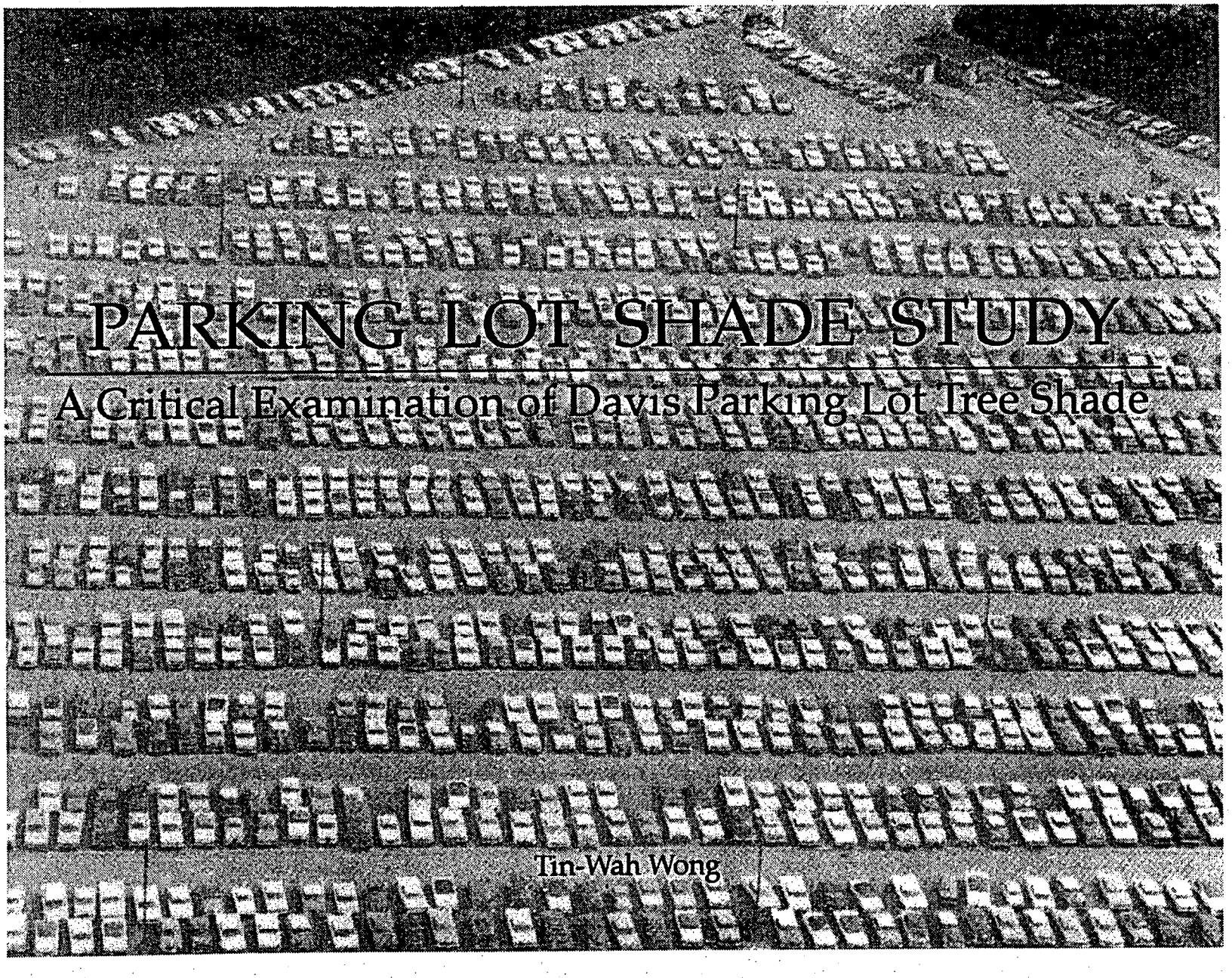


PARKING LOT SHADE STUDY

A Critical Examination of Davis Parking Lot Tree Shade

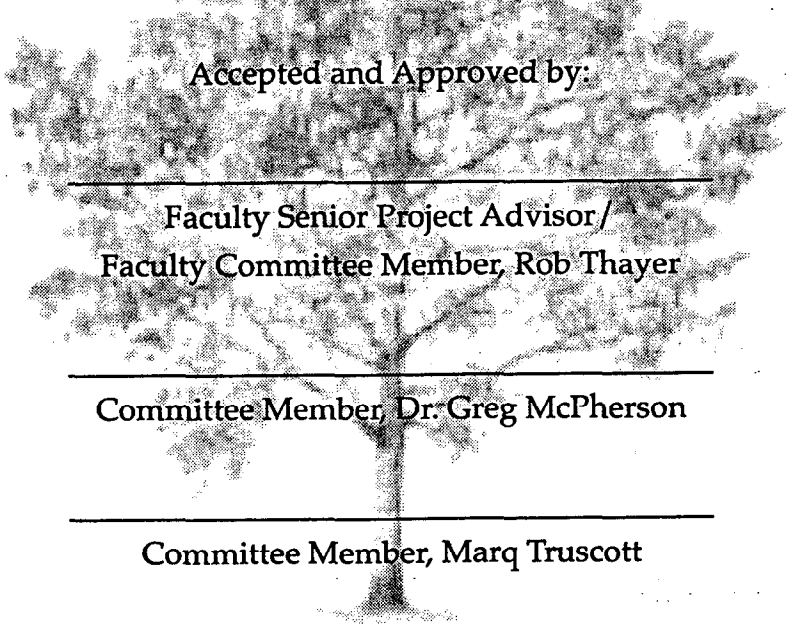
Tin-Wah Wong

PARKING LOT SHADE STUDY

A Critical Examination of Davis Parking Lot Tree Shade

A Senior Project
Presented to the Faculty of the
Program of Landscape Architecture
in Partial Fulfillment of the Requirements for the Degree of
Bachelors of Science of Landscape Architecture

Accepted and Approved by:



Faculty Senior Project Advisor /
Faculty Committee Member, Rob Thayer

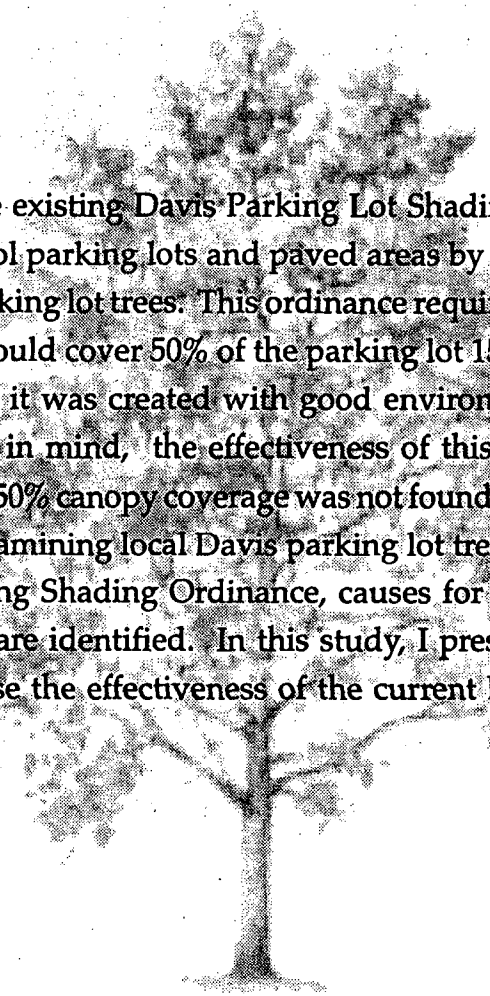
Committee Member, Dr. Greg McPherson

Committee Member, Marq Truscott

by
Tin-Wah Wong
June, 1996

Abstract

Creation of the existing Davis Parking Lot Shading Ordinance was intended to cool parking lots and paved areas by insuring adequate shading by parking lot trees. This ordinance requires that parking lot tree canopy should cover 50% of the parking lot 15 years after planting. Although it was created with good environmental awareness and intentions in mind, the effectiveness of this ordinance can be disputed since 50% canopy coverage was not found in five Davis parking lots. By examining local Davis parking lot tree conditions along with the existing Shading Ordinance, causes for noncompliance of the ordinance are identified. In this study, I present recommendations to increase the effectiveness of the current Davis Parking Lot Ordinance.



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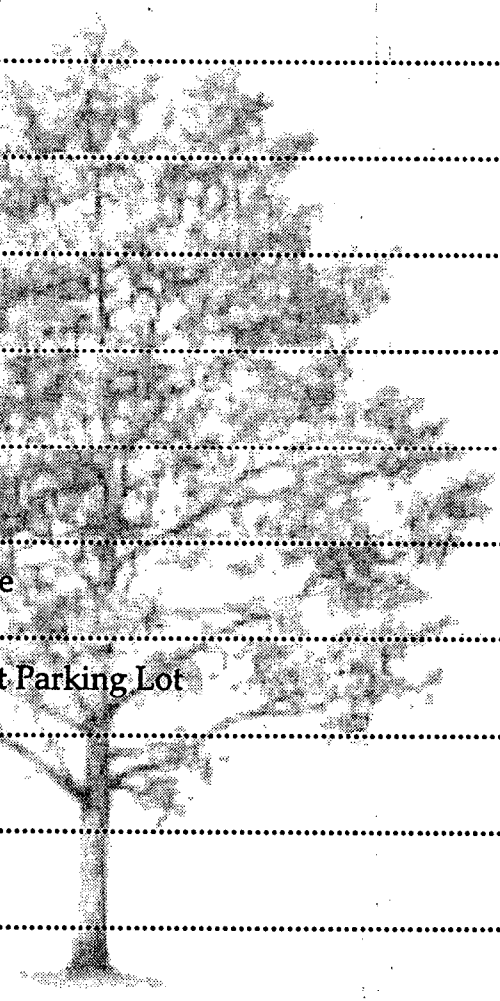


Part1. Introduction

1.1 Statement of Purpose

Humans began the urbanization of natural landscapes early on by destroying natural elements and substituting them with artificial structures. Many natural land forms were altered to flat barren land along with the destruction of native trees. This progression of land use changes evolved to the creation of cities. Along with the evolution of cities came automobiles and parking lots. Our technological advancements coupled with our automotive fascination catalyze the continual development of parking lots. Americans, in general, are having a love affair with their vehicles. It is hard to divorce their ties with these metal contraptions due to their strong habitual reliance on vehicles. Automobiles symbolize freedom and represent the illusion of 'The American Dream'. To many people, vehicles are also regarded as an essential form of transportation. From our undying obsession, devotion, and infatuation with vehicles, we continually invest millions of dollars into the automotive industry. Ironically, little money is spent on parking lot trees which structurally and environmentally protect our cars when not in use. Instead of following the idealistic notion of severing all ties with automobiles, we should plan for their growth. The drastic approach of doing away with personal vehicles and depending on mass transit, biking, and walking as means of transportation may be impossible for some due to increased cost, inconvenience, location of residence to work place, and unwillingness to change lifestyles.

Currently, our dependency on personal vehicles is prevalent in many cities and results in traffic stalls and grid lock. These traffic stalls can be witnessed frequently on most major highways and downtown streets during peak hours (around 8 AM and 5 PM) due to the enormous number of cars impacting roads. Reliance on automobiles will only increase due to urban sprawl and a steady increase in population size. With this in mind, we should begin to plan for the growth of automobiles by mitigating their impact on the environmental and aesthetics quality of cities. Numerous types of improvements can be made to streets, highways, and parking lots ranging from surface paving conditions, lighting, and landscape vegetation.

Figure 1: Comparison of parking lot without trees and parking lot with trees.

My focus which led me to focus on trees as one means to improve parking lots is based on the numerous advantages stemming from trees. One powerful and crucial role of trees is their ability to harmonize and balance our derelict urban environments with their natural and structural presence. Trees provide the vital gift of life to our cities. Without lush, majestic trees, our cities will remain as desolate slabs of concrete and stone constantly being engulfed by artificial architecture. However, this is only one advantage of trees in cities; additional urban forest benefits will be covered in the later parts of this study. Since ubiquitous parking lots act as integral components of cities, trees will also provide the same benefits to these urban sites. It is the lack of healthy, well established trees in parking lots which prompts my desire to investigate the reasons leading to the deterio-

ration of parking lot trees.

The purpose of this study is to evaluate compliance with the Davis parking lot tree canopy ordinance,which requires 50% shade within 15 years after planting. Parking lots may cover as much as 25-30% of urban downtown (Beatty, 1989, pp.339). Non-landscaped parking lots are major contributors to heat build-up due to immense exposure of concrete and asphalt. By increasing tree coverage in parking lots, heat build-up over these sites can be reduced. Landscaping also improves the visual characteristics of unattractive and hostile parking lots. Based on these environmental benefits, it is critical to maintain the health and growth of parking lot trees. The methods implemented for this parking lot study will include: examining city parking lot shading ordinances; interviewing the Davis Superintendent of Parks and Open Space to discuss the current problems of shade trees in parking lots; analyzing the landscape maintenance programs used for parking lots; surveying the health and condition of existing parking lot trees; reviewing the tree selections, evaluating the tree siting; and studying different parking lot layout designs. The primary reason for this research is to identify ways to sustain the health and longevity of shade trees in parking lots through improving the present city shading ordinance. Therefore, recommendations on revising the ordinance to result in higher compliance will be made. Lastly, suggestions on parking lot layout designs, selection of appropriate plant species, and education on the proper management of parking lot trees

will be generated.

1.2 Research Questions

1. Does or will Davis parking lot tree shade conform with the Davis parking lot shading ordinance?
2. If Davis parking lot tree shade does not conform with the current Davis parking lot shading ordinance, why?
    a. lack the potential to grow at time of installation
        - compacted soil unacceptable for tree planting
        - inadequate number of trees, too small in size
    b. parking lot layout
        - no initial reviewing of the parking lot design
        - void of wheel stop
        - curb too close to tree trunks
        - type of irrigation system used (bubbler vs. drip)
    c. tree siting
        - tree spacing too close
        - planting specs/details very general, not specific to site conditions
    d. inappropriate plant species selection
        - unsuitable climate zone
        - inappropriate tree species size
        - tree species' lack of tolerance to site conditions
    e. Improper tree maintenance
        - tree injuries (vandalism, tree trunk damages by

vehicles)
- removed trees not being replaced
- pruning

f. others
-irrigation

3. Assuming that 50% tree shading in parking lots15 years af ter installation is a desirable goal, are there ways of improv ing the existing Davis parking lot shading ordinance to re sult in a higher percentage of shading?

1.3 Delimitations and Limitations

Delimitations: Delimitations of the study will include the general location of the parking lot studied. Individual parking lots surveyed will be in Davis, CA since it is the Davis parking lot shade ordinance which will be reviewed.

Limitations: The limited amount of time allotted for the completion of this study restricts the type of parking lots and number to be evaluated. In order to obtain a general representation of different types of parking lots, an apartment complex related parking lot, a park/recreational parking lot, and a commercial parking lot will be examined. The Davis city ordinance for parking lot shading will be the only ordinance reviewed.

1.4 Definitions

Bubbler- small sprinkler-like head which applies water to vegetation

Drip irrigation- frequent, slow application of water through emitters located along a delivery line.

Heat Island Effect- difference in air temperature between urban and surrounding rural areas.

Heading- cutting a currently growing or one year-old shoot back to a bud, or cutting an older branch or stem back to a stub or a tiny twig. (Harris, pp.338)

Urban Forest- the sum of all woody and associated vegetation in and around dense human settlements, ranging from small communities in rural settings to metropolitan regions (Miller, 1988, pp.24)

1.5 Significance of the Study

Results from this study that focus on ways of improving shade trees in parking lots may be implemented in any city. The void of generous shade tree coverage or existence of unhealthy trees in parking lots often creates unwanted discomfort among vehicular and pedestrian users. Many existing parking lots have the problem of inadequate tree shade. By creating conditions that promote the growth of trees in parking lots, the amount of heat reflected from hardscapes especially during sweltering summers seasons will be reduced dramatically, therefore improving the comfort of parking lots users. A previous urban parking lot tree shade study conducted in Davis , CA showed that vehicular users have a preference for shaded parking

spaces and this tendency increased during warmer days and months (Elliott, 1988, pp.36-37). Increased tree coverage also adds to the attractiveness of parking lots. Ubiquitous urban parking lots covered with black asphalt can be transformed from existing inhospitable places to enjoyable spaces adorned with trees.

Part 2: Background Information

2.1 Benefits of the Urban Forest

In order to improve environments in cities, trees are planted in the urban landscape. Numerous visionary landscape architects, including Frederick Law Olmsted, Charles Eliot, and Horace Cleveland, have left a legacy of public park systems, planted streets and boulevards, and open space preserves that comprise a large portion of the urban forest in many American cities (Zube, 1973). People often associate trees with only shade and ornamental functions, yet trees make other crucial contributions as well. These multitudinous urban forest benefits can be described in the following general classifications: visual, climatic, and engineering.

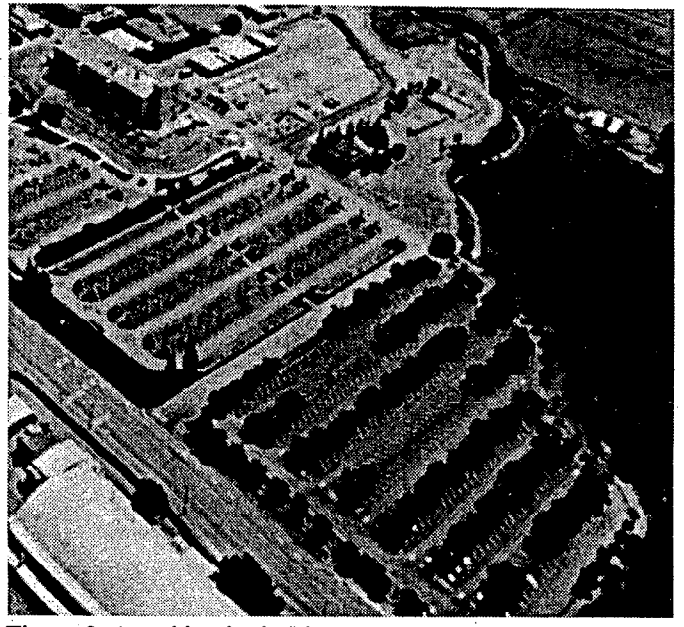


Figure 2: A parking lot in Livermore, CA depicts the aesthetic impact of parking lot trees.

The aesthetic characteristics of trees include the contrasting foliage colors and the diverse overall natural structural forms. These visual qualities all have their own specific functions and values. As a seasonal indictor, tree foliage tends to change its size, color, and texture to distinguish and emphasize various seasons. An array of foliage tones including yellows, oranges, bronze, and reds can be witnessed at certain times of the year. Structurally, trees have the unique ability to harmonize humans with nature. Trees tend to break up large areas into specific spaces which humanize the urban landscape. Human scaled sites may evolve with the addition of trees which often deter foreign asphalt sites from dominating people. By planting trees strategically and sensitively, trees can form enticing vistas, frame views, provide focal points, and define space (Harris, 1985, pp.10). Trees

Figure 3: Aesthetic contributions of trees in an urban site.

may also be planted in such a way to hide unwanted views, therefore acting as visual buffers. Visual tree qualities affect people positively in numerous ways. Humans also can respond to the visual presence of trees educationally and psychologically.

Trees provide wildlife habitat opportunities which inadvertently increase humans' social awareness of their surrounding urban nature. Exposure to wildlife species and natural environments help people develop an increased knowledge of and interest in urban nature (Black *et al.*, 1985). A survey by Shaw and others (1985) found that 55% of all residents enjoy interaction with wildlife species near their homes by observing, providing nourishment, photographing, or painting them. Interlinked planting of native species often increases the chance of reintroducing wildlife into urban areas.

By studying the physiological responses of humans, many psychological benefits from being in environments with natural elements have been discovered. Benefits of the natural environment include the ability to reduce heart and breathing rate, and to promote relaxation and recovery from stress (Schroeder *et al.*, 1986, pp.55-60).

Along with the psychological benefits of trees, economic advantages may also be noted. Since people enjoy and prefer comfortable, humanized sites with lush green trees, these landscaped sites often have a higher land value. Trees can add to the appraised value of undevel-

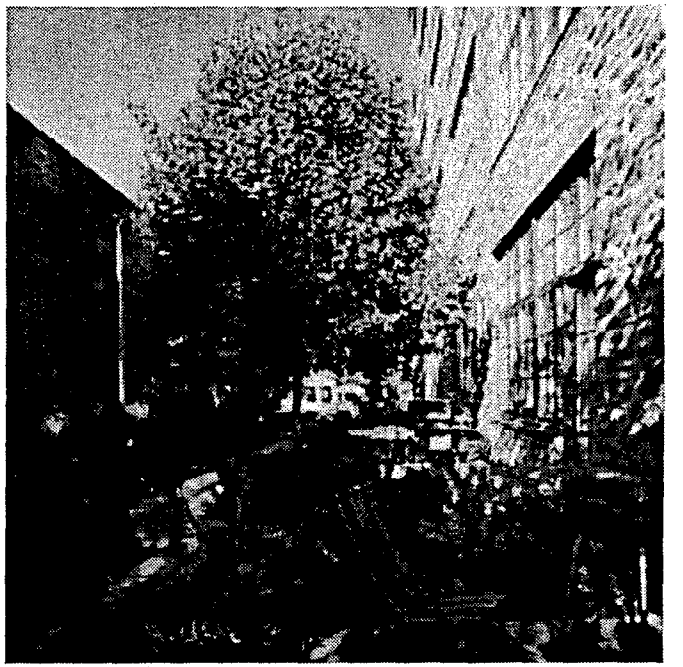
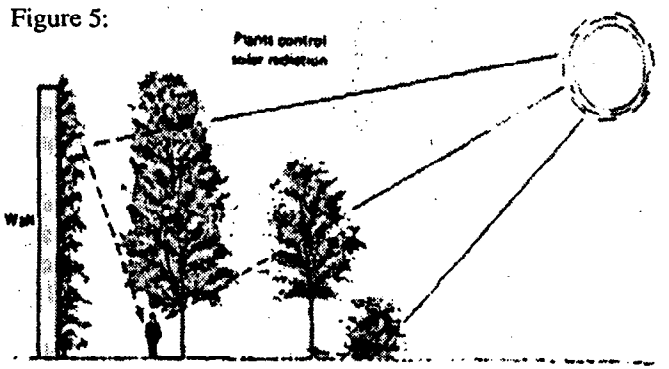


Figure 4: Aesthetic contributions of trees in an urban environment.

oped land by as much as 27% (Harris, 1985, pp.12).

Climatic contributions from trees include wind control, solar regulation, temperature control, and precipitation control. Harsh and arid micro-climates created by the abundance of impervious surface may be discomforting. Trees can regulate the amount of wind into a certain site by either guiding and accelerating or restricting and minimizing the intensity of airflow. Trees may channel wind away from structures or to areas where maximum cooling may be achieved, conversely wind velocity may also be decreased by passing through a dense screen of foliage (Younker *et al.*, 1990, pp.21).

Figure 5:



Climatic Functions-Plants can be used to interceopt, filter, or block unwanted solar radiation.

Trees can also regulate the amount of solar radiation by intercepting, reflecting, and absorbing solar rays. Trees can shade and filter certain solar radiation by blocking the intensity of solar rays from penetrating an area. Deciduous trees have the ability to adjust to seasonal light and climate by reducing excessive solar radiation with full tree canopies during the summer and allowing sunlight to warm surrounding surfaces with defoliated tree crowns during cold winters. The effectiveness of tree solar regulation depends on these determinants: tree form, crown density, and tree orientation.

Precipitation control of trees includes inhibiting the amount of rain, hail, and snow onto a site (Elliott, 1988, pp.12). Temperature of the urban climate may also be modified by the regulation of transpira-

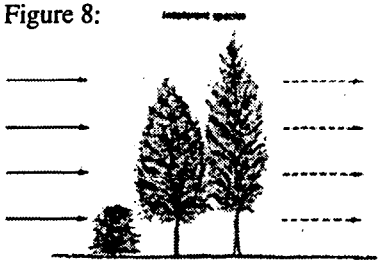
tion. Urban sites are commonly warmer than unaltered natural country lands since solar rays are easily trapped by surfaces created from artificial materials such as asphalt, concrete, brick, gravel, steel, and glass. Tree canopies can prevent direct sunlight from striking surfaces, slowing their heating ability, and therefore the amount of heat they store. By placing trees adjacent to nearby building structures and other artificial surfaces, surface temperatures can be dramatically reduced by lowering the amount of short-wave radiation that is absorbed (Younker *et al.*, 1990, pp.22). This leads to considerable monetary savings by lowering air conditioning consumption of many buildings.

Beneficial engineering functions of trees include glare and reflection control, traffic regulation, auditory control, atmospheric purification, and erosion control.

Dual functions of glare and traffic controls can be met by planting trees in median strips. Trees contribute by reducing glare from oncoming automobile headlights, street lights, and reflective materials (McPherson, 1988, pp. 283). Trees also guide and direct traffic by dividing opposing traffic lanes, by separating vehicular from pedestrian designated roads, by indicating entrances, exits, and change in course direction.

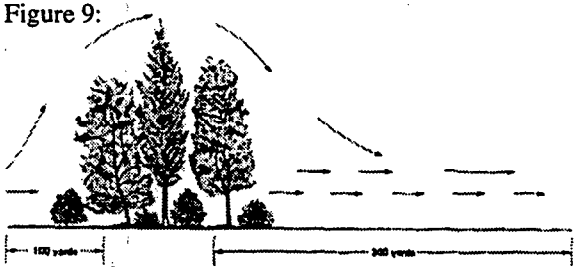
Reduction of disturbing urban noise is another benefit of trees. A

Figure 8:



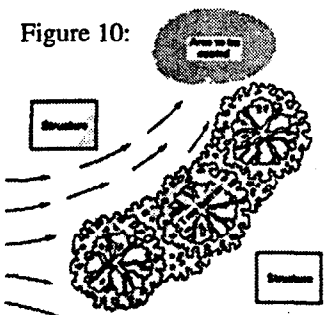
Climatic Functions (Wind Control)- Vegetation screen as a wind filter.

Figure 9:



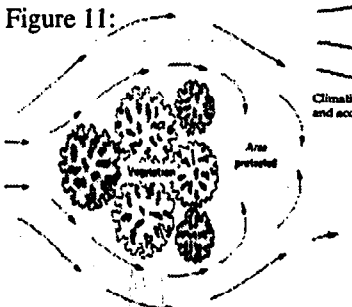
Climatic Functions (Wind Control)- Plants act as barriers to unwanted wind. In this case a 30 foot (9m) high shelterbelt affects air speed100 yards (90m) up wind and 300 yeards (270 m) downwind.

Figure 10:



Climatic Function (Wind Control) - Plants may be used to guide and accelerate air movement.

Figure 11:



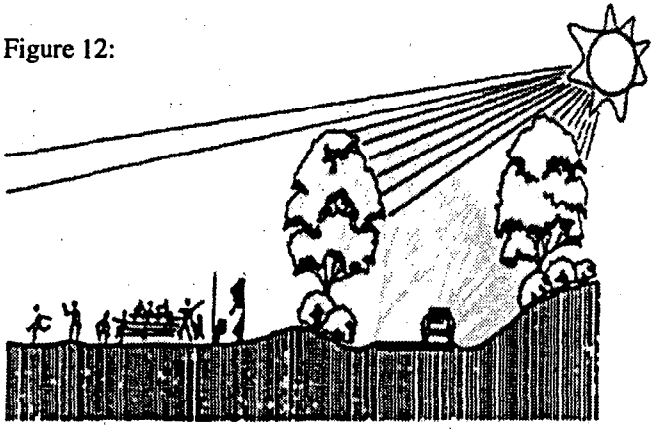
Climatic Function (Wind Control)- Wind deflected by vegetation.

1988 noise reduction study demonstrated that low frequency sound is absorbed by the earth and high frequency sound is dispersed by densely planted trees branches and foliage (McPherson, 1988, pp. 281-298).

Trees can purify the atmosphere in two ways. They improve air quality by intercepting microscopic airborne pollutants on foliar surfaces and by absorbing gaseous pollutants. Trees can be viewed as systems which filter out microscopic pollutants. Sedimentation of particulates captured on exposed leaf surfaces recudes the amount of these pollutants in the atmosphere, therefore cleansing the air. Also, trees decrease air pollution by taking up gaseous pollutants which ultimately lower pollution levels. A life and health sustaining relationship is present between animal species and trees, as trees absorb the carbon dioxide exhaled by humans and release pure oxygen back into the atmosphere (Solotaroff, 1911, pp.4). A study by Madder and Lawrence (1985) explained the effects turbulence had on polluted air in a heavily tree-lined area by bringing toxic gases into close contact with gas exchange systems of tree foliage.

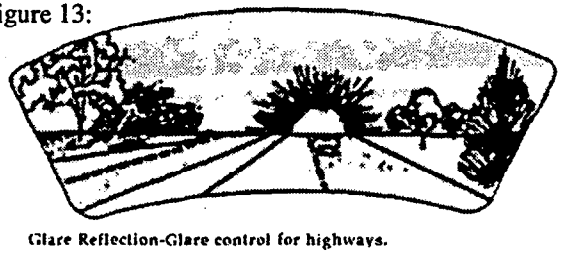
Trees have the ability to control soil erosion. Exposure to rain and flowing water will cause unprotected bare soil to erode faster especially the water application exceeds the infiltration of water into the soil. Tree canopies can control soil erosion by intercepting rain, slowing its impact so it reaches the soil surface gradually and recharging

Figure 12:

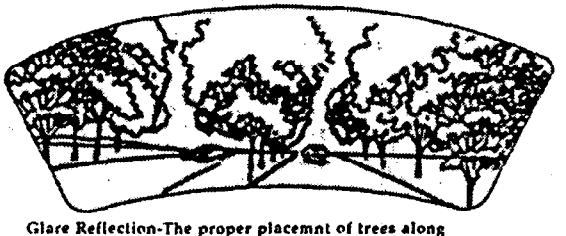


Glare Reflection-Trees in urban environment can be used to intercept primary glare.

Figure 13:



Glare Reflection-Glare control for highways.



Glare Reflection-The proper placemnt of trees along highways and median strips can alleviate early morning and late evening gare hazards.

ground water. In addition, trees' fibrous root systems also stabilize the soil by reducing erosion. Runoff of pollutants can also be prevented (McPherson, 1988, pp. 283).

These numerous benefits of trees enable our surrounding environments to support the existence of humans and other animal species. We are currently witnessing unhealthy trees in most urban areas, particularly parking lots. In order to deter this debilitating trend, a solution to such a severe problem must be addressed on a more local level before effectiveness may be achieved globally. This is the justification for focusing on Davis parking lots only. A change to parking lot shade trees in this general location may create an example for other cities to follow.

2.2 City of Davis Parking Lot Shading Ordinance

The City of Davis Parking Lot Shading Ordinance Number 920, Section 29-160 (f) established in 1977, states that "50% of the paved parking lot surface shall be shaded with tree canopies within 15 years of acquisition of building permit; development of such canopy shall be in accordance with master parking lot tree list guidelines" (Appendix One). This ordinance was created to mitigate the heat island effect by cooling urban sites, improving visual and aesthetic characteristics of parking lots, enhance users' perception of place, and to enhance fuel efficiency by reducing the use of automobile air conditioners. All Davis parking lots constructed or revised after 1977 are re-

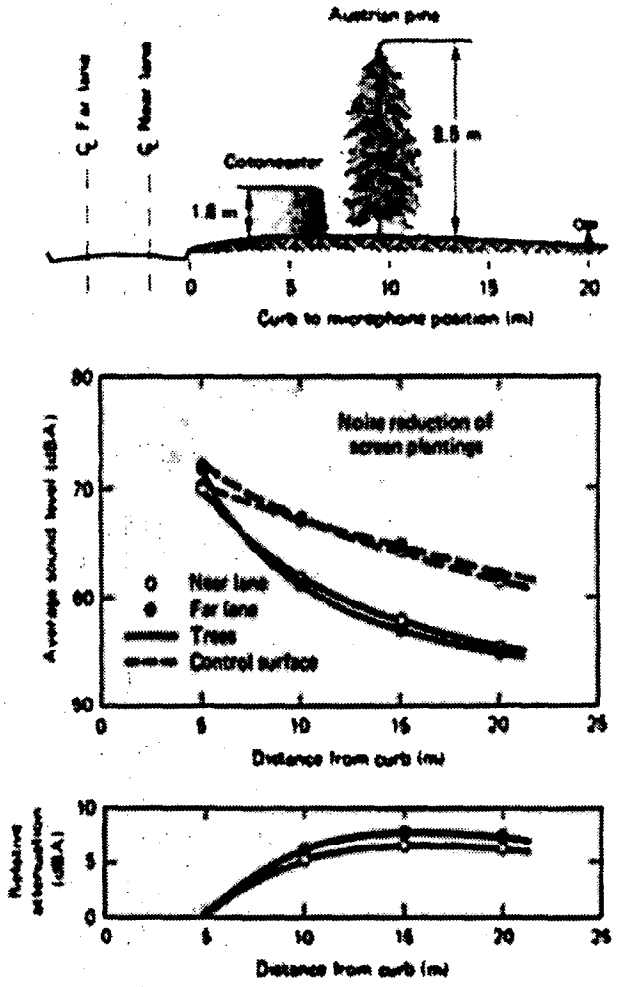


Figure 14:
Excess sound attenuation on a residential street using trees and shrubs.

quired to comply with this Davis Parking Lot Shading Ordinance.

Many specific regulative details are not stated in the shading ordinance leading to ambiguity and vagueness. The items which are questionable in context or excluded from the current Davis parking lot shading ordinance are noted as follows. First, the given list of acceptable trees for use in Davis parking lot areas is very brief suggesting only nine different tree species. Second, no follow up inspections are required after the planting of parking lot trees to ensure that appropriate tree installation has been achieved. This ordinance also fails to mention the proper tree planting or tree maintenance procedures for parking lots. In addition, missing details include the requirement of appropriate soil type and volume favored to maximize parking lot tree growth. This ordinance also ignores any tree planting design requirements regarding the minimum tree well dimensions for parking lot trees. Incentives for compliance of the Davis Parking Lot Shading Ordinance by punishment for noncompliance of the ordinance are not mentioned. Lastly, the sample shade diagram accompanied by the Davis Parking Lot Shading Ordinance describes the procedures for calculating the percentage of paved area shaded by parking lot trees, but this sample shade diagram lacks important details. Only one design of a very simplified parking lot condition is presented which demonstrates paved area shaded by tree canopy. This Shade Diagram states that the percentage of paved area shaded is derived from the total paved area in square feet divided by the total paved

GUIDELINES FOR PROVISION OF
30% SHADING OF PARKING LOTS
AS REQUIRED BY ORDINANCE #920

Ordinance #920 states:

Section 29-150(f). Covered parking. 30% of the paved parking lot surface shall be shaded with tree canopies within 15 years of acquisition of building permit; development of such canopy shall be in accordance with master parking lot tree list guidelines.

The following guidelines are offered so that applicants and designers can adequately comply with this requirement.

A. Submission of a site-landscape plan to scale is required detailing the degree of compliance with the requirement.

B. Such plan shall be approved by the staff prior to building permit, however, the plan is encouraged to be submitted at the time of the Design Review application.

C. The plan shall show:

1. All landscaped areas.

2. Tree canopies drawn to scale representing the estimated canopy at a 15 year growth period.

3. The total area in square feet of the paved parking lot and driveways; and the area shaded by tree canopies. Also note the percentage of area shaded by trees.

4. Specific names of trees to be planted, and their locations and plant sizes.

D. The following are examples of acceptable trees for use in parking lot areas:

Tree Growth Habit	Example of Species	Maximum 15 year Canopy Diameter
1. Fast growth with wide spread *	Morus Alba - fruitless mulberry Ulmus Parvifolia - Chinese elm	40'
2. Moderate growth with wide spread	Celtis Australis - European hackberry Celtis Sinensis - Chinese hackberry Sapium Sebiferum - Chinese tallow tree Tilleva Servata - Zeeland milleva	30'
3. Fast growth with moderate spread	Alnus Rhombifolia - white alder	25'
Moderate Growth with moderate spread	Koelreuteria Elegans - Chinese flametree Pyrus Calleryana 'Bradford' - Bradford pear	25'

* Recommended only in larger commercial parking lot areas with proper planting procedures.

E. In determining the area shaded, the following methodology shall be used:

1. Measure the shaded area on the pavement assuming that the shaded area is only that area directly under the tree canopy or dripline.

2. Landscape planters under the canopy may be counted as shaded area.

3. Paved areas shaded by structures (such as second stories of buildings, carports) may be deducted from the total paved area.

Figure 15: Davis City Parking Lot Shade Ordinance.

area shaded in square feet, as follows:

$$\% \text{ of paved area shade} = \frac{\text{total paved area shaded (ft}^2\text{)}}{\text{total paved area (ft}^2\text{)}}$$

This diagram fails to address neighboring street tree or peripheral tree shade which also contribute to shading parking lot properties. These three guidelines are to be followed in determining the area shaded:

1. Measure the shaded area on the pavement assuming that the shaded area is only that area directly under the tree canopy or drip line.
2. Landscape planters under the canopy may be counted as shaded area.
3. Paved areas shaded by structures (such as second stories of buildings, carports) may be deducted from the total paved area.

These three directions fail to clarify confusing issues related to defining the shaded paved areas. Methodology One simply fails to note all other shade patterns produced by the sun's varying angles throughout the day. The array of different shading patterns which occurs throughout the day should be taken into account when determining the total paved area shaded as it affects the final percentage of paved area shaded by adding or reducing to the final paved shading percentage.

Procedure Two classifies the landscaped planter under the canopy as part of the shaded paved area, yet this shaded region is not paved. By including this shaded landscape area as a paved shaded area, the percentage of the total paved area shaded is underestimated.

Guideline Three is valid by subtracting paved areas shaded by stationary structures (second stories of buildings and carports) other than trees from the total paved area. Since this type of shade is produced from structures other than trees, it can not be included in the total shaded paved area. By deducting all paved areas shaded by structures from the total paved area, a more accurate percentage of paved area shaded by trees will result. However, there are no instructions on calculating shadow projections for different times of day and various seasons of the year.

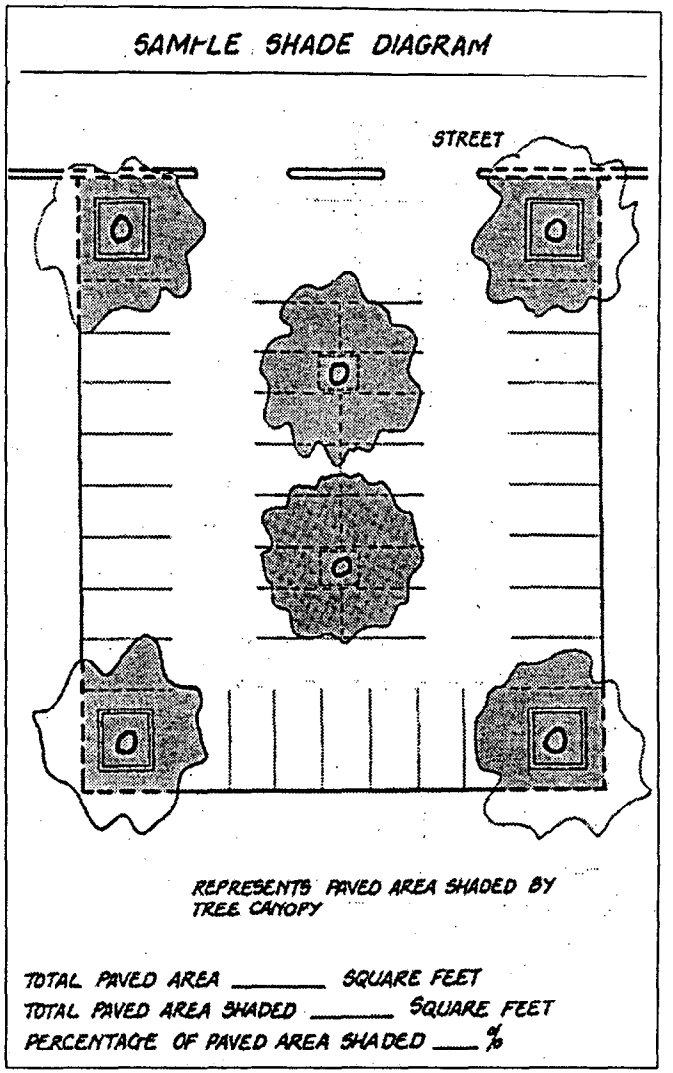


Figure 16: Davis City Parking Lot Shade Ordinance Sample Shade Diagram

Part 3. Methodology

3.1 Project Approach

This section of the report will review previously completed shade tree study findings, including a thesis on tree shade in urban parking facilities by Kathryn Elliott, an urban shade tree study by Russ Beatty and, as well as other related parking lot literature.

Five different Davis parking lots were studied: the Davis High School parking lot located on West Fourteenth Street; the Albertson's parking lot on 1800 East Eighth Street; the University Mall parking lot on the corner of Russell Boulevard and Anderson Road; the School District Building parking lot on 726 B Stree; and the Cranbrook and Pinecrest apartment parking lot on 920 Cranbrook Court. These lots were chosen to represent both public and private parking lots with varying degrees of parking lot tree shade success in Davis, CA.

Individual interviews with different tree maintenance crews, supervisors, and arborists have been conducted to record information pertaining to tree characteristics unattainable by observation, (age and life history of the parking lot trees). Other tree maintenance programs, irrigation, fertilization, disease and pest control frequencies implemented on the parking lot trees were also be recorded from the interviews. The age of the different parking lots is required to determine if the parking lot has reached its fifteenth year after planting. If the parking lot has reached its fifteenth year after establishment, 50% tree shade should be present in the parking lot, according to the ordi-

nance. If 50% shade coverage can not be found in a 15 year old parking lot, the lot is not complying with the present Davis Parking Lot Shading Ordinance. If a chosen parking lot has not reached fifteen years in age, tree canopy growth measurement projections were conducted to obtain approximations of the tree canopy diameters at year fifteen based on Typical Sacramento Shade Tree Growth Data.

Davis High School parking lot at year 8 has an average tree crown spread of 3.5m and looking at the Sacramento Tree Growth Data, typical crown width at year 15 is 6m (Table 1). Taking the 15th year crown width (6m) and subtracting the 8th year crown spread of (3.5m) from it equals 2.5m. Over a 7 year period, (2.5m/7 years) = .35m per year for 7 years before reaching the 6m crown width at year 15. Based on this information, the average tree crown spread of 3.5m at year 8 has an annual growth of .35m per year to year 15.

year 8 = 3.5m 6m-3.5m = 2.5m
year 15 = 6m $\frac{2.5\text{ m}}{7\text{ yrs}}$ = .35 m per year for 7 years

University Mall parking lot at year 12 has an average tree crown spread of 4.9m and looking at the Sacramento Tree Growth Data, typical crown width at year 15 is 6m (Table 1). Taking the 15th year crown width (6m) and subtracting the 8th year crown spread of (4.9m) from it equals 1.1m. Over 3 years, (1.1m/3 years) = .36m per year for 3

TABLE #1: TYPICAL SACRAMENTO SHADE TREE GROWTH					
Year	2.54 dbh (cm)	annual inc. dbh (cm)	0.3048 Cw (m)	0.3048 Ht (m)	Ann Inc. Ht (m)
0	2.5	0	0.9	1.5	1.5
1	4.5	1.9	1.2	2	0.5
2	6.4	1.9	1.5	2.5	0.5
3	8.3	1.9	1.8	3	0.5
4	10.2	1.9	2.1	3.5	0.5
5	12.1	1.9	2.5	4	0.5
6	14	1.9	2.8	4.4	0.5
7	15.8	1.9	3.1	4.9	0.5
8	17.74	1.8	3.5	5.4	0.5
9	19.5	1.8	3.8	5.9	0.5
10	21.4	1.8	4.2	6.3	0.5
11	23.2	1.8	4.5	6.8	0.5
12	25	1.8	4.9	7.2	0.5
13	26.7	1.8	5.3	7.7	0.5
14	28.5	1.7	5.6	8.1	0.4
15	30.2	1.7	6	8.6	0.4

years before reaching the 6m crown width at year 15. Based on this information, the average tree crown spread of 4.9m at year 12 has an annual growth of .36m per year to year 15.

History of these parking lots is important in order to understand the chronological events which may affect the condition and treatment of those specific parking lot trees. If a parking lot has been switched to a different property owner, different tree maintenance practices may result due to inconsistent care of trees. Trees receiving great care may suddenly experience deplorable maintenance or visa versa. Information on the type of tree maintenance practiced on specific parking lot trees was noted to see if indeed proper, consistent tree maintenance is followed.

Next phase of this study was to identify the deficiencies of tree shade in each parking lot by observing the health, aesthetic, and overall condition of shade trees. This is where all visible tree characteristics were noted, including any visible tree damage caused by parked cars, vandalism, incorrect staking practices, overhead clearance, insects, or diseases. Tree measurements, including existing tree canopy diameters and tree heights, were recorded and mapped to estimate existing tree shade. Surface paving measurements of the individual parking lots were also recorded. The area of the paved surface of the parking lot was calculated. Color infrared photographs taken on August 18, 1995 of the 5 different parking lots were digitized and classi-

fied to estimate percentage of existing shade. Planting plans of the various parking lots were consulted. Mature tree diameters were added to the infrared image to calculate the percentage of shade planned to exist 15 years after development. The existing tree canopy and the landscape architect's design of the intended tree canopy were both examined to see if 50% tree shade was attained.

Lastly, recommendations for improving the health and condition of trees in parking lots through revision of the current Davis Parking Lot Ordinance were derived from field data analysis and related shade tree literature.

3.2 Data Collection and Recording Procedures

Individual tally sheets were made for each parking lot to record property information, land use type, property size, parking stalls, landscape management and maintenance, tree spacing, species information, planting plan specification, planting site information record parking lot tree conditions, number of parking lot spaces, tree shaded area, and the different tree information. This step was necessary to determine the extent and distribution of existing shade trees in parking lots. I then assessed the size and health of parking lot trees and surveyed the planter designs and parking lot layout. Various parking lot plans were graphically noted with existing shade tree coverage to examine the ratio of tree area coverage to the overall size of the parking lots. Results indicated whether the existing shade trees coverage

does or does not meet the current parking lot shade ordinance. Unusual tree damage, tree maintenance practices, and tree conditions, were documented by photographs. Copies of each original parking lot site plans were also brought into the field and used to graphically note removed trees due to tree mortality or to record newly planted trees.

3.3 Data Analysis/Verification of Results

All phases of this research study, including the results, were be verified by Dr. Greg McPherson, USDA Research Forester / Project Leader, to ensure accurate information and viable recommendations.

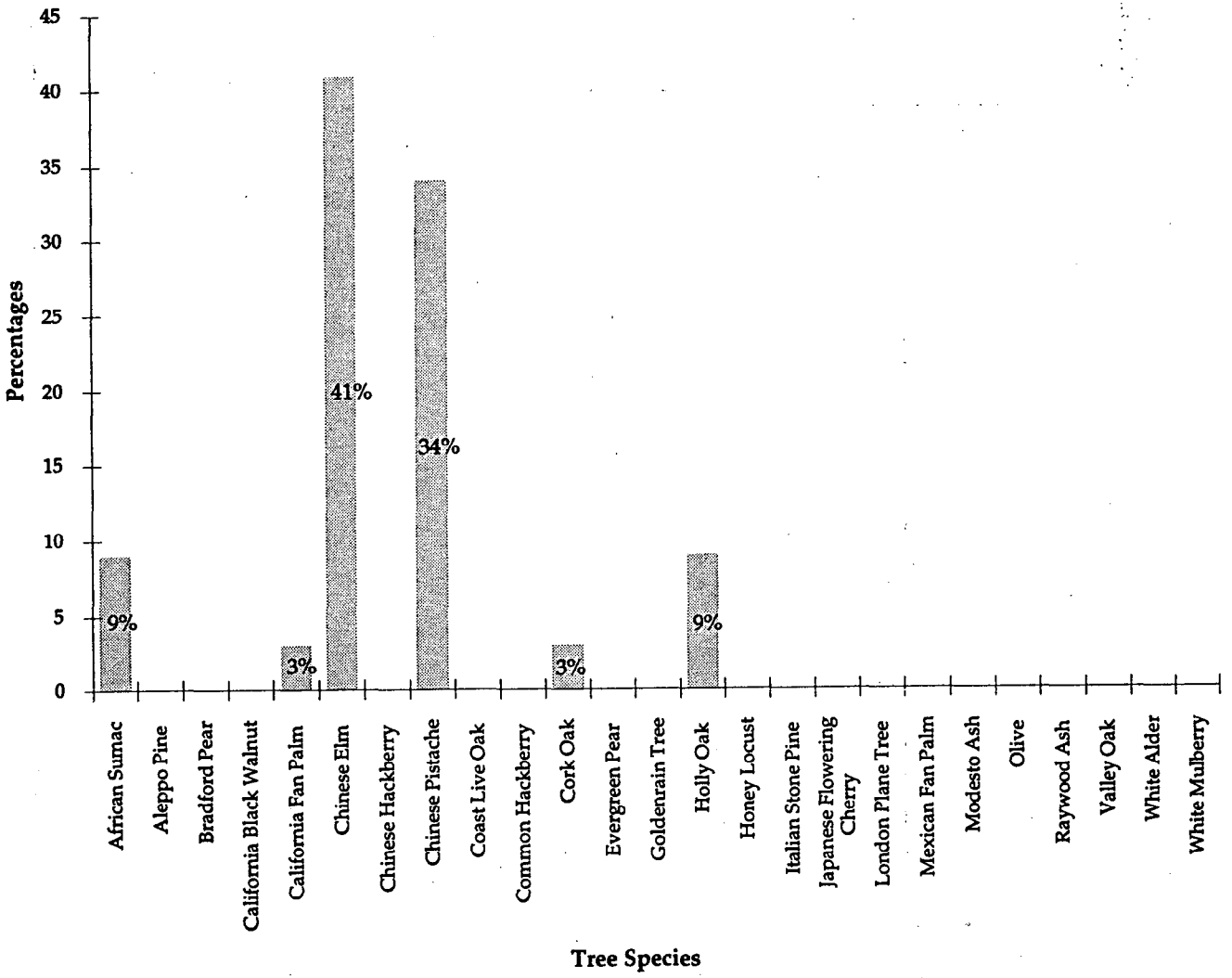
TABLE #2: SHADING RESULTS						
	Years After Planting	Intended Design Shade Coverage	Actual Shade Coverage (1995)	ProjectedShade Coverage @ Year 15	Code Difference (50%-Yr.15)	Design Difference (Design -Yr. 15)
Albertson's Parking Lot	18	38%	29%	29%	21%	9%
Cranbrook/Pinecrest Parking Lot	25	47%	45%	45%	5%	2%
D.J.U.S.D. Parking Lot	18	18%	22%	22%	28%	-4%
*Davis High School Parking Lot	8	44%	8%	24%	26%	20%
**University Mall Parking Lot	12	43%	23%	35%	15%	9%
* Assumes average tree crown spread of 3.5m in diameter, annual growth of .35m for 7 years before reaching year 15.						
**Assumes average tree crown spread of 4.9m in diameter, annual growth of .36m for 3 years before reaching year 15.						

TABLE #3: PARKING LOT LAYOUT					
	Albertson's Parking Lot	Cranbrook/Pinecrest Parking Lot	D.J.U.S.D. Parking Lot	Davis High School Parking Lot	University Mall Parking Lot
Property Information					
Date Constructed / Rennovated	18	25	18	8	12
Paved Area	4,973m	7,554m	2,877m	9,809m	17,197m
Total Number of Stalls	89	219	64	332	450
Handicapped Stalls	4	3	2	11	6
Compact Stalls	21	0	0	54	86
Regular Stalls	64	216	62	267	358
Driving Lane Widths	6.7m	7.4m &76.8 m	14.1m&11.1m	7.6m	6.9m, 4.9m, 4.3m, 7.6m, 8.2m
Tree Information					
Predominant Row Orientation	North-South	North-South	East-West	East-West	North-South/ East-West
Tree Row Spacing	6.5m	7m	7m	9m	
Tree Row Separation	17.8m	20m	24m	18.3m	
Planting Plan Specification					
Number of Trees Planned	34	58	19	55	173
Staking	Yes		Yes	Yes	No
Number of Trees Removed	2	3	0	1	53
Number of Tree Replaced	0	1	0	0	0
Planting Site Information					
Interior Planters					
Typical Dimensions	1.2mX.6m	7.5mX2.5m	7mX1.4m	1.4mX2.5m/ 1.1mX4.3m	1.4mX9m/ 2.15mX5m/ 2.2mX2.2m/ 2.2m R
Typical Surface Material	Bark	Soil/Shrub	Mulch	Wood Chip	River Cobble
Irrigation	Spray	Spray	Bubbler	Drip	Spray
Trunk Protection	Yes	No	Wheel Stop	No	Wheel Stop
Soil Compaction					
Initial Construction	No	Yes	Yes	Yes	Yes
Foot Traffic	No	No	No	Yes	Yes
Perimeter Planter					
Typical Dimensions	Large Planter		7mX1.25m		Various
Typical Surface Material	Shrub/ Ground Cover	Grass	Mulch	Lawn/Shrub	Groundcover
Irrigation	Spray	Spray	Spray	Spray	Bubbler/Spray
Trunk Protection	Not Needed	No	Wheel Stop	No	Not Needed
Soil Compaction					
Initial Construction	Yes	Yes	Yes	Yes	No
Foot Traffic	Yes	No	No	Yes	No

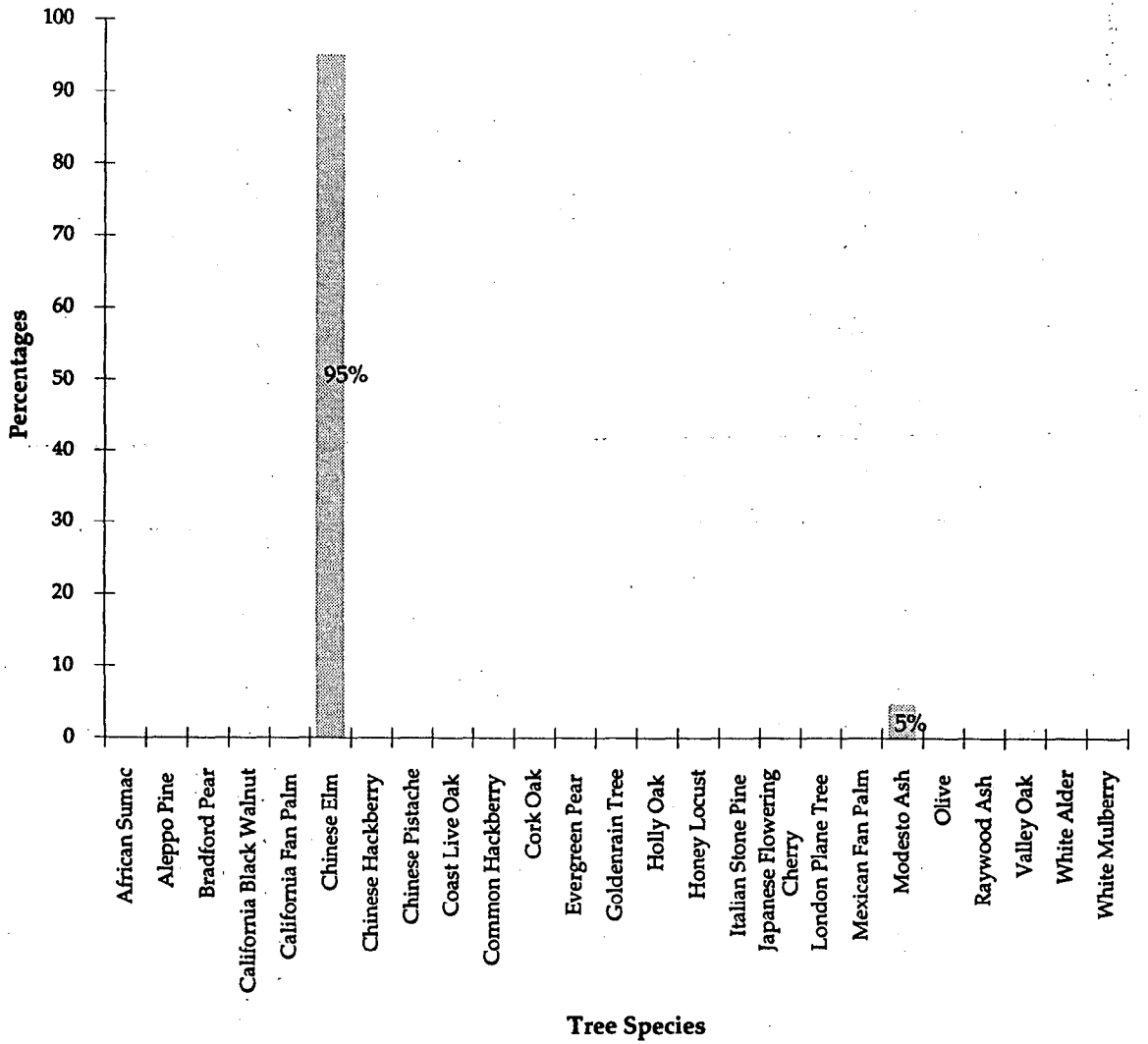
TABLE #4: TREE SPECIES						
	Albertson's Market	Cranbrook & Pinecrest Apt.	D.J.U.S.D. Administration	Davis High School	University Mall	Total # of Tree Species in 5 Parking Lots
African Sumac (Rhus lancea)	(3/32)=9%					3
Aleppo Pine (Pinus halepensis)					(4/121)=3%	4
Bradford Pear (Pyrus calleryana 'Bradford')				(8/55)=15%	(8/121)=7%	16
California Black Walnut (Juglan hindsii)					(1/121)=1%	1
California Fan Palm (Washingtonia filifera)	(1/32)=3%					1
Chinese Elm (Ulmus parvifolia)	(13/32)=41%	(53/56)=95%		(11/55)=20%	(10/121)=8%	87
Chinese Hackberry (Celtis sinensis)				(14/55)=25%	(28/121)=23%	42
Chinese Pistache (Pistachia chinensis)	(11/32)=34%			(3/55)=39%	(3/121)=2%	17
Coast Live Oak (Quercus agrifolia)					(2/121)=2%	2
Common Hackberry (Celtis occidentalis)			(15/19)=79%	(11/55)=20%	(3/121)=2%	29
Cork Oak (Quercus suber)	(1/32)=3%				(4/121)=3%	5
Evergreen Pear (Pyrus kawakamii)				(1/55)=2%	(7/121)=6%	8
Goldenrain Tree (Koelreuteria paniculata)					(10/121)=8%	10
Holly Oak (Quercus ilex)	(3/32)=9%					3
Honey Locust (Gleditisia triacanthos)				(3/55)=5%	(1/121)=1%	4
Italian Stone Pine (Pinus pinea)					(6/121)=5%	6
Japanese Flowering Cherry (Prunus serrulata)					(4/121)=3%	4
London Plane Tree (Plantanus acerifolia)				(2/55)=4%	(1/121)=1%	3
Mexican Fan Palm (Washingtonia robusta)					(2/121)=2%	2
Modesto Ash (Fraxinus velutina 'Modesto')		(3/56)=5%	(4/19)=21%	(1/55)=2%		8
Olive (Olea europaea)					(6/121)=5%	6
Raywood Ash (Fraxinus oxycarpa 'Raywood')					(1/121)=1%	1
Valley Oak (Quercus lobata)					(2/121)=2%	2
White Alder (Alnus rhombifolia)				(1/55)=2%		1
White Mulberry (Morus alba)					(18/121)=15%	18
Total # of Trees in Each Parking Lot	32	56	19	55	121	283

TABLE #5: MAJOR PARKING LOT PROBLEMS					
	Albertson's Parking Lot	Cranbrook/Pinecrest Parking Lot	Davis High School Parking Lot	D.J.U.S.D. Parking Lot	University Mall Parking Lot
Small amount of intial shade designed.					
The number of trees designed intially are too few/small.	X				
Crown Conflict					
Lighting conflict	X			X	X
Trees designed too close	X			X	X
Street tree conflict				X	
Wrong Type of Irrigation					
Spray instead of bubbler irrigation	X				
High Tree Mortality					
Many young replacement trees	X		X		
High tree removal without any replacements					X
Replacement of large growing trees with small growing trees.			X		
Drought Stress					
Inadequate soil volume	X	X			
Inadequate infiltration		X			
Inadequate irrigation		X	X		
Pruning Management					
Trees are topped (too severely pruned)					X
Other Inadequate Tree Maintenance					
High tree vandalism			X		
Stakes left on trees rub against the tree bark.			X		

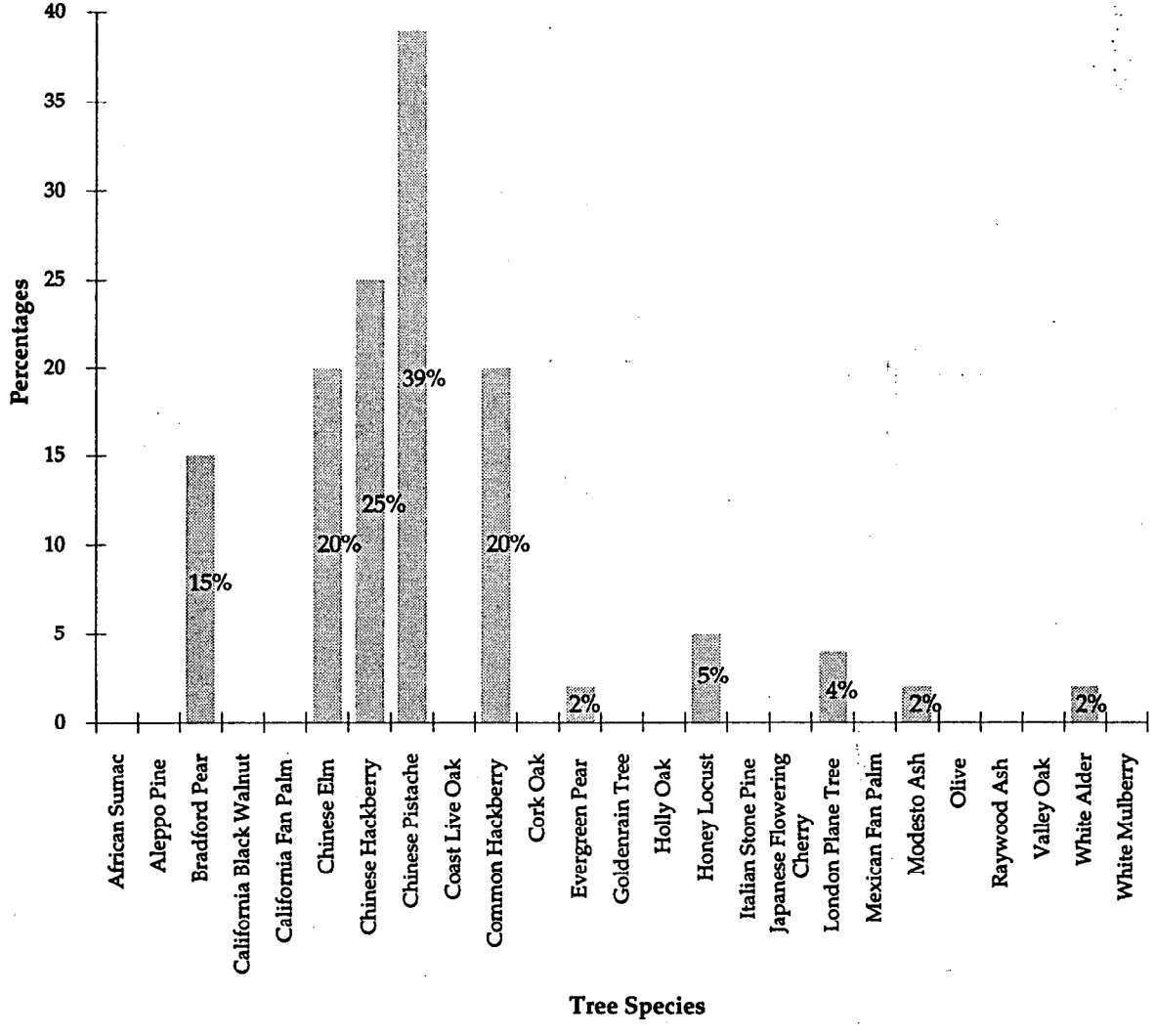
GRAPH #1: Albertson's Parking Lot



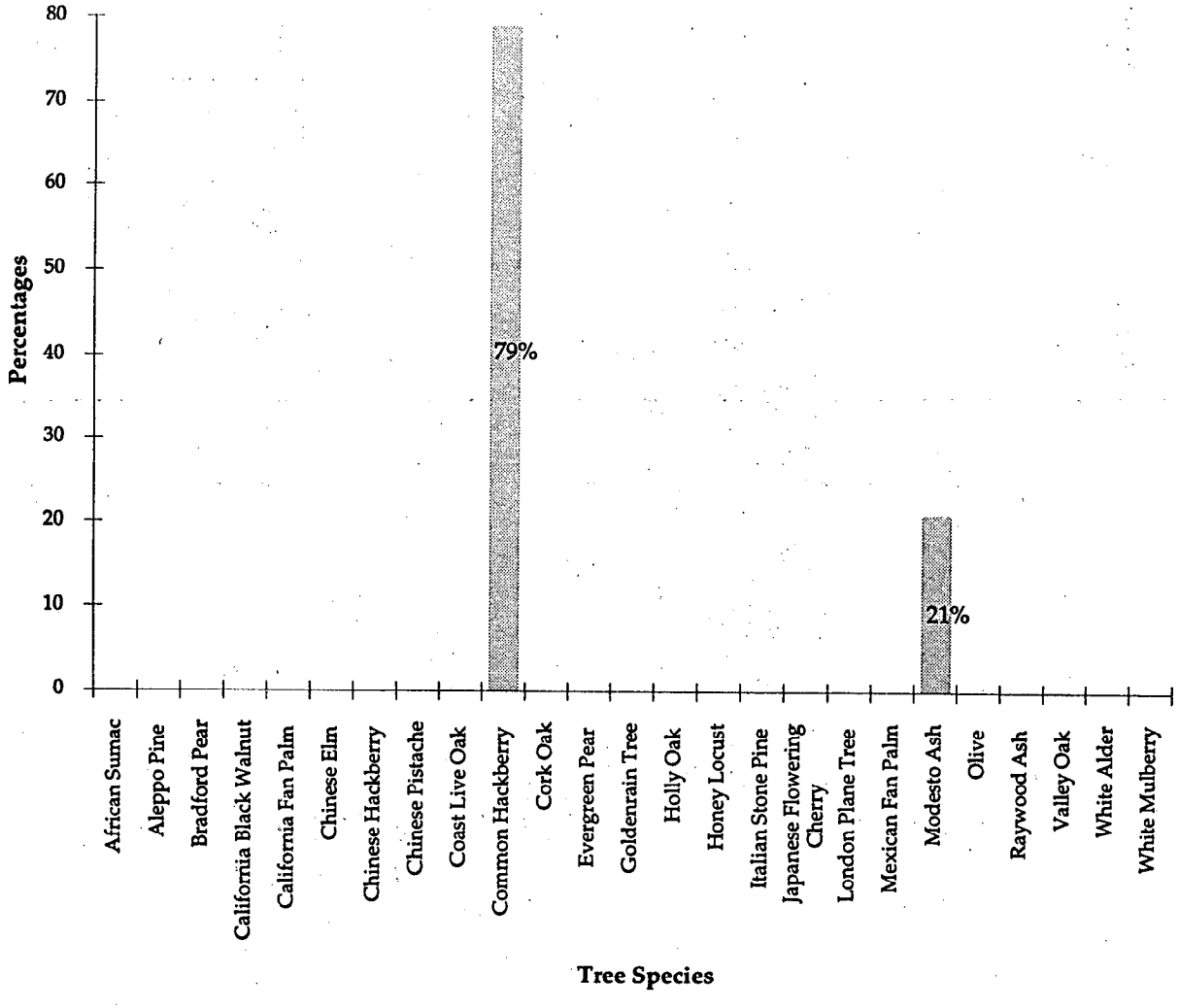
GRAPH #2: Cranbrook/Pinecrest Parking Lot



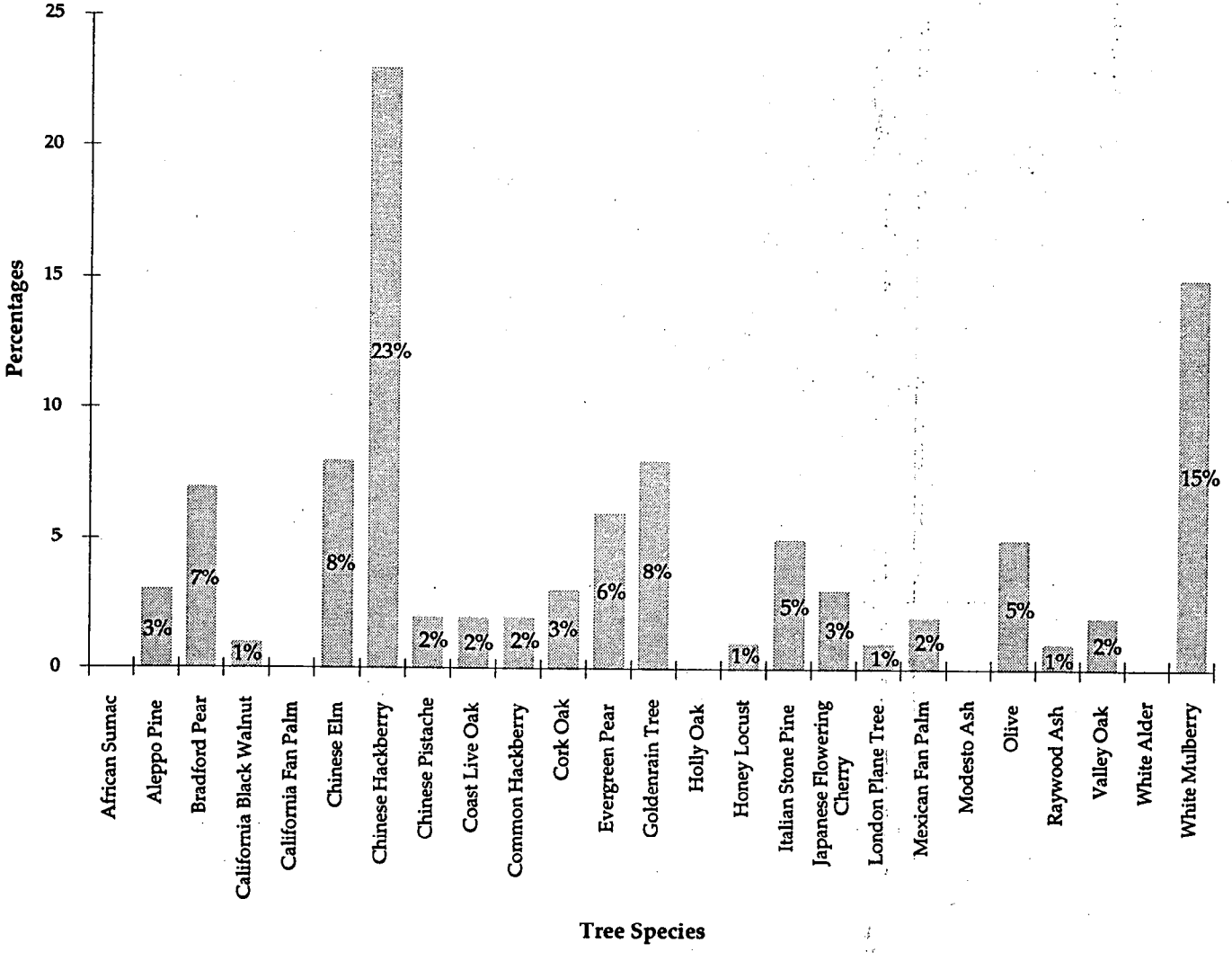
GRAPH #3: Davis High School Parking Lot



GRAPH #4: D.J.U.S.D. (Davis Joint Unified School District) Parking Lot

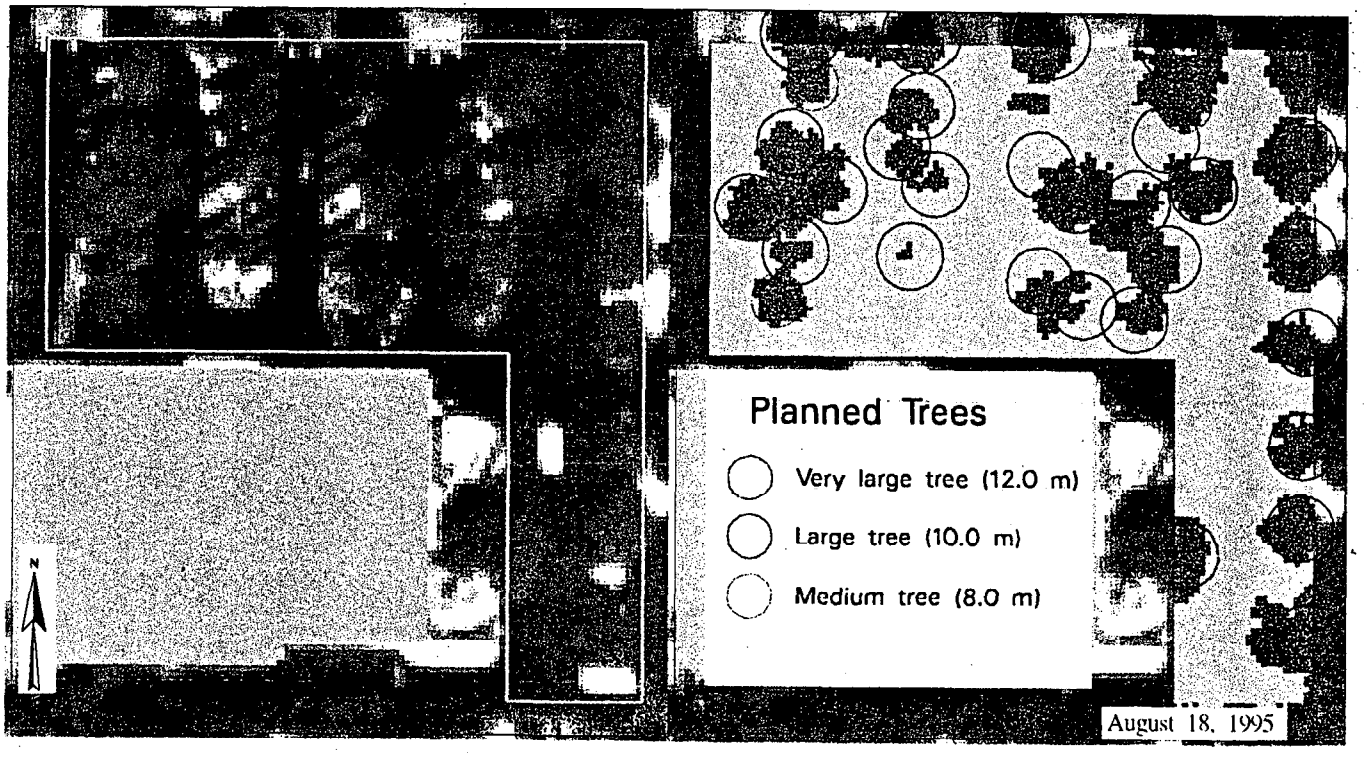


GRAPH #5: University Mall Parking Lot



Tree Cover Survey

(Albertsons Parking Lot, Davis, California)



Paved area boundary

Actual tree shade

Percent of Paved Area Shaded - Planned 38%
Percent of Paved Area Shaded - Actual 29%

Tree Cover Survey

(Cranbrook Court Parking Lot, Davis, California)

Paved area boundary

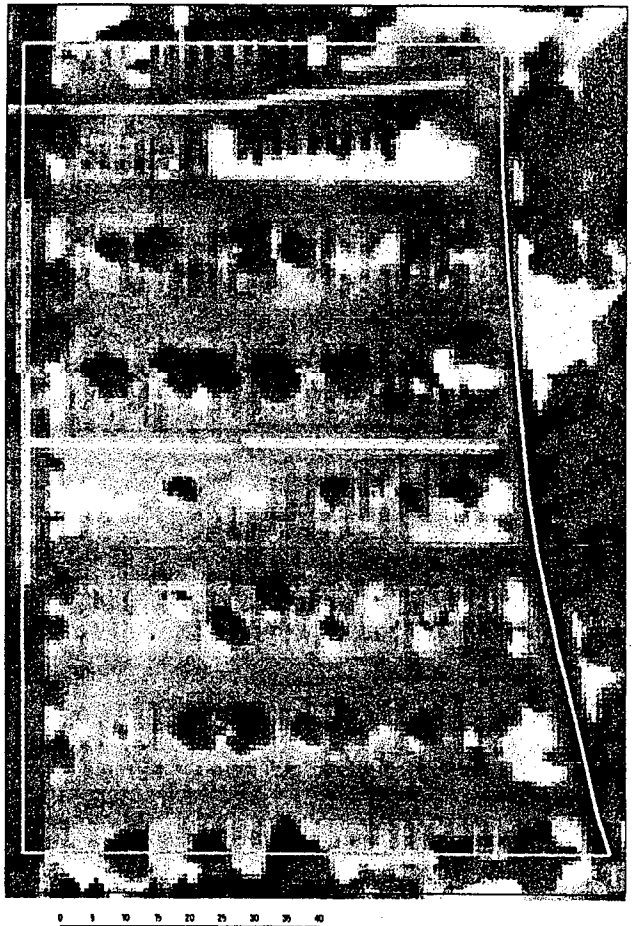
Actual tree shade

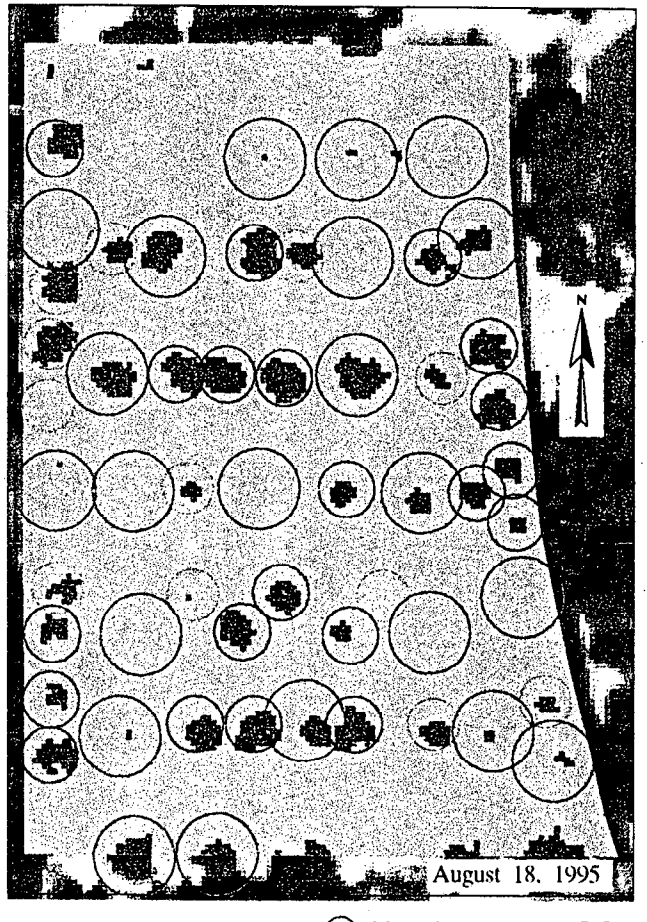
Planned Trees ○ Large tree (10.0 m) ○ Medium tree (8.0 m)

Percent of Paved Area Shaded - Planned 41%
Percent of Paved Area Shaded - Actual 45%

Tree Cover Survey

(Davis High School / Community Center Parking Lot, Davis, California)





Paved area boundary

Actual tree shade

Planned Trees

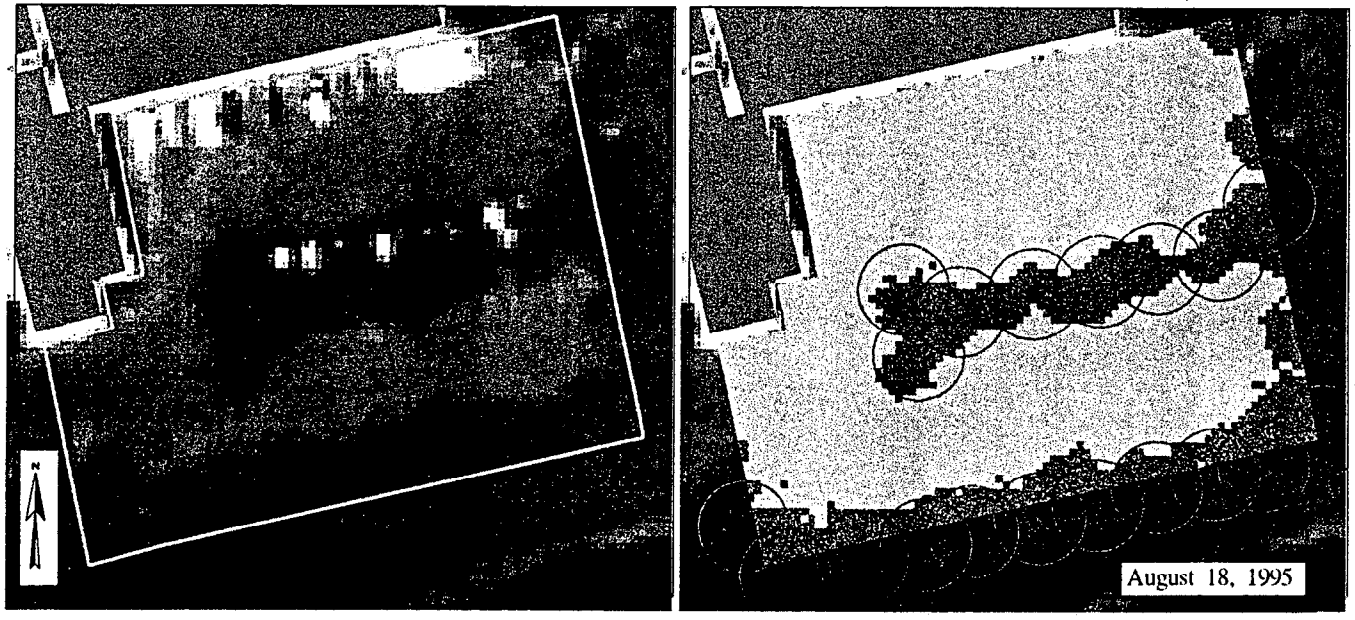
- Very large tree (12.0 m)
- Large tree (10.0 m)
- Medium tree (8.0 m)

Percent of Paved Area Shaded - Planned 44%

Percent of Paved Area Shaded - Actual 8%

Tree Cover Survey

(D.J.U.S.D. Administration Parking Lot, Davis, California)



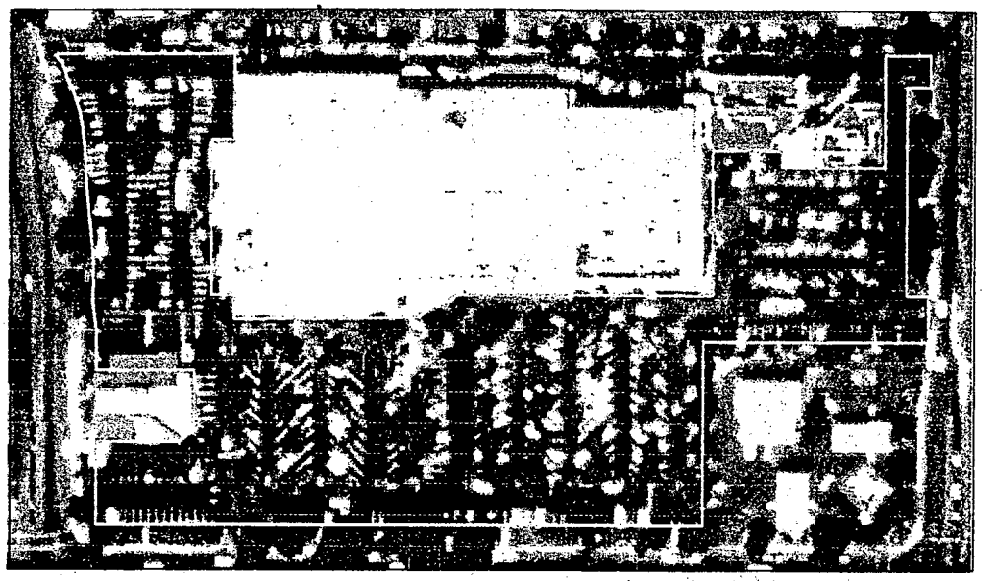
Paved area boundary

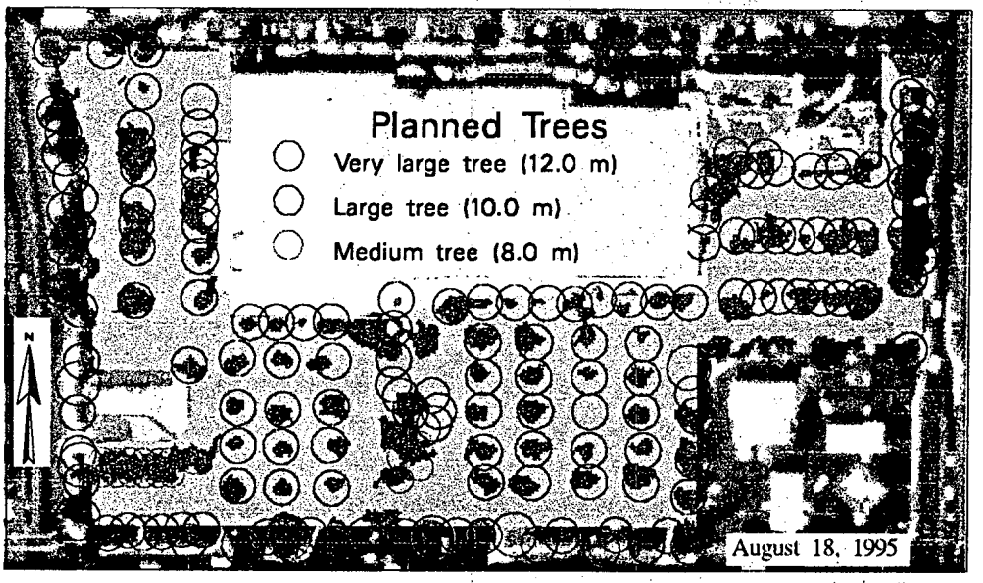
Actual tree shade

Planned Trees ○ Medium tree (8.0 m)

Percent of Paved Area Shaded - Planned 18%
Percent of Paved Area Shaded - Actual 22%

Tree Cover Survey
(University Mall Parking Lot, Davis, California)





Paved area boundary

Actual tree shade

Percent of Paved Area Shaded - Planned 43%
Percent of Paved Area Shaded - Actual 23%

Part 4: Results

4.1 LOT #1: Albertson's Parking Lot

4.1.1 Summary of Parking Lot Characteristics

The location of Albertson's supermarket is 1800 East Eighth Street on a paved area of 4,973m^2. This is a privately owned and maintained commercial-retail parking lot. The total number of parking stalls is 89. These stalls include 4 handicapped stalls with the dimensions of 6.3 meters by 5.3 meters, 21 compact stalls with the dimensions of 5.7 meters by 2.7 meters, and 64 regular stalls with the dimensions of 6.3 meters by 2.7 meters. The driving lane width is 6.7 meters. The Albertson's parking lot was renovated in 1978 and is 18 years old (Table 3).

Figure 17: Albertson's parking lot.

4.1.2 Tree Maintenance Program

The Albertson's parking lot trees are maintained by Aborist & Son Company. The individual responsible for the health and care of the Albertson's parking lot trees interviewed over the phone was very cautious and discreet with information pertaining to the type of maintenance work given to Albertson's parking lot trees. Information collected from the interview includes general information regarding the type and frequency of pruning, the type of spray used, and the reason why he is unable to perform any disease and pest control on the trees. He explained that he trims the Albertson's parking lot trees once per year. Fertilization is given to parking lot trees only when necessary. To combat weeds, organic spray (Round Up) is used. He also claimed that pest and disease control of the trees must be approved by the City of Davis, therefore he is discouraged from performing any type of pest and disease control to the parking lot trees.

4.1.3 Tree Information Summary

Tree species found on this parking lot include Holly Oak (*Quercus ilex*), Cork Oak (*Quercus suber*), African Sumac (*Rhus lancea*), Chinese Pistache (*Pistacia chinensis*), Chinese Elm (*Ulmus parvifolia*), Siberian Elm (*Ulmus pumila*), Coast Redwood (*Sequoia sempervirens*), and Califorina Fan Palm (*Washingtonia filifera*). Two most frequent tree species are Chinese Elm (41%) and Chinese Pistache (34%) with the other tree species at 9% or less (Table 4). The parking lot was designed with 34 trees on the site, yet throughout the years, 2 trees have

been removed and replacement trees have not been planted. The row orientation of these parking lot trees are north-south with row spacing (distance between trees) of 6.5 meters. The row separation (distance between rows) is 17.8 meters (Table 3).

4.1.4 Planting Site Information

Interior Trees- Two different types of planters were used for the interior trees: raised circular concrete planters with diameter of 1.2 meter; and height of 0.6 meter and large rectangular planting beds (Table 3). Raised circular planters may be too small in size which can cause restrictive problems for Chinese Pistache by confining the growth of root systems. Large rectangular beds may be more appropriate for the growth of healthy parking lot trees by allowing more water and nutrients to be available. Typical surface material found in these planters is bark with spray irrigation. Trunk protection is provided to all interior trees by the raised containers. Soil compaction does not appear to be a problem for raised containers, yet foot traffic can be observed on the large rectangular planters.

Perimeter Trees- Perimeter trees are planted in large rectangular planting beds on the periphery of the parking lot with shrub, ground cover, and grass serving as the typical surface material (Table 3). Trunk protection is not needed by perimeter trees since they are planted further away from the planter's edge resulting in no damage by parked vehicles.

Figure 18: Raised round planter in Albertson's parking lot.

4.1.5 Observed Problems

Stakes are left on new replacement trees. The stakes appear to be unnecessary since the trunks of the replacement trees are of good, stable, independent size and the stakes are also conflicting with branches and tree trunks. Black plastic linings were left in the large interior planting beds. Some interior tree canopies are conflicting with the interior lighting. Spray irrigation heads found in raised circular planters may not be appropriate for these smaller planters since most of the water dispersed from the sprayers is not retained in the raised planters but forced outside the planter onto the asphalt. Bubblers would provide more water for trees grown in raised planters.

Figure 19: Stakes left on tree in Albertson's parking lot.

4.1.6 Shading Results

The initial tree coverage designed for the Albertson's parking lot is 38%, yet the actual current tree shade is 29% (Table 2). Since this parking lot was renovated in 1978, it is currently 18 years old. Three years after the parking lot's fifteenth year, it still has not achieved its 50% shade tree coverage. Reasons for the noncompliance of the Davis Parking Lot Shade Ordinance are mainly due to the parking lot design: 1) too few trees initially,

2) spray instead of bubbler irrigation,

3) inadequate replacement of dead trees,

4) inadequate soil volumes for trees to reach potential mature size,

5) crown conflicts, and

6) too many young replacement trees (Table 5).

The landscape architect designed this parking lot for a maximum shade tree coverage of 38%. This goal does not comply with the Davis Ordinance of 50% tree coverage. If parking lots are not designed with the 50% shade tree coverage potential, parking lots will never have the capability of reaching 50% tree coverage. The intended Albertson's parking lot design included 34 trees on the site, yet two trees have been removed and have not been replaced. Percentage of tree coverage will increase minutely by replacing these two trees, though it is unlikely that this parking lot will ever attain 50% tree coverage since it was not designed with this 50% tree coverage goal in mind. Size of raised interior round planters may be too small to house the trees' extensive root systems leading to inadequate growth of the tree. This restriction of root system will ultimately cause for the stunting of the overall tree form. Reduction in tree form will also decrease the size of the tree canopy. Spray irrigation heads designed in raised circular planters therefore may not be appropriate for these smaller planters since most of the water is distributed outside the planters and trees in the planters may not be receiving adequate amounts of water. Reduction in water source may cause trees to stunt in growth which may result in decreased tree canopy sizes. A large above ground water pump/valve unit is actually sitting in one of the large, interior, rectangular planter close to a tree. This device may increase the soil compaction causing for the tree's root system to undergo stress. Soil compaction reduces the amount of nutrient, water, and aeration the tree

will receive. This will also contribute to stunted growth.

4.1.7 Aerial Map of the Albertson's Parking Lot

Infrared aerial photos of the Alberton's parking lot site were taken on August 18, 1995. The red images represent tree canopy foliage. From these diagrams, representation of the designer's intended tree shade over paved area is 38%, while the current tree shade over the paved area is 29%. The boundary of this Albertson's parking lot paved area extends to the edge of parking lot and excludes the back delivery drive way. This parking lot does not comply with the existing Davis Parking Lot Tree Shade Ordinance.

4.2 Lot #2: Cranbrook/Pinecrest Apartment

4.2.1 Summary of Parking Lot Characteristics

Cranbrook/Pinecrest Apartment parking lot, located on 920 Cranbrook Court, was built in different phases. Currently the entire parking lot is divided along the central east-west axis of the parking lot with the south side of the parking lot under the Pinecrest Apartment ownership and the north portion of the parking lot owned by Cranbrook Apartment. Two different tree management practices can be seen on both portions of the parking lot.

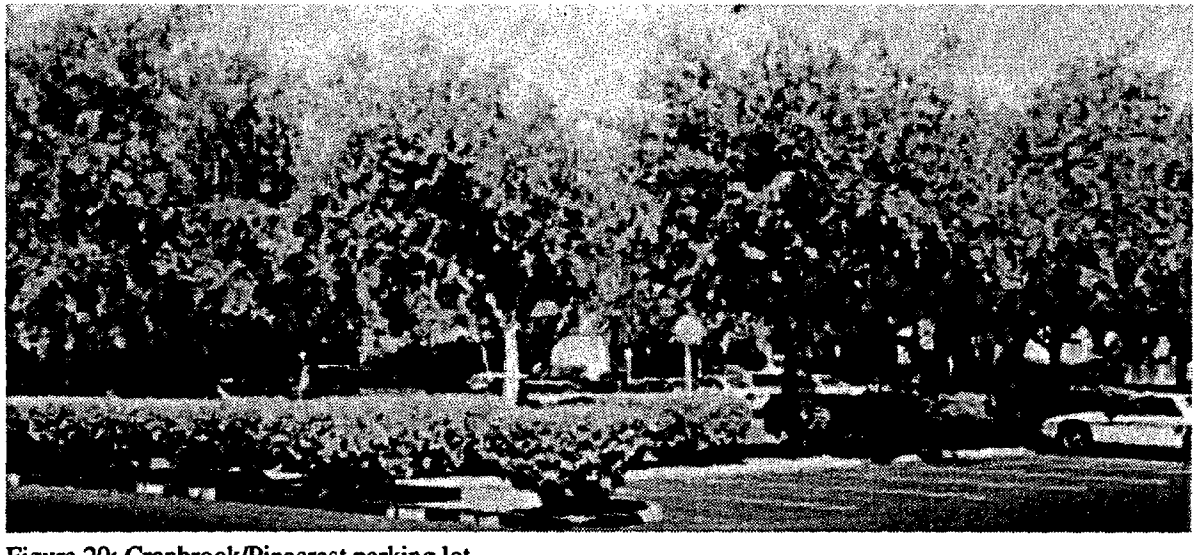


Figure 20: Cranbrook/Pinecrest parking lot.

This high density residential parking lot is owned and maintained privately. Pinecrest portion of the parking lot has 92 regular parking stalls all with typical dimensions of 5.5 meters by 2.75 meters. Typical driving lane width is 6.8 meters. Cranbrook section of the parking lot has a total of 127 parking stalls with 3 handicapped stalls of 4.9 meters by 4.5 meters and 124 regular stalls of 4.9 by 2.85 meters. Driving lane width for the Cranbrook side of the parking lot is 6.8 meters. Combined parking lot size (including the Pinecrest and Cranbrook portions of the parking lot) is 7,544 m^2 of paved area (Table 3).

Two opposing halves of the parking lot (Cranbrook and Pinecrest) were developed at different stages. Cranbrook part of the parking lot was developed in 1971 and Pinecrest side of the parking lot was constructed in 1969 (Table 3). Though both sides of the parking lot were developed at different stages, the layout of the entire parking lot is a consistent and congruent design. Similar design decisions and characteristics seen from both sides of the parking lot include identical planter type, planter size, irrigation heads, and tree species. While both sides of the parking lot were developed with similar characteristics, the parking lot tree maintenance provided by the two different apartment owners vary. Parking lot tree conditions appear to vary between different ownerships. Cranbrook parking lot trees are significantly lower in height with denser, fuller canopy spread, yet adjacent Pinecrest parking lot trees of the same species are much taller in

height with less compact foliage cover.

4.2.2 Tree Maintenance Program

Julie Rundtree is the manager of the Pinecrest Apartment and Leona Span is the manager of the Cranbrook Apartment.

Jeff Richardson, Pinecrest Landscape Maintenance Supervisor, is responsible of the tree maintenance of the Pinecrest parking lot. He practices the thinning method (pruning back to the laterals) a couple of times per year on the Pinecrest parking lot trees. Pruning jobs on the larger trees are contracted out. Tree irrigation is done throughout the year at intervals of 30 minutes 3 times per week. Frequent summer irrigation is at intervals of 10 minutes every 2 hours due to high evapotransportation rate. Type of irrigation head used is bubblers. Fertilizing is done once per year by application of iron sulfate. Round Up is used to control weeds. One observed pest problem is aphid, yet pest control method has not been performed. Interior parking lot trees experience major drought stresses during summer due to compacted clay soil. This type of soil reduces water penetration to the root system. Water stress causes trees to defoliate throughout summer. Mr. Richardson is trying all methods to avoid pollarding the trees. By following present tree management techniques, nice dense foliage canopies are still not achieved as compared to the same trees species planted on the neighboring Cranbrook portion of the parking lot.

Jesus Canchola, Cranbrook landscape maintenance caretaker of thirteen years, maintains Cranbrook parking lot trees. Mr. Canchola thins parking lot trees three to four times per year based on his observations. He refers to his pollarding techniques as thinning practices though the parking lot trees in this site were observed to have been pollarded in late November of 1995. Fertilization of the parking lot trees is contracted out to a company twice a year. Parking lot trees are irrigated twice per week depending on the season. During winter seasons, no irrigation is given to trees due to tree dormancy. No pest or disease control is practiced on the Cranbrook parking lot trees since pest or disease is not present.

4.2.3 Tree Information Summary

Only two tree species were found in this lot, Chinese Elm *(Ulmus parvifolia)* and Modesto Ash *(Fraxinus velutina 'Modesto')* with the dominant tree species being Chinese Elm with 95% and Modesto Ash as the remaining 5% (Table 4). A total number of 56 parking lot trees exist in this parking lot. Designers have planned this parking lot with 58 trees. Throughout the years, 3 trees were removed and 1 tree was replaced (Table 3).

Row orientation for the entire Cranbrook/Pinecrest Parking Lot is north-south. Other similar parking lot layout features include the 7 meter row spacing (distance between the trees) and the 20 meter row separation (distance between the rows).

4.2.4 Planting Site Information

Interior Trees- Interior Pinecrest parking lot trees are planted in typical rectangular planters with dimensions of 7 meters by 2.5 meters in width. General surface materials found in these planters are a combination of soil and shrub. Type of irrigation head is bubbler (Table 3). No apparent truck protection is designed along these planters to discourage vehicles from damaging interior parking lot tree trunks. Trees found in the interior portion of the Cranbrook parking lot are also placed in typical rectangular planters of 7 meters by 2.5 meters with shrubs or bare soil to act as surface material in those planters. Bubblers are found to irrigate interior parking lot trees. Again, no trunk protection as wheel stop is found along the planters, but planting spaces provided are wide enough to prevent automobiles from injuring tree trunks.

Perimeter Trees- Both Pinecrest and Cranbrook perimeter parking lot trees are planted on the periphery. Surface material used along the perimeter planting areas is ivy groundcovers, and turfgrass (Table 3). Since the peripheral parking lot trees are planted further away from the curb's edge, vehicles are deterred from damaging perimeter tree trunks. Spray irrigation heads are used on perimeter parking lot trees.

4.2.5 Observed Problems

Type of compacted clay soil found in the planters of this parking lot is not favorable for successful and healthy tree growth. Soil found in

the interior planters was dry with fissures. One specific problem present on the Pinecrest portion was the closely spaced interior trees resulting in canopy conflicts. Interior Chinese Elm canopies conflicted with other neighboring Chinese Elm canopies. Peripheral parking lot tree canopies also conflicted with street tree canopies.

4.2.6 Shading Results

Planned amount of total shade coverage for the Cranbrook/Pinecrest parking lot is 47%, with existing tree shade of 45% (Table 2). This parking lot has a general age of 25 years old, yet it still has not obtained 50% tree shade coverage. Major causes for ordinance are mainly due to:

1) non diverse and inppropriate tree species selection,
2) inadequate amount of soil leading to drought stress,
3) inadequate infiltration, and
4) improper irrigation.

Intended shade coverage of 47% is slightly less than 50%. This existing shade coverage comes close to the current ordinance. Twenty five years after the development of this parking lot, resulted in only 47% tree coverage. The Cranbrook parking lot trees were noted to have been pollarded in November 1995. This type of pruning (pollarding) is appropriate for these trees and results are shown by currently healthy Chinese Elms. Thinning of the Pinecrest parking lot trees has resulted in less vigorous and sparse canopy than pollard-

ing. Most of the Chinese Elms seen on the Pinecrest portion have canopy conflicts with other neighboring trees. Conflicting tree canopies will compete for sunlight. Without an adequate amount of sunlight, trees may be further stressed.

4.2.7 Aerial Map of the Cranbrook/Pinecrest Parking Lot

Aerial photos, taken on August 18, 1995, show that designers intended the parking lot to have a total tree shade of 47%. Boundary for paved parking lot area (7,554m^2) was determined by including all pavement up to lot periphery. Since this parking lot currently has 47% shade, existing shade percentage comes close to 50%shade. This parking lot does currently comply with the Davis Parking Lot Tree Shade Ordinance.

4.3 Lot #3: Davis High School

4.3.1 Summary of Parking Lot Characteristics

Davis High School Parking Lot, located on 315 West Fourteenth, has a paved area of 9,809m^2. This is a public parking lot shared and frequented by Davis High School students and neighboring Davis Community Center users. Davis School District owns the parking lot property, yet current development of this parking lot was by the City of Davis in 1988. Goals of this parking lot redevelopment project was to extend the east end of this site and to remove dying Alders and replace them with healthy trees. City of Davis converted the gravel lot to the present landscaped parking lot. The existing Davis High School parking lot has a total of 332 parking stalls which include 11 handicapped stalls of 5.7 meters by 4.4 meters, 54 compact stalls of 4.9 meters by 2.95 meters, and 267 regular stalls of 5.7 meters by 2.95 meters. General driving lane width found in this parking lot is 7.6 meters (Table 3).

Figure 21: Davis High School parking lot.

4.3.2 Tree Maintenance Program

Davis School District Supervisor of Grounds, Mr. Jim Newman, maintains the Davis High School parking lot trees. These trees receive pruning once or twice per year. During these pruning cycles, goals of removing dead wood and thinning of lower lateral branches to avoid conflicts and injuries with pedestrians or automobiles are paramount in order to prevent liability suits. Irrigation of parking lot trees is provided once or twice per week. Weed control is maintained by spraying around bottom portions of tree trunks. Two important tree maintenances, fertilization and pest/disease control, have been disregarded due to insufficient funds in the budget. Special fertilizers are not given directly to the parking lot trees due to the school district's departmental cut backs. Perimeter parking lot trees do obtain small percentage of fertilizer from the lawn. Fertilizers applied to peripheral lawns once to twice per year may be shared by trees planted on the same turfgrass area. These parking lot trees are then able tooreceive some of the nutrients through absorption by their root systems.

4.3.3 Tree Information Summary

Tree species found on this lot include Chinese Elm *(Ulmus parvifolia)*, Modesto Ash *(Fraxinus velutina 'Modesto')*, Bradford Pear *(Pyrus calleryana 'Bradford')*, Evergreen Pear *(Pyrus kawakamii)*, Thornless Honey Locust *(Gleditsia triacanthos inermis)*, Chinese Hackberry *(Celtis sinensis)*, White Alder *(Alnus rhombifolia)*, and Chinese Pistache

(Pistachia chinensis). Five most frequently found tree species on this lot include Chinese Pistache (39%), Chinese Hackberry (25%), Chinese Elm and Common Hackberry (20%), with remaining tree species 15% or less (Table 4). Tree row orientation is east-west positions. Row spacing (distance between trees) is 9 meters and row separation (distance between rows) is 18.3 meters. Fifty-six trees were originally planned for this parking lot site by the designer, one tree has been removed. No additional tree was added to replace the removed tree (Table 3).

4.3.4 Planting Site Information

Interior Trees- Two different types of interior planters were seen in this Davis High School parking lot. One type of interior planter has dimensions of 1.4 meter by 2.5 meters while the other interior planter has dimensions of 1.1 meter by 4.3 meters (Table 3). These inappropriate planters hold small soil volumes which are insufficient in supplying adequate amounts of water and nutrients to root systems. Maximum tree sizes will not be obtained due to the restriction of nutrients and water in the soil. Tree root growth will also be limited due to the small, confined, soil areas inside these planters. Typical surface material used in these interior planters was wood chips. Drip irrigation was also present in these planters to supply interior trees with water. No trunk protection was seen.

Perimeter Trees- Perimeter planters include large rectangular lawn

Figure 22: Inadequate planter size.

Figure 23: Davis High School parking lot tree planter.

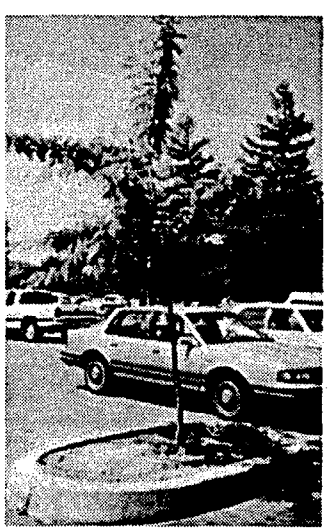


Figure 24: Inadequate planter size.

areas. Turfgrass is the typical surface material seen in these perimeter planters. Drip irrigation is also present to provide both perimeter parking lot trees and surrounding lawn with water (Table 3).

4.3.5 Observed Problems

Based on parking lot tree observations, it is noted that 9 out of the 55 trees examined have vandalism on the exterior tree trunks. One prevalent type of vandalism consists of letter / figure carving on tree trunks. Effects of this type of damage might include greater disease and pest susceptibility and restrained tree growth. Another type of problem found in this parking lot site includes stakes and plastic ties left on trees. Stakes have been left on trees that do not require support or protection. Both of stakes and plastic ties may prevent proper development of trees. Amount of soil in these planters is too small and does not provide the essential water and nutrients levels needed for the mature growth size of the trees.

4.3.6 Shading Results

Existing tree shade in the Davis High School Parking Lot is 8% while the proposed tree shade is 44%. This parking lot was renovated in 1988 and is 8 years old. By projecting the current tree shade percentage to year fifteen, 24% of tree shade coverage will be achieved missing the 50% shade ordinance by 26%. Though the designer's intended canopy coverage of 44% does come close to the 50% shade ordinance, results of the actual tree shade for this parking lot is only 8%(Table 2).

Figure 25: Stakes left on a parking lot tree.

Figure 26: Stakes and plastic ties left on the tree.

Causes for deficient amount of tree shade present include:

1) high vandalism and many young replacement trees,

2) inadequate irrigation, and

3) stakes left on trees causing damage to tree bark (Table 5).

Tree vandalism, as removal or damage of outer tree bark, may injury trees by allowing disease and pest to invade tree trunks. Removal of the outer layer of tree bark is in essence abandonment of the outer protective layer of the tree. Once disease or pest infests trees, it is most likely for trees to become unhealthy and die within a certain period. Many tree barks were also seen to have been damaged by tree stakes and letter/figure carving. Frequent replacement of dead or dying trees may explain the 8% shade coverage in the Davis High School parking lot. Another possibility for this present low percentage of tree coverage is the improper planters used in the interior portions of the parking lot. Tree root development will be restricted due to the confinement of the small soil size of the planters. Restricted root growth will ultimately affect the entire tree form by dwarfing its size. Smaller overall tree forms will create minimum tree canopy coverages.

4.3.7 Aerial Map of the Davis High School Parking Lot

Infrared aerial photos were taken on August 18,1995. Based on this aerial photo image, it was determined that the actual shade coverage is 8% and the planned parking lot tree shade coverage to be 44% at year fifteen. The intial design of shade coverage comes relatively close

to the 50% shade ordianance. This parking lot was planted with 55 trees. The paved area boundary include all of the parking lot area up to the perimeter planters. This parking lot does not comply with the existing Davis Parking Lot Tree Shade Ordinance. By projecting the shade coverage to year fifteen, an amount of only 24% actual tree shade will be achieved. This is a difference of 26% in shade coverage.

4.4 Lot #4: Davis Joint Unified School District (D.J.U.S.D.) Administration Parking Lot

4.4.1 Summary of Parking Lot Characteristics

D.J.U.S.D. Administration parking lot, on 726 B Street, is a public parking lot. This parking lot was developed in 1978 resulting in the parking lot being 18 years old. Paved area of this school district building parking lot is 2,877 m^2. There are a total of 64 parking stalls in this parking lot with 2 handicapped stalls of 5.45 meters by 3.9 meters and 62 regular stalls of 5.2 meters and 2.75 meters. Driving widths are 14.1 meters and 11.1 meters (Table 3).

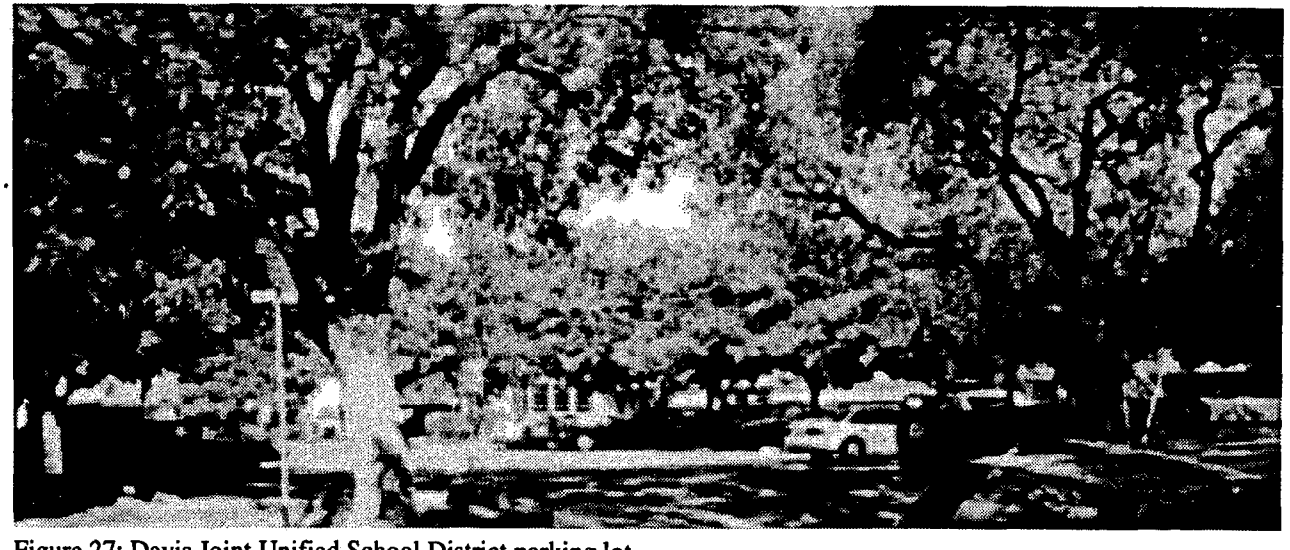


Figure 27: Davis Joint Unified School District parking lot.

4.4.2 Tree Maintenance Program

Jim Newman, Davis School District Supervisor of Grounds, is in charge of providing landscape care to the parking lot trees. One major problem being dealt with by Mr. Newman is the depleting source of funds available for parking lot tree maintenance. Due to this budget deficit, many neccessary maintenance tasks are limited or disregarded. This lack of funds limits the pruning cycle to once per year. During each annual tree pruning, dead branches are removed for liability purposes, lower tree branches removed for overhead vehicle and pedestrian clearance. No fertilizing can be given to trees due to shortage of funds provided for maintenance purposes. Tree irrigation is done once per week and not at all during rainy seasons for rain water tends to percolate down into the soil providing the root system with adequate water. Control of weed is provided as needed by methods of applying 'Round Up' or by mechanical pulling. Currently, no pest or disease can be detected from the parking lot trees. Again a lack of fund basically prevents any type of pest/disease control to be made even if it is required.

4.4.3 Tree Information Summary

Two present parking lot tree species are Common Hackberry (*Celtis occidentalis*) and Modesto Ash (*Fraxinus velutina 'Modesto'*). The most common tree species found in this lot is Common Hackberry (79%) followed by Modesto Ash (21%) (Table 4). Nineteen trees were designed into the parking lot, due to suitable tree maintenance tech-

niques no trees were removed or replaced.

4.4.4 Planting Site Information

Interior Trees- Interior parking lot trees are planted in rectangular planters with dimensions of 7 meters by 1.4 meters. Typical surface material found in these planters is small shredded wood mulch. Bubblers are used to irrigate the interior parking lot trees (Table 3).

Perimeter Trees- Perimeter parking lot trees are planted in 7 meters by 1.25 meters rectangular planters. Wood mulch chippings are once again used as surface material for these parking lot planters. Wheel stops are present along perimeter planter edge to prevent automobiles from damaging perimeter trees (Table 3).

4.4.5 Observed Problems

There are two centrally located lights which conflict with the lower one third portions of interior parking lot tree canopies. South trees are planted too closely together conflicting with street trees. Adjacent shade trees also contribute shade to this parking lot. North portion of this parking lot is void of any parking lot trees which may cause for noncompliance of the 50% shade ordinance.

4.4.6 Shading Results

Present D.J.U.S.D. parking lot tree shading coverage is 22%. Designer of this parking lot intended for the site to achieve 18% tree shade and

this goal of 18% tree shade was met by year fifteen. Currently, the actual shade coverage for this parking lot exceeds intended shade coverage by 3% (Table 2). Davis Parking Lot Shading Ordinance was in effect in 1977. This is actually one year prior to the development of this lot, yet the designer of this site chose to ignore this parking lot shading ordinance since he planned for only 18% tree shade at year fifteen instead of 50% tree shade leaving for a code difference of 35%. For this particular parking lot, conditions and tree maintenance are well suited for vigorous tree growth which can be shown by the actual tree shade exceeding the amount of intended tree shade. Major parking lot problems include:

1) design flaw- no trees shading north side of the parking lot,
2) lighting conflict,
3) trees designed too close, and
4) street tree conflict.

Perhaps if these parking lot trees were designed with more separation between the trees, conflicts of tree canopy may have been avoided and a higher percentage of shade coverage may be achieved in this parking lot. Due to tree canopy conflicts, lateral limbs need to be pruned off. By thinning these conflicting lateral limbs, amount of shade provided is decreased. Designer also failed to note the mature canopy size of these trees and designed the trees too closely together detering trees from reaching their mature maxium growth potential.

4.4.7 Aerial Map of D.J.U.S.D. Parking Lot

Aerial map of D.J.U.S.D. parking lot taken on August 18, 1995 show current shade coverage to be 22% while the designer intended parking lot to received at most 18% tree coverage. This parking lot does not comply with the existing Davis Parking Lot Tree Shade Ordinance because 50% tree shade coverage was not reached at year fifteen.

4.5 Lot #5: University Mall

4.5.1 Summary of Parking Lot Characteristics

University Mall, located on the corner of Russell Boulevard and Anderson Road, is a retail/commercial type of establishment. University Mall parking lot is privately owned and maintained. This parking lot was developed twelve years ago in 1984 with a parking lot design concept of controlling surface root pavement damage by planting Mulberry trees 12" deep in the soil. Parking lot size is 17,197 m^2 of paved area with a total of 450 parking stalls. These parking stalls include six handicapped stalls with dimensions of 5 meters by 4.5 meters, 86 compact stalls with dimensions of 3.9 meters by 2.85 meters, and 358 regular stalls with dimensions of 5 meters by 2.85 meters. Driving lanes of various widths exist in this parking lot. 'One-Way' driving lane widths include 6.9 meters, 4.9 meters, and 4.3 meters. A couple of 'Two-Way' driving lane with widths of 7.6 and 8.2 meters are also found in this parking lot (Table 3).

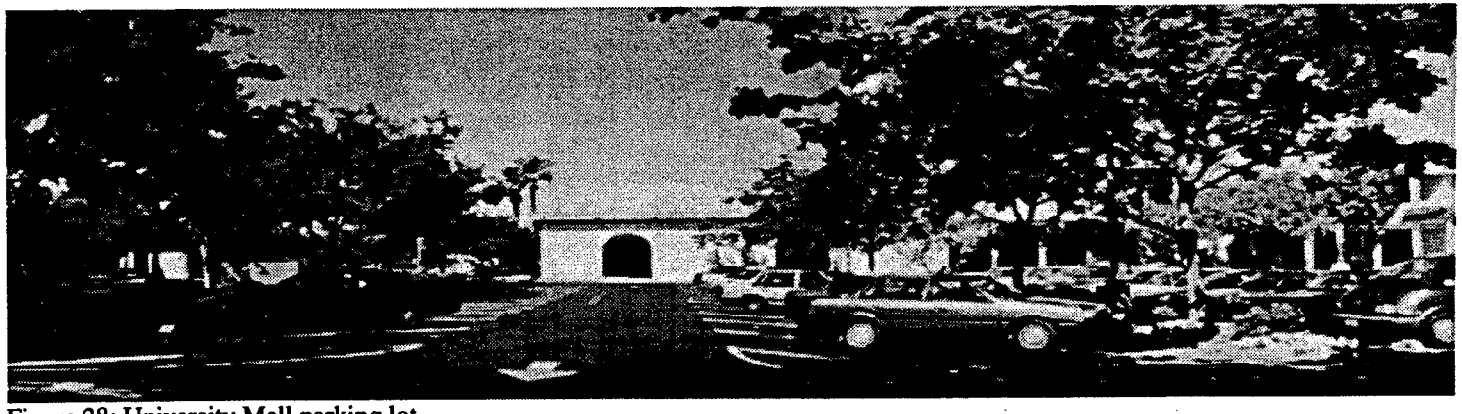


Figure 28: University Mall parking lot.

4.5.2 Tree Maintenance Program

Patrick Wait, a certified arborist, of Tree Care Incorporated (a tree maintenance company located in Rancho Cordova) performs the University Mall parking lot trees maintenance. Mr. Wait began maintaining the University Mall parking lot trees four years ago. Prior to Mr. Wait's tree maintenance, the Mulberrys in the central east portion of the mall had been topped by the current mall owner for store signage visibility. This is a technique not practiced by Mr. Wait, instead he prunes the trees once every other year upward to achieve larger canopy spread which will ultimately increase shade coverage in this parking lot. He was also able to educate the current mall owner of benefits resulting from thinning instead of pollarding techniques. By training tree limbs upward, better store signage visibility will be achieved along with taller, increased canopy spread resulting in greater shade coverage. Mr. Wait is aware of the Davis Parking Lot Shade Tree Ordinance is trying to achieve the 50% goal. This type of thinning trains the tree to grow upward which also avoids damage to lower limbs by cars and trucks. No fertilizer is applied directly to the parking lot trees by Mr. Wait, but he suspects that traces of lawn fertilizer are being infiltrated to tree roots grown on those lawns. Observed problems include fruit litter droppings from Olive trees in the central east parking lot portion and aphids from Elm trees. He has been spraying the Olive trees with Fruit Fix, a plant growth regulator, to keep the Olive tree from fruiting. Amount of olive litter has been reduced by this spraying method, but this problem still persists.

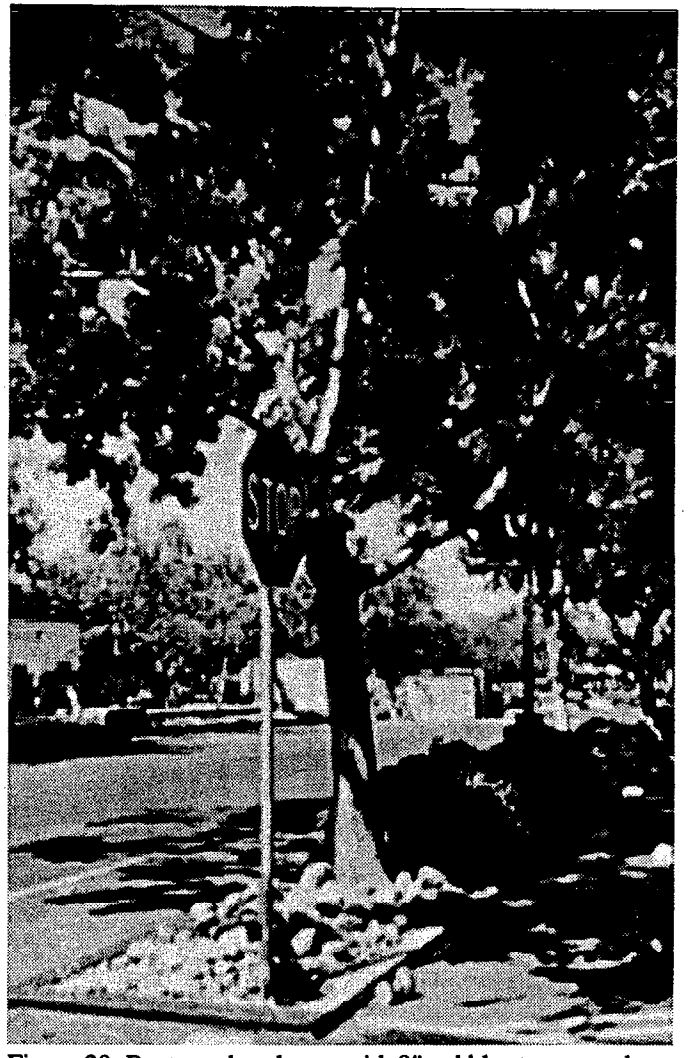


Figure 29: Rectangular planter with 9" cobble stones used as surface material. Mulberry trees have been lowered 12" to prevent surface root damage to asphalt.

University Mall customers often dislike messy olive litters since olive juice does stain shoes and clothing. No aphid control has been performed by Mr. Wait. Other parking lot tree pest or disease has not been detected by Mr. Wait.

Mr. Wait also commented on the effectiveness of present, deep, tree plantings as seen from the Mulberrys planted 12" deep in the University Mall parking lot for root damage prevention. He believes that trees' surface roots will eventually upset the asphalt due to the majority of nutrients found most predominant within upper 24 inches soil profile. He feels that tree root systems will search for nutrients by growing toward these crucial resources present in soil upper top layer and inevitably causing pavement damage.

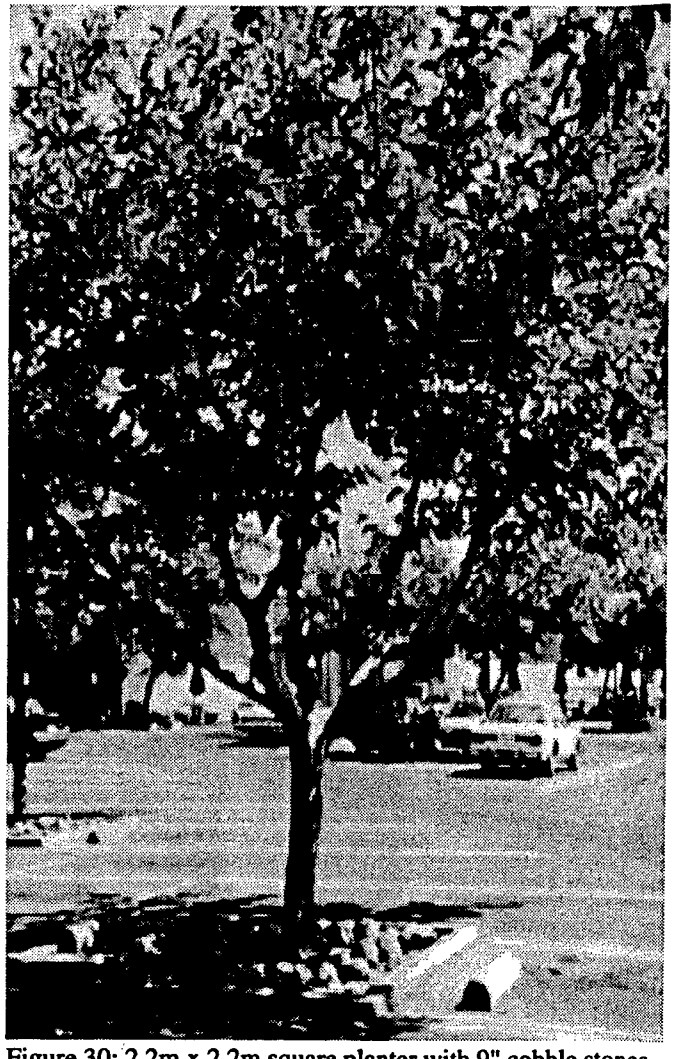


Figure 30: 2.2m x 2.2m square planter with 9" cobble stones.

4.5.3 Tree Information Summary

This lot contains a variety of trees species including California Black Walnut *(Juglans hindsii)*, Coast Live Oak *(Quercus agrifolia)*, Valley Oak *(Quercus lobata)*, Cork Oak *(Quercus suber)*, Italian Stone Pine (*Pinus pinea)*, Chinese Elm *(Ulmus parvifolia)*, Evergreen Pear *(Pyrus kawakamii)*, Modesto Ash *(Fraxinus veleutina 'Modesto')*, Chinese Hackberry *(Celtis sinensis)*, Common Hackberry *(Celtis occidentalis)*, Bradford Pear *(Pyrus calleryana 'Bradford')*, Japanese Flowering Cherry *(Prunus serrulata)*, Chinese Pistache *(Pistacia chinensis)*, White Mulberry *(Morus alba)*, Raywood Ash *(Franxinus oxycarpa 'Raywood')*, Olive *(Olea europaea)*, Goldenrain Tree *(Koelreuteria paniculata)*,Mexican

Fan Palm *(Washingtonia robusta)*, Aleppo Pine *(Pinus halepensis)*, Thornless Honey Locust *(Gleditsia triacanthos inermis)*, and London Plane *(Platanus acerfolia)*, (Table 4). Two different types of row orientation are north-south and east-west. For the east-west oriented trees, row spacing (distance between trees) is 9 meters with row separation (distance between rows) of 18 meters. Different row spacing and separation characteristics can be found for the north-south oriented trees. The row spacing for these trees is 11 meters with the row separation of 15.5 meters (Table 3). Another section of this parking lot has the same north-south parking lot tree orientation, but with different row spacing of 5 meters. Designer has planned for the parking lot to house 173 trees. 52 trees (mostly perimeter trees) have been removed without replacement.

5.5.4 Planting Site Information

Interior Trees- Four different interior planters can be found in this University Mall parking lot each with distinctive surface material, irrigation type, trunk protection, and soil compaction. The first type of square interior planters have dimensions of 2.2 meters by 2.2 meters. Nine inch river cobbles are used as surface material in this type of square planters. No irrigation source could be found in these planters, yet wheel stops are present along the edge of these planters to prevent tree trunk damage from occurring. Soil compaction was caused by initial construction, yet no foot traffic add presently to soil compaction. Nine inch cobble stones used as surface planter mate-

rial certainly deter people from walking on the cobbles since the irregular stones make it pretty unstable for people to walk on. Other advantages of using cobble stones as surface material include an increased amount of water and moisture to the root structures. The second type of interior planters is circular raised planters with 2.2 meters in radius. Again 9 inch river cobbles are used as surface material medium. No irrigation source could be found in this type of circular planters. Trunk protection is not truly needed since the raised planters protect tree trunk damage, yet wheel stops are still found along this type of planter. Initial construction might have caused soil compaction, but little foot traffic contributes to increasing compaction. The last type of interior planter type found in this parking lot has dimensions of 2.15 meters by 5 meters. Bare soil and Oleander were used as surface planter materials. Spray irrigation is present in these interior planters. Wheel stops are available along planter's edge. Soil compaction could have been caused by initial construction. No foot traffic exist now since the Oleander shrubs prevent people from tramping through these planters (Table 3).

Perimeter Trees- Several different large planting beds are present along the perimeter of this parking lot. Peripheral groundcover materials include ivy, Lily-of-the-Nile, and turfgrass. Raised turf grass berms deter people from walking over them also. Spray and bubbler irrigation are found in the perimeter planters (Table 3).

Figure 31: Raised round tree planted seen in University Mall Parking Lot.

4.5.5 Observed Problems

Some interior tree canopies conflict with interior parking lot light fixtures. Interior trees may have been incorrectly designed not leaving enough space for mature tree canopy to develop resulting in canopy conflicts.

4.5.6 Shading Results

Intended shade design coverage by the landscape architect was 43% at year fifteen, yet current shade coverage is only 23% (Table 2). The designer was certainly aware of the Davis Parking Lot Shading Ordinance for his parking lot design had 43% tree shade coverage. This tree coverage percentage lacks 50% shade by 7%. By projecting shade coverage in year fifteen based on the current shading of 23%, at year fifteen an amount of 27% tree shade will be achieved. Reasons for noncompliance of shade ordinance are due to:

1) lighting conflicts,
2) interior trees designed too close,
3) high tree removal without any replacements, and
4) inappropriate tree pruning practice (topping) (Table 5).

It can be seen that 173 trees were designed onto the lot, yet within 12 years 52 trees have been removed. Most removedperimeter trees are not replaced were perimeter trees. Since perimeter trees contribute considerably less shade to the entire parking lot paved area compared to interior trees, removal of such trees is not too significant.

4.5.7 Aerial Map of University Mall

Aerial map of the University Mall taken on August 18, 1995 show current shade coverage to be 23% while the designer planned for a tree coverage of 35% at year fifteen (Table 2). Paved area boundary includes all paved area up to the edge of all buildings and excludes the back service portion of the parking lot. This parking lot does not comply with the existing Davis Parking Lot Tree Shade Ordinance since it will not achieve 50% tree shade at year fifteen.

Part 5. Conclusion: Davis Parking Lot Shading Ordinance Recommendations

5.1 Five Parking Lot Results

Since none of the five parking lots examined have 50% tree shade fifteen years after development and do not comply with the Davis Parking Lot Shading Ordinance, recommendations to ensure sufficient amounts of tree shade provided to the different sites are made. Recurring parking lot tree problems are mainly due to the initial design layout and tree maintenance. All of the parking lots studied are not designed with the intention of providing 50% shade coverage at year fifteen. Cranbrook/Pinecrest parking lot had the highest intended tree shade coverage, at 47%. Many of the selected planters used in the interior portions of the parking lots are too small in size. They are not able to provide tree root systems with sufficient nutrients, water, room to grow. All of these detrimental factors will cause parking lot trees to become less healthy leading to reduced tree growth. Unhealthy trees will often generate smaller tree canopies.

5.2 Recommendations

Following methods may be implemented to increase the number of parking lots in compliance with the Davis Parking Lot Shading Ordinance: Conclusions of these five examined parking lots show that none have achieved 50% tree shade coverage.

5.2.1 Clearer definition of what "paved area" in the Davis Parking Lot Shading Ordianance should be included to provide better understand-

ing of the paved parking area calculations. Explicit definition of landscaped and pedestrian areas near buildings, landscaped island within lots, and the role of shade from perimeter landscaping including street trees should also be stated in the ordinance.

5.2.2 Very specific guidelines and design reviews should be stated in the Davis Parking Lot Shading Ordianance. These guidelines must be met and design reviews must be conducted prior to the approval of parking lot planting plans. Specific guidelines should address:

1) appropriate tree species which may be grown successfully in this certain city,
2) proper tree spacing based on realistic tree growth in stress ful urban environments,
3) soil related issues including adequate amount of soil required by a tree to perform successfully, amenities which may be added to improve soil,
4) planting details,
5) proper tree maintenance practices,
6) type of irrigation appropriate for certain parking lot design,
7) perimeter landscape & street trees,
8) service areas near buildings,
9) pedestrian areas, and
10) islands shaded or unshaded by trees or other plants.

All of these recommendations should aid toward the growth of these parking lot trees to their mature sizes. Design reviews should exam-

ine the mentioned items pertaining to the successful growth of proposed parking lot trees. All of these required items must be met before the approval of parking lot planting plans.

5.2.3 Types of incentives or punishment for the compliance or the noncompliance of the 50% Parking Lot Shade Ordinance should be stated in the ordinance. Punishment may include payment of fines by the designer of proposed parking lot planting plan. These fees will range accordingly depending on the number of specific guidelines being violated.

5.2.4 Educating the community often leads to better awareness of the importance of shade trees in parking lots. Landscape maintenance crews can be taught correct pruning methods. Owners of commercial parking lots can learn the benefits of creating less hostile environments by maintaining the health of parking lot shade trees which will usually promote consumer patronage to stores near well shaded parking lots. People often tend to seek shaded parking areas especially warm days.

5.3 Following guidelines are to be followed after the approval of proposed parking lot planting plan.

5.3.1 Mandatory Review of Proposed Parking Lot Design
Size of any designed planters for parking lot will be inspected to en-

sure that adequate area is available for parking lot tree root systems. If designed planters are not well suited for mature tree growth, alternative parking lot design schemes must be submitted for approval.

5.3.2 Unannounced Site Reviews During Construction of the Parking Lot

Unanticipated site visits should be made to ensure proper tree plantings and installation of irrigation systems. During this time, tree planting techniques will be observed to ensure proper planting techniques. Tree planting holes will also be inspected for adequate depth and width. Soil conditions checked will include the degree of soil compaction and type of soil.

5.3.3 Mandatory Tree Pruning/Removal Permits for Parking Lot

After development of parking lot and establishment of parking lot trees, the following permits are required prior to any work done to trees. If any tree removal or tree pruning is needed on any private commercial, industrial, multi-residential, or public parking lots, a 'City Tree Pruning Permit' must be obtain prior to any pruning practices. A 'Tree Removal Permit' is also needed before any tree removal is done on these parking lots. Similar to the County of Sacramento Tree and Landscape Policy, these two permits enforce the existence and longevity of parking lot trees. Any pruning practices done on the site must be performed by a California Licensed Contractor. California licensed contractor shall also be certified by the International So-

ciety of Arboriculture as a Ceritfied Tree Trimmer or Certified Arborist. Pruning of trees include removal of dead wood to prevent hazards to private property and general public, to retain sufficient clearance to parking stalls by vehicles and pedestrians. Tree with split limbs are to be saved if possible to prevent lost of a tree.

'Tree Removal Permit' allows for removal of trees because of unsafe, unhealthy, and deplorable conditions. No remedy can be made to the tree to imporve its current condition, therefore causing for removal of tree. This shall be the only reason for removal of any tree on such parking lot sites.

5.3.4 Required Parking Lot Shade Coverage Review 15 Years After Tree Planting

Mandatory site visits to all parking lots, 5 years after development, should be conducted by the Davis Superintendent of Parks and Open Space to check on conditions of tree shade coverage. Insufficient amount of tree shade coverage found on parking lot will result in violation of the current Davis Parking Lot Shading Ordinance. If 50% shade coverage is not met at year fifteen due to tree removal and improper pruning practices, a fine based on the shade percentage deviating from the 50% shade coverage goal must be paid by the property owner. Number of intended tree designed by the landscape architect will be compared with existing number of present trees. The owner is responsible for replacing all removed trees with 15 gallon

sized trees. This tree size is recommended by the Sacramento Tree Foundation for replacement trees of this size result in healthier tree conditions over a longer term period (County of Sacramento Tree and Landscape Policy, May 1992).

5.4 Repercussion from Noncompliance of the Davis Parking Lot Shading Ordinance

If parking lot owners violate the Davis Parking Lot Shading Ordinance of 50% tree shade at year fifteen, fines may be charged against the property owners. Onerous fines will range in various amounts based on the shade percentage deviating from the 50% shade coverage.

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