

THE DAVIS EXPERIMENT



ONE CITY'S PLAN TO SAVE ENERGY

**THE
DAVIS
EXPERIMENT**
One City's Plan To Save Energy

by THE ELEMENTS



A Public Resource Center Book

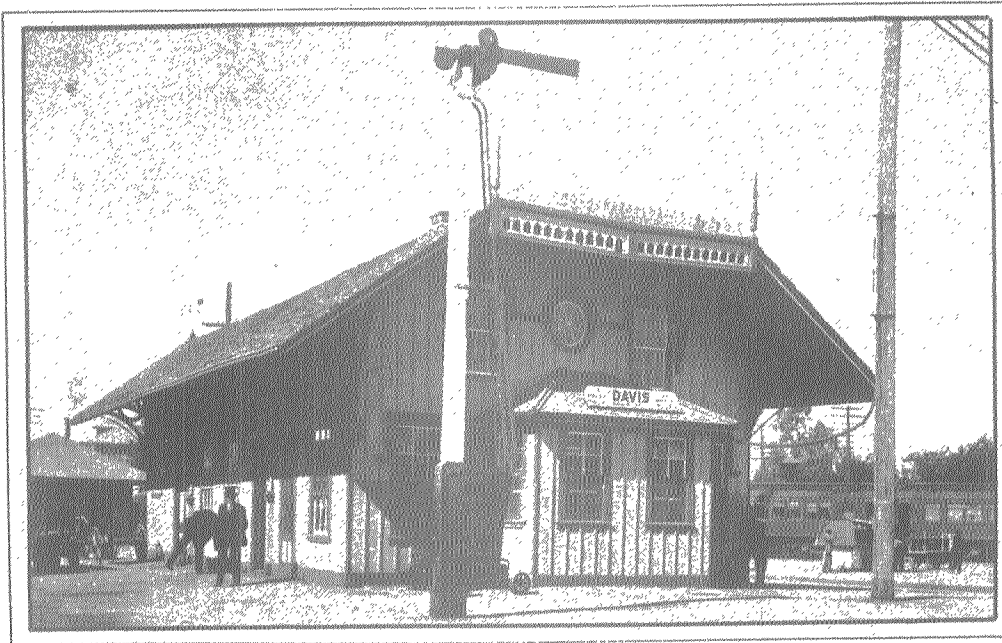
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Davisville Junction, 1868

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INTRODUCTION

For many people the energy crisis still seems remote, an alienating issue to be decided by the oil companies and government bureaucrats in Washington.

That is why we are publishing this book on the energy conservation experiment in Davis, California. This experiment shows what ordinary citizens can do through government. Davis is a small city, located in the lush farmlands of the northern Central Valley. It is part university town, part bedroom city for nearby Sacramento. Like many other American cities, it has been threatened by unchecked growth, swarming automobiles, and in recent times by steeply rising costs of energy.

But unlike many other towns and cities which leave energy policy to the federal government or the big energy corporations, the citizens of Davis decided to act on their own. After lengthy debate, the City Council moved to curb growth. It turned against the automobile and embraced the bicycle as a means of transport. After sponsoring an inquiry into energy uses, the Council endorsed a series of measures aimed at reducing energy use by as much as one half. That meant regulating how a new house or apartment building is situated on a lot, what kind and how much insulation builders use, where and how much glass is to be employed, and so on. And it encouraged developers and

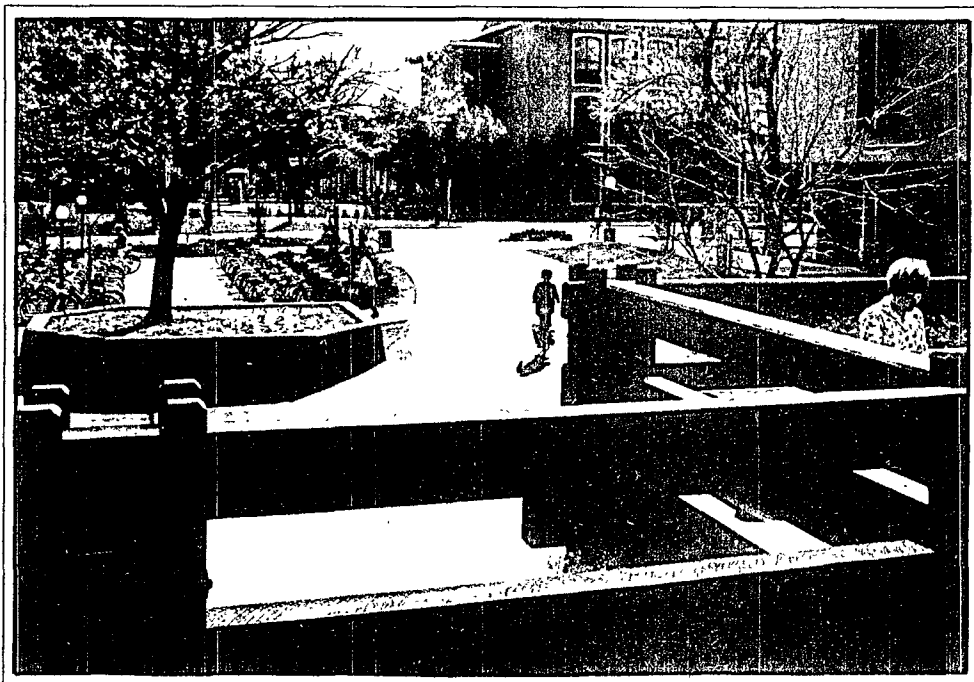
builders to begin adapting solar energy on a wide scale. The city obtained funds and hired consultants to design model solar buildings to show what could be done. Now it is constructing them. When completed, the solar models will house families of farm workers.

And Davis has gone further. It has decided to cut back on the use of pesticides on the thousands of trees and shrubs that shade the streets, adopting instead a policy of biological control for insects. The city's fleet of cars and trucks have been transformed into a fleet of compact vehicles. When a Davis employee has to get around town, he borrows a bike from the city rack. Davis even passed a law formally and solemnly sanctioning the clothesline.

This book is a collection of codes, ordinances, drawings, photographs and plans that make up the Davis experiment. While many of the provisions of these papers are designed to meet Davis' unique needs, our hope is that the ideas and plans will be of use elsewhere.

Most important, the Davis experiment proves that citizens working through local government, really can have a substantial effect on a major international issue.

—The Elements
September, 1977



Davis Campus of the University of California

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- 1 DAVIS, CALIFORNIA.** The citizens of Davis have been involved in progressive city planning and energy conservation since 1968, when the City Council decided to facilitate bicycle transportation by developing a system of bike-ways. In 1972, the City drew up a general plan for future development, based on questionnaires distributed to residents. Their goals were to limit growth and to conserve land, water, energy, and other natural resources.
- 2 ENERGY USE.** An important part of Davis' General Plan was to determine how energy was being used by residents. A survey of residents showed that automobiles represented 50 per cent of energy consumption, and space heating and cooling accounted for 25 percent. So, transportation and building construction became important focal points in the Davis Plan.
- 3 BUILDING CODE.** The Energy Use Survey revealed that a building's placement on a Lot — its east-west orientation — greatly influenced its space heating and cooling needs. Insulation, amount of window area, exterior roof and wall colors, overhang shading, and other factors were also important. Armed with this information, the City Council drew up a building construction code which local developers have followed successfully.
- 4 SOLAR HOUSES.** To demonstrate to local builders and developers methods for complying with Davis' new construction code, the city is building model solar homes — one single-family dwelling which took advantage of natural southern-exposure sunlight, and several duplex buildings which create a basic plan that could be adapted to difficult siting ("worst case") situations.
- 5 SOLAR DRYERS.** Like many other communities, several years ago Davis banned the use of clotheslines as un-aesthetic. After the Energy Use Survey, Davis reversed its position and nullified its ordinance banning clotheslines.
- 6 SWIMMING POOLS.** When the Energy Use Survey revealed that many of Davis' 700 swimming pools cost \$40 to \$60 a month to heat, the city decided to ban any new pool heating except solar systems, and to require that current gas-heated pools be converted to solar heating within the next ten years.
- 7 FENCES AND HEDGES.** In most communities, fencing regulations require that fences be constructed relatively close to houses — leaving a large amount of yard space between the fence and the street. Davis had similar regulations until the city realized that fencing close to a house blocks the winter sun.
- 8 WORK IN THE HOME.** By encouraging cottage industry, Davis hopes to cut down on home-to-office transportation and to reduce some of the need for new office-building construction.
- 9 STREETS.** As new developments are built, Davis believes that reducing street width from 34 to 28 feet or less will not only save space — it would also use less asphalt and may contribute to slower auto speeds, thereby enhancing fuel efficiency.
- 10 RECYCLING.** Davis' recycling effort began five years ago and has grown into a full-fledged trash-collection, deposit, and recycling center that handles newspapers, cans, glass, even waste oil. With large initial investments in drop boxes, a collection scooter, trucks, and a can crusher, the recycling effort lost money in its early years. But now, the operation breaks even by selling \$3,000 worth of recyclables every month.
- 11 SHADE TREES.** Trees provide important shading for the city's streets and buildings, and the city maintains them with care. Davis plants a large number of evergreen trees to decrease the need for leaf pickup in the Fall.
- 12 BICYCLES.** Davis' bikeways and bicycle safety programs provide unique incentives to bicycle transportation unequalled anywhere else in the U.S. In a city of 33,000 people, Davis has some 25,000 bicycles registered.
- 13 BUSES.** By using second-hand, deisel-fueled, double-decker buses, Davis is able to provide convenient public transportation facilities at minimum cost and energy use.
- 14 APPENDICES.** To assist other city planners and public officials, Davis' city codes, ordinances, and plans related to residential construction, trees, and bicycle traffic are reproduced in appendices, A, B, and C.

1 DAVIS, CALIF.

Davis is a small city of 33,000 people located in the northern part of California's great Central Valley. It is close by the Sacramento River, which flows into the San Francisco Bay fifty miles downstream. Davis itself sits astride and is surrounded by valuable farm land. The terrain is flat. Big farms stretch out in all directions.

There were Indian settlements here 1,500 years ago. In 1821, the first Mexican expedition arrived, and was soon followed by an onslaught of trappers from Canada, Colorado and the Southwest. Following the trappers came the first American settlers from Missouri.

The city proper was established in the 1850s as a depot where rail lines from San Francisco met those that connected with the transcontinental railroad. Subsequently Davis became an important junction for the Southern Pacific Railroad, linking the railroad's lines running down the Valley with those going east and west. A few decades after the railroad arrived, the University of California decided to locate the state's agricultural experiment station at Davis, and that gave the community the beginnings of an important second industry.

The basic shape of the city remained much the same until the late 1950s when the agricultural school was expanded to become a full-fledged campus of the University of California. A medical school and liberal arts college were added to the veterinary school and agricultural college already on the Davis campus.

With rapid growth of the city, citizens became increasingly concerned about planning. In 1968, a progressive city council began to deal with the growth issue. As a first step it decided

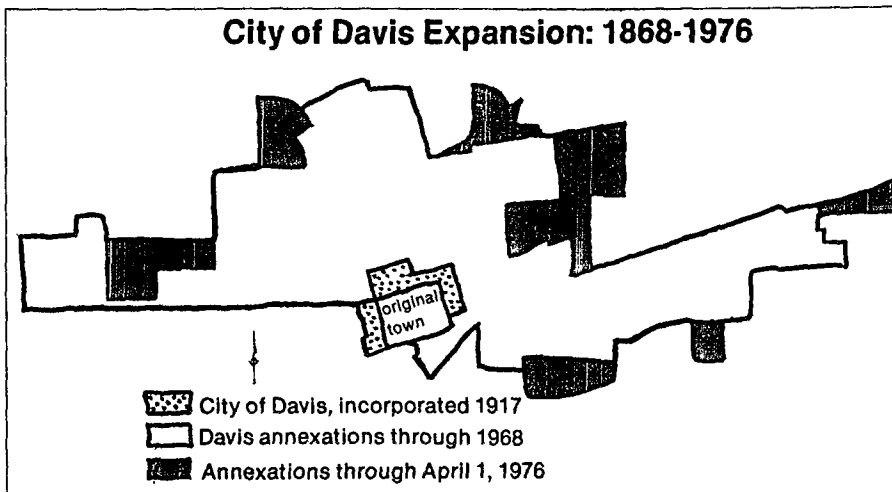
that bicycles should be considered an important mode of transportation and a system of bike-ways was planned and developed. Four years later a new general plan was drawn up, based on questionnaires distributed to residents. It put special emphasis on conservation of land, water, energy and other natural resources, and moved towards a general limit on growth.

GENERAL PLAN

Gloria McGregor, the city's community development director, explains basic features of the general plan:

California, has, for many years, taken the position that it wishes local government to solve and guide its own destiny, within a very loose framework. Within that contest, it has been the evolving position, as evidenced by the recently adopted General Plan, that Davis has some very distinct responsibilities to its citizens, which it accepts, but that it feels considerably less need to take up the burdens of surrounding communities, most importantly Sacramento. From this ethic sprang the policies and ordinances which circumscribe growth management in Davis.

The most important of the enabling documents is termed the Housing Development Priority Program. Its preamble calls for orderly residential development to meet the needs of the community, protection of adjacent prime agricultural land, provision of housing and services for the student body and faculty of the University of California at Davis, in an environmentally and socially responsible manner. A strong expression of the need for adequate housing in Davis for those persons of low, moderate, or fixed incomes whose



Davis' energy program began with a basic questionnaire to all residents to gain social and economic data as well as information on energy uses

work, and, on other connections with the city of Davis led them to desire to live here, threads throughout the document. This is the single most important part of the Davis General Plan which removes from it the sting and flavor of exclusion which might otherwise be present.

The method to determine the need for housing in Davis is the Annual Needs Survey, which, in as detailed a way as possible, compares the existing housing stock in the planning areas of the city with the need for new housing stock, and sets an annual needs number encompassed within an overall three year needs number. This can be compared to a capital budget in the way it operates. The first year's number's definite and definite approval to build follows, the second and third year needs numbers are tentative and tentative approval follows. This Annual Needs Survey is conducted during the summer and the allocation of approvals to build is granted in the fall for the following three years.

The Needs Survey, first completed in 1974, attempts to identify the numbers of low, moderate and high income single and multiple family housing units needed in each of the planning areas of Davis. Another important principle of the General Plan, of significant social and economic importance, is the direction to achieve a similar mix in types of housing available across the city, so that property values and social interaction will be maintained wherever one lives in the city. This aspect of the control of housing construction contributes a great deal to the general atmosphere of good will between the University and the city, not often present in other similarly dominated cities.

The second of these important expressions of policy is called the Amplification of Housing Development Priority Criteria. Upon the completion of the Annual needs Survey, all those builders who wish to receive an allocation must present their plans to the Housing Review Board at the same time, to be examined in the light of the ten criteria set forth in this Resolution. (The property must be already in the right timing phase of the General Plan, and have the proper zoning; the zoning must be planned development to allow for mix of types.) These are, in order of their importance: internal growth needs, economic mix, low and moderate income housing, environmental impact, availability of public services and facilities, compactness, design diversity, economic impact, feasibility and competition. Since each application must be in the form of a planned development, over which the city

has complete control, refusal of an allocation can be based on the failure to satisfactorily meet these criteria. This is the strong mechanism, for example, under which the city can assure that an adequate supply of low and moderate income housing is to be built.

The third significant feature of the adopted General Plan is the Phasing Map, which sets forth the order in which the city shall develop, based on 21 criteria developed by the General Plan Committees and the Planning Commission and Council. Roughly speaking, Phase I and Phase II are to be completed by 1990, which would result in a population of approximately 50,000; those areas designated Urban Reserve will then be considered.

This is a capsule view of the Growth Management Plan of Davis. It is a sincere and responsible effort to state the acceptance of the city to provide the housing and services which people whose work, study or other connections need, to enable them to live in Davis. It is equally plain in its expression of disinclination to allow destruction of its attractive character and ambience by its regional location and magnetic pull for those who work elsewhere. Whether any city, without backing at the regional or state level, is able to maintain its uniqueness may be questioned.

CLIMATE

The Davis climate is characterized as mediterranean. Summers are quite dry with hot days and pleasant nights under usually cloudless skies. July average maximum temperatures are 32.2 C(90 F) with mean minimum temperatures of 14.5 C(58 F). The absolute maximum temperature for July was 45.5 C(114 F) while the absolute minimum for July was 8.3 C(47 F). Rainfall during the summer months is almost zero.

Winters in Davis have periods of cool or cold and foggy weather depending upon the number and intensity of rain-bearing storms entering the area from the Pacific. These winter storms, lasting only a few days each, increase in frequency as fall turns to winter, and become more sporadic as the spring months give way to the dry summer. Average annual rainfall is 45.7 cm(18 in.) with a range from dry years to wet years from 11.9 cm(4.7 in.) to 92.2 cm(36 in.).

Summer winds affecting Davis are usually from the south; cool air flows into the southern Sacramento Valley through the Carquinez Straits. Spring and fall winds alternate between dry northerly winds channeled southward down the Sacramento Valley and southerly winds associated with winter storms.

2 ENERGY USE

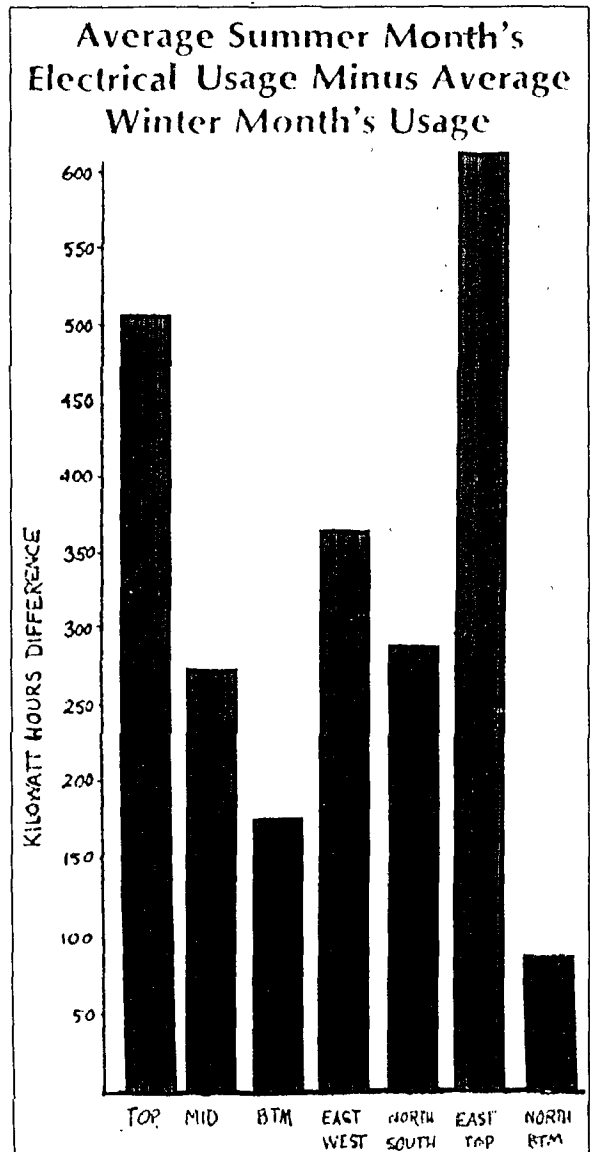
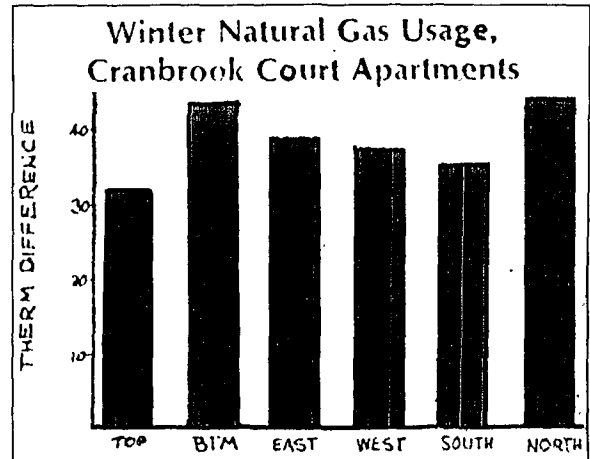
In order to achieve the General Plan objective of energy conservation, a research group at the University of California, Davis, was funded to develop an energy conservation building code. The first task of the group was the collection of data on the energy use of Davis households. The goals of the research were twofold: 1) determine how design features of dwellings affect gas and electric consumption, and 2) to identify household management practices and appliance use which would reduce energy consumption.

Temperature records for apartments and houses were collected over a period of months, in summer and winter, to provide data which would contribute to understanding how design features affect energy use. In addition, utility bills were evaluated to determine actual energy use during a period of several years. The results of this data collection and evaluation formed the basis for the Davis Energy Conservation Building Code. The figure below shows the summer temperature differences between similar apartments with different orientation.

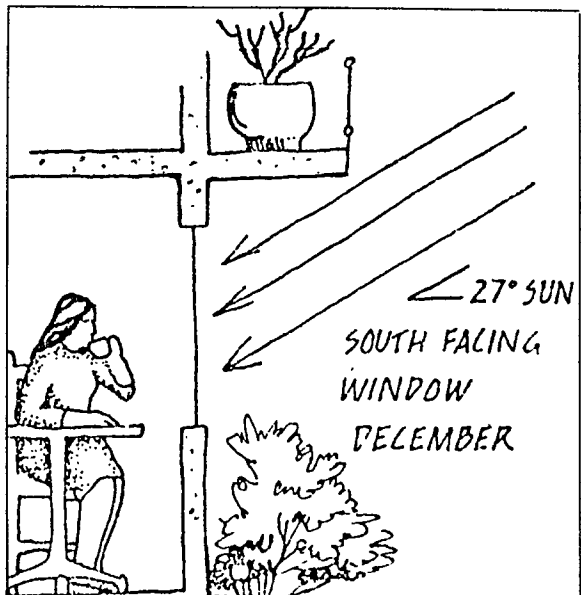
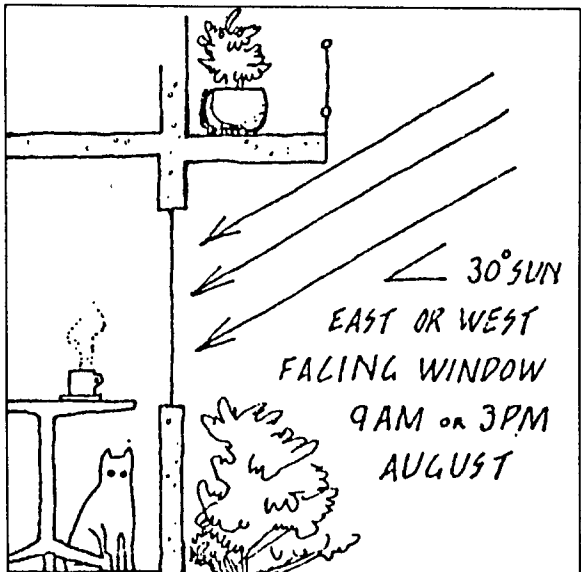
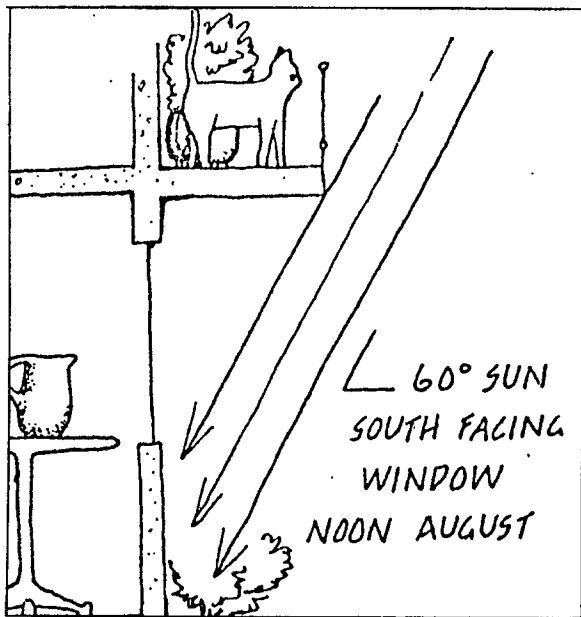
In the summer, the second floor rooms averaged 12 C (52 F) warmer than those on the ground floor; and north-south exposures were much cooler than east-west. The coolest units were north-south facing on the ground floor, reaching a maximum of 24 C (75 F), perfectly comfortable in hot summer weather. The hottest apartments were those facing east-west on the top floor. The results of the temperature tests were perfectly paralleled by the actual electrical use of the apartments.

In the winter, the south facing apartments performed significantly better than those facing north, east, and west. On several occasions, south facing apartments had high temperatures in the 80s F on sunny winter days, with a maximum of 87 F. During several days the high temperatures were 24 F above ambient, and 17 F above apartments with north, east, or west exposure. These high temperatures occurred in selected vacant apartments built with solar exposures that were far from ideal. By comparison, a specially constructed research room with nearly ideal south window exposure registered an interior maximum temperature 48 F above the maximum ambient.

Tests on single family detached houses provided less clear results than apartments. However, it was evident that the houses in the core area used less electricity for cooling per square foot than other dwellings. This was attributed to the shade trees in the area which



From A Strategy for Energy Conservation, 1974



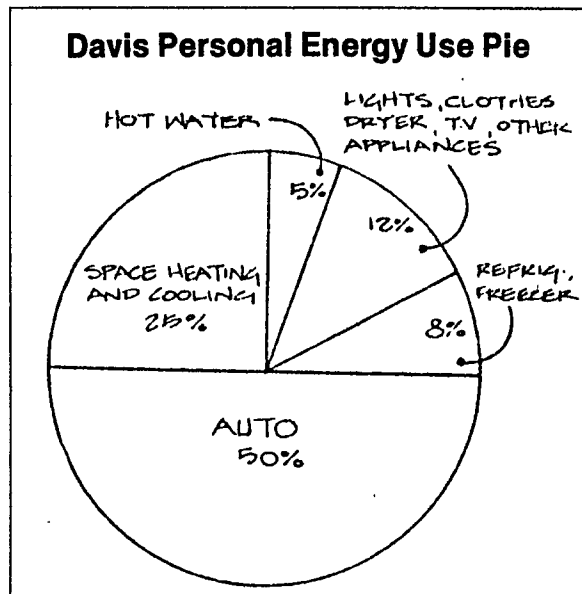
Short overhangs protect south windows from the summer sun, but not east and west windows.

prevented the hot summer sun from reaching the dwellings. West Davis homes had the best insulation and this accounts for their superior performance in both summer and winter.

Research on building in the Central Valley climate has continued for more than thirty years at the University of California, Davis. Most of this work on design with climate has been carried out by L. W. Neubauer, F. A. Brooks, and Richard Cramer. Their achievements provided much of the background for the Davis Energy Conservation Ordinance, and supported the contention that it is possible to achieve good thermal performance by providing proper orientation and shading windows.

Precise answers to the second question of how household management practices and appliance usage affect energy consumption were more difficult to obtain because of the high degree of variability from household to household. Data was collected from household interviews and from gas and electric bills. Analysis of the data showed that electric consumption is positively correlated with the number of children in the household, the hours of television watched, and the number of washloads per week. Electric consumption in the households is also highly related to the number of appliances owned.

Data collected from the survey was updated in the past year with actual case studies where individual appliances were metered in households for their electrical consumption. This information has been used to compile a composite average Davis household energy use pie.



The south-facing window collects 1,000 BTUs of winter sun per square foot of glass.

3 BUILDING CODE

The basic idea of the Davis Energy Conservation ordinance is that new housing built in Davis shall not experience an excessive heat gain in the summer nor excessive heat loss in the winter. The requirements vary depending on the size of the housing unit and are expressed in BTUs gained or lost per square foot of the house each day. Thus, the thermal efficiency of all housing designs presented to the city's building inspection division must be tested against conditions assumed to exist on typical summer and winter "design" days. The designated design days are August 21 and December 21. The conditions considered include the angle of sunlight at Davis' latitude at different times of the day, the intensity of sunlight, wind speed (assumed to be 15 miles per hour) and outside temperature (45 degrees as a 24 hour-average in the winter, hourly variation in the summer ranging from 59 to 100 degrees).

Maximum permissible amounts of heat gain/loss are shown in the following table, taken from section 10 of the ordinance.

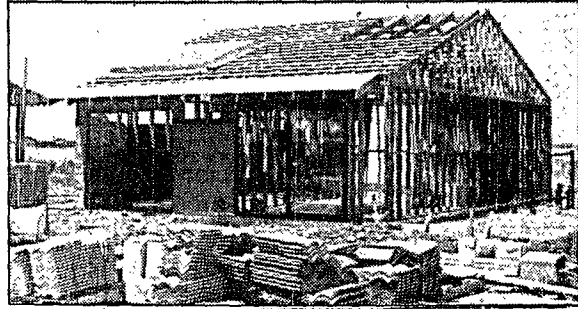
Detached Group 1 Dwelling Unit Thermal Standards		
Floor Area (sq. ft.)	Winter Heat Loss (BTUs/sq.ft./day)	Summer Heat Gain (BTUs/sq.ft./day)
500	363	118
1000	239	103
1500	208	98
2000	192	95
2500	182	93
3000	176	91

The methods used to meet the requirements set forth above include the following:

Infiltration. All swinging doors and windows opening to the exterior or to unconditioned areas such as garages shall be fully weather-stripped, gasketed or otherwise treated to limit infiltration.

Loose Fill Insulation. When blown or poured type loose fill insulation is used in attic spaces, the slope of the roof shall be not less than 2½ feet in 12 feet and there shall be at least 30 inches of clear headroom at the roof ridge. ("Clear headroom" is defined as the distance from the top of the bottom chord of the truss or ceiling joists to the underside of the roof sheathing.)

Pipe Insulation. All steam and steam condensate return piping and all continuously circulating domestic or heating hot water piping which is located in attics, garages, crawl spaces, underground or unheated spaces



Construction in Davis' Corbett development.

other than between floors or in interior walls shall be insulated to provide a maximum heat loss of 50 BTU/hr. per linear foot for piping.

Walls. All exterior walls (excluding windows and doors) shall use R-11 batt insulation between studs. Group H structures must have light colored walls or shaded walls.

Roof/Ceilings; Ceiling/Attics. All roof/ceilings and ceiling/attics must use insulation achieving a minimum resistance of R-19 for the insulation itself. Group H occupancies having roof surfaces unshaded on August 21, at 8:00 a.m., 12:00 noon, or 4:00 p.m., shall be no darker than No. 6 on the Munsell chart.

Floors. Suspended floors over a ventilated crawl space or other unheated space shall have insulation with a minimum resistance of R-11. Concrete slabs on grade require no insulation.

Glazing Area. In Group H occupancies, exterior single-pane glazing (windows, skylights, etc.) may not exceed 12½% of the floor area. Exterior double-pane glazing may not exceed 17½% of the dwelling unit's floor area.

Glazing Shading. All glazing which is not oriented to the north must be shaded to protect it from direct solar radiation for the hours of 8:00 a.m., 12:00 noon, and 4:00 p.m. (P.S.T.), August 21. In group H occupancies the total accumulated amount of unshaded glazing may not exceed 1.5% of the dwelling unit's floor area. The use of approved shade screen systems may be employed to demonstrate compliance. Tinted, metalized, or frosted glass shall not be considered self-shading.

The regulations are expressed in two forms; Path I and Path II. Path I is a set of prescriptive standards and Path II is a set of performance standards. The city provided two versions so that a builder with a standardized product might have a routine means of compliance, while those using innovative techniques and materials might have additional scope.

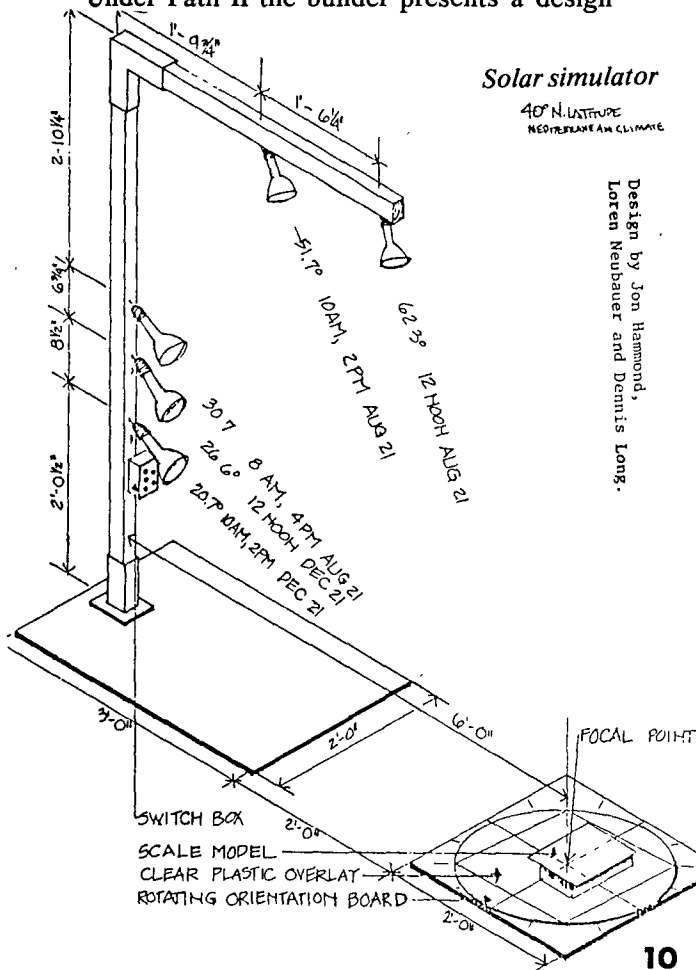
Builders can follow Path I and conform to these provisions:

- A light-colored roof with a Munsell rating of six to ten.
- Six-inch insulation (R-19) as a minimum in the roof.
- Three and a half-inch insulation (R-11) in the walls between the studs.
- Light-colored or shaded exterior walls, with a limit of 15 percent dark allowed for trim.
- Glazing limited to 12.5 percent of the floor area for apartments, with an additional 20 square feet of window area allowed for single family homes, intended to benefit especially small houses.
- Unshaded glazing limited to 1.5 percent of the floor area.

The code includes more detail and some additional provisions, but these have the most significant effect on construction.

Or a builder can follow Path I "with exceptions". Essentially, credit is given when standards are exceeded in one part of the dwelling which can then be applied to another portion. Thus, if the builder improves insulation in the floor or wall, applies heat storage concepts or adds double-paned glass, the area of glass in the house may be increased.

Under Path II the builder presents a design



which he certifies meets the standards for winter and summer heat loss.

The three different paths involve different fee structures. For plans conforming to Path II, the building inspection division adds \$20 to the permit fee.

Once the builder has selected the path he proposes to follow, he then decides which of several possible plan check methods he will use. The city has produced a workbook which leads the builder through the energy plan check process. The most important variable to be checked at this point is the amount of glazing permissible in the proposed home, since glass has a very low degree of thermal resistance.

The builders choosing prescriptive standards may elect to have their plans checked in any one of three ways. The simplest approach, the "math method" asks the builder to make a few easy arithmetic calculations to determine how much glass is allowable considering building square footage and other variables. In general, window areas may not exceed 12.5 percent of the building's floor area; but the true amount of glazing permissible may be much greater if the windows are properly shielded from the summer sun.

A second method of checking the glazing requires the builder to make a scale model of the building for examination under a solar simulator which is kept in the building inspection division office. The simulator reproduces the position of the sun at different times on the summer and winter design days.

A third, more complicated approach (profile angle method) requires analysis of windows according to shading angles cast by roof overhangs.

Builders choosing performance standards must also submit their designs for a plan check and may, if they desire, simplify the analysis of glazing by using either the solar simulator, or profile angle methods.

City Ordinances 784 and 787, which establish energy conservation standards for residential construction in Davis, appear in appendix A.

The construction ordinance is one formal step in the Davis energy conservation program. Another step involves adoption of design standards for subdivisions and city circulation systems. These standards have not been adopted, but they are used in an informal manner in the design of planned developments. Since Davis has a housing development priority program which allows for residential construction by permit only, the city has considerable control over the type and design of construction.

One major reason for the success of the Davis building code program was the support by local builders. In November, 1976, three Davis builders testified before the California Energy Resources Conservation and Development Commission on their reactions to the code. Excerpts follow:

Michael Corbett: I build houses in Davis and have been building for ten years, about 100 houses. The last five years I have been building energy-efficient houses, and of course the last eight months under the Davis Energy Ordinance. Building under the Davis Energy Ordinance has been no difficulty. I was doing basically the same thing prior to the Ordinance. It has caused a few minor changes, but it has still allowed a lot of diversity in design. In fact, we are just beginning to find a lot of new ways to design houses working within the Ordinance.

I think the 12 percent glass, unearned glass, in Davis, works well. Sometimes we do houses that would have 20 or 22 percent glazing and still fall into the Ordinance. In one case we had 28 percent glazing and still fell under the Ordinance. So it's not really a limitation. It just means if you put more glass on, you have to have the appropriate designs to utilize that glass as passive solar heating.

Q: What is the aspect of the Code that allowed you to go over the 12½ percent limit?

Mr. Corbett: I basically relied on using additional mass or the mass of the building and having the glazing on the south side shaded in the summer and then available for solar collection in the winter. I have been working in passive solar design and shuttering and experimentation with two by six walls versus two by four walls....

I'd like to make one other comment. We have found that we have been able to sell about 70 percent of our houses without air conditioners, and this was unheard of through the '60's and early '70's. Based on compliance with the Energy Ordinance, the houses are naturally cool enough that we can have a sales pitch to sell them without air conditioners and the people that have lived in them now for the first summer are not objecting at all and are happy that they are saving that amount of energy and still living in a quite comfortable temperature.

John Whitcombe: I have been building ten years. I have built about a thousand units, seven hundred fifty apartments and two hundred fifty homes. Every unit (in a 138 unit apartment complex) is oriented north-south to meet the Davis Energy Ordinance. It is almost impossible to meet it unless you do, particularly with apartment units. And it is a very energy-efficient kind of apartment complex.

The problem we have with it is number one, the spaces. The interior space is one of the tradeoffs you have. The interior spaces aren't as nice as they are in a complex that you can design on a pinwheel kind of basis.

When you begin talking about multi-family complexes, apartments and condominiums, you are not just talking about a single lot that has a fence around it. Orientation become more difficult from a design point of view.

I am not saying your values shouldn't ride towards energy, but at the same time you should recognize the kind of tradeoffs that you are talking about with the Davis Energy Code.

I'd concur with the comment that 16 percent glass is probably satisfactory. We should probably have two percent unshaded. The fact that you have a 40 degree angle and an east-west wall just means for a typical window you might have to have an 8 or 10-foot overhang rather than one 14-foot overhang from a practical basis. You are going to have either a very substantial overhang or you're not going to have a window there. And many designs you might have a bathroom, for example. You might be able to get your bedrooms north and south on a north-south lot, but even on a north-south lot, you might have a bathroom, and that precludes a window in that bathroom.

A lot of people talk about costs, and the costs of the Energy Ordinance are really subjective. You have to get a handle on lot yield on a given piece of land and that's very difficult to do without a specific situation.

But, once again, it is a subjective kind of thing. You are concerned about both life cycle costs and about pricing out moderate and low-income people, I think there is a conflict there, because when you go on a life cycle analysis, you are looking at it from an investment point of view. You are saying you are going to put up some money now, we are going to lose some money for a while, and then we are going to gain more money back here and then in the total we are going to make money.

But lower-income people don't have the money to make investments.

Ron Broward: I am a builder and I have been a builder for 16 years. I have built approximately 500 hundred houses; 178 apartment units, and a little over 300 houses.

First of all, I was opposed to the Ordinance when it was adopted because I felt the estimated added cost to meet the requirements would not result in a like amount of energy saved. I also felt that after having built several hundred homes during the past sixteen years I knew how to build energy-conserving homes better than the young men who proposed the Ordinance. I was wrong

and now believe the Davis Energy Ordinance should be a model for all homes being built.

The added cost is minimal. The average cost for the twenty-one homes we have built since the Ordinance was adopted was approximately \$60 per home.

The Ordinance does work and I would like to list some of the reasons why I believe so.

The single most important factor is proper lot orientation. A lot which faces north or south and has proper window placement will permit the nightly cooling breezes to penetrate a home.

Going hand in hand with lot orientation is the reduced glazing allowed. We have had no difficulty in meeting this requirement.

When the Davis Energy Ordinance was first proposed the unshaded glazing allowed was 1.5 percent of the total floor area. Through compromise with builders, this was upped to 3.5 percent. I believe the less unshaded glazing permitted, the more energy efficient the home will be.

During this past summer we built four homes on lots with a lot orientation of N 00° 18' 55". These homes had a 2'6" overhang and were insulated with R-11 wall insulation and R-19 ceiling insulation. The windows permitted the night breezes to penetrate the homes. Thermostats were placed in the homes after they were drywalled and were checked daily in the late afternoon.

I might add that I did this not to prove the Ordinance out. I put those thermostats on there because I thought that what the consultants, the people that proposed the Ordinance, I felt that what they proposed wasn't going to work and I was going to try to prove just the opposite.

When the outside temperature was in the high 90s to over 100°, the inside temperature was 72° to 75°. This was without any exterior or interior window screening. If screening had been installed, the temperature would have been lower.

In conclusion, I would like to stress the importance of early adoption of the standards in the Davis Energy Ordinance. The planning stage of proposed lot development is the single most important part of energy conservation. Planners should be encouraged to design streets which have as many north and south facing lots as possible.

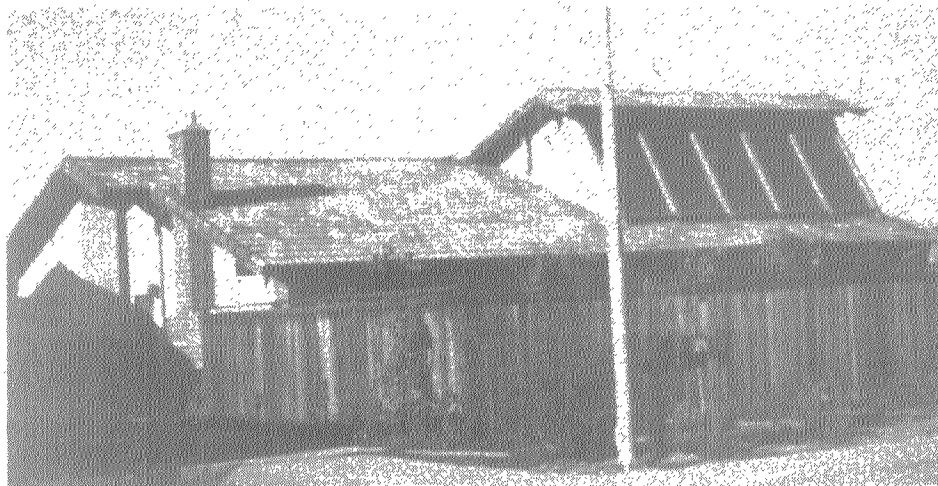
The Davis Energy Ordinance does work, and I am firmly convinced that the result will be less energy consumption and lower utility bills for the consumer.

I'd like to pass these out. This was a study that I had Living Systems do for me on a seven-unit apartment on an elderly project that was going to be built in Davis. And after I presented my program to FHA, they did say that we could redesign the heating and cooling systems to reduce it from a central heating and air conditioning system, a zone system, and in this study we will show calculations of what the monthly utility bills are going to be.

In the winter, we have calculated that the utility bill, the total utility bill for the five months' season, is about \$11.95, and in the summer months, \$7.90, and in the spring and fall, \$6.76. Averaging this out over the year, the total utility bill per month per apartment is going to be about \$9.30.

Now, these apartments were designed with the Davis Energy Ordinance in mind and tried to utilize several energy conservation materials.

And I might add that by being able to redesign the heating and air conditioning system for these apartments, we are going to save approximately \$500 an apartment, which amounts to about \$35,000 over the project. The standards increased the costs of my houses on an average of \$60 per house and my houses range in square footage from 1,600 to 2,000 square feet.



Completed house in the Corbett subdivision.

4 SOLAR HOUSES

An important aspect of the Davis energy conservation project was to develop designs of innovative energy conserving buildings which would demonstrate for local builders and developers methods for complying with the new building code. Several prototype buildings were designed which include various schemes for solar heating and cooling. Some of these designs have been tried out in houses outside Davis, others in the city itself. Living Systems, the city's consultants, carried out this work under a HUD grant.

Before the buildings could be designed, general goals were set forth:

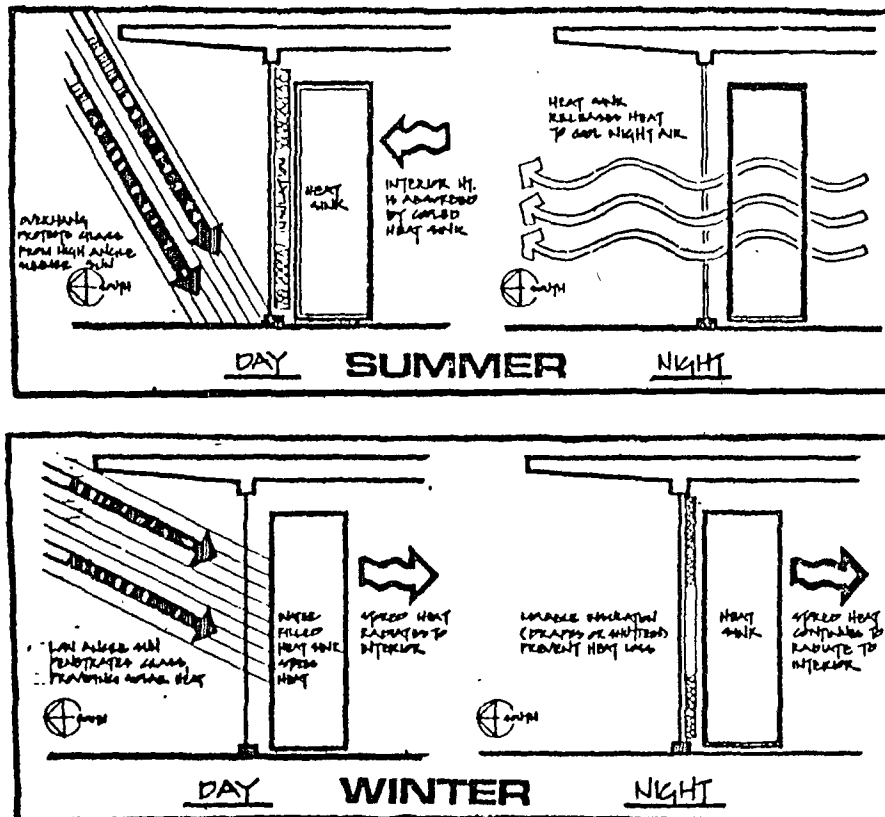
- Develop a 80-90 percent solar heated and 100 percent naturally cooled dwelling.
- Reduce the total cost of the dwelling through the use of conventional construction techniques, the reduction of built square footage consistent with the provision of a comfortable living environment, and the maximum use of simple efficient solar technology.
- Develop a system of landscaping that would improve the thermal performance of the building

by allowing both solar access in the winter and shading in the summer.

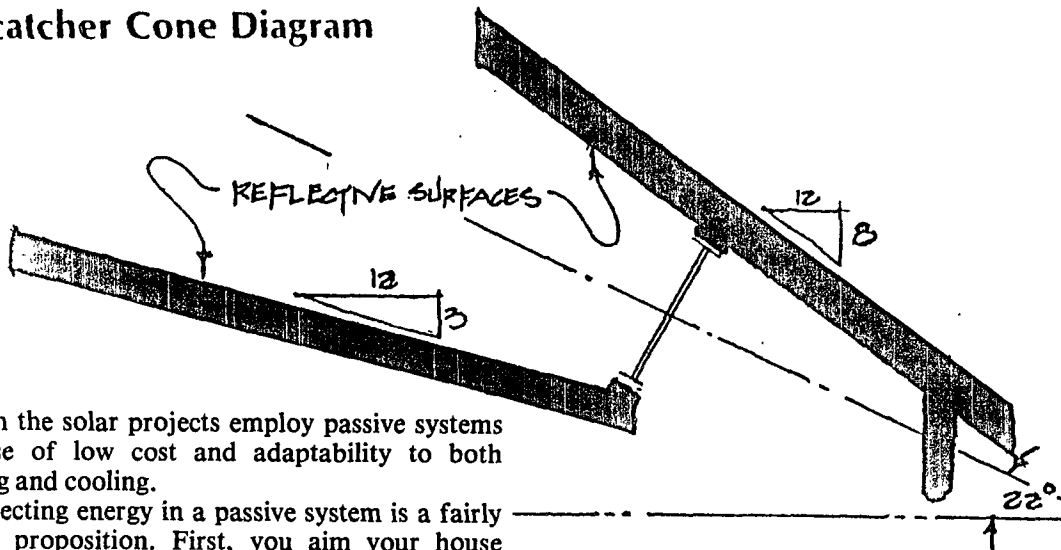
- Create outdoor spaces that extend and enhance interior spaces and provide usable space for year-round outdoor activity.
- Promote an efficient and integrated use of natural and artificial lighting to provide a high quality visual environment at low energy-use levels.
- Utilize high-efficiency appliances: low water use fixtures, solar hot water heating, and a "solar clothes dryer."
- Provide full handicapped access to all rooms and services.

Living Systems then designed two prototype buildings to meet these goals. The first of these, called the Alice Street house, was planned for a lot owned by the city adjacent to a junior high school. The second, "Sun Catcher," was a solar duplex. The city was granted funds from the Farmers Home Administration and HUD for construction of the projects. The buildings will be used in part as residences for farm workers.

Operation of Passive System



Suncatcher Cone Diagram



Both the solar projects employ passive systems because of low cost and adaptability to both heating and cooling.

Collecting energy in a passive system is a fairly simple proposition. First, you aim your house south with large window exposure. However, storage and distribution can be problems. The solution lies in providing mass within the building structure — dense interior materials with high heat holding capacity such as masonry, adobe, concrete, stone, water. These are materials that absorb surplus heat from sunlight entering the windows and radiate it back into the room after dark. The term “mass” is used in its most literal meaning. Thick walls are a crucial part of the passive system. Water can be the medium for storing heat. In drums or columns facing the sun, it picks up heat faster and stores more of it than any other common material. Insulation is used to trap the heat in the structure. By manipulating heat flow and storage it is possible to take advantage of those parts of the daily and weekly temperature fluctuations that drive the temperature of the building above or below the average outdoor temperature.

The first of the building projects, the Alice Street house, involved designing a home for a large family or a group of students on a city-owned lot located in the outskirts of Davis. That meant providing three or four bedrooms, two bathrooms, a sizeable dining area, large kitchen with space for storage, laundry and general storage. The house is to be set on the lot to take advantage of southern exposure, and the design calls for vegetable gardens, a garage, and patios.

The Alice Street house is to be of wood frame set on a concrete slab. It has 2” x 6” exterior walls to allow for R-19 batts in the walls, and the ceiling insulation is R-30 batts. There is no slab edge insulation. The 235 square feet of south glass act as a solar collector during the winter months. Only 79 square feet of glass face other directions to reduce unwanted heat gain and heat loss. There are 13 solar cylinders in the house, which hold 320 cubic feet of water for a total of 20,000 pounds of water or about 85 pounds of water per square foot of collector. Solar cylinders are vertically upright steel tubes. They are painted dark colors on the

south to absorb the solar energy coming in through the south windows in the winter. In the summer the sun is blocked by overhangs, awnings, and special insulated draperies made with aluminum foil bonded to a cloth substrate. The solar cylinders absorb internal heat gain on summer days and release this heat at night.

One sunny day in January should provide heating carryover for one to two cloudy days. Carryover for other months would be slightly better due to higher average temperatures. Also, the greater number of days successive sunshine, the greater the carryover of the heat storage.

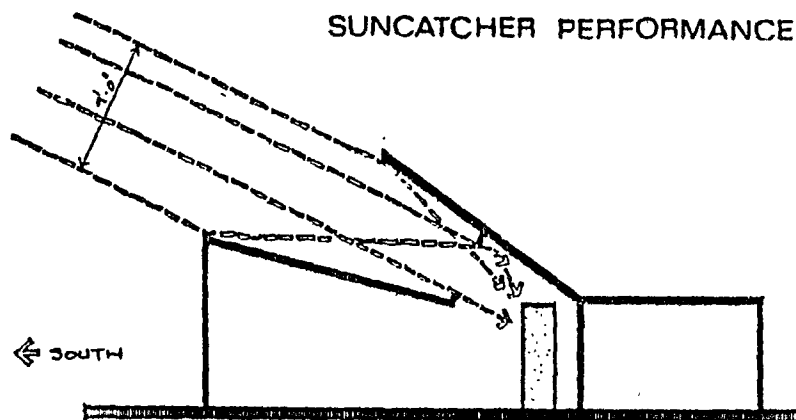
The Alice Street house design calls for a small backup system (gas heater 35,000 BTUs), but requires no backup cooling system. Calculations by Living Systems indicate a thermal performance 3.5 times better than a typical Davis Energy Conservation Code house in the winter with full natural cooling during the summer. It is estimated that between 70 and 80 percent of the heating will be provided by the solar passive system during an average winter in Davis.

The estimated gas heating budget for an average year is 14,150,000 BTUs (assuming 2,189 heating degree days), while there is no cooling energy demand. Water heating is mostly achieved with a flat plate solar water heater which saves 150 therms of natural gas per year. The estimated electrical use is 250 KWH per month, or 3,000 KWH/year, and 342 therms per year of natural gas. These figures are computed for a family of four with typical lifestyle.

The projected energy use for the Alice Street House is compared with average Davis figures for 1973-1975 (from PGE) and average California figures for 1975 (from Rand).

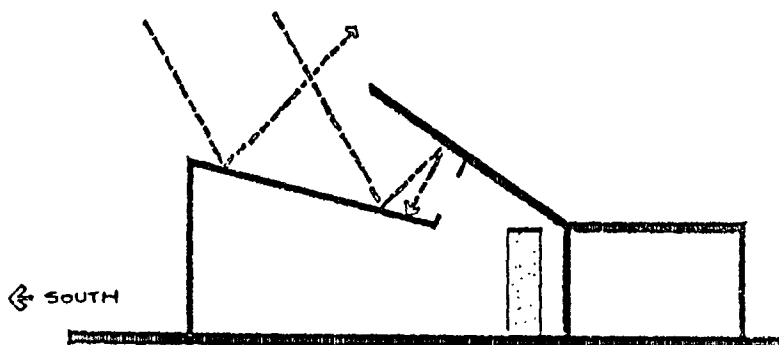
	A.S.H. estimate	Davis 1973	Davis 1974	Davis 1975	CA. Av. Use 1975
KWH/hr	3000	7210	6800	6744	6370
THERMS/yr	342	1044	946	1024	793

SUNCATCHER PERFORMANCE



August 21, 12:00 — 62° Sun Angle

Summer heat gains are minimized. The overhang shades the window from direct solar radiation, and the geometry of the "Suncatcher" prevents sunlight reflected off of the roof from entering the windows. In addition, the window is shuttered to reduce conducted heat gain.



December 21, 12:00 — 26° Sun Angle

Winter radiant gains can be approximately doubled through the "Suncatcher" scoop by the use of reflective surfaces on the roof below and the eave above the window. The window is shuttered to prevent night heat loss.

Since the Davis climate is not typical for California, the average energy use per household is greater. The Alice Street house nevertheless should use less than half the energy consumed by the average California household.

The second solar building project, the Sun Catcher solar duplex, is based on similar concepts and goals as the single family Alice Street house. But Living Systems was anxious to develop a design that did not rely heavily on solar devices built into the south-facing portion of the building. After all, what could be done with lots or buildings that did not necessarily afford large openings to the South?

Living Systems wanted to integrate the solar collectors and water heaters more directly into the shape of the building as a whole. Thus, it set out to create a basic plan that could be employed in "worst case" sites, those lots that were hopelessly oriented away from good southern exposure. The specific program for the duplex included:

- Provide a duplex of two identical three bedroom, one bath units for use by a family or a group of students.
- Provide cooking facilities, laundry facilities, a dining area to seat six people, and adequate storage.
- Provide a one-car garage for each unit.

The design for the duplex utilizes the Sun Catcher concept for the first time. It will reduce the amount of south glass necessary while increas-

ing the amount of solar radiation passing through the glass. The scoop configuration shown above is the basic element of the Sun Catcher.

Various cone configurations were studied for their performance in both summer and winter. The attempt was to both maximize winter radiant heat gain and minimize summer gain. After investigation of several cones, it was decided that a south facing cone of 19° that was rotated 22° from horizontal satisfied these requirements.

To test the graphic studies a scale model was built and tested. Through light meter readings, Living Systems determined that the effect of the reflective cone could provide double the amount of light entering the house. For example, if the ambient level outdoors was 7,000 Fc., then the readings just inside the glass would be 14,000 Fc.

By placing the glazing at the end of a cone of reflecting materials, the glazing was reduced to, in this case, 4'0". It reduced detrimental heat gains and losses through the glass. Shutters and curtains cost were likewise reduced.

The architectural implications of the Sun Catcher cone on a dwelling could be beneficial. To begin with, it reduced dependence on the south facade. When used as a clerestory on the roof, it is less likely to be shaded by nearby houses, trees, etc. Secondly, the clerestory allows the penetration of light and heat into the center of the house, allowing for a more even distribution of the solar heat. Thus, more of the water cylinders could be placed away from the south windows.

5 SOLAR DRYERS

Like many other communities, Davis had once banned clotheslines as unsightly. These prohibitions always had popular support — but not any more.



Davis resident Dorothy Cecil hangs her wash on a "solar dryer."

In April, 1977, Davis passed Ordinance No. 876 nullifying regulations that banned the use of clotheslines and establishing requirements for clotheslines in new multi-unit dwellings. The Ordinance states:

The City Council of the city of Davis does hereby ordain as follows:

Section 1. Purpose: It has been determined

(a) Clotheslines are economical and are the most energy efficient method of clothes drying;

(b) Concern for aesthetics has occasionally resulted in subdivision restrictions or landlord rules and regulations banning the construction and use of clotheslines;

(c) Energy required to operate electric and gas clothes-dryers has become increasingly expensive and may in the future become less available; and

(d) The desirability of permitting the use of clotheslines outweighs the aesthetic disadvantages.

Section 2: Section 29-169.1 is hereby added to Chapter 29 of the Code of the City of Davis, 1971, as amended, to read as follows:

Section 29-169.1 Clotheslines:

It shall be unlawful and a nullity to establish any private covenant or restriction which prohibits the use of a clothesline in any residential zone, except that all multi-family developments (three-family and greater densities) requiring Design Review Commission approval shall require suitable space or facilities except where such space would preclude good project design, to enable residents to dry their clothes using the sun. Such clotheslines shall be convenient to washing facilities and oriented so as to receive sufficient sun to dry clothes throughout the years.

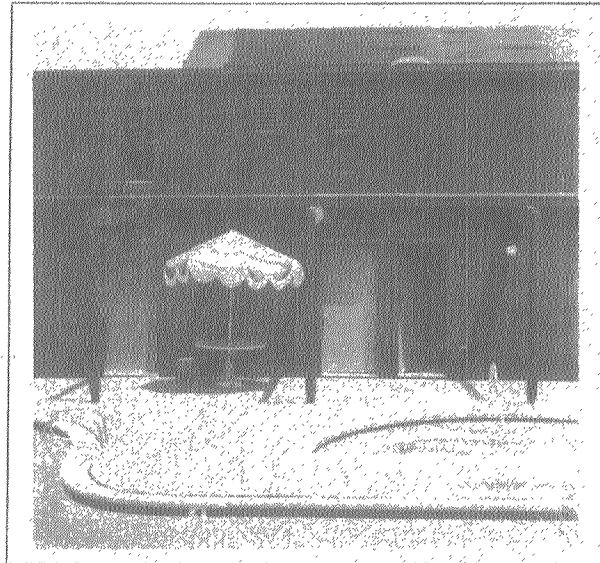
6 POOLS

Swimming is a popular pastime in Davis, where summer temperatures can reach 114°F. But heating pools in cooler weather had become an expensive and energy-consuming luxury.

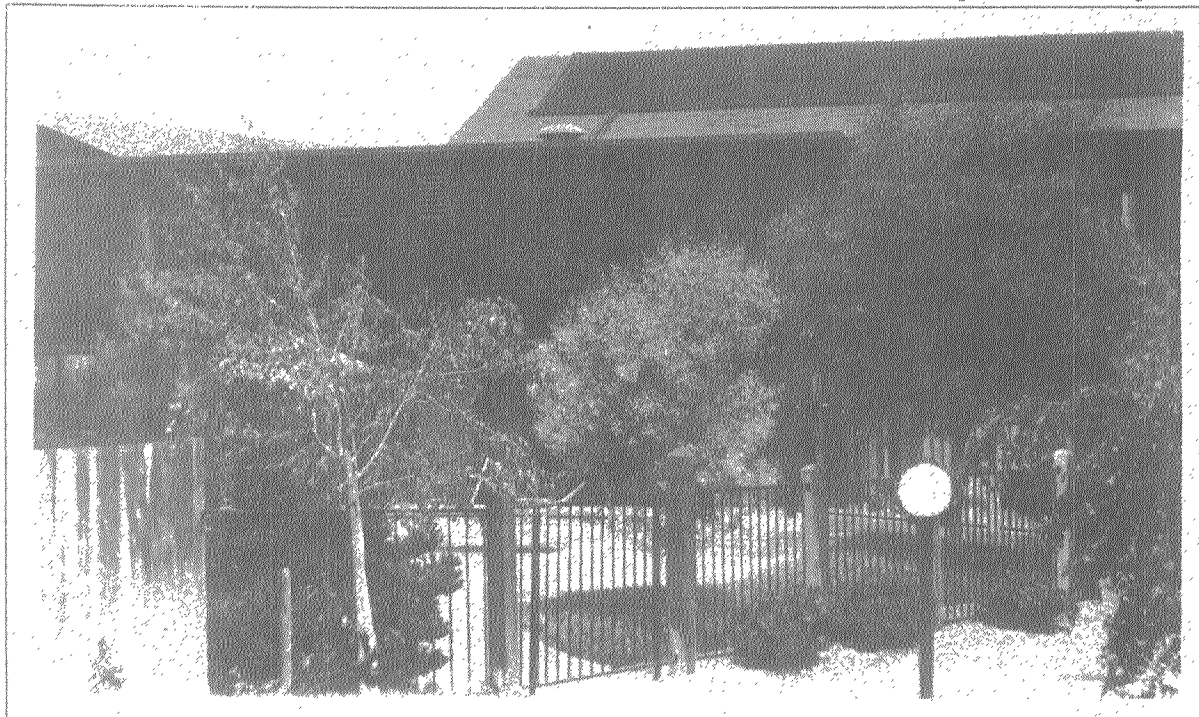
There are perhaps 700 swimming pools in Davis, many of them heated by gas. To increase the temperature of a swimming pool from 70 to 80 degrees can cost \$40 to \$60 a month in gas bills.

The city now is switching its pools to solar heat. And in March of 1977 the City Council was considering a new ordinance which would ban pools heated by any other means than solar. The proposed ordinance reads in part:

"New swimming pools, hot tubs or similar devices, installed after _____ shall not be heated by gas, electricity, oil, propane, kerosene, gasoline or butane. Such existing heaters utilizing gas, electricity, oil, propane, kerosene, gasoline or butane shall become non-conforming by this ordinance and shall be abated within 10 years of the date of adoption of this ordinance."

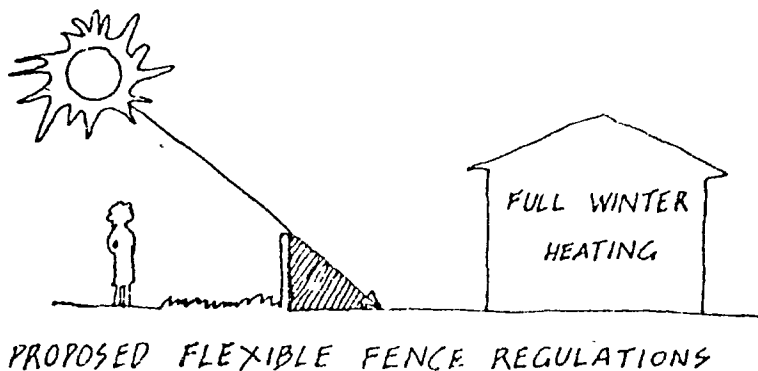
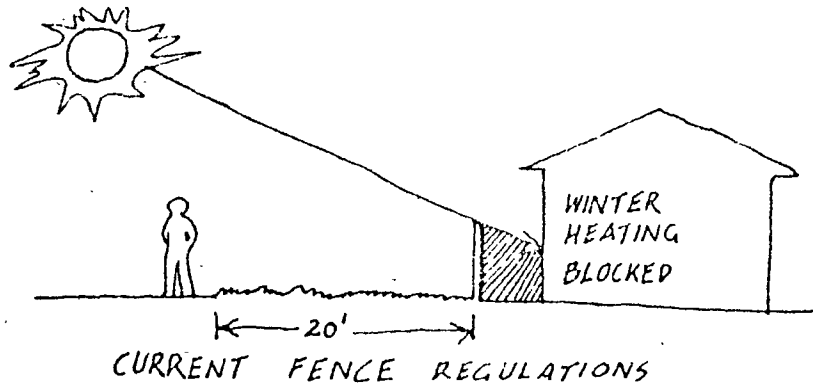


Casitas del Valle pool with solar panels



7 FENCES & HEDGES

By allowing fences and hedges to be higher and set back closer to the street, Davis gives its residents more yard space and uses natural solar heat to reduce winter fuel use.



The city also is gradually moving to a new approach in setbacks -- the arrangement of houses in relation to sidewalks and fences or hedges. If houses are to have large south facing windows to take advantage of the winter sun, they must also have adequate space between the window and fence to allow the low angled winter sun to enter the window. That means fences must be set back closer to the street when the house faces south.

If zero lot lines (i.e. attached "townhouses") are encouraged, less energy loss will occur because there will be fewer outside walls to heat or cool. In addition, if front yards are allowed to be fenced close to the street, there will be a great deal more private yard space which can be utilized by the occupants. Here again, we see a return to private inner court-yards.

Set forth below are a variety of measures undertaken in city ordinance no. 816 to cut down on the use of energy through standards on the location of fences, walls, and hedges:

Fences, walls and hedges may be located in required yards as follows:

(1) If not exceeding at any point four feet in height above the elevation of the surface of the ground at such point, they may be located in any yard or court, except for a corner lot.

(2) If not exceeding at any point six feet in height above the elevation of the surface of the ground at such point, they may be located in any required rear yard or interior side yard.

(3) On a corner lot, a fence or hedge over three feet in height, measured from the curb gutter grade, shall not be located in a triangular area measured twenty-five feet along the inside face of the sidewalk in either direction from the sidewalk intersection. Where no sidewalk exists, the measurement shall be made along the right-of-way line.

(4) Fences not exceeding six feet in height may be located at the fifteen foot setback in the front yard.

(5) The Community Development Director may issue a permit to allow a fence to:

(i) Be located at the five foot setback for the rear yard portion of the street side yard provided that the subject lot and adjoining lot have a common rear lot line and provided that such fence will not conflict with public utility easements; or

(ii) exceed the six foot height limitation up to a maximum height of eight feet for side and rear yard fences only if such proposed fence design will not have an adverse affect upon adjoining properties.

8 WORK IN HOMES

One way to reduce the use of energy is to work in the neighborhood where you live. But in many cities, zoning prohibits development of work places in residential areas. Nonetheless, thriving cottage industries in crafts, photography, editing and so on often are carried on despite formal prohibitions. In Davis the City Council decided to back cottage industry within the home through an ordinance allowing home owners to operate small businesses.

To protect residential neighborhoods, but still allow for cottage industry, the City Council set out these "home occupation" definitions in Ordinance 875, adopted April 20, 1977:

Home Occupation: A home occupation is an accessory use of a residential dwelling unit which shall be conducted entirely within the dwelling. It shall be conducted by the inhabitants of the dwelling, and one non-familial employee, if desired. A home occupation shall be clearly incidental and secondary to the primary use of the residential dwelling; shall not change the character thereof or adversely affect the uses permitted in the residential district of which it is a part; shall create no additional traffic or require additional parking space; and, shall not have outdoor storage of materials, equipment supplies visible from outside the premises other than materials equipment and supplies necessary for domestic purposes.

Criteria. The following criteria shall be employed by the Community Development Director to determine a valid home occupation:

1. No employment of help other than the members of the resident family and one assisting non-familial employee.
2. No external use of material or equipment not recognized as being part of the normal practices in the residential district.
3. No direct sales of products or merchandise from the home.
4. The use shall not generate pedestrian

or vehicular traffic beyond the normal to the residential district.

5. It shall not involve the use of commercial vehicles for delivery of materials to or from the premises.

6. The home occupation shall not involve the use of advertising signs on the premises except that one nameplate (name/occupation only) is permitted not to exceed 0.5 square feet in area. The nameplate is to be located flat against the building wall only.

7. No more than 25 percent of the area of one floor of the residence shall be used for such purposes.

8. In no way shall the appearance of the structure be altered or the occupation within the residence be conducted in a manner which would cause the premises to differ from its residential character either by the use of colors, materials, construction, lighting, signs, or the emission of sounds, noises, vibrations.

9. There shall be no use of utilities or community facilities beyond that normal to the use of the property for residential purposes.

10. No storage or display of materials, goods, supplies, or equipment related to the operation of a home occupation shall be visible from outside the premises.

11. No equipment or process shall be used in such home occupation which creates noise,

THE DAVIS EXPERIMENT/WORK IN THE HOME

vibration, glare, fumes, odors or electrical interference detectable to the normal senses off the lot, if the occupation is conducted in a single family residence, or outside the dwelling unit if conducted in other than a single family residence. In the case of electrical interference, no equipment or process shall be used which creates visual or audible interference in any radio or television receivers off the premises, or causes fluctuations in line voltage off the premises.

12. Persons with demonstrated physical handicaps may be permitted special review by the Planning Commission. The applicant may request waiving of one or more, or a portion thereof, of requirements (1) through (9). This special request shall be reviewed by the Planning Commission, at a Public Hearing, involving the notification of property owners within 100 feet of subject property. In reviewing the request, the Planning Commission shall consider any waivers based solely on the applicant's physical inability to function within the requirements of (1) through (9).

13. In cases where the Community Development Director is undecided about the compatibility of the use with the neighborhood, the Director may issue temporary approval for a specific time period. After the stated time period, the Community Development Director shall review this use, and shall consider adjacent property owner comments and any other information regarding the conduct and operation of the use. After such review, the Director may approve such use

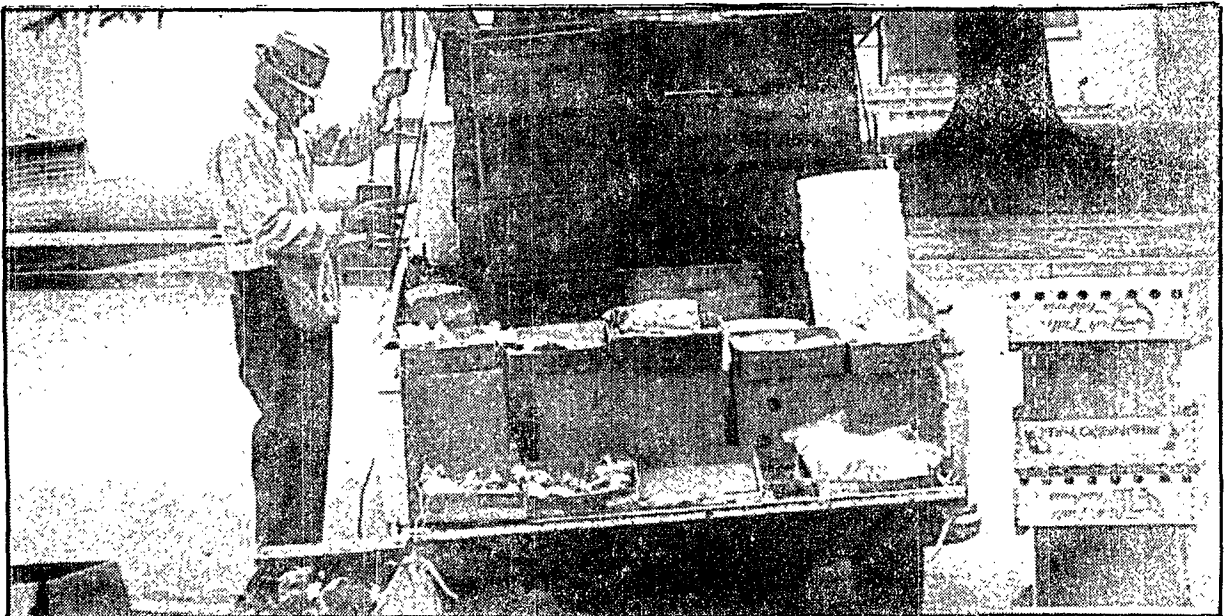
permanently but must notify originally surveyed property owners.

Exclusions. The following uses are examples of those uses which are specifically prohibited: (1) Schools of any size or type. (2) Boarding or lodging house as defined in Zoning Ordinance. (3) Antique shop. (4) Barber shop, beauty parlor. (5) Funeral chapel or home, mortuaries. (6) Gift shop. (7) Medical or dental clinic or hospital, animal hospital or grooming facilities. (8) Day care centers or nursery schools. (9) Private clubs. (10) Restaurants. (11) Auto or motorcycle, boat or trailer, similar type repair shops. (12) Kennels. (13) Office of a health care provider when special mechanical equipment is required.

Application and Procedure. Application for a Home Occupation shall be made to the Community Development Department on a form provided by the Community Development Department, and shall be accompanied by the appropriate filing fee. The decision of the Community Development Department shall be final unless an appeal is filed within 15 days of the decision. Any appeal shall be reviewed by the Planning Commission.

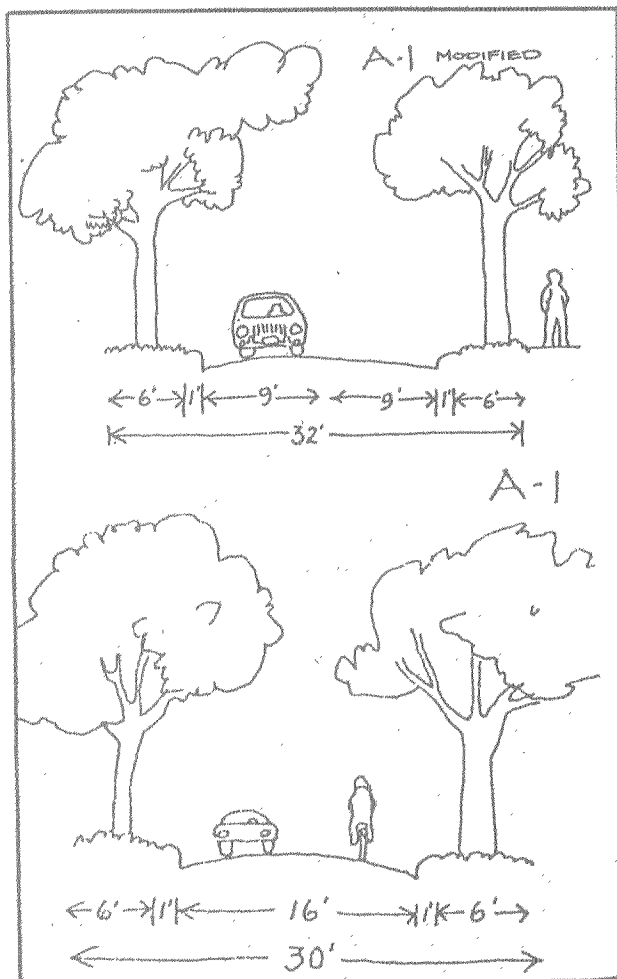
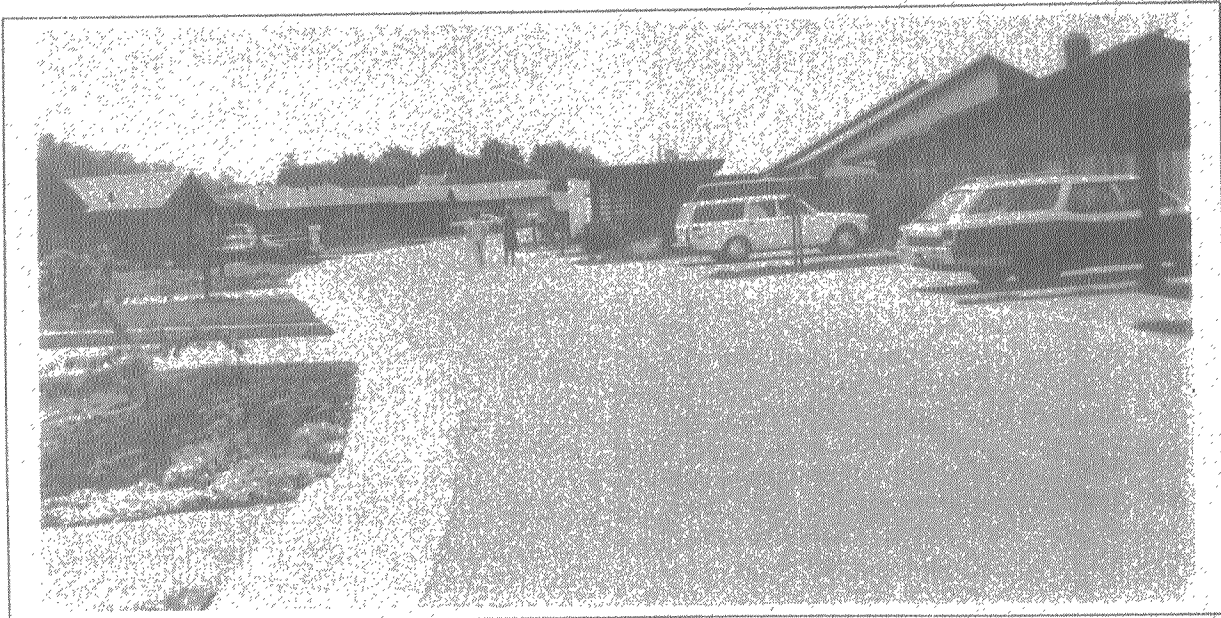
Voiding of Permit. The Community Development Director may void any Home Occupation for noncompliance with the criteria set forth in this section.

Time Limit. All Home Occupations shall be valid for a period of two years from initial date of approval. Request for a time extension shall be submitted to the Community Development Department in writing, accompanied by the appropriate fee and one month prior to expiration.



In addition to encouraging cottage industry, Davis facilitates small neighborhood farmers' markets.

9 STREETS



Proposed access, one or two way street, serving less than 20 units.

Narrow streets save space and use less asphalt. They also may contribute to slower auto speeds, thereby enhancing fuel efficiency and safety.

In Davis there has been a move towards narrower streets. The widths of streets are determined primarily by the width of fire trucks, with a minimum acceptable width of a street being equal to two times the width of a fire truck plus some clear space to allow for passing.

Narrow streets are less energy consuming in several ways: They cost less and savings in land and site development could be as high as \$1,000 per lot. They use less asphalt. They probably contribute to lower speeds by autos, thereby enhancing fuel efficiency. If use of alternative transportation systems such as buses, walking or bicycles became important enough, wider streets would be less and less needed anyway. The reduction of local streets from 34 to 28 feet is contemplated, with a possibility of further reduction in width in conjunction with neighborhood parking bays.

10 RECYCLING

The recycling effort in Davis dates back to 1972, when a small group of volunteers formed a non-profit organization called the Resource Awareness Committee of Davis (RACD). They got permission from the UC-Davis campus to set up a recycling center at a publicly convenient location on university property near the downtown of Davis, and started accepting glass, aluminum, bi-metal cans, and newsprint. A full-time employee was hired to keep the center clean, and to make sure that the various commodities being brought in by the public were properly sorted: volunteer employees pitched in as well. Hauling to market was basically handled by the various commodity buyers (Coors for aluminum, Owens-Illinois for glass, a large Sacramento garbage company for paper).

In July 1974, the Davis City Council passed an ordinance requiring the separation of newspapers from garbage, and ordered the Davis Waste Removal Co. (DWR) to collect the separated papers at the curb along with the garbage. Cognizant of some of the problems that other companies had experience with putting newspaper racks under their garbage trucks, DWR decided to run a separate scooter for newspapers only.

DWR's president Charles Hart describes the recycling program:

"The community's response was quite good; in fact many citizens requested that we extend the recycling pick up service to include cans and glass as well. Unfortunately, considerable friction had developed between DWR and the paid help at the RACD's recycling center. (The employee felt that we were in direct competition.) Even though the founders of the RACD didn't share this view, to defuse the situation we agreed to furnish the RACD with our collection scooter fully maintained and insured, so that they could go house-to-house and collect cans and glass as well as newspapers. Furthermore, we put our own 50-cubic-yard drop boxes over at the recycling center (the Sacramento garbage company removed its boxes), and, because the price of newsprint was plummeting (from \$30 per ton to \$2 per ton), we agreed to haul for RACD at no charge.

"Between furnishing the collection scooter and furnishing drop boxes and hauling, our contribution to the RACD was worth \$900-1,000 per month. This continued for many months, until newsprint (the backbone of the



Davis' recycling center handles newspapers, cans, oil, and organic waste.

recycling effort) began to rise again in price. Then the RACD agreed to pay us \$50 for each load of newsprint or cans that we hauled to market, and although this did not meet our costs, our subsidy to recycling dropped to \$500-600 per month.

"In April 1976, DWR received permission from the Davis City Council to build a combined shop/office/recycling center which included a concrete pit so that recyclables could be easily and efficiently top-loaded into our drop boxes. It was intended by mutual agreement between the RACD, UC-Davis, DWR, and the Davis City Council that DWR would take over the community recycling effort upon completion of its facility. However, construction suffered several lengthy delays (the yard is still not completed); meanwhile, DWR ran afoul of the Public Utilities Commission because we were charging RACD lower rates for hauling than those authorized by the PUC. Moreover, the RACD was having a tremendous problem with employee turnover, abuse of our collection scooter, and lack of daily route supervision. Consequently, with the blessing of the RACD, DWR took over complete management and control of the recycling effort on December 1, 1976.

"We immediately made several changes in the operation. First, we took one of our most conscientious employees off the garbage routes and now have him collecting only recyclables. Second, we built a small trailer for the collection scooter and our one man is now able to cover the town in five 8-hour work days (servicing about 1400 houses per day, as well as apartments, all of which have containers for "newspapers only"); RACD in recent months had found it necessary to employ two full-



Oil recycling

time and one part-time employees to cover town. Third, we discontinued the RACD's time-consuming practice of banding pallets together and lining them with cardboard for storing color-sorted glass; instead, we switched to a drop box and now mix all colors together. (We get \$20 per ton for mixed glass rather than \$30 per ton for color-sorted, but because of the convenience and labor-savings, we still come out ahead.) Fourth, we built a can-crusher and now flatten all of the aluminum cans to cut down on trucking. (We also tried crushing bi-metal cans but this did not prove to be economically feasible-- too much time was being spent crushing bi-metal cans in return for too little time saved trucking.)

"We handle approximately 125 tons per month of recyclables: 85 tons of newsprint, 35 tons of glass, four tons of bi-metal cans, and one ton of aluminum. This represents about 10 percent of the garbage that we collect each month. Roughly two-thirds of the recycled materials are collected by our employee, while the other one-third is brought in by the public. For that material which we collect, the only requirement is that recyclables must be placed out at the curb in shopping bags on regular garbage collection day. It is not necessary for the homeowner to wash out containers, crush cans, break glass, or even sort by material. We have tried to make the participation as simple as possible, and we think that a good 40-50 percent of the households do recycle at least some of their waste each month.

"As for the material that is brought to the center by the public, we do have a few problems. We do not find it feasible to man the center, since it is accessible to the public at all times. Nevertheless, we do police it daily (including Saturdays, Sundays, and holidays), and between can-crushing, glass-breaking, and clean-up, we must spend at least one hour per day at the center. When the recycling center is moved

to our new corporation yard, we will very likely have to restrict public access; i.e., Monday-Saturday open from 8:00 a.m. to 5:00 p.m., closed Sundays and holidays. Inasmuch as we do provide weekly curbside pickup, we will continue to encourage the public to let us come get the recyclables, so restricted hours should not curtail the effort.

"On the subject of economics-- profitability-- of recycling, we find that we presently sell about \$3,000 worth of recyclables each month (gross income), while operating expenses consume about \$3,000 per month: One full-time employee and scooter to go house-to-house; five drop boxes for storing and hauling recyclables to market (\$15,000 investment); amortization of can-crusher (\$2,000 investment); trucking of recyclables to market (two full truck-days per month at \$320 per truck-day); minimum one hour per day of management time to keep the center clean and check on routes; daily garbage service (two 2-cubic-yard bins full of trash are emptied at \$250 per month).

"Thus, we do not consider recycling to be truly profitable. Nevertheless, to be breaking even with recycling after all of these years of losing money is indeed encouraging.

"Unfortunately, we have no control over the market price paid for recyclables, and our gross income from recyclables could just as well be \$1,000 per month as \$3,000 (if newsprint again dropped to \$2 per ton), while our recycling expenses stay at \$3,000 per month. Recycling will then be a drain on our business again, and when our total waste operations start losing money, we will have no choice but to go to the City Council for a rate increase. Because the Council has ordered us to recycle as a part of our contract with the City, the Council must be prepared to make up the deficit through the rate structure by which we are compensated. (This is of course with the understanding that deficits are not the result of inefficiency and/or incompetence.)

"It is with great pride that I have recounted DWR's progressive role in making recycling successful in Davis. We intend to continue actively in this field, whether it makes us a buck each month or not, and to handle this operation as efficiently and conscientiously as possible. We feel that recycling is important in making the public conscious of its waste, and hope that through this awareness the public will waste less. Although this line of reasoning --coming from a garbage company-- may surprise you, it is our conviction that recycling is an integral part of professional waste management, and we consider ourselves professionals."

SHADE TREES

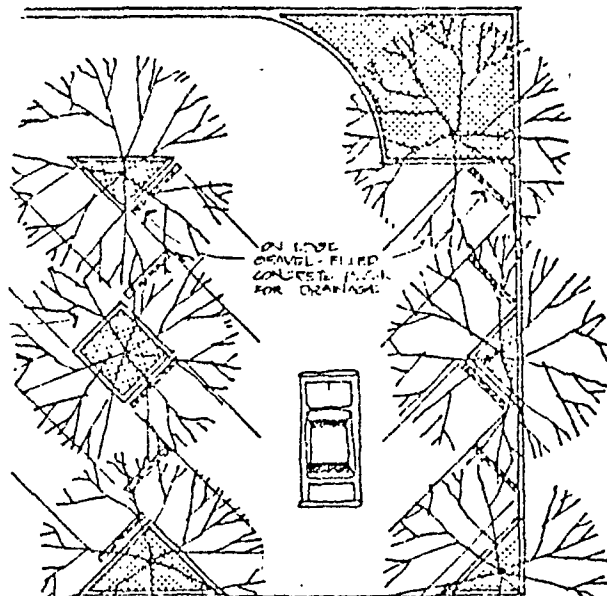
The City Council picks a street tree committee, made up of five citizens, to advise them on matters pertaining to the trees. It meets quarterly and all gatherings are public.

The committee originally prepared an ordinance which was made law in 1963. The committee and the park superintendent put together a master list of every tree in the city, and then laid out a plan for planting of trees. A complete inventory and card system of every tree has been established. The basic idea of the ordinance is to develop and maintain a comprehensive plan for planting and maintaining trees and other plants, and to set up rules for planting, maintenance and care of the trees.

The city's basic tree policies are that all planting is done by city crews. One tree is required per lot (on corner lots one on each street front) and is planted in the 10 foot easement behind the sidewalk. Planting is done only after homes are occupied. The street tree committee designates a tree for each street. When it comes to pruning, this too is done by city crews.

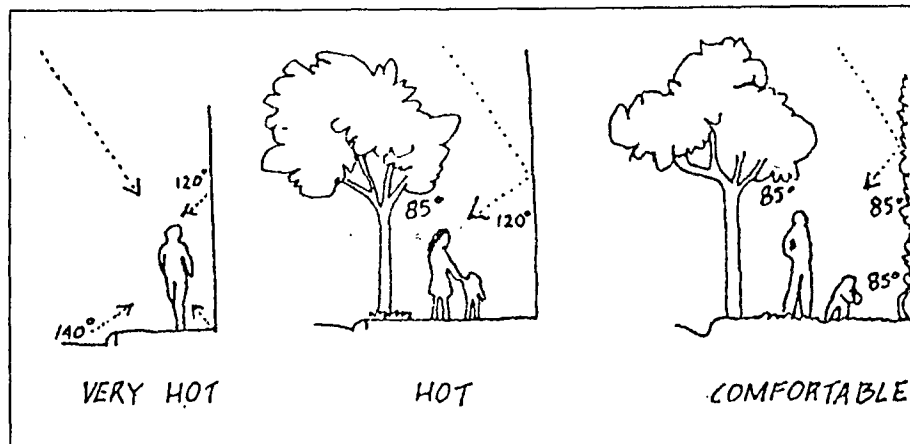
In the older section of the city there are about 3,000 trees of various kinds, in the newer areas there are about 6,000, and the city is planting about 700 additional new trees each year. The total tree population is about 17,800. There are some 80 different kinds of trees, and the tree committee has set limits on the numbers of any one kind of tree by establishing use categories.

The planting program calls for evergreen trees to be planted on major streets and either evergreens or deciduous trees on the embounded streets. Evergreens on the major streets reduce the problems of leaf pickups in the fall, provide good scale and give the appearance of a city of trees year around.



Within the last year, Davis has inaugurated an integrated pest management program for its trees. The idea here was to reduce the use of toxic pesticides. Usually the city treats about 10,000 trees with pesticides. In 1976, however, under a program devised by the University of California at Berkeley and utilized in other California cities, only 810 trees were treated. During the first year the Berkeley advisors made an investigation and inventory of all the major pests and what trees they attacked. Then they set about designing a program that attempts to control pests by introducing natural predators, careful pruning, and instead of pesticides, the use of water washing.

In Appendix B are the Davis city code on trees and shrubs, and programs designed to protect two major trees in the city.



Air temperature and radiation are about equal in their effect on human comfort. Thus on a 90° day a person on an 85° surface (grass) might feel only slightly warm, yet on a street with surface temperature of 140° she would be very uncomfortable. This discourages cyclists and pedestrians and increases the use of autos, with air conditioners.

12 BICYCLES

Davis has 25,000 bicycles. Considering that the city has a population of only 30,000, probably no other city in the US has as high a proportion of its citizens owning bicycles and using them as a regular means of transportation.

In their paper, "Bikeways in Action", Robert Sommer and Dale Lott describe Davis' unique transportation situation:

A number of factors produced this situation--the presence of many young people attending the Davis Campus of the University of California, the flat terrain, the mild weather, and the many wide streets. When the campus expanded greatly and the population in the area grew rapidly in the early 1960s, the streets became much busier. About the time the first stop light was installed, people riding bicycles began to feel crowded. At the local bicycle shop, it was common to see bikes appearing with damaged front wheels when riders were forced onto the curb by passing cars. Competition, both for space on the streets and opportunities to cross at intersections, grew between bicycles and automobiles. It was a lopsided competition at best-- bicycles are small and frail, automobiles large and sturdy. It became clear to a number of concerned Davis citizens that, if bicycles were to remain a viable part of the city transportation system, they would have to be given a place of their own in city traffic planning.

What was needed was some way to separate bicycles from automobiles, and the plan adopted was the bicycle path or bikeway-- a strip of pavement or concrete from which automobiles would be excluded. At first this suggestion was rejected by the City Council; it was considered to be visionary, impractical, potentially dangerous, and its proponents were regarded as cranks. However, as the debate continued, it became apparent that there was widespread support for bicycle paths. A citizens group circulated a petition asking the City Council to establish bicycle paths along principal streets and rights-of-way as an integral part of the city's transportation system. This petition was signed by 90 percent of the several hundred voters approached. Bike paths became the central issue in a city election of 1966 and the pro-bikeway candidates won. Soon after that, the first bike paths were established along the sides of existing wide streets.

Since that time, Davis has been developing a bicycle path network that is probably unique

SPECTROGRAPHICS



in the United States. New housing tracts in the city are required to set aside space for bicycle lanes separated from traffic, and a special act was passed by the California Assembly to enable the city to formulate traffic regulations for bicycles. It is important to realize that the bicycles are not merely owned, stored or used for recreational purposes; they are an important part of the transportation system. On one heavily trafficked street, traffic counts during the summer (with few University students in town) show that bicycles represented 40 percent of all traffic. During the rush hour, 90 percent of all riders are adults. The emblem of the city shown on many municipal vehicles is a gay nineties two-wheeler. Many business leaders in the community are strong proponents of bike riding, and admit that this is a matter of self-interest. The bicycle has also helped preserve the central city core as a viable shopping district, since parking is not a serious obstacle to shopping downtown. The University and high schools have been able to set aside less space for parking lots than they would ordinarily. The acceptance of the bicycle as a viable means of transportation by virtually all segments of the community provides the unique opportunity to learn the structural and social requirements of safe, efficient and pleasurable bike riding.

The potential of bicycle transportation cannot be realized without the necessary environmental support system. Just as one cannot have a railroad without tracks, or a bus system without highways, so one needs special facilities and regulations for bicycle traffic. This means planning which must rest on firm knowledge of the special requirements of the bicycle. One simply does not design highways for automobiles and sidewalks for pedestrians, leaving bicyclists squeezed in between moving automobiles,

THE DAVIS EXPERIMENT/BICYCLES

parked cars and pedestrians.

First let us review the history of the Davis bicycle path network. About eight years ago a group of concerned citizens formed the Bike Safety Committee which investigated bicycle traffic problems in the city and made various suggestions about how to alleviate them. The city Public Works Department became interested and made traffic counts to determine the streets most heavily used. There was very little precedent to follow in developing bike lanes. The city Public Works Department believed that the most feasible plan was to create bike lanes on the outsides of the streets over 50 feet wide. Where this contradicted the California Motor Vehicle Code a special bill relating to bike lanes was passed with the help of the State Assemblymen. This bill permitted the Davis City Council in 1967 to pass Ordinance 442 creating bike lanes and regulating bike traffic. (The Davis City Code on bicycles appears in Appendix C.)

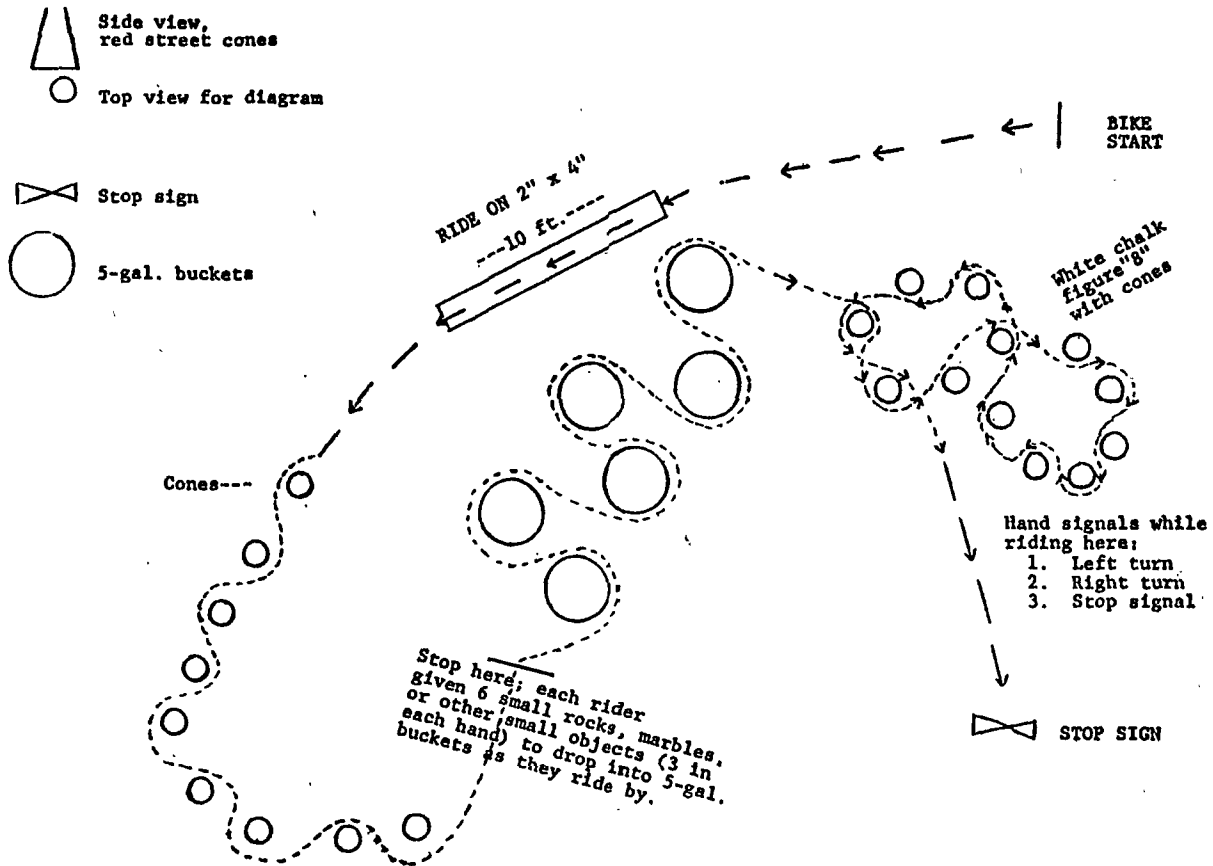
The city now operates programs in bicycle education, safety, and enforcement, through the police department. Under this program an officer visits each grade three or four times a year. A specially prepared curriculum introduces bikes in the kindergarten and continues

on up through the ninth grade. The curriculum includes a talking bicycle, films, slides, lectures and hand-out materials.

A bike rodeo held on the school's grounds during the school day tests the rider's ability to balance, turn, stop and signal for turns. On bike safety check day, each bike at school is inspected for safe use. Bolts, nuts, pedals, etc. are checked and minor repairs done by a police officer.

Bike licenses are sold for a three year period at a cost of \$4.50 each. The license information is put on a computer, and this data permits identification of Davis registered bikes in other areas and those that are lost or stolen.

All uniformed patrols of the Davis police department can issue citations to individuals, regardless of age, who are in violation of the bicycle ordinance. The "Bike Enforcement Officer" rides a 10 speed bike in uniform and he checks to make sure riders are obeying the bike traffic laws. In addition, the bike-aide is responsible for retrieving stolen or abandoned bicycles. He maintains the bike files, assists with licensing at rush times of the year and conducts bike auctions. Abandoned bicycles must be held 90 days prior to being auctioned off. About four auctions are held each year.



Course used to test school children in bike proficiency.

13 BUSES



Used English bus travels through Davis, still proclaiming its London destinations.

Ian Ross, general manager of the Davis University Transport System (Unitrans) describes the city's bus system:

Bus service at Davis began as a campus oriented transit service on an experimental basis by the Associated Students of the University of California, Davis (ASUCD) in 1967. In April 1967 ASUCD decided to buy two London double-deck buses in hopes that their distinctive appearance would increase transit usage.

Through the years, as patronage increased, more vehicles were purchased. In 1977 we have 13 operational buses, seven 56-passenger London double-deck buses, and six single deck standard diesel 45 or 48 passenger buses. Two additional buses, one of each type, are kept for parts, as all equipment in service is over 20 years old.

Normal transit service is provided primarily by the double-deck buses, while the standard diesels are used to provide additional service on rainy days when patronage doubles or triples.

Double-deck buses are used not only because of their distinctive appearance, but because of their efficiency. They get twice the fuel mileage of our single decks. They have a greater seating capacity, and are shorter, and this more suitable for Davis' somewhat narrow streets. Also, a conductor located in the passenger section is available to collect fares and help in safe loading and unloading of passengers.

Six routes are currently travelled by Unitrans during the day. In addition, during the 1977-78 school year, night service will be offered on four routes. The six daytime routes radiate from the terminal at the campus to approximately two to four miles into the city of Davis. Buses operate from 7:30 a.m. to 11:45 p.m. on UCD school days only. Three lines are covered twice an hour, one line is covered once an hour, and two lines are covered once an hour except twice an hour during morning, lunch, and evening peaks.

Total yearly patronage has been 225,522 passengers in 1975-76 and 188,294 passengers in 1976-77. Unitrans expects 250,000 passengers in 1977-78.

The 1976-77 decline in patronage is attributed to the drought Davis has experienced this year.

Although some staff, faculty, and Davis residents use the system, most of Unitrans' patrons are students. Fares on the system are 15 cents for single rides, 10-ride tickets are \$1.25, and a five-week unlimited-use pass is \$4.25. Night Service passes are \$1.75 for five weeks.

Unitrans employs five part-time student managers including a general manager, three operations managers, a planning and marketing manager, 28 drivers, 18 conductors, and two coach cleaners. Its operating budget for 1977-78 is \$136,108. Income is obtained from fares, charters, advertising, ASUCD subsidy, and local/state transportation fund monies.

14 APPENDICES

APPENDIX A: Davis' energy conservation ordinance for residential construction



DAVIS CITY CODE

CHAPTER 12A: HOUSING

Sec. 12A-1. Purposes of chapter.

The city council hereby finds and determines:

(a) The city has adopted a comprehensive general plan which calls for refined planning and residential development review in order that suburban growth meets the needs of the community and proceeds in a logical, orderly, efficient and environmentally sound manner.

(b) The city is located upon and adjacent to prime agricultural land which is a limited resource of statewide significance.

(c) The city derives much of its social and cultural character from its historical development as a "university town" which provides housing and services for a large segment of the student body, faculty and employees of the University of California, Davis campus.

(d) Inadequately planned speculative residential development has sometimes created in the past and unless controlled in the future will create or aggravate the following conditions:

(1) Wasteful construction of public facilities on a crisis basis. .

(2) Overburdening of municipal services and utilities.

(3) Increases in tax costs in excess of tax gains.

(4) Unavailability of adequate low cost and moderate cost housing to serve the needs of students, the elderly and persons of low and moderate incomes.

(5) Premature and inefficient commitment of prime agricultural lands to urbanization.

(6) Environmentally detrimental development patterns.

(e) There are many persons of low, moderate or fixed incomes whose work, studies or other connections with the city have led such persons to desire to reside in the city. Many such persons cannot locate adequate housing within the city within their economic means and this fact may have a disproportionate exclusionary impact upon disadvantaged citizens. The only effective means to prevent such exclusion is the provision of ample low and moderate income housing. Additional federal subsidies may or may not be presently unavailable and traditional zoning has been ineffective in this regard. Thus, only through residential development review is there any likelihood of securing such housing.

(f) Zoning ordinances alone cannot provide the comprehensive types of development review procedures which will ensure a high level of environmental protection, encouragement of the construction of low and moderate income housing, sequential orderly development and achievement of other goals set forth in the general plan.

(g) The public welfare requires the establishment of a housing development priority program and housing development review board, hereinafter referred to as the "board," to accomplish the following:

(1) Prevent premature development in the absence of necessary utilities and municipal services.

(2) Coordinate city planning and land regulation in a manner consistent with the general plan.

(3) Facilitate and implement the realization of general plan goals which cannot be accomplished by zoning alone.

(4) Provide significant incentives to developers to include low and moderate income housing in their undertakings.

(5) Prevent unplanned capricious growth which has no relationship to community needs and capabilities.

(6) Encourage and facilitate development proposals which accomplish the objectives of the general plan. (Ord. No. 765, § 1.)

Sec. 12A-2. Applicability of chapter.

(a) Except for a single-family or duplex residence on a lot legally in existence before November 6, 1974, no building permit shall be issued for single-family or duplex residential construction, including mobile homes, within the city; unless such construction has been approved in accordance with the standards and procedures provided for by this chapter. A lot will be deemed to be in existence if a final subdivision map has been submitted to the city for approval prior to November 6, 1974.

(b) In the event that the city council, by resolution, declares the necessity for inclusion of other types of residential development within the housing development priority program, such other types of residential development shall be subject to the restrictions and procedures of such program during such time period as is specified by such resolution.

THE DAVIS EXPERIMENT/APPENDIX

(c) The foregoing notwithstanding, residential lots legally in existence before November 6, 1974, may be divided into a maximum of four lots through the appropriate parcel map process, and building permits may be issued for the construction of residences thereon without regard to the requirements of this chapter. (Ord. No. 765, § 2; Ord. No. 774, § 2; Ord. No. 845, § 1.)

Sec. 12A-3. Housing development review board generally.

(a) Composition. The duly appointed members of the planning commission shall serve as the housing development review board.

(b) Meetings. The board shall meet on or before September 15 of each year and thereafter for so long as is required to rate all projects for the next ensuing construction season and later seasons. The board shall complete its report no later than November 15 of each year.

(c) Staff. The community development department of the city shall serve as the staff of the board. (Ord. No. 765, §§ 3, 4, 6; Ord. No. 845, § 1.)

Sec. 12A-4. Development proposal--Applications.

Upon the written application filed with any required environmental impact reports by a developer, the housing development review board shall consider any residential development proposal which is within an appropriate phase or phases as shown on the general plan's time phasing maps and which has zoning or rezoning appropriate to the development proposal. Such an application and proposal shall be filed with the city office of community development prior to October 1, 1975, and September 1 of each subsequent year for apartment projects and August 15 of each year for all other projects. The proposal shall be submitted on a form provided by the city and shall contain all data and information as called for therein.

As used in this chapter the term "proposal" shall include the developer's application and any and all maps, schematics, written information and data submitted by the developer in support of his or her application. In addition, the application shall state the minimum number of units acceptable to the applicant. (Ord. No. 765, § 5.)

Sec. 12A-5. Same--Hearings.

The housing development review board shall conduct a separate hearing on each proposal. The sole issue at such hearing shall be the rating of the project. The board shall have no authority to disapprove or remand an application. All hearings shall be public. The developer and all interested persons shall be entitled to appear and testify. After the conclusion of the hearings, the board shall render a decision rating the project on the basis of the criteria set forth in section 12A-6. (Ord. No. 765, § 8.)

Sec. 12A-6. Same--Ratings.

(a) All proposals shall be preliminarily rated by the housing development review board staff in accordance with the criteria set forth in subsection (b) of this section. The developer shall be furnished with a copy of such rat-

ing and any supporting data at least five working days prior to the board's hearing thereon.

(b) The following criteria shall be used to rate projects which are in conformity with the city general plan:

- (1) Internal growth needs.
- (2) Economic mix.
- (3) Low and moderate cost housing.
- (4) Environmental impact.
- (5) Availability of public services and facilities.
- (6) Compactness.
- (7) Design diversity.
- (8) Economic impact.
- (9) Feasibility.
- (10) Competition.

These criteria shall be applied and evaluated in accordance with the amplification of criteria contained in city Resolution No. 1604, Series 1974, adopted December 18, 1974, and any subsequent amendments thereto. (Ord. No. 765, §§ 7, 9.)

Sec. 12A-7. Same--Approvals--Generally.

When all rating hearings are completed, the housing development review board shall determine, on the basis of comparative ratings, projects which are eligible for approval based upon the number and types of units to be allowed in accordance with section 12A-8. (Ord. No. 765, § 10.)

Sec. 12A-8. Same--Same--Number per three year period.

Prior to August 15, 1975, and June 1 of each subsequent year, the city council shall meet and determine the number and types of residential units which should be approved during the subsequent three year period. This determination shall be based upon:

- (a) The general plan of the city.
- (b) The number of units approved and actually constructed in prior years.
- (c) Availability of utilities and public services.
- (d) The goals, purposes and objectives contained in section 12A-1.
- (e) The three year residential needs report which shall be annually reviewed and adopted as prescribed in the city housing action program. (Ord. No. 765, § 11.)

Sec. 12A-9. Same--Same--Partial or conditional.

If a development involves more than twenty units, the project may be considered

in segments. If the segments are interdependent, the board may approve the entire plan or a portion of the entire plan subject to the requirement that a limited number of units will be constructed each year but approval shall not be given for more than a three year period.

The board shall have discretion to approve a portion of the housing units proposed and to disapprove or differentially rate the balance of the housing units proposed in any particular project. In granting partial approvals, the board shall evaluate economic feasibility and cost factors in small projects.

The board shall impose such conditions as may be determined necessary or desirable in order to implement the city general plan and the purposes and objectives of this chapter. (Ord. No. 765, § 12.)

Sec. 12A-10. Same--Same--Modification.

Notwithstanding any other section of this chapter, the city council may at any time increase the number and types of approvals determined pursuant to section 12A-8. Such modifications shall only be made when unforeseen circumstances occur which justify such modification based upon those factors listed in section 12A-8.

In the event of a modification of the number or types of approvals, the board may increase the number of approved units in a project or it may accelerate the phasing of a project. (Ord. No. 765, § 13.)

Sec. 12A-11. Same--Same--Effect.

The approval of units pursuant to the procedures and provisions of this chapter shall not exempt nor affect the developer's obligation to obtain all required zoning, environmental, subdivision and other approvals as are required by statute or ordinance as a prerequisite to the application for building permits. (Ord. No. 765, § 14.)

Sec. 12A-12. Same--Same--Revocation, etc.

The board may approve development proposals upon condition that construction shall commence and be carried out in accordance with an established development or construction schedule. Failure to comply with such development or construction schedule shall be good cause for the revocation or modification of approval. Approved single-family and duplex units shall be deemed to have been completed for purposes of this section upon the date that a final subdivision or parcel map pertaining to such units has been approved.

Failure to comply with conditions imposed pursuant to section 12A-9 of this chapter shall be good cause for the revocation or modification of approval; provided, that such revocation or modification shall be made by the board only after conducting a hearing into the causes of such noncompliance upon ten days written notice to the developer. The developer and all interested parties shall be entitled to appear and testify as to the reasons for noncompliance with the requirements of the board.

Revocation of approval may permit reallocation of units to other projects. (Ord. No. 765, § 15.)

Sec. 12A-13. Appeals from decisions.

(a) Any member of the city council, upon the majority vote of those present

and voting, or any applicant for a development aggrieved by any action of the housing development review board may file written notice of appeal with the city clerk, which notice shall be filed within fifteen days of the action and shall set forth in general terms the alleged error which is the basis of the appeal. An appeal shall suspend the effect of the board's approval as to all applications for which the fifteen day appeal period has not expired as of the date upon which the notice of appeal is filed. Upon receipt of the notice of appeal, the city council shall schedule a public hearing and shall publish notice of the time and place of such hearing in a newspaper of general circulation within the city, which notice shall be published at least ten days in advance of the hearing date. Notice of the hearing date shall be mailed to all applicants whose applications are affected by the appeal. Mailed notices shall be addressed to the applicant as shown upon the written application provided for in this chapter. Failure to actually receive such mailed notice shall not affect the validity of the appeal proceedings.

(b) Upon conclusion of the public hearing, the council shall affirm, overrule or modify the action which is the subject of the appeal. The action of the city council shall be final.

(c) Any legal action to challenge any decision, procedure, approval or denial of the city council must be filed in a court of competent jurisdiction within thirty days after the act challenged. (Ord. No. 765, §§ 16, 17.)

Sec. 6-8. Severability of chapter.

If any section, subsection, sentence, clause or phrase of this chapter is for any reason held by a court of competent jurisdiction to be invalid, such a decision shall not affect the validity of the remaining portions of this chapter. The city council hereby declares that it would have passed this chapter and each section or subsection, sentence, clause or phrase thereof, irrespective of the fact any one or more sections, subsections, clauses or phrases be declared invalid. (Ord. No. 725, § 2.)

Article II. Energy Conservation Standards
for Residential Construction.

Sec. 6-9. Definitions.

For the purposes of this article, the following words and phrases shall have the meanings respectively ascribed to them by this section:

(a) Floor area. The total habitable area of a dwelling unit, expressed in square feet, which is within the exterior face of the insulated shell of the structure and which is heated or cooled.

(b) Summer design day. A day upon which it shall be assumed, for purposes of structural heat gain calculations, that all of the following climatological conditions exist:

(1) The sun's path and resultant angles of direct sunlight shall be those which occur on August 21 of each year at latitude 38° 32' north. These angles can be approximated by using latitude 40° north.

(2) The sun's intensity through glazing shall be calculated for August 21 of each year at latitude 38° 32' north; this can be approximated by using latitude 40° north data.

(3) The outside temperatures on August 21 shall be assumed to be, at each hour, Pacific Standard Time, as follows:

<u>Time A. M.</u>	<u>Temp. °F</u>	<u>Time P. M.</u>	<u>Temp. °F</u>
1:00	66	1:00	95
2:00	64	2:00	99
3:00	61	3:00	100
4:00	60	4:00	99
5:00	59	5:00	98
6:00	59	6:00	95
7:00	67	7:00	91
8:00	72	8:00	87
9:00	78	9:00	81
10:00	82	10:00	77
11:00	87	11:00	73
12:00	91	12:00	68

(4) For the sake of determining the exterior air film coefficient, the wind speed shall be 15 m.p.h. in accordance with ASHRAE procedures.

(c) Winter design day. A day upon which it shall be assumed, for purposes of structural heat loss calculations, that all of the following climatological conditions exist:

(1) The sun's path and resultant angles of direct sunlight shall be those which occur on December 21 of each year at latitude 38° 32' north. These angles can be approximated by using latitude 40° north data. (See Table 1.)

(2) The sun's intensity through glazing shall be calculated for December 21 of each year at latitude 38° 32' north; this can be approximated by using latitude 40° north data.

(3) The 24 hour average outside temperature is 45°F.

(4) For the sake of determining the external air film coefficient, the wind speed shall be assumed to be 15.0 m.p.h. in accordance with ASHRAE procedures.

(Ord. No. 784, § 2.)

Sec. 6-10. Minimum performance standards--Adoption.

The city hereby adopts minimum standards for the thermal performance of buildings to be constructed within the city. In order to achieve maximum thermal performance, the performance standards have been carefully adjusted to the special problems and opportunities of the city climate. These standards shall apply to all residential structures designated Group H and Group I in the Uniform Building Code.

(a) Winter performance standard. For a winter performance standard the total day's heat loss per square foot of floor area during the winter design day shall be as follows: For single-family, detached structures designated U.B.C. Group I, see table 2; for multiple dwellings, U.B.C. Group H, the total day's heat loss shall not exceed one hundred twenty BTU's per square foot of floor

area. Commonwealth Group I structures shall meet Group H standards. The resolution establishing methods of compliance with the performance standards will allow for numerically increasing the permissible standard on the basis of surface areas in common in order to equitably deal with the variability which occurs in this class of dwelling units.

(b) Summer performance standard. For a summer performance standard, the total day's heat gain per square foot of floor area during the summer design day shall be as follows: for single-family, detached structures, U.B.C. Group I, see table 2; for multiple dwellings U.B.C. Group H, the total day's heat gain shall not exceed forty BTU's per square floor area. Commonwealth Group I structures shall meet Group H standards. The resolution establishing methods of compliance with the performance standards will allow for numerically increasing the permissible standard on the basis of surface areas in common in order to equitably deal with the variability which occurs in this class of dwelling units. (Ord. No. 784, § 3.)

Sec. 6-11. Same--Methods of compliance to be established by resolution.

Standard methods for calculating the performance of a proposed structure to determine compliance with the standards of this article shall be adopted by resolution of the city council. (Ord. No. 784, § 4.)

Sec. 6-12. Administration and enforcement.

(a) The provisions of this article and the resolution establishing the methods of compliance shall be administered by the building official of the city.

(b) No building permit shall be issued by the building official for any new structure subject to this article unless such structure is found to be in compliance with the winter and summer performance standards hereby established. (Ord. No. 784, § 5.)

Sec. 6-13. Partial exemptions.

(a) Structures designated U.B.C. Group I to be built on lots which are unimproved with structures and for which a tentative subdivision map has been approved prior to September 1, 1974, shall be exempt from requirements adopted by resolution pursuant to section 6-11 of this article. To the extent that the exemption from requirements causes a structure to exceed the performance standards established by section 6-10 of this article, such incremental excess shall be permitted.

(b) Structures designated U.B.C. Group I to be built on lots which are unimproved with structures and for which a tentative subdivision map has been approved prior to January 1, 1976, but after September 1, 1974, and which lots front upon a portion of street having an axis between 292.5° and 067.5° true (N67.5°W and N67.5°E) and 247.5° and 112.5° true (S67.5°W and S67.5°E), shall be exempt from glazing shading requirements adopted by resolution pursuant to section 6-11 of this article. To the extent that the exemption from glazing shading requirements causes a structure to exceed the performance standards established by section 6-10 of this article, such incremental excess shall be permitted. (Ord. No. 784, §§ 6, 7; Ord. No. 787, § 1.)

Sec. 6-14. Variances.

(a) Purpose. The purpose of a variance is to allow variation from the strict application of the requirements of this article and implementing resolutions where, by reason of the exceptional narrowness, shallowness or unusual shape of a specific piece of property, or other extraordinary situation or condition of such piece of property, or of the use or the development of property immediately adjoining the property in question, the literal enforcement of the requirements of this article would involve practical difficulties or would cause undue hardship unnecessary to carry out the spirit and purpose of this article. In most cases, the variance shall only relate to the allowable area of unshaded glazing permissible under the resolutions implementing this article.

(b) Application. Application for a variance shall be made by the property owner or the board of building appeals or the community development director on a form prescribed by the city, and shall be accompanied by a fee as prescribed by resolution adopted pursuant to City Code section 29-12.1, no part of which shall be refundable. No fee shall be charged if the variance is initiated by the board of building appeals or the community development director.

(c) Maps and drawings. Maps and drawings required to demonstrate that the conditions set forth in this article apply to the subject property, together with precise and accurate legal descriptions and scale drawings of the property and existing buildings, and other data required, shall be submitted with the application for a variance.

(d) Grounds for granting. The board of building appeals may grant a variance only when all of the following conditions are found:

(1) That any variance granted shall be subject to such conditions as will assure that the adjustment thereby authorized shall not constitute a grant of special privilege inconsistent with the limitations upon other similarly situated properties which were developed under the limitations of this article.

(2) That because of special circumstances applicable to the subject property, the strict application of this article is found to deprive subject property of privileges enjoyed by other similar properties which were developed under the limitations of this article.

(3) That the authorizing of such variance will not be of substantial detriment to adjacent property, and will not materially impair the purposes of this article or the public interest.

(4) That the condition or situation of the subject property or the intended use of the property for which the variance is sought is not so general or recurrent in nature as to make reasonable or practicable the formulation of a general regulation for such conditions or situations.

(5) That there are not available reasonable alternative construction methods which will bring the proposed structure into compliance with the performance standards of this article.

(e) Examples of grounds for granting. The following types of physical or topographical factors are examples of conditions which may justify the

grant of a variance from the glazing shading requirements to be established by resolution as provided by section 6-11 of this article:

(1) Overriding off-site view considerations which are determined to add appreciable incremental value to the subject property.

(2) Minimum size lots with fixed and adverse orientation problems.

(3) Adverse lot orientation dictated by street or utility improvements or similar physical limitations where such limitations are in existence prior to the adoption of this article.

(f) State standards. No variance shall be granted under this section which will result in a structure which exceeds the then existing state residential energy conservation standards.

(g) Notice of variance hearing. Upon the filing of an appeal, the building official shall provide written notice of the filing of the appeal to all persons interested in the matter and shall cause notice of public hearing to be published in a newspaper of general circulation.

(h) Review of the decision. The decision of the board of building appeals to grant or deny the application shall be subject to appeal in accordance with the resolution establishing the board of building appeals. (Ord. No. 784, § 8.)

Sec. 6-15. Appeals.

Any person aggrieved by a determination of the building official in the application of this article may appeal such determination to the city board of building appeals. Such appeal shall be in writing and shall be filed with the building official within fifteen days of the determination appealed. All appeals shall be accompanied by payment of a fee in the amount set forth in the city's community development fee schedule.

Upon the filing of an appeal, the building official shall provide written notice of the filing of the appeal to all persons interested in the matter and shall cause notice of public hearing to be published in a newspaper of general circulation.

In consideration of an appeal, the board of building appeals shall have authority to determine the suitability of alternate materials and methods of construction and to provide for reasonable interpretation of the provisions of this article and implementing resolutions, provided, that no alternate material nor method of construction shall be approved which results in a reduction in the performance standards established by this article for both summer and winter conditions.

The decision of the board of building appeals shall be subject to appeal in accordance with the resolution establishing the board of building appeals. (Ord. No. 784, § 9.)

Article III. Housing.

Division 1. Uniform Housing Code.

Sec. 6-17. Adoption.

That certain document, three copies of which are on file in the office of the city clerk; being marked and designated as "Uniform Housing Code, 1973 Edition," which is published by the International Conference of Building Officials, is hereby adopted as the Housing Code for the city, pursuant to section 50022.1 et seq., of the Government Code of the State of California. Said document, as amended by this division, shall regulate use, occupancy and maintenance of all residential structures. (Ord. No. 820, § 2.)

Sec. 6-18. Amendments.

The Uniform Housing Code, 1973 edition, as adopted by section 6-17, is hereby amended by the following additions, deletions and amendments:

(a) Section 203, "Housing Advisory and Appeals Board," is amended by changing five (5) members to seven (7) members.

(b) Section 204, "Violations," is amended by changing "misdemeanor" to "infraction."

(c) Section 502(d), "Projections," is amended to read:

"Projection may encroach into required yards as provided by Chapter 29 of the Code of the City of Davis, 1971 as amended."

(d) The following section is added to read as follows:

"Section 1205. Preliminary Appeal.

"When mutually agreeable with the Building Official and appellant, a

Table 2

Detached Group I Dwelling Unit
Thermal Standards

<u>Floor area</u> <u>(sq. ft.)</u>	<u>Winter heat loss</u> <u>(BTUs/[sq. ft.] [day])</u>	<u>Summer heat gain</u> <u>(BTUs/[sq. ft.] [day])</u>
500	363	118
1000	239	103
1500	208	98
2000	192	95
2500	182	93
3000	176	91

Note: Direct interpolation shall be used for floor areas not shown.

Infiltration and internal heat production are not considered under the requirements of these standards. These are very important considerations in the real performance of a building and must be estimated when sizing heating and cooling devices whether conventional or solar. However, for the present purpose they are too variable to be standardized.

preliminary hearing may be conducted in accordance with procedures set forth in Section 204 of the Uniform Building Code, 1973 edition.

"NOTE: The section references in subsections (a) through (d) refer to section numbers of the Uniform Housing Code, 1973 edition."
(Ord. No. 820, § 3.)

Division 2. Certificates of Occupancy;
Reports of Deficiencies.

Sec. 6-19. Definitions.

For the purposes of this division, the following words and phrases shall have the meanings respectively ascribed to them by this section:

Administrator. The building official of the community development department.

City. The City of Davis.

Person. An individual, partnership, corporation or association, or the rental agent of any of the foregoing.

Unit. A dwelling unit in a single-family, two-family or multi-family residence building, motel, hotel, rooming or boarding house, fraternity, sorority or similar living accommodation. (Ord. No. 820, § 4.)

Sec. 6-20. Required.

No owner shall enter into an agreement to sell, exchange, rent or lease with an option to sell or purchase, nor shall any person act as a salesman, broker or agent in connection with the preparation of an agreement for the sale, exchange, rental or lease with an option to sell or purchase any unit until a certificate of occupancy or report of deficiencies has been issued by the administrator as hereinafter provided. Prior to the sale, execution of a contract of sale or of an agreement to rent or lease with an option to purchase any unit within the city, the owner or salesman, broker or agent thereof shall provide a copy of the certificate of occupancy or report of deficiencies to the

RESOLUTION NO. 1833, SERIES 1975

RESOLUTION ADOPTING PROCEDURES FOR COMPLIANCE WITH THE ENERGY
CONSERVATION PERFORMANCE STANDARDS FOR RESIDENTIAL
CONSTRUCTION WITHIN THE CITY OF DAVIS

WHEREAS, the City of Davis has, by ordinance, established certain energy conservation performance standards for new residential construction within the City of Davis; and

WHEREAS, the ordinance which establishes energy conservation performance standards provides that standard methods for determining compliance of proposed buildings shall be established by resolution;

NOW, THEREFORE, BE IT RESOLVED by the City Council of the City of Davis as follows:

Section 1. Application.

Compliance with the energy conservation performance standards established by the City of Davis shall be determined by reference to the provisions of this resolution and any amendments thereto.

Section 2. Definitions.

For purposes of this resolution and the energy conservation performance standards ordinance of the City, the following words and phrases shall have the meanings respectively ascribed to them by this section:

A. R Values. ($1/U = R$) Thermal Resistance (R) is the measure of the resistance of a material or building component to the passage of heat. The units of measurement are: (Hours) (Degrees Fahrenheit) (Square Feet)/BTU. The resistance value (R) of mass-type insulations shall not include any value for reflective facing. (NOTE: For reflective foil insulation, use ASHRAE procedures only. Calculate both the winter and summer composite resistance value and use whichever is less.)

B. Composite Thermal Resistance (R_t) is the sum of each of the resistance values of the parts of an assembly of materials which together form an external skin element of the structure. For example, a commonly used wall is one which has an interior air film, one-half (1/2) inch thick plaster board, three and one-half (3-1/2) inches batt insulation, stucco, and finally, an exterior air film, all of which have R values which are added together to derive the R_t value for the wall element.

C. Orientation. The compass directions are designated as follows when the attached tables are used:

North	337.5° - 022.5°
Northeast	022.5° - 067.5°
East	067.5° - 112.5°
Southeast	112.5° - 157.5°
South	157.5° - 202.5°
Southwest	202.5° - 247.5°
West	247.5° - 292.5°
Northwest	292.5° - 337.5°

D. Exterior Surface Area. The area for each dwelling unit of walls, ceilings, suspended floors, glazing, doors, etc. enclosing conditioned spaces and exposed to ambient climatic conditions.

E. Heavy Exterior Building Elements. The walls, suspended floors and/or ceilings which contain a heat storage capacity of 30 BTU's/Day for each square foot of surface area are considered to be heavy (see definition K). Only those materials located on the interior side of insulation materials may be counted. (An eight [8] inch thick light-weight concrete block wall with exterior insulation slightly exceeds these requirements.)

F. Color. Surfaces with a Munsell lightness value of 6.0 to 10.0 are to be considered light in color. Surfaces with a Munsell lightness value of 9.0 to 10.0 are to be considered very light in color. Unpainted wood surfaces are to be considered light in color. The Building Inspector shall prepare two (2) representative collections of materials and surface covering materials, one with Munsell lightness values greater than 6 and one of materials with Munsell lightness values greater than 9. These collections shall be available for inspection by the public.

G. Glazing. All vertical, horizontal, and tilted translucent or transparent exterior building elements shall be considered

glazing with a thermal resistance and daylight transmittance as specified by the manufacturer or as calculated by ASHRAE methods or other reliable references or procedures.

H. Shading Coefficient. The ratio of the solar heat gain through a shading-glazing system to that of an unshaded single-pane of double strength window glass under the same set conditions.

I. Hour's Solar Heat Gain. The amount of energy transmitted through an area of glazing oriented to a particular direction in one (1) hour. The following formula is used for calculation:

$$\text{HSHG} = (\text{SC}) (\text{SHGF}) (\text{A})$$

Where:

HSHG = Solar Heat Gain through the glazing for one (1) hour (BTU's/hour)

SC = Shading Coefficient

SHGF = Solar Heat Gain Factor for the hour from attached Table 1 (BTU's/square foot of glazing) using December 21 for winter and August 21 for summer.

A = Area in square feet of glazing exposed to the sun (square feet).

J. Solar Heat Gain Factor. The number of BTU's of solar energy transmitted through one (1) square foot of clear 1/8-inch glass in one (1) hour. This is determined by using the attached Table 1 which applies to 40° North latitude and the eight (8) compass orientations (see definition C).

K. Heat Storage Capacity. The mass located inside the insulated shell of the structure that fluxes through a temperature cycle each day in summer and winter, absorbing heat during overheated periods and storing it for release during underheated periods. Heat storage capacity shall be estimated by the following procedure:

$$\text{HS} = (\text{WM}) (\text{SH}) (\Delta\text{T})$$

Where:

HS = Heat Storage Capacity (BTU's/Day)

WM = The weight of the materials (lbs.) inside the insulated shell of the building to a depth yielding a resistance of R-1, except in the case of slab floors where only the slab itself is credited.

SH = Specific Heat of those materials (BTU's/[lb.] [degree F])

ΔT = Temperature flux; 5°F will be the maximum allowable for calculation purposes, except that light weight frame construction will be allowed to flux 10°F. (In order to determine the heat or cold available for storage, see Path II, Section 5.)

This total stored heat may be subtracted from the day's heat loss or gain to yield the adjusted Total Day's Heat Loss or Total

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Day's Heat Gain. Mass located in exterior elements to which the Equivalent Temperature Differential Method (E.T.D.) is applied to calculate summer heat gain shall not be included in the summer heat storage capacity credit.

L. Floor Area. Total habitable area of a dwelling unit (expressed in square feet) which is within the exterior face of the insulated shell of the structure and which is heated or cooled.

M. Accepted References. The following are useful and acceptable references:

Handbook of Fundamentals 1972, American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE), N. Y., N. Y., 1972.

Architectural Graphic Standards, Charles G. Ramsey and Harold R. Sleeper, John Wiley & Sons, Inc., N. Y., N. Y., Sixth Edition, 1970.

Design with Climate, Victor Olgyay, Princeton University Press, Princeton, New Jersey, 1963.

Concepts in Thermal Comfort, David Egan, Tulane University, School of Architecture, New Orleans, Louisiana, 1972.

Thermal Design of Buildings, Tyler Stuart Rogers, John Wiley & Sons, Inc., N. Y., N. Y., 1964.

Sun Angle Calculator, Libbey-Owens-Ford Company, Toledo, Ohio, 1975.

Energy Design Manual for Residential Buildings, State of California, Department of Housing and Community Development, Division of Codes and Standards, Sacramento, California, 1975.

Section 3. Standard Methods of Building Performance Calculation.

A. There are hereby adopted two (2) alternative standard methods of determining compliance with the City of Davis energy conservation performance standards. The two (2) alternative standard methods shall be referred to as Path I and Path II approaches.

B. Structures utilizing either Path I or Path II shall comply with the following:

(1) Infiltration. All swinging doors and windows opening to the exterior or to unconditioned areas such as garages shall be fully weatherstripped, gasketed or otherwise treated to limit infiltration. All manufactured windows and sliding glass doors shall meet the air infiltration standards of the 1972 American National Standards Institute (A134.2, A134.3 and A134.4), when tested in accordance with ASTM E 283-73 with a pressure differential of 1.57 lbs./ft.² and shall be certified and labeled.

(2) Loose Fill Insulation. When blown or poured type loose fill insulation is used in attic spaces, the slope of the roof shall be not less than 2-1/2 feet in 12 feet and there shall be at least 30 inches of clear headroom at the roof ridge. ("Clear headroom" is defined as the distance from the top of the bottom chord of the truss

or ceiling joists to the underside of the roof sheathing.) When eave vents are installed, adequate baffling of the vent opening shall be provided to deflect the incoming air above the surface of the material and shall be installed at the soffit on a 45-degree angle. Baffles shall be in place at the time of framing inspection. When loose fill insulation is proposed, the R value of the material required to meet these regulations shall be shown on the building plans or calculation sheet.

(3) Pipe Insulation. All steam and steam condensate return piping and all continuously circulating domestic or heating hot water piping which is located in attics, garages, crawl spaces, underground or unheated spaces other than between floors or in interior walls shall be insulated to provide a maximum heat loss of 50 BTU/hr. per linear foot for piping up to and including 2-inch and 100 BTU/hr. per linear foot for larger sizes. Piping installed at depth of 30 inches or more complies with these standards.

Section 4. Path I (Prescriptive Method).

Buildings meeting all of the following criteria will fulfill the required energy conservation aspects of this code with no overall performance calculations required.

Calculations using the applicable methods outlined in Path II may be employed to demonstrate compliance of alternatives to any particular section of Path I. Thermal trade-offs between sections of Path I must be done by using Path II or by referring to approved thermal trade-offs table developed by the Building Inspector.

A. Walls. All exterior walls (excluding windows and doors) shall use R-11 batt insulation between studs. Group H structures must have light colored walls or shaded walls. Fifteen percent (15%) of the wall area may be dark colored to allow for trim and color accents. (Group I structures have no wall color requirement.)

Exceptions:

(1) All exterior walls shall achieve a composite resistance value (Rt) of 10.52 if the insulation is not penetrated by framing, and Rt of 12.50 if the insulation is penetrated by the framing or furring. (California Administrative Code, Title 25, Chapter 1, Subchapter 1, Article 5, Section 1094[a].)

(2) Heavy walls with exterior insulation not penetrated by furring or framing shall have an Rt of 7.36, and Rt of 8.75 if the insulation is penetrated by furring or framing.

(3) Group H structures with dark colored walls shall increase their applicable Rt requirements by twenty percent (20%).

B. Roof/Ceilings; Ceiling/Attics. All roof/ceilings and ceiling/attics must use insulation achieving a minimum resistance of R-19 for the insulation itself. Group H occupancies having roof surfaces unshaded on August 21, at 8:00 a. m., 12:00 noon, or 4:00 p. m., shall be no darker than No. 6 on the Munsell color chart. Unshaded roof areas on Group I occupancies shall be no darker than No. 4 on the Munsell color chart. Roofs having unshaded areas and color darker than No. 6 or No. 4 respectively must increase the total insulation to yield R25 for the insulation itself.

Exceptions:

(1) All roof/ceilings and/or ceiling/attics sections shall achieve a composite resistance value (Rt) of 16.67 if the insulation is not penetrated by framing or furring and Rt of 20.0 if the

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insulation is penetrated by the framing or furring. (California Administrative Code, Title 25, Chapter 1, Subchapter 1, Article 5, Section 1094[c].) Blown insulation (loose fill type) shall be considered to be penetrated by the framing.

(2) The roof/ceiling and/or ceiling/attic sections of the dwelling unit as a whole may be insulated to values greater and/or less than required in (1) above if the resulting heat loss equals or is less than that which would occur if the values required in (1) above were met, or if the thermal resistance values of the ceiling areas satisfy the following equation:

$$\begin{aligned} 1/Rt \text{ required} &= (\text{Area A/Total Area})(1/Rt \text{ achieved}) \\ &+ (\text{Area B/Total Area})(1/Rt \text{ achieved}) \\ &+ \dots + (\text{Area N/Total Area})(1/Rt \text{ achieved}) \end{aligned}$$

(3) In Group H occupancies, roof/ceilings or ceiling/attics located beneath dark colored roofs shall achieve composite resistance values (Rt) 30% greater than the values in (1) and (2) above, i. e., Rt = 21.67 and Rt = 26.00 respectively. In Group I occupancies, roof/ceilings or ceiling/attics located beneath roofs that are darker than Munsell Color No. 4 shall achieve composite resistance values (Rt) 30% greater than the values in (1) and (2) above, i. e., Rt = 21.67 and Rt = 26.00 respectively.

C. Floors. Suspended floors over a ventilated crawl space or other unheated space shall have insulation with a minimum resistance of R-11. Concrete slabs on grade require no insulation.

Exceptions:

(1) Suspended floors over an unheated space shall achieve a composite resistance value (Rt) of 10.52 if the insulation is not penetrated by framing, and Rt of 12.50 if the insulation is penetrated by framing.

(2) Heavy suspended floors with exterior insulation shall achieve a composite resistance value (Rt) of 7.36 for insulation not penetrated by framing members, and Rt of 8.75 for insulation penetrated by framing members.

D. Glazing Area. In Group H occupancies, exterior single-pane glazing (windows, skylights, etc.) may not exceed 12-1/2% of the floor area. Exterior double-pane glazing may not exceed 17-1/2% of the dwelling unit's floor area. In Group I occupancies, a glazing constant of 20 square feet in single-pane glazing and 28 square feet in double-pane glazing may be added to the percentage figures allowed above.

Exceptions:

(1) A combination of single and double-pane glazing may be used so long as the area of the single plus the area of the double glazing divided by 1.4 is not greater than 12-1/2% (plus 20 square feet for Group I occupancies) of the dwelling unit's floor area.

(2) A combination of single and/or double-pane glazing with interior shutters may be used to increase the allowed glazing provided that:

(i) The interior shutters are of a permanent construction and installed so that they are operable, and tight fitting or weatherstripped so that a seal is created.

(ii) The areas in each treatment do not exceed those allowed by the following procedure.

$$GC + (FA)(.125) = Area_s + (Area_D)(.64) + (Area_{shut})/R_t$$

Where:

- GC = Glazing constant (square feet) taken at 20 square feet in Group I and zero in Group H occupancies.
- FA = Floor Area (square feet).
- Area_s = Area in single-pane glazing (square feet).
- Area_D = Area in double-pane glazing (square feet):
- Area_{shut} = Area in interior shuttered glazing (square feet).
- R_t = The composite resistance of the shutter-glazing systems.

(3) When the area of glazing allowed by application of (1) or (2) is exceeded, the excess area will be considered justified if all the following conditions are met:

(i) Glazing must be south facing. If it is mounted other than vertically, it must be tilted at least 30° up from the horizontal to face south.

(ii) It must be clear. (Shading coefficient numerically greater than or equal to .80 for the glazing itself.)

(iii) It must receive full direct sun from 10:00 a. m. to 2:00 p. m. (P. S. T.) on December 21.

(iv) For each square foot of glazing being justified, the building must contain a heat storage capacity (HS) equivalent to 750 BTU's/Day, located inside the insulated shell of the structure, and not covered with insulation materials such as carpet yielding an R_t of 1.0 or greater. The following will allow a quick method for calculation of mass needed for each square foot of exempted glazing:

59 Square feet of interior stud partition wall
(2" x 4"s - 16" o.c. with 1/2" gypsum two sides).

117 Square feet of exterior stud wall or ceiling
(2" x 4"s - 16" o.c. with 1/2" gypsum inside, insulation, and various external treatments).

21 Square feet of 8-inch lightweight concrete block masonry exterior wall insulated externally, cores filled for structural support only.

15 Square feet of concrete slab floor provided with a steel trowel finish, exposed aggregate, tile (vinyl, asbestos, or ceramic), terrazo, or hardwood parque not greater than 1/2-inch thick.

(NOTE: Lightweight stud frame walls are assumed to flux 10°F; heavy walls are assumed to flux 5°F. See Definitions E and K.)

E. Glazing Shading.

(1) All glazing which is not oriented to the north must be shaded to protect it from direct solar radiation for the hours of 8:00 a. m., 12:00 noon, and 4:00 p. m. (P.S.T.), August 21. Glazing facing SE or SW must also be checked for shading at 10:00 a. m. for SE and 2:00 p. m. for SW in addition to the standard three hours. For each check hour the area of glazing not shaded is calculated and

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accumulated. In Group H occupancies the total accumulated amount of unshaded glazing may not exceed 1.5% of the dwelling unit's floor area. In Group I occupancies the total accumulated amount of unshaded glass may not exceed 3% of the dwelling unit's floor area. Shading shall be demonstrated to the satisfaction of the Building Inspection Division of the Community Development Department. Drawings showing shadows cast by shading systems, or scale models suitable for use in the solar-ranger setup by the Building Inspection Division, or the use of approved shade screen systems may be employed to demonstrate compliance. Tinted, metalized, or frosted glass shall not be considered self-shading.

(2) Interior mounted shutters meeting the following specifications may be utilized to meet the shading requirements:

(i) The exterior oriented side must be very light in color (Munsell of 9.0 or greater) and flat.

(ii) The shutters must be tight fitting or all cracks or edges in the system must be weather stripped to create a seal.

(iii) The shutters must be opaque.

(iv) A composite resistance value of $R_t = 1.0$ for the shutters must be achieved.

(3) Exterior mounted shading systems meeting the following specifications may be utilized to meet the shading requirements:

(i) They shall be of permanent materials and construction. A permanent frame with sheathing having a life expectancy of five years minimum must be provided and guaranteed by the builder.

(ii) For the required design hour, the shading device must be capable of intercepting 100% of the direct beam solar radiation, or provide a minimum shading coefficient of 0.2 or less. If the shading system at a design hour does not perform to these standards, then the portion of the glazing which is left exposed is to be calculated and added to the accumulated unshaded glazing total.

(4) Other types of shading systems are allowed if they comply with either of the following:

(i) All on-site and off-site obstructions to the sun, providing 80% attenuation of the direct solar beam, may be considered as external shading devices and may be accounted for in the summer shading calculations. (NOTE: If during the life of the structure the off-site obstructions to the sun used to achieve shading standards compliance are modified or removed, then the structure may be found to be in violation of the Code if other compensating obstructions to the sun or shading devices have not been deployed.)

(ii) A shading system may be temporary, provided that it is designed and constructed to function to the standards above and built to last until its function is replaced by plantings. Plan and elevation drawings must show expected plant configuration and accurately state the number of years required for the projected plant growth. Final occupancy permits shall not be issued until the specified plants are in place.

F. Ventilation for Summer Night Time Cooling. Where design of the dwelling unit is such that openable windows may only be provided along one elevation, mechanical cross ventilation must be installed to provide 15 air changes per hour ducted to the exterior.

Section 5. Path II (Performance Method).

Buildings regulated by the Residential Energy Conservation Code that do not meet the criteria of Path I must be calculated by a registered architect, engineer, building designer, or other qualified person to show that the proposed building will not exceed the standards set forth in Section 3 of Ordinance No. . The required calculation schedule is outlined below. (NOTE: More precise calculations may be submitted using ASHRAE or other comprehensive methods provided that the same design days are used.)

Commonwall U.B.C. Group I dwelling units may increase the permissible thermal standards for Heat Loss or Heat Gain using the following equation:

$$TS^* = TS_H + (TS_I - TS_H) (1 - SAC/[1.5][FA])$$

Where:

TS = The Thermal Standard which is applicable to the dwelling unit (BTU's/[sq. ft.][Day])

TS_H = The Thermal Standard for Group H structures (BTU's/[sq. ft.] [Day])

TS_I = The Thermal Standard for a detached Group I dwelling unit of the same floor area (BTU's/[sq. ft.][Day])

SAC = The Surface Area in Common with other dwelling units such as ceilings, walls, and floor (square feet)

FA = The dwelling unit's Floor Area (square feet)

A. Winter Calculations.

(1) The Total Day's Heat Loss shall not exceed the standards set in the Residential Energy Conservation Ordinance, Section 3.

(2) Winter heat loss calculations shall be based on the following formula:

$$TDHL = (DHL - SHGC)/(FA)$$

Where:

TDHL = Total Day's Heat Loss (BTU's/[sq. ft.][Day])

DHL = Day's Heat Loss (BTU's/Day)

SHGC = Solar Heat Gain Credit (BTU's/Day)

FA = Floor Area of dwelling unit (sq. ft.)

(3) The Design Day for sun angle considerations is December 21 at latitude 40°N or 38° 32' N. The outside daily temperature average for December and January is 45°F, yielding a 23°F difference between the inside (68°F) and the outside (45°F) average daily temperatures. The number of degree hours in the design day is the temperature difference times 24 hours or 552 for Davis. This figure is used as described in Paragraph (4)(i) below. (NOTE: This design, outdoor condition, is not intended to be for equipment sizing, but rather is meant to serve the purpose of performance design for energy conservation by more closely predicting the long term average conditions and energy use of the structure. Equipment sizing will require additional standard peak load calculations.)

(4) Calculation of Day's Heat Loss (DHL): Winter heat loss is determined by the composite resistance (R_t) of the exterior building surface to heat transfer to the outside air from the heated interior spaces.

$$DHL = HL + SHL$$

Where:

DHL = Day's Heat Loss (BTU's/Day)

HL = Heat Loss from outside surface elements (except slab) (BTU's/Day)

SHL = Slab on grade Heat Loss (BTU's/Day)

(i) The heat loss for all surfaces (except slabs on grade) facing the outside air or unheated spaces may be determined by the following formula:

$$HL = (A_1/R_{t_1}) (552) + (A_2/R_{t_2}) (552) + \dots + (A_n/R_{t_n}) (552)$$

Where:

HL = Heat Loss from exterior surface element except a slab on grade (BTU's/Day)

A = Area of the exterior surface element (sq. ft.)

R_t = The element's composite thermal resistance ([hours] [Deg. F] [sq. ft.]/BTU)

552 = Davis Design Day Degree Hours ([Deg. F] [hours]/Day)

All exterior elements (walls, ceilings, doors and suspended floors) which are exposed to unheated enclosed or partially enclosed spaces shall be calculated as if they are exposed to outside conditions, or the temperature difference may be altered according to accepted ASHRAE procedures for surfaces adjacent to unheated spaces.

(ii) Concrete slab floors on grade lose heat in direct relation to the perimeter dimension in linear feet. The following formula applies:

$$SHL = (F) (P) (552)$$

Where:

SHL = Heat Loss from Slab (BTU's/Day)

F = The thermal conductivity of the edge of the slab with $F = 0.81$ (BTU/[foot] [hour] [Deg. F]) where no insulation is used and $F = 0.55$ where slab is insulated with edge insulation of $R = 4.5$ minimum. The insulation shall come within one inch of the top of the slab and extend sixteen inches below grade.

P = Perimeter dimension (feet)

552 = Davis Design Day Degree Hours ([Deg. F]
[hours]/[Day])

(5) Calculation of Solar Heat Gain Credit (SHGC). Direct use of solar energy is dependent on the Day's Solar Heat Gain (DSHG) through the glazing, the Heat Storage (HS) characteristics of the building, and the Solar Climatic Variable (SCV). The following steps are to be followed to calculate the SHGC:

(i) Calculate the Day's Solar Heat Gain (DSHG), by adding up the Solar Heat Gain for each daylight hour of December 21 design day for each square foot of glazing receiving sun.

$$DSHG = (HSHG_1 + HSHG_2 + \dots + HSHG_n) (SCV)$$

Where:

DSHG = Day's Solar Heat Gain (BTU's/Day)

HSHG = Hour's Solar Heat Gain. HSHG is found according to the procedure described in Definition I. The number of hours added depends on the hours of sunlight on the glazing surface in question. (BTU's/hour)

SCV = Solar Climatic Variable (no units).
SCV = 0.56 for Davis. This was determined by averaging the mean fraction of possible sunshine available for each month of the winter heating season (November, December, January, February, March).

(ii) Calculate the Heat Storage capacity of the building (HS). (See Definition K for calculation procedure.)

(iii) Then the Solar Heat Gain Credit (SHGC) (BTU's/Day) equals:

$$SHGC = DSHG \text{ or } HS, \text{ whichever is less.}$$

B. Summer Calculations.

(1) The Total Day's Heat Gain (TDHG) shall not exceed the standard set in the Residential Energy Conservation Ordinance, Section 3.

(2) Summer heat gain calculations shall be based on the following formula:

$$TDHG = (DHG - HS)/FA$$

Where:

TDHG = Total Day's Heat Gain (BTU's/[sq.ft.][Day])

DHG = Day's Heat Gain (BTU's/Day)

HS = Heat Storage (BTU's/Day)

FA = Floor Area of the dwelling unit (sq. ft.)

(3) The calculations below are based on the design day cited in the Residential Energy Conservation Ordinance taken at the

five hours of 8:00 a.m., 10:00 a.m., 12:00 noon, 2:00 p.m., and 4:00 p.m.

(4) The Day's Heat Gain (DHG) is based on the weighted sum of calculations done at each of the five heat gain calculation hours (see equation [a] below). Structures without elevations oriented to the intercardinal directions may delete calculations for 10:00 a.m. and 2:00 p.m. and equally weigh the remaining three calculation hours by multiplying them by four (see equation [b] below). The following two weighted sun equations hold respectively.

$$(a) \text{ DHG} = ([\text{HG}_{8:00 \text{ a.m.}}][3] + [\text{HG}_{10:00 \text{ a.m.}}][2] \\ + [\text{HG}_{12:00 \text{ noon}}][2] + [\text{HG}_{2:00 \text{ p.m.}}][2] \\ + [\text{HG}_{4:00 \text{ p.m.}}][3])$$

or

$$(b) \text{ DHG} = ([\text{HG}_{8:00 \text{ a.m.}} + \text{HG}_{12:00 \text{ noon}} + \text{HG}_{4:00 \text{ p.m.}}] \\ [4])$$

Where:

DHG = Day's Heat Gain (BTU's/[Day])

HG = Heat Gain at the hour calculated (BTU's/hour)

(NOTE: More detailed analysis of Heat Gain may be done by calculating each hour's heat gain for the daylight hours. The digits "2", "3" and "4" in equations (a) and (b) above have the units of hours.)

(5) The Heat Gain (HG) may be calculated by using the following formula:

$$\text{HG} = \text{WHG} + \text{OHG}$$

Where:

HG = Heat Gain (BTU's/hour) at one of the design hours

WHG = Heat Gain through Windows (BTU's/hour)

OHG = Heat Gain through Opaque surfaces (BTU's/hour)

(i) Heat Gain through Opaque surfaces. Calculations will be based on the Total Equivalent Temperature Differential Method (TETD) as described in ASHRAE Handbook of Fundamentals 1972, Chapter 22, pages 411-417. The TETD appropriate for the wall or roof section is found in attached Tables 2 and 3. Since the average Davis design day temperature is 5°F less than that used by ASHRAE, 5°F should be subtracted from the TETD values given in attached Tables 2 and 3 in accordance with ASHRAE procedures, as shown in the calculation below. (The interior temperature is assumed to be 75°F in accordance with ASHRAE.) The Heat Gain through Opaque surfaces is calculated as follows:

$$\text{OHG} = A_1(\text{TETD}-5)/R_{t_1} + A_2(\text{TETD}-5)/R_{t_2} \\ + \dots + A_n(\text{TETD}-5)/R_{t_n}$$

Where:

- OHG = Heat Gain through opaque surfaces at the calculation hour (BTU's/hour)
- A = Area of the outside surface element (sq. ft.)
- Rt = The element's composite thermal Resistance ([hours][Deg. F] [sq. ft.]/BTU)
- TETD = The element's Total Equivalent Temperature Difference from attached Tables 2 and 3

(ii) Glazing. Summer Heat Gain through windows (WHG) shall be calculated using the following formula:

$$WHG = ([A][SC][SHGF] + [\Delta T][A]/Rt)_1 + (A \dots)_2 + \dots + (A \dots)_n$$

Where:

- WHG = Direct solar heat gain plus conducted heat gain through windows at the calculation hour (must be done for each wall or roof section with glazing). (BTU's/hour)
- A = Area of glazing surface being calculated (sq. ft.)
- SC = Shading Coefficient (see Definition H). (Unitless)
- SHGF = Solar Heat Gain Factor at the hour being calculated. (BTU's/[hours][sq. ft. of glazing])
- Rt = Thermal Resistance of the glass (0.9 for single weight glass and 1.7 for double-pane). ([hours][Deg. F][sq. ft.]/BTU's)
- ΔT = Difference between the outside and the inside temperatures, with 75°F being taken as the inside temperature. (Deg. F)

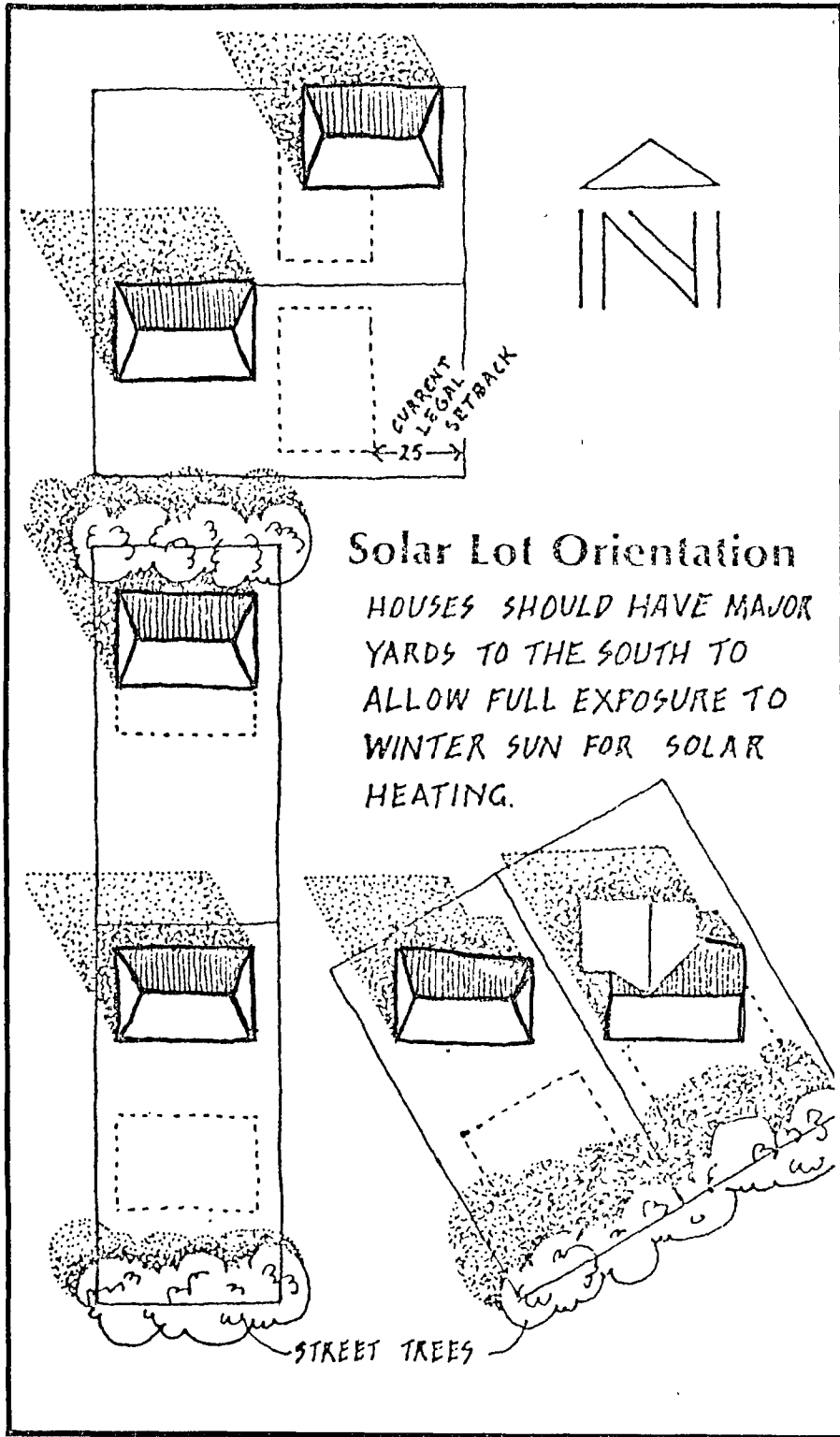
(6) Heat Storage Capacity (HS). Where the building design provides for ventilation in minimum conformance with Section 4 F, credit can be taken for the Heat Storage capacity of the structure. (NOTE: When calculating the heat storage capacity for the summer, no credit may be taken for exterior elements.)

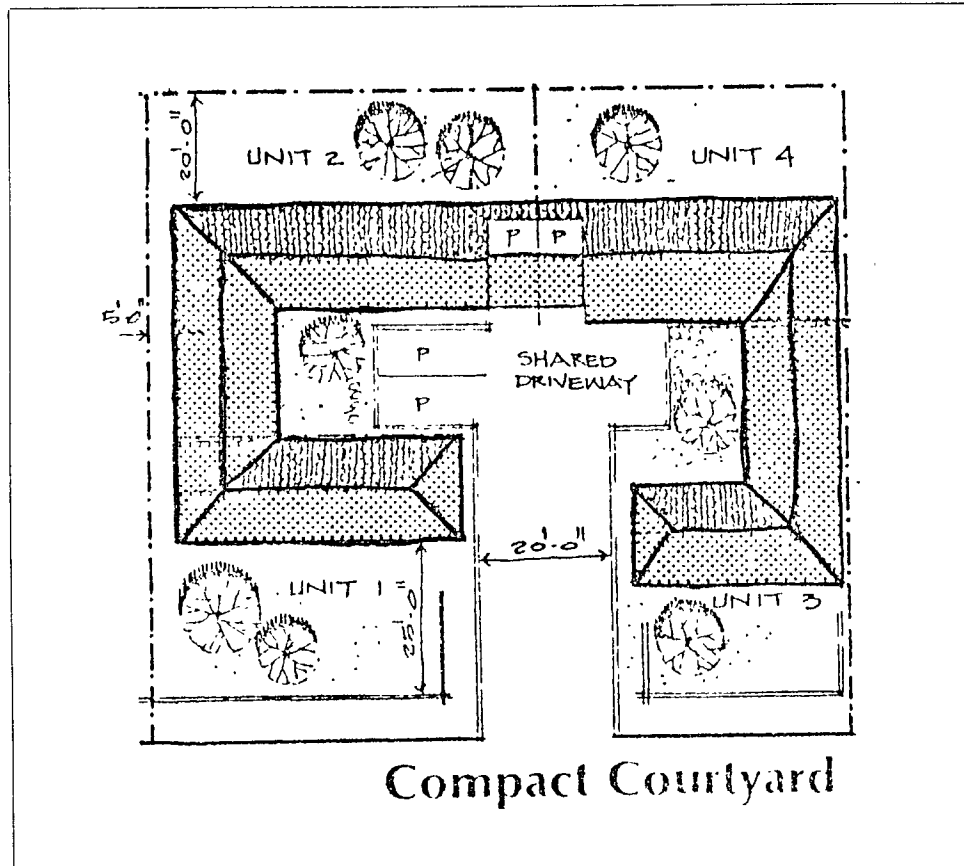
Section 6. Fees.

The following schedule of fees shall be applicable for the checking of plans for conformity with the performance standards of the Residential Energy Conservation Code:

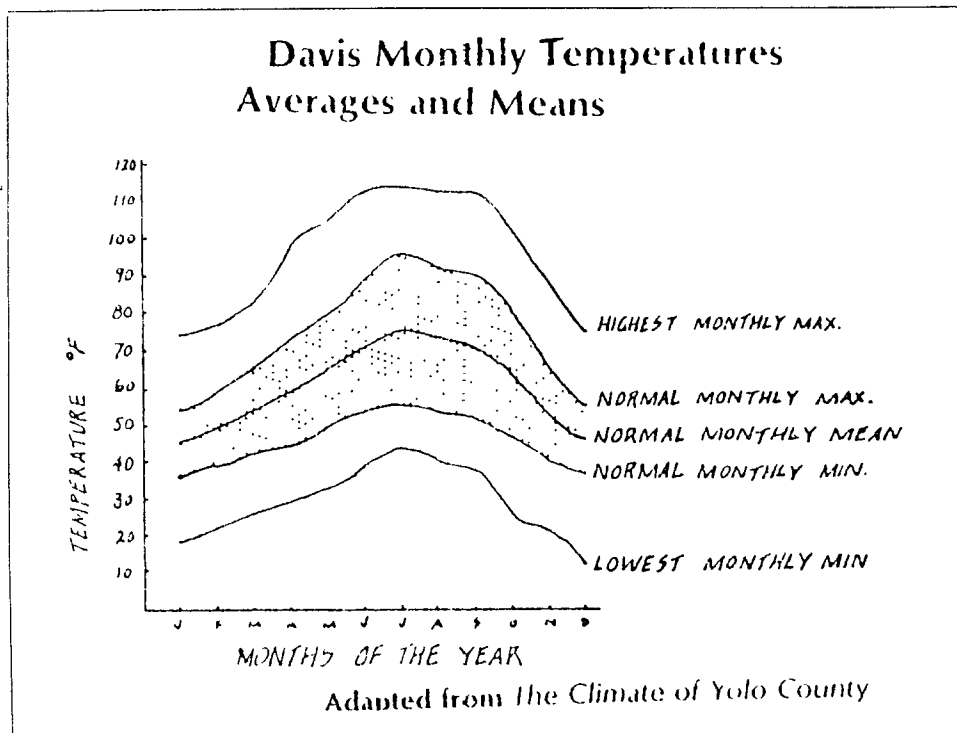
Path I (No Exceptions)	No Charge
Path I (Exercising Exceptions)	\$20.00
Path II	\$25.00

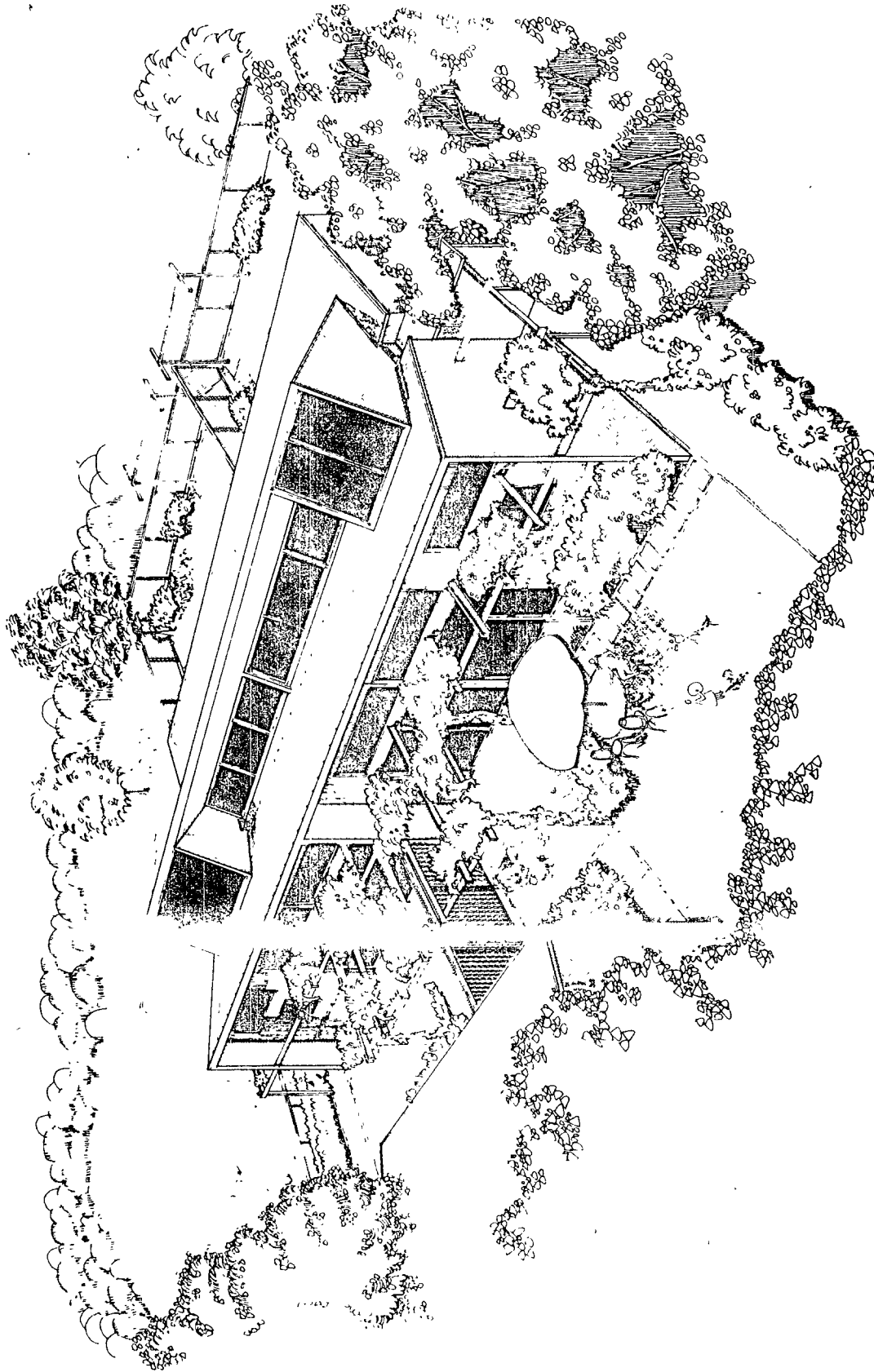
PASSED AND ADOPTED by the City Council of the City of Davis on this 15th day of October, 1975.





Compact Courtyard



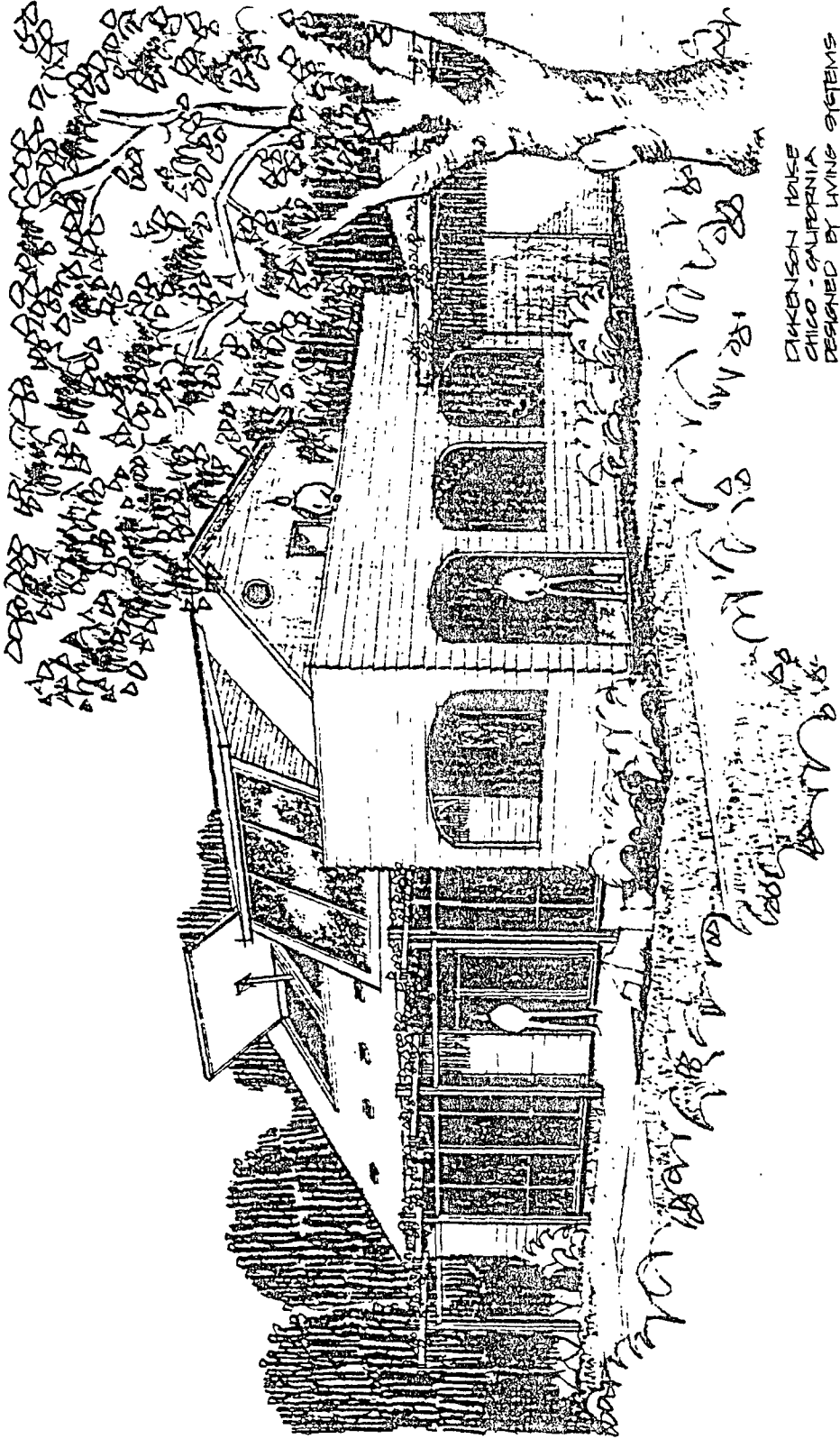


SUN CATCHER SOLAR DUPLEX

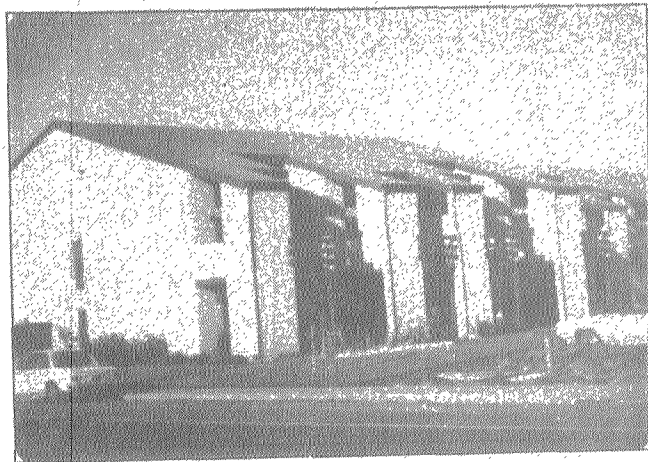
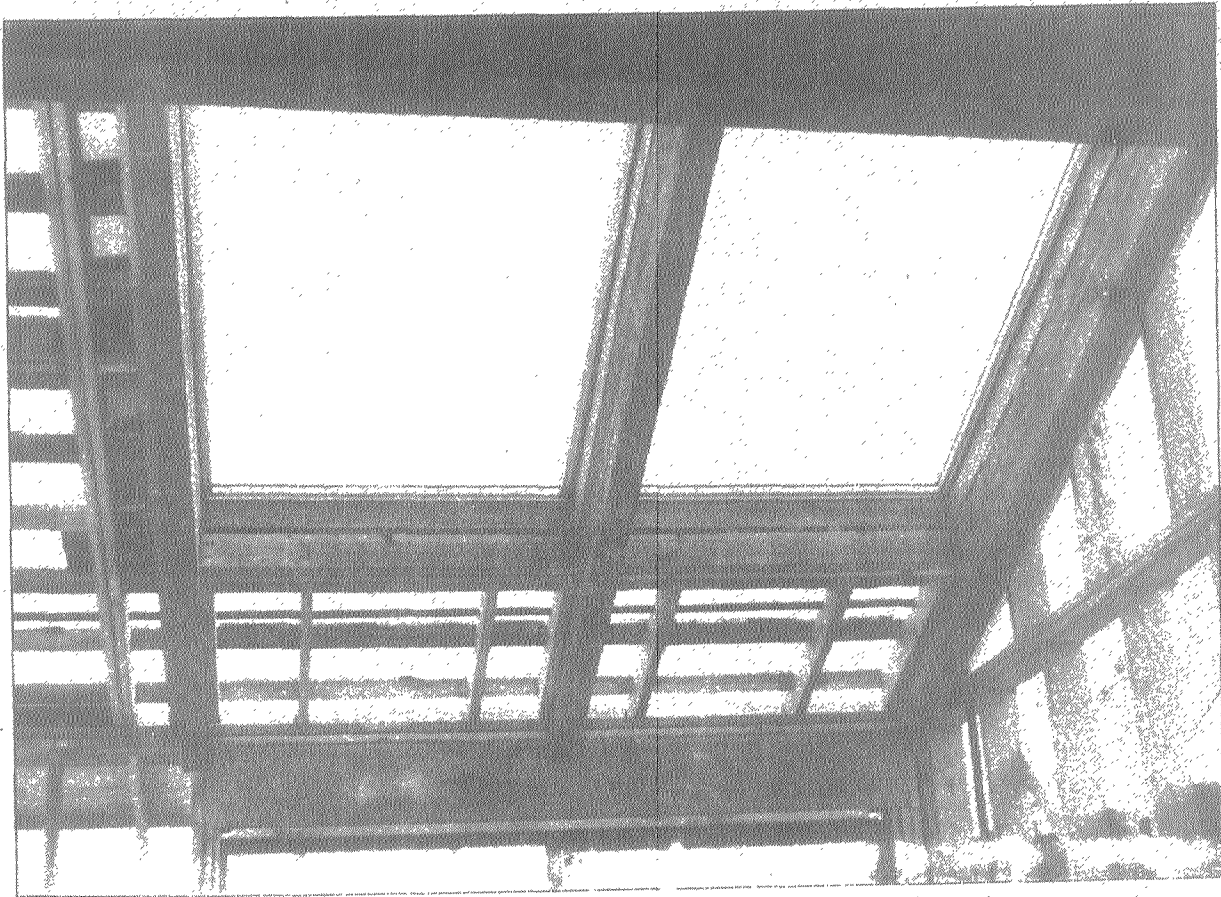
**DAVIS ENERGY CONSERVATION PROJECT
CITY OF DAVIS**

HUD INNOVATIVE PROJECT GRANT NO. B-75-S1-06-001





DICKENSON HOUSE
CHICGO - CALIFORNIA
DESIGNED BY LIVING SYSTEMS



Top: Skylight of house under construction in the Corbett development. Above: Sundance, built under the Davis Code by Arthur & Russell. Left: Longview School solar cylinders, which hold water to cool and heat the school.

APPENDIX B:
The Davis
Code to plant,
maintain and
protect its
trees & shrubs



DAVIS CITY CODE

CHAPTER 26: TREES AND SHRUBS

Sec. 26-1. Definitions.

For the purposes of this chapter, the following words and phrases shall have the meanings respectively ascribed to them by this section:

Master street tree list. The trees designated by the street tree committee and the park supervisor, and approved by the city council, for planting in the streets of the city. The master street tree list shall be reviewed annually by the street tree committee and the park and grounds superintendent. This list shall be kept on file at the city clerk's office for public information.

Official street tree plan. The plan designating specific trees for specific locations in the city, as approved by the city council. This plan shall be reviewed by the street tree committee and the park and grounds superintendent, and shall be kept current by the park and grounds superintendent. This plan shall be kept on file in the city clerk's office.

Sec. 26-2. Purpose of chapter.

This chapter is adopted for the purpose of establishing rules and regulations relating to the planting, care and maintenance of trees and other plants which overhang public streets. (Code 1964, § 7-9.01.)

Sec. 26-3. Street tree committee.

There is hereby created a street tree committee. Such committee shall be composed of five members, appointed by the mayor of the city by and with the consent of the city council. The term of each member of the street tree committee shall be three years. The members of the street tree committee first appointed shall by lot stagger their terms of office so that the terms of no more than two members of the street tree committee shall expire in any given calendar year. In addition to all other duties set out in this chapter, the committee shall act in an advisory capacity to the city council and the parks and grounds superintendent on street tree matters, including trees and landscaping materials to be used on city-owned property. (Code 1964, § 7-9.04; Ord. No. 808, § 1.)

Sec. 26-4. Responsibility of park and grounds superintendent.

The park and grounds superintendent or his duly authorized representative shall be charged with the enforcement of this chapter, and shall be responsible for the planting, maintenance and removal of trees or other plants

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in any public way or place in the city in accordance with the provisions of this chapter and, in addition, may remove any and all street trees which are not contained in the master street tree list and replace the same with trees which are contained in the master street tree list. (Code 1964, § 7-9.05.)

Sec. 26-5. Deposits by subdividers.

Subdividers are hereby required to deposit a sum equal to eighty cents for each foot of each lot in a subdivision facing on a sidewalk. Such sum shall be used by the city for planting, staking and initial maintenance of street trees within the subdivision for which paid or guaranteed. Prior to the approval of the final subdivision map, the deposit shall have been either paid or guaranteed by the subdivider's bond. (Code 1964, § 7-9.06; Ord. No. 656, § 1.)

Sec. 26-6. Street tree fees required when buildings constructed or remodeled.

Any person who constructs or causes to be constructed any building or dwelling, or remodels or substantially improves any existing structure within the city, shall

pay, prior to the issuance of a building permit, the following street tree fees to the city, unless adequate street trees already exist. Determination as to whether adequate street trees exist at the time of issuance of such a permit shall be made in each instance by the director of public works or such other employee of the city as the director of public works may from time to time designate.

(a) In the event tree wells must be constructed in sidewalk areas to plant the street tree, the street tree fee shall be one dollar per front foot for all street frontage adjoining the property.

(b) In the event that tree wells are not required, or if the person who constructs or causes to be constructed the building or dwelling or remodels or substantially improves an existing structure installs the required tree wells, the street tree fee shall be eighty cents per foot for all street frontage adjoining the property.

(c) The abovementioned street tree fees shall not apply in areas within the city where street tree fees have previously been paid at the time of subdivision of the land. (Ord. No. 491; Ord. No. 656, § 2.)

Sec. 26-7. Care and planting generally.

Only the park and grounds superintendent or his duly authorized agent or deputy shall cut, trim, prune, spray, brace, plant, move, remove or replace any tree in any public way or place within the city or to cause the same to be done, except as provided in section 26-8. (Code 1964, § 7-9.07.)

Sec. 26-8. Permits.

Any person desiring to do anything to a street tree shall make written application to the park and grounds superintendent for a permit to do so. The applicant shall set forth the act intended to be done, the number, kind and location of trees to be affected, the proposed manner of doing the act and such other information as the superintendent may require. The permit shall be issued by the superintendent if the pro-

posed act and the proposed method is satisfactory. The park and grounds superintendent may issue comprehensive permits to any public utility, in accordance with this section, to be valid for the period of one year from the date of issuance. If a permit is denied, a written denial shall be given to the applicant setting forth the reasons therefor and copy of such denial shall be delivered to the street tree committee and the city manager.

Any work undertaken by the permittee or his agent may be stopped immediately and the permittee's permit may be revoked by presentation of a written order of revocation of the permit by the park and grounds superintendent when in his opinion, the work or conditions outlined in the permit are not being complied with. (Code 1964, §§ 7-9.08, 7-9.09.)

Sec. 26-9. Prohibited acts generally; planting by property owners.

It shall be unlawful for any person to break, injure, deface, mutilate, kill or destroy any tree in any public place or way in the city, and to knowingly cause or permit any wire charged with electricity to come into contact with any tree in any public place or way, and to place, apply, attach or keep attached to any such tree or to any guard or stake intended for the protection thereof, any wire, rope, sign, paint or other substance, structure, thing or device of any kind or nature whatsoever, and to place or maintain any stone, cement or other substance so that it shall substantially impede the free access of water or air to the roots of any street tree. Owners of property are hereby granted the right to place and maintain plants in the planting area of streets adjacent to their property unless otherwise prohibited by this chapter. (Code 1964, § 7-9.10.)

Sec. 26-10. Protection while constructing, etc., buildings.

During the erection, repair, alteration, removal or moving of any building, house or structure, good and sufficient guards shall be placed to prevent injury, damage or defacement to any park or street tree in the vicinity of such operation. (Code 1964, § 7-9.11.)

Sec. 26-11. Right of inspection.

The park and grounds superintendent may inspect any tree or other plant on private property in the city to determine whether the same or any portion thereof is in such a condition as to constitute a public nuisance and, in addition, for the purpose of abating or correcting any condition or thing declared to be a public nuisance under this chapter. (Code 1964, § 7-9.12.)

Sec. 26-12. Public nuisance--Certain conditions designated.

The following are declared public nuisances:

(a) Any tree or other plant or part thereof growing upon private property but overhanging the street or interfering with the use of any street, which in the opinion of the park and grounds superintendent endangers the life, health, safety or property of the public.

(b) The continued existence of any tree or other plant on private property within

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the city that is infested or infected with insects, mites, fungus, bacteria, virus or growths which constitute a threat to or may be injurious to trees or other plants in the surrounding area.

(c) Any tree or other plant more than thirty-six inches in height measured from the curb gutter grade and planted in a triangular area measured twenty-five feet along the inside face of the sidewalk in either direction from the sidewalk intersection.

(d) Any plant which does interfere with, impair or destroy any street improvement, sidewalk, curb, gutter, sewer, street trees or any public improvement.

(e) Vines or climbing plants growing into or over any street tree or any public hydrant, pole or electrolier. (Code 1964, § 7-9.13.)

Sec. 26-13. Same--Abatement; liability of city, etc.

The park and grounds superintendent shall in writing notify the owner of the property on which a public nuisance exists describing the nuisance and stating the work necessary to remove the same. If the owner of such property does not correct or remove such nuisance within ten days after receipt of such written notice, or within ten days after notice of the decision of the street tree committee, the park and grounds superintendent shall cause the nuisance to be corrected or removed and the cost shall be assessed to such owner.

Nothing contained herein shall be deemed to impose any liability upon the city, its officers or employees, nor to relieve the owner of any private property from the duty to keep any tree or other plant upon his property or under his control in such a condition as to prevent such tree or other plant from constituting a public nuisance. (Code 1964, § 7-9.14.)

Sec. 26-14. Appeals from decision of park and grounds superintendent; appeals from street tree committee to city council.

Any person who is denied a permit, whose permit is revoked or who is the owner of the private property on which a public nuisance is determined by the park and grounds superintendent to exist, may within ten days appeal such denial, determination or revocation to the street tree committee. This determination, or any other determination of the street tree committee, may be appealed to the city council in the same manner as such appeals are effected pursuant to article XXXIII of chapter 29 of this Code; except, that the chapter referenced in section 29-274 shall be deemed to refer to this chapter 26; and except, that any action of an administrative official shall first be appealed to the street tree committee as in this section provided. The appellate procedures set forth in this section shall be applicable to all decisions or determinations made or rendered since November 1, 1971, and the time limits for filing an appeal from a decision or determination made or rendered between November 1, 1971, and the effective date of Ordinance No. 612, shall commence as of the effective date of Ordinance No. 612. (Code 1964, § 7-9.15; Ord. No. 612, § 1.)

Sec. 26-15. Interference with enforcement officers prohibited

No person shall interfere with or delay the authorized representatives of the city from the execution and enforcement of this chapter, except as provided by law. (Code 1964, § 7-9.16.)

A BIOLOGICAL CONTROL PROJECT ON THE ELM LEAF BEETLE
 Urban Shade Tree Project, Biological Control Unit, Univ. of Calif., 7/76

The elm leaf beetle was first discovered in N. America in 1834. Probably with the help of the automobile, it reached California in 90 years. Early attempts, from 1905 to 1935, at introducing natural enemies of this beetle from Europe and Japan failed. In 1939, 31 females of a parasite fly (Erynniopsis rondanii) of the family Tachinidae were released in Stockton, Cal. By December, 1940, 20% of the hibernating adult beetles were parasitized. This tachinid deposits its eggs on the outside of elm leaf beetle larvae. When the fly maggots hatch they burrow into the beetle larvae. This parasite is more effective in the cooler coastal areas of California and may account for the effective control of the beetle in those areas.

The other parasite which occurs in California is the eulophid, Tetrastichus brevistigma. It was successfully introduced into California in 1934 from the east coast of N. America where it was believed to be indigenous. This species attacks prepupae in the bark and at the base of the trees. Up to 50 females (males are not common) can develop in one pupa and 1-4 adults can emerge from an adult beetle. Overall this species does not offer complete control even where it is common. It seems reasonable to assume that a parasite species native to northeastern US would find life difficult in the hotter areas of California summers. In 1974, in cooperation with Iranian entomologists, an importation project against the elm leaf beetle was again initiated. At this stage the project needs the cooperation of people who live near elm trees that are heavily attacked by these beetles. Such trees represent excellent sites for colonizing the beetles' natural enemies. These natural enemies of the elm leaf beetle are minute in size, attack only this insect species, and thus cannot cause harmful environmental disruptions.

Your city is also sponsoring the importation and colonization of another eulophid mini wasp which also attacks the elm leaf beetle. This species is Tetrastichus galerucae which has been reported to frequently kill a large percentage of the pupae in Iran. With the cooperation of the public we can hope to get a successful introduction by primarily avoiding the use of pesticides, which can destroy these introduced parasites.

Until a successful introduction is achieved there are physical controls that can be used to reduce the larvae and pupal populations. One method is water washing the larvae off the tree by aiming the water spray at the heavily infested leaves of the tree. In moist conditions a fungus may kill the larvae, pupae and adult. The force of the water dislodges the larvae and they are rarely able to return back up into the tree. Another method that could help reduce the pest population is to prune the inner canopy of the tree. This will reduce the total feeding area available to the larvae and leave the accessible outer canopy to treat with the water stream.

When the larvae come down to the base of the tree it is often easy to sweep them up with whisk broom and dust pan. This is an effective way to get rid of many of the beetles in cases where the base of the tree is cleared of sucker growth. These larvae are also being vacuumed up and taken back to the laboratory for parasitization. Thereafter, the parasitized beetles will be returned to the city so that the parasites can emerge and attack more beetles.

If the biological control program against this beetle is successful, then year by year the numbers of beetles should diminish and eventually the beetle will cause less defoliation of the trees.

CITY OF DAVIS

GRAPE MYRTLE MONITORING PROGRAM

The City of Davis is sponsoring an integrated pest management program on the city shade trees under the guidance of the Biological Control Unit, University of California, Berkeley. The major goal is to develop alternative methods of managing insect pest problems on the trees, and thereby reduce the reliance upon synthetic chemical pesticides as much as possible. Thus, all the shade tree insect problems are being monitored weekly, alternative treatments are being tried and evaluated, and pest insects are screened for possible initiation of a biological control introduction project.

The Grape Myrtle (*Lagerstroemia indica*) is one of the shade trees being studied in this program. It is a native of China and, as happens with many exotic plants, an insect native to the area of its origin invaded and is also present on the tree here. This insect is an aphid (*Tinocallis kahawaluokalani*). Unfortunately, when this aphid invaded it left its natural enemies behind and thus, without controls, the aphid populations become very large. The result is an annoying honeydew drop upon the sidewalk and parked cars. The growth of the tree is presumably slowed down (although in some cases this is desirable) and complaints may be received by the City about the insects on the trees.

The ideal solution to this problem would be to search the Chinese mainland for the natural enemies of this aphid; however, the political situation makes it difficult to do this at this time. There are some useful alternatives, however.

The first is to tolerate as many aphids as possible so as to encourage the development of high ladybird beetle populations that will prey upon the aphids. Second is the release of commercially raised green lacewings, another predator that may help reduce aphid numbers. A third is to exclude ants from the trees by means of sticky bands, since ants will tend to protect the aphids from their predators and thus encourage their numbers. A fourth is to identify the trees that have the highest honeydew drip and wash them off periodically.

Water washing, if timed properly, can be a very useful tool. Not only does it knock off the aphids physically and clean up the sticky leaves, but the increase in humidity encourages the spread of fungus diseases among the aphids. It is cheap and safe to use, but the disadvantage is that it may have to be repeated frequently during the season when the aphid populations are high.

For severe cases a botanical insecticide, Pyrenone, may be used in spot treatments. However, every effort will be made to time all treatments so as to disturb the predators on this aphid as little as possible. This way, large numbers of beneficial insects can be built up in the city over the years bringing benefit to city vegetation and backyard gardens alike.

Urban Shade Tree Project
Biological Control Unit
University of California
7/76

**APPENDIX C:
City Code &
ordinances
to encourage
& regulate
bicycle traffic**



DAVIS CITY CODE

CHAPTER 5: BICYCLES
(incorporating subsequent ordinances)

Article I. In General.

Sec. 5-1. Definitions.

For the purposes of this chapter, the following words and phrases shall have the meanings respectively ascribed to them by this section:

Bicycle lane. That portion of a roadway set aside for the use of bicycles and so designated as provided in section 5-33.

Bicycle path. A pathway for bicycles and pedestrians paralleling a roadway, the side of the bicycle path closest to the roadway being not more than seventy-five feet distant from said roadway. Persons riding bicycles upon such pathways shall be subject to the provisions of section 5-22. (Ord. No. 568, § 6.)

Sec. 5-2. Responsibility of parent.

The parent of any child and the guardian of any ward shall not authorize or knowingly permit any child or ward to violate any of the provisions of this chapter. (Code 1964, § 4-3.1701.)

Sec. 5-3. Applicability of chapter.

The regulations contained in this chapter shall apply whenever a bicycle is operated upon any street or sidewalk, or upon any public path set aside for the exclusive use of bicycles, subject to those exceptions stated herein. (Code 1964, § 4-3.1701.)

Sec. 5-4. Penalty for violating chapter.

Where this chapter has been violated by persons under the age of eighteen years, in lieu of fines and imprisonment therefor, and in lieu of filing charges in juvenile court, the chief of police or his duly appointed representative may impound the bicycle so used in such violation for a period not to exceed thirty days and the owner's registration card shall be held for like period or require of the violator any of the following or any combination thereof:

- (a) Attend traffic school for a period of six Saturdays.
- (b) Be deprived of bicycle for a period not to exceed thirty days.

(c) Have parents of violator deprive violator of bicycle for a period not to exceed thirty days.

(d) Have bicycle equipment inspected at the police department within five days of any equipment violations.

(e) Write a composition of not less than two hundred words on a subject, title specified by the chief of police or his representative.

(f) Obtain a city bicycle license immediately and pay the penalty required in section 5-9.

(g) Copy the section of bicycle chapter violated one hundred times. (Code 1964, § 4-3.1701.)

Sec. 5-5. Transfer of ownership.

Upon the sale or other transfer of a licensed bicycle, the licensee shall remove the license plate and shall either surrender the same to the chief of police, or may upon proper application, but with payment of an additional fee of twenty-five cents, have the plate assigned to another bicycle owned by the applicant for the unexpired term thereof. (Code 1964, § 4-3.1710.)

Sec. 5-6. Requirements imposed on rental agencies.

A rental agency shall not rent or offer any bicycle for rent unless the bicycle is licensed and a license plate is attached thereto as provided in this chapter and such bicycle is equipped with the lamps and other equipment required in this chapter. (Code 1964, § 4-3.1711.)

Sec. 5-7. Reports by dealers.

Every person engaged in the business of buying or selling new or secondhand bicycles shall make a report, within ten days, to the chief of police of every bicycle purchased or sold by such dealer, giving the name and address of the person from whom purchased or to whom sold, a description of such bicycle by name or make, the frame number thereof and the number of license plate, if any, found thereon. (Code 1964, § 4-3.1712; Ord. No. 558, § 3.)

Article II. Licenses.

Sec. 5-8. "Bicycle" defined.

For purposes of this article, a bicycle is any device upon which a person may ride, which is propelled by human power through a system of belts, chains or gears, and which has wheels at least twenty inches in diameter and a frame size of at least fourteen inches. (Ord. No. 775, § 1.)

Sec. 5-9. License--Required.

No person shall ride, move or leave standing or allow to be ridden, moved or left standing any bicycle on any street, highway, public way or public prop-

erty within the city unless such bicycle has been registered and licensed pursuant to the licensing requirements of state law, and a current license or renewal tag affixed to the bicycle in accordance with the provisions of this chapter

Any license tag issued prior to October 1, 1975 shall be recognized as valid in satisfaction of the requirements of this section until August 31, 1976, at which time a new license must be obtained pursuant to this chapter. (Ord. No. 775, § 1.)

Sec. 5-10. Same--Application.

Application for a bicycle license shall be made upon a registration form provided by the city. The registration form shall contain the name and address of the owner of the bicycle; a description of the bicycle, including its serial number; the make, type and model of the bicycle and such other information as may be required by the chief of police to properly register and identify the bicycle to be licensed. (Ord. No. 775, § 1.)

Sec. 5-11. Same--Renewal.

Application for renewal of a bicycle license shall be made upon a renewal form provided by the city. The renewal form shall contain such information as may be required by the police chief to properly renew the bicycle license. (Ord. No. 775, § 1.)

Sec. 5-12. Same--Fees.

Every applicant for a bicycle license and every applicant for renewal of a bicycle license shall pay to the police chief a license fee to be assessed on the basis of one dollar and fifty cents per year or fractional part thereof. The time period for which the license fee is to be calculated shall commence from the date the applicant is liable for the licensing of the bicycle to the last day of the license period.

All amounts collected in excess of the cost of conducting and administering the bicycle licensing program shall be used for the support of this article and to improve bicycle safety programs and to construct, maintain and promote bicycle trails, paths, and lanes. (Ord. No. 775, § 1.)

Sec. 5-12.1. Same--Refunds.

Whenever the owner of a bicycle licensed by the city under this article intends to establish residence in another state or foreign country and to remove such licensed bicycle to such out of state or foreign residence, such person may, within sixty days of the change of residence, apply for a refund of a pro-rata portion of the license fee attributable to the unexpired licensing period calculated from the first day of the month following the change of residence.

All such applications for refund shall contain a declaration under penalty of perjury that the applicant intends to terminate his or her state residency upon a stated date, within sixty days of the application for refund. Such application shall be accompanied by the bicycle license indicia. (Ord. No. 785, § 1.)

Sec. 5-13. Same--Period of validity.

The license period shall be as specified by the director of the department

of motor vehicles for the state. A license issued after the first day of a license period shall be valid from the date of issuance of the license to the last day of the license period. (Ord. No. 775, § 1.)

Sec. 5-14. Same--Issuance by sellers.

The police chief may authorize the issuance of licenses by sellers of bicycles in conformity with the requirements of this chapter, and may adopt administrative regulations to implement this section. (Ord. No. 775, § 1.)

Sec. 5-15. License and registration certificate.

Upon satisfactory completion of the registration form and payment of the license fee, the city shall issue to the applicant a license and a registration certificate which shall have corresponding numbers. The license shall be provided by the state and shall be affixed to the frame of the bicycle on the seat support member halfway between the seat and the pedals facing forward. The police chief shall keep a record of the date of issue of each license, to whom issued and the number thereof. The license shall bear a unique license number and shall be permanently assigned to the bicycle. Renewal tags shall be provided by the state and shall be affixed in the manner prescribed by law. If a license is damaged or destroyed, a replacement shall be obtained from the police chief upon presentation of the registration certificate and a fee to be determined by the police chief, but not to exceed one dollar. (Ord. No. 775, § 1.)

Sec. 5-16. Removal or alteration of numbers or licenses.

No person shall wilfully or maliciously remove, destroy, mutilate or alter the number of any bicycle frame licensed under this chapter. No person shall remove, destroy, mutilate, reproduce or alter any license, renewal tag or registration certificate during the time such license, renewal tag or registration certificate is in effect; provided, that nothing in this chapter shall prohibit the city from stamping numbers on the frames of bicycles on which no serial number can be found, or on which the number is illegible or insufficient for identification purposes. (Ord. No. 775, § 1.)

Sec. 5-16.1. Authority of police chief to number bicycle.

All bicycles shall have, as a means of identification, serial numbers stamped on the frame of the bicycle. The police chief, or the police chief's authorized representative, may stamp numbers or symbols on the frames of bicycles not bearing manufacturer's serial numbers. (Ord. No. 775, § 1.)

Sec. 5-16.2. Retailers.

Any person engaged in the retail business of selling new or secondhand bicycles shall make periodic reports to the police chief, as specified by the police chief on forms provided by the city, giving a list of all sales by such retailer which shall include:

- (a) The name and address of each person to whom a bicycle is sold.
- (b) A description of the bicycle sold, including the brand name, color and other distinguishing marks.

- (c) The serial number and where located on bicycle.
- (d) The number of the state license affixed thereto, if any.

Such retailer shall also send to the police chief with such reports the registration certificate, if any, of the former owner of each secondhand bicycle sold. In addition, such retailer shall supply to each purchaser a record of the information, name of retailer, address of retailer, year and make of bicycle and serial number. (Ord. No. 775, § 1.)

Sec. 5-16.3. Change of owner or address.

(a) Whenever the owner of a bicycle which is licensed pursuant to provisions of this chapter sells or otherwise disposes of the bicycle, he or she shall, within ten days, notify the police chief of such disposition.

(b) Whenever the owner of a bicycle which is licensed pursuant to the provisions of this chapter changes his or her address, he or she shall, within ten days, notify the police chief of the old and new address. (Ord. No. 775, § 1.)

Sec. 5-16.4. Transfer of license.

Any person who purchases or otherwise acquires possession of a bicycle which is licensed pursuant to the provisions of this chapter shall, within ten days of taking possession, apply for the transfer of the license to his or her name. Such person shall present the current registration certificate for the bicycle and other proof of ownership as may be required by the police chief with a fee to be determined by the police chief, not to exceed one dollar at the time of application for transfer of the license. (Ord. No. 775, § 1.)

Sec. 5-16.5. Rental agencies.

A rental agency shall not rent or offer any bicycle for rent in the city unless the bicycle is licensed, a license is attached thereto and the bicycle complies with the equipment requirements of the state Vehicle Code. (Ord. No. 775, § 1.)

Sec. 5-16.6. Exceptions to license requirements.

(a) Bicycles owned by children living in any charitable institution or owned by such institution shall be licensed, but no fee shall be collected for these licenses.

(b) Bicycles purchased by any group or organization qualifying for the state welfare exemption as defined in Revenue and Taxation Code section 214 shall be licensed, but no fee shall be collected for these licenses.

(c) Any person who is not a resident of the city is not required to obtain a city license for a bicycle which remains in the city for a period of less than five days. (Ord. No. 775, § 1.)

Sec. 5-16.7. Penalties.

(a) Any bicycle left standing in a public place, which bears no license, may be impounded until the owner obtains a license as required under this chapter. If the bicycle is held for ninety days and within that time no one

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lawfully entitled to the bicycle appears at the police department and requests the release of the bicycle and obtains a license, the bicycle may be sold or disposed of according to law.

(b) No parent of any child or the guardian of any ward shall authorize or knowingly permit any such child or ward to violate any of the provisions of this chapter.

(c) Any violation of this chapter shall be deemed to be an infraction. The fine imposed for any violation shall not exceed the sum of five dollars.

(d) Failure of owner to claim a bicycle within seven days after notification of storage by the police department may result in the charging of twenty-five cents per day storage fee. Fees shall not be charged for the first seven days of storage. (Ord. No. 775, § 1.)

Article III. Operation Generally.

Sec. 5-17. Applicability of traffic laws.

Every person riding a bicycle upon a street or sidewalk shall be granted all of the rights and shall be subject to all of the duties applicable to the driver of a vehicle by the laws of this state declaring rules of the road applicable to vehicles, this Code or other ordinances of this city applicable to the driver of a vehicle, except as to those provisions of laws and ordinances which by their nature can have no application, and except as otherwise provided in this chapter. (Code 1964, § 4-3.1713; Ord. No. 442, § 1.)

Sec. 5-18. Obedience to traffic control devices.

Any person operating a bicycle shall obey the instructions of official traffic control signs, and other control devices applicable to vehicles and bicycles, unless otherwise directed by a police officer. (Code 1964, § 4-3.1714; Ord. No. 442, § 2.)

Sec. 5-19. Method of riding; number of riders.

(a) A person propelling a bicycle shall not ride other than astride a permanent and regular seat attached thereto.

(b) No bicycle shall be used to carry more persons at one time than the number for which it is designed and equipped. (Code 1964, § 4-3.1715.)

Sec. 5-20. Riding on roadways and bicycle lanes.

(a) Every person operating a bicycle upon a roadway shall ride as near to the right-hand side of the roadway as practicable, exercising due care when passing a standing vehicle or one proceeding in the same direction.

(b) Persons riding bicycles upon a roadway shall not ride more than two abreast, except on lanes or parts of roadways set aside for exclusive use of bicycles. (Code 1964, § 4-3.1716; Ord. No. 442, § 3; Ord. No. 568, § 1.)

Sec. 5-21. Speed.

No person shall operate a bicycle at a speed greater than is reasonable

and prudent under the conditions then existing. (Code 1964, § 4-3.1717.)

Sec. 5-22. Emerging from alley, driveway, bicycle path, etc.; entering bicycle lane or roadway.

The operator of a bicycle emerging from an alley, driveway, bicycle path, building or otherwise approaching upon a sidewalk or a sidewalk area extending along any such area shall yield the right of way to all pedestrians approaching on such sidewalk or sidewalk area, and upon entering a bicycle lane, shall yield the right of way to all bicycles approaching on such lane, and upon entering the roadway shall yield the right of way to all vehicles or bicycles approaching on such roadway. (Code 1964, § 4-3.1718; Ord. No. 442, § 4; Ord. No. 568, § 2.)

Sec. 5-23. Clinging to vehicles prohibited.

No person riding upon any bicycle shall attach the same or himself to any vehicle upon a roadway. (Code 1964, § 4-3.1719.)

Sec. 5-24. Carrying packages, etc.

No person operating a bicycle shall carry any package, bundle or article which prevents the rider from keeping at least one hand upon the handlebars. (Code 1964, § 4-3.1720.)

Sec. 5-25. Parking.

No person shall park a bicycle upon a street other than the roadway against the curb or in a rack to support the bicycle or against a building or at a curb, in such a manner as to afford the least obstruction to pedestrian traffic. When a parking rack is provided, no person shall park a bicycle, except in such rack, on an adjacent street or sidewalk within a distance of four hundred feet from such rack. (Code 1964, § 4-3.1721; Ord. No. 358.)

Sec. 5-26. Riding on sidewalks, playgrounds, etc.

(a) No person shall ride a bicycle upon a sidewalk within the central traffic district.

(b) The city traffic engineer, with the approval of the traffic committee, is authorized to erect or place signs in any other district on any sidewalk or roadway, prohibiting the riding of bicycles thereon by any person and when such signs are in place no person shall disobey the same. Before such a sign is erected or placed, it must be found by the traffic committee, (1) that the riding of bicycles on such sidewalk or roadway will endanger pedestrian traffic or the public safety, or (2) that a property right or interest belonging to the city may be terminated or forfeited if the riding of bicycles on such sidewalk or roadway is not prohibited.

(c) Whenever any person is riding a bicycle upon a sidewalk, such person shall yield the right of way to any pedestrian and shall give audible signal before overtaking and passing such pedestrian.

(d) No person shall ride or operate a bicycle upon any playground, park or school ground, where children are playing, without the permission of the persons having supervision of the playground, park or school ground. (Code 1964, § 4-3.1722.)

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Sec. 5-27. Passengers.

No person riding or operating a bicycle in the city shall carry another person on the bicycle, unless such person or passenger is seated upon an individual seat or carrier separate from that intended to be used by the operator. No person shall ride upon a bicycle as a passenger, unless he is seated upon an individual seat or carrier separate from that intended to be used by the operator. (Code 1964, § 4-3.1725.)

Article IV. Equipment.

Sec. 5-28. Lights and reflectors.

Every bicycle when in use at nighttime shall be equipped with a lamp on the front which shall emit a white light visible from a distance of at least five hundred feet to the front and with a red reflector on the rear of a type which shall be visible from all distances from fifty feet to three hundred feet to the rear when directly in front of lawful upper beams of headlamps on a motor vehicle. A lamp emitting a red light visible from a distance of five hundred feet to the rear may be used in addition to the red reflector. (Code 1964, § 4-3.1723.)

Sec. 5-29. Brakes.

Every bicycle shall be equipped with a brake which will enable the operator to make the braked wheel skid on dry, level, clean pavement. (Code 1964, § 4-3.1723.)

Sec. 5-30. Stands.

Every bicycle shall be equipped with a stand, and such stand shall be of a type approved by the chief of police. (Code 1964, § 4-3.1724.)

Article V. Bicycle Paths and Lanes.

Sec. 5-31. "Right hand side of roadway" defined.

If a bicycle lane is separated from the traffic lane by a parking lane, then the edge of the bicycle lane nearest the center of the roadway shall be deemed the equivalent of the "curb" or the "right hand side of the roadway" or the "shoulder of the roadway" or any other word or phrase in this Code, or in the state law, which word or phrase references the extreme right hand side of the roadway. It is the intent of this section that a substitute right hand side of the roadway be created for purposes of compliance with local and state laws which reference the right hand side of the roadway for parking, emergency parking, driving and all other purposes. (Ord. No. 442, § 5.)

Sec. 5-32. Establishment; signs.

The city engineer, upon approval of the traffic committee, is authorized to erect or place signs upon any street or adjacent to any street in the city indicating the existence of a bicycle lane and otherwise regulating the operation and use of vehicles and bicycles with respect thereto, so long as the same are consistent with this chapter. Before such a sign is erected, the subject bicycle lane shall be designated on such street by a raised curb, appropriate painting, reflectorized buttons or in such other manner as the city engineer, upon approval of the traffic committee shall determine will provide sufficient notice of existence of such bicycle lane. When such signs are in place, no person shall disobey the same. Before such a sign is erected or placed,

it shall be found by the traffic committee that without the establishment of a bicycle lane separated from a vehicle lane, the public is endangered. (Ord. No. 442, § 5.)

Sec. 5-33. Riding on roadway adjacent to bicycle lane.

No person shall ride or operate a bicycle upon a roadway adjacent to which or upon which bicycle lanes have been designated, except within such bicycle lane or except as otherwise permitted by the provisions of this chapter. No person shall ride or operate a bicycle upon a roadway adjacent to which there is a bicycle path which parallels such roadway and which bicycle path, when measured from the edge of the roadway to the edge of the bicycle path nearest the roadway, is not more than seventy-five feet distant, except within such bicycle path or except as otherwise permitted by the provisions of this chapter. (Ord. No. 442, § 5; Ord. No. 568, § 3.)

Sec. 5-34. Direction of travel.

No person shall ride or operate a bicycle within a bicycle lane in any direction except that permitted of vehicular traffic traveling on the same side of the roadway; provided, that bicycles may proceed either way along a lane where arrows appear on the surface of the lane designating two-way traffic. (Ord. No. 442, § 5.)

Sec. 5-35. Right of way at intersection.

Upon approaching an intersection, any person riding or operating a bicycle in a bicycle lane shall yield the right of way to all vehicles within or approaching such intersection; except, that all vehicles which must stop before entering an intersection because of a stop sign and all vehicles making a left-hand turn at an intersection shall not proceed into such intersection nor make such a turn without first yielding the right of way to all bicycles within or approaching such intersection, and shall proceed only when it is safe to do so. (Ord. No. 442, § 5; Ord. No. 568, § 4.)

Sec. 5-36. Leaving lane.

Once having entered a bicycle lane, no person riding or operating a bicycle shall leave such lane except at intersections; provided, that such person may leave a bicycle lane upon dismounting from a bicycle, walking the same, and being subject then to all laws applicable to pedestrians; provided further, that such person may leave the bicycle lane between intersections in order to make a U-turn, where such a turn is permissible for vehicular traffic or to turn into driveways on the right or left hand sides of the bicycle lane. Upon leaving a bicycle lane, the rider or operator of such bicycle shall yield the right of way to all vehicles and shall not leave the bicycle lane until it is safe to do so. (Ord. No. 442, § 5.)

Sec. 5-37. Walking bicycles.

Bicycles may be walked subject to all provisions of law applicable to pedestrians. (Ord. No. 442, § 5.)

Sec. 5-38. Driving vehicles across paths or lanes.

No person shall drive a vehicle upon or across a bicycle path or lane except to enter a driveway and except to park such vehicle or leave a parking space. No person shall drive upon or across a bicycle lane as permitted by this section except after giving the right of way to all bicycles within the lane. (Ord. No. 442, § 5; Ord. No. 568, § 5.)

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