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Effectiveness of San Jose's Solar Access Guidelines : a policy evaluation

Sharada Thattey
San Jose State University

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**EFFECTIVENESS OF SAN JOSE'S SOLAR ACCESS GUIDELINES:
A POLICY EVALUATION**

A Thesis

Presented to

The Faculty of the Department of Environmental Studies

San Jose State University

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

by

Sharada Thattey

December 2001

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APPROVED FOR THE DEPARTMENT OF ENVIRONMENTAL STUDIES

Dr. Lester Rowntree

Mr. Darren Bouton

Dr. Karina Garbesi, California State University, Hayward

APPROVED FOR THE UNIVERSITY

ABSTRACT

EFFECTIVENESS OF SAN JOSE'S SOLAR ACCESS GUIDELINES: A POLICY EVALUATION

By Sharada Thattey

The Solar Access Guidelines were developed to help reduce energy use of San Jose's residents. The objective of this study was to evaluate the implementation of Solar Access Guidelines. A secondary objective was to determine if the guidelines are consistent with best solar design practices for residential development.

This study found that Solar Access Guidelines have not been implemented effectively, and therefore have not encouraged the use of passive solar design to help reduce energy use in San Jose. A major barrier to implementation is the voluntary nature of compliance. Also, lapses were found in the guidelines, particularly, the focus on low density housing, and omission of several solar design features. This study recommends updating the guidelines to include important solar design features like providing thermal mass, and also recommends addressing high-density residential housing. It makes recommendations about improving voluntary compliance, and also provides creative solutions that can be adopted to achieve enhanced compliance.

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I. INTRODUCTION

MOTIVATION

Energy production and use is among the most environmentally destructive of human activities. It is a primary cause of air pollution, acid rain, and climate change, and a major cause of soil and water pollution. The United States, like the rest of the world, relies heavily on fossil fuels for energy. In 1998, fossil fuels (namely coal, crude oil, and natural gas), together with natural gas plant liquids (ethane, propane, butane, and others), accounted for over 80% of the total US energy production (Energy Information Administration, April 28, 1999). Worldwide, in the same year, petroleum accounted for 39.8% of world primary energy production, followed by coal and natural gas, accounting for 23.2% and 22.4% respectively of world primary energy production, thus together accounting for about 85% of world primary energy production (Energy Information Administration, Jan. 24, 2000). Energy consumption, specifically fossil fuel combustion, is the major source of U.S. carbon emissions (Energy Information Administration, April 28, 1999). In 1996, carbon dioxide emissions constituted 83% of the total US greenhouse gas emissions (Energy Information Administration, April 28, 1999). From a global perspective, in the same year, the United States produced about 24% of the worldwide energy-related carbon emissions (Energy Information Administration, 1998).

Worldwide, buildings currently account for about a third of global primary energy use (Energy Information Administration, April 28, 1999). In the United States, energy use in buildings accounts for 35% of the total primary energy consumption, 42% of the total energy costs, and produces 35% of all US carbon emissions (Kreith and West, 1997,

pp. 7). Space heating and cooling account for the majority of energy use in the residential sector. Space conditioning, which includes heating, cooling, and ventilation, is the most energy intensive use in the sector and it accounts for most of the direct use of fossil fuels (Energy Information Administration, April 28, 1999). In the United States in 1997, average energy consumption per housing unit was 101 million Btu, out of which an average of 51 million Btu -- about 51% -- was consumed for space heating (Energy Information Administration, Jan. 23, 2001). To summarize, energy production in the US is primarily driven by combustion of fossil fuels, which is responsible for negative environmental effects. Since space conditioning accounts for a large percentage of residential energy use, reducing energy use for space conditioning would help reduce fossil fuel use; thereby helping to reduce carbon emissions and to alleviate related environmental problems.

There is a great potential to reduce energy use in residential buildings by applying energy efficient strategies and passive solar features. Passive solar design uses renewable solar energy and helps displace fossil fuel energy use, specifically natural gas for heating and cooling, and electricity for daylighting. It also reduces the threat from volatility of fossil fuel prices and the risk of energy crisis situations like in the 1970s and the recent California energy crisis. Passive solar design essentially uses the building structure to capture sunlight and store and distribute heat, or to obstruct sunlight and avoid unwanted heat. It can significantly reduce energy used for residential heating, cooling and daylighting. It employs simple strategies like providing solar orientation, south-facing glazing, natural ventilation, overhead shading and appropriate landscaping. Incorporating

these simple strategies can reduce a typical home's heating and cooling costs by 15-25%, while adding thermal mass in walls or floor and further expanding south-facing glazing could result in overall energy savings of 30-70% (Brower, 1994, pp. 45).

Passive solar design is a low technology alternative that requires low investment if incorporated in the early phase of design, and has a short payback time. Soon after the energy crisis of 1973, the American Institute of Architects estimated that passive solar design would add little to the cost of buildings, yet save half of their energy costs (Holzman, 1984). According to Edward Dean, author of the California Energy Commission publication Energy Principles in Architectural Design, passive solar design is recognized "as the most effective technique to produce building designs that demand a minimum of non-renewable energy for the least additional cost (1981, pp. 38)." Ideally, design of homes should be approached with a "whole building" perspective, where buildings are viewed as integrated systems, rather than a series of independent components (Energy Efficiency And Renewable Energy Network, 2000). For example, it would be prudent to incorporate energy efficiency and passive solar strategies in the preliminary design stage, and follow them through in the planning and construction stages. This would lead to an energy efficient building design, and energy costs of the completed building would be greatly reduced at a negligible additional cost of construction. In contrast, passive solar design is often not achievable as a retrofit, and if attempted, the retrofit costs could be significantly higher. The cost of employing passive solar design is negligible if incorporated at the design stage because it involves appropriately distributing elements that are commonly incorporated in buildings.

In CRC Handbook of Energy Efficiency, Jeffery H. Morehouse clarifies the difference between a passive solar system and energy conservation. Energy conservation measures are designed to reduce the energy required for space conditioning of a building regardless of the source of energy. Conversely, passive solar features are designed to reduce non-renewable conventional (fossil fuel) energy use and increase the use of renewable (solar) energy for heating and daylight. They also use the ambient “coolth” for cooling -- Morehouse explains that passive cooling systems use natural energy flows to transfer heat to environmental sinks, specifically, ground, air and sky.

A fundamental concept of passive solar heating is “solar access,” the unobstructed availability of solar radiation. Without available incident solar radiation, or solar access, it is impossible to apply principles of passive solar heating. Passive solar systems use natural means to capture sunlight, absorb and store heat, and to transfer heat back to the building interior. Solar heating is a process whereby sunlight enters a building through glazing, is absorbed by solid surfaces and re-radiated as infrared radiation (IR) that is absorbed by the indoor air, thus heating it. In passive systems, transfer of heat is achieved by natural means. Surface of the thermal mass absorbs heat either directly from incident sunlight, or from IR radiation losses from the air mass (if the air is hotter than the thermal mass), and then conducts it into the cooler interior of the thermal mass. Thus on a typical winter evening, when indoor air temperature is lower than that of the thermal mass, heat absorbed during the day is lost from the thermal mass to the air. In this reverse process, heat is conducted from the interior of thermal mass to the surface of

BACKGROUND

In 1989 and 1990, San Jose, along with San Francisco, California, and Portland, Oregon, undertook the Sustainable City Project initiated by the Energy Task Force of the Urban Consortium for Technology Initiatives. The Urban Consortium is composed of over forty of the largest US cities and counties (measured by population). According to consortium member City of San Jose, it provides a “unique forum to define urban problems” and “to develop, apply, transfer and commercialize technologies and innovative management techniques to address those problems (City of San Jose, 1991, inside front cover).” In that context, the Urban Consortium Energy Task Force (UCETF) defines programs to meet the following objectives:

- i. definition of critical urban energy problems,
- ii. development of technologies and management solutions to resolve problems,
- iii. transfer of resulting solutions to UCETF and to other local governments.

The aim of the tri-city Sustainable City Project was to develop and implement sustainable energy planning methods and programs for the cities. The three cities coordinated their efforts via bi-weekly teleconferences and project meetings, and followed similar planning processes, however, each city developed different sets of policies and implementation strategies (City of San Jose, 1991, pp. 1-3).

San Jose, whose activities are the focus of this study “sought to develop an integrated energy management plan that promotes energy efficiency, economic development and environmental protection (City of San Jose, 1991, pp. 43).” San Jose’s Energy Management Program documented and assessed current and projected energy use

trends and energy conservation potential across all economic sectors. This research led to the development and adoption of a long-term energy policy based on principles of sustainable development. San Jose City Council adopted the Sustainable City Strategy in September 1989, to promote a sustainable future by reducing by 10% of the projected energy use in all sectors by the year 2000. The purpose of the strategy was “to enhance the livability, economic strength and well-being of the city’s residents and businesses and reduce environmental problems, particularly emissions that contribute to global warming (City of San Jose, 1991, pp. 50).” According to Mary Tucker, Supervising Environmental Services Specialist, Environmental Services Department, City of San Jose, the city has achieved this goal and probably even exceeded it in city facilities. Further, she said energy consumption in city facilities in the year 2001 was approximately 10% lower than in 1999 (personal communication with Mary Tucker). Data on energy use in city facilities is not available for public review.

As part of the Sustainable City Strategy, City of San Jose developed the Solar Access Guidelines. They were incorporated in the October 1992 update to the City’s Residential Design Guidelines, and in February 1997 were formally adopted by the City Council. The Solar Access Guidelines are intended to encourage use of solar access as an element of project design in new residential development. They define providing solar access as “the planning of a site layout to maximize the unobstructed availability of direct sunlight into a residential unit during the winter months and to minimize it during the summer months (City of San Jose, 1999, pp. 71-74).” They acknowledge that “proper solar orientation of attached and detached residential buildings during the design phase

can significantly reduce building energy use for space heating (in winter) and cooling (in summer) without any other changes to the building design at a negligible cost (City of San Jose, 1999, pp. 71-74).” They also recognize specific benefits associated with proper solar orientation such as low building heating and cooling energy demands and costs; preservation of future options for the use of solar energy technologies; and various environmental benefits like reduced air pollution, enhanced natural daylighting, and promotion of the conservation ethic.

PROBLEM STATEMENT

The City of San Jose’s *Residential Design Guidelines: Toward Community* specifies that although measures recommended by the Solar Access Guidelines are desirable, they are not required. Consequently, while the Solar Access Guidelines are intended to “encourage” solar access and solar orientation, compliance with the guidelines is voluntary. Therefore there is justifiable question whether implementation of the Solar Access Guidelines has been effective.

The central research question is to assess if the Solar Access Guidelines have encouraged a change in planning and design of new residential developments and individual residential units. The specific goal is to determine whether they have been effectively implemented since their adoption in 1997; and if not, to explore the reasons why not. A secondary goal is to determine if the Solar Access Guidelines are consistent with best practices recommended in literature for passive solar site and building design, and for protection of solar access.

To successfully address the central research question, the following research questions were investigated:

- ◆ What is the institutional framework supporting the Solar Access Guidelines?
- ◆ What design measures do the Solar Access Guidelines Recommend?
- ◆ What are the best practices recommended in literature for residential passive solar design?
- ◆ Are measures outlined in the Solar Access Guidelines consistent with best practices recommended in literature for residential passive solar design?
- ◆ How are Solar Access Guidelines implemented?
- ◆ How are Solar Access Guidelines addressed in the standard approval process for residential development?
- ◆ Are the builders and developers changing their building and site design strategies according to the Solar Access Guidelines?
- ◆ How could the guidelines and their implementation be improved?

The specific research objectives and the methods used to achieve them are described in Chapter III, Research Design.

II. CALIFORNIA SOLAR PROGRAMS AND LAWS

INTRODUCTION

According to Schepp and Hastie (1985, pp. 6), the most important result of the energy crisis of the seventies “was that solar energy was taken a bit more seriously as a potential energy source.” The United States made significant efforts for the first time, directed toward the practical use of the sun for building heating and cooling. Kreider and Kreith (1982) note that the “first federal funding of solar research . . . amounted to \$ 1.7 million in fiscal year 1972,” and that “[b]y 1975 the figure was \$ 50 million; by 1980 it was more than \$ 100 million.” Further, Kreider and Kreith add that the increased federal solar research budget “provided the impetus required to move solar energy . . . to the first level of practical, widespread use.”

During that time the US Congress passed two pieces of solar legislation, the Solar Heating and Cooling Demonstration Act and the Solar Energy Research, Development and Demonstration Act, which formed the basis for the national solar program (Schepp and Hastie, 1985, pp. 6). The demonstration programs helped inform the public about solar energy’s potential as a practical resource for home energy use. Several cities and counties also passed solar ordinances in the 1970s, e.g., to protect solar easements and require solar water and pool heating. The federal government encouraged the purchase of solar energy systems by offering tax credits that reduced costs to the buyer (Hoyt et al, 1998). Unfortunately, in the mid 1980s with fossil fuel energy prices falling, the solar tax credit programs were terminated, thereby making solar energy systems less attractive to

the investors. Many of California's solar ordinances were subsequently repealed (Hoyt et al, 1998).

LOCAL SOLAR PROGRAMS

Several issues have rekindled interest in solar energy, such as the inability of cities to achieve compliance with state and federal air pollution regulations, increasing concerns over greenhouse emissions, and most recently, California's energy crisis where natural gas prices have tripled, and electricity prices threaten to rise. Energy Conservation Under The Sun: A Resource Book For Local Governments was produced by the Local Government Commission -- a consortium of Bay Area local governments -- in Fall 1998. It is meant to provide local elected officials and staff with, among other things, an overview of current state solar energy laws, a summary of local solar ordinances and programs, and a catalogue of actions that local governments can undertake to promote solar energy use. The following information on solar ordinances in local governments was gathered from the Resource Book.

San Jose is one of very few California cities and counties that retain a solar energy policy or ordinance -- as mentioned earlier, many of California's solar ordinances were repealed in the 1980s. The City of Claremont requires solar water heating devices on new residential and commercial buildings. Claremont also encourages designs that integrate passive heating and cooling strategies. In recent years, however, City approval of exemptions from solar water heating requirement has increased steadily. The town of Los Gatos promotes the use of solar and other renewable energy resources in new and

existing residential and commercial developments. The town of Los Gatos requires pre-plumbing for solar water heating in all new construction. Protection of solar access for existing buildings is also a pre-condition of approval in all new developments. The town's design review committee encourages applicants to maximize southern solar exposure. Los Gatos as well as the City of Del Mar require solar heating devices as the primary means of heating new swimming pools. The City of San Bernardino, San Luis Obispo County, Santa Barbara County, Shasta County, the Town of Los Gatos, and Southern California Association of Governments, all include aspects of solar energy use or solar access and design to some extent in the energy element of their respective general plans.

The City of San Jose appears to be the only California city that has instituted passive solar design -- through the Solar Access Guidelines. In August 1991, San Jose co-authored the Sustainable City Project, a publication that contains information about the tri-city collaboration for developing and implementing sustainable urban energy practices. The Sustainable City Energy Strategy emerged as a result of the Sustainable City Project, and the Solar Access Guidelines were developed as a part of this strategy to help reduce energy use of San Jose residents. As a supporting document to the Solar Access Guidelines first proposed in 1992, and adopted by City Council in 1997, the city also commissioned the preparation of the Solar Access Design Manual in June 1993. This manual was intended to help project developers obtain additional information and suggestions regarding ways to achieve reduction in home energy use. It is meant to provide practical design tips, detailed strategies, and examples for solar site and building

design, and landscaping. The city's Department of Planning, Building and Code Enforcement prepared the final draft of the current Residential Design Guidelines, Toward Community, in April 1999. Chapter 14 of the city's Residential Design Guidelines is titled Solar Access, and it evolved from the Solar Access Guidelines first proposed in 1992.

In addition to Solar Access Guidelines, San Jose has been working towards establishing a Green Building Program. The program encourages and facilitates the development of green building principles; provided educational resources; and promotes practical application of green building principles to minimize the impact of the building on the environment. In June 2001, the San Jose City Council accepted the report on Green Building Guideline Recommendations and adopted the Green Building Policies (City of San Jose, September 2001). Currently the Green Building Policy applies only to City facilities, but the City is taking steps to encourage it in the private sector as well. The Green Building Policy Recommendations include measures to reduce energy use in buildings. San Jose's Green Building Policy goals with respect to energy and atmosphere are as follows (City of San Jose, September 2001).

- 1) **Minimum Energy Performance:** establish the minimum level of energy efficiency for the base building systems,
- 2) **Optimize Energy Performance:** achieve increasing levels of energy performance above the minimum standard to reduce environmental impacts associated with excessive energy use,

- 3) **Building Commissioning:** verify and ensure that the entire building is designed constructed and calibrated to operate as intended,
- 4) **Measurement and Verification:** provide for the ongoing accountability and optimization of building energy and water consumption performance over time,
- 5) **Renewable Energy:** encourage and recognize increasing levels of self-supply through renewable technologies to reduce environmental impacts associated with fossil fuel energy use,
- 6) **Green Power:** encourage the development and use of grid-source renewable energy technologies on a net zero pollution basis, and
- 7) **Reduce Ozone Depletion:** support early compliance with the Montreal Protocol by eliminating the use of CFC-based refrigerants and reducing the use of HCFCs and Halons.

The Solar Access Guidelines encourage use of renewable energy to reduce dependence on fossil fuels for energy requirements, and as such could be eventually covered under the broader umbrella of Green Building Policy. The guidelines offer a low technology alternative that does not require either expensive equipment, or high material costs, or highly qualified consultants, all of which may potentially drive the cost of incorporating renewable energy technologies for residential use. They can be easily incorporated in the planning stages without increasing the cost of construction of a project.

Another energy related program that San Jose is currently implementing is the Cool Roofs Incentive Program (City of San Jose, August 2001). The program's purpose

is to reduce peak energy loads in San Jose by encouraging commercial and multi-family building owners to install highly reflective and highly emissive roof surfaces (City of San Jose, August 2001). By reflecting solar radiation, cool roofs can reduce heating loads on buildings, thus reducing cooling energy costs by 20% or more. If a building qualifies for this program the building owner or property manager receives an incentive of 20 cents per square foot of roof work and an additional 10 cents per square foot of ductwork after the roof work is complete (City Of San Jose, August 2001). Today, with the energy crisis in California, this program can help reduce the need for rolling blackouts, since peak energy loads correspond primarily with sunny and hot afternoons.

In addition, Mary Tucker informed the author that on August 6, 2001, Environmental Services Department presented a report to the Economic Development and Environment Committee of the City Council proposing an ordinance to suspend collection of taxes associated with the installation of solar energy technologies. The Committee accepted the report and intends to present it to the full Council for further action. The Building Division will provide an authorization form to be signed by the property owner recognizing the waiver of tax fees for any application for solar technology installation that is filed with the Building Division.

LEGAL FRAMEWORK FOR SOLAR SYSTEMS IN CALIFORNIA

In addition to information on solar ordinances in local governments, Energy Conservation Under The Sun: A Resource Book For Local Governments provides information about Solar Legislation in the State of California. When the oil embargo of

the 1970s brought energy problems into focus, the State of California passed two bills addressing solar energy – The Solar Rights Act of 1978 and the Solar Shade Control Act of 1979. The Solar Rights Act requires subdivision maps to provide, to the extent feasible, for passive or natural heating/cooling opportunities, including proper solar orientation. The Act also authorizes local governments to require the dedication of solar easements – defined as “the right of receiving sunlight across real property of another for any solar energy system” – as a condition of subdivision approval. The Act precludes local governments and homeowner associations from enacting ordinances that prohibit solar energy systems. The Solar Shade Control Act prohibits any tree or shrub occurring subsequent to the installation of a solar system on another property from casting a shadow greater than 10% of the solar collector area on the collector surface between the hours of 10 a.m. and 2 p.m. local standard time. These two acts establish the legal framework supporting solar energy systems in California.

In addition, California’s Energy Efficiency Standards for residential and non-residential buildings -- California Title 24, part 6 – were established in 1978 in response to a state mandate to reduce California’s energy demand. It indirectly supports passive solar design in the context of energy conservation, since good insulation and weatherization help retain solar heat in winter and help keep it out in summer. Passive solar design and energy conservation are mutually inclusive – passive solar design reduces conventional energy consumption thus conserving energy, and energy conservation measures facilitate space conditioning with passive solar design.

III. RESEARCH DESIGN

This chapter describes the main objectives as well as the methods used to achieve them. The combination of methods involve review of literature and public documents, a structured comparison between Solar Access Guidelines and best practices detailed in literature, a project sample review, and interviews with city officials and with developers.

OBJECTIVE 1: Determine the consistency of Solar Access Guidelines with best practices recommended in literature for residential passive solar design.

To achieve this objective, it was necessary to determine the recommendations and goals of the Solar Access Guidelines, and the recommended best practices detailed in literature. There is vast literature available on passive solar design and solar heating and cooling. Primary literature on solar energy addresses a wide range of topics such as types of passive systems, solar radiation calculations, solar collectors, heat transfer, thermal energy storage, solar water heating, passive solar space heating systems, and solar cooling. Some books also have information about solar energy economics, solar legislative terms, financial incentives, and loan and grant programs. In addition, almost all the literature contains information and tools relevant to design of solar systems such as sun-path diagrams, hourly clear sky solar radiation, monthly insolation maps, monthly average solar and climatic data for locations in the contiguous United States, solar angles, and heating and cooling degree day charts. Theoretical books on solar systems design provide details about thermal properties of materials, physical properties of materials, system sizing methods, and heating and cooling load calculations.

Good examples of literature on solar design theory are Solar Design Components, Systems, Economics by Jan Kreider, Charles Hoogendoorn, and Frank Kreith; Solar Heating and Cooling, Active and Passive Systems by Jan Kreider and Frank Kreith; and CRC Handbook of Energy Efficiency edited by Frank Kreith and Ronald West. The Passive Solar Handbook prepared by the California Energy Commission in 1980 was designed for building professionals. In addition to general information on passive solar design, it contains performance charts and architectural details for different components of passive solar systems. The Energy Design Handbook edited by Donald Watson, prepared by the American Institute of Architects, discusses topics such as site analysis, thermal envelope, passive heating and cooling concepts, shading, fenestration, daylighting, HVAC (heating, ventilation, and cooling) systems, etc. to aid architects in designing of energy efficient buildings. A good resource for site design strategies for solar access is Planning Solar Neighborhoods, a California Energy Commission publication authored by Jonathan Hammond. Another resource for the same is Site Planning for Solar Access, A Guidebook for Residential Developers and Site Planners, published in 1979 by the American Planning Association, authored by Duncan Erley and Martin Jaffe.

Jeffery Morehouse in CRC Handbook of Energy Efficiency provides an excellent summary of methods to estimate the performance of solar buildings, including tabulated estimates of energy savings in buildings with different solar design features in different climate zones. Modeled estimates are given for 219 US and Canadian locations. Modeled system types include direct gain, vented and unvented trombe walls, water

walls, and sunspace systems. Design variations include thermal storage capacity, amount of glazing, mass-area to glazing-area ratio, and the load to collector ratio (or in other words, the ratio for space conditioning load to south-facing glazing area). Morehouse (1997) summarizes the estimates for six cities in his chapter in CRC Handbook; the complete results are contained in PSDH (1984).

Casual literature, like manuals on building your own solar home, is also widely available, as is literature on planning strategies for providing solar access and orientation. Residential Energy by John Krigger, sponsored by the United States Department of Energy Weatherization Assistance Program and by Existing Building Efficiency Research Program, was written for the interested homeowner and uses graphics to explain some of the concepts and to make them interesting to the average reader. The Passive Solar Energy Book by Edward Mazria is another example and also contains several illustrations.

METHODS: Comparative analysis

The Solar Access Guideline recommendations and goals were summarized and studied to examine which aspects of passive solar design they address. Other documents authored or commissioned by the City of San Jose were reviewed to learn about the evolution of Solar Access Guidelines and their eventual adoption by City Council. This provided an overview of the guidelines in the institutional context, which is described in the Background section of this thesis. Literature on passive solar design was reviewed to

determine best practices recommended for use of passive solar design in building and site development.

The best practices detailed in literature were compared to the Solar Access Guideline recommendations. Based on the structured comparison, an attempt was made to identify omissions and inconsistencies in Guideline recommendations if any. A matrix was formulated to provide a quick overview of the comparison (see Table 1).

OBJECTIVE 2: Evaluate the Implementation of Solar Access Guidelines.

To achieve this objective, it was necessary to determine the implementation process for the Guidelines and to understand when and how the Guidelines are addressed in the standard approval process of residential projects in San Jose. The criteria for successful implementation were based on the knowledge of the target audience, i.e. the developers, about the Solar Access Guidelines, and on whether they were encouraged by the city staff to apply Solar Access Guidelines in their proposed projects.

METHODS: To study implementation process

The main method employed was interviews with staff members of the city's Planning Department and Environmental Services Department. The Planning Department is responsible for the approval of residential proposed residential projects, and therefore for the implementation of the Solar Access Guidelines. The Environmental Services Department was responsible for developing and writing the initial text of the proposed Solar Access Guidelines, and lobbying for their adoption by the City Council.

Members of staff representing the Planning department were interviewed to explore how the Guidelines have been implemented so far, particularly, how are they addressed in the city's planning and review process for new residential development. Two senior planners from the Planning Department, Mike Enderby and Susan Walsh, were interviewed to understand the process of filing and approval for residential projects. Mike Enderby, Senior Planner, Department of Planning, Building and Code Enforcement, was asked the following questions related to Solar Access Guidelines:

- i. Were developers informed about the Solar Access Guidelines when they were proposed in 1992, and after they were adopted in 1997? How?
- ii. Are all planners aware of the Solar Access Guidelines?
- iii. How are the Solar Access Guidelines implemented? What methods do planners use to assess a site for application of the guidelines?
- iv. Could you describe a residential project suitable for implementation of the Solar Access Guidelines? How often have you come across such a site?
- v. Have you recommended measures outlined in the Solar Access Guidelines to developers during meetings for reviewing proposed projects for approval?
- vi. Would it be possible to make Solar Access Guidelines mandatory?
- vii. How do you address other residential design guidelines compared to the Solar Access Guidelines?
- viii. Are there any other guidelines implemented for energy conservation?
- ix. Could you describe the recent proposed projects in San Jose?

The author was directed to another planner Susan Walsh, also a Senior Planner with the Department of Planning, Building and Code Enforcement, for issues relating to the filing and approval process for new residential projects. The objective of this interview was to understand the different stages in the approval process and determine how many contacts the developer typically has with the Planning Department before the project is approved. In addition to questions relating to the approval process, she was also asked questions about implementation of Solar Access Guidelines:

- i. Are copies of the Residential Design Guidelines, which include the Solar Access Guidelines, regularly distributed to developers?
- ii. At what stage, typically, do the developers first interact with the planning department for approval of a proposed project?
- iii. How long does it take for a proposed project to be approved?
- iv. What drawings are submitted when the project application is filed?
- v. What critical design aspects are considered when reviewing a project?
- x. How do you analyze projects to assess for application of Solar Access Guidelines?
- vi. Have you recommended measures outlined in the Solar Access Guidelines to developers during meetings for reviewing proposed projects for approval?
- vii. Is the Environmental Services Department involved in review of Planned Development residential projects?

Staff members representing the Environmental Services Department (ESD) were contacted to determine the department's role, if any, in implementation of Solar Access

Guidelines. Mary Tucker, Supervising Environmental Services Specialist, was instrumental in the development and preparation of the initial text of the Guidelines. She was interviewed for background information on the Guidelines and for information regarding current implementation. She recommended talking to Everett Wilson, Associate Environmental Specialist, ESD, who works at the City's Wastewater Treatment Plant. He used to oversee the environmental review process for Planned Development projects, and was asked questions regarding the role of ESD in implementation of the Solar Access Guidelines. Melody Tovar, Sanitary Engineer, ESD, also works at the Wastewater Treatment Plant. She took over the task of supervising the environmental review process from Everett Wilson. She was also interviewed and provided information regarding the review process.

METHODS: To determine effectiveness of implementation

To determine if implementation of Solar Access Guidelines was effective, the main research method employed was interviews with developers responsible for large residential projects on file for approval with the City of San Jose. Review of residential projects was limited to those with twenty-five or more single-family housing units. This choice was made because large developments typically allow developers more freedom with site layouts, and provide better opportunity to meet the goals outlined in the Solar Access Guidelines. It is difficult to provide solar access and orientation for projects with a smaller number of units, as new developments have to interface with existing ones and options for site layout are limited.

Sample Selection

A list of projects (with more than 25 single-family housing units per development) on file for approval was obtained from the Internet website of the City of San Jose's Planning Department.¹ A list of developers was derived from the project sample and the Planning Department staff supplied contact information for 14 developers that were responsible for those projects. This number was consistent with the number quoted by a planner in response to a query about the number of developers that file for approvals on a regular basis -- about a dozen.

All of the 14 developers identified were contacted to request an interview. Of these 9 responded and were interviewed. The remaining 5 did not respond in spite of several attempts to contact them. Of the 9 who responded, the author interviewed 2 in person, 5 by phone, and 2 mailed back answers on a questionnaire (Appendix 1). The latter were also contacted by phone for clarifications. Each developer was asked the same basic set of questions (Appendix 1). Some developers gave descriptive answers and discussed the issues at length; but others only answered in the affirmative or negative with very short explanations. Among those interviewed, the level of knowledge about and interest in Solar Access Guidelines and passive solar design varied greatly.

¹ Through links titled "Recently Submitted Projects (reviewed list from week of March 12, 2001, to week of July 16, 2001)," and "Pending Projects (last checked Pending Land Use Applications as of July 16, 2001)."

IV. RESULTS

SOLAR ACCESS GUIDELINES

The Solar Access Guidelines, developed as part of the Sustainable City Strategy, acknowledge that proper solar orientation of residential buildings during the design phase can significantly reduce building energy use for space heating and cooling. They address not only solar access and orientation, but also several other aspects of passive solar design. The measures recommended by the Solar Access Guidelines are summarized below. The author has tried to retain original text to convey the recommendations as they are currently worded.

A. Solar Orientation

The Solar Access Guidelines recommend that site plans be designed according to the following criteria:

1. To maximize solar orientation, solar oriented buildings should be designed to have windows facing south,
2. To maximize south facing glazing, the long axis of the building should be oriented east-west, so that the broad face of the building faces south,
3. Wide south facing walls with windows should abut front yards, rear yards or common open spaces to facilitate solar access,
4. To achieve optimal solar orientation for individual buildings, streets should be oriented within 30 degrees of the true east-west axis.

B. Percentage of Solar Oriented Units

The Solar Access Guidelines stipulate a goal for solar oriented units in new residential projects. The percentage goal of solar oriented units varies inversely with project density as follows:

<u>Density range (Dwelling Units/Acre)</u>	<u>Solar Orientation Goal</u>
0 to 10	80% of housing units
10 to 25	65% of housing units
25+	No specific goal

The Solar Access Guidelines also provide exemption criteria to allow adjustments if the following conditions exist that prevent optimum solar orientation for a given project:

1. There is steep natural topography (slopes greater than 20%), and the slope faces a direction greater than 45 degrees east or west of true south,
2. Existing street orientations or grading policies prevent solar orientation of streets,
3. Compliance with Solar Access Guidelines would cause a reduction in housing density otherwise achievable,
4. Physical constraints exist on site, such as creeks, or other natural topographic features, that prevent solar orientation of streets and buildings, and
5. Compliance with Solar Access Guidelines prevents compliance with other residential design guidelines.

C. Solar Access of Existing Homes

The Solar Access Guidelines recommend that new projects should not cause substantial shading of existing adjacent private open spaces that provide solar exposure for the current occupants.

D. Solar Friendly Landscaping

The Solar Access Guidelines recommend use of deciduous street and on-site trees where these trees will grow to shade windows of residential structures, to help reduce temperatures by providing shade in summer, and shed leaves to allow sunlight during cooler months. They recommend including evergreen trees in the landscape where these trees will not have solar impacts on buildings.

E. Parking Area Landscaping

The Solar Access Guidelines recommend that trees be generously planted in landscaped areas around and within parking areas to buffer winds and to reduce heat and glare.

F. Solar Equipment

The Solar Access Guidelines recommend that exterior solar equipment be visibly compatible with the building and not be easily visible from public streets.

G. Solar Access of Adjacent Units

The Solar Access Guidelines recommend that within a project, residential units should not be located in positions that will result in substantial shading of private open spaces of other adjacent residential units in the project.

H. Overhang Design

The Solar Access Guidelines recommend that units should incorporate overhangs designed so that they allow low winter sun to penetrate the unit while blocking the high summer sun.

I. Cooling Load Reduction

The Solar Access Guidelines recommend that cooling loads should be reduced as much as possible, not only by providing appropriate overhangs, but also by landscaping, in addition to orienting the units so that excessive solar penetration is avoided during the hot summer months.

The basic goal of the Solar Access Guidelines appears to be focused on appropriate solar orientation. Guideline A recommends solar orientation for streets, buildings, and glazing. Guideline B details the solar-orientation goal to achieve a minimum percentage of solar-oriented units in planned developments, where the percentage is inversely proportional to density of the development. According to the Solar Access Design Manual (published by the Environmental Services Department in 1993 as a supporting document), as housing density increases, the goal is reduced to account for increased development constraints. A density of 10 units per acre corresponds to a lot size of approximately 4356 square feet, and a density of 25 units per acre corresponds to a lot size of approximately 1742 square feet. Therefore, Guideline B really addresses single-family homes, and provides no specific goal for higher density residential developments.

The other recommendations can be viewed in the context of achieving the solar orientation goal according to Guideline B, and can be grouped as follows:

- Those essential for solar access, namely, Guidelines A-1, A-2, A-3, C, G;
- Those that facilitate access, but not essential, namely, Guidelines A-4, D; and
- Those that facilitate reduction of cooling loads, namely, Guidelines D, H, I,

Guidelines H and I are unrelated to solar design. Guideline H deals with landscaping in parking areas. Guideline F deals with the aesthetic aspect in placement of exterior solar equipment. Guideline F would help to provide better solar access if it relaxed the emphasis on aesthetics and focused instead on appropriate orientation for the equipment. Focus on aesthetic aspect could potentially act as a barrier for achieving solar access and orientation for exterior solar equipment.

COMPARISON BETWEEN BEST PRACTICES AND SOLAR ACCESS GUIDELINES

This section presents a series of design recommendations for passive solar design in residential projects derived from available literature. The author provides justification for each design recommendation, and comments on whether it is addressed in the Solar Access Guidelines, noting omissions or inconsistencies if any. The results of this comparison are also summarized in a matrix (see Table 1).

Solar Access

Important considerations in planning for solar access are the laying out of streets, buildings, landscaping, and open spaces “so that unobstructed solar energy can be

received by existing and future south facing windows, glass doors or solar collectors (Crowley and Zimmerman, pp. 23)”. The availability of local solar radiation to replace conventional energy, and factors affecting energy conservation, should also be considered. To preserve solar access on site, efforts need to be made to minimize the extent of shading by natural or man-made elements. According to Crowley and Zimmerman, in providing for solar access in a development, “[t]he objective is to lay out streets and lots in such a way that as many homes as possible have proper orientation to the sun (pp.24)” and to avoid shading south facing glazing during the winter while providing shade during summer. Solar orientation is essential for solar access. Appropriate solar orientation, along with its benefits, is discussed in detail as a separate design recommendation following this section on solar access.

Site Planning For Solar Access, A Guidebook For Residential Developers and Site Planners co-authored by Duncan Erley and Martin Jaffe, was prepared by the American Planning Association for the U.S. Department of Housing and Urban Development in September 1979. The Guidebook categorizes the levels of solar access as follows: rooftop access, south-wall access, south-lot access, and detached collector access. In the context of this research, south-wall access is the most relevant since the Solar Access Guidelines specifically address south facing walls and glazing. South-wall access is recommended for most developments because “it leaves open the possibility of using either active or passive solar energy systems,” and since “it preserves a variety of solar options for future lot owners (Erley and Jaffe, pp. 32).” Providing rooftop access would also be advantageous in the interest of preserving the option for use of solar

energy technologies in the future, namely, active systems like solar hot water, and photovoltaic systems.

According to Crowley and Zimmerman, the south wall of a home should be protected from shading between 9:00 a.m. and 3:00 p.m. on December 21, when the sun is at its lowest altitude and casts the longest shadows (see Figure 1). If solar access for a site is protected on this date, it is automatically protected for the entire heating season as the sun has higher altitude angles at all other times. In other words, external natural or man-made elements should be short enough to allow sunlight to reach the south-wall on December 21, to allow the south wall to have solar access at all other times of the year.

Source: Sunset Books, 1978.

Source: Prowler, Donald, 1996.

FIGURE 1: Solar Access and Orientation

Guidelines C and G address solar access for existing homes and adjacent units, but they do not make any specific recommendations for the duration of time when the south wall of a unit should get solar access. They do not recommend restricting the height of external elements on the south side to prevent obstruction of sunlight. Therefore they are partially consistent with recommended best practices.

Solar Orientation

“Proper orientation of streets, lots, and homes, is the single most important design strategy in energy conserving solar access planning (Crowley and Zimmerman, pp. 41).” Building orientation usually depends on the lot orientation and lot orientation depends on street orientation, since “most regulations require the exterior walls of a home to be parallel to the lot lines and the lot lines to be perpendicular or radial to the street (Crowley and Zimmerman, pp. 42).” Though not essential to achieve solar orientation for individual units, the preferred orientation for streets is true east-west when planning for solar access because it allows all lots to either face or back up to south.

Crowley and Zimmerman explain that in the northern latitudes 32° to 56° , the south-facing wall receives three times more radiation in winter than sides with other orientations (pp. 18). Conversely, during summer, the south-facing wall receives less radiation than any other side except north. Solar intensity on the south wall is lower in the summer, as the sun altitude angles are high and sunlight hits the south wall at an oblique angle, diminishing the intensity of the beam on the wall surface. Accordingly, summer heat gain on a south-facing wall can be controlled easily with appropriate

shading and/or landscaping. Therefore proper orientation for a home is achieved when its long face faces south.

Orientation alone can produce significant energy savings in any US climate. Crowley and Zimmerman (pp. 176) quote studies performed by Victor Olgyay, the Solar Homes Council, Lawrence Berkeley Laboratory (LBL), and Computer Computation Bureau/Cumali Associates (CCB/CA) in reporting orientation recommendations for homes. LBL as well as the CCB/CA conducted computer simulations to test the differences in the effect of orientation of the major glass areas on annual heating and cooling energy consumption. The simulations were conducted with respect to four broad climate regions in the US. The studies show that the respective LBL and CCB/CA reference homes with the major area of glazing facing east or west, consume considerably higher heating and cooling energy than the same home with the major area of glazing facing south. In the same study, when the major glazing area faces north, the reference home consumes yet more total heating and cooling energy. The results of this study are applicable in the Northern Hemisphere. Thus, both sets of analyses show that the orientation of the major area of glazing can significantly affect annual energy consumption for heating and cooling.

Guidelines A and B, related to orientation, are most consistent with best practices recommended in literature than any other guidelines. However, they do not make recommendations about minimizing glass expanses on east and west sides of the building to help prevent excessive heat gain in summer, and on the north side to help reduce heat loss in the winter.

Thermal Mass

Most recommendations made by the Solar Access Guidelines relate to Direct Gain systems, which use solar radiation to heat the living space directly. “A requirement for direct gain passive systems that are to provide more than approximately one-third of the heat load is the use of thermal storage. If thermal storage is sized and located properly, daytime overheating during periods of reduced heating loads can be avoided and solar heat can be stored for later use during darkness or overcast periods (Kreider et al, 1989, pp. 153).” Thermal mass in floor and walls can be used to collect and store solar energy entering a building through south-facing glass (see Figure 2). Richard Montgomery explains in The Solar Decision Book of Homes why glass is extensively used as a component of solar collector systems. Glass transmits solar radiation, (short-wave radiation) extremely well, but transmits thermal radiation (long wave radiation) very poorly. Solar radiation passes readily through glass into the interior, hits a solid surface and heats it. When the heated surface emits long-wave thermal radiation back to the air mass, it cannot easily escape outdoors through the glass.

Materials commonly used for heat storage in walls and floor are masonry and water. Masonry includes concrete, brick, stone, and adobe (Mazria, 1979, pp. 29). If water storage is used, it is usually contained in concrete, plastic or metal containers. Thermal storage materials are usually dense and have the property to retain heat and release it after an interval of time (Mazria, 1979, pp. 265).

Drawing 33: Thermal mass for heat storage

Source: Sunset Books, September 1978.

FIGURE 2: Thermal mass

In hot climates thermal mass can be used to keep a building cool during the day. Thermal mass provided in external walls absorbs solar energy and keeps the heat from reaching the interior of the building until the evening when temperatures are cooler. In cooler climates, thermal mass absorbs and stores solar radiation during the day and releases it at night when heating loads are higher. Also solar radiation entering the living space through large south-facing windows could potentially cause overheating during the day, but thermal mass mitigates that effect by absorbing and storing excess heat that can be released at night when temperatures are cooler. Thus, thermal mass acts as a buffer against large indoor temperature swings. By regulating indoor temperature, thermal mass reduces cooling loads as well as heating loads for residence interiors and thereby reduces the need for use of fossil fuels to control indoor temperatures.

Sizing of thermal mass is a critical factor. Correct size for thermal mass should depend upon the space heating requirements for a given space, in addition to local climate and latitude. Watson (1993) recommends a minimum area for thermal mass three times that of south-facing glazing, assuming concrete as the storage material with a minimum thickness of 4 inches. Kreider et al (1989) recommend 60–85 L of water per square meter of glazing area as storage material, and further recommend a glazing area about a third of the floor area.

Thermal mass can also be used in the Indirect Gain approach, Attached Greenhouse approach, and the Isolated Gain approach (Mazria, 1979). With the indirect gain approach, the interior living space is heated indirectly -- sunlight passing through glazing first strikes the thermal mass which absorbs it and converts it to thermal energy, and then transfers it to the living space. This approach requires the thermal mass to be located 4 inches or more directly behind south facing glazing. The air mass between the glazing and the thermal mass is heated by sunlight and is circulated through vents in the mass wall to the interior of the building. An attached greenhouse, which combines the direct gain and indirect gain approaches, is constructed on the south side of a building with a mass wall separating the greenhouse from the building. With the isolated gain approach solar collection and thermal storage are isolated from the living spaces and function independently of the building. The Solar Access Guidelines do not address thermal mass in any way, greatly limiting the energy saving potential for houses with solar access. Of the passive solar approaches mentioned above, the direct gain approach

could be easily and practically incorporated to make recommendations for providing thermal mass in residential buildings.

According to Morehouse (extracted from PSDH, 1994) for Santa Maria, California, by doubling the thermal storage capacity from 30 to 60 Btu/°F per square foot of south-facing glazing in a direct gain solar house, energy savings are increased by about 15% if windows are not insulated at night and by about 10% if they are.² For example, doubling the thermal storage capacity resulted in an increase in energy savings from 75% to 90% (an increase of 15%) in one case, and from 45% to 61% (an increase of 16%) in another case. It should be noted that even the lower thermal storage capacity of 30 Btu/°F per square foot of south-facing glazing represents an effort to use thermal storage resulting in significant energy savings, and this value is far more than what is provided in a typical (non-solar) residential building. Therefore the energy savings referenced by Morehouse actually underestimate the benefits of providing thermal mass in residential buildings in San Jose. Also as mentioned earlier, including thermal mass with other passive solar strategies can result in typical overall energy savings of 30% to 70%.

Landscaping

Landscaping is a component of site design that assists passive solar design. Trees and other vegetation can reduce cooling needs in summer by providing shade, and reduce heating needs in winter by acting as windbreaks (Erley and Jaffe, pp. 91). These

² Well-insulated windows help retain heat indoors, hence energy savings are lower if windows are insulated at night.

reductions in energy use help in providing the competitive edge for a passive solar system with respect to conventional heating systems. It is more difficult to plan for vegetation than for buildings to protect solar access since shading characteristics differ with species, season, and year. The attributes of a tree that have an important effect on the extent to which they cast shadows thus providing shade are, height at maturity, spread of the canopy, the growth rate, duration of the leaf season for deciduous trees, and density of the twigs and branches during winter.

Generally, deciduous trees are recommended to provide shade for south facing walls and windows. They provide shade in summer during their leaf season thus helping to avoid over-heating; and shed their leaves in winter thus aiding solar access by allowing solar radiation to reach indoors (see Figure 3).

Source: Sunset Books, September 1978.

FIGURE 3: Landscaping

In cold climates even deciduous trees may be undesirable on the south side, as they would limit solar access in winter depending on the density of their branches. In

San Jose, care should be taken while planting to ensure that solar access is maintained for future roof mounted solar systems. Vine-covered trellises can also be effective for shading south walls and windows. Evergreens are recommended on the north side to buffer the building from cold north winds in the winter (see Figure 3). When solar friendly trees are incorporated in a new residential development for shading, other devices need to be provided for shading till the time the tree reaches maturity and can perform the function satisfactorily.

Guidelines D and E address landscaping, but they do not specifically recommend locating deciduous trees on the south side to provide shade for south-facing glazing and walls, or locating evergreen trees on north side to buffer cold north winds. They do not address strategic placement of different landscaping elements to aid passive heating and cooling.

Shading devices

Literature provides information on shading south facing walls and glazing to avoid excessive heat gain in the summer months, including sizing details for external overhangs. Among the various methods used to shade south facing walls and glazing are eaves overhangs; shutters; internal devices like blinds, roller shades and drapes; tinted windows; external reflective surfaces to monitor solar radiation; etc. (see Figures 4,5,6).

According to Edward Mazria, the most effective way for shading south facing glass in summer is with an overhang, which is simply a solid horizontal or near-horizontal projection located above an exterior window. A fixed overhang will provide

the same shading on September 21 and on March 21 as the sun follows the same path across the sky on these two days, but the weather is warm in September and cool in March. Hence adjustable overhangs may potentially be a better solution as they can be regulated seasonally. Overhangs do not work well on east and west facing glazing due to the low angle of the sun in mornings and evenings, which could cause overheating in summer. Adjustable vertical louvers and awnings are more effective methods to block intense solar radiation in summer, from east in mornings and from west in late afternoons and evenings. Internal shading devices like blinds and drapes are easy to operate and maintain, but not as effective. Landscaping with tall hedges, deciduous vine covered trellises, and trees can also provide adequate protection from the sun on east and west faces.

Drawing 26: Fixed overhang shading

Drawing 30: Movable shading: vines

Source: Sunset Books, September 1978.

FIGURE 4: Shading Devices

Source: Niles and Haggard, January 1980.

FIGURE 5: Flexible overhang

Drawing 28: Movable shading: hinged overhang

Drawing 29: Movable shading: blinds

Source: Sunset Books, September 1978.

FIGURE 6: Adjustable shading devices

Guideline H recommends providing eaves overhangs. Literature provides extensive data on sizing of overhangs based on window height, latitude, and climate. The Solar Access Guidelines do not utilize such data to make specific recommendations about

sizing of overhangs. The guidelines do not address any shading devices other than eaves overhangs.

Building Shape and Location of Indoor Spaces

The optimum shape of a building is one that loses a minimum amount of heat in the winter and gains a minimum amount of heat in the summer (Mazria, 1979). A building elongated along the east-west axis exposes the longer south side of the building to maximum heat gain as required in winter, while exposing only the shorter east and west sides to maximum heat gain in summer when the heat gain is not wanted (see Figure 7). The width of a building is also an important consideration. To ensure that sunlight entering a building through south facing glazing will penetrate the entire space, the depth of spaces along the south wall should not exceed 2.5 times the height of windows from the floor (Kreith et al, 1989, pp. 155). Therefore, for an average window height of 7 feet, the maximum depth of the room should be 14 to 18 feet. This also provides for adequate daylighting of interior spaces.

Rooms of a house that have a high heating requirement, like living and working spaces, should be placed on the south, south-east, and south-west faces of the building. The north side of the building can house spaces with low heating and lighting requirements like closets, corridors, laundry rooms, garages, etc. These spaces can act as buffers between the south facing sunlit heated spaces and the cooler north side (see Figure 7) if they are sealed off with insulated weather-stripped doors. Thus if major living

spaces are placed along the south face, and buffer spaces are placed along the north face, the depth of a building will be about 25 to 30 feet, and suitable for passive solar design.

Source: Sunset Books, September 1978.

FIGURE 7: Building shape & Location of indoor spaces

Guideline A recommends orientating the long face of a building towards south, but does not make any recommendations about the shape or the footprint of the building, nor the location of interior spaces.

Clerestory

Spaces that need sunlight but are not located along the south face of a building can receive direct sunlight through south-facing clerestories. A clerestory is a vertical or near-vertical opening projecting up from the roof plane (see Figure 8). Clerestory windows offer a way to work around the recommendation that solar buildings be narrow to allow sunlight to reach into interior spaces (Watson, 1993, pp. 105-107).

Source: Niles and Haggard, January 1980.

FIGURE 8: Clerestory

Clerestories can be particularly effective if a building site does not allow for an elongated south face and it is necessary to locate some living spaces farther inside a building. It is also an effective way for direct sunlight to reach an interior thermal storage wall that could not be located to receive appropriate solar radiation from south-facing windows (see Figure 8). A clerestory should be shaded in the summer by extending its roof to provide appropriate overhang.

The Solar Access Guidelines do not address clerestory windows. Including recommendations about use of clerestory windows could help increase potential for energy savings, especially in conjunction with recommendations for thermal mass in residential units where the long face of the building cannot be oriented towards south.

Surface Color

The perimeter of a building can be used to absorb or reflect solar radiation as required. Dark colors absorb more heat, whereas light colors reflect heat. There is a conflict when dark colored surfaces are desired for maximum solar absorption in winter,

and light colored or polished surfaces are desired for minimum absorption in summer. Mazria suggests that this conflict can be resolved by taking advantage of the sun's seasonal paths. If the south façade is medium to dark in color, it will absorb low south winter sunlight with low angle of sun rays striking the south wall at an angle close to perpendicular. Conversely, it will absorb less in the summer when the sun is high in the sky and its rays fall obliquely on the south side, and if the wall is appropriately shaded. The roof can be painted a light color or polished to reflect the high summer sun. Internally, if thermal mass is provided, it should be dark in color to absorb maximum heat, and other surfaces should be light in color to reflect heat onto the thermal mass.

The Solar Access Guidelines do not address the surface color in any way. As mentioned earlier, the city is currently implementing the Cool Roofs Incentive Program, but it does not apply to single-family residences.

To summarize the results of the comparison (also see Table 1), the Solar Access Guidelines are most consistent with best practices relating to solar orientation. Though the guidelines make recommendations about solar access, landscaping, and shading, they omit a few key points about these topics. The guidelines do not address thermal mass, location of indoor spaces, building shape, clerestory windows, and surface color in any way. One reason for this could be that the fundamental intention of Solar Access Guidelines is to promote “solar access” in residential development, and not overall passive solar design. However, since the salient intention of the guidelines is also to help

reduce energy use in the residential sector in San Jose, the guidelines need to address all major aspects of passive solar design. The Residential Design Guidelines may be the only way the developers get exposure to solar design. Additional recommendations need to be included in the guidelines to relay important information on all aspects of solar design, particularly, thermal mass and the importance of well-insulated building envelope. The latter is covered to some extent, as new construction in California must comply with Title 24 requirements, which deal with building energy efficiency.

TABLE 1: MATRIX FOR COMPARATIVE ANALYSIS

TOPIC	LITERATURE RECOMMENDS	SAG RECOMMENDS	LAPSES IN SAG RECOMMENDATIONS
1 Solar Access			
a Open Space	As provided by the Solar Rights Act and the Solar Shade control Act.	Protection from shading of open spaces adjacent to units.	
b South Wall	Protection from shading between 9:00 am and 3:00 p.m. on Dec. 21.		Do not specify protection of solar access for south wall, or duration of time for protection of solar access.
c External Elements	External natural or man-made elements should be short enough to allow sunlight to reach south wall on Dec. 21.		No specific recommendation for preventing external elements from obstructing sunlight incident on the south wall.
2 Solar Orientation			Provide exemption criteria to allow adjustments, potentially providing loopholes to avoid compliance.
a Street	Along east-west axis.	Within 30 degrees of east-west axis.	
b Building	Long axis should be oriented east-west, so that the broad face orients south.	Broad face orients south.	
c Glazing	Maximize south facing glazing minimize glazing on east, west, and north faces.	Windows face south.	Do not recommend minimizing glazing on east, west, and north sides.

TOPIC	LITERATURE RECOMMENDS	SAG RECOMMENDS	LAPSES IN SAG RECOMMENDATIONS
3 Thermal Mass			
a Materials	Masonry and water.		Do not address thermal mass.
b Sizing	Appropriate for the interior space to be heated.		Do not address thermal mass.
4 Landscaping			
a Deciduous Trees	Use of deciduous trees on south side for shading south facing glazing and south wall, evergreens to buffer cold north winds.	Use of deciduous trees wherever they will shade glazing.	Do not specify locating deciduous trees on south to shade south facing walls and glazing, evergreens on north to buffer cold.
b Vine covered trellises, tall shrubs, etc.	Use of vine covered trellises to shade south facing windows.		Do not mention trellises or other landscape elements.
c Location of Landscaping Elements	Specifies location of landscape elements to shade south side in summer.		Do not specify locating landscape elements to provide shade on south side.
5 Shading Devices			
a Overhangs	Overhangs to allow low winter sun and block high summer sun. Also provides appropriate sizing details for overhangs based on window height.	Incorporate overhangs to allow low winter sun and block high summer sun.	Do not address sizing of overhangs.
b Internal Devices	Mentions ease of operation for internal devices.		Do not mention use of internal devices.
c Landscaping	Encourages use of landscape elements for shading all sides of the building.		Do not promote use of landscape elements as shading devices.

TOPIC	LITERATURE RECOMMENDS	SAG RECOMMENDS	LAPSES IN SAG RECOMMENDATIONS
6 Building Shape	Specifies building shape elongated along the east-west axis so as to receive optimum solar radiation on south side.	Only specifies orienting long face towards south.	Do not specify that the building be elongated along the east-west axis.
7 Locating Indoor Spaces			
a Living Spaces	Recommends living and working spaces be located on the south face of building.		Make no recommendations for locating indoor spaces.
b Buffer Spaces	Recommends corridors, closets, etc. be located on the north face of building.		Do not recommend locating buffer spaces.
8 Clerestory	Recommends use of clerestories to provide solar radiation for living spaces not located on south facade.		Do not address use of clerestory windows.
9 Surface Color	Recommends building surfaces to be painted light or dark colors to absorb or reflect heat as required.		Do not address use of surface color to absorb or reflect heat.

IMPLEMENTATION OF SOLAR ACCESS GUIDELINES

To understand the processes for approval of residential developments and for the implementation of the Solar Access Guidelines, the author interviewed Mike Enderby and Susan Walsh, senior planners with the city's Planning, Building, and Code Enforcement Department.

The Solar Access Guidelines were first proposed in 1992, and formally adopted by City Council in 1997. According to Mike Enderby, Senior Planner, City of San Jose, all planners with the City's Planning Department are regularly informed about any additions and changes to the Residential Design Guidelines. They were sent memos about the Solar Access Guidelines when they were first proposed, as well as after they were adopted. Similarly developers, builders, and project proponents who visited the Planning Department were given copies of the proposed Solar Access Guidelines to keep them informed about the new development. A draft of the current copy of Residential Design Guidelines (which includes the formally adopted Solar Access Guidelines) was also handed out free for almost a year, to all developers who visited the Planning Department. The final copy of Residential Design Guidelines, prepared in April 1999, was also available at the front desk for a few months.

According to Susan Walsh, developers of large residential projects begin to interact with the Planning Department at the preliminary stages of project design, usually even before an application for Site Development or Planned Development Permit is filed. Initial meetings take place weekly, and a planner is assigned as the project manager. At this stage preliminary drawings are discussed that show site development plans including

street layout, grading and drainage, open spaces, parking, and plot layouts. These initial meetings typically go on for about three to four months. The author is of the opinion that this is the stage at which it is critical for planners to recommend incorporating the Solar Access Guidelines in proposed projects. Discussions at this stage about orienting the streets along the east-west axis would lead to appropriate orientation for the individual lots and residential units, which will be designed at a later stage. Susan Walsh informed the author that after the project is filed, critical design aspects considered in addition to the site development plans are number of residential units, lot layouts, building plans, perimeter setbacks, and interfacing of new development with existing streets and buildings. Once an application for a Site Development Permit or a Planned Development Permit is filed, it typically takes six to eight months for the Planning Department to approve it.

The Solar Access Guidelines do not appear to be a priority with the planners. Planners and developers meet several times during the approval process for large residential projects, before as well as after the proposed project is filed for approval. The planners have plenty of opportunity to recommend incorporating Solar Access Guidelines in the proposed projects from the early design phase onwards. However, according to Mike Enderby, San Jose planners do not routinely recommend the measures outlined in the Solar Access Guidelines to developers during meetings held for approval of residential projects. Susan Walsh asserted that the planners review projects for all of the residential design guidelines, but admitted that Solar Access Guidelines have not been a priority. Walsh and Enderby both concur that planners do not conduct a thorough

analysis to assess a site for potential to apply Solar Access Guidelines. Walsh said planners have to consider all the residential design guidelines and do not review projects in great detail to check potential to apply Solar Access Guidelines. Enderby said they review site plans for street orientation but if redesign for solar orientation results in lower number of units, they do not recommend it. Upon later questioning, even this appears to overstate the level of Solar Access Guidelines review being conducted. By their admission, neither Enderby nor Walsh has ever counted the number of units with solar orientation in a project, to determine if a project achieves the solar orientation goal based on density according to Guideline B. Also, neither planner has recommended use of Solar Access Guidelines in any project they have reviewed. When asked if he suggests tips and solutions from the Solar Access Design Manual (published by City of San Jose) to developers, Enderby admitted that he has not done so.

Mike Enderby said other issues take precedence over the Solar Access Guidelines, like setback requirements and interfacing of proposed development with existing roads and neighborhoods, etc. He explained that there are also practical difficulties in incorporating the measures outlined in the Solar Access Guidelines. Grading and drainage of the land to be developed is an important issue from the planners' standpoint. The street layout partly depends on the grading and drainage, and this may interfere with providing solar access and orientation to the proposed residential units. It could also be a challenge, and not always possible, to connect new roads to the existing ones while assuring that they run along the east-west direction as recommended by the Solar Access Guidelines. Walsh reiterated what Enderby said about compliance with other residential

design guidelines. Neither Enderby nor Walsh indicated what percentage of projects they considered particularly problematic in that way.

Mike Enderby is of the opinion that it would not be possible to make the Solar Access Guidelines mandatory, since each site is different and the pre-existing on site conditions would determine whether the guidelines could be effectively incorporated in the design for a particular site. He says, usually the developer wants to maximize the number of units in a residential development. If the project designed according to Solar Access Guidelines reduces the number of residential units that can be built, it would result in economic losses for the developer. The developers are therefore unwilling to consider solar land planning in their designs for residential development. According to Enderby, a good example of a site where the Solar Access Guidelines could be effectively incorporated would be one with an abundant square footage, on flat land, to be developed primarily for a large number of single-family residential units. He claims he has rarely come across such a project, and has never recommended applying Solar Access Guidelines to any project.

According to Mike Enderby, almost 90% of proposals for residential development in San Jose are for Planned Development. The Planned Development Permit process reviews site design, landscaping, architecture, parking, and the space relationships of the project, and the project's compatibility with adjacent development. All large-scale projects like Planned Development projects are referred to San Jose's Environmental Services Department (ESD) for environmental review. Although the final authority lies with the Planning Department, the ESD can make recommendations concerning

environmental issues like drainage, storm water discharge, garbage disposal, noise, etc., and also energy issues including Solar Access Guideline recommendations. This suggests that the ESD plays a minor role in the approval process for new residential projects.

The ESD was responsible for the initial preparation of the Solar Access Guidelines manuscript, and strongly recommended that the Guidelines be incorporated as part of the Residential Design Guidelines for San Jose. The ESD had also commissioned the preparation of a manual in 1993 as a supporting document to the Guidelines. The Solar Access Design Manual provides practical tips, detailed design strategies and examples of solar site and building design relevant to single-family as well as multi-family residential development.

The author interviewed staff members of the City's Environmental Services Department, to understand ESD's role in the approval process and implementation of Solar Access Guidelines. Everett Wilson, Associate Environmental Specialist, ESD, works at the City's Watershed Protection Division, which manages the review of development projects, and used to oversee the environmental review process for developments. He confirmed that the Planning Department sends weekly copies of their review agenda of Planned Development Permits to ESD for environmental review. ESD assigns staff representatives who are responsible for reviewing issues related to South Bay Water, Integrated Waste Management, Watershed Protection, Water Pollution Control Plant, Water Efficiency, and Energy. A copy of the review agenda is sent to designated staff and everyone can attend the review meeting and make comments about

the Watershed Protection Division prepared an internal draft document, *Guidelines for Reviewing a Development Project*, in August 1999 to assist ESD staff in framing their comments on development projects and contains standard language for the purpose. It includes a chapter on energy efficiency, which outlines the recommended percentage (or solar goal) of dwelling units per development that should have solar access and orientation, as detailed in the Solar Access Guidelines. Everett Wilson says in the three years before year 2000 the ESD staff commented regularly on energy issues related to land use or new construction but he couldn't recall comments specifically about Solar Access Guidelines. Through the year 2000 there were no comments on energy issues.

The Environmental Services Department is minimally involved with implementation of the Solar Access Guidelines. They do not take the opportunity to comment on the use of Solar Access Guidelines, and focus only on general energy efficiency. Melody Tovar, Sanitary Engineer, ESD, also works at the Watershed Protection Division and now manages the review team. She took over from Everett Wilson a little over a year ago. According to her, during her tenure with this process, ESD has commented only on general energy efficiency and on advocating for the Cool Roofs Incentive Program. ESD has also commented on use of energy efficient appliances mostly in multifamily residential buildings, and recommends using water efficient as well as energy efficient appliances like washers, dryers, etc. She says, in the past ESD would at times submit long lists of steps a developer could consider to improve energy efficiency, but she says she knows of no focus on the Solar Access Guidelines in comments that ESD provides.

The ESD does not have authority over the recommendations the staff makes on environmental issues. The planners seem to be responsible for the final decision on whether the recommendations are ultimately followed. Everett Wilson explained that copies of the comments and recommendations by ESD staff are sent out to the Planning Department as well as the developer. Recommendations are marked as “Must” and “Should.” Recommendations classified “Must” need to be implemented and implementation of those marked “Should” is at the discretion of the Planning Department. In either case, according to Everett Wilson, ESD has no set procedure to follow-up and confirm whether any of the recommendations have in fact been implemented. Everett Wilson opines that since the developers also get a copy of the comments, they could voluntarily incorporate the recommendations if they so choose.

According to Mary Tucker, Supervising Environmental Specialist, ESD, the staff at the main office of ESD does indeed receive memoranda about upcoming meetings for environmental review of residential projects; but the information is restricted to location, zoning information, parcel numbers, file numbers, and permit being filed for. It does not include layouts and plans, so there is no way to tell whether there is potential for a site to be a good candidate for incorporating the Solar Access Guidelines. According to Mary Tucker, the ESD was short staffed and staff members had a heavy workload. Most did not have the time to find out more information on projects and make comments accordingly. Formerly a staff member was assigned to comment on energy related issues, but as of October 2000, there had been no one in that role for a few months. This

time frame corresponds to the lapse in energy related comments in the review agenda mentioned by Everett Wilson.

According to Melody Tovar, within ESD various programs are supported through revenue generated from rate based funds. For example, support for programs related to water pollution control is provided from fees collected for wastewater services provided by the city. Likewise, support for programs related to solid waste is provided from fees collected for solid waste services provided by the city, like garbage collection. The City is not an energy utility and hence does not collect any fees related to energy services. Unlike solid waste and water pollution, there is no revenue stream for the city to fund energy projects. Most energy programs are funded through the General Fund, which is meant to support general services provided by the City, like street repair and maintenance, police department, fire department, etc. According to Mary Tucker, though ESD consistently tries to obtain funds from the General Fund, energy issues have to compete with other city services and are rarely successful. As a result, energy programs are funded primarily through grants obtained from outside sources.

Mary Tucker said ESD staff usually evaluated issues like water supply, wastewater, and garbage, which were considered essential for project approval; energy conservation and other energy issues were not considered essential for the approval process. According to her it had been difficult to get attention focused on energy problems and energy related programs due to lack of funding, and it was challenging just to get the Solar Access Guidelines included as part of the Residential Design Guidelines. What progress had been made on energy issues, including work on the Solar Access

Guidelines, was made possible through funds received from grants. Mary Tucker informed the author in August 2001, that there is now a staff member on ESD's Development Review Team assigned to evaluate energy issues for projects on the Planning Department's review agenda.

EFFECTIVENESS OF THE IMPLEMENTATION

Project sample review

To see if the solar orientation goal outlined in Guidelines B was applicable to projects on file with the city for approval the author conducted a comprehensive sample review for density. The Internet search for single-family projects on file with the city for approval yielded 24 projects. The sample was further restricted to large projects, those with twenty-five or more single family housing units per project, because large developments typically allow developers more freedom with site layouts and provide better opportunity to meet the goals. This yielded 17 single-family projects, which were analyzed for density of housing units to determine if the solar orientation goal according to Guideline B could be applied. Of the total only 1 project had a housing density of 64 dwelling units per acre (du/ac) and is located in downtown San Jose where density of housing is typically higher. Of the 17 projects reviewed, 16 projects had housing densities under 25 du/ac; therefore 94% of the projects under review had the appropriate density for applicability of the solar orientation goal. In addition, of the 16 projects to which the goal was applicable, 7 had densities lower than 5 du/ac, and 10 projects had

more than 50 housing units per development, both facts implying higher chances of achieving solar street orientation.

Results of interviews with developers

A total of fourteen development firms were contacted for interviews, but only nine granted interviews. From the answers received, planners do not seem to effectively relay information about the guidelines to the developers. A majority of developers (8 out of 9) had not received information about the existence of Solar Access Guidelines from the planners, and most said that planners had never recommended use of Solar Access Guidelines in their projects. In addition, most of developers had only a basic knowledge about solar design and did not see major advantages in incorporating it in their projects, other than energy conservation. They were able to articulate disadvantages of incorporating the guidelines, notable among them the perception that designing a layout for solar orientation results in a lower number of units than otherwise achievable, and ultimately results in financial losses for developers. This seems to corroborate what Mike Enderby said about the developers' reluctance to apply the Solar Access Guidelines. Following is a summary of the answers received from the developers to the interview questions (see Appendix 1). These results are also tabulated for easier reference (see Table 2).

Of the nine developers interviewed (denoted by alphabets in this thesis), most represent firms that have worked with San Jose's Planning Department for several years and some for decades; though some of the representatives personally have done so for

anywhere from 2 to 14 years. Five developers – Developers B, E, G, H, and I, were aware of City of San Jose’s policy to encourage the use of passive solar design in residential buildings, mostly because they had read the Solar Access Guidelines. The other four were not aware of it. Only Developer B remembered being informed about the Solar Access Guidelines. Developer B was given a copy, but could not recall if the Planning Department voluntarily handed out a copy. He says it is possible he asked for it since the firm he works for likes to stay abreast of new developments. Developer B also has a copy of the Solar Access Design Manual in the office. None of the other developers were aware of the existence of the manual.

All developers except Developers B and I (7 out of 9) reported that none of the planners at the city’s Planning Department had ever recommended incorporating Solar Access Guidelines in any of their projects. Developer B said that sometimes the newer planners included a copy of the Solar Access Guidelines with their comment sheet, probably to provide information; but the planners who have worked at the Planning Department for a long time have not mentioned it. Developer I said that their firm had once received comments related to shading of windows, and type of glazing to be used, namely, low-e double pane glazing. Eight developers said they had some awareness of the principles of passive solar design, or in other words, the principles on which the Solar Access Guidelines are based; but most have only basic knowledge mainly through their own efforts. Developer C was not familiar with the principles of passive solar design.

Most developers could not articulate advantages to incorporating Solar Access Guidelines recommendations other than energy conservation. Only two developers, A

and F, are of the opinion that if public demand increases because of the current energy crisis in California, those developers that incorporate solar design could benefit.

Developer G allows that there may be benefits on a case-by-case basis -- there may be value added in some cases and trade-off in others. Developers C and E could not qualify what advantages they perceived. Developer H thinks there would not be significant advantages, and Developers B and D categorically said there were no advantages to the developers by incorporating the Solar Access Guidelines. Many developers perceive financial disadvantages in incorporating Solar Access Guidelines or passive solar design in residential projects. Specifically, Developers A, B, F, G, and I, further clarified that the financial disadvantage resulted from a lower housing density (lower number of housing units in a project) if the projects are designed for solar orientation. The perception is that developers cannot maximize the number of units on each site if they incorporate the recommendations for solar orientation of streets and individual units. Developer I said that Solar Access Guidelines were not suitable for high-density infill housing and Developer H explained that some buyers were not open to having large expanses of glass, or hard surfaces for thermal mass in their homes. Developers C and E do perceive disadvantages incorporating the Solar Access Guidelines but could not qualify any specific disadvantage.

Developers A and B volunteered additional comments about incorporating the Solar Access Guidelines. According to Developer B, the guidelines lead to low land use efficiency, and that is the reason why nobody uses them. According to this developer, many times there are practical difficulties in trying to fit in new roads oriented for solar

design with existing streets. Also, the profile of new buildings in San Jose is changing, with infill structures and high-rise buildings becoming more common. Solar access and orientation may be inappropriate for this building pattern considering that the shadows cast by existing structures and new high-rise structures may obstruct solar radiation reaching building surfaces. This developer was also of the opinion that the authors of the Solar Access Guidelines have no idea about how developers work. They seem to assume that the process is very organized when in fact it is not. He says “the authors have no concept of how projects get financed, designed, approved (the politics involved), and actually executed.” Developer B thinks the guidelines will work better if, “instead of dictating terms”, they specify a framework or some parameters, and offer suggestions about what can be done to implement the recommendations, given a set of conditions. This developer is of the opinion that the guidelines as written are not flexible, the building profiles and scenarios keep changing and the guidelines need to be adaptable so as to get the maximum benefit.

Developer A explained how financial losses could be incurred if developers had to incorporate the Solar Access Guidelines. Before developers buy land they design an initial street layout to help them figure out how many housing units could be accommodated on it. The price they offer to buy the land depends on this estimate. If after they have bought the land, they have to redesign the streets along the east-west axis and design individual units for solar orientation, they may lose a few of the potential housing units and therefore suffer financial losses. On the other hand, if they initially design streets to run along the east-west axis, they run the risk of having a lower number

of residential units, which leads them to bid lower for the land, which in turn causes them to lose out to competition. In either case, he thinks there is a disadvantage to the developer whether financial or competitive, based on the prevalent perception that designing for solar orientation results in lower housing density. Developer A also reiterated what Mike Enderby said about existing site conditions and neighborhoods dictating the layout for new developments. Elevation, grading and drainage, other topographical features, existing road layout, etc. all act as barriers to successfully incorporating the Solar Access Guidelines in a project. Developer A also agreed with Mike Enderby's statement that other Residential Design Guidelines take precedence over the Solar Access Guidelines; for example, an east-west road may not be approved by the planners if it causes driveways of individual residential lots to open directly onto a busy street.

Clearly, the developers are not getting information, education, and guidance on incorporating Solar Access Guidelines from the planners. The Solar Access Guidelines are not addressed at all through the approval process for residential development. The planners seem to share the developers' perception of disadvantages resulting from designing layouts for solar orientation. Planners also see conflict with other guidelines as a barrier to implementing the Solar Access Guidelines.

TABLE 2: RESULTS OF INTERVIEWS WITH DEVELOPERS

	Questions for Developers	Developer A	Developer B	Developer C
1	Duration working with CSJ Planning Department for project approvals?	About 13 years	14 years	About 10 years.
2	Aware of CSJ's policy to encourage use of passive solar design in residential buildings?	No, not until this interview.	Yes, is aware that CSJ has had that policy for several years.	No
3	Informed about the SAG by CSJ Planners?	No, was not informed.	Yes.	No
a	How?	N/A	Not sure, was either handed a copy of SAG or asked for it.	N/A
b	Received copy of the manual?	Not aware of the manual.	Yes, has a copy.	No
4	Have CSJ Planners recommended incorporating SAG for any project?	Never so far.	Some newer planners occasionally include SAG information sheet with other comments.	No
5	Aware of principles of passive solar design?	Yes, a little, through own research.	Yes, through own research. Also may have attended a workshop offered by SJ about SAG.	No, not very familiar with them.
6	Perceive advantages in incorporating SAG? What?	Yes. If public demand for it increases, developers will benefit.	No advantage to the developer.	Some (could not qualify answer).
7	Perceive disadvantages in incorporating SAG? What?	Yes. Financial disadvantage, compounded by a competitive disadvantage.	Yes. Financial disadvantage, because of inefficient land use if incorporated.	Some (could not qualify answer).

	Questions for Developers	Developer D	Developer E	Developer F
1	Duration working with CSJ Planning Department for project approvals?	About 4 years.	18 months.	18 months personally, the firm several years.
2	Aware of CSJ's policy to encourage use of passive solar design in residential buildings?	No.	Yes.	Yes, aware of it, but not sure it can be incorporated in projects.
3	Informed about the SAG by CSJ Planners?	No.	No.	No.
a	How?	N/A	N/A	N/A
b	Received copy of the manual?	No.	No.	No.
4	Have CSJ Planners recommended incorporating SAG for any project?	No.	No.	No.
5	Aware of principles of passive solar design?	Yes, has basic knowledge.	Yes, basic knowledge.	Yes, has a background in urban planning.
6	Perceive advantages in incorporating SAG? What?	Currently there is no advantage to the developer.	Yes (did not qualify answer).	Possibly with the current energy crisis, energy conservation may become a selling point.
7	Perceive disadvantages in incorporating SAG? What?	At this point there are only a small number of interested buyers, so no incentive to incorporate SAG.	Yes (did not qualify answer).	Yes, if strictly enforced, the number of units in a project could be impacted, and lead to financial disadvantage.

	Questions for Developers	Developer G	Developer H	Developer I
1	Duration working with CSJ Planning Department for project approvals?	3 and a half years.	Several years.	1 year with current company.
2	Aware of CSJ's policy to encourage use of passive solar design in residential buildings?	Yes, aware of it, has read the SAG.	Yes.	Yes, has read SAG.
3	Informed about the SAG by CSJ Planners?	No.	No.	No.
a	How?	N/A	N/A	N/A
b	Received copy of the manual?	No.	No.	No.
4	Have CSJ Planners recommended incorporating SAG for any project?	No.	No.	Have recommended shading and use of double-pane glazing.
5	Aware of principles of passive solar design?	Yes, has basic knowledge.	Yes, has knowledge of the basic principles.	Yes, only basic knowledge.
6	Perceive advantages in incorporating SAG? What?	Yes, on a case by case basis.	No significant advantages.	Not really, there maybe advantages in personal lifestyle.
7	Perceive disadvantages in incorporating SAG? What?	Yes, there may be a trade-off, number of units may be compromised.	Disadvantage using expanses of mass and glass - the buyers do not want them.	Yes, financial disadvantage. Also not suitable for high density infill housing.

List of Abbreviations:

CSJ: City of San Jose

SJ: San Jose

SAG: Solar Access Guidelines

V. CONCLUSIONS

The city of San Jose did a commendable job by developing the Solar Access Guidelines and adopting them as part of the Residential Design Guidelines to help reduce energy use in the residential sector. However, the city has not been able to achieve any measure of this goal since implementation of the guidelines has been ineffective. There are several barriers that impede successful implementation. This chapter discusses barriers to implementation of the guidelines and drawbacks of the guidelines.

The major barrier to implementation seems to be the voluntary nature of compliance with the guidelines. The planners as well as the developers ignore the guidelines. The developers are reluctant to even attempt incorporating them because of perceived disadvantages of incorporating Solar Access Guidelines, lack of knowledge or interest in solar design, and a lack of persuasion from the planners.

In addition, the review of projects for assessing potential for incorporating the Solar Access Guidelines seems to be voluntary too. The time taken for the approval process of proposed residential projects is almost one year; three to four months of initial meetings even before the application for approval is filed and six to eight months thereafter for processing the application. The planners and developers meet during this process on a regular basis and there is enough opportunity for planners to recommend Solar Access Guidelines in proposed projects. Nonetheless, the guidelines are not addressed at any stage in the review of proposed projects during the approval process. Results of the project sample review discussed earlier suggest that majority of the current residential projects on file for approval would in fact be eligible for the solar orientation

goal based on density of development. Planners have missed this fact, as they do not have any set procedure to review projects for compliance with the guidelines. Consequently they do not make any attempts to encourage the developers to consider solar access and orientation in their projects.

It is clear that the developers do not see any value in incorporating the guidelines. They have not been provided with essential information about the Solar Access Guidelines. The planners may be aware of the advantages of the Solar Access Guidelines, but are not convinced of their value either. They are certainly not committed to implementing them; in fact, as one of the planners said the Solar Access Guidelines are not a priority. The Environmental Services Department obviously sees the value of Solar Access Guidelines, considering it was responsible for developing them. However, the ESD is restricted to an advisory role in the implementation, which is also apparently disregarded. Members of ESD staff have not taken the opportunity to recommend Solar Access Guidelines for the projects they review.

Thus, the voluntary nature of the guidelines, combined with the planners' and developers' reticence stemming from their shared perception of disadvantages, and the ESD's disregard of the guidelines, have all contributed to ineffectiveness of the implementation of Solar Access Guidelines. To augment this set of problems, the Solar Access Guidelines have several inherent drawbacks that may also contribute to ineffectiveness of their implementation.

A significant drawback of the Solar Access Guidelines is the fact that they focus mainly on single-family housing developments. The guidelines do not offer suggestions

for solar design in multi-family residential development; they do not have a solar orientation goal for densities higher than 25 dwelling units/acre, and therefore exclude multifamily housing from this goal. The profile of housing is changing in response to dwindling land parcels available for residential development. There has been an increase in higher density in-fill housing projects in San Jose in recent years. The current Solar Access Guidelines cannot be effectively applied to high-density housing, like clustered housing or multi-family housing. Though solar design is easier to achieve in low-density projects, it is not impossible to achieve in high-density housing developments. Strategies for achieving solar access and orientation for multi-family housing developments are available in literature, specifically in *Site Planning for Solar Access* by Erley and Jaffe.

Moreover, though the Solar Access Guidelines attempt to address aspects of passive solar design other than solar access, the comparative analysis carried out suggests that there are significant lapses in the Solar Access Guidelines compared to best practices recommended in literature. The Solar Access Guidelines omit key points about the recommendations that they do address like solar access and orientation, landscaping, and shading. They completely neglect an important aspect of passive solar design, namely providing thermal mass. Thermal mass greatly enhances passive heating and cooling of homes, and providing thermal mass in addition to other solar design strategies can result in overall savings of 30% to 70%, as mentioned earlier. The Solar Access Guidelines also neglect other aspects of solar design like building shape, location of indoor spaces, clerestory windows and surface color. Additionally, Guideline F of Solar Access Guidelines focuses on the aesthetic aspect of placing exterior solar equipment rather than

focusing on appropriate orientation and protection of solar access for the solar equipment. Aesthetics can be controlled without restricting placement options for solar equipment. Solar collectors placed parallel and close to the roof surface look similar to skylights. Emerging generation of solar equipment, e.g., photovoltaic roofing material, is integrated with the building and aesthetically pleasing. If San Jose planners were to implement the Solar Access Guidelines effectively, the above lapses would reduce the potential for significant savings in energy use. To make them more efficient it would be necessary to expand the scope of the existing guidelines to address these lapses.

Additionally, exemption criteria provided with Guideline B of the Solar Access Guidelines weaken the potential for implementation of the guidelines. The exemption criteria allow adjustments if compliance with Solar Access Guidelines would prevent compliance with other residential design guidelines, or lead to conflict with existing street orientation and grading policies. The planners see conflict with other guidelines as a deterrent to implementing Solar Access Guidelines. The exemption criteria also allow adjustments if compliance with Solar Access Guidelines would result in a reduction of housing density. This was an important issue with the developers who try to maximize density of development for optimum financial gain, and with the planners because lower densities signify inefficient use of land. Therefore, in effect, the exemption criteria really provide both planners and developers an excuse to avoid compliance with Solar Access Guidelines. It would be advantageous to modify the exemption criteria if planners decide to implement the guidelines in future.

VI. RECOMMENDATIONS

If the City of San Jose hopes to achieve its objective of reducing energy use in the residential sector through the Solar Access Guidelines, several steps would be necessary to achieve compliance. This section provides recommendations to enhance compliance with Solar Access Guidelines.

An important aspect of Solar Access Guidelines that needs to be reviewed and modified is the focus on single-family housing. The Solar Access Guidelines should address high-density development in San Jose. Lower density, sprawling growth patterns that have characterized development in the United States for last several decades, are a major cause of many of the problems of American cities today, as they make inefficient use of land and are environmentally damaging (Beatly and Manning, 1997, pp. 40). Higher densities offer many benefits, including enhancing the public transport system, allowing greater opportunities for walking and bicycling, and reducing energy consumption and pollution (Beatly and Manning, 1997, pp. 50). Because of this and because of changing profiles of housing in San Jose, the Solar Access Guidelines should include additional guidelines to promote solar design in high-density residential development to include clustered and multi-family housing.

Both planners and developers argue that solar design of site layout results in lower housing density and appear to perceive this as a major disadvantage. However, review of literature suggests that it is possible to achieve high densities even while planning for solar orientation. Additionally, the city's own documents contradict them. According to Erley and Jaffe (September 1979, pp. 40), density concerns need not rule

out solar access planning; it is possible to maintain densities similar to conventional development even while protecting solar access and providing optimum solar orientation. Edward Dean (1981, pp. 29) provides a diagram in *Energy Principles in Architectural Design* showing redesign of a layout to increase number of units with appropriate solar orientation without compromising density of development (see Figure 9).

Source: Dean, Edward, 1981.

FIGURE 9: Redesign of layout for solar orientation

Additionally, the city's own document contradicts this perception of reduced density and resulting disadvantages. The *Solar Access Design Manual* commissioned by the ESD

Single Family Case Study

Source: City of San Jose, June 1993.

FIGURE 10: Case study – Redesign for solar orientation

reports findings from a case study for redesign of a single-family development with a density of 10 du/ac to apply Solar Access Guidelines (City of San Jose, June 1993, pp. 3-1 to 3-3). In the redesigned layout, the proportion of solar oriented lots/housing units was increased from 42% to 80% of total units, while maintaining total number of housing units, housing density, average lot sizes, and development amenities (see Figure 10). In addition, total infrastructure costs were slightly reduced, and there was no change in overall traffic circulation pattern. The planners could use this example to dispel the developers' perception (and first their own) that site planning for solar orientation reduces the number of units otherwise achievable in a residential development. Apparently, the planners have not used the design manual to persuade developers to consider solar design. The planners have not been diligent about supplying information about existence of the Solar Access Guidelines to developers and they have neglected providing guidance to developers to incorporate the guidelines, though a manual was prepared for the purpose.

The planners need to be educated about the advantages of solar design and the value of Solar Access Guidelines. They need to be convinced that Solar Access Guidelines and other residential guidelines can be complementary to each other and co-exist. The planners should be able to provide the developers with concrete suggestions on incorporating the Solar Access Guidelines. The emphasis needs to be on achieving the goals of the guidelines and not so much on the methods used, e.g., it is important to achieve a maximum number of building units with solar orientation regardless of whether the street or the lot is appropriately oriented. Following are some examples of how the

planners could offer creative solutions to developers and guide them to incorporate recommendations provided by the Solar Access Guidelines.

When streets cannot be oriented along the east-west axis, the individual lots can still have the desired north-south orientation (Erley and Jaffe, September 1979). If the street is oriented between the cardinal directions (e.g. north-east to south-west), the lot lines could be along the north-south axis if they are laid out at oblique angles to the street, so that the building can have optimum solar orientation (see Figure 11). San Jose's *Residential Design Guidelines* encourage building lines and frontages to be parallel to the street (City of San Jose, April 1999, pp. 13,14) but this guideline is not mandatory. In this example, the planners could recommend rotating the building to achieve orientation towards south, even if the lot lines have to be perpendicular to the street (see Figure 12). Also, if the streets are oriented along the north-south axis, the long axis of the building typically has excessive east and west exposure to solar radiation. This can be avoided by using flag lots and orienting the long face of the building along the east-west axis (Erley and Jaffe, September 1979). The flag lot technique can be employed if the streets are placed far enough apart that four lots can be run in an east-west direction, with the pole of the flag connecting the inner lots to the street (see Figure 13). These are examples of how solar access and orientation can be achieved for buildings even if the streets do not have the desired east-west orientation. The planners should place a greater emphasis on maximizing the number of solar homes in a development; the means to achieve that goal should take a lower priority to allow for more creative solutions.

Source: Erley and Jaffe, September 1979.

FIGURE 11: Lot orientation

Source: Hammond et al, August 1980.

FIGURE 12: Building orientation

Figure 66. Combining Lots for Proper Orientation

Figure 67. Using Flag Lots for Proper Orientation on North/South Streets

Source: Erley and Jaffe, September 1979.

FIGURE 13: Lot orientation and Flag lots

This work also strongly recommends updating the Solar Access Guidelines to include several passive solar features that have been omitted, particularly thermal mass. Morehouse (1997, pp. 856) makes concise recommendations for the inclusion of thermal mass in direct gain buildings given the desired energy savings (Solar Savings Fraction or SSF).³ “A thermal storage wall should have 14 kg SSF (%) of water or 71 kg SSF (%) of masonry for each square meter of solar projected area. For a direct gain space, the mass above should be used with a surface area of at least three times the solar projected area, and masonry no thicker than 10-15 cm. If the mass is located in the back rooms, then four times the above mass is needed (Morehouse, 1997, pp. 856).” Solar projected area refers to the area of south facing glazing projected onto a vertical surface. As the usual recommendation for size of glazing area is one-third or one-fourth the floor area (Kreider et al, 1989, pp. 155), this means that the thermal mass area for masonry should be approximately equal to the floor area or larger. The mass must be within or enclosing the direct gain space, and must not be insulated from the space. Watson (1993, pp. 108-109) provides a list of absorptance of different materials and colors, and recommends that overall absorptance of the space should be between 0.5 and 0.8. Generally, thermal mass should be dark in color to be an effective absorber, and other non-absorptive surfaces should be lighter to reflect sunlight into the mass. Additionally, if mass is to be placed in the floor, it must be insulated from below. If recommendations about use of thermal mass are added and are rigorously implemented, it will lead to significant reduction in conventional energy consumption.

³ SSF is the fraction of total space conditioning energy use saved by passive solar features of a house.

To enhance implementation of the Solar Access Guidelines, the city can consider a few alternatives. The planners can either try to improve voluntary compliance, or they could consider making compliance mandatory. A more effective way may be to achieve compliance through incentive programs. However, currently, there is no entity to oversee the implementation of Solar Access Guidelines. If the city decides in the future to implement the guidelines, it needs to first create responsibility and accountability for effective implementation of Solar Access Guidelines, and to track progress of the implementation on a periodic basis.

There are several steps the planners could take to improve voluntary compliance. First they need to initiate discussion about Solar Access Guidelines early in the approval process, when reviewing preliminary layouts, to increase the chances for incorporating the guideline recommendations. They need to develop methods to assess site potential for application of Solar Access Guidelines and set performance measures accordingly, and as mentioned earlier, provide guidance to developers. They should also allow mitigating measures for other guidelines to facilitate including solar design. This may involve providing flexibility for compliance with other residential design guidelines in addition to devising ways to achieve an optimum design for a development based on requirements for all the residential design guidelines. For example, in developments where the streets already have the desired orientation along the east-west axis, some units may not have optimum solar access if the buildings are sited with equal front and rear yard setbacks (Erley and Jaffe, September 1979). The distance between houses that back each other may be relatively smaller than the distance between houses that face each

other as these take advantage of added distance of the street width (see Figure 14).

Consequently, solar access for houses on the south side of the street may be jeopardized.

Solar access in such developments can be equalized by reducing front yard setback and

increasing the rear yard setback, whereby the distance between houses that back on to

each other is nearly the same as the distance between houses that face each other. If the

setback requirements outlined in the residential guidelines are relaxed, this strategy could

be used to equalize solar access within a development.

Figure 69. Reducing Setback to Equalize Access

Hypothetical site, flat at 40°N. latitude, with a shadow projection of 87.5' for 25'-high buildings. In A, only buildings to the North of road right-of-way have south-wall access. By reducing setback by 10' (from 30' to 20'), all structures have south-wall access in B. This affects shading only by buildings; street trees must be regulated to prevent shading problems.

Source: Erley and Jaffe, September 1979.

FIGURE 14: Equalizing solar access

It appears however, that the main problem with implementation is that the planners and the developers are just not interested. Therefore the only way to achieve compliance is to either require compliance or to devise incentives to promote compliance. The planners could make compliance mandatory based on site conditions. Again, the planners would need to first conduct a thorough analysis of the site to assess potential for incorporating the Solar Access Guidelines, and enforce compliance based on the results of the analysis. One way to do this is to prepare a checklist of recommendations as a tool and create tiered goals related to site conditions. The checklist could have items such as density, number of units, feasibility for solar orientation of street/lot/building unit, landscaping elements, etc. Based on the findings compiled from the checklist, the projects could be assigned tiers of applicability for Solar Access Guidelines, such as high, medium, or low. The planners could then give the developers some parameters for achieving a level of compliance depending upon the tier assigned to the proposed project. Greater involvement of the ESD in the implementation process, using either voluntary or enforced compliance, would also help improve chances of incorporating the Solar Access Guidelines in proposed projects.

A better method of achieving compliance may be through introduction of incentive programs. The incentives offered could persuade professionals from the field of construction and development like architects, contractors, developers, etc., to voluntarily devise ways to comply with the guidelines. There could be two types of incentives, process oriented and fee based. Process oriented incentives could assure developers a higher priority and faster approval for their projects if they meet or exceed a

compliance goal incorporating the Solar Access Guidelines. Alternatively, the developers could be charged lower development fees or reduced property taxes, as an incentive for projects that achieve compliance. Developers not achieving any level of compliance could be charged an “environmental damage” tax as a disincentive. Some European cities impose “environmental” or “green” taxes, and a recent study commissioned by the European Environment Agency concluded that such systems have generally been successful at achieving their environmental goals (Beatly, 2000, pp. 252). San Jose could emulate the example of these European cities and levy “energy” taxes, which may also prove to be an effective way to generate funds for the city’s energy programs. Renewable energy sources, including passive solar, solar hot water systems, and photovoltaic systems could be kept exempt from the energy tax to promote their use.

Many European cities also have “sought to ensure that the new housing constructed in their communities is designed and built in ways that greatly minimize the energy consumed (Beatly, 2000, pp. 267).” Some cities take a proactive stand by building demonstration projects emphasizing the feasibility and practicality of energy efficient housing (Beatly, 2000, pp. 267). San Jose may consider being more active in the land development process than it is now. When a city owns and develops the land, it can set its own priorities with an emphasis on important environmental issues like sustainability and renewable energy, and develop design requirements to reflect them. San Jose could also hold design competitions to tap into the creativity of industry professionals to produce an energy efficient, sustainable, solar housing demonstration project.

As mentioned earlier, the city has been developing the Green Building Policy for a few years and the San Jose City Council adopted the Green Building Policy recommendations in June 2001. This may provide impetus to the city's efforts towards all sustainable development strategies, including energy issues. Currently the Green Building Policy recommendations have been mandated for city facilities, but the city eventually aims to promote it in the private sector too. If the recommendations are expanded to address the private sector, the Solar Access Guidelines could be modified to fall under the broader umbrella of the Green Building Policy.

This thesis as a critique has identified many negative aspects of the Solar Access Guidelines and their implementation. Nonetheless, there are redeeming features to the guidelines. Intended to encourage solar access as an element of residential project design, they were also developed with an aim to help reduce the energy use of San Jose residents. The Solar Access Guidelines therefore attempt to address not only solar access, but also other important aspects of passive solar design like solar orientation of streets, buildings, and glazing; reduction of cooling loads; and solar friendly landscaping. By promoting the use of renewable solar energy to heat and cool homes, the Solar Access Guidelines essentially encourage displacing conventional energy for the purpose of space conditioning, which accounts for the majority of energy use in the residential sector. This is one of the strongest points in favor of the Solar Access Guidelines with reference to energy and the environment. Reduction in use of fossil fuel energy for an energy

intensive use like space conditioning would ultimately help lower carbon emissions believed to contribute to global warming.

The most important aspect of the Solar Access Guidelines is that they have been formally adopted by the San Jose City Council, and are an integral part of the Residential Design Guidelines. Adoption of Solar Access Guidelines by the San Jose City Council provides official acknowledgment of the energy conservation value of solar access and passive solar design. This is an important first step that raises awareness, and is a stepping stone to implementation. To realize its potential, the city must take the next steps. It is well within the scope of the concerned agencies to implement Solar Access Guidelines to the fullest extent possible if they are committed to do so.

The decision-making authorities, specifically planners, must realize the importance of the concepts, and must be provided tools for easy project evaluation. They must be educated on the difference between the goals of Solar Access Guidelines and the means to achieve them, with higher emphasis on the former. Ultimately, there are three proven means for the city to achieve high levels of compliance with environmental standards: by requiring compliance, by providing incentives to meet and exceed minimum standards, or by acquiring lands and developing them as city-owned projects.

BIBLIOGRAPHY

- Alliance To Save Energy, American Council For An Energy-Efficient Economy, Natural Resources Defense Council, Tellus Institute, and Union Of Concerned Scientists. June 1997. Energy Innovations: A Prosperous Path To A Clean Environment.
- Brower, Michael. 1994. Cool Energy, Renewable Solutions to Environmental Problems. The MIT Press, Cambridge, Massachusetts.
- Beatly, Timothy, and Kristy Manning. 1997. The Ecology Of Place: Planning For Environment, Economy, And Community. Island Press, Washington DC
- Beatly, Timothy. 2000. Green Urbanism: Learning From European Cities. Island Press, Washington DC
- City of San Jose. August 1991. The Sustainable City Project, A Tri-City Collaboration For Developing And Implementing Sustainable Urban Energy Practices. Energy Task Force of the Urban Consortium. Public Technology Inc., Washington DC.
- City of San Jose. June 1993. Solar Access Design Manual. Environmental Services Department, San Jose, California (Prepared by Les Tumidaj and Associates, O'Brien and Associates, and Robert H. Foster).
- City of San Jose. April 1999. Residential Design Guidelines, Toward Community. Department of Planning, Building and Code Enforcement, San Jose, California.
- City of San Jose. August 31, 2001 - last accessed. Cool Roofs Incentive Program. <<http://www.ci.san-jose.ca.us/esd/ALE-CoolRoofs.htm>>
- City of San Jose. September 31, 2001 -- last accessed. Green Building Policies. <<http://www.ci.san-jose.ca.us/esd/gb-policies-new.htm>>
- Crowley, John S., and L. Zaurie Zimmerman. 1984. Practical Passive Solar Design: A Guide to Homebuilding and Land Development. McGraw Hill Book Company, New York.
- Dean, Edward. 1981. Energy Principles in Architectural Design. California Energy Commission (CEC), Sacramento, California (Publication Number P400-81-004).
- Energy Information Administration. April 28, 1999 -- last modified. What Does The Kyoto Protocol Mean To US Energy Markets And Economy? Report Number:

SR/OIAF/98-03(s). Retrieved from <<http://www.eia.doe.gov/oiaf/kyoto.html>> January 2001.

- Energy Information Administration. January 24, 2000 -- last modified. International Energy Annual 1998 – Overview. Retrieved from <<http://www.eia.doe.gov/emeu/iea/overview.html>> January 2001.
- Energy Information Administration. March 31, 2000 -- last modified. World Energy Consumption. Report Number: DOE/EIA-0484 (2000). Retrieved from <<http://www.eia.doe.gov/oiaf/ieo/world.html>> January 2001.
- Energy Information Administration. January 23, 2000 -- last modified. Residential Energy Consumption Survey, 1997. Retrieved from <<http://www.eia.doe.gov/emeu/recs/contents.html>> January 2001.
- Energy Efficiency and Renewable Energy Network. December 18, 2000 -- last modified. Whole Building Design. Retrieved from <http://www.eren.doe.gov/buildings/build_design.html> January 2001.
- Erley, Duncan, and Martin Jaffe. September 1979. Site Planning for Solar Access: A Guidebook for Residential Developers and Site Planners. Prepared for the U.S. Department of Housing and Urban Development (HUD-PDR-481). American Planning Association, Chicago, Illinois.
- Hammond, Jonathan, James Zanetto, and Cesar Adams. August 1980. Planning Solar Neighborhoods. California Energy Commission, Sacramento, California (CEC Publication Number: P500-81-018).
- Holzman, David. 1984. Technology Review, Jan 1984 v87 p69 (2). In U.S. Homebuilders: Ignoring Solar.
- Hoyt, Steve et al. Fall 1998. Energy Conservation Under The Sun: A Resource Book For Local Governments. Prepared by the Local Government Commission.
- Kornher, Steve, and Andy Zaugg. The Complete Handbook Of Solar Air Heating Systems. 1984. Rodale Press, Emmaus, Pennsylvania.
- Kreith, Frank, and Ronald E. West, Editors. 1997. CRC Handbook of Energy Efficiency. CRC Press, Boca Raton, Florida.
- Kreider, Jan, Charles J. Hoogendoorn, and Frank Kreith. 1989. Solar Design, Components, Systems, Economics. Hemisphere Publishing Corporation, New York.

- Kreider, Jan, and Frank Kreith. 1982. Solar Heating And Cooling, Active and Passive Design. Hemisphere Publishing Corporation, New York.
- Mazria, Edward. 1979. The Passive Solar Energy Book. Rodale Press, Emmaus, Pennsylvania.
- Montgomery, Richard H. 1982. The Solar Decision Book Of Homes. John Wiley and Sons, New York.
- Morehouse, Jeffery H. 1997. Passive Solar Heating, Cooling, and Daylighting. Pages 849-902 in Kreith, Frank and Ronald E. West, eds. CRC Handbook of Energy Efficiency. CRC Press, Boca Raton, Florida.
- Niles, Philip W.B., and Kenneth L. Haggard. January 1980. Passive Solar Handbook. California Energy Commission, Sacramento, California.
- Olgyay, Victor. 1963. Design With Climate. Princeton University Press, Princeton, New Jersey.
- Prowler, Donald et al. June 1996. Designing Low Energy Buildings: Passive Solar Strategies & Energy-10 Software 1.0. Passive Solar Industries Council, Washington DC.
- PSDH. 1984. Passive Solar Design Handbook, Part One: Total Environmental Action, Inc., Part Two: Los Alamos National Laboratory, Part Three: Los Alamos National Laboratory. Van Nostrand Reinhold, New York.
- Schepp, Brad, and Stephen M. Hastie. 1985. The Complete Passive Solar Home Book. Tab Books Inc., Blue Ridge Summit, Pennsylvania.
- Sunset Books (Eds). Sunset Home Owner's Guide to Solar Heating. September 1978. Lane Publishing Company, Menlo Park, California.
- The US Department of Housing and Urban Development, Office of Policy Development and Research. 1976. Solar Dwelling Design Concepts. Prepared by the AIA Research Corporation, Washington DC. US Government Printing Office, Washington DC.
- Watson, Donald, Editor. 1993. The Energy Design Handbook. Prepared by the American Institute of Architects. The AIA Press, Washington DC.

APPENDIX A

Interview Questions for Developers

1. For how long have you been dealing with City of San Jose's (CSJ's) Planning department for approval of projects (personally and for your company)?
2. Are you aware of CSJ's policy to encourage the use of passive solar design in residential buildings?
3. Were you informed about the Solar Access Guidelines (SAG) which are a part of San Jose's Residential Design Guidelines?

If so:
 - (a) How was the information made available to you?
 - (b) Did you get a copy of the manual published by CSJ that offers tips on incorporating SAG in residential buildings?
4. Have San Jose planners recommended incorporating either SAG or passive solar design in any of your projects?
5. Are you aware of the principles of passive solar design, or in other words, the principles on which the SAG are based?
6. Do you perceive any advantages in incorporating SAG or passive solar design in your residential projects? Describe briefly.
7. Do you perceive any disadvantages in incorporating SAG or passive solar design in your residential projects? Describe briefly.

APPENDIX B

CONSENT FORM

Agreement to Participate in Research

Responsible Investigator: Ms. Sharada Thattey

Name of Subject: _____

Title of Protocol: San Jose's Solar Access Guidelines: Strengths and Pitfalls

1. I have been asked to participate in a research study investigating implementation of the Solar Access Guidelines, which are a part of the Residential Design Guidelines for the City of San Jose.
2. I will be asked to answer some questions about Solar Access Guidelines with respect to the following:
 - (a) the origin and development of Solar Access Guidelines,
 - (b) adoption of the Solar Access Guidelines by the City Council,
 - (c) implementation procedures for the Solar Access Guidelines,
 - (d) other City programs that bear relevance to the Solar Access Guidelines, and
 - (e) other related issues.
3. I have been informed that no risks or discomforts are anticipated for subjects participating in the study.
4. I have been informed that no discernible benefits are to be expected as a result of participation in the study.
5. I have been informed that an alternative procedure would be to not participate in the study.
6. I have been informed the subjects will not receive any compensation for participation in the study.
7. Tick (a) OR (b) in parentheses provided:
 - a. () *This applies to those subjects who are private citizens, i.e. developers or builders.*

I have been informed that the results of the study may be published, but the identity of the subjects will not be divulged.

- b. () *This applies to subjects who are City Officials from San Jose's Planning Department and Environmental Services Department.*

I give permission to publish statement as part of the researcher's thesis to be submitted to the Environmental Studies Department, San Jose State University.

Subject's Initials

Date

8. I promise to follow my agency's rules for giving interviews.
 9. I understand that this interview may be tape-recorded.
 10. I have been informed that:
 - (a) Questions about the research may be addressed to the principal investigator, Sharada Thattey, at (408) 243-6537.
 - (b) Complaints about the research may be presented to Dr. Lester Rowntree, Chairman, Department of Environmental Studies, at (408) 924-5487.
 - (c) Questions about the research or subjects' rights may be addressed to Mr. Nabil Ibrahim, Ph.D., Associate Vice President for Graduate Studies and Research, at (408) 924-2480.
 11. I understand that no service of any kind, to which a subject is otherwise entitled, will be lost or jeopardized if a person chooses to "not participate" in the study.
 12. I have voluntarily consented to participate in the study. I understand that a subject may refuse to participate in the study or in any part of the study. I also understand that if a subject participates in the study, he or she is free to withdraw at any time without prejudice to the subject's relations with San Jose State University or any other participating institutions.
 13. I have received a signed and dated copy of this consent form.
- ◆ The signature of a subject on this document indicates agreement to participate in the study.
 - ◆ The signature of a researcher on this document indicates agreement to include the above named subject in the research and attestation that the subject has been fully informed of his or her rights.

Subject's Signature (Public Officials)

Date

Subject's Signature (Private citizens)

Date

Investigator's Signature

Date

APPENDIX C

Approval To Use Human Subjects

San José State
UNIVERSITY

**Office of the Academic
Vice President**
Associate Vice President
Graduate Studies and Research
One Washington Square
San Jose, CA 95192-0025
Voice: 408-924-2480
Fax: 408-924-2477
E-mail: gstud-as@wanoo.sjsu.edu
http://www.sjsu.edu

To: Sharada Thattey
350 Hillsdale Avenue
Santa Clara, CA 95051

From: Nabil Ibrahim,
AVP, Graduate Studies & Research

Date: May 4, 2001

The Human Subjects-Institutional Review Board has approved your request to use human subjects in the study entitled:

"San Jose's Solar Access Guidelines: Strengths and Pitfalls."

This approval is contingent upon the subjects participating in your research project being appropriately protected from risk. This includes the protection of the anonymity of the subjects' identity when they participate in your research project, and with regard to any and all data that may be collected from the subjects. The approval includes continued monitoring of your research by the Board to assure that the subjects are being adequately and properly protected from such risks. If at any time a subject becomes injured or complains of injury, you must notify Nabil Ibrahim, Ph.D., immediately. Injury includes but is not limited to bodily harm, psychological trauma and release of potentially damaging personal information. This approval is in effect for one-year and data collection beyond May 3, 2002 requires an extension request.

Please also be advised that all subjects need to be fully informed and aware that their participation in your research project is voluntary, and that he or she may withdraw from the project at any time. Further, a subject's participation, refusal to participate, or withdrawal will not affect any services the subject is receiving or will receive at the institution in which the research is being conducted.

If you have any questions, please contact me at
(408) 924-2480.

The California State University:
Chancellor's Office
Bakersfield, Chico, Dominguez Hills,
Fresno, Fullerton, Hayward, Humboldt,
Long Beach, Los Angeles, Maritime Academy,
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APPENDIX D

Permission To Use Copyrighted Material

Sunset

Sunset Books

December 10, 2001

Sharada B. Thattey
350 Hillsdale Avenue
Santa Clara, California 95051

Dear Ms. Thattey,

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Drawing 7	Sun's Annual Path, p. 8
Drawing 12	Heat Zoning, p. 9
Drawing 26	Fixed Overhang Shading, p. 12
Drawing 28	Movable Shading: hinged overhang, p. 13
Drawing 29	Movable Shading: blinds, p. 13
Drawing 30	Movable Shading: vines, p. 13
Drawing 31	Landscaping for Heat Control, p. 14
Drawing 32	Passive Heat Collection, p. 15
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Lois Tucker

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Sent: Wednesday, November 28, 2001 1:52 PM
To: LTucker@planning.org
Subject: Using illustrations in thesis

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SIGNED.

Editorial Assistant

Date

Hello Lois,

I had left a message on your voicemail regarding using some illustrations from an APA publication in my graduate thesis.

I am a graduate student at San Jose State University, Environmental Studies Department. I am finishing up my graduate thesis titled "Effectiveness of San Jose's Solar Access Guidelines: A Policy Evaluation." In this thesis to be submitted to the University, I'd like to use some illustrations from "Site Planning for Solar Access: A Guidebook for Residential Developers and Site Planners" published in September 1979 by the American Planning Association.

Following is the list of illustrations I'd like to include in the thesis:
Fig. 64 - Lot Orientation on Intercardinal Streets,
Fig. 66 - Combining Lots for Proper Orientation,
Fig. 67 - Using Flag Lots for Proper Orientation on North-South Streets,
Fig. 69 - Reducing Setback to Equalize Access.

I wish to use the above illustrations in my thesis for the purpose of explaining ways to achieve solar orientation and access in residential developments, and I request your permission for the same. I shall of course cite the source for the illustrations according to the information listed on the copyright page of the book, as follows:

Erley, Duncan, and Martin Jaffe. September 1979. Site Planning for Solar Access: A Guidebook for Residential Developers and Site Planners. Prepared for the U.S. Department of Housing and Urban Development (HUD-PDR-481). American Planning Association, Chicago, Illinois.

Could you let me know if I can use the illustrations, and if yes, could you send me a permission letter for the same? Following is my contact information.

My address: 350 Hillsdale Avenue, Santa Clara, CA 95051.
My phone: (408) 243-6537.
My email: <tosharada@hotmail.com>
My name in the University records: Sharada B. Thattey.

Hope to hear back from you soon.
Sincerely,

Dear Ms. Godbole,
You have the Energy Commission's permission to use any of the illustrations listed for your thesis. Please credit to California Energy Commission, etc.

Thank you for your interest and good luck with your thesis.

Sincerely,

Susanne Garfield- Jones
Media and Communications
California Energy Commission
>>> "Sharada Godbole" <tosharada@hotmail.com> - 12/7/01 12:38 PM >>>
To,
Susan Garfield
California Energy Commission.

Hello Susan,
I had called your office regarding using some illustrations from CEC publications in my graduate thesis.

I am a graduate student at San Jose State University, Environmental Studies Department. I am finishing up my graduate thesis titled "Effectiveness of San Jose's Solar Access Guidelines: A Policy Evaluation." In this thesis to be submitted to the University, I'd like to use some illustrations from three different CEC Publications.

Following is the list of illustrations I'd like to include in the thesis.

From "Energy Principles in Architectural Design" by Edward Dean, 1981
(Publication number P400-81-004):
'Subdivision Site Plan for Solar Orientation' on Page 29.

From "Passive Solar Handbook" by Philip W.B. Niles and Kenneth L. Haggard:
'Thermal Zoning Assumptions' (Clerestory) on Page 36,
'Flexible South Overhang' on Page 63.

From "Planning Solar Neighborhoods" by Jonathan Hammond, James Zanetto, and Cesar Adams, August 1980 (Publication number P500-81-018):
Illustration to demonstrate that 'On intercardinal streets housing can be sited to permit a south orientation.'

I wish to use the above illustrations in my thesis for the purpose of explaining ways to achieve solar orientation and access in residential developments, and I request your permission for the same. I shall of course cite the sources for the illustrations according to the information listed on the copyright pages of the respective publications.

Could you let me know if I can use the illustrations, and if yes, could you send me a permission letter for the same? Following is my contact information.

My address: 350 Hillsdale Avenue, Santa Clara, CA 95051.
My phone: (408) 243-6537.
My email: <tosharada@hotmail.com>
My name in the University records: Sharada B. Thattey.

Hope to hear back from you soon.
Sincerely,
Sharada Thattey Godbole.

Sharada,

For a student paper, all we ask is to receive a copy of the paper. We'd be happy to have you use the image. Thank you for asking. Pls send us an electronic or hard copy.

Thank you,
Doug Hargrave

At 07:45 PM 11/25/2001 -0800, you wrote:

Dear Sir/Madam,

I am a graduate student at San Jose State University, California. In my graduate thesis, I'd like to use an illustration from the manual for Energy 10 software - Designing Low Energy Buildings - specifically Figure C-1: Winter and Summer Angles. The thesis is titled "EFFECTIVENESS OF SAN JOSE'S SOLAR ACCESS GUIDELINES: A POLICY EVALUATION." I'd like to use the illustration to explain solar access and orientation.

Could you advise me about whether I can do so? If yes, do I need a permission letter, and how would I go about acquiring one?

Hope to hear back from you soon.
Thank you very much.

Sincerely,
Sharada Thattey Godbole.

Get your FREE download of MSN Explorer at <http://explorer.msn.com/intl.msx>

Doug Hargrave
Associate Director
Sustainable Buildings Industry Council
1331 H Street, NW
Suite 1000
Washington, D.C. 20005
dhargrave@SBIcouncil.org
202-628-7400, x209