

*ATTITUDES AND SATISFACTION OF RESIDENTS OF SINGLE- AND MULTI-FAMILY EARTH-SHELTERED HOUSING*

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*ABSTRACT*

*User response to existing earth-sheltered housing is critical to the design of increasingly acceptable earth-sheltered dwellings. This study addresses the issue of earth-sheltered/underground housing "acceptability" by assessing the attitudes and housing satisfaction of current residents of single- and multi-family earth-sheltered residences. Energy efficiency is found to be an important motive for choosing an earth-sheltered dwelling. However, other features of this housing alternative are found to be important as well. These features differ between the townhouse and single-family detached (SFD) home groups. Overall, the SFD group expresses more positive attitudes toward earth-sheltered living, suggesting that, even among owners of "unconventional" housing, the single-family detached house is the preferred structure type.*

*INTRODUCTION*

"Earth-sheltered" housing differs from conventional housing in several important aspects. The most salient difference is the use of earth bermed against one or more sides of the dwelling and, in some instances, the presence of earth on the roof. According to Impson and Impson (1984), "Earth-sheltered housing (ESH) can be any structure that makes the earth an integral part of the design to achieve energy savings and other benefits" (p.28). One major reason for covering a structure with earth is to reduce heating and cooling costs by moderating temperature extremes. However, other benefits include reduced maintenance and quieter interiors because of the sound-attenuating capability of an earthen mass. Earth sheltering also offers protection from storms, earthquakes and intruders. In addition, earth sheltering is compatible with active and passive solar energy techniques enhancing its energy conservation potential (Bartz, 1985; Frenette, 1981; Labs, 1976; Labs and Watson, 1981; Sterling, Farnan and Carmody, 1982; Wendt, 1983).

This paper reports the results of a post-occupancy study of the attitudes and housing satisfaction of residents of earth-sheltered homes in the Minneapolis-St. Paul Standard Metropolitan Statistical Area (SMSA). Residents of earth-sheltered townhouses and single-family detached houses are included in the investigation. Each household was asked about its attitudes toward the home, why earth-sheltered living was selected and what the advantages and disadvantages of the current dwelling were considered to be. In addition, the respondents were asked to compare specific dimensions of their current residences with features of their previously owned "conventional" homes. Because residents of earth-sheltered

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housing are a potentially valuable source of information for improving acceptability, this study seeks to identify the characteristics of earth-sheltered housing that are important for acceptance.

Because there are few post-occupancy studies of earth-sheltered housing, there is a need to obtain information about attitudes toward earth-sheltered structures. According to Stewart, McKown, and Newman (1981)

Attitudes regarding design features, comfort, adequacy and other aspects of underground dwellings can provide valuable information to those responsible for the humanistic design of future residential structures (p. 108).

Although the number of respondents in this study is small, the expectation is that the information will be used to develop hypotheses for testing in a more comprehensive study in the future. It can also provide preliminary information to improve acceptability of "nontraditional" housing forms.

#### LITERATURE REVIEW

Although the development and use of earth-sheltered techniques date to prehistoric times, the contemporary earth-sheltered dwelling is not widely produced. The energy crisis of the '70s spawned renewed interest in earth sheltering. Energy conservation appears to be the primary motive for choosing the earth-sheltered housing alternative. Perhaps the disadvantages associated with earth sheltering prevent widescale adoption. The limitations associated with earth-sheltered or underground housing include the fear that an earth-sheltered dwelling will be dark and damp. There is generally a stigma that classifies basements and other below-grade spaces as dismal (Stewart et al., 1981). In addition, the construction cost of earth-sheltered dwellings limits their acceptance. Although estimates of the cost compared to similar above-ground dwellings vary widely, it is generally agreed that a properly designed and constructed earth-sheltered dwelling costs more to build because of higher structural loads and greater waterproofing requirements (Sterling et al., 1982; Wendt, 1983).

While its energy-conserving function is recognized, continuity with existing and accepted architectural forms in the environment has been less successfully achieved by the earth-sheltered dwelling. As more designers and building professionals become involved, however, there is a growing awareness that energy conservation is not the only consideration in the creation of an earth-sheltered dwelling. Labs (1976) was the first to recognize the critical importance of the site and climate in determining the form and suitability of earth sheltering. Frenette (1981) argues that a well-designed earth shelter must express a continuity with its physical, cultural and historical context.

Historically, housing forms acquire acceptability through a gradual process of adaptation and change within a given cultural context. As they evolve, they acquire meaning and significance and become widely recognized, understood and assimilated as part of the built environment (Rapoport, 1969; 1982). The social acceptability of modern earth-sheltered housing is a matter of improving the design of succeeding generations of dwellings. Feedback from first-generation users is a critical component in the process of designing more acceptable dwellings. Labs and Watson (1981) recognize this component when they observe that,

Although the control of climate is one of the earliest themes of architecture, it is not in itself the chief end of design. Other issues

and circumstances give shape to buildings as well...the ultimate issue in performance is always user satisfaction (p.48).

Few studies survey the responses of users, or of potential users, to the earth-sheltered environment. In a study of perceptions of housing alternatives, McCray, Tremblay and Navin (1985) find that most respondents (56 percent) are unwilling to consider earth-sheltered/underground housing. The respondents say that psychological perceptions, design/appearance, "musty odor, dampness, mildew" and cost prevent them from liking earth-sheltered/underground housing. Twenty-three percent of those respondents say they would probably not consider this housing alternative, while 33 percent say they would definitely not consider it. Only 3.7 percent of those queried in the McCray, Tremblay and Navin study say they have an interest in earth-sheltered/underground housing and less than one percent have ever lived in this form of housing. However, the respondents say they like some characteristics of earth-sheltered/underground housing. Energy efficiency, comfort/convenience and safety are most frequently noted as the features that respondents feel increase the "acceptability" of earth-sheltered housing.

A study comparing attitudes of above-ground and dugout dwellers in Coober Pedy, Australia finds strong user acceptance among people who have actually experienced underground living, and moderate acceptance among those who have not had similar experiences (Baggs, 1982). In a survey of visitor reaction to an earth-sheltered prototype home in North Carolina (Stewart et al., 1981), three attitudes are found to be strongly related to the desire to live in a similar home: perception of acceptability of such a dwelling in the community, ease of access, and evaluation of lighting adequacy. Cook (1981) finds that residents of earth-sheltered housing rate their homes significantly higher in terms of safety, privacy, exterior design, views, lighting, acoustics, and comfort than do residents of conventional housing. In a study comparing owners of earth-sheltered housing with those "considering" the purchase of earth-sheltered housing, both groups rate energy conservation as the most important among twelve housing attributes (Rivers, Warde, and Helm, 1981).

Several studies show that the features of the dwelling, such as physical characteristics and tenure, are powerful predictors of residential satisfaction (Campbell, Converse, and Rodgers, 1976; Hanna and Lindamood, 1981; Johnson and Abernathy, 1983; Lane and Kinsey, 1980; Morris and Winter, 1978). Among the physical characteristics, structure type is an extremely important predictor of residential satisfaction. Winter and Morris (1982) state that

Evidence from studies of housing desires and aspirations clearly indicates that North American families, almost without regard to income, occupational status, race or ethnic background, seek ownership of single-family dwellings (p. 71).

An additional variable relevant to housing satisfaction in the present study is user participation in home design and construction. Involvement in the planning and building of one's home is an important source of satisfaction (Becker, 1977; Turner, 1976; Turner and Fichter, 1972). In the present study, almost all residents of single-family detached homes were involved in planning and building the home, while none of the townhouse residents were similarly involved. Thus, it is difficult to determine whether differences in housing satisfaction are attributable to the "involvement" variable or the "structure-type" variable.

*PROCEDURES*

The data for this study were collected in 1980 in connection with a joint project by the Center for Urban and Regional Affairs, the School of Architecture, and the Family Studies Center at the University of Minnesota. The respondents were recruited from a list of individuals who had made inquiries about earth-sheltered housing with the Underground Space Center at the University of Minnesota. All homes in the study were owner-occupied. The fourteen single-family households who participated in the study represent an estimated 5-10 percent of the earth-sheltered households in the Twin Cities, Minnesota Standard Metropolitan Statistical Area (SMSA) at the time of the study.

The townhouse subjects were residents of the Seward Townhouses, a 12-unit development located on an access road to a busy freeway near downtown Minneapolis. This is the only earth-sheltered townhouse development known to exist in the United States. Thus, the eight townhouse households in this study may well represent three-fourths of all earth-sheltered townhouse residents at the time of data collection. Although the sample size is small (consisting of 22 households, 20 male and 19 female subjects), it represents a significant proportion of the universe of earth-sheltered households at the time of this study.

In-person interviews were conducted with an adult male and an adult female in each household. The questionnaire was approximately 23 pages in length. The first two pages, which covered demographic information, were jointly answered by males and females if both were present in the home. Most of the remainder of the questionnaire was answered by males and females separately. Open-ended questions were used to assess the attitudes of residents toward the earth-sheltered environment. These questions were analyzed by a frequency distribution of responses relating to topics suggested by the responses. In addition, there was a series of questions concerning the presence of appliances and energy-conserving devices in past and present homes.

The respondents were also asked to evaluate a number of physical features of their past and present homes as "desirable", "adequate", or "undesirable". It was on the basis of a comparison between the evaluations of the pre- and post-move environments that housing satisfaction was assessed in this report. A significantly lower evaluation of a feature in the past home than in the present (earth-sheltered) home was employed as an indicator of satisfaction with the present home. Conversely, a significantly lower evaluation of the present home than of the past home on a given feature would suggest this feature to be a source of dissatisfaction in the earth-sheltered home.

Although the number of respondents is small and presents some problems for analyses, several questions relevant to the study of earth-sheltered housing "acceptability" can begin to be addressed by these data. Since those who choose an earth-sheltered home represent a very small percentage of the population of housing consumers, it was anticipated that socio-demographic differences would exist between earth-sheltered housing residents and the general population of the Minneapolis/St. Paul SMSA. Based on the literature concerning user attitudes toward earth-sheltered living, earth-sheltered housing consumers in the present study could be expected to express positive attitudes toward their residential environments. Consistent with the literature concerning satisfaction with conventional structure types, single-family home owners in this study could be expected to express more positive attitudes than townhouse owners.

## RESULTS

### *Socio-Economic Characteristics of Respondents*

A comparison of townhouse and SFD participants in this study with the general population of Minnesota indicates that differences and similarities exist between the groups (see Table 1). Median ages for the two groups (townhouse and SFD) are 30 and 34 years, respectively. It appears that townhouse residents are similar in age, while SFD residents are somewhat older than their Minnesota counterparts, whose median age is 29.2 years. The mean family income for both groups (townhouse and SFD), \$26,929 and \$27,731 respectively, is close to the average of \$27,931 for Region 11 (Region 11 includes Anoka, Carver, Dakota, Hennepin, Ramsey, Scott, and Washington counties in Minnesota). However, according to the 1980 census, the *median* family income for Region 11 that year was \$21,434. The median income for earth-sheltered townhouse and SFD residents was \$27,500 and \$22,500 respectively.

The townhouse group is composed entirely of singles or couples without children. The average household size of 1.5 persons for this group is smaller than both the average of 2.9 persons for the SFD sample and the 2.7 average household size in the state. Based on median income and family size, it appears that the financial situation of the townhouse group is better than that of the single-family group.

Residents of earth-sheltered townhouses and single-family housing are better educated than are residents of the region as a whole. The townhouse respondents are highly educated. All have attended college and half have earned a graduate or professional degree. The educational attainment of SFD residents is also higher than Minnesota's general population. Just over 17 percent of the people in Minnesota attended four or more years of college. Just under 20 percent of the SFD residents not only have college degrees, they have more than 16 years of education.

The two groups of respondents, townhouse and SFD residents, differ in terms of occupation. Eighty-three percent of the townhouse group are employed in managerial and professional occupations. Over one-third (35.7 percent) of the males in the SFD group are employed in "precision production, crafts or repairs". Of these most are in the building trades, which may contribute to their willingness to live in "nontraditional" dwellings. Some of the females in the SFD group (33 percent) are not employed outside the home. Among the women in the SFD group employed outside the home, 50 percent are in clerical positions and 35.7 percent are in administrative or technical positions. None of the women living in townhouses are homemakers; all are employed in administrative/managerial (50 percent) or professional (50 percent) positions.

### *Housing Characteristics*

The majority of the SFD group (71.4 percent) were owners before moving to their earth-sheltered homes, while the majority of the townhouse group (87.5 percent) were previously renters (see Table 2). For the townhouse group, the move resulted in more bedrooms and bathrooms than previously, but the number of "other finished rooms" did not increase. For the SFD group, the number of bathrooms increased, while the number of bedrooms remained about the same. As with the townhouse residents, the number of other finished rooms for the

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Table 1. Socio-Economic and Household Characteristics of Minnesota Respondents

	Townhouses			SFD			Minnesota*
	Male	Female	Cmb	Male	Female	Cmb	
Number							
Households							
in sample	--	--	8	--	--	14	--
Respondents							
in sample	6	6	12	14	13	27	--
Median age	32.0	27.5	30	34.5	34	34	29.2
Mean household size			1.5			2.9	2.7
Family income							
Median			\$27,500			\$22,500	\$21,434
						Region 11	
Mean			\$26,929			\$27,731	\$27,931
Percent							
Family Income							
To \$9,999	--	--	--	--	--	--	11.7
\$10,000-14,999	--	--	14.3	--	--	7.7	10.4
\$15,000-19,999	--	--	14.3	--	--	7.7	12.6
\$20,000-24,999	--	--	14.3	--	--	38.5	15.8
\$25,000-29,999	--	--	42.9	--	--	15.4	14.7
\$30,000-39,999	--	--	--	--	--	15.4	18.9
\$40,000-49,999	--	--	--	--	--	15.4	7.9
\$50,000+	--	--	14.3	--	--	--	8.1
Years of School Completed							
0-11	--	--	--	--	--	--	18.9
12	--	--	--	14.3	16.7	15.4	40.0
13-15	33.3	--	16.7	50.0	41.7	46.2	21.2
16	16.7	50.0	33.3	7.1	33.3	19.2	11.6
17+	50.0	50.0	50.0	28.6	8.3	19.2	8.2
Children (Age in Years)							
None	--	--	100	--	--	42.8	--
Under 6	--	--	--	--	--	21.4	--
6-17	--	--	--	--	--	14.3	--
18-24	--	--	--	--	--	14.3	--
6-17 and 18-24 years	--	--	--	--	--	7.1	--
Persons in Household							
1	--	--	50.0	--	--	7.1	24.5
2	--	--	50.0	--	--	35.7	30.5
3	--	--	--	--	--	28.6	16.4
4	--	--	--	--	--	14.3	15.9
5+	--	--	--	--	--	14.3	12.7
Occupation							
Adm./Mngr	16.7	50.0	33.3	14.3	12.5	13.6	12.6

(Table 1. continued)

Professn'l	50.0	50.0	50.0	21.4	--	13.6	13.5
Technician	16.7	--	8.3	7.1	25.0	13.6	4.1
Sales	16.7	--	8.3	--	--	--	10.7
Adm. Support--	--	--	--	--	50.0	18.2	20.0
Service	--	--	--	7.1	--	4.5	13.0
Farm/Forest--	--	--	--	--	--	--	.9
Prec. Prod.,							
Craft, Rpr.	--	--	--	35.7	--	22.7	10.3
Oprtr./							
Fabrc./							
Laborer	--	--	--	14.3	12.5	13.6	15.0

Note: Columns may not total 100 due to rounding

\* "Population Notes", Minnesota State Planning Agency, May, 1985.

Region 11 "Minnesota Analysis and Planning System", 1980 summary census data. Region 11 includes the Minnesota counties of Anoka, Carver, Dakota, Hennepin, Ramsey, Scott and Washington.

SFD group did not increase with the move to the earth-sheltered dwelling. The median number of rooms in the earth-sheltered home is 4.5 for the townhouse and 7.5 for the SFD residents. Thus, the median number of rooms for the townhouse group is somewhat smaller, while the number of rooms for the SFD group is larger than the 5.9 median number of rooms for households in the Minneapolis/St. Paul SMSA.

Length of residence in the earth-sheltered home, especially for the townhouse group, is generally of short duration. Eighty-seven percent of the townhouse sample have lived in their homes for less than six months. Length of residence is longer for the SFD group. Half have lived in their homes at least six months. Over one-fourth have lived in their current homes for over one year.

#### *Housing Attitudes and Satisfaction*

Criteria and motives employed in choosing a home differ somewhat between the townhouse and SFD groups (see Table 3). While energy efficiency is the most frequently mentioned criterion for each group, location and price are mentioned more frequently by townhouse residents. Spatial features are mentioned more frequently by the SFD residents. Aesthetics, comfort, floor plan and amenities are mentioned only by SFD residents. Energy conservation is by far the strongest motivating factor in housing choice for the SFD group. For the townhouse group, energy conservation and related economic advantages are equally important, and together account for two-thirds of this group's responses.

A comparison of reported attitudes prior to moving to the earth-sheltered home and attitudes in the post-move environment suggests that respondents' attitudes toward earth-sheltered living become more positive. When respondents were asked what they thought earth-sheltered housing would be like prior to the move, their answers were about equally divided between positive, negative and neutral. Prior to moving, positive attitudes are related to thermal comfort, energy efficiency and reduced sensory stimulation (i.e., "quiet", "peaceful"). Negative attitudes are most frequently related to thermal discomfort and an unpleasant sort of sensory input (i.e., "damp", "dark"). By contrast, attitudes expressed toward

earth-sheltered living after the move are mostly positive. Three-fourths of the townhouse group and all of the SFD group report that they would recommend their earth-sheltered homes to others. Reasons given most frequently have to do with energy conservation and related money-saving aspects of the dwelling. Those in the townhouse group who would not recommend their homes give economic reasons (i.e., the cost and concern about resale potential).

The respondents were also asked how excited, proud and reluctant they were to describe the home, and how difficult it was to describe. Fifty to 86 percent of the respondents in each group responded that they are "very excited" and "very proud" to describe their earth-sheltered homes. The majority of respondents are not reluctant to describe their homes.

Evidence of satisfaction with the earth-sheltered environment is presented in Table 4. The respondents were asked to rate their past and current homes in terms of the desirability or undesirability of a number of features. The McNemar Test for Significance of Changes is used to measure differences in reported features of the past and current homes. The McNemar Test is a nonparametric statistic that is particularly appropriate for small samples and for "before and after" designs in which each subject serves as his/her own control. It utilizes the Chi-square sampling distribution and requires a minimum expected frequency of at least five. When frequencies in the appropriate cells are too small to permit use of the McNemar Test, the Binomial Test is used instead. The smaller of the observed frequencies and the N are presented in the cell for Binomial Test results and the Chi-square value is presented in the cells where the McNemar Test is employed. No entry in Table 4 indicates that no significant change occurred in ratings between past and current homes.

Based on the McNemar and the Binomial Test, none of the features of the earth-sheltered home are rated significantly less desirable in the current home when compared to the previous home. The greatest change occurs in the rating of the energy-saving features of the current home. The earth-sheltered home is rated more desirable by the townhouse SFD and combined groups. The SFD groups, as well as the combined sample, rate the earth-sheltered home as more expressive of their personalities than the previous dwelling. The same is true for exterior design, the view, privacy inside, storage space in the garage, hobby space and floor plan. Storage space in the house is significant only for the SFD group. Significant changes in terms of space in the home, aesthetics of the interior, privacy outside, and amount of light emerge for the combined sample only. It is noteworthy that, while some negative attitudes prior to moving to the earth-sheltered environment involve concerns about darkness, amount of light in the earth-sheltered homes is rated as desirable by the combined groups.

Differences between the past and current homes also emerge when respondents report on appliances and energy features of their homes. Those who live in townhouses report significantly more washers and dryers, storm doors, insulated shutters and shaded south-facing windows in the earth-sheltered home than in their previous dwelling. The increase in washers, dryers and storm doors probably is attributable to the fact that the majority of townhouse residents moved from apartments where these features were not available. The SFD group reports significantly more thermopane windows and fewer window air conditioners and storm windows in the earth-sheltered home. For the combined sample, the earth-sheltered home has significantly more washers and dryers, insulated shutters, thermopane and south-shaded windows than previous homes.

When asked to evaluate heating and cooling costs, over 90 percent of the

Table 2. Characteristics of Past and Current Earth-Sheltered Dwellings

	Townhouses		SFD		Minneapolis- St. Paul SMSA*
	Past	Current	Past	Current	
Percent					
<b>Length of Residence</b>					
Less than 6 mos.	--	87.5	--	21.4	--
6-11 months	12.5	12.5	7.1	50.0	
1-5 years	75.0	--	57.1	28.6	
6-10 years	12.5	--	14.3	--	--
10+ years	--	--	21.4	--	--
<b>Own/Rent</b>					
Own	12.5	100	71.4	100	66.6
Rent	87.5	--	28.6	--	33.4
<b>Structure Type</b>					
SFD	--	--	78.6	100	--
Duplex	25.0	--	7.1	--	--
Apartment	62.5	--	7.1	--	--
Townhouse	12.5	100	--	--	--
Mobile home	--	--	7.1	--	--
<b>Number of Bedrooms</b>					
None and 1	62.5	--	21.4	7.1	4.3
2	37.5	87.5	28.6	21.4	27.1
3	--	12.5	14.3	71.4	46.1
4 or more	--	--	35.7	--	22.6
<b>Number of Baths</b>					
1	87.5	75.0	64.3	21.4	--
2	12.5	25.0	21.4	57.1	--
3	--	--	14.3	21.4	--
<b>Number of Other Finished Rooms</b>					
1	--	--	--	14.3	--
2	37.5	25.0	21.4	7.1	--
3	37.5	75.0	28.6	7.1	--
4	25.0	--	21.4	42.8	--
5	--	--	21.4	21.4	--
6	--	--	7.1	7.1	--
Median No. Rooms	4.5	4.5	6.5	7.5	5.9

Note: Percent columns may not total 100 percent due to rounding

\* "Annual Housing Survey" 1977. Minneapolis-St. Paul SMSA

Table 3. Criteria and Motives for Choosing a New Home.

CRITERIA						
Before you acquired this place, did the family have any standards or criteria for a new home?						
	Townhouses		SFD		Combined	
	Percent (number)					
Energy efficiency	18.9	(7)	22.4	(15)	21.1	(22)
Spatial	8.1	(3)	22.4	(15)	17.3	(18)
"larger house"						
"more storage"						
Location	35.1	(13)	4.5	(3)	15.4	(16)
"accessible"						
"in the city"						
Aesthetics	--	--	14.9	(10)	9.6	(10)
"view"						
"airy"						
Comfort	--	--	9.0	(6)	5.8	(6)
"ease of living"						
Reduced sensory stimulation	5.4	(2)	6.0	(4)	5.8	(6)
"quiet"						
Price	10.8	(4)	1.5	(1)	4.8	(5)
"affordable"						
Reduced maintenance	5.4	(2)	3.0	(2)	3.8	(4)
Amenities	--	--	6.0	(4)	3.8	(4)
Floor Plan	--	--	6.0	(4)	3.8	(4)
Other	16.2	(6)	4.5	(3)	8.7	(9)

MOTIVES

What sold you on this kind of housing?

Energy Conservation	33.3	(3)	46.2	(12)	42.9	(15)
Economic advantages	33.3	(3)	7.7	(2)	14.3	(5)
"cost comparable to conventional"						
"spend savings on extras"						
Reduced maintenance	--	--	11.5	(3)	8.6	(3)
Earth shelter/solar concept	22.2	(2)	--	--	5.7	(2)
Security	--	--	7.7	(2)	5.7	(2)
Uniqueness	--	--	7.7	(2)	5.7	(2)
Privacy	--	--	7.7	(2)	5.7	(2)
Other	11.1	(1)	11.5	(3)	11.4	(4)

Note: Parenthetical numbers denote number of responses. Percent columns may not total 100 due to rounding.

Table 4. Comparison of desirability of past and current (earth-sheltered) homes

Earth-sheltered home more desirable/adequate than previous residence					
Features	Townhouses	SFD	$\chi^2$	Combined	$\chi^2$
	X/N	X/N		X/N	
Energy Savings	0/7**		13.06***		20.05***
Space in Home					4.92*
Space in Yard					
Floor Plan		0/7**		1/8**	
Hobby Space		0/9**			9.6**
Storage Space in House		0/8**			
Storage Space in Garage		1/9**			6.75**
Amount of Light				0/5*	
Privacy Inside		0/6*		0/8**	
Privacy Outside				0/9**	
Location for Schools					
Location for Work					
Neighbors					
Neighborhood					
Aesthetics of Interior				0/6*	
External Design		0/6*			5.82*
View			5.82**		3.5*
Expressive of Personality		0/9**			8.64**

Note:  $X/N$  = Binomial Probability Test when  $P=Q=1/2$   
 $\chi^2$  = McNemar Test for the Significance of Changes

\* $p < .05$

\*\* $p < .01$

\*\*\* $p < .001$

combined sample respond that the earth-sheltered home costs less to heat and cool than the previous home. The respondents were asked to compare actual heating and cooling costs with the expected heating and cooling costs in the earth-sheltered home. Over half of the townhouse responses for this question are missing. Of the very small group remaining, townhouse residents assess their heating and cooling costs less favorably than do SFD residents. In the SFD group, males most often report costs to be less than expected, while females most often report them to be as expected. Seventeen percent of the SFD group is undecided on this question.

Most of the owners of single-family earth-sheltered housing participated in the planning of that housing. In 64 percent of the cases, plans for the home were drawn by one or more of the family members. In slightly over one-fourth of the cases, plans were drawn by an architect or engineer, while one family purchased stock plans. In several cases, the respondent also mentioned books or magazines as sources of house-plan ideas.

Approximately half of the respondents report they had to give up something to move into the earth-sheltered home. The townhouse residents most frequently mentioned money, followed by possessions and space. The SFD residents most

frequently mention locational convenience, followed by space and money. Responses to this question cannot necessarily be interpreted as things unwillingly given up (e.g., one respondent in the SFD group mentioned giving up "unneeded space").

About two-thirds of the females and about half of the males responded "yes" to the question, "Have there been any major surprises about living in your home?" This question was the only one that clearly elicited more negative responses than positive responses. Positive attitudes make up slightly over one-fourth of the responses. Over half of these responses are that the home is quiet. The remaining positive responses relate to the thermal performance and acceptance by others. Half of the negative responses relate to the thermal performance of the house, including longer heating hours, poor ventilation, higher heating bills and extra coolness. An interesting difference between townhouse and SFD residents is that the former group mentions that the units are not as cool as expected, while the latter group indicates that the homes are too cool. However, when respondents are asked what their "ideal" home would be, one-third of the SFD group describe it as the same or similar to their present homes. While 13 percent of the townhouse group describe the ideal home as similar to the present home, none describe it as the same as the present home. Both the townhouse and SFD groups also frequently describe the ideal home in terms of natural environmental features (i.e., "wooded lot", "lakeshore").

#### DISCUSSION

Attitudes toward earth-sheltered living, although generally favorable, appear to be more positive overall for residents of single-family homes than for townhouse residents. This result is predictable from the literature on housing preferences and satisfaction that suggests that single-family home ownership is the preferred choice of the majority of housing consumers (Campbell et al., 1976; Dillman, Tremblay, and Dillman, 1979; Michelson, 1977; Morris and Winter, 1978). Another explanation for the difference may lie in the participation of the SFD residents in planning and building the home. A number of males in the SFD group are employed in the building trades, which may have facilitated their involvement. At least one family member in all but one of the single-family homes was involved in the design and, in some cases, the construction of the home. The literature on the subject of user involvement in housing design and construction suggests that such participation results in a high level of satisfaction with the finished product (Becker, 1977; Turner, 1976; Turner and Fichter, 1972). It seems possible that involving consumers in the planning and design of their homes would increase acceptability. Consumers must first be attracted to the earth-sheltered concept.

The results of this study are consistent with Cook's (1981) research suggesting that residents of earth-sheltered housing rate their homes very highly in terms of design features. The results are also consistent with Baggs' (1982) Australian study suggesting that the experience of actually living in earth-sheltered homes results in more positive attitudes. It is important that housing consumers become aware that current residents of earth-sheltered housing are very satisfied with their homes, they do not find them dark or damp, and that attitudes toward their housing appear to improve in the post-move environment. A number of features of earth-sheltered living, in addition to energy conservation, are found in this study to be important and desirable to residents. These features, which suggest areas for concentration in the design of future earth-sheltered housing, include reduced maintenance, security, privacy, spatial and sensory aspects of the home, including natural lighting, reduced sensory stimulation and thermal comfort. Thermal performance of the earth-sheltered home and the resulting comfort of

the occupants is clearly an area for further investigation. It appears that, while expectations about the thermal performance of the house are not always fulfilled, the home is still rated far superior to the previous home in terms of energy efficiency.

Some of the SFD residents report having to give up convenience. However, this group does not rate location significantly less desirable than in the previous home. Since a natural setting is an important feature of the "ideal" home, perhaps the rural environment outweighs the disadvantages of an inconvenient location for the SFD group. For the townhouse group, however, location is an important criterion for the choice of the home, and may overshadow the desire to be closer to nature. Economic factors (i.e., cost, resale value) are a major source of negative attitudes. These factors are a concern primarily to the townhouse group. In terms of increasing the acceptability of earth-sheltered housing to a greater number of consumers, reducing the cost may be critical and is an issue that should be addressed through design and technology.

The findings of this study are preliminary given the small number of respondents. Data analysis is hampered by the uneven division of this small sample size between two different structure types. The short length of residence in the earth-sheltered home presents an additional limitation. The results of this study strongly support the conclusion that, at least within the first few years of occupancy, user attitudes toward the earth-sheltered residential environment are very favorable. The question of if and how attitudes change during longer periods of occupancy remains to be addressed in another study. Conclusions from which hypotheses for future investigations can be drawn include:

1. Residents of earth-sheltered townhouse and single-family homes differ from each other and/or from the general population in a number of socio-demographic characteristics, including occupation, education and family size and composition. Whether an owner of single-family or townhouse homes, the earth-sheltered householder living in an urbanized region is better educated than the population in general.
2. Earth-sheltered home owners are more satisfied with their homes than are owners of traditional structures. However, those who own townhouses are less satisfied than are owners of single-family homes. In addition, attitudes toward earth-sheltered living improve over time.
3. Occupants of earth-sheltered housing exhibit an interest in energy conservation and "natural surroundings" both before and after the purchase of a earth-sheltered structure. Their commitment to these ideals is greater than that of conventional home owners.
4. Occupants of multi-family earth-sheltered housing in the inner city exhibit an interest in value, energy conservation and location.
5. Occupants of single-family earth-sheltered housing in an urbanized region exhibit an interest in energy conservation, aesthetics, spatial and design features.
6. Males and females living in earth-sheltered housing assess the adequacy of the physical features of their dwellings similarly.

7. Residents involved in home planning and building are more satisfied with their dwelling than those who are not similarly involved.

Improved "acceptability" of earth-sheltered housing can be accomplished by investigating the attitudes and housing satisfaction of current residents of earth-sheltered dwellings. Post-occupancy investigations can help provide information to design more aesthetically pleasing, more habitable and more economically feasible earth-sheltered housing. Based on the insights of residents of earth-sheltered dwellings, "acceptability" of nontraditional housing forms can be improved. Addressing critical design issues and increasing consumer awareness of the benefits of earth-sheltered housing can provide the incentives necessary to increase the acceptability of earth-sheltered living.

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