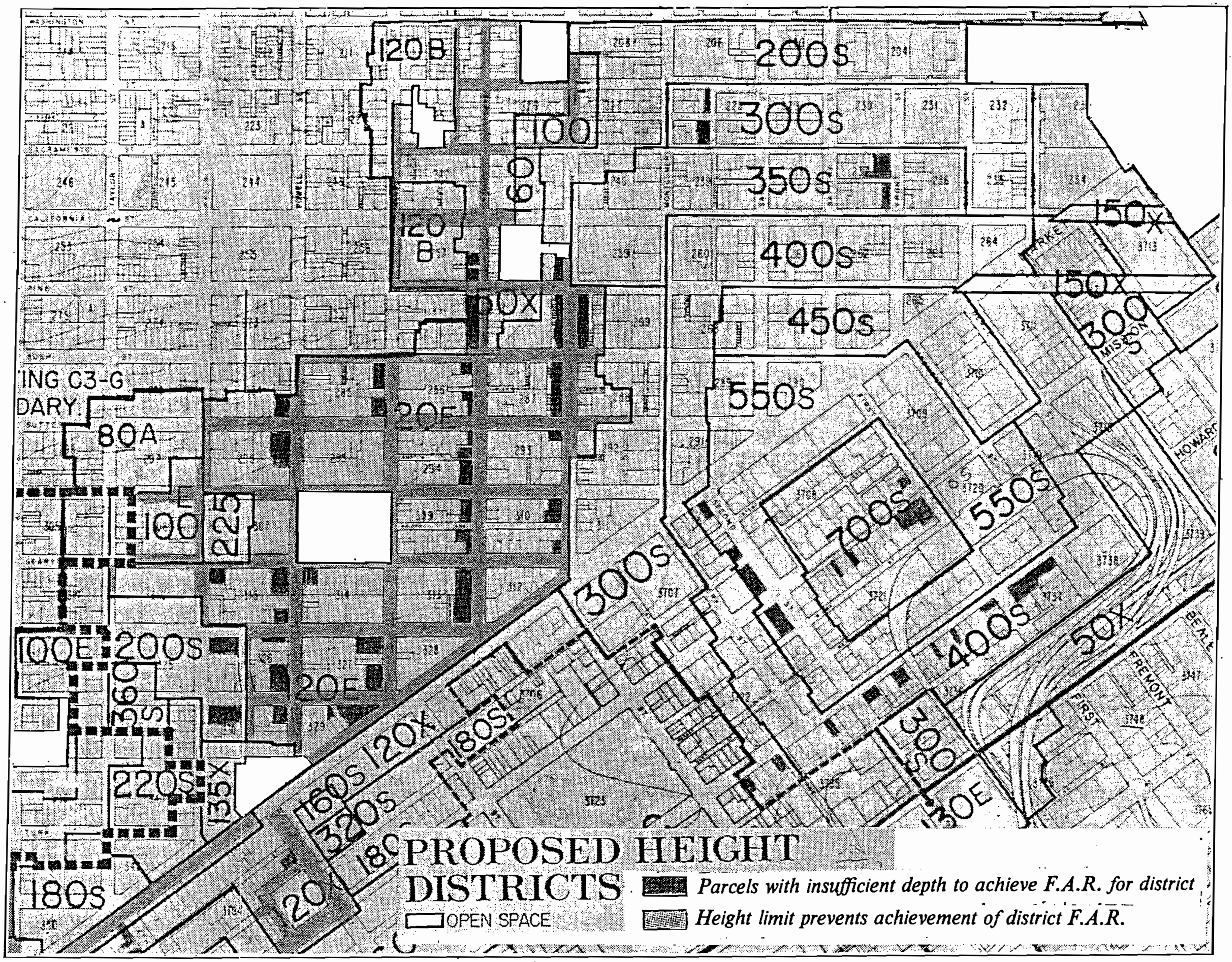
Fig. 30 - Proposed changes to height zones envision a shift of the downtown peak to the south of Market.



Map 4 - Map indicates areas where existing *building height zones are in conflict with building heights defined by solar fan.*



Map 5 - Map indicates areas where proposed *building height zones are in conflict with building heights defined by solar fan.*



Map 6 - Map shows parcels where maximum allowable F.A.R. cannot be achieved due to solar access planes. (Lot assembly is not taken into consideration.)

Manual

This section of the report provides a manual illustrating scale and sun access guidelines for the downtown area.

DEFINITION OF TERMS USED IN SUN ACCESS DIAGRAMS

Orientation: Indicates direction of street with respect to true south.

Critical Side of Street--

for Sun Access: The side of street where direct sunlight is obtainable with mitigated development.

for Development: The side of the street where potential development may limit sun access across the street.

Critical Time: Indicates the optimum time period for which sun will reach the street. For example, on Kearny Street a 70° cut-off angle for the east side of the street will allow sun to reach the west sidewalk at 11:00 AM. A 50° cut of angle for the west side of the street will ensure that sunlight will reach the east sidewalk until 1:00 PM. This condition will provide sunlight on the street for the entire year.

Cut-off Angle: Formed between the horizontal plane of the street and a plane sloping upwards from the curb line on the opposite side of the street on which development may occur.

Sun Profile Plane: The plane established by the cut-off angle. Any projection above the slope of this plane will restrict sun access at critical times of the year.

MAXIMUM HEIGHT OF BUILDING FOR SUN ACCESS CRITERIA FOR STREETS

To determine the maximum height of a building that respects sun access criteria (the calculation can be used for any given point on a particular site):

1) Use manual to determine cut-off angle;

2) In plan: determine the distance from point "A" (a point for which you want to know the maximum height) to the opposite curb line (point "B");

3) Multiply the distance between "A" and "B" by the tangent of the cut-off angle (see table below). The result is the maximum height at point "A".

<u>height</u> = <u>d(AB)</u> <u>x</u> <u>TAN(cut-off angle)</u>

Cut-off Angles	Tangent
70°	2.7474
65°	2.1145
62°	1.8807
59°	1.6642
52°	1.2799
50°	1.1917

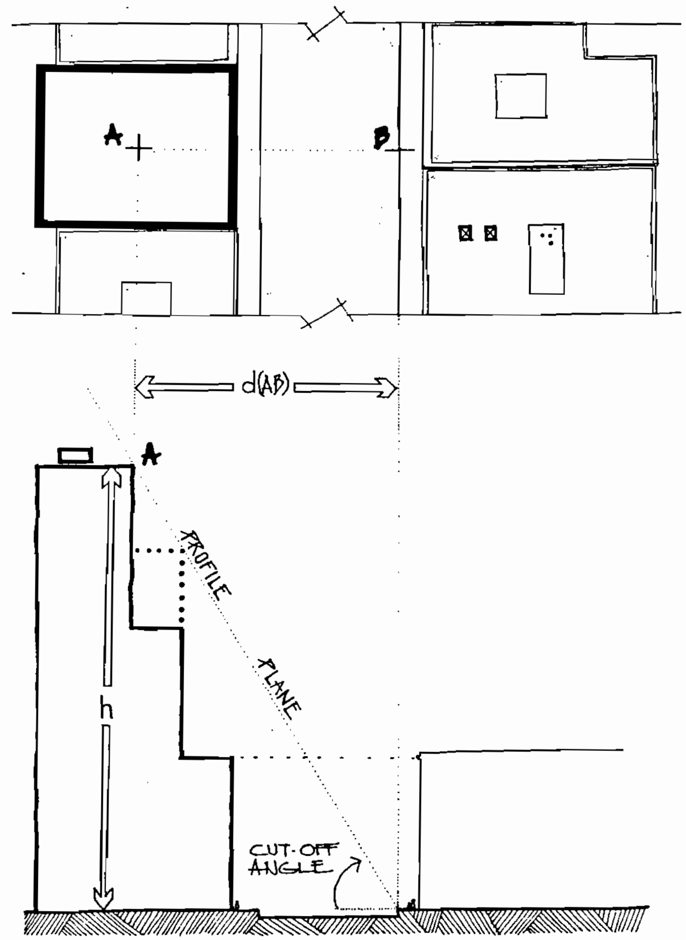
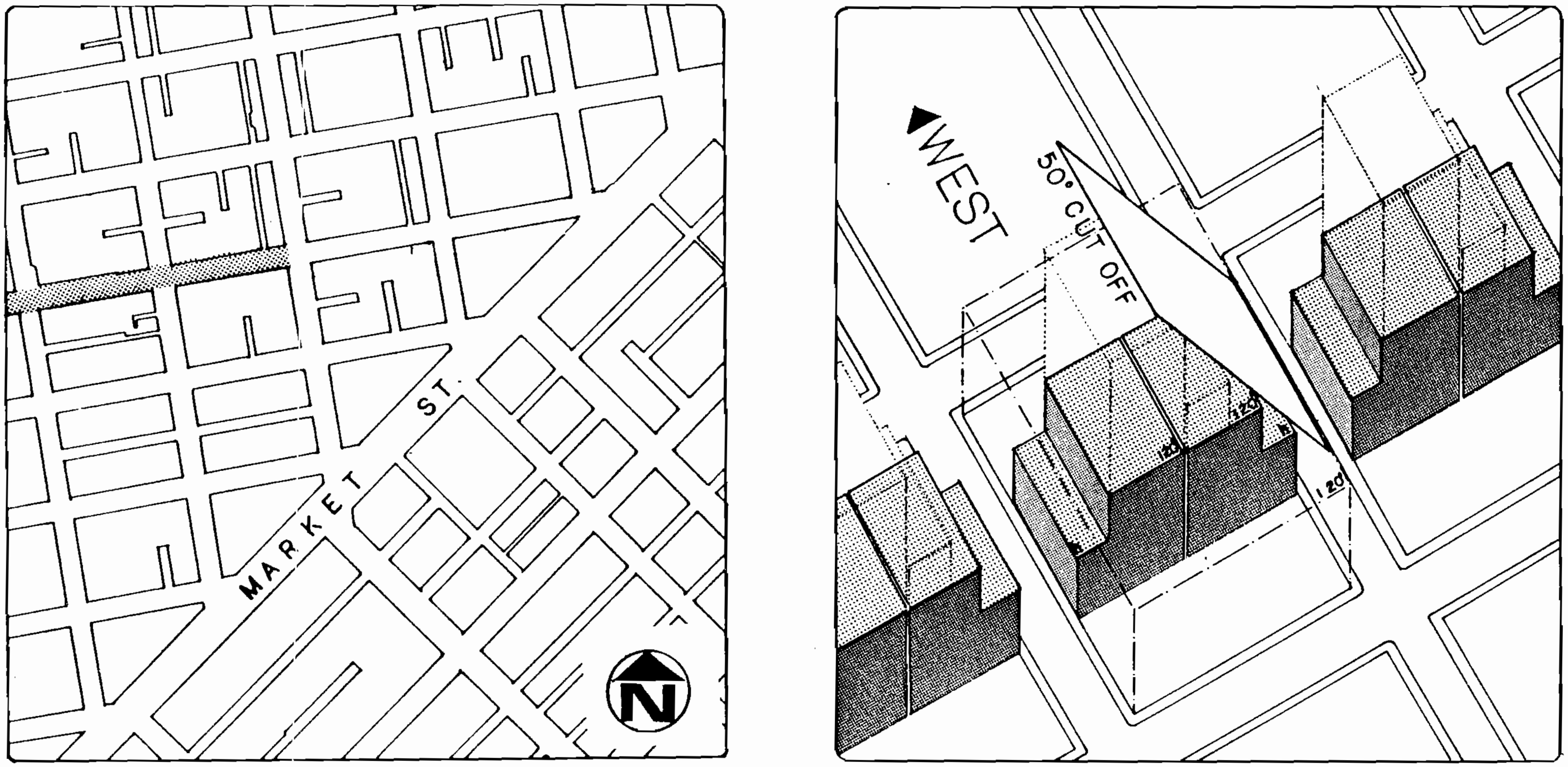


Fig. 31 - Building height calculation

Sun Access for Streets

NORTH OF MARKET : EAST – WEST RETAIL DISTRICT



ORIENTATION : 81° WEST OF TRUE SOUTH

CRITICAL SIDE OF STREET :
for SUN ACCESS ; NORTH (Sidewalk)
for DEVELOPMENT ; SOUTH

CRITICAL TIME : from 11:00 am, Mar./Sept.

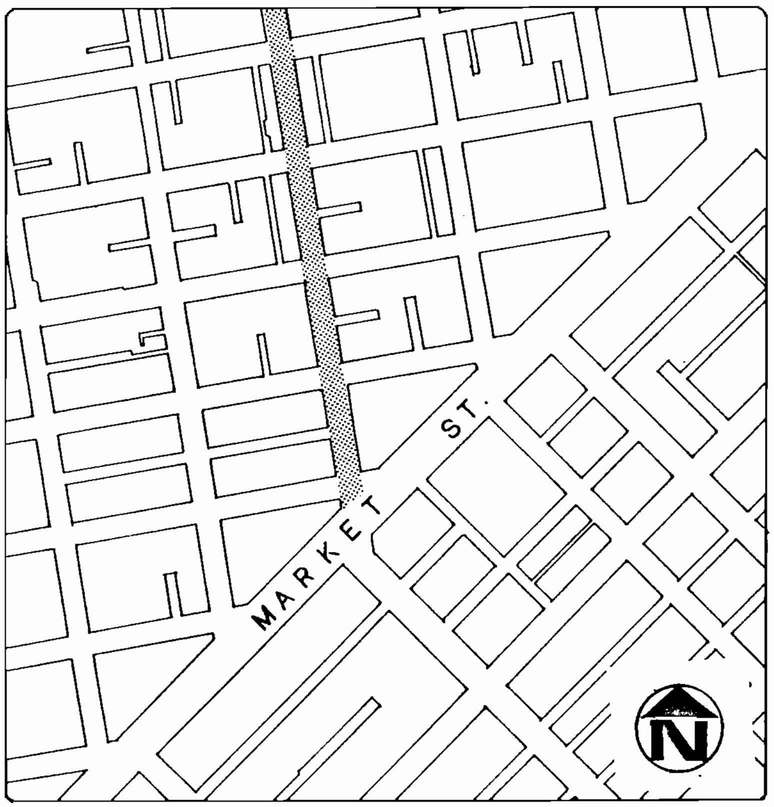
CUT OFF ANGLE : 50°

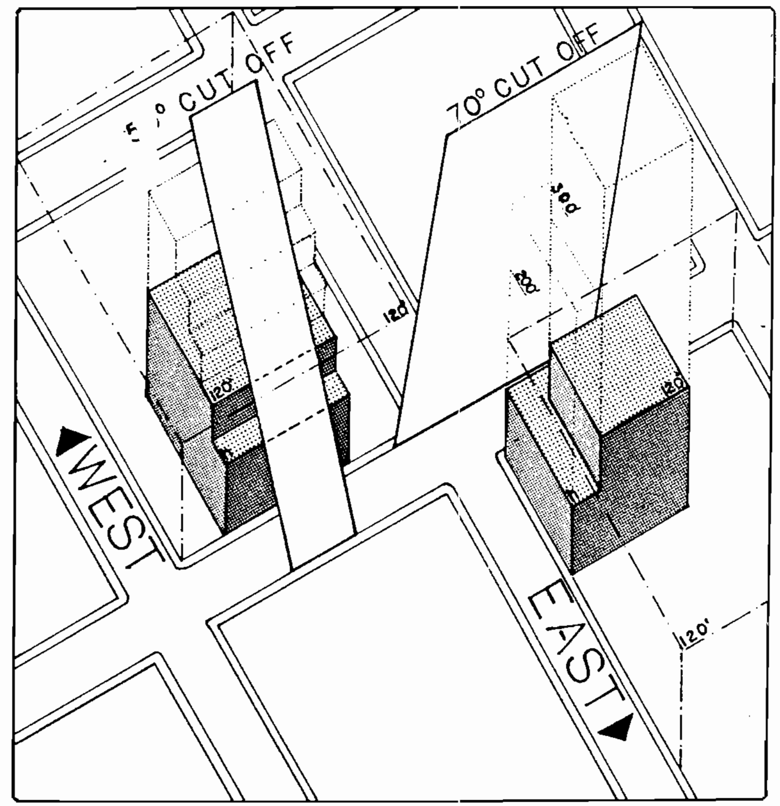
Fig. 32

MAXIMUM STREET WALL HEIGHT IN FEET (h)

Street	
BUSH	65'
SUTTER	66'
POST	66'
GEARY	65'
O'FARRELL	66'
ELLIS	68'

NORTH OF MARKET : NORTH – SOUTH RETAIL DISTRICT





ORIENTATION : 9° EAST OF TRUE SOUTH

CRITICAL SIDE OF STREET : EAST and WEST

CRITICAL TIME : EAST, from 11:00 am, Dec. 21st
WEST, until 1:00 pm, Dec. 21st

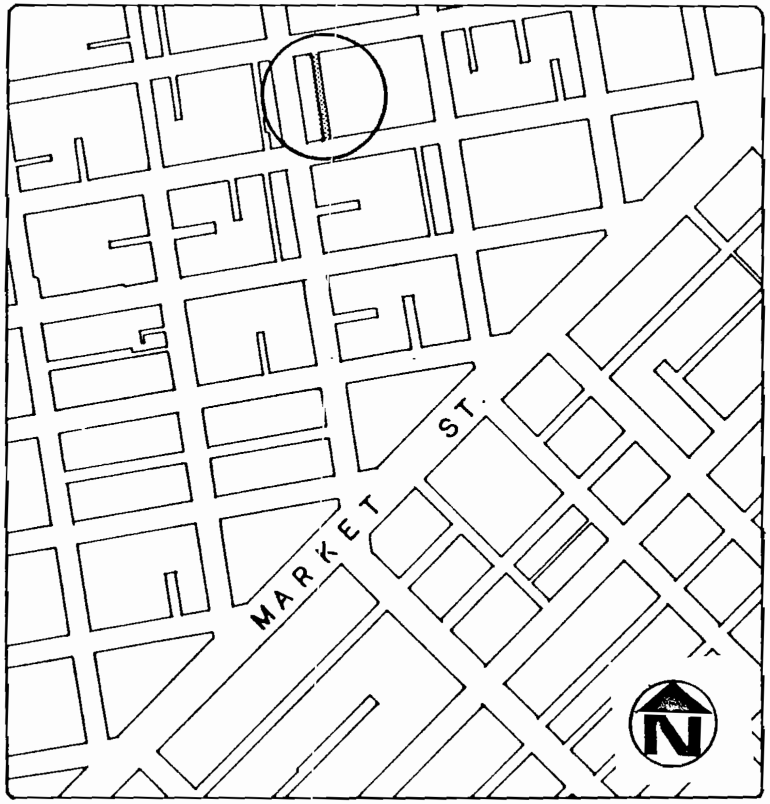
CUT OFF ANGLE : EAST 70°, WEST 50°

MAXIMUM STREET WALL HEIGHT IN FEET (h)

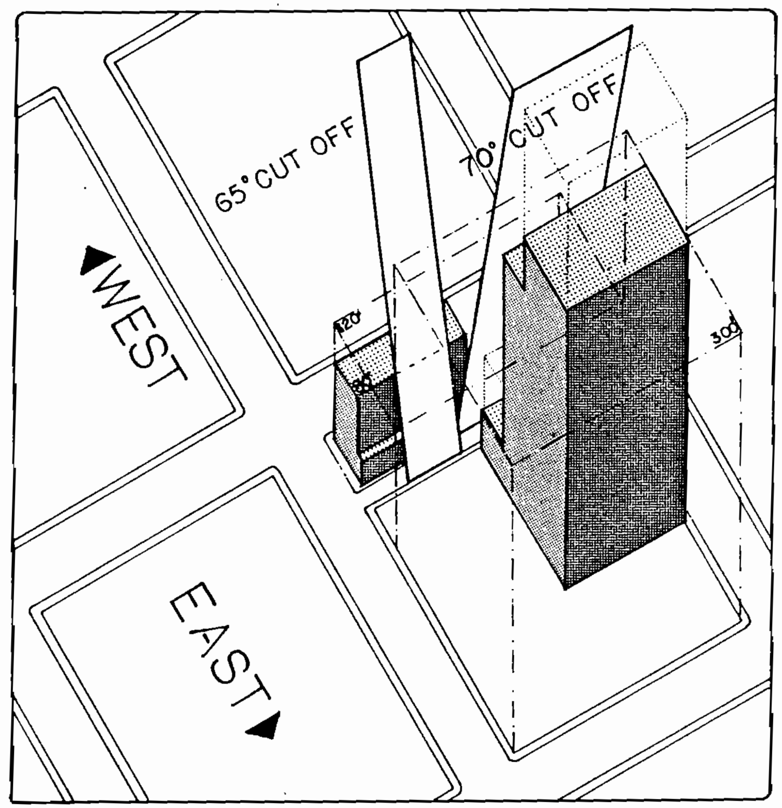
Street	East	West
POWELL	151'	65'
STOCKTON	148'	65'
GRANT	170'	74'
KEARNY	170'	74'

Fig. 33

NORTH OF MARKET : NORTH – SOUTH



RETAIL DISTRICT LUNCH TIME MALL



ORIENTATION : 9° EAST OF TRUE SOUTH

CRITICAL SIDE OF STREET : EAST and WEST

CRITICAL TIME : EAST, from 11:00 am, Dec. 21st
WEST, until 1:00 pm, Mar./Sept.

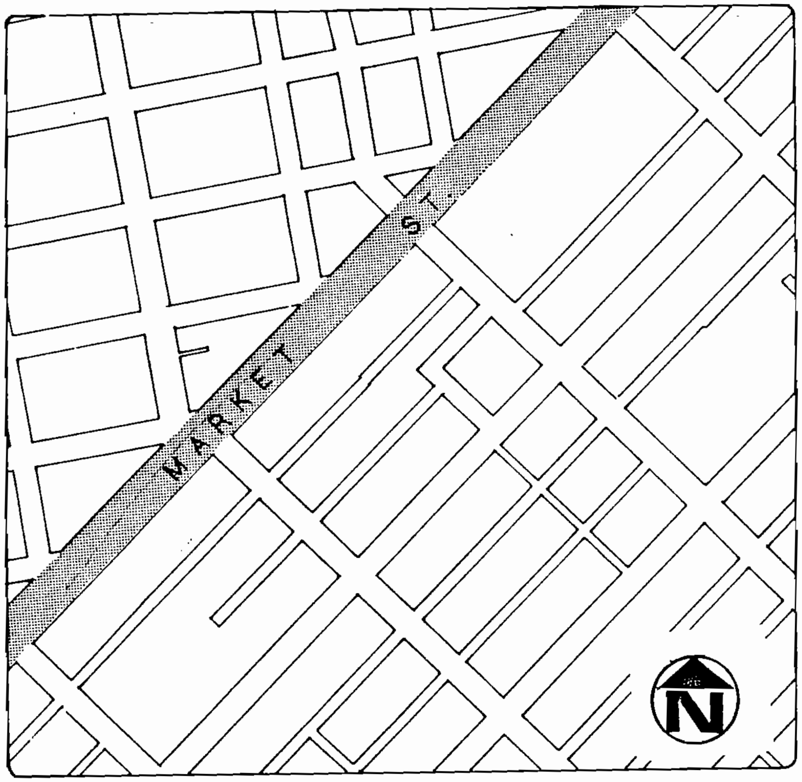
CUT OFF ANGLE : EAST 70°, WEST 65°

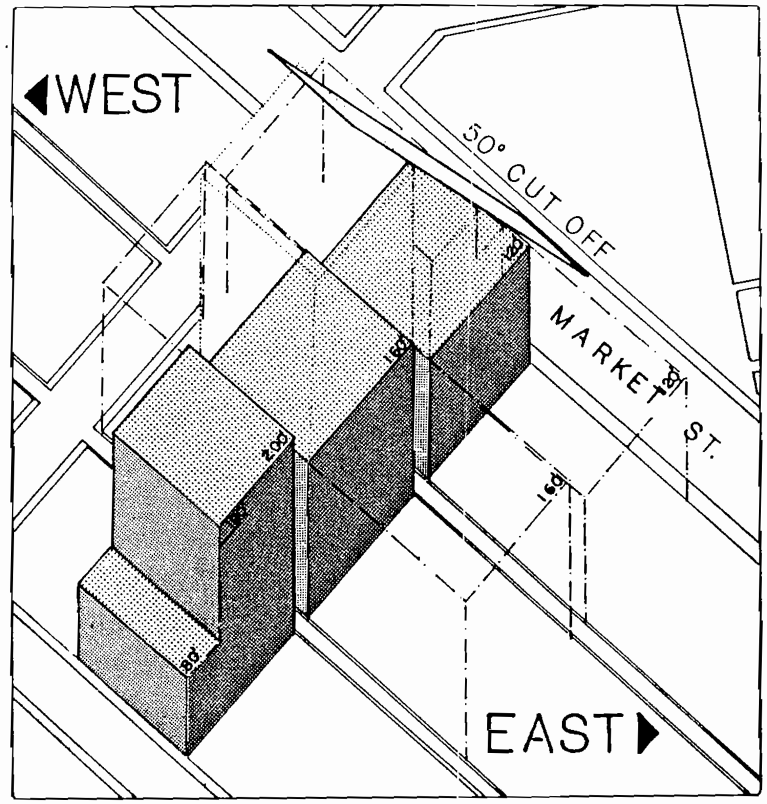
MAXIMUM STREET WALL HEIGHT IN FEET (h)

Street	East	West
BELDEN	71'	55'

Fig. 34

MARKET STREET : WEST OF YBC





ORIENTATION : 45° WEST OF TRUE SOUTH

CRITICAL SIDE OF STREET :
for SUN ACCESS ; NORTH (Sidewalk)
for DEVELOPMENT ; SOUTH

CRITICAL TIME : from 11:00 am, Mar./Sept.

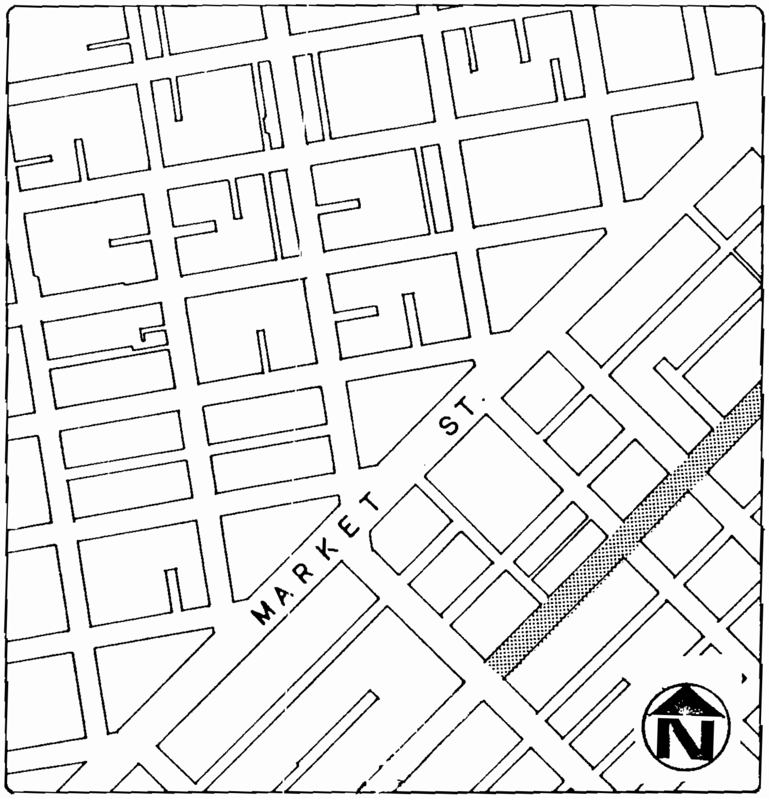
CUT OFF ANGLE : 50°

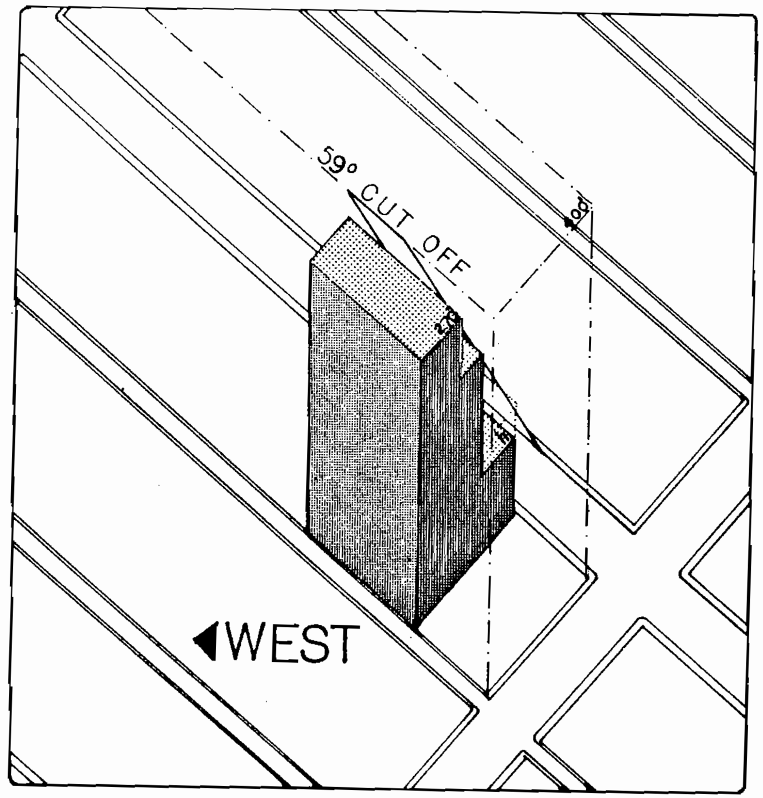
Fig. 35

MAXIMUM STREET WALL HEIGHT IN FEET (h)

Street	
MARKET	119'

SOUTH OF MARKET : EAST - WEST   EAST OF YBC





ORIENTATION : 45° WEST OF TRUE SOUTH

CRITICAL SIDE OF STREET :
for SUN ACCESS ; NORTH (Sidewalk)
for DEVELOPMENT ; SOUTH

CRITICAL TIME : from 12:30 noon, Mar./Sept.

CUT OFF ANGLE : 59°

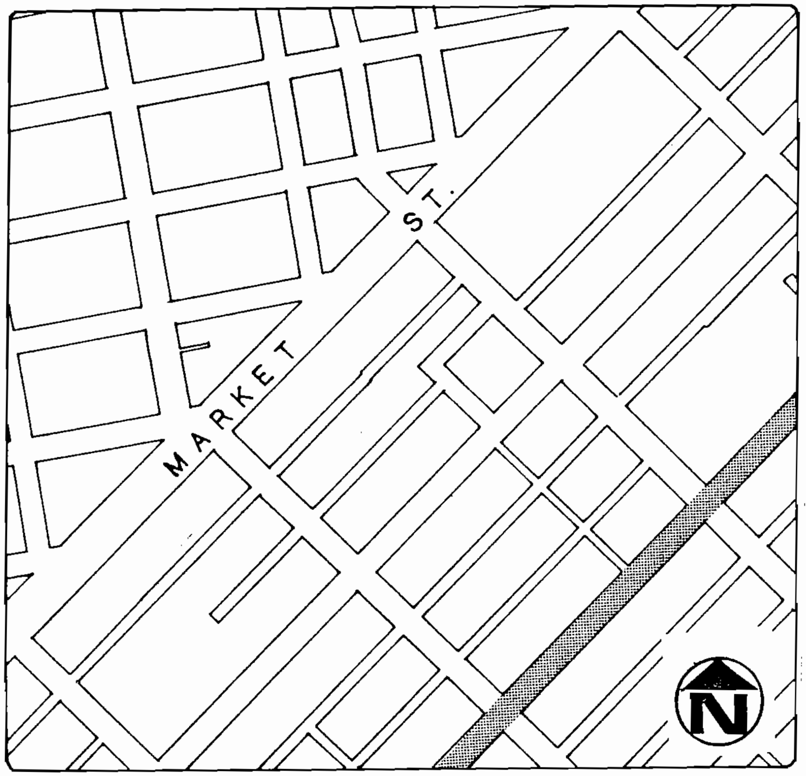
Fig. 36

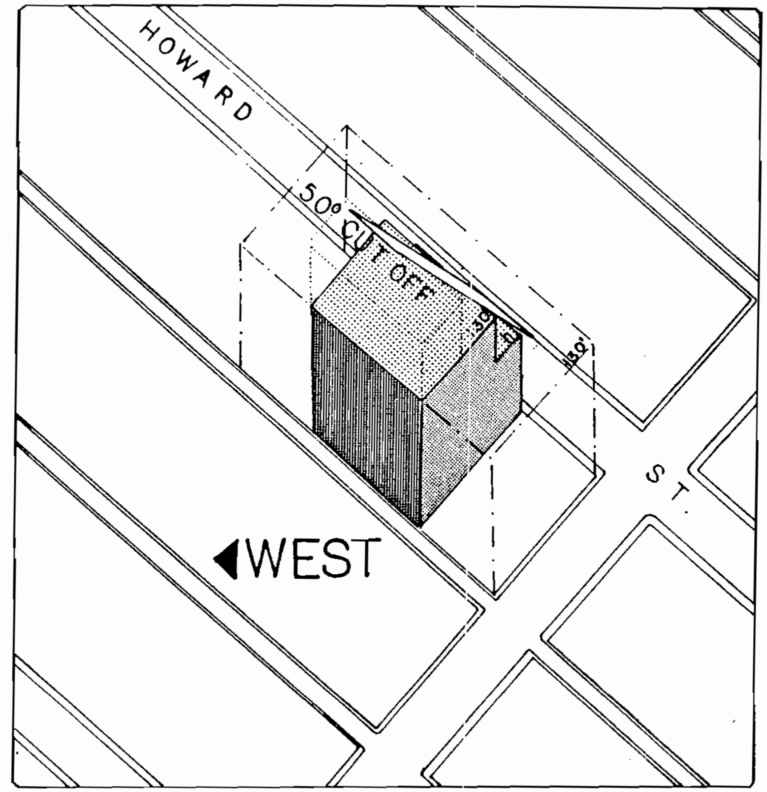
MAXIMUM STREET WALL HEIGHT IN FEET (h)

Street	
MISSION	117'
HOWARD	117'
FOLSOM	117'
HARRISON	117'

SOUTH OF MARKET : EAST – WEST

WEST OF YBC





ORIENTATION : 45° WEST OF TRUE SOUTH

CRITICAL SIDE OF STREET :
for SUN ACCESS ; NORTH (Sidewalk)
for DEVELOPMENT ; SOUTH

CRITICAL TIME : from 11:00 am, Mar./Sept.

CUT OFF ANGLE : 50°

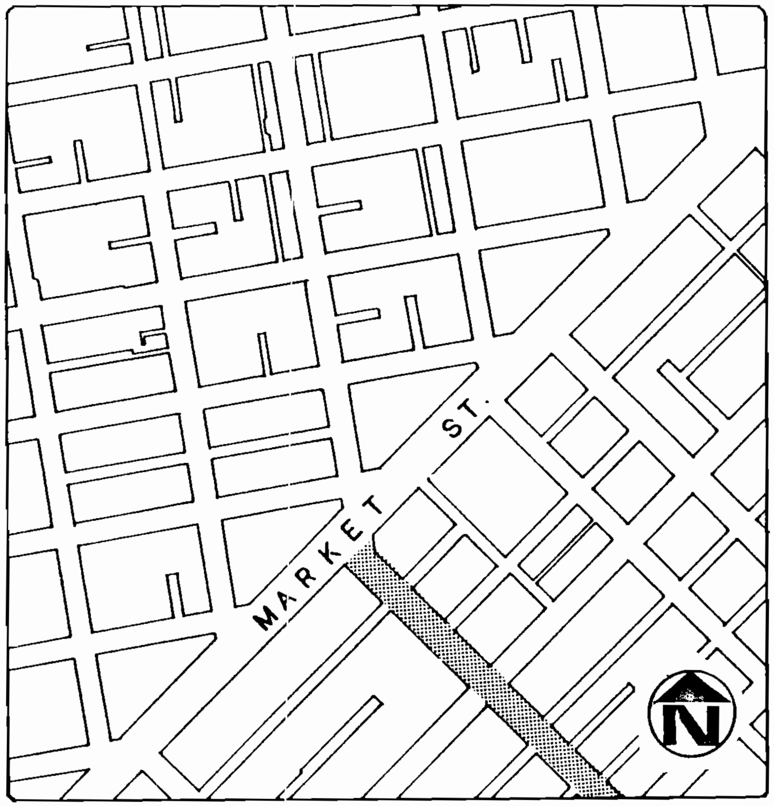
Fig. 37

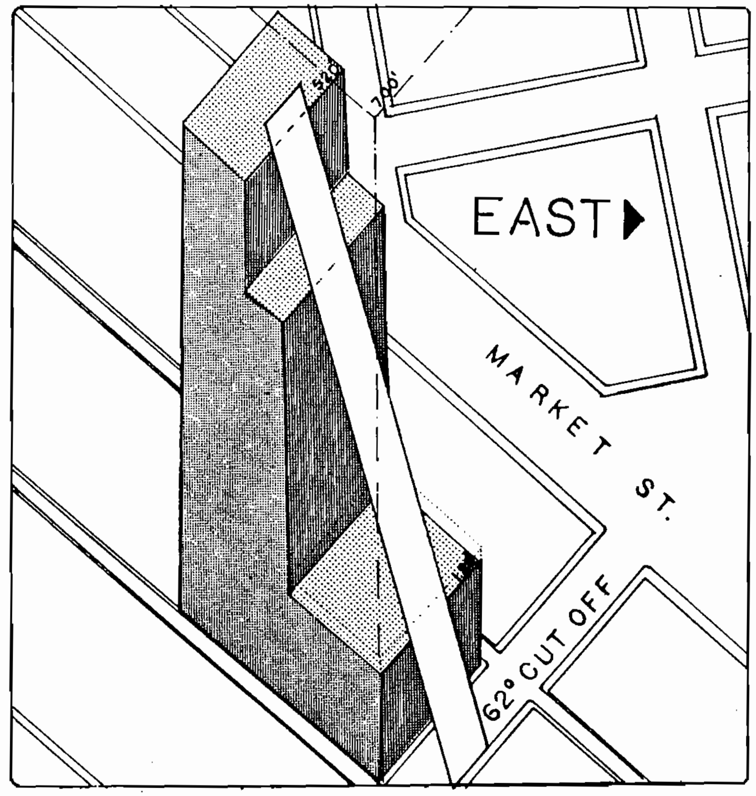
MAXIMUM STREET WALL HEIGHT IN FEET (h)

Street	
MISSION	84'
HOWARD	84'
FOLSOM	84'
HARRISON	84'

SOUTH OF MARKET : NORTH - SOUTH

EAST OF YBC





ORIENTATION : 45° EAST OF TRUE SOUTH

CRITICAL SIDE OF STREET :
for SUN ACCESS ; EAST (Sidewalk)
for DEVELOPMENT ; WEST

CRITICAL TIME : until 12:00 noon Mar./Sept.

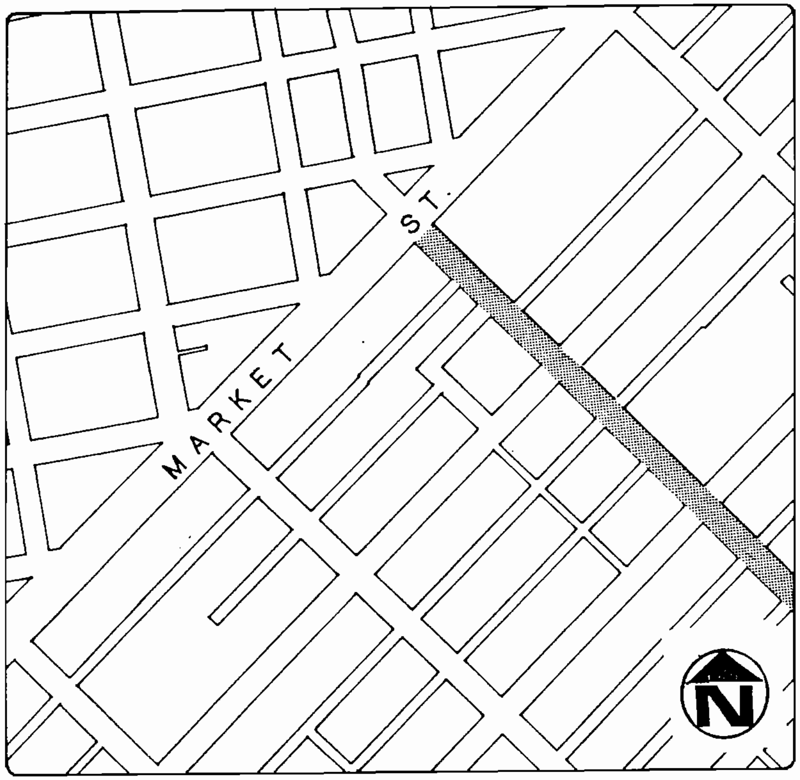
CUT OFF ANGLE : 62°

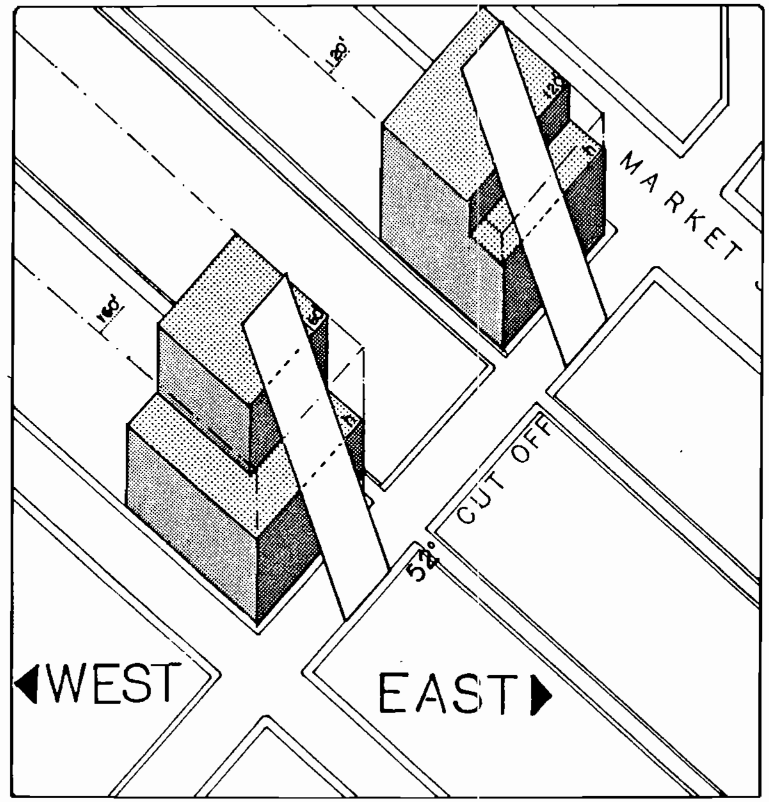
Fig. 38

MAXIMUM STREET WALL HEIGHT IN FEET (h)

Street			
STEUART	132'	FIRST	132'
SPEAR	132'	SECOND	132'
MAIN	132'	NEW MONTGOMERY	132'
BEALE	132'	THIRD	132'
FREMONT	132'		

SOUTH OF MARKET : NORTH – SOUTH WEST OF YBC





ORIENTATION : 45° EAST OF TRUE SOUTH

CRITICAL SIDE OF STREET :
for SUN ACCESS ; EAST (Sidewalk)
for DEVELOPMENT ; WEST

CRITICAL TIME : until 1:00 pm, Mar./Sept.

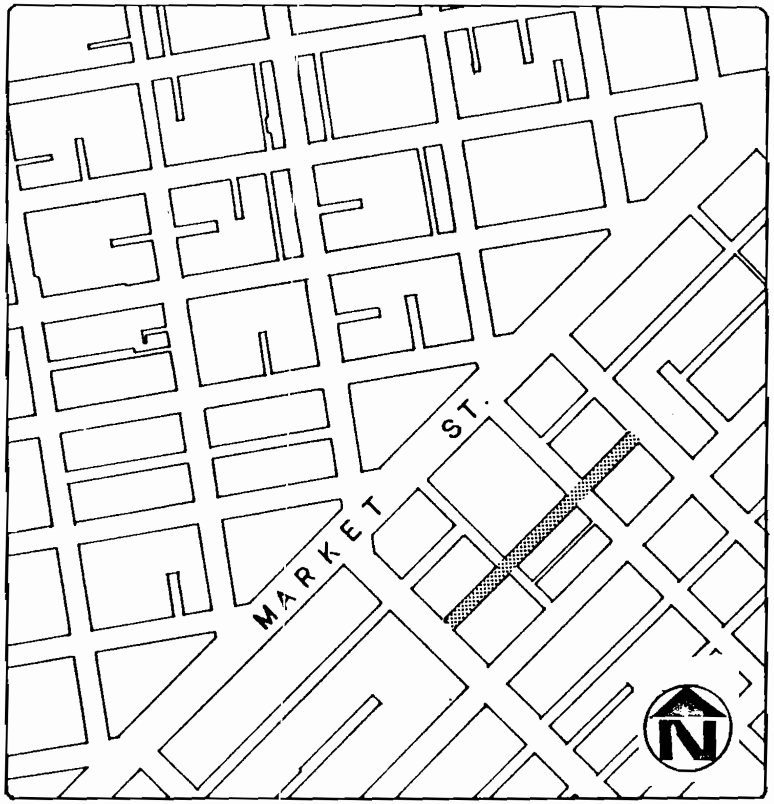
CUT OFF ANGLE : 52°

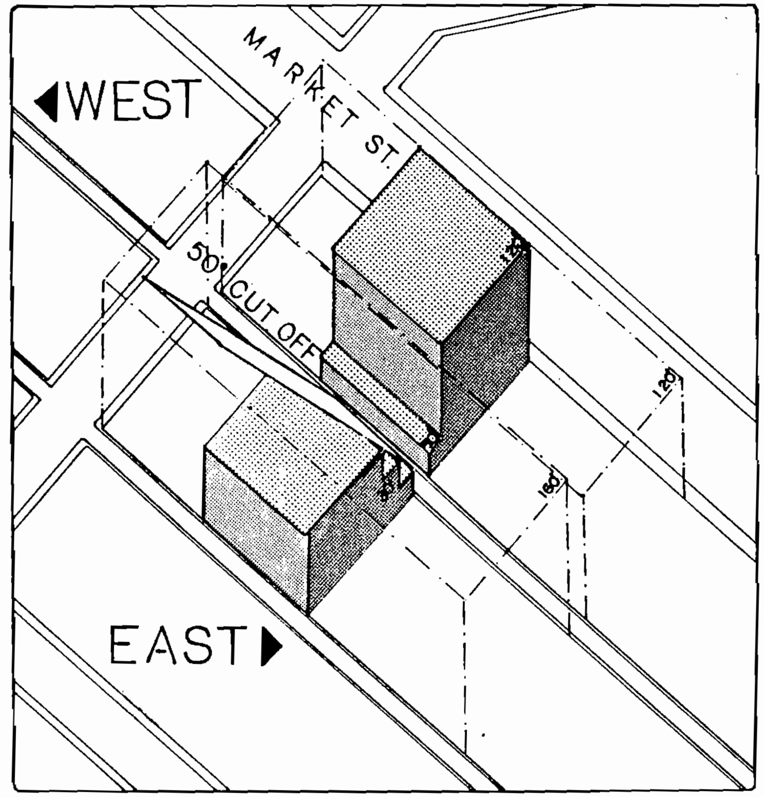
Fig. 39

MAXIMUM STREET WALL HEIGHT IN FEET (h)

Street	
FOURTH	90'
FIFTH	90'
SIXTH	90'
SEVENTH	90'
EIGHTH	90'

SOUTH OF MARKET : EAST - WEST ALLEYWAY





RECOMMENDED FOR RESIDENTIAL/MIXED USE DEVELOPMENT ONLY

ORIENTATION : 45° WEST OF TRUE SOUTH

CRITICAL SIDE OF STREET :
for SUN ACCESS ; NORTH (Sidewalk)
for DEVELOPMENT ; SOUTH

CRITICAL TIME : from 11:00 am, Mar./Sept.

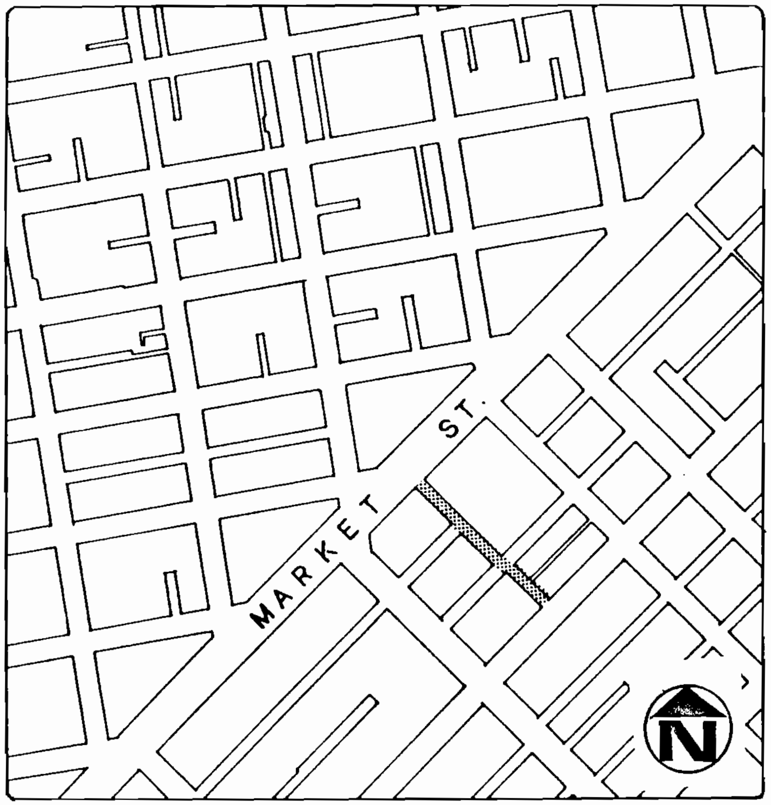
CUT OFF ANGLE : 50°

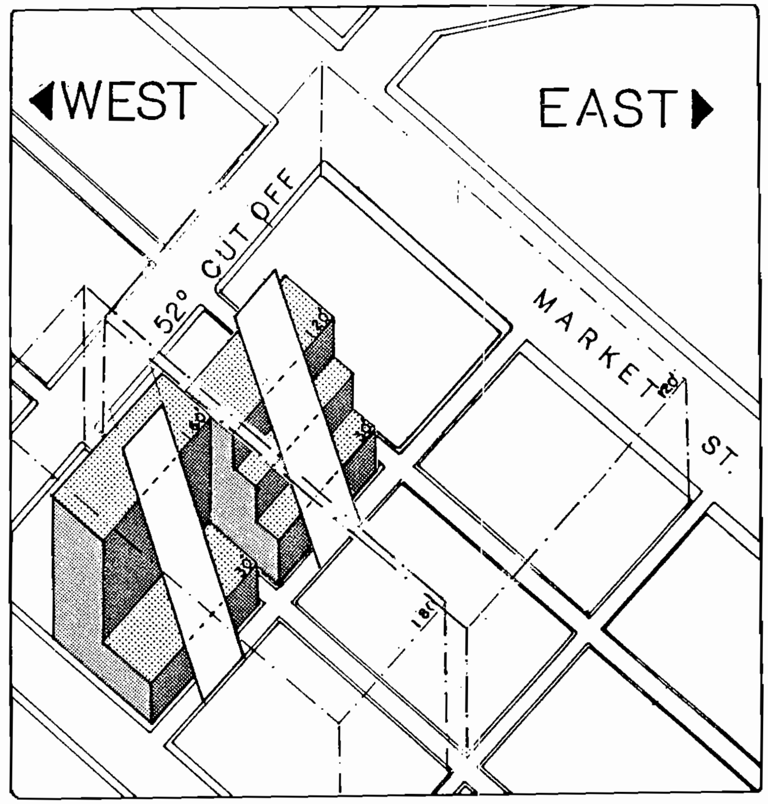
Fig. 40

MAXIMUM STREET WALL HEIGHT IN FEET (h)

Street	
STEVENSON	50'
JESSIE	50'
MINNA	36'
NATOMA	36'

SOUTH OF MARKET : NORTH – SOUTH ALLEYWAY





RECOMMENDED FOR RESIDENTIAL/MIXED USE DEVELOPMENT ONLY

ORIENTATION : 45° EAST OF TRUE SOUTH

CRITICAL SIDE OF STREET :
for SUN ACCESS ; EAST (Sidewalk)
for DEVELOPMENT ; WEST

CRITICAL TIME : until 1:00 pm, Mar./Sept.

CUT OFF ANGLE : 52°

Fig. 41

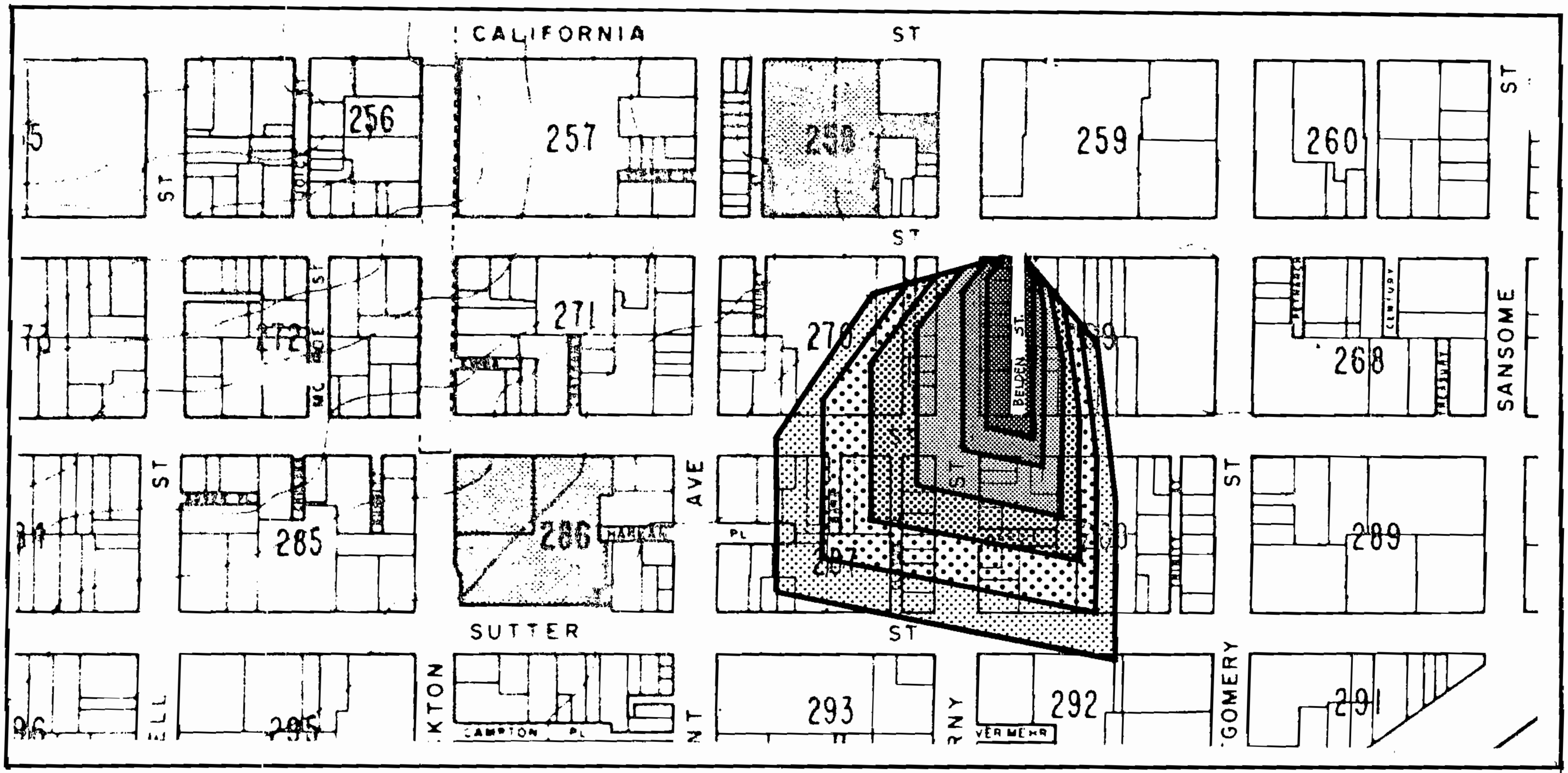
MAXIMUM STREET WALL HEIGHT IN FEET (h)

Street	
MINT	33'

Sun Access for Parks, Plazas, and Squares

BELDEN STREET

SOLAR FAN



CRITICAL TIME: 11:00 a.m. to 2:00 p.m. (Standard Time)
12:00 a.m. to 3:00 p.m. (Daylight Savings)

CRITICAL MONTHS: March 21st. to Sept. 21st.

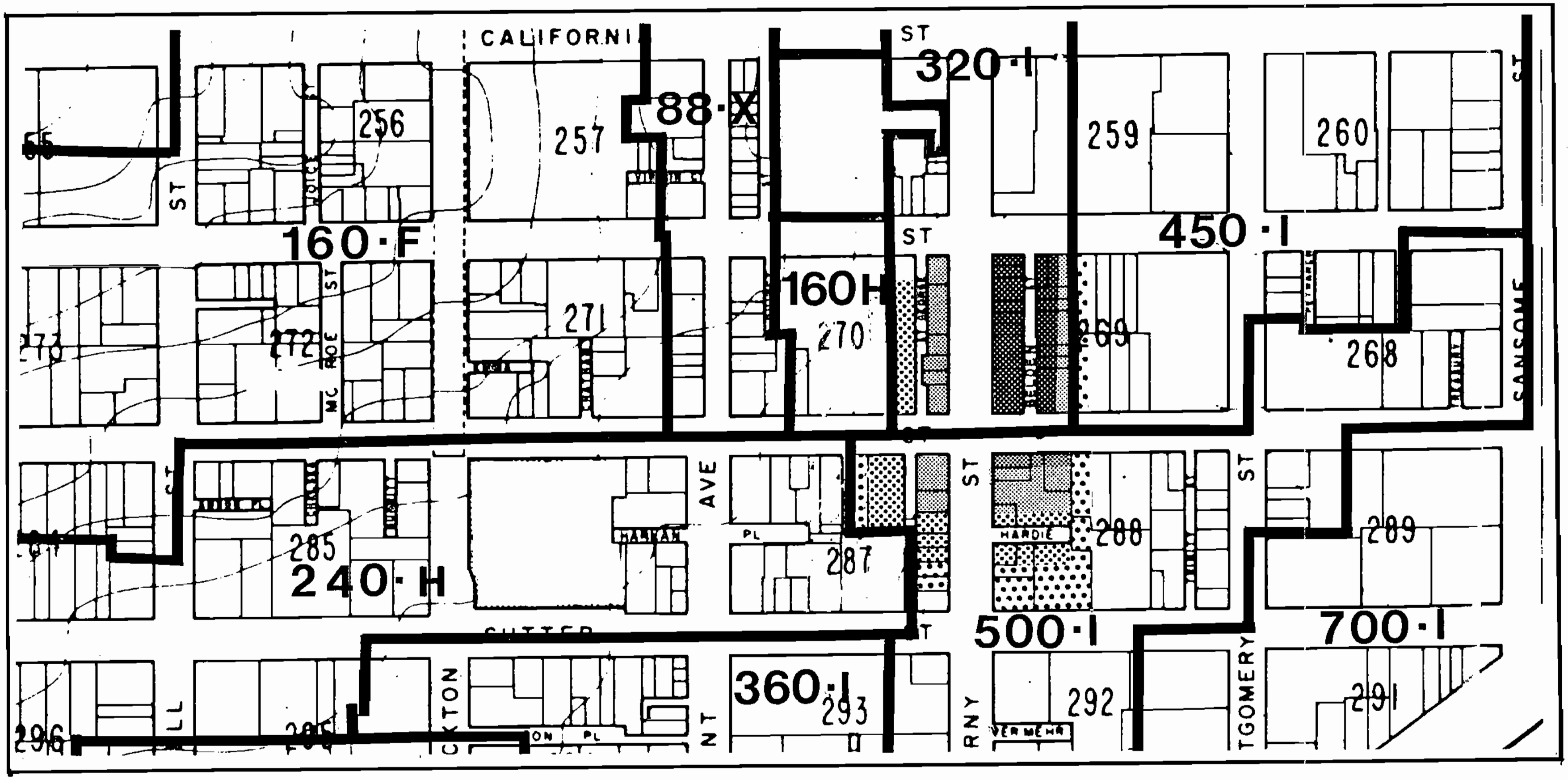
50 FEET
80 FEET
100 FEET
200 FEET
300 FEET
400 FEET

300 FEET

Fig. 42

BELDEN STREET

PROPOSED SUN ACCESS ZONING WITH EXISTING HEIGHT LIMITS



CRITICAL TIME: 11:00 a.m. to 2:00 p.m. (Standard Time)
12:00 a.m. to 3:00 p.m. (Daylight Savings)

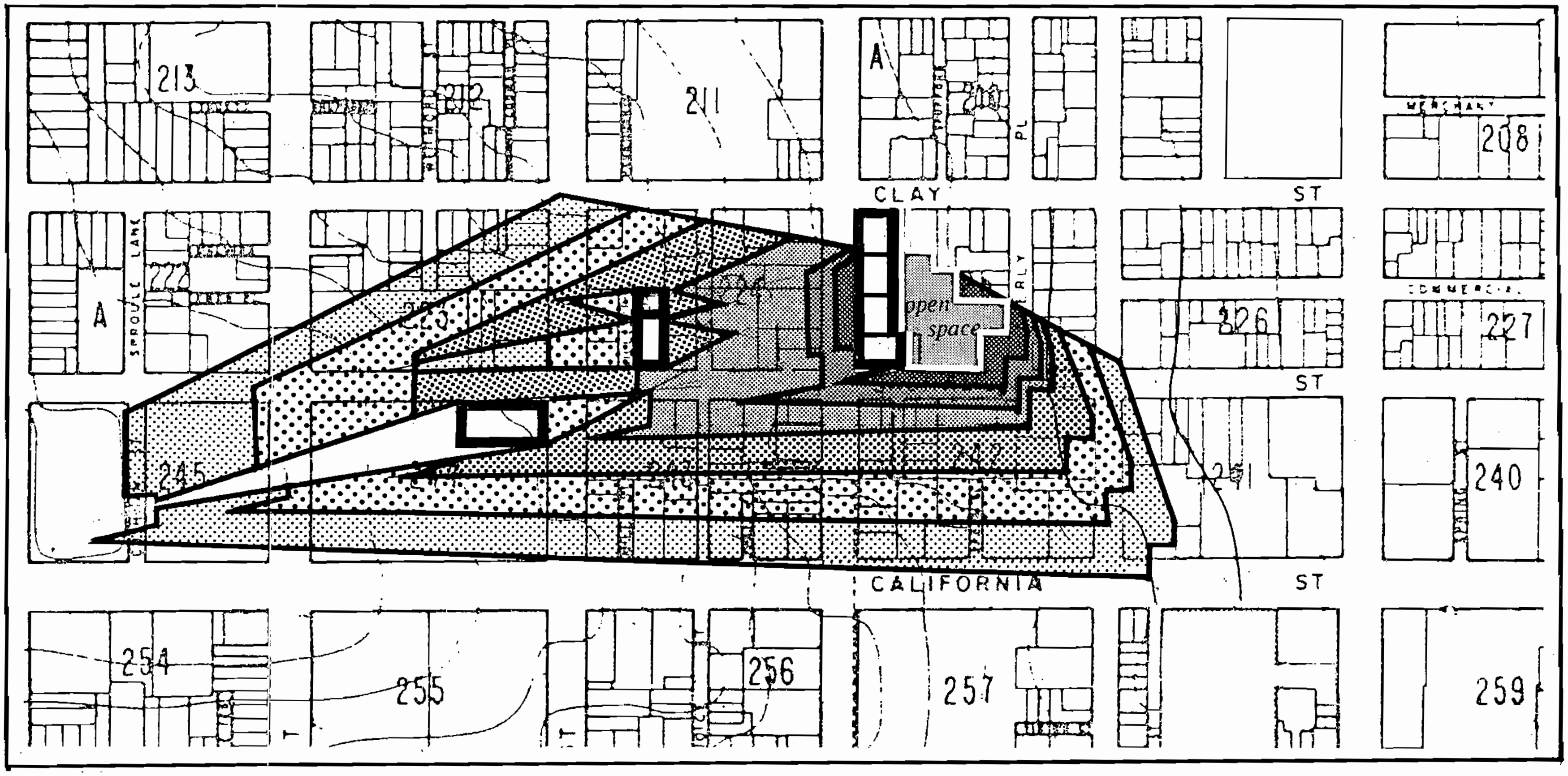
CRITICAL MONTHS: March 21st. to Sept. 21st.

50 FEET
80 FEET
100 FEET
200 FEET
300 FEET
400 FEET

300 FEET

Fig. 43

CHINESE PLAYGROUND SOLAR FAN



CRITICAL TIME: 10:00 a.m. to 4:00 p.m. (Standard Time)
11:00 a.m. to 5:00 p.m. (Daylight Savings)

CRITICAL MONTHS: March 21st. to Sept. 21st.

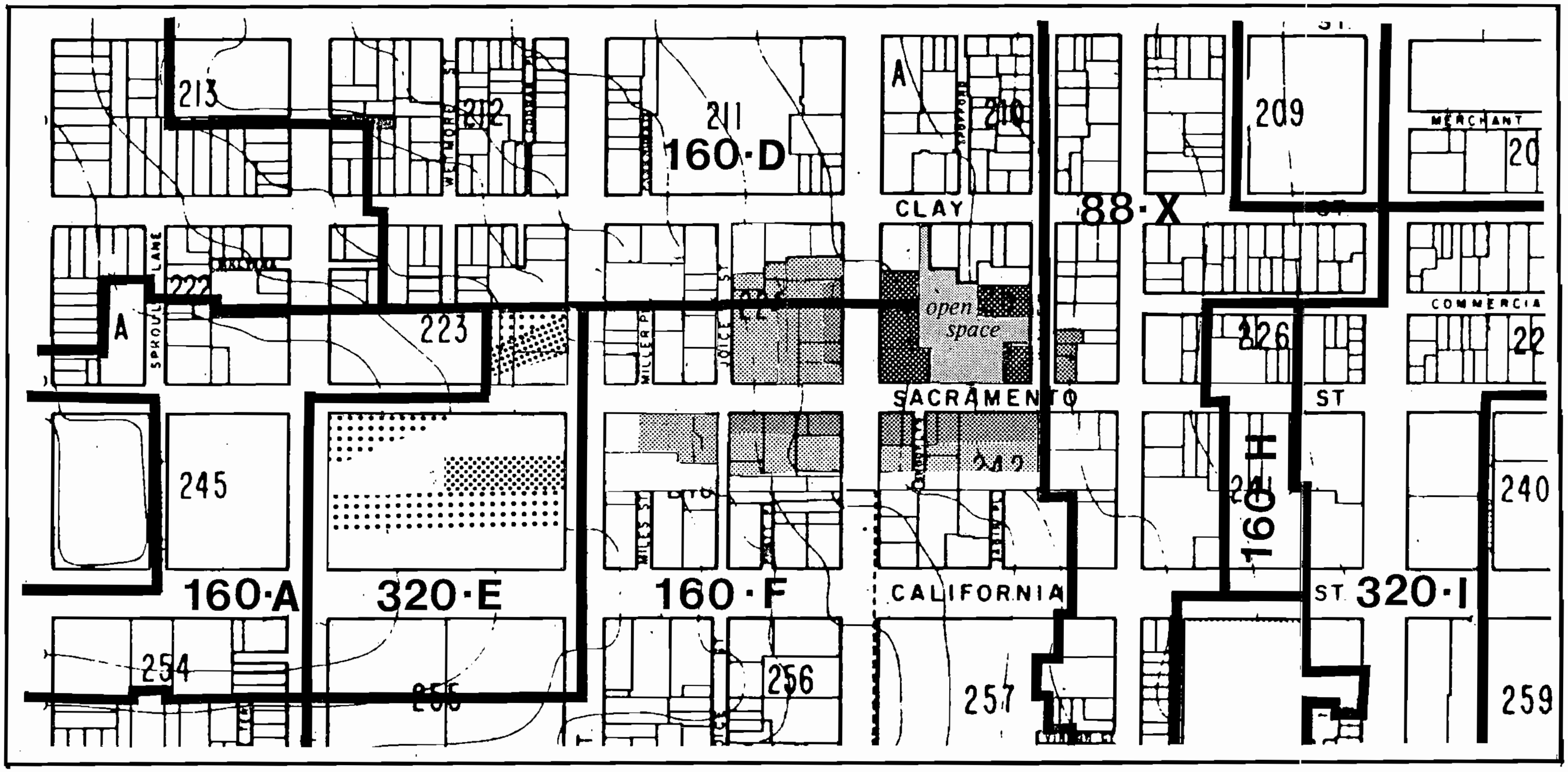
Buildings in conflict with Solar Fan.

50 FEET
80 FEET
100 FEET
200 FEET
300 FEET
400 FEET
OPEN SPACE
300 FEET

Fig. 44

CHINESE PLAYGROUND

PROPOSED SUN ACCESS ZONING COMPARED WITH EXISTING HEIGHT LIMITS



CRITICAL TIME: 10:00 a.m. to 4:00 p.m. (Standard Time)
11:00 a.m. to 5:00 p.m. (Daylight Savings)

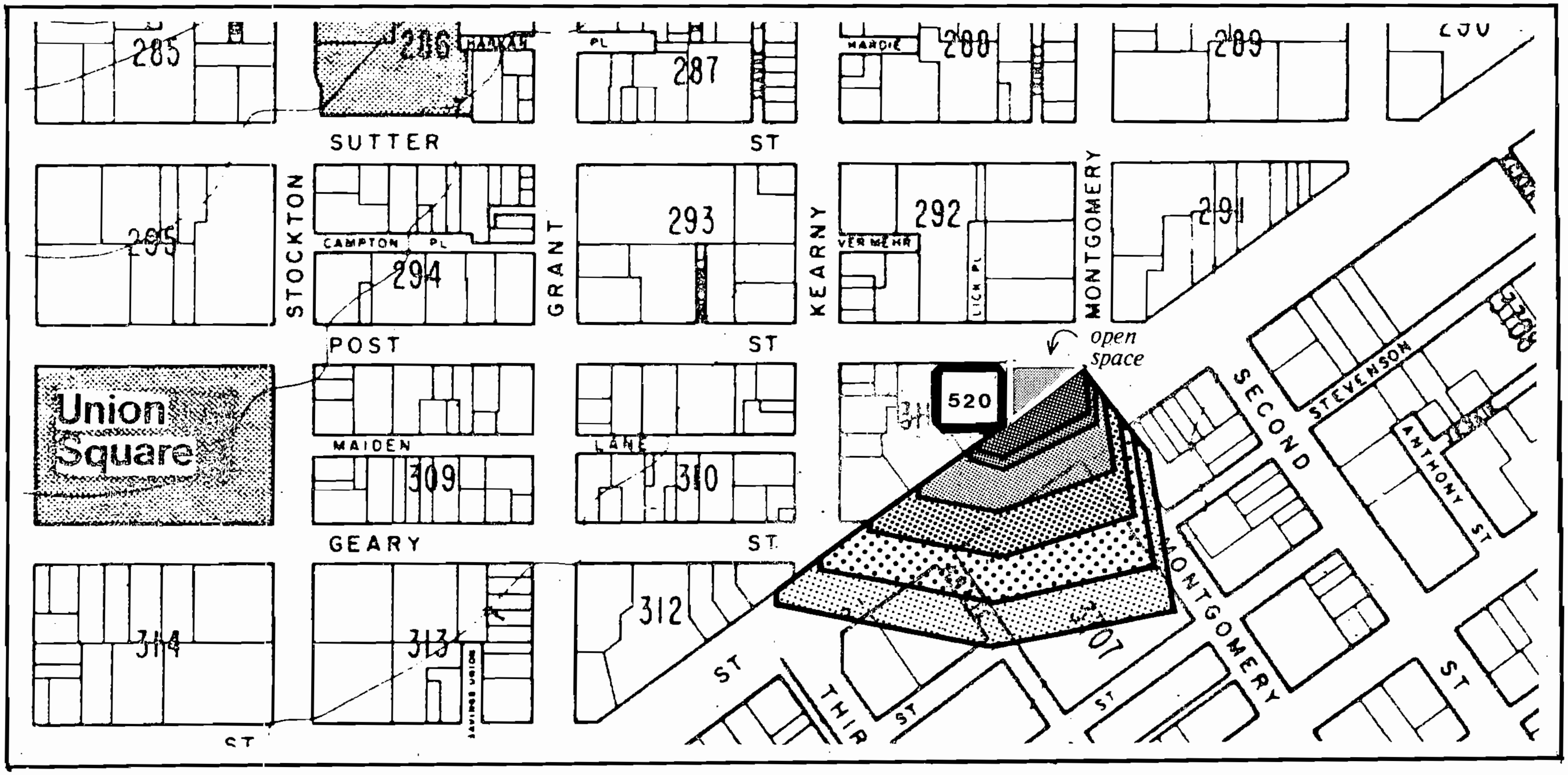
CRITICAL MONTHS: March 21st. to Sept. 21st.

50 FEET
80 FEET
100 FEET
200 FEET
300 FEET
400 FEET
OPEN SPACE

300 FEET

Fig. 45

CROCKER PLAZA SOLAR FAN



CRITICAL TIME: 11:00 a.m. to 2:00 p.m. (Standard Time)
12:00 a.m. to 3:00 p.m. (Daylight Savings)

CRITICAL MONTHS: March 21st. to Sept. 21st.

Buildings in conflict with Solar Fan.

50 FEET

80 FEET

100 FEET

200 FEET

300 FEET

400 FEET

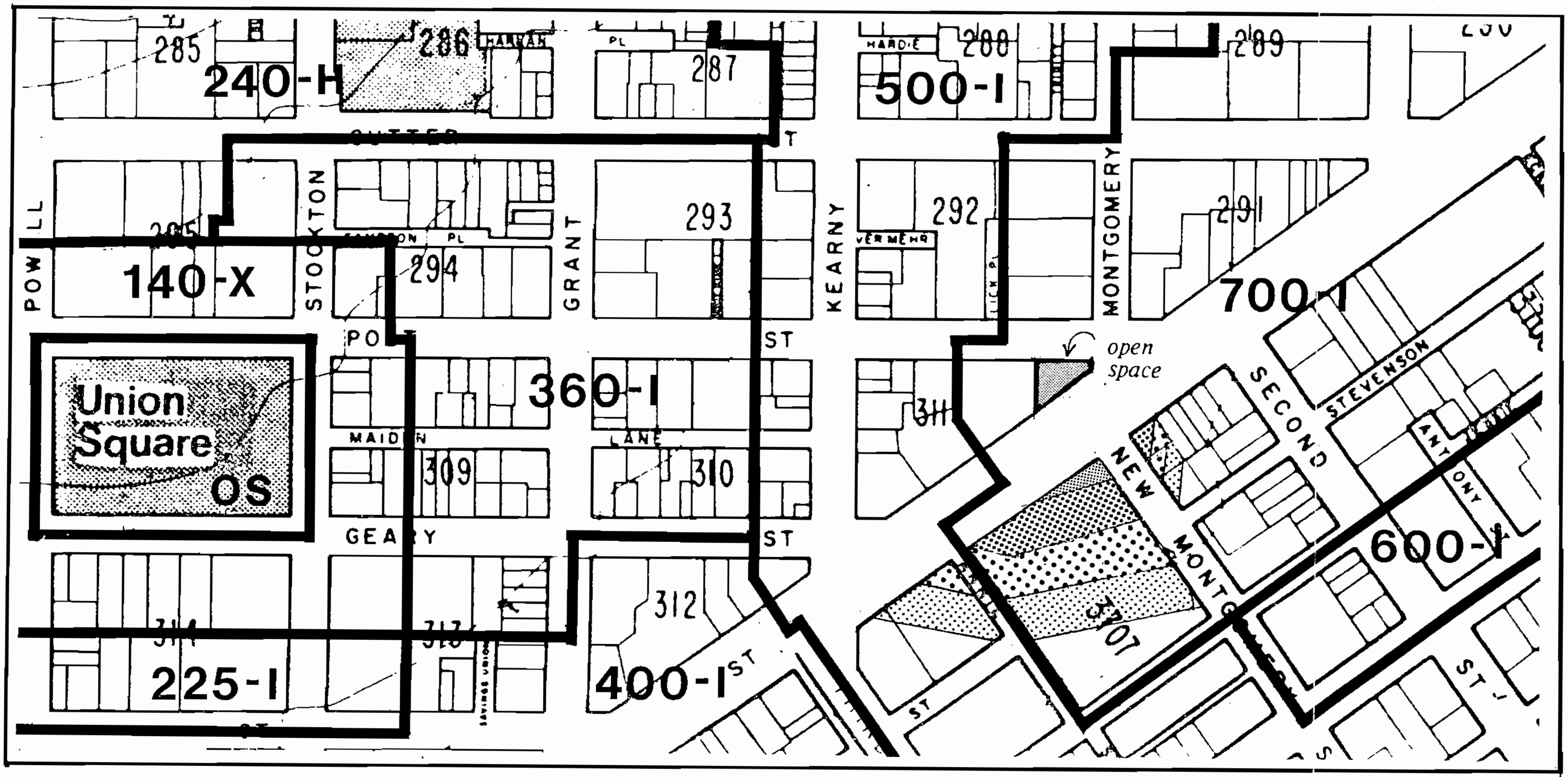
OPEN SPACE

300 FEET

Fig. 46

CROCKER PLAZA

PROPOSED SUN ACCESS ZONING COMPARED WITH EXISTING HEIGHT LIMITS



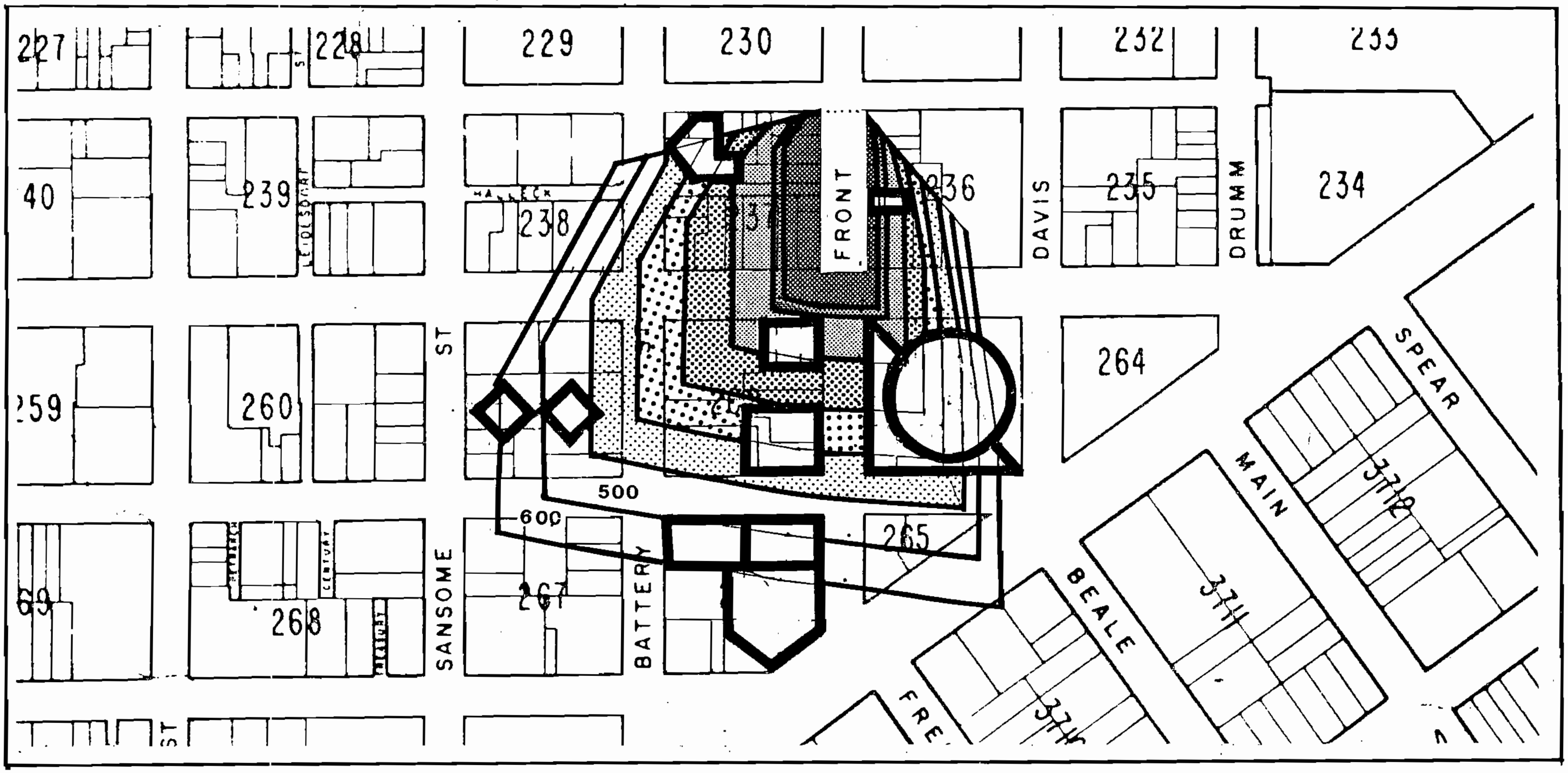
CRITICAL TIME: 11:00 a.m. to 2:00 p.m. (Standard Time)
12:00 a.m. to 3:00 p.m. (Daylight Savings)

CRITICAL MONTHS: March 21st. to Sept. 21st.

50 FEET	200 FEET	OPEN SPACE
80 FEET	300 FEET	
100 FEET	400 FEET	300 FEET

Fig. 47

FRONT STREET SOLAR FAN



CRITICAL TIME: 11:00 a.m. to 2:00 p.m. (Standard Time)
12:00 a.m. to 3:00 p.m. (Daylight Savings)

CRITICAL MONTHS: March 21st. to Sept. 21st.

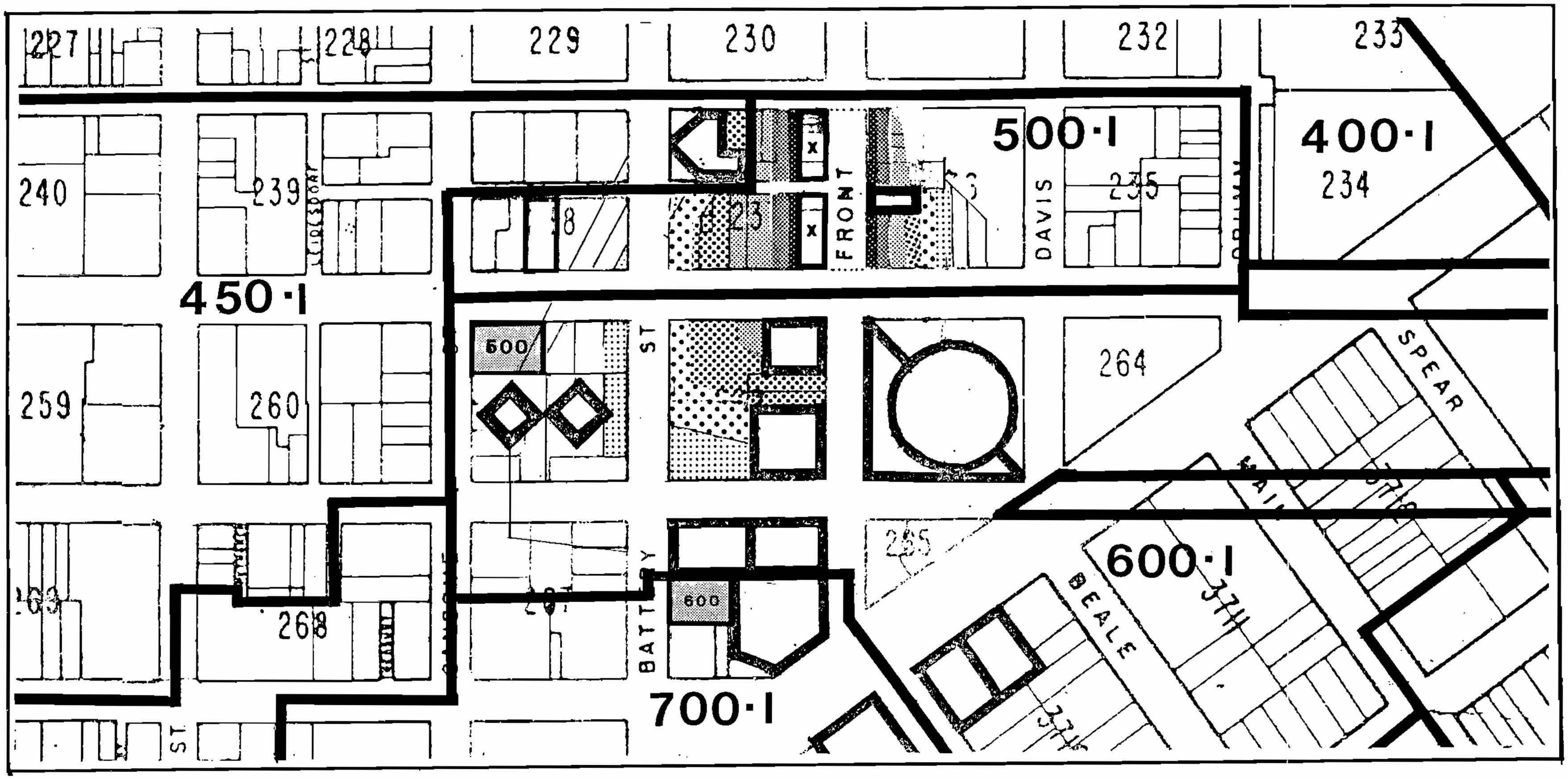
50 FEET
75 FEET
100 FEET
200 FEET
300 FEET
400 FEET

300 FEET

Fig. 48

FRONT STREET

PROPOSED SUN ACCESS ZONING COMPARED WITH EXISTING HEIGHT LIMITS



CRITICAL TIME: 11:00 a.m. to 2:00 p.m. (Standard Time)
12:00 a.m. to 3:00 p.m. (Daylight Savings)

CRITICAL MONTHS: March 21st. to Sept. 21st.

50 FEET

80 FEET

100 FEET

200 FEET

300 FEET

400 FEET

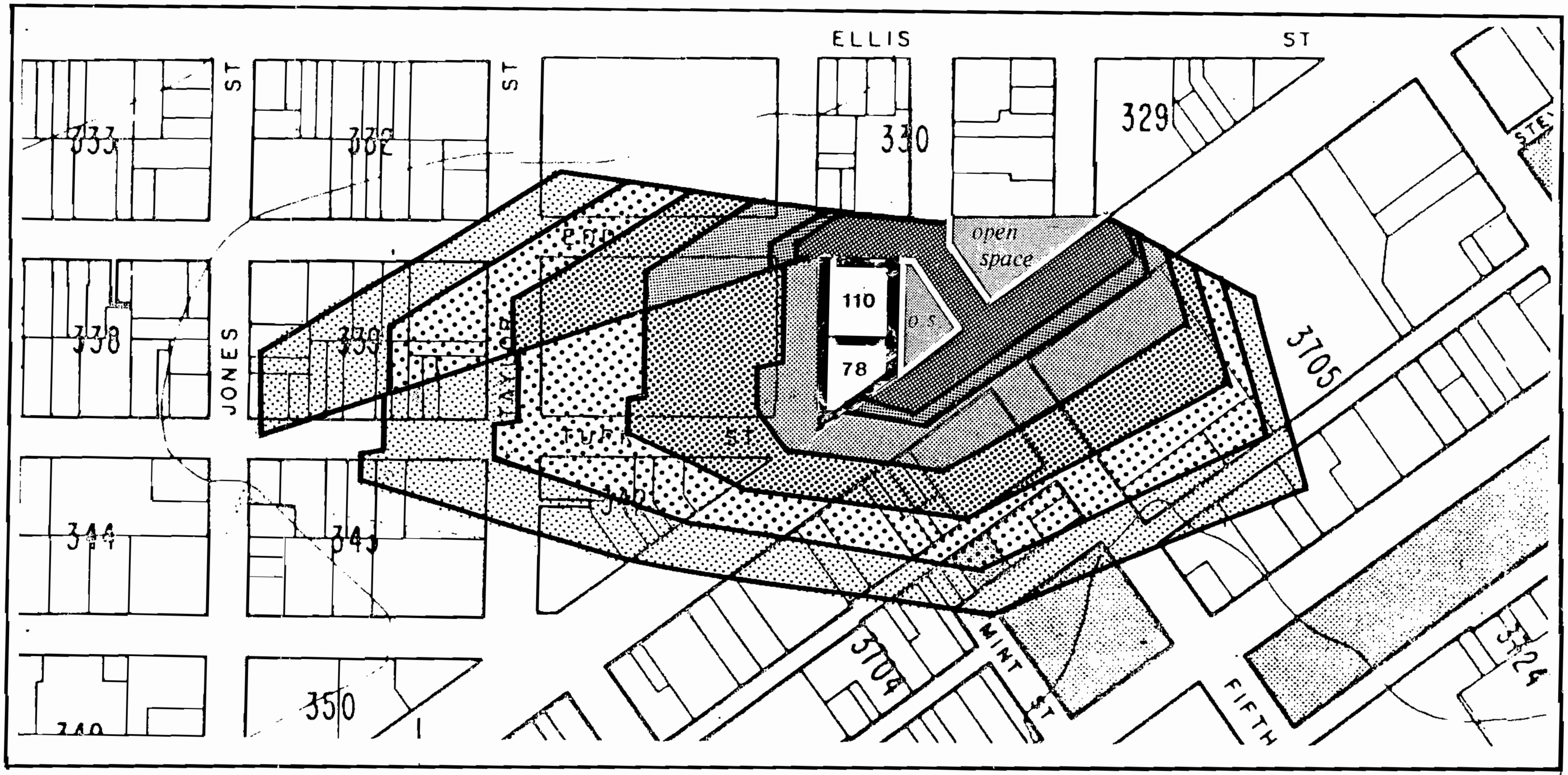
x Existing or 40' height

300 FEET

Fig. 49

HALLIDIE PLAZA

SOLAR FAN



CRITICAL TIME: 10:00 a.m. to 4:00 p.m. (Standard Time)
11:00 a.m. to 5:00 p.m. (Daylight Savings)

CRITICAL MONTHS: March 21st. to Sept. 21st.

Buildings in conflict with Solar Fan.

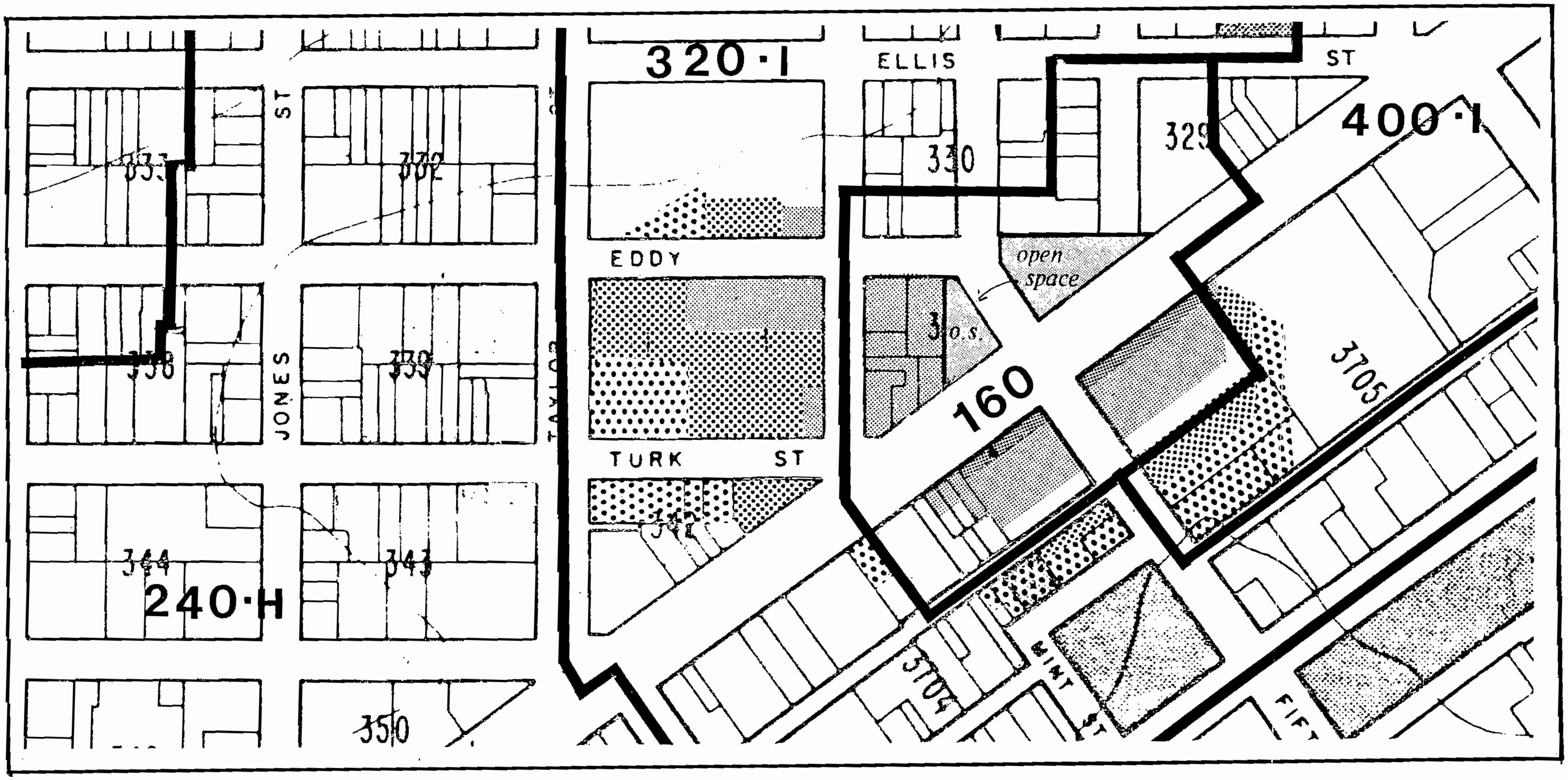
50 FEET
80 FEET
100 FEET
200 FEET
300 FEET
400 FEET
OPEN SPACE

300 FEET

Fig. 50

HALLIDIE PLAZA

PROPOSED SUN ACCESS ZONING COMPARED WITH EXISTING HEIGHT LIMITS



CRITICAL TIME: 10:00 a.m. to 4:00 p.m. (Standard Time)
11:00 a.m. to 5:00 p.m. (Daylight Savings)

CRITICAL MONTHS: March 21st. to Sept. 21st.

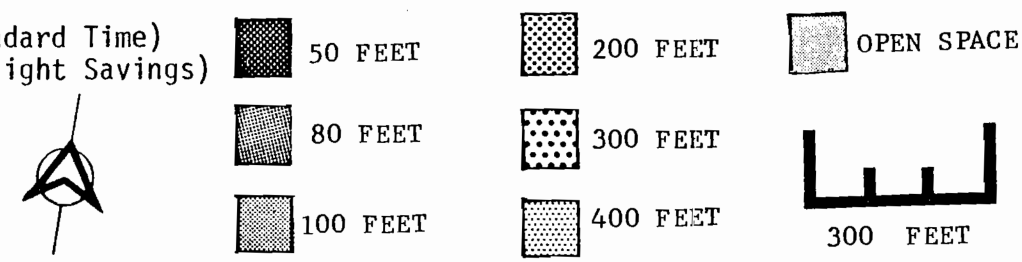
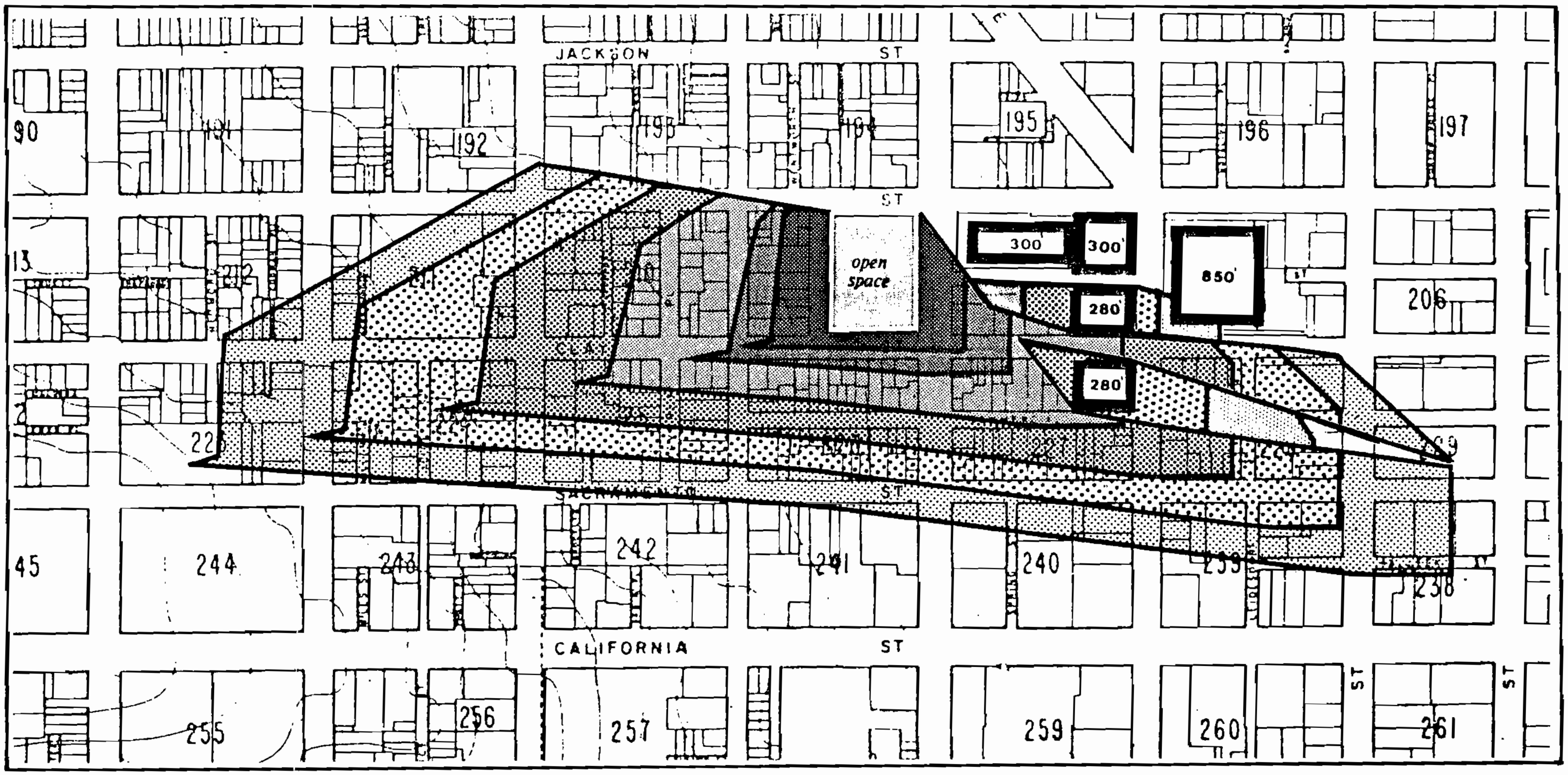


Fig. 51

PORTSMOUTH SQUARE SOLAR FAN



CRITICAL TIME: 8:00 a.m. to 4:00 p.m. (Standard Time)
9:00 a.m. to 5:00 p.m. (Daylight Savings)

CRITICAL MONTHS: March 21st. to Sept. 21st.

Buildings in conflict with Solar Fan.

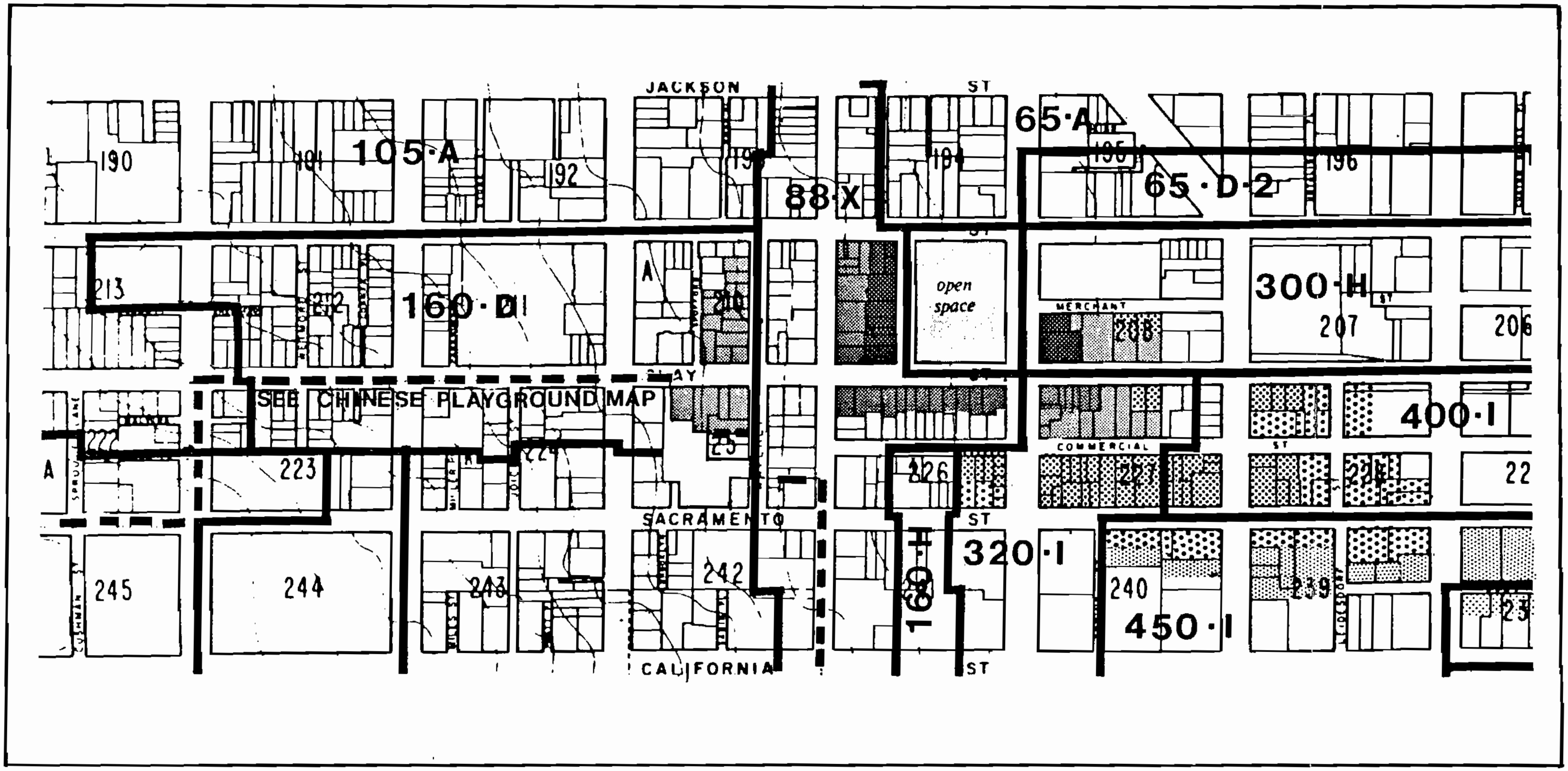
- 50 FEET
- 80 FEET
- 100 FEET
- 200 FEET
- 300 FEET
- 400 FEET
- OPEN SPACE

300 FEET

Fig. 52

PORTSMOUTH SQUARE

PROPOSED SUN ACCESS ZONING COMPARED WITH EXISTING HEIGHT LIMITS



CRITICAL TIME: 8:00 a.m. to 4:00 p.m. (Standard Time)
9:00 a.m. to 5:00 p.m. (Daylight Savings)

CRITICAL MONTHS: March 21st. to Sept. 21st.

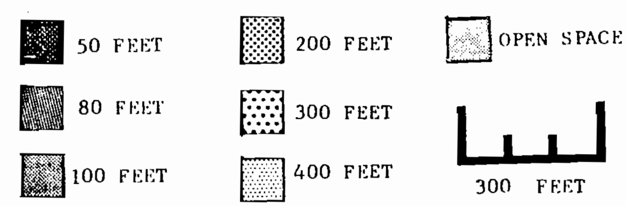


Fig. 53

ST. MARY'S SQUARE SOLAR FAN

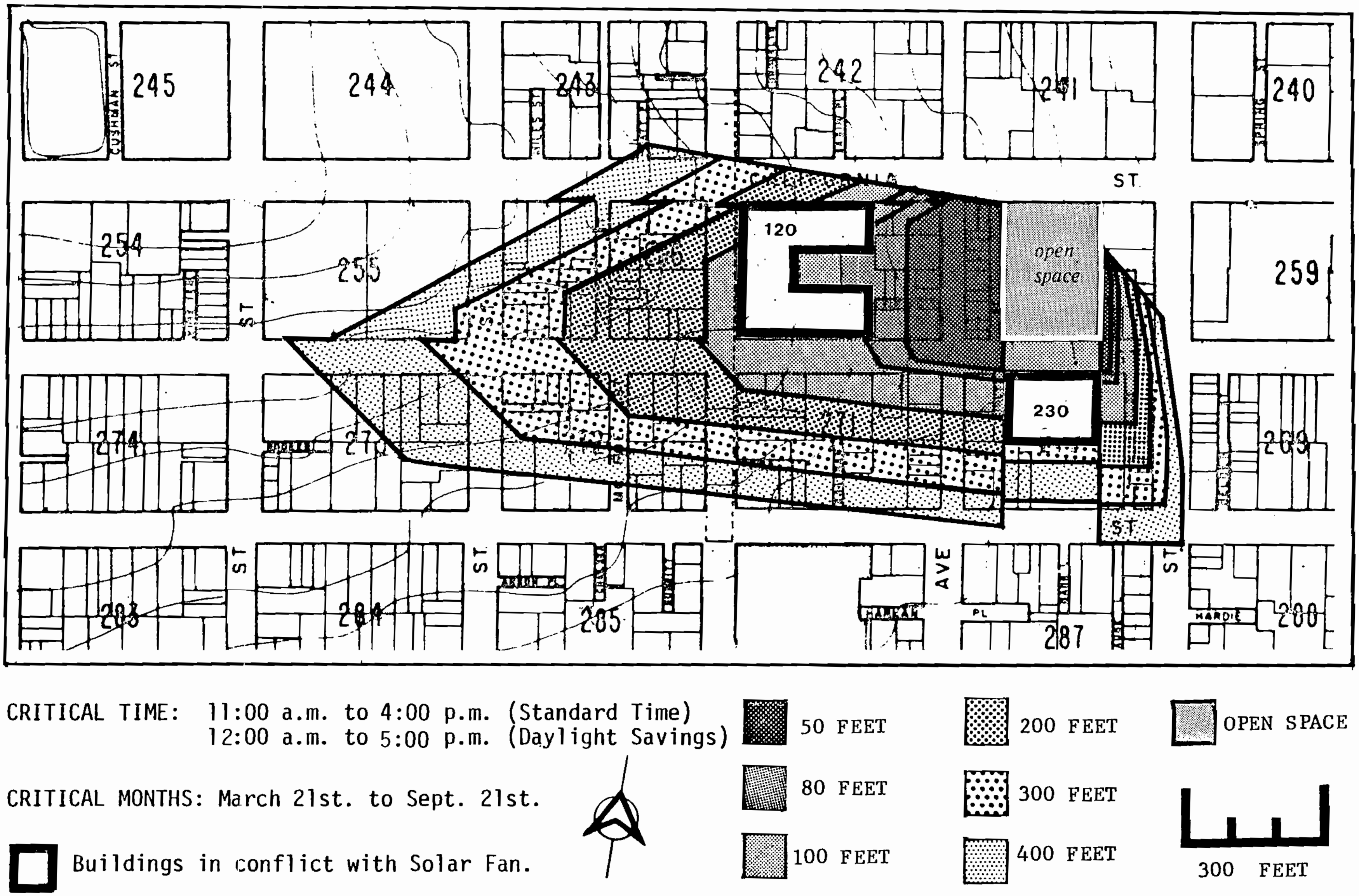
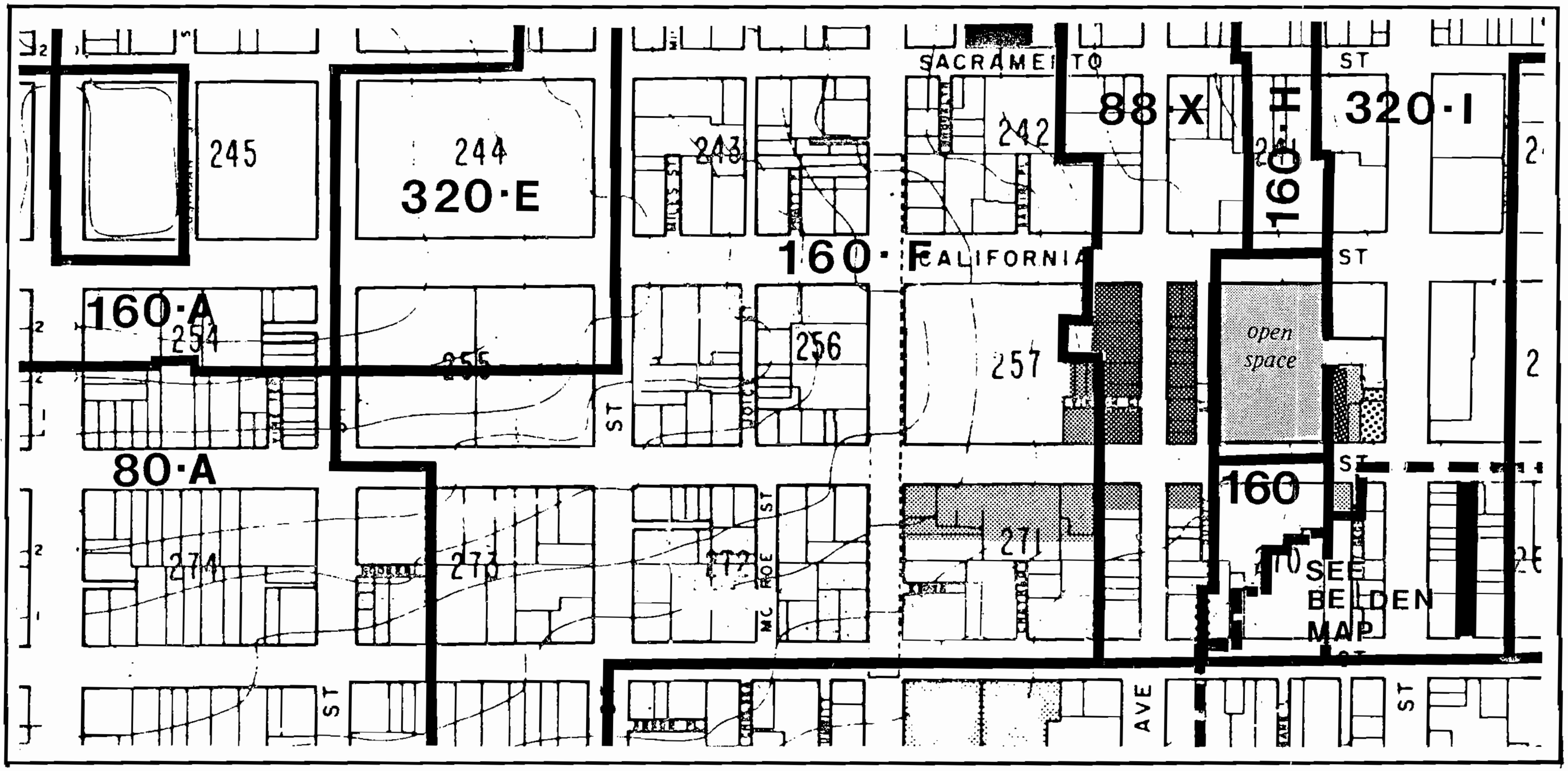


Fig. 54

ST. MARY'S SQUARE

PROPOSED SUN ACCESS ZONING COMPARED WITH EXISTING HEIGHT LIMITS



CRITICAL TIME: 11:00 a.m. to 4:00 p.m. (Standard Time)
12:00 a.m. to 5:00 p.m. (Daylight Savings)

CRITICAL MONTHS: March 21st. to Sept. 21st.

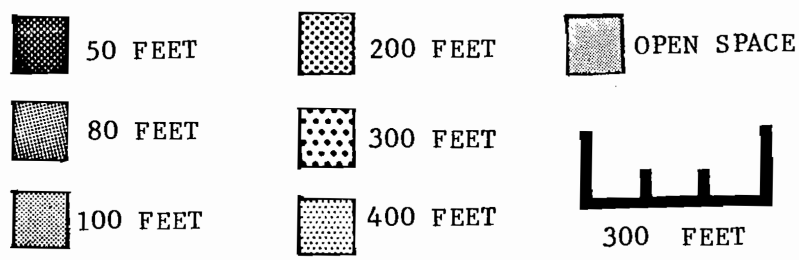
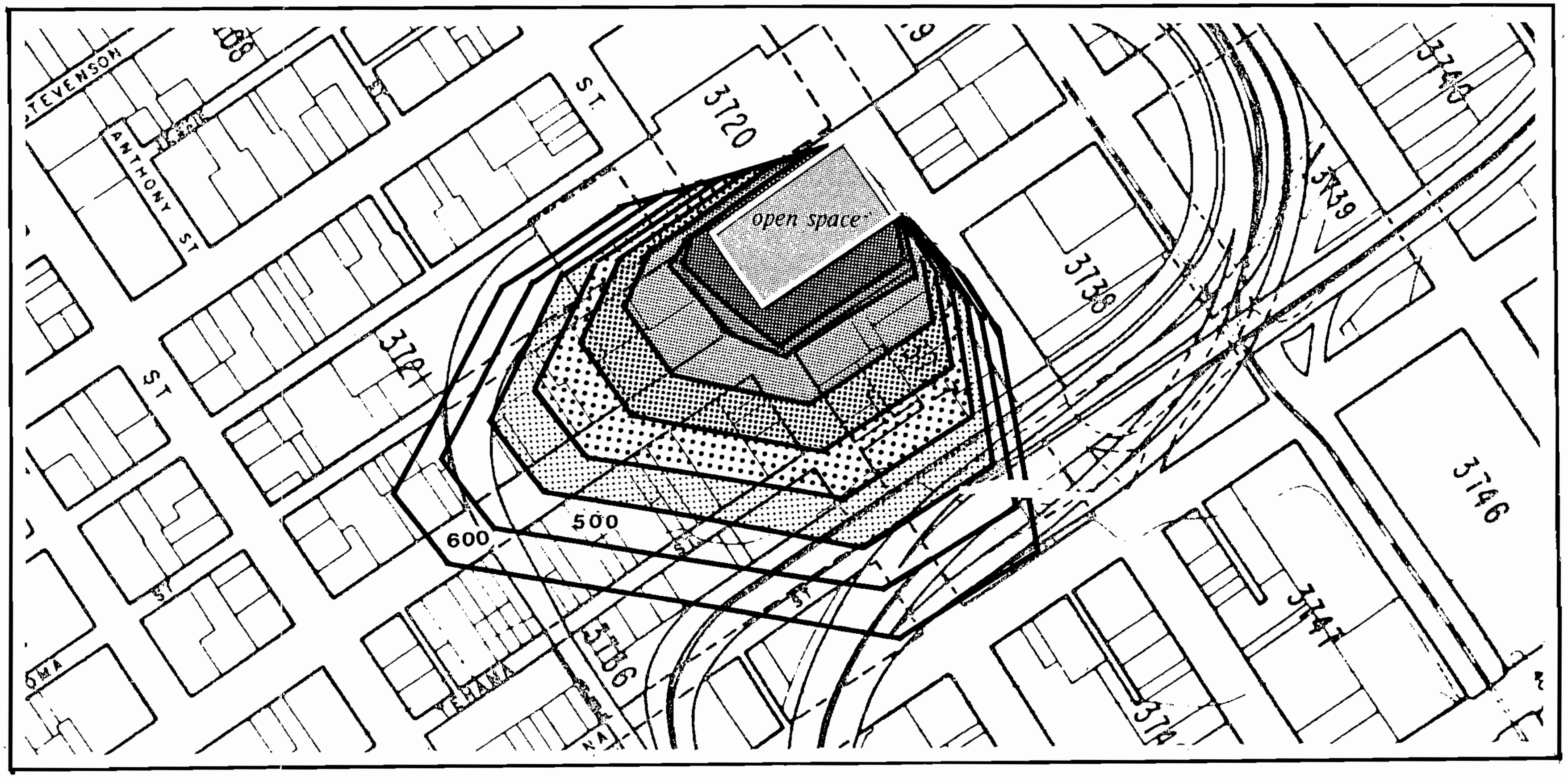


Fig. 55

PROPOSED SOUTH OF MARKET PARK SOLAR FAN



CRITICAL TIME: 11:00 a.m. to 2:00 p.m. (Standard Time)
12:00 a.m. to 3:00 p.m. (Daylight Savings)

CRITICAL MONTHS: March 21st. to Sept. 21st.

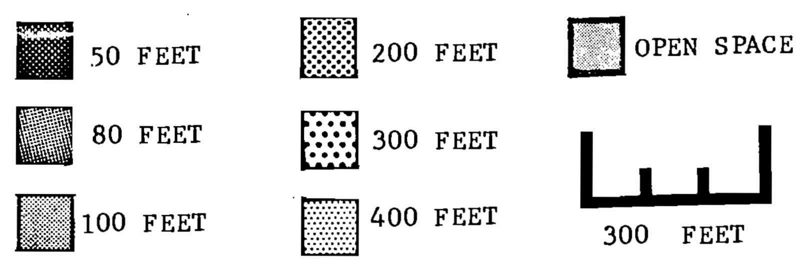
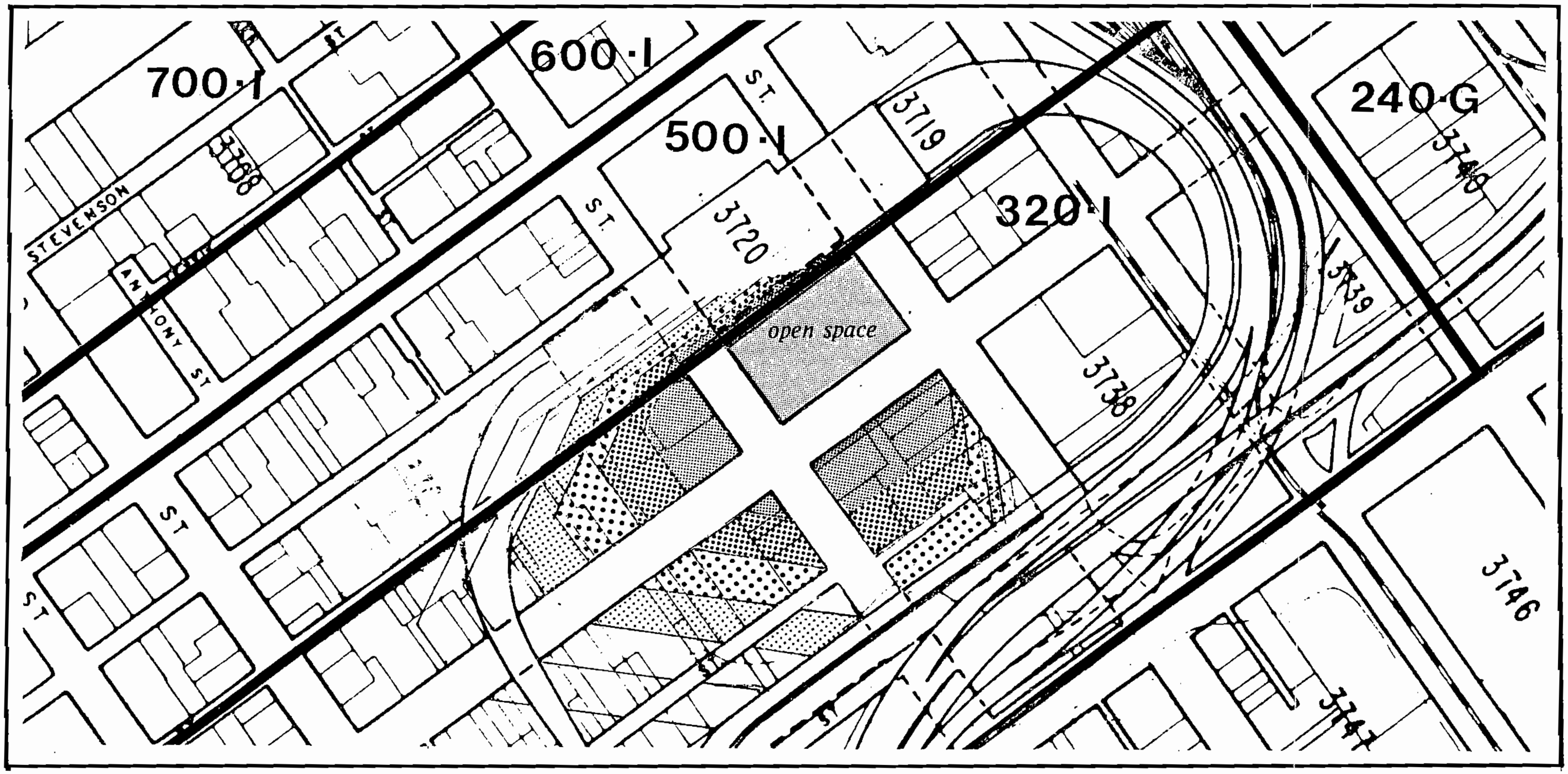


Fig. 56

PROPOSED SOUTH OF MARKET PARK

PROPOSED SUN ACCESS ZONING COMPARED WITH EXISTING HEIGHT LIMITS



CRITICAL TIME: 11:00 a.m. to 2:00 p.m. (Standard Time)
12:00 a.m. to 3:00 p.m. (Daylight Savings)

CRITICAL MONTHS: March 21st. to Sept. 21st.

50 FEET
80 FEET
100 FEET
200 FEET
300 FEET
400 FEET
OPEN SPACE

300 FEET

Fig. 57

NEW TENDERLOIN PARK (SGT. McAULTY PARK) SOLAR FAN

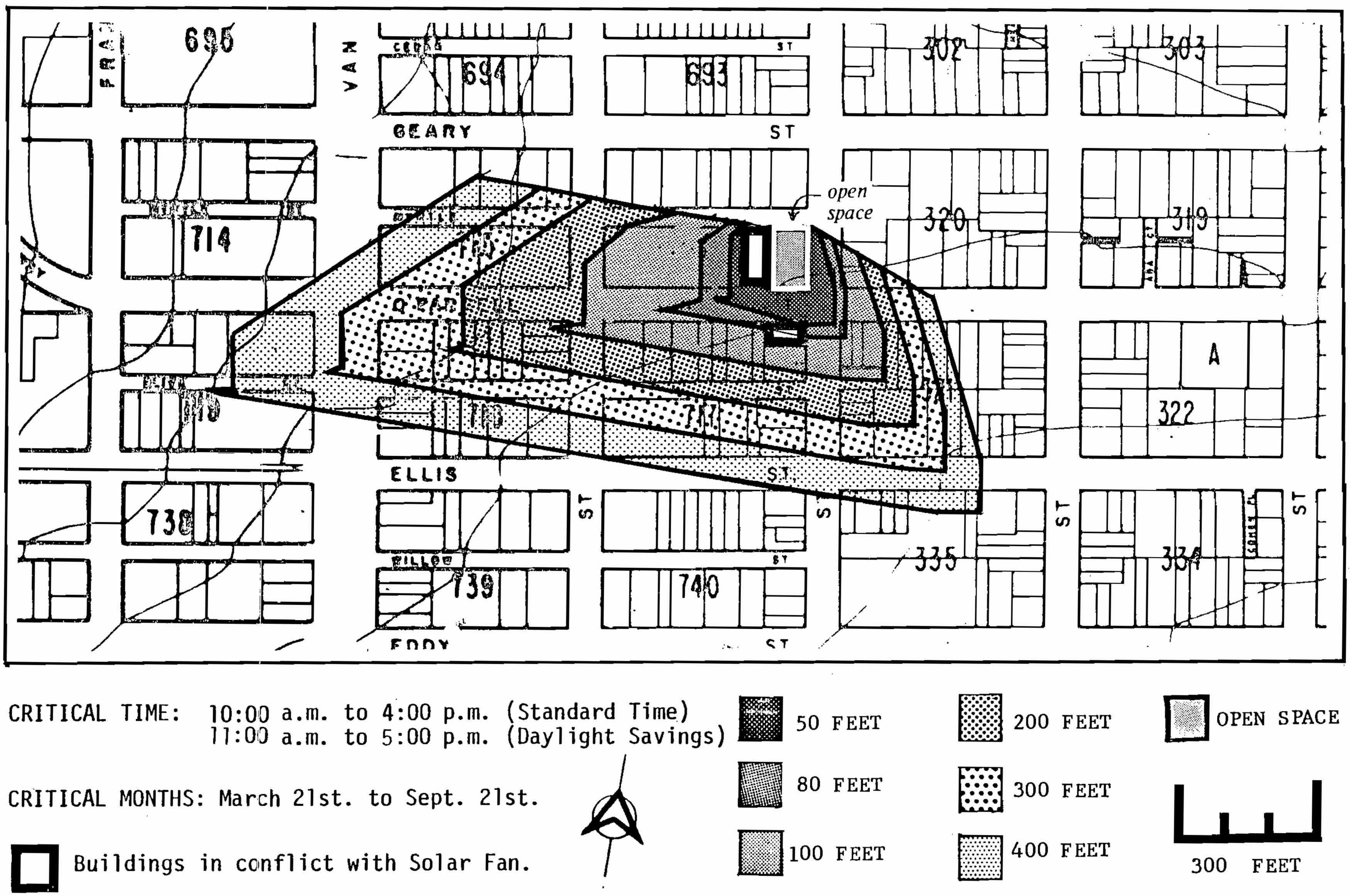
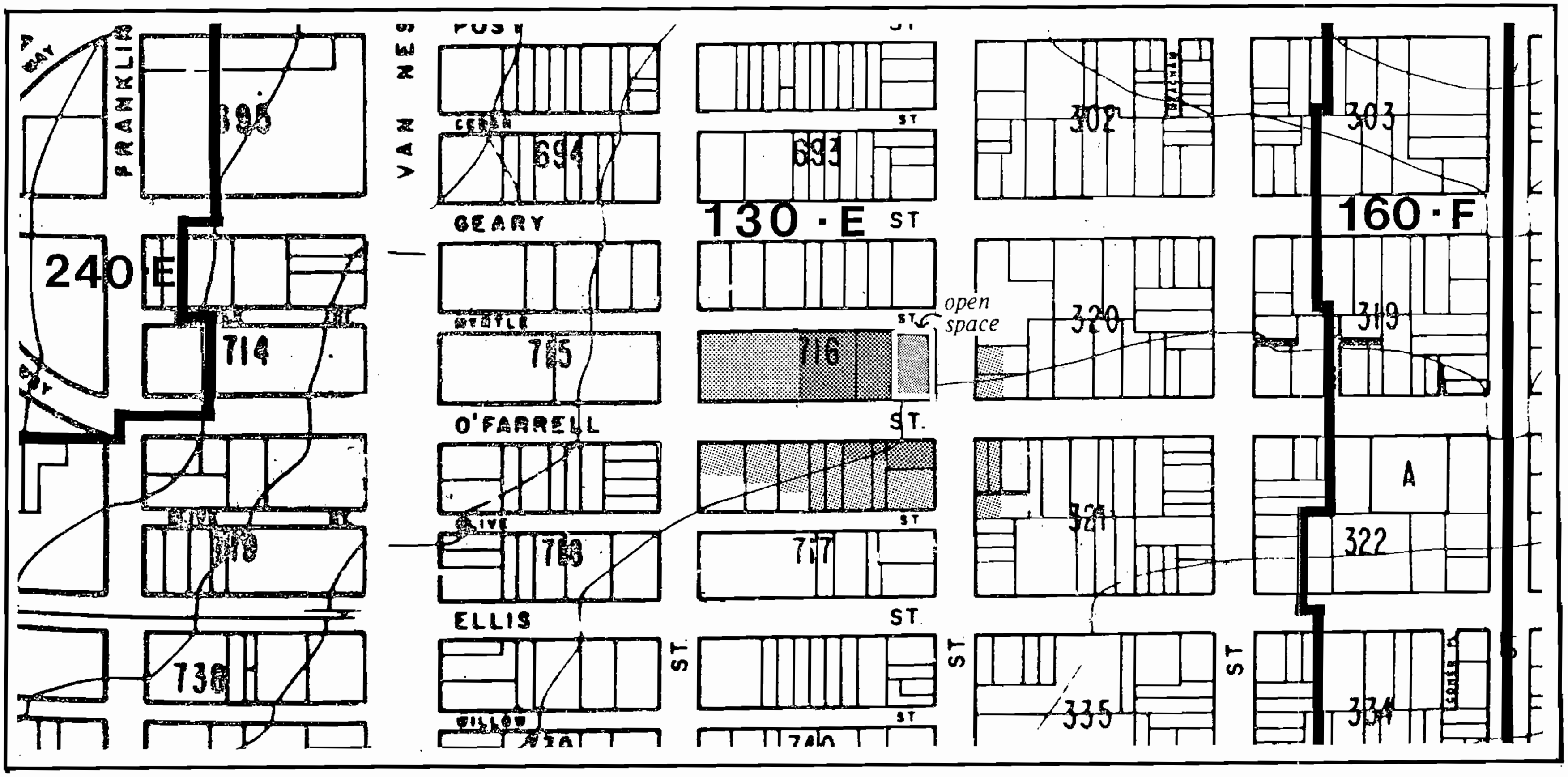


Fig. 58

NEW TENDERLOIN PARK (SGT. McAULTY PARK) PROPOSED SUN ACCESS ZONING COMPARED WITH EXISTING HEIGHT LIMITS



CRITICAL TIME: 10:00 a.m. to 4:00 p.m. (Standard Time)
11:00 a.m. to 5:00 p.m. (Daylight Savings)

CRITICAL MONTHS: March 21st. to Sept. 21st.

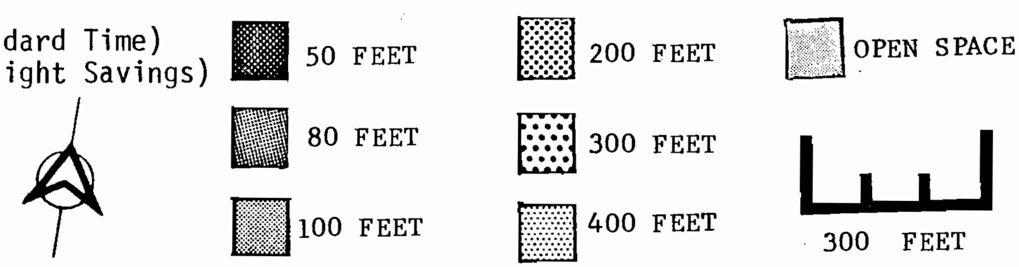
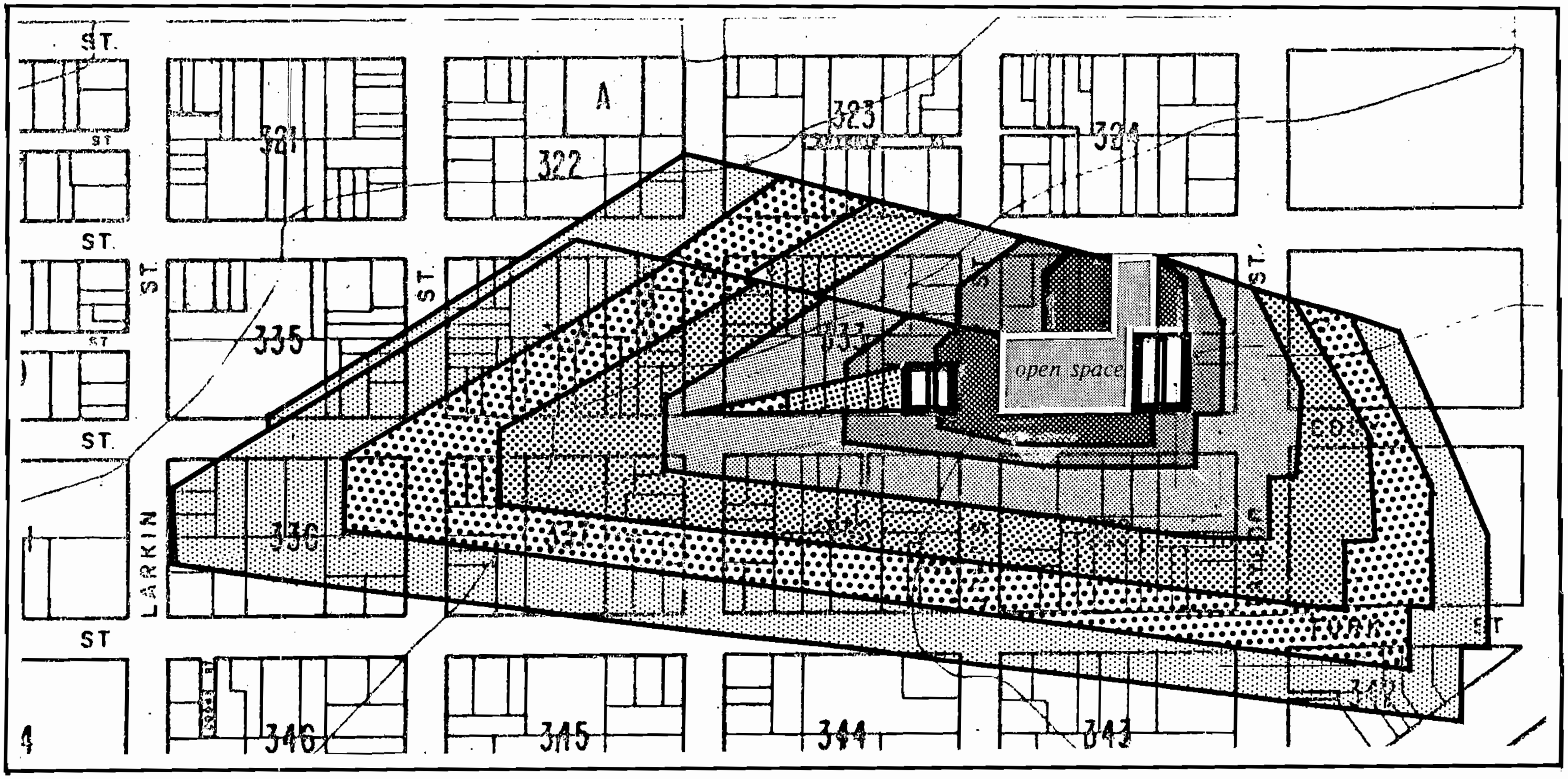


Fig. 59

PROPOSED TENDERLOIN PARK SOLAR FAN



CRITICAL TIME: 9:00 a.m. to 4:00 p.m. (Standard Time)
10:00 a.m. to 5:00 p.m. (Daylight Savings)

CRITICAL MONTHS: March 21st. to Sept. 21st.

Buildings in conflict with Solar Fan.

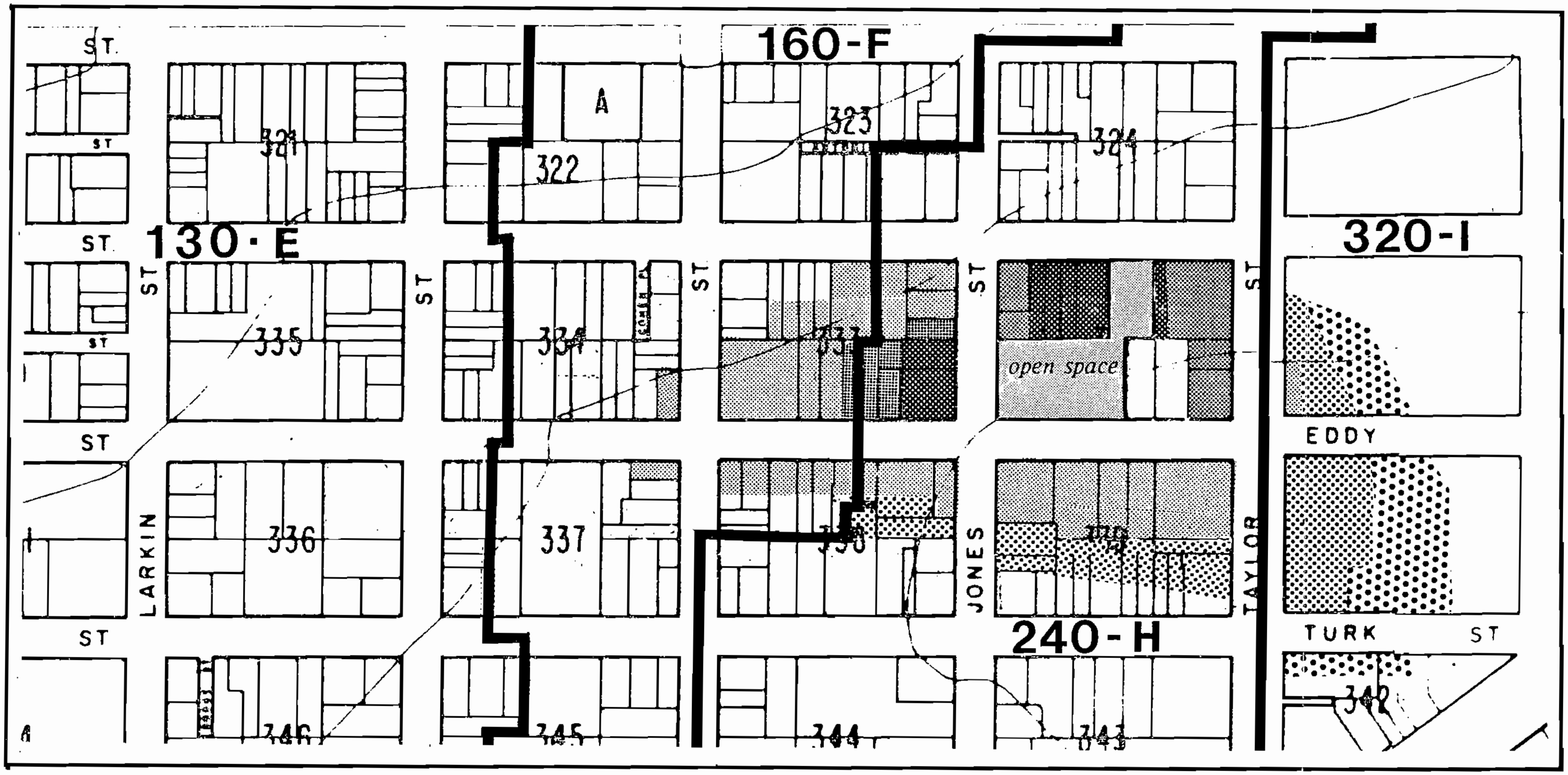
50 FEET
80 FEET
100 FEET
200 FEET
300 FEET
400 FEET
OPEN SPACE

300 FEET

Fig. 60

PROPOSED TENDERLOIN PARK

PROPOSED SUN ACCESS ZONING COMPARED WITH EXISTING HEIGHT LIMITS



CRITICAL TIME: 9:00 a.m. to 4:00 p.m. (Standard Time)
10:00 a.m. to 5:00 p.m. (Daylight Savings)

CRITICAL MONTHS: March 21st. to Sept. 21st.

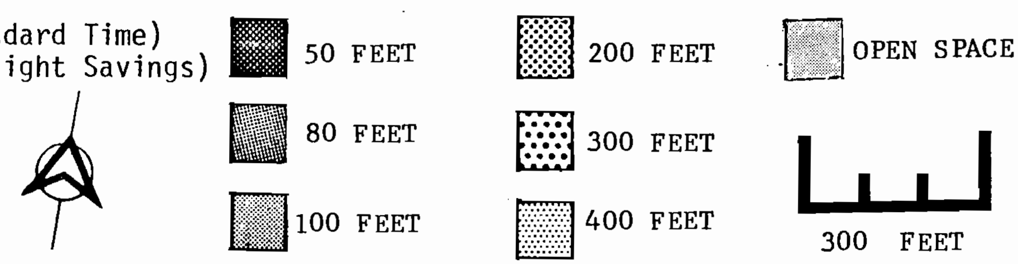
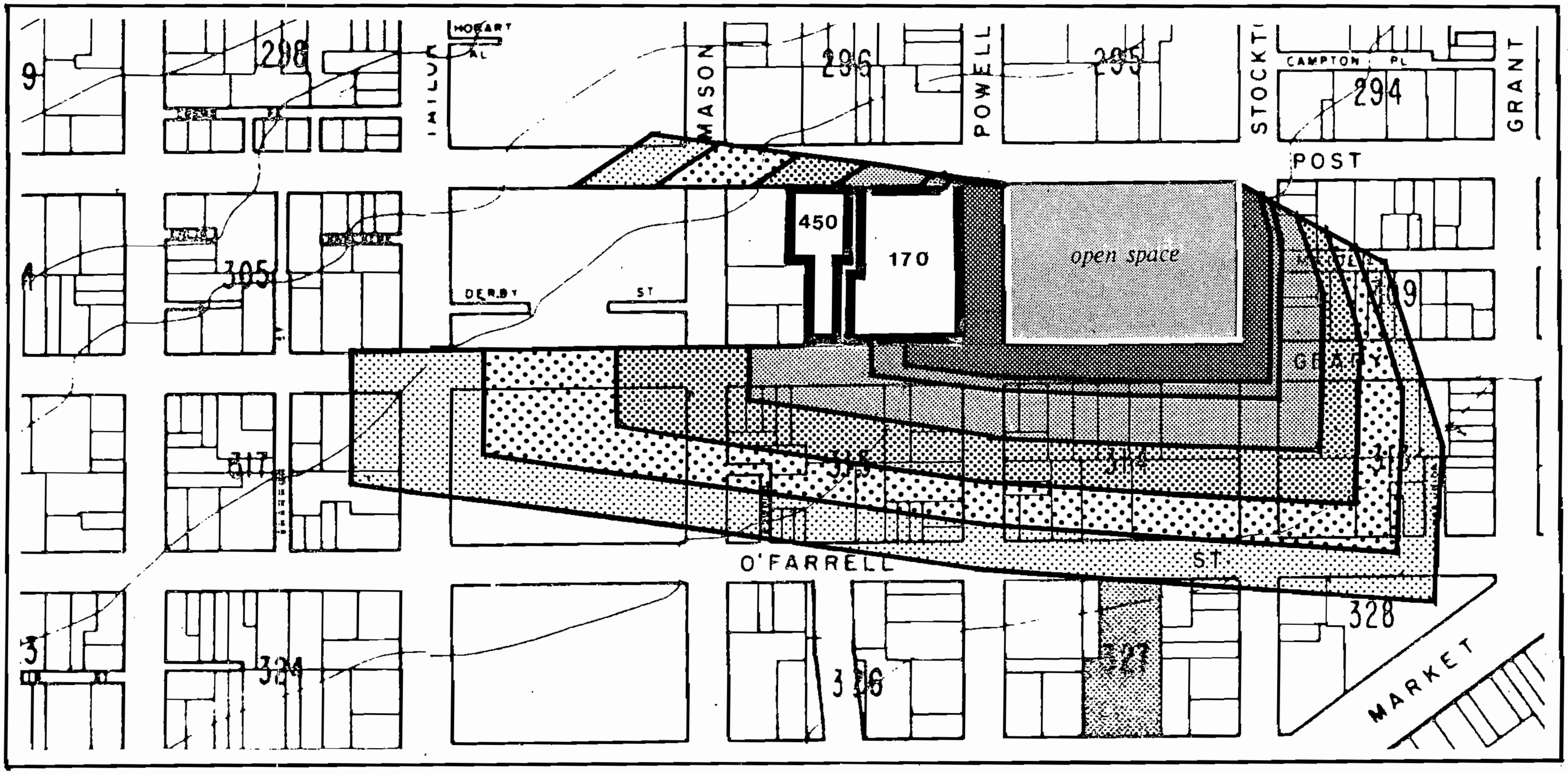


Fig. 61

UNION SQUARE SOLAR FAN



CRITICAL TIME: 10:00 a.m. to 4:00 p.m. (Standard Time)
11:00 a.m. to 5:00 p.m. (Daylight Savings)

CRITICAL MONTHS: March 21st. to Sept. 21st.

Buildings in conflict with Solar Fan.

50 FEET

80 FEET

100 FEET

200 FEET

300 FEET

400 FEET

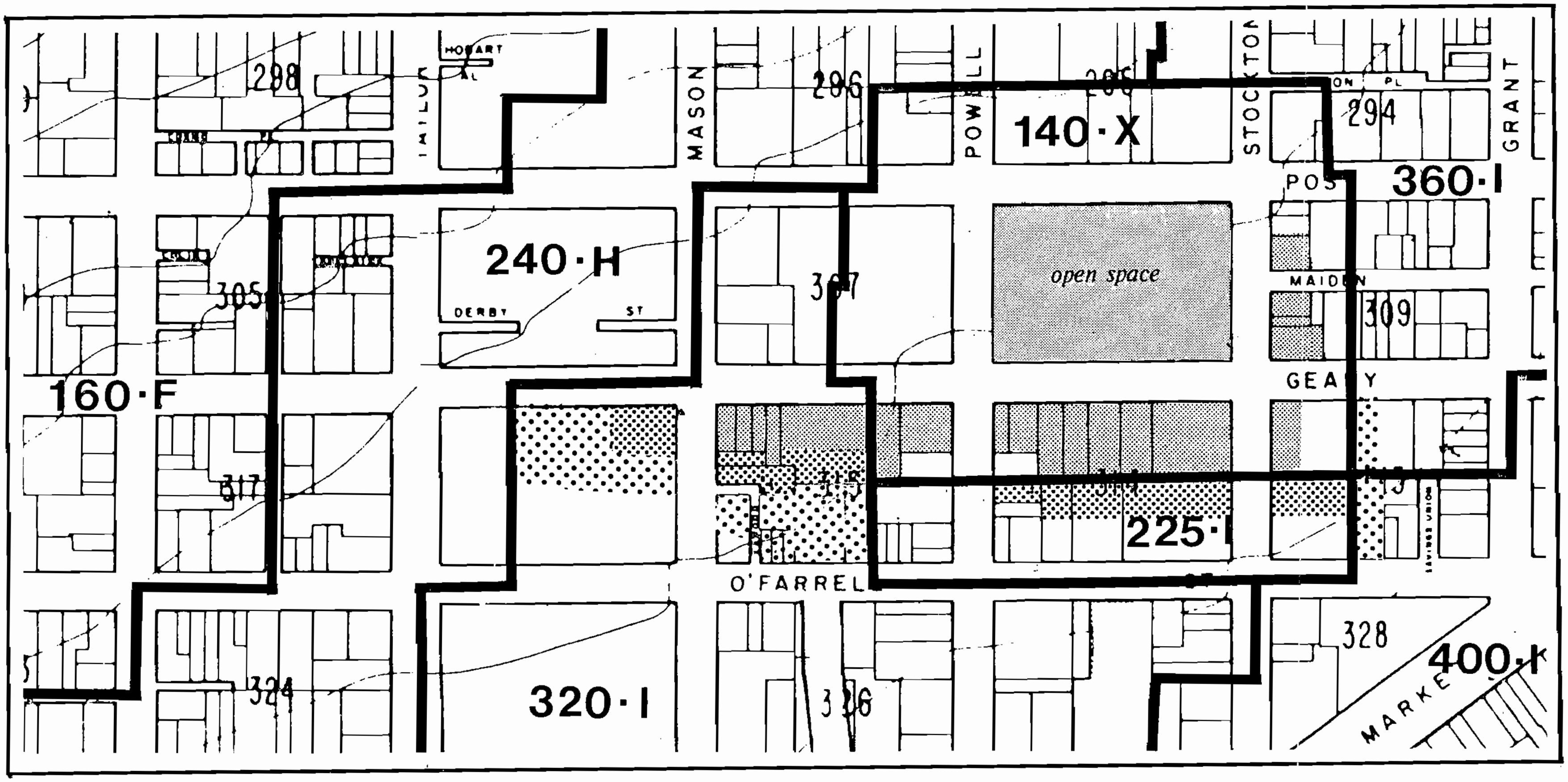
OPEN SPACE

300 FEET

Fig. 62

UNION SQUARE

PROPOSED SUN ACCESS ZONING COMPARED WITH EXISTING HEIGHT LIMITS



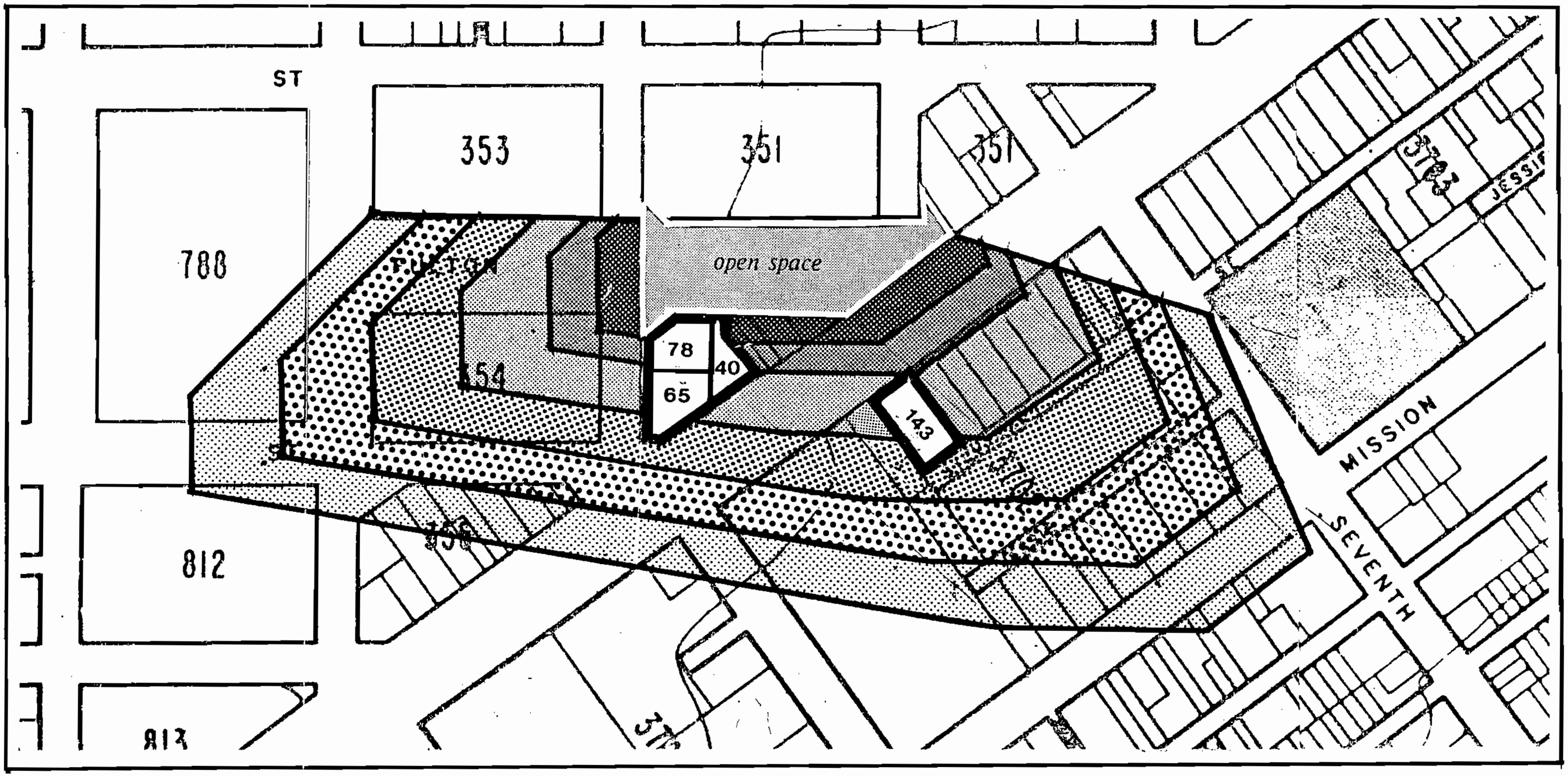
CRITICAL TIME: 10:00 a.m. to 4:00 p.m. (Standard Time)
11:00 a.m. to 5:00 p.m. (Daylight Savings)

CRITICAL MONTHS: March 21st. to Sept. 21st.

50 FEET
80 FEET
100 FEET
200 FEET
300 FEET
400 FEET
OPEN SPACE
300 FEET

Fig. 63

UNITED NATIONS PLAZA SOLAR FAN



CRITICAL TIME: 9:00 a.m. to 3:00 p.m. (Standard Time)
10:00 a.m. to 4:00 p.m. (Daylight Savings)

CRITICAL MONTHS: March 21st. to Sept. 21st.

Buildings in conflict with Solar Fan.

50 FEET
80 FEET
100 FEET
200 FEET
300 FEET
400 FEET
OPEN SPACE
300 FEET

Fig. 64

UNITED NATIONS PLAZA

PROPOSED SUN ACCESS ZONING COMPARED WITH EXISTING HEIGHT LIMITS

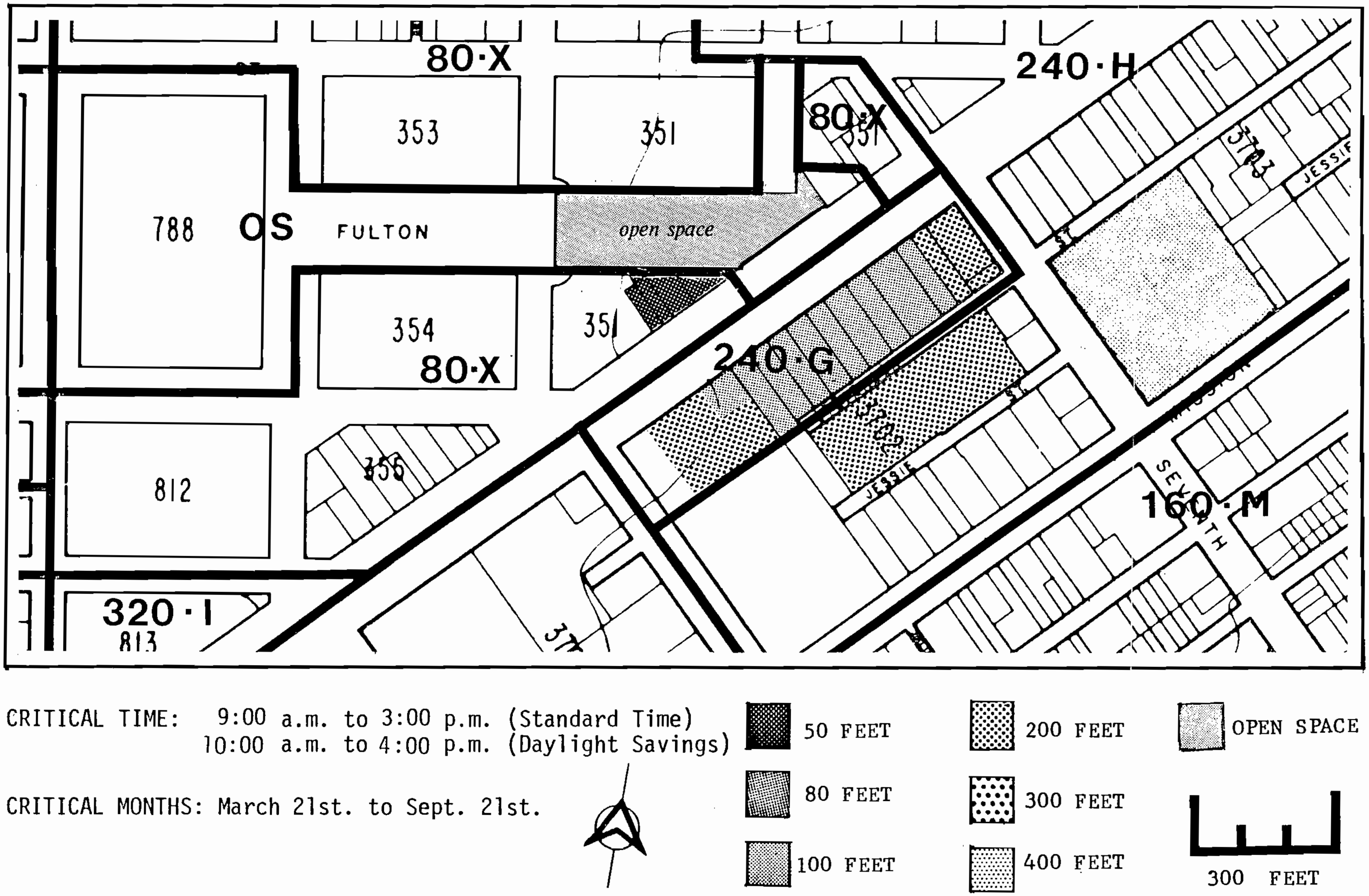


Fig. 65

Methodology

This section of the report gives an account of methodologies used in conducting area specific studies.

SUN CALCULATOR

Understanding the movement of the sun is crucial in understanding the application of sun access criteria to issues of urban design. The sun is perpendicular to the equator on or about March 21st, the vernal equinox, after which time it moves northward until it reaches its zenith directly above the Tropic of Cancer on June 21st, the summer solstice. During the rest of the year, the sun moves southward, crossing the equator on September 21st, the autumnal equinox, until it reaches the Tropic of Capricorn on December 21st, the date of the winter solstice.

In order to apply sun access criteria in establishing open space policies it is necessary to measure the sun's position in relation to a given location on the earth's surface. The most practical instrument for this task is the sun calculator developed by Libbey-Owens-Ford Company in the 1950's to provide architects and urban designers a simple, quick, and relatively accurate method for determining solar angles (Fig. 66). The angles that can be found with this instrument include the bearing (or azimuth) of the sun with respect to true south measured at the sun's maximum daily altitude, and the angle of incidence, that is the angle formed between the line of the sun's rays and the vertical face of a building.

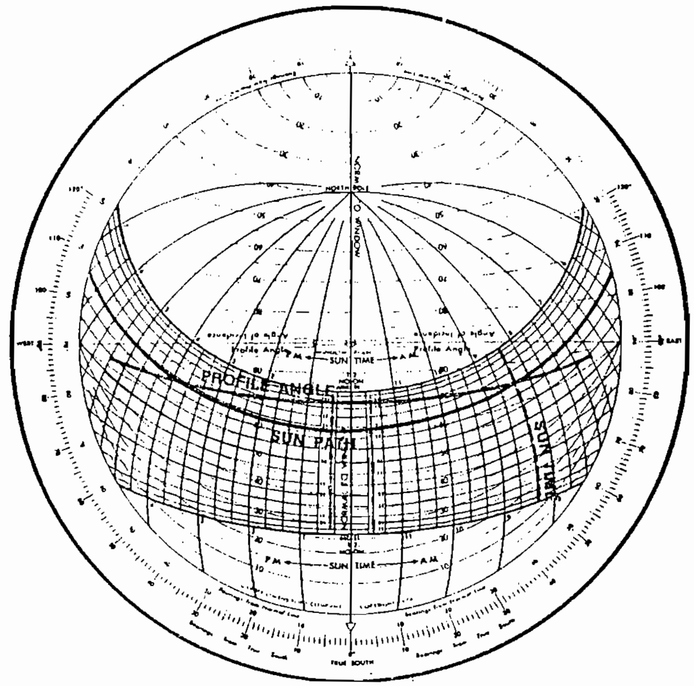


Fig. 66 - Solar calculator showing sun path and profile angle lines, both used to determine sun access guidelines.

In essence the sun calculator is a small disc upon which a series of curved lines represent the position of the sun above the surface of the earth. All the angles mentioned above can be discovered by superimposing a sun chart over the sun calculator and observing where the superimposed latitudinal lines, measured in intervals of 4°, intersect the curved reference lines below. A wedge shaped scaled cursor, pivoted at the center of the sun calculator disc, can be used to establish the bearing angle and to find the true altitude. Once this basic information has been read, cut-off angles and profile planes can be determined for any given open space at any given location.

SKY EXPOSURE STUDIES

In the fall of 1982 the Environmental Simulation Laboratory conducted a set of comprehensive sky exposure studies throughout the downtown area of San Francisco in order to evaluate existing sun access conditions. Sky exposure studies are carried out to photographically gauge the amount of exposed sky above a given street at a given location. This measurement is made possible by using a 360° fish-eye lens attached to a single reflex camera set perpendicular to the horizontal plane and placed in the center of the street. Photographs of the amount of sky exposed above buildings aligning the street can be compared to photographs taken at different locations. A relative, rather than absolute measure of the amount of sky exposed above specific locations can therefore be made (see Fig. 67).

Sky exposure measurements are valuable in providing an understanding of the degree to which large buildings prevent daylight from reaching the street. The

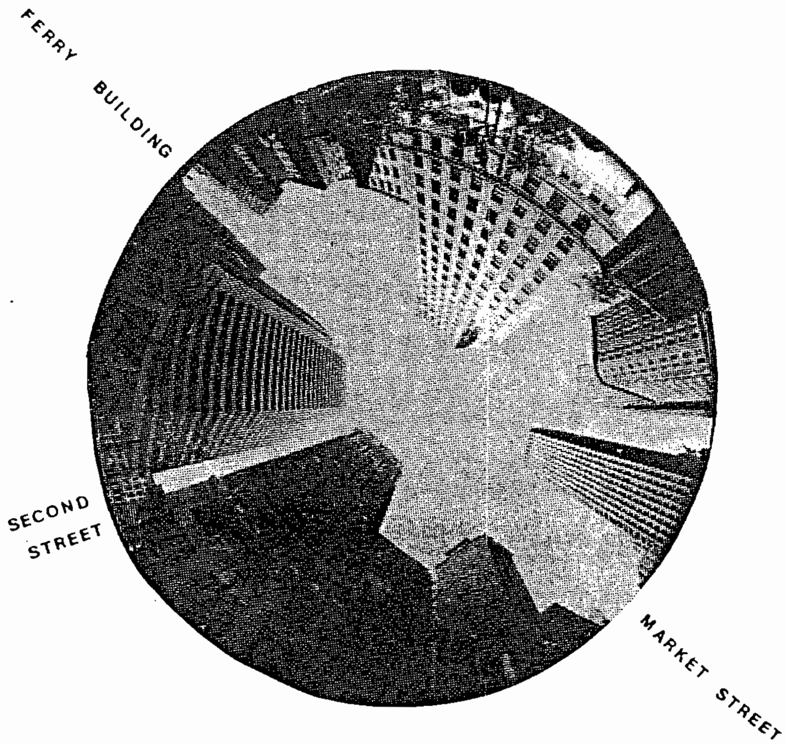


Fig. 67 - A photograph of Market St. using a fish-eye lens to quantify the amount of sky obscured by highrise buildings.

WEST

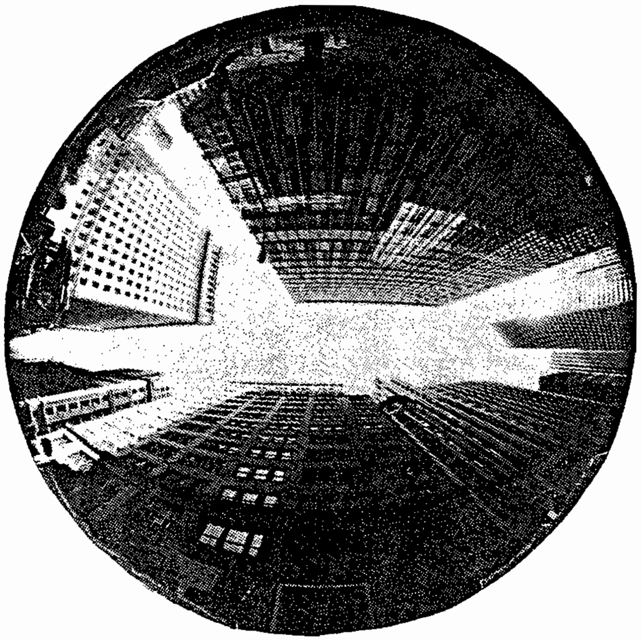
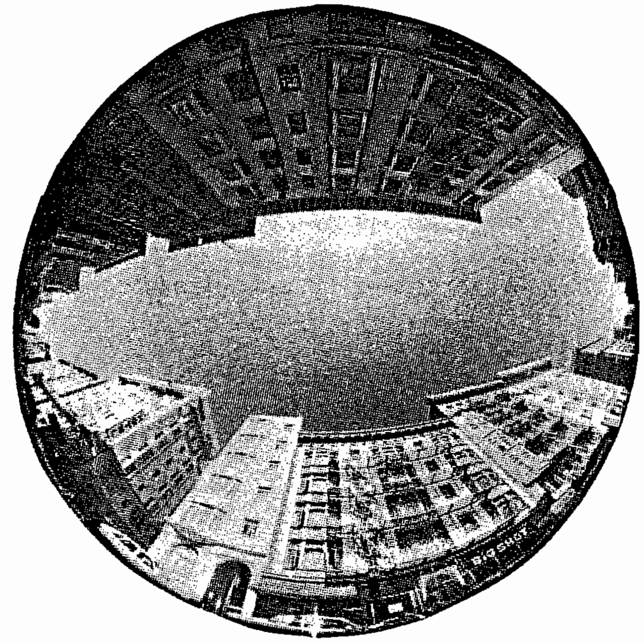


Fig. 68 - Fish-eye view of Sutter St. in the Financial District.



EAST

Fig. 69 - Fish-eye view of Sutter St. in the Retail District.

visual impact, for example, of the amount of sky exposed above streets in the Business District is striking when compared with the amount of sky exposed above the Retail District (see Fig. 68 and 69). As the canyon-like street walls of the Business District give way to the more traditional urban scale of the Retail Area, the volume of sky exposed expands, allowing more air and sunlight to reach the street. These latter conditions are conducive to a more leisurely pedestrian pace for shopping and strolling, which suggests a direct link between the economic activity of an area, the degree of comfort people feel on the street, and the amount of sky exposure that exists in various parts of the city.

SUN PATH OVERLAYS

Fish-eye lens photography, similar to those described in the Sky Exposure section of this report, can be used not only to give a comparative measure of the volume of sky exposed above a given point, but they can also be employed in a more analytic fashion to examine the number of hours in a day that the sun reaches street level. Using photo montage techniques, the path of the sun, calculated by using the sun calculator, can be superimposed on a photograph taken at a specific reference point, and the critical hours for sun access for a particular locality can be determined.

Figure 70, a fish-eye view taken along Market Street, illustrates the use of sun path overlays. The illustration shows the path of the sun across the sky at four times in the year: December 21st, June 21st, and on March 21st and September 21st when the sun travels the same path for both dates. The path of the sun in June, the highest of the three, is the one less likely to be compromised by potential high rise development along Market Street. On

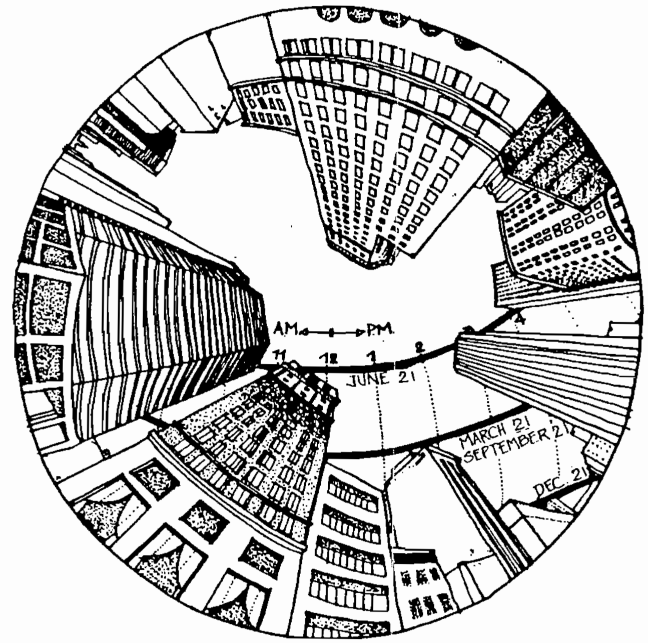


Fig. 70 - Sketch taken from fish-eye photograph along Market St.

June 21st direct sunlight reaches the street at 10:30 AM then disappears at 11:00 AM. The sun reappears at 11:30 AM then stays on the street until 2:45 PM when it disappears briefly, only to return at 3:20 PM. Direct sun at street level ceases at approximately 4:10 PM.

On its March/September path the sun reaches street level from 8:45 AM until 9:15 AM before disappearing. Shortly after 12:00 noon, the sun stays on the street until 3:45 PM at which time it disappears for the day. Since the path of the sun is lowest on December 21st, it is the most obstructed. On this date the sun reaches the street only between 3:30 PM and 4:00 PM over the southern extremity of Market Street.

Sun path overlay studies are important for two reasons: they can show the line of the path of the sun at any given time of the year, and they can measure both the duration and precise time of the sun at the street level for any day of the year. They therefore can be used as parameters to define sun access criteria on an areawide basis or for specific streets or public open space. When a photo montage of a new high rise development is set against sun path overlays for a given site, the degree to which new buildings compromise existing sun access conditions can also be illustrated. Used in this way sun path overlay studies can be a powerful tool in the evaluation and design of downtown development, and for the urban design process.

SKY DOME (LUMINOSITY/DAYLIGHT DISTRIBUTION/REFLECTIVITY)

The hemispherical sky dome simulator in the College of Environmental Design at UC Berkeley is a 24 foot diameter indoor facility capable of realistically simulating various conditions of sky luminance. The sky simulator can reproduce either stable and uniform overcast or clear sky conditions on command. The direct luminance of the sun can either be incorporated into or selected out of these conditions. The reflective properties of street surfaces or light-colored building facades can also be modeled, adjusted and analyzed within this facility. A range of possible lighting conditions generated by potential development projects can be simulated in the sky dome and compared with existing lighting conditions measured in the field. Different design solutions can therefore be tested and optimal lighting conditions obtained.

Daylight luminosity is not uniformly distributed throughout the sky. If we construct a cylinderical graph about a model of a prototypical building design, as in Figure 71, and record variations in light intensity on the graph, we can observe that light levels about the sun indicate a higher level of luminosity than areas distant from the sun. If we now separate the graph along its north-south axis and "unroll" the eastern half of the cylinderical wall into a two dimensional plane, the shape within this plane can be taken to represent the amount of daylight obscured by the prototypical design model. When spring, summer and winter lighting conditions are compared, we find that a tall building mass placed at the north end of a

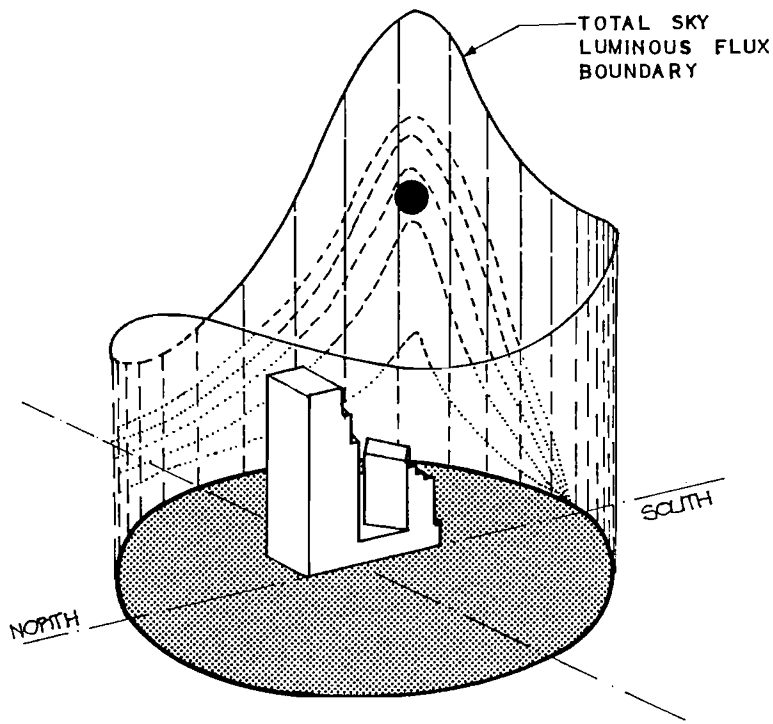


Fig. 71 - Cylindrical graph

site will always obscure less daylight than a similar building mass positioned at the south end of the site. This finding therefore strongly supports the recommendation of this report that sun access criteria are necessary for the future design of the downtown area.

The future development of San Francisco must also take note of the important effect light-colored building facades can have in the downtown core. Reflected light does not significantly increase the thermal comfort of outdoor locations denied direct sunlight. The use and "enjoyment" of a number of small streets, alleyways, lunchtime malls, and parks can be greatly enhanced by reflected sunlight. Despite the use of light-colored surfaces in some new high rise buildings, study of the qualities and properties of reflected light in terms of its impact on urban design remains neglected. Nevertheless opportunities exist in downtown San Francisco to exploit this facet of design and therefore a greater understanding of the potential use of reflected light in a creative way is urgently needed.

Site Studies

This section of the report gives an account of site studies carried out at four locations in downtown San Francisco. The areas studied included Portsmouth Square, Hallidie Plaza, Belden Street, and the Chinese playground.

PORTSMOUTH SQUARE

Portsmouth Square lies within a pocket of potential development along Kearny Street, at a point where the boundaries of the Retail District, the Business District and Chinatown meet. The square has historic significance in the development of San Francisco; it was in this square that the American flag was raised for the first time in California in 1846, the city of San Francisco first

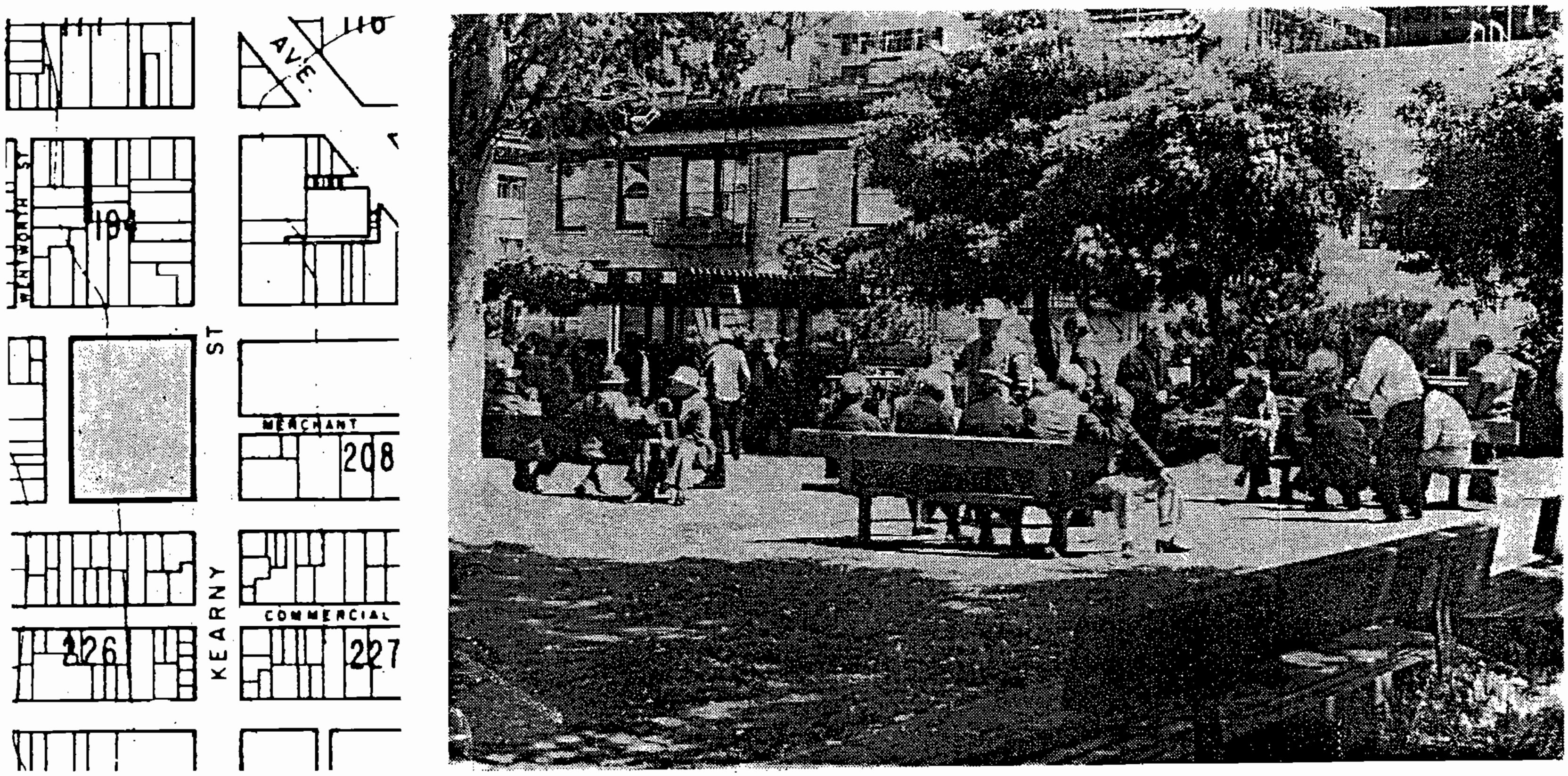


Fig. 72 - Portsmouth Square; a daily gathering place for the Chinatown community. Notice the empty benches in the shadow and the intense use of benches in the sun.

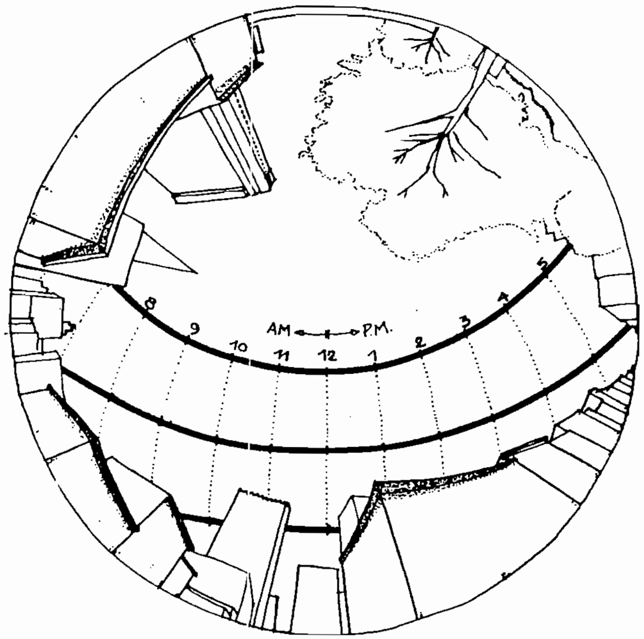


Fig. 73 - Portsmouth Square; fish-eye sketch of existing conditions.

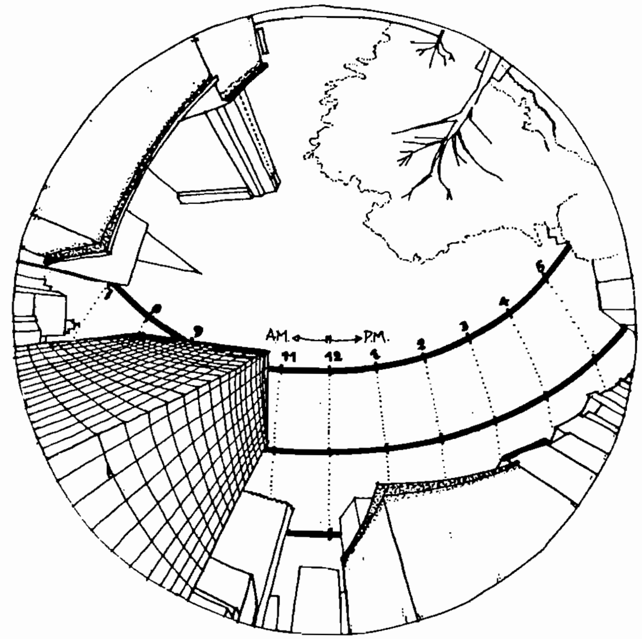


Fig. 74 - Portsmouth Square; illustrating a building envelope with floor area ratio of 17.

grew about this square, and in 1883 the world's first cable car line began operation from the corner of Kearny and Clay. Portsmouth Square is today an important space for the Chinese community, and morning outdoor activities in the square are particularly dependent on the availability of sun and light.

Sun path overlays for the square, for the spring, summer, and fall, demonstrate that under existing conditions,

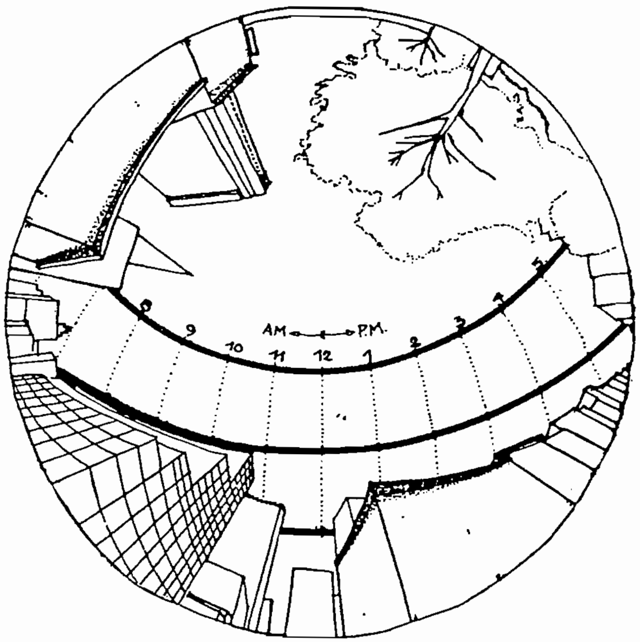


Fig. 75 - Portsmouth Square; illustrating a building envelope with floor area ratio of 12.

sun is available in the square throughout most of the year (Fig. 73). In the past height and zoning restrictions for a site at the southeast corner of the square allow an F.A.R. of 17. Studies revealed that a building envelope with this F.A.R. could prevent sun from reaching the square until 10:45 AM in the spring and fall (Fig. 74). A prototypical design allowing early morning sun to reach the square and yielding an F.A.R. of 12 was designed indicating that the development of the site was feasible (Fig. 75). (The proposed height zone has now been lowered in the vicinity of the square to respect sun access criteria.)

HALLIDIE PLAZA

Hallidie Plaza, at the junction of 5th and Market Streets, has traditionally been a major shopping area and transportation node of the city, and remains so today. A partly submerged urban amphitheater attracts crowds of office workers, shoppers, and tourists all day long.

Sun access above the plaza is currently generous and ample, and on a sunny afternoon benches in the plaza are

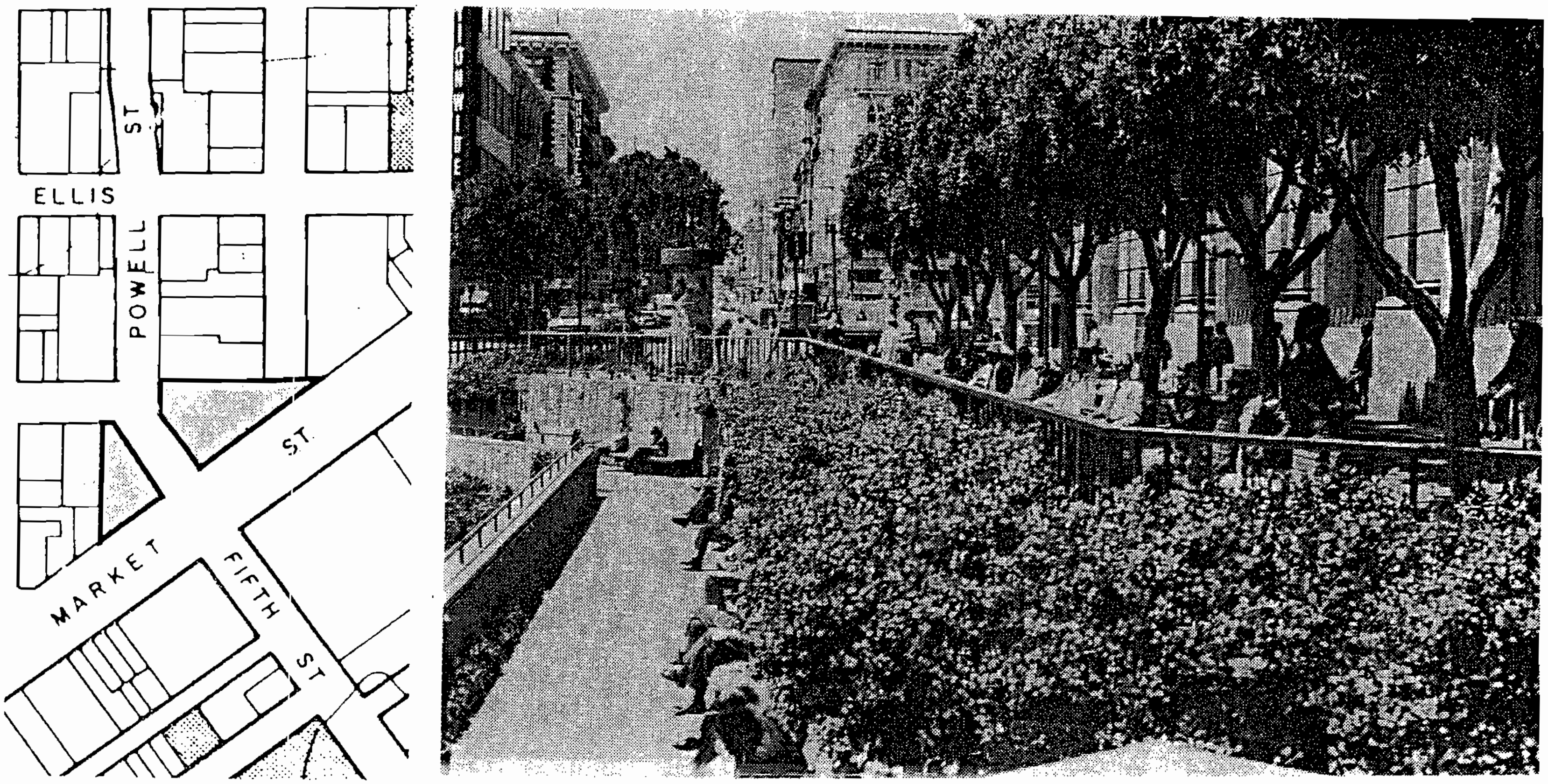


Fig. 76 - Hallidie Plaza at Powell and Market. Area includes Bart station, tourist information center, cable-car terminal. The sunken plaza attracts large crowds on sunny days.

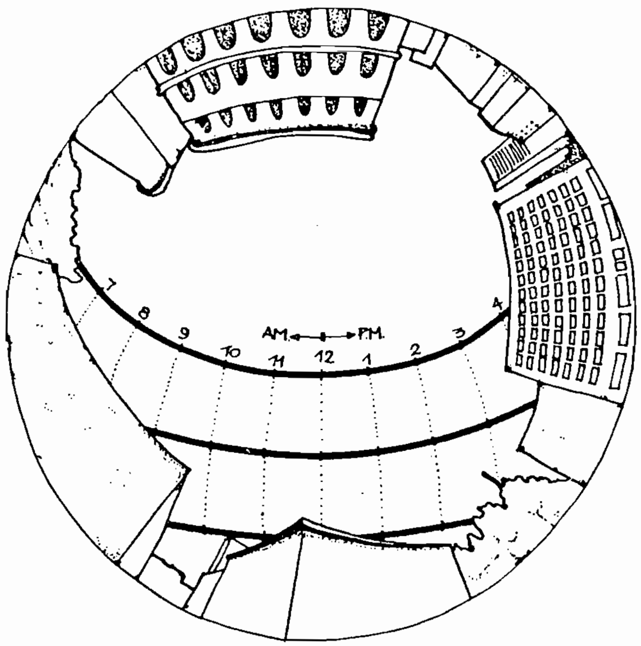


Fig. 77 - Hallidie Plaza; fish-eye sketch of existing conditions.

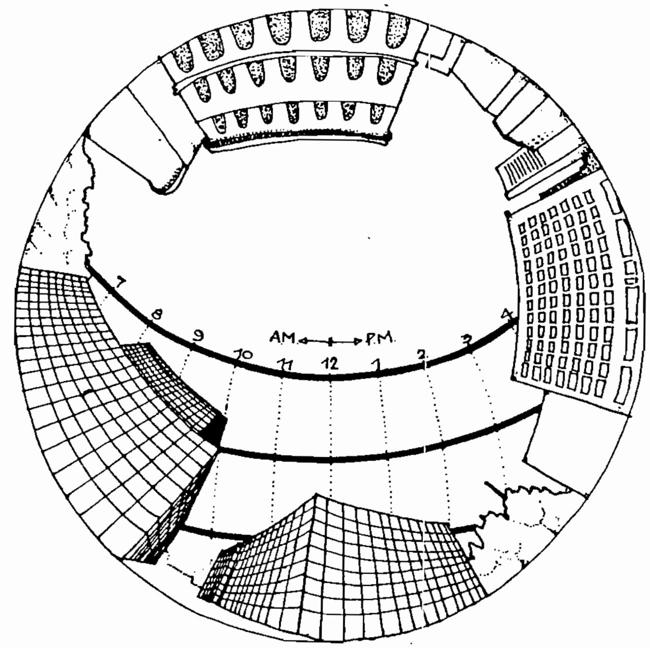
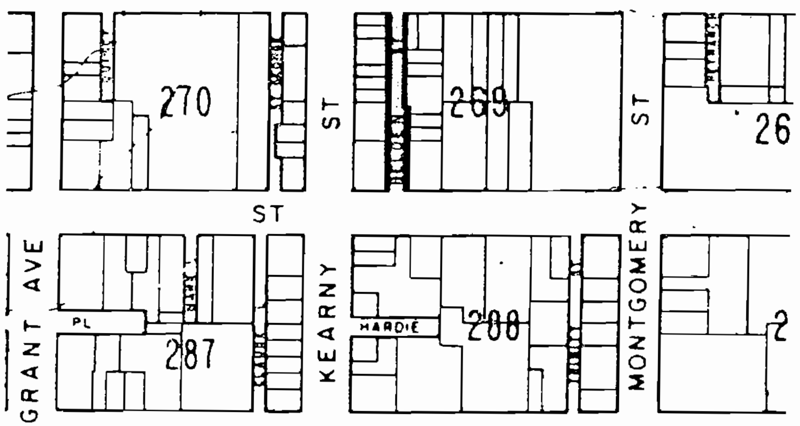


Fig. 78 - Hallidie Plaza; illustrating building envelopes for sites at Fifth and Market.

filled to capacity. Development plans for sites across from the plaza along the south side of Market Street, on both sides of 5th Street, suggest that this location will continue to anchor regional retail activity for some time to come. Current zoning regulations allow a 400 foot tower on the back of a lot at the southeast corner of 5th and Market Streets, and the development of the old J.C. Penney store site at the southwest corner is proposed in the near future. Studies made in Hallidie Plaza demonstrated that development on either or both of these sites is not likely to compromise existing sun access conditions in the plaza. However, given the existing scale of Market Street and the proximity of a number of historic buildings with considerable architectural merit, the mass and bulk of any new development on these key sites must be made compatible with the surrounding urban context.

BELDEN STREET

Belden Street is a short narrow lane parallel to Kearny Street that lies in a transition zone on the edge of the Retail District and the Business District. Architecturally the street is important, since it contains mostly small, three to five-story brick buildings constructed between 1906 and 1908. The uniform scale, style, and age of these buildings represent a streetscape common throughout San Francisco in the pre-1906 era. Because of its location, use, and protected environment, each work day the street comes to life as a lunchtime mall--a transformation made possible because existing conditions



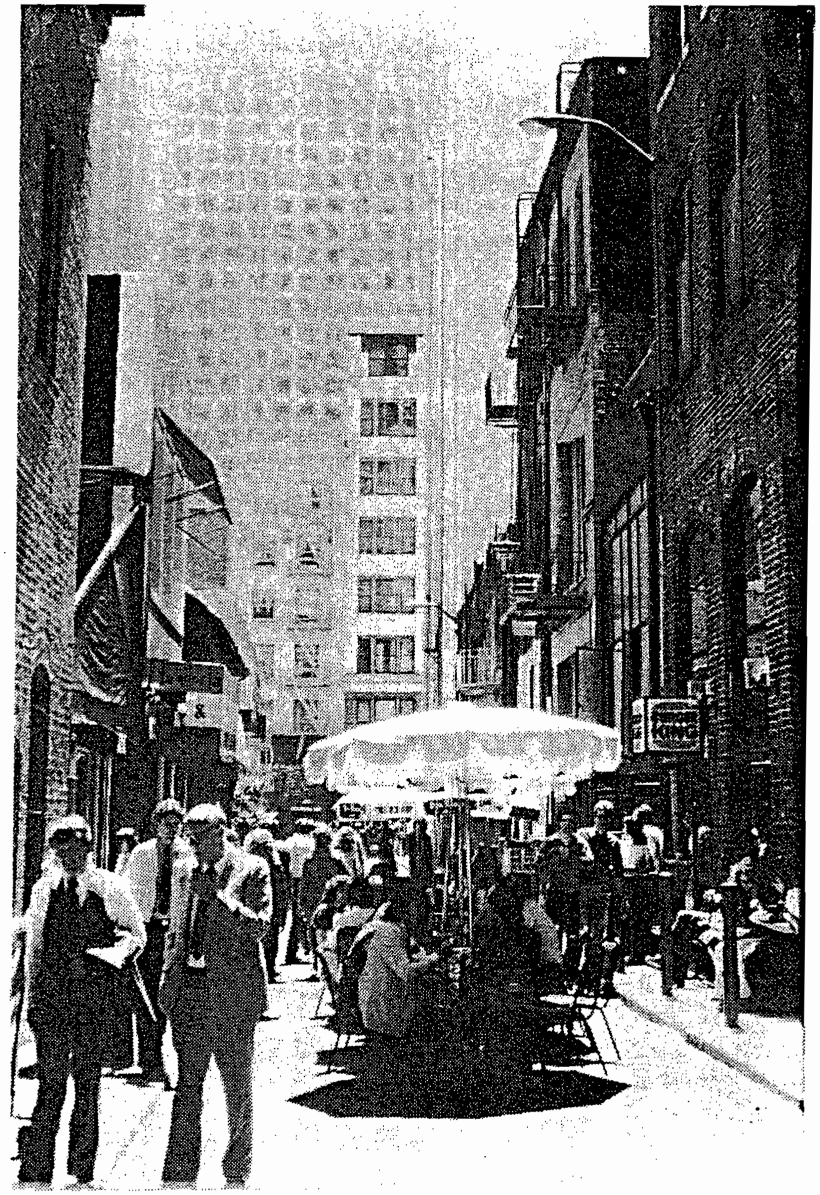


Fig. 79 - Belden Street; a jewel of an open space in the middle of San Francisco--intensely used at lunchtime.

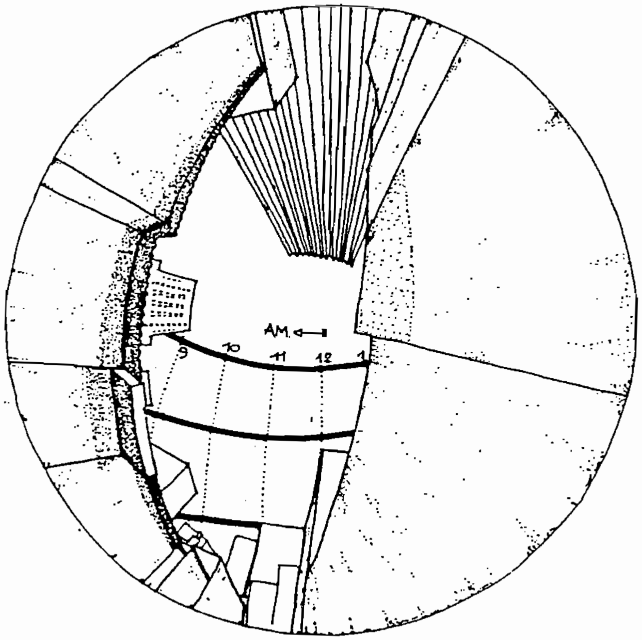


Fig. 80 - Belden Street; fish-eye sketch of existing conditions.

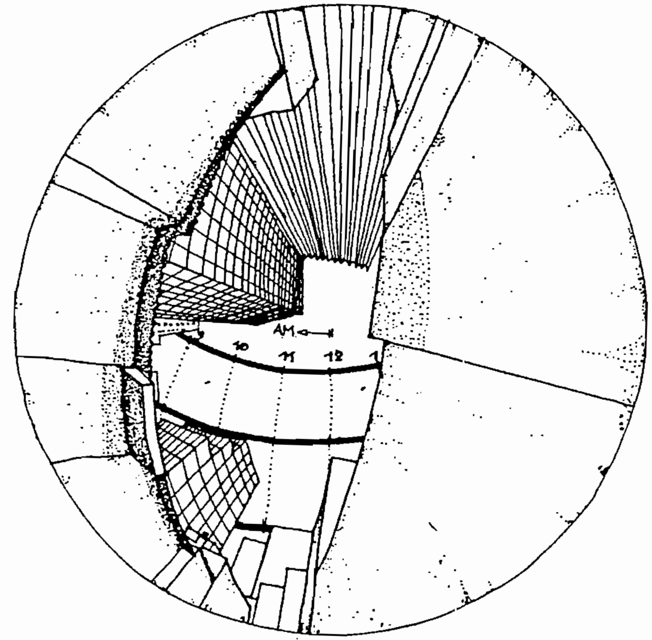


Fig. 81 - Belden Street; illustrating a modified two-tower solution with F.A.R. of 14.

allow the sun to reach street level during critical hours at mid-day. This transformation therefore highlights the crucial connection made in this report between street scale, sun access, the function of an area, and ultimately the economic activity it sustains.

Taking advantage of development bonuses, current zoning would allow a 400 foot tall building above a 50 foot set back height 50 deep along the east side of Belden Street, yielding an F.A.R. of 16. A building constructed under these conditions would shorten a good portion of the available sunlight from reaching street level during mid-morning hours. To offset this condition, studies defined a building envelope that produced a two tower design solution for the site that yielded an F.A.R. of 14 (see Fig. 81).

THE CHINESE PLAYGROUND

The Chinese playground is situated at the junction of Hang Ah alleyway and Sacramento Street, one half block east of Stockton Street. The playground is actively used by both children and adults throughout the week since it is one of only two areas of public open space in Chinatown. During morning hours the playground is routinely used by school children. A nearby private grade school and a preschool use the area for supervised play. After regular school hours children continue to use the playgound before attending Chinese School, which begins at 4:00 PM daily. Many children, therefore, have only a couple of hours of unstructured play during the critical use time of 2:00 PM to 4:00 PM (see Map 7).

A residential highrise 132 feet high is proposed directly west of the playground, taking advantage of the current height limit of 160 feet. To study this proposal, sky exposure photographs were taken at the center of each of the six sub-play areas in the playground. Photomontage fish-eye studies were then produced showing possible building envelopes reaching the allowable building height of 160 feet. A photomontage fish-eye illustrating the proposed 132 feet highrise was also produced. On this photograph sun path diagrams were superimposed so that the amount of sunlight lost in the square by the proposed development could be quantified.

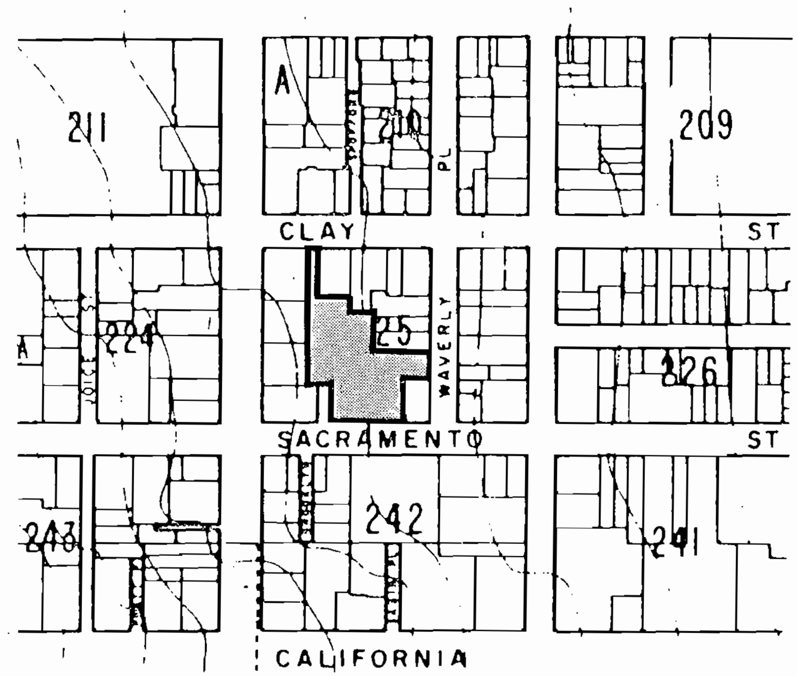


Fig. 82 - Chinese playground on Sacramento between Stockton and Waverly.

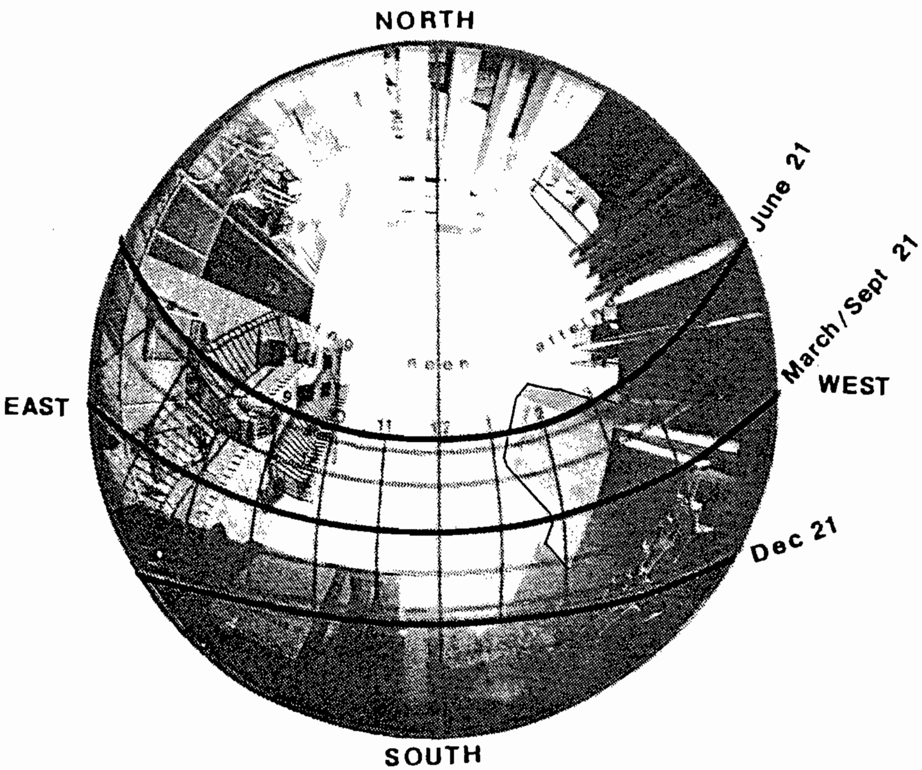
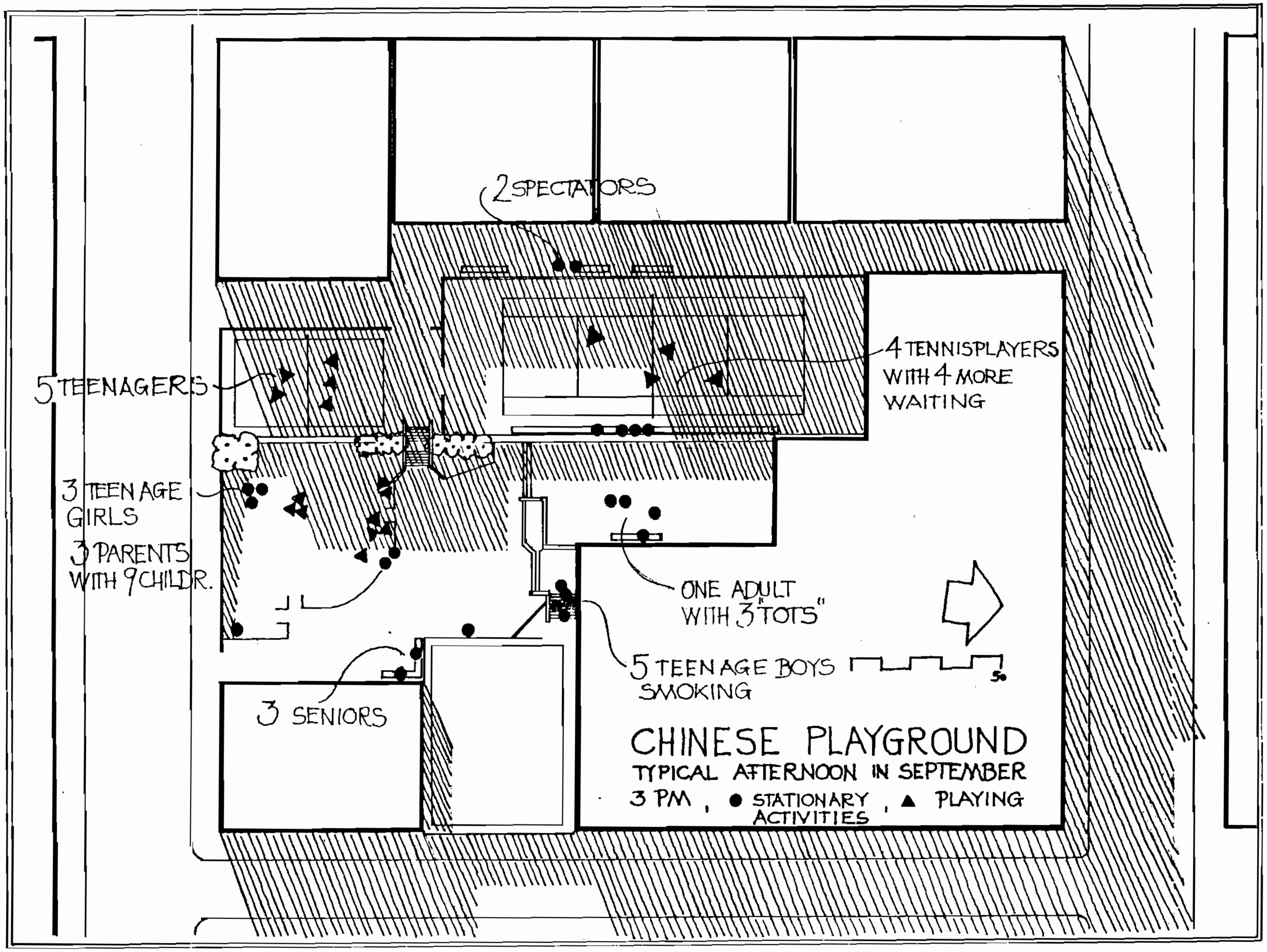
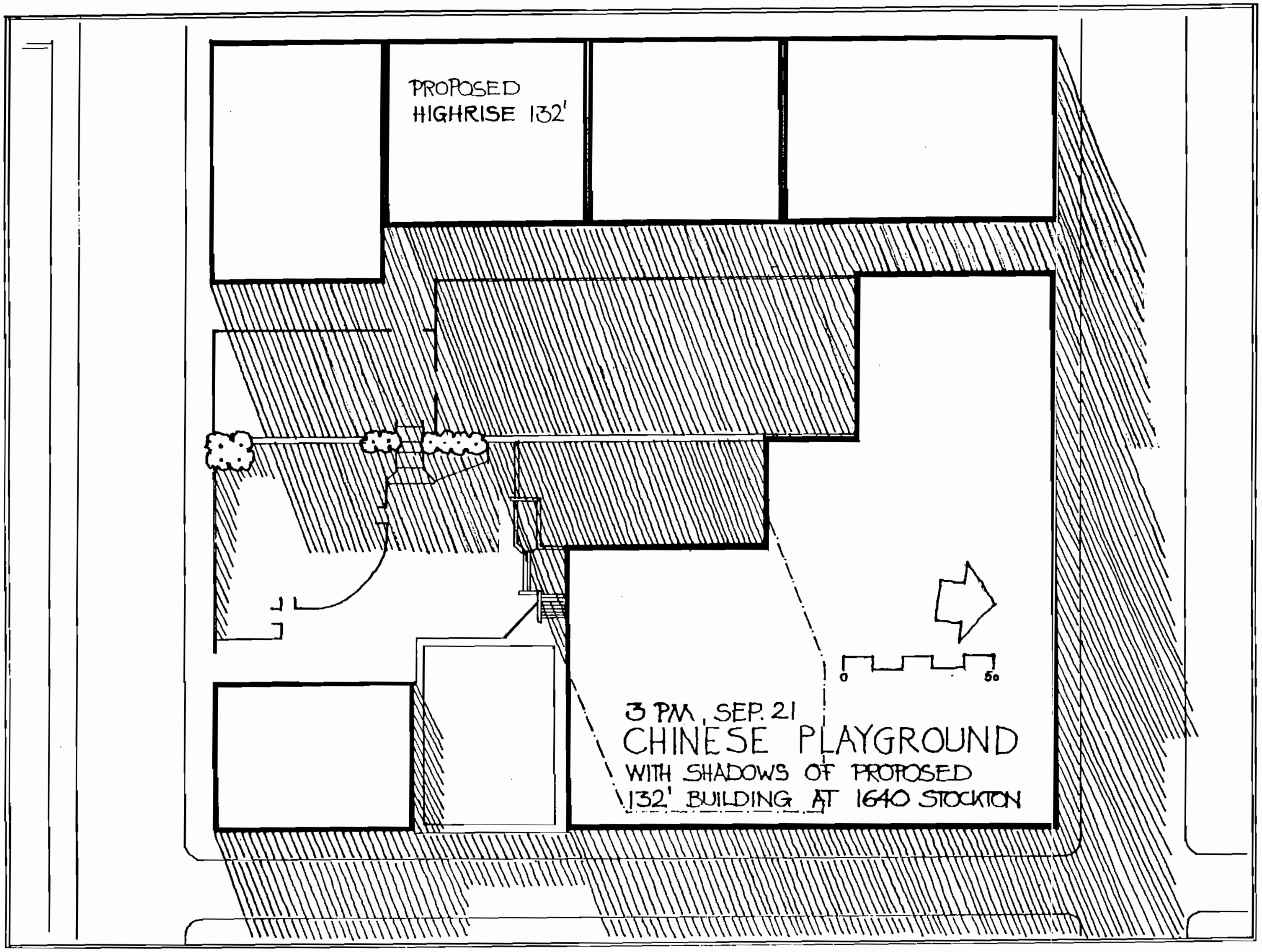


Fig. 83 - Chinese playground; fish-eye photograph used to assess the impact of the proposed building (Tot Lot location).

Meteorological data shows that the sun is out only 63% of the total available time from March to September. Under present conditions each subarea receives an average of five hours of sunlight on a sunny day. The proposed residential highrise would reduce sunlight for five of the six subareas by an average of 19%, or one and a quarter hours per afternoon. If the proposed building is approved, only an average of 30 minutes of sunshine can be expected in the playground during the critical two hour afternoon period of unstructured play (see Map 8). Should all neighboring sites to the south and west of the playground be developed to the current allowable 160 height limit, the amount of sun reaching the playground will be eliminated during critical afternoon use hours.



Map 7 - Chinese playground; activity patterns and existing shadow patterns.



Map 8 - Chinese playground; shadow east of proposed building.

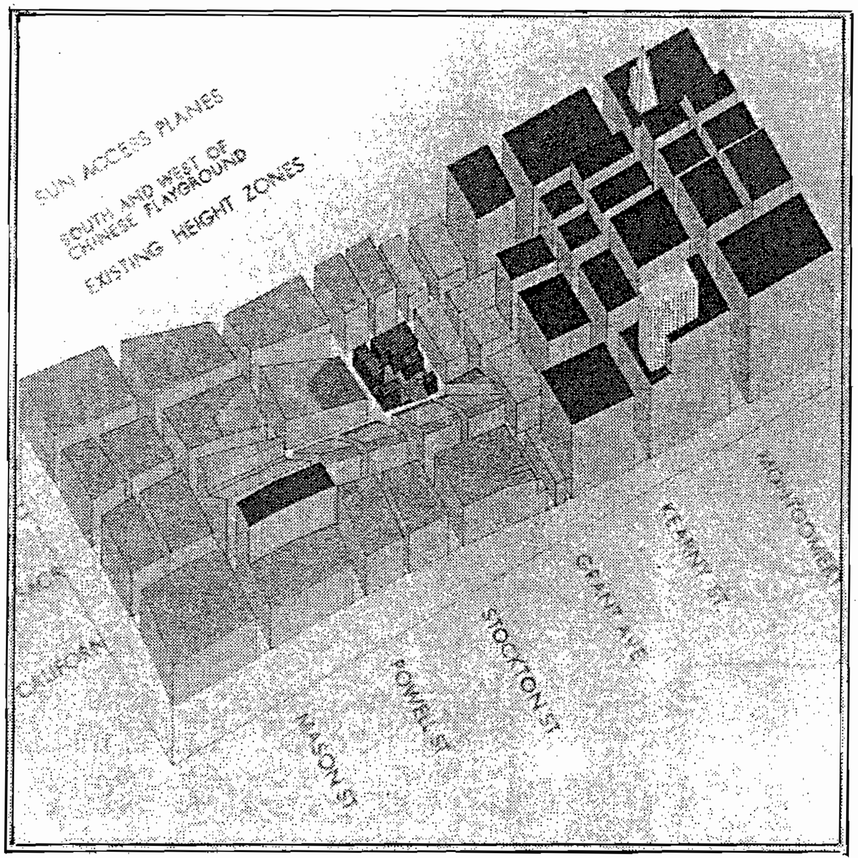


Fig. 84 - Chinese playground; sun access planes as they sculpture existing height zones.

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