United States
Environmental Protection
Agency

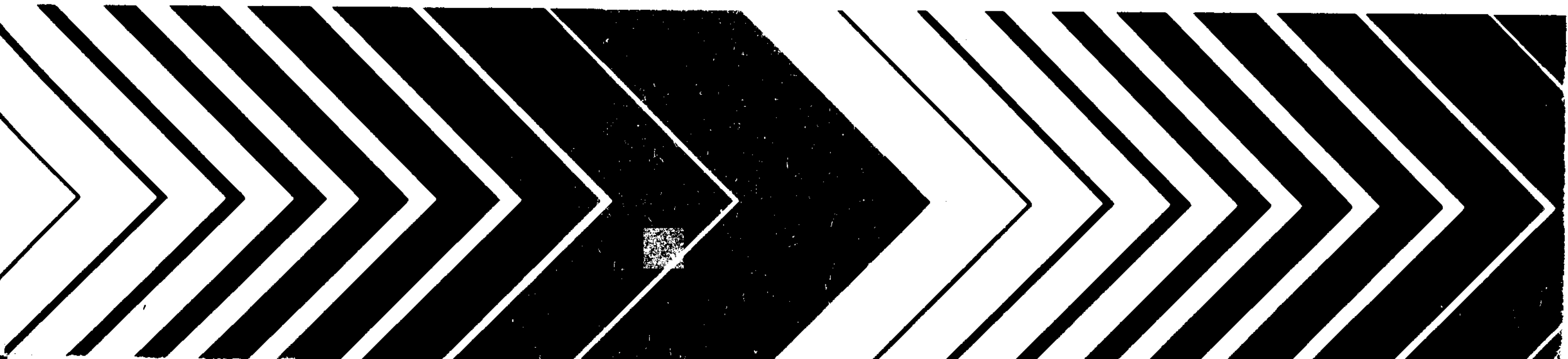
Office of Health and
Ecological Effects
Washington DC 20460

EPA-600/5-79-001b
February 1979

Research and Development

Methods Development for Assessing Air Pollution Control Benefits

Volume II, Experiments in Valuing Non-market Goods: A Case Study of Alternative Benefit Measures of Air Pollution Control in the South Coast Air Basin of Southern California



OTHER VOLUMES OF THIS STUDY

Volume I, Experiments in the Economics of Air Pollution Epidemiology, EPA-600/5-79-001a.

This volume employs the analytical and empirical methods of economics to develop hypotheses on disease etiologies and to value labor productivity and consumer losses due to air pollution-induced mortality and morbidity.

Volume III, A Preliminary Assessment of Air Pollution Damages for Selected Crops within Southern California, EPA-600/5-79-001c.

This volume investigates the economic benefits that would accrue from reductions in oxidant/ozone air pollution-induced damages to 14 annual vegetable and field crops in southern California.

Volume IV, Studies on Partial Equilibrium Approaches to Valuation of Environmental Amenities, EPA-600/5-79-001d.

The research detailed in this volume explores various facets of the two central project objectives that have not been given adequate attention in the previous volumes.

Volume V, Executive Summary, EPA-600/5-79-001e.

This volume provides a 23 page summary of the findings of the first four volumes of the study.

This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161.

EPA-600/6-79-001b
February 1979

METHODS DEVELOPMENT FOR ASSESSING TRADEOFFS IN ENVIRONMENTAL MANAGEMENT

Volume II

Experiments in Valuing Non-Market Goods: A Case Study of Alternative Benefit Measures of Air Pollution Control in the South Coast Air Basin of Southern California

by

David S. Brookshire, Ralph C. d'Arge and William D. Schulze*
University of Wyoming
Laramie, Wyoming 82071

Mark A. Thayer
University of New Mexico

USEPA Grant #R805059010

Project Officer:
Dr. Alan Carlin
Office of Health and Ecological Effects
Office of Research and Development
U.S. Environmental Protection Agency
Washington, D.C. 20460

OFFICE OF HEALTH AND ECOLOGICAL EFFECTS
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

---

*William D. Schulze's contribution to this volume was performed while he was an Associate Professor of Economics at the University of Southern California.

DISCLAIMER

PREFACE

The motivation for this volume can be traced to the authors' convictions that the valuation of non-market goods through the application of economic analysis could be accomplished. The various contributions to the literature that formed the underpinnings of this effort are many and diverse. Yet, the work by Alan Randall in setting forth the framework and first empirical application of the iterative bidding technique for valuing non-market goods must be noted. Many individuals including Drs. Fred Blank, Robert Rowe, Robert Horst, Jr., Alan Randall, Mr. Larry Eubanks, Mr. Berry Ives, Mr. Rex Adam have provided worthwhile comments and criticisms. None of these individuals are responsible, however, for the results.

ABSTRACT

In this study, the empirical results obtained from two experiments to measure the health and aesthetic benefits of air pollution control in the South Coast Air Basin of southern California are reported. Each experiment involved the same six neighborhood pairs, where the pairings were made on the basis of similarities in housing characteristics, socio-economic factors, distances to beaches and services, average temperatures, and subjective indicators of housing quality. The elements of each pair differed substantially only in terms of air quality. Data on actual market transactions, as registered in single-family residential property transactions, and on stated preferences for air quality, as revealed in neighborhood surveys, were collected. It was expected that a relation would exist between what people do pay for air quality as reflected in property value differences, and what they say they will pay, provided there are no incentives for them to distort their bids.

Given various assumptions on income, location, aggregation by areas, specific housing characteristics, and knowledge of the health effects of air pollution, both the survey and the property value experiments yielded estimates of willingness-to-pay in early 1978 dollars for an improvement from “poor” to “fair” air quality of from \$20 to \$150 per month per household. The results, therefore, indicate that air quality deterioration in the Los Angeles area has had substantial negative effects on housing prices and that these effects are comparable in magnitude to what people say they are willing to pay for improved air quality.

CONTENTS

Appendices

FIGURES

TABLES

CHAPTER I

INTRODUCTION TO VOLUME 11

Determining the benefits of non-market, public, or collective goods such as environmental quality as become more important as increased regulation by government agencies has- imposed heavy costs on the private and public sector. The question “Do benefits of environmental programs exceed costs?” is being asked with increasing frequency. This study attempts both to compare methodologies for estimating the benefits of environmental control and to provide specific estimates of the benefits of air pollution control for selected areas of the South Coast Air Basin of Southern California.

Although a number of methodologies are available, here we “focus on two; the use of survey instruments and on the use of property value differentials to measure the value of air quality. The overall focus of Chapter II is primarily to set the existing work on non-market valuation in perspective. We initially present a theoretical basis for the variety of valuation approaches in Section 2.1 where the theoretical linkages between techniques such as the property value and survey approaches are shown. The structure of what is termed the survey instrument substitution approach will be discussed in detail in Section 2.2. The iterative bidding technique also using the survey instrument will be presented in Section 2.3. Endemic to both the substitution and iterative bidding approach are potential biases and other limitations on what we term the contingent valuation approach in which hypothetical situations are utilized. In Section 2.5, arguments are presented which suggest some advantages to the contingent valuation approach. These arguments have been typically ignored while the bias issues in Section 2.4 have tended to dominate the propositions in existing literature. Section 2.6 presents a brief review of the existing work using contingent valuation methods. The remainder of the volume is devoted first to reporting in Chapter 111 on the paired sample methodology used in the South Coast Air Basin study. Then, the design and results of the South Coast survey instrument are presented in Chapter IV including summary estimates of total air pollution control benefits in the South Coast Air Basin.

CHAPTER II
THEORETICAL FOUNDATIONS

2.1 Valuing Non-Market Goods: A Common Theoretical Basis

The provision or control of collective goods and bads has falleen implicitly to the public sector. Given the economists goal of efficiency, implying a price oriented framework, an immediate problem arises. That is, the price of a public good or intangible cannot readily be observed in a market setting yet the employment of benefit-cost analysis requires some form of price information for such goods as aesthetics. How then is the requisite information obtained?

Several approaches have been recently subjected to theoretical development and empirical scrutiny for ascertaining the value of non-market goods. One such approach is a direct valuation method which, simply stated, asks the consumer to bid in a highly structured situation the dollar values for alternative levels of provision of the public commodity in question [Davis, 1963; Kurz, 1974; Bohm, 1972; Bohm, 1971; Randall, *et.al.*, 1974; Brookshire, *et.al.*, 1976; Blank, *et.al.*, 1977; Randall, *et.al.*, 1978; Thayer and Schulze, 1977; Brookshire and Randall, 1978]. Another approach is the travel cost method which has had many empirical applications [Knetsch, 1963; Clawson and Knetsch, 1966; Davis and Knetsch, 1966; Pearse, 1968]. In the case of air pollution there have been more than several property value studies: [Ridker and Henning, 1967; Anderson and Crocker, 1971; Freeman, 1974]. These property value studies are based on the hedonic market approach which is theoretically founded on the household production model of the consumer, [Lancaster, 1966; Rosen, 1974; Muellbauer, 1974; Hori, 1975]. Consumers are conceptualized as combining private and public commodities through a household production function to produce characteristics that the consumer values. In these studies, observed variations in market prices are associated with characteristics such as environmental quality. Finally, questionnaire approaches have been employed to gather data on household technology and preferences. A primary motivation in the development of this indirect valuation approach was to provide a cross-check for the empirical estimates derived from direct valuation methods, [Blank, *et.al.*, 1977]. Actual empirical efforts to apply this indirect valuation method have concentrated on producing data useful in estimating the household technology, [Blank, *et.al.*, 1977; Brookshire, Randall, *et.al.*, 1977].

The direct and indirect valuation methods rely on what are essentially a set of hypothetical situations, both in terms of the level of provision of the public commodity, as well as in terms of the property rights structure associated with use of the public commodity. Therefore, the empirical values which are produced are contingent upon the hypothetical structures which are presented to the consumer.[1/] It is for this reason that these two methods have come to be known as "contingent valuation" methods.[2/]

In the contingent valuation format consumers are queried as to willingness to pay, willingness to accept compensation, past and current experiences, potential expenditures adjustments, and so forth in estimating compensated demand functions for public commodities. Thus the motivation for contingent valuation approaches is to produce valuation measures that can be used in benefit-cost analysis under the Pareto improvement criterion.

The emphasis to date in developing non-market valuation techniques has been toward choosing a well-defined public good and designing a survey instrument for the valuation procedure. This process involves issues of replication, 3/ bias testing, 4/ and methodological cross-checks.[5/]

These efforts have fallen short in several ways. First, the variety of approaches have no common theoretical framework. Second, no acknowledgment of the various characteristics of the good have been set forth. That is, the good "air quality" can have an aesthetic characteristic, a health characteristic, plus others possibly. Thus a bid or value placed on changing levels of air quality, where only a single characteristic such as aesthetics is bid upon, will possibly produce a lower bound estimate. Finally, the lack of a common theoretical framework has precluded designing a survey instrument which obtains information for every individual, enabling a cross testing of various methodological approaches for valuation. 6/

The variety of approaches used to value public goods lack a common theoretical basis. Whether the analysis employs contingent, actual observed behavior or market prices, the results have been based on narrow theoretical structures which have little relationship to others. That is, the initial assumption sets are not identical and differing modeling structures further aggrevate the problem.

Certain characteristics must exist in a common modeling structure, such as the possibility of consumer substitutions across activities and sites, and must include site or activity specific levels of environmental quality. Individual utility can then be specified as a function of levels of activities, $A_1, \ldots, A_i, \ldots, A_n$ (where the subscripts denote either sites or different activities for a given site) as a function of environmental quality for each environmentally related activity or site, $Q_1, \ldots, Q_i, \ldots, Q_n$ (where we take increases in Q_i as increasing environmental quality), and as a function of a composite commodity X. Utility is then a quasi-concave function.

$$U(A_1, \ldots, A_n; Q_1, \ldots, Q_n; X), \tag{2.1}$$

where $\partial U/\partial A_i = U_A^i \geq 0$, $\partial U/\partial Q_i = U_Q^i \geq 0$, and $\partial U/\partial X = U_X \geq 0$ so utility is increasing in A_i, Q_i, and X. Of course, a number of assumptions on the separability of U are obvious given environmental quality is related to specific activities in the model. However, we do not pursue that issue here. Rather, we focus on the form of an economic unit's marginal willingness to pay for environmental quality.

The budget constraint necessary to specify the individuals optimization problem is given as:

$$Y - \sum_{i=1}^{n} P_i A_i - X \geq 0 \tag{2.2}$$

or income Y minus the sum of expenditures on environmentally related activities $\sum_{i=1}^{n} P_i A_i$ (P_i is taken as the price of activity i which may, in fact, represent joint consumption of several market commodities) minus expenditures for the composite consumption commodity X (price is taken as unity to simplify the analysis).

For a given vector of environmental quality, an economic actor will then choose to allocate his activities such that (2.1) is maximized subject to ~2.2) which in turn implies that:

$$\frac{U_A^i}{U_X} \leq P_i, \ \left(\frac{U_A^i}{U_X} - P_i\right) A_i = 0, \ A_i \geq 0 \qquad i = 1,2, \ldots, n, \tag{2.3}$$

or the marginal rate of substitution between activity i and the composite commodity X equals the price of activity i - if that activity is chosen ($A_i > 0$). We, of course, assume $X > 0$.

To determine the marginal willingness to pay for environmental quality at a particular site, for example i = 1, we set utility as given in equation (2.1) equal to a constant and totally differentiate the resulting expression. By then taking the total differential of equation (2.2), setting $dQ_i = 0$ for $i \neq 1$ and by using (2.3) we obtain:

$$\frac{dY}{dQ_1} = \sum_{i=1}^{n} A_i \underset{(a)}{\frac{dP_i}{dQ_1}} - \underset{(b)}{\frac{U'_Q}{U_X}} \tag{2.4}$$

as the change in income necessary to offset a change in environmental quality at site 1.[1] Another expression for dY/dQ can be obtained simply by taking the total differential of the budget constraint, equation (2.2), again setting $dQ_i = 0$ for $i \neq 1$):

$$\frac{dY}{dQ_1} = \underbrace{\sum_{i=1}^{n} A_i \frac{dP_i}{dQ_1}}_{(c)} + \underbrace{\sum_{i=1}^{n} P_i \frac{dA_i}{dQ_1}}_{(d)} + \underbrace{\frac{dX}{dQ_1}}_{(e)}, \qquad (2.5)$$

presuming that the dA_i/dQ_i are consistent with constant utility. Comparing the two expressions for marginal willingness to pay implies that since the terms (a) and (c) in equations (2.4) and (2.5) respectively are identical, that:

$$\sum_{i=1}^{n} P_i \frac{dA_i}{dQ_1} + \frac{dX}{dQ_1} = \frac{U'_Q}{U_X} < 0, \qquad (2.6)$$

so the sum of the terms (d) and (e) in equation (2.5) are negative.

The interpretation of (2.5) provides the basis for comparing various methodologies. If the objective is to determine the marginal willingness to pay for environmental quality dY/dQ_1, one obvious approach is to simply postulate in a survey instrument that Q_1 changes by a small amount, dQ_1, and request information on the contingent willingness of the individual to accept compensation for a decrease in quality or payment to prevent a decrease in quality. This direct approach, however, is open to questions of bias, a topic we take up in Section 2.4.

A second approach, which we term the substitution approach, is to assume that prices of activities do not change in response to change in environmental quality. For many situations this may well be a reasonable approximation. For example, if an energy development such as a powerplant disrupts a recreation site, recreationists may respond by driving further to other alternate sites. If no entrance fees are employed or if such fees are institutionally fixed, if driving costs, the price of gasoline, etc., and prices of recreation equipment don't change, then the assumption that $dP_i = 0$ appears to be a good one. In that case the marginal willingness to pay becomes identical to (2.6) above or:

$$\frac{dY}{dQ_1} = \sum_{i=1}^{n} P_i \frac{dA_i}{dQ_1} + \frac{dX}{dQ_1} < 0. \qquad (2.7)$$

Where prices are known, estimates of the value of environmental quality can be obtained empirically by collecting data on dA_i/dQ_1 (the change in the pattern of recreation activities in response to a change in quality), and on dX/dQ_1 (the change in expenditures not related to recreation activities). Of course, the change in environmental quality can be contingent, resulting in changes in activities, or actual cross-sectional or time series data can be employed where environmental quality varies over space or time. In any case, all studies to date focusing on substitution of activities or commodities in response to changes in environmental quality that we are aware of have assumed prices to be fixed.

In contrast to the actual or contingent substitution approaches, the hedonic approach, focusing on price effects of changes in environmental quality effectively assumes both the allocation of some activities and other expenditures is invariant to changes in quality ($dA_i/dQ_1 = 0$, for some i, and $dX/dQ_1 = 0$), but also assumes that all prices other than P_1, the price associated with A and in turn Q_1, remain fixed ($dP_i/dQ_1 = 0$, $\forall_i \neq 1$). Thus, from equation (2.5):

$$\frac{dY}{dQ_1} = A_1 \frac{dP_1}{dQ_1} \quad . \tag{2.8}$$

As an example of this approach, consider a study which uses changes in property values of homes near streams and lakes in response to changes in water quality as a measure of the value of water quality improvements. Serious questions must be raised however, concerning the reality of the assumptions that other prices and levels of other activities are fixed. For example, if water quality deteriorates in a small lake, local residents may well substitute other recreation alternatives so property values will not fully capture the willingness to pay for water quality.

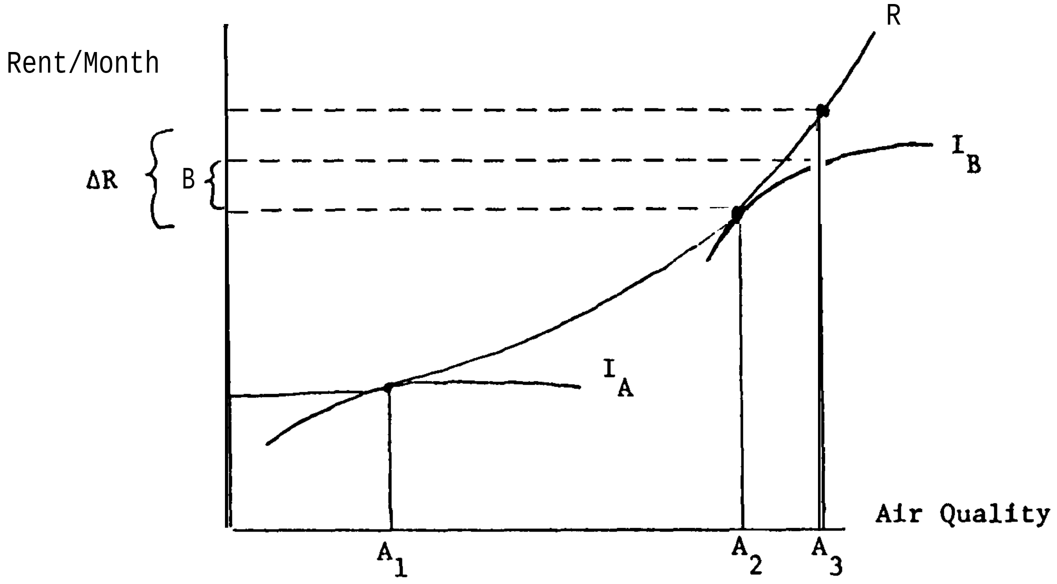
In summary, the marginal willingness to pay of individuals for environmental quality can be determined as shown in our theoretical context by three approaches. First, individuals can be directly asked to provide their marginal willingness to pay: dY/dQ_1. Second, assuming no price changes occur, information can be collected on, dA_i/dQ_1 and dX/dQ_1, the substitution of activities and expenditures which occurs in response to a change in environmental quality. From this data one can impute a marginal willingness to pay. Third, assuming the allocation of activities and expenditures is invariant to a quality change and assuming all prices. but one are also invariant, the change in the single remaining price, dP_1, can be used to impute environmental benefits. Of the three approaches, the one which requires the fewest a priori assumptions and minimal data collection is the first, contingent valuations derived from survey instruments. However, this direct approach remains to be systematically compared to other methods. The empirical portions of this research attempt to address this situation.

One final point needs to be made with respect to non-marginal changes in environmental quality which require in turn that proper measures of willingness to pay as opposed to marginal willingness to pay be utilized for comparing alternative methodologies. In the empirical studies presented below, individuals were asked to bid on non-marginal changes in air quality. These direct non-marginal bids are then compared to the changes in property value which are associated with a similar shift in environmental quality. What then is the theoretical relationship between the property value measure of willingness to pay as compared to the direct asking approach? If we assume that property values capture the entire willingness to pay for clean air, then Figure 2.1 provides an answer.

In Figure 2.1 monthly rent or equivalent monthly payments for owner owned homes is plotted on the vertical axis. On the horizontal axis we plot air quality. Now, hedonic price theory implies that if people prefer clean air, rents should rise across a region (everything else

Figure 2.1

Willingness to pay Comparison for Property Values versus Iterative Bidding Results



held constant) as the air quality improves. This results in the rent gradient denoted by R in Figure 2.1. Individuals with different preferences, tastes, over different levels of air quality will locate at different points along R. Thus, an individual A with indifference curve I_A chooses to live in an area with poor air quality, A_1, and pay lower rent, while an individual B who prefers clean air with an indifference curve I_B will chose to live in an area with better air quality, A_2, but must give up income to pay the higher associated rent. How, if we ask individual B located at air quality level A_2 how much at the most he or she is willing to pay to improve air quality at that location to A_3, the individual should be willing to pay $B per month as shown in Figure 2.1. Note, however, that if we compare the rents of air quality at location A_2 to those at a location with improved air quality, A_3, equivalent to that specified in the hypothetical question above, the rent difference is AR, as shown in Figure 2.1, which exceeds the bid B. This occurs because although the rent gradient gives the same valuation at the margin as the bid, (the indifference curve I_B and the rent gradient R have the same slope at A_2), when non-marginal changes in air quality are employed, the rent gradient moves across individuals of differing tastes with respect to air quality. In other words, the rent gradient may overestimate willingness to pay because higher rents in clean air air areas are associated with especially sensitive individuals and not with the general population. 8/ Thus, although as- we have shown in preceding arguments, property value studies may underestimate marginal willingness to pay, they may also overestimate non-marginal or total willingness to pay.

2.2 The Substitution Framework

The analytical framework of the substitution approach is that of the household production function approach to consumer behavior. Three inter-related substitution approaches are possible to implement. Although each approach contains empirical characteristics which distinguish them, they are all the result of a single analytical structure. It is believed to be very important to provide consistency checks within the overall research effort and within, where possible, a single approach. As such, each approach, although requiring a separate set of assumptions and empirical structures, should be able to generate substantially identical outputs in analytical terms which can be compared. The analytical structure along with a description of the three sub-approaches will be presented in general terms.

Specifically; this section discusses in detail the hedonic and substitution approaches set forth in the contingent valuation framework in the previous section (see equations 2.7 and 2.8). Clearly, consideration of the approaches principally involves issues of replication. While the overall substitution framework is discussed, the reader should be forewarned that no empirical results are presented in this report. However, the necessary data was collected as described below. Thus, a comparison between alternative approaches is forthcoming. 9/

The essential elements in the substitution framework are: (1) a utility function (set of preferences); (2) a household technology; (3) budget and time constraints; 10/ and (4) the prices of marketed goods.

The economic agent is presumed to derive utility or satisfaction from a set of characteristics which are produced within the user unit itself. Inputs into the individual's production process are the market goods which the individual purchases given the individual's income and market prices, Analytically, the individual's problem is that of maximizing a utility function, U(Z), which is a function of the vector of characteristics, Z, subject to the user's technology, $Z \cdot F(X)$, or means of transforming a vector of market goods, X, into characteristics, and subject to the individual's income constraint, $P^TX = \bar{I}$, where P^T is the transpose of the vector of market prices and $\bar{I}$ is the individual's fixed income.

That is:

$$\max_{Z} \quad U(Z)$$

$$\text{s.t.} \quad Z = F(X)$$

$$I = P^TX \tag{2.9}$$

The dimensions of this problem are perhaps best illustrated by way of a two-stage optimization procedure. The first stage of the problem would be:

$$\min_{X} \quad P^TX$$

$$\text{s.t.} \quad \bar{Z} = F(X) \tag{2.10}$$

Here, of course, the problem is to minimize the expenditures the individual makes in producing a given vector of characteristics, $\bar{Z}$. The Lagrangrian for this problem is:

$$L = P^TX + \lambda[\bar{Z} - F(X)] \tag{2.11}$$

where λ is a multiplier. First order interior conditions are:

$$\partial L/\partial X = P - F'(X)\lambda = 0$$

$$\partial L/\partial \lambda = \bar{Z} - F(X) = 0$$

(2.12]

The solution to this system of necessary conditions gives, first, a system of input demand functions:

$$X = X(P,Z), \tag{2.13}$$

which are functions of prices and the fixed vector of produced characteristics, and second, a vector of shadow costs, or hedonic prices for the produced characteristics:

$$\lambda = \partial PX^0/\partial \bar{Z} = P/F'(X) \tag{2.14}$$

where X^0 denotes the optimal value of X.[11]

In addition, the minimum value for expenditures is obtained by multiplying the optimal demands for the inputs by their presumed fixed input prices. The resulting function is known as a cost function, 12/ and it gives the maximum expenditure to achieve a given output vector. It is, of course, a function of input prices out, and the output vector. chosen:

$$C(P,Z) = P^{T}X(P,Z) \qquad (2.15)$$

Note an interesting property of this function. The partial derivative of the cost function taken with respect to the characteristic vector is the marginal cost of producing the characteristic, which is the hedonic price.

$$\partial C(P,Z)/\partial Z = \partial P^{T}X^{9}/\partial Z = \lambda \qquad (2.16)$$

Here is the motivation for the empirical studies utilizing what has come to be known as the hedonic price technique. The approach appears quite simple in that simply relating observed expenditures on measures of characteristics produces hedonic price equations when the estimated relation is partially differentiated with respect to a characteristic.13/

The second stage in solving the individual's problem is written:

$$\begin{aligned} &\max_{z} && u(z) \\ &\text{s.t.} && \bar{I} = C(P,Z) \end{aligned} \qquad (2.17)$$

This problem chooses that combination of characteristics that the individual will produce in order to maximize his utility subject to the condition that his budget be exhausted.

The Lagrangian for this problem is:

$$L = U(Z) + \propto[\bar{I} - C(P,Z)] \qquad (2.18)$$

where $\propto$ is a multiplier. First order interior conditions are:

$$\partial L/\partial Z = U'(Z) - \partial C(P,Z)/\partial Z \propto = 0$$

$$\partial L/\partial\propto = I - C(P,Z) = 0 \qquad (2.19)$$

This solution to this system of necessary conditions gives, first, a system of characteristic demand functions:

$$A = Z(\lambda,\bar{I}) \qquad (2.20)$$

which are functions of hedonic prices, λ, since $\lambda = \partial C(\cdot)/\partial Z$, and income, and second the marginal utility of income:

$$\propto = \partial U(Z)/\partial I \qquad (2.21)$$

The dual to the problem solved in stage 2 is written:

$$\min_{Z} \quad C(P,Z) \qquad (2.22)$$

$$\text{s.t.} \quad \overline{U} = U(Z)$$

The Lagrangian for this problem is written:

$$L = C(P,Z) + \gamma[\overline{U} - U(Z)] \qquad (2.23)$$

and the necessary conditions for an interior optimum are:

$$\partial L/\partial Z = \partial C(P,Z)/\partial Z - U'\gamma = 0 \qquad (2.24)$$

$$\partial L/\partial \gamma = \overline{U} - U(Z) = 0 \qquad (2.24]$$

Solution to this system of equations yields income compensated demand functions for the characteristics:

$$Z^* = Z^*(\lambda,\overline{U}) \qquad (2.25)$$

which are functions of the constant utility index and hedonic prices. In addition note that since hedonic prices are functions of the market prices of inputs, the income compensated demand for the characteristics can also be expressed as functions of market prices and a constant utility level. Furthermore, equations (2.25) could be substituted into equations (2.13) to obtain income compensated demand functions for the inputs as in-equation (2.26].

$$X^* = X^*(P,\overline{U}) \qquad (2.26)$$

It is also possible to define an expenditure function as the minimum expenditure necessary to achieve a given utility level. The expenditure function can be obtained by multiplying the compensated characteristic demand functions by the vector of hedonic prices as in equation (2.27).

$$M(\lambda,U) = \lambda^{T}Z^*(\lambda,\overline{U}) \qquad 2.27$$

Similarly, the income compensated input demand functions might be multiplied by the vector of market prices in order to obtain an expenditure function relating directly to input markets. However, since income compensated demands for the characteristics were utilized in obtaining income compensated input demands, and since hedonic prices are functions of input prices, deriving the expenditure function with respect to characteristics would be equivalent to deriving an expenditure function looking at the input side.

Now that the basic analytical structure has been presented, each specific approach will be outlined. Each approach is embodied in the analytical structure and is distinguished by the point within that structure at which empirical estimation begins and with respect to the information required to implement each approach. List 2.1 presents an outline of each approach. The following discussion will follow the outline presented in this list.

The expenditure equation approach is primarily involved in estimating hedonic prices and ordinary characteristic demand functions. The first step in this procedure is to estimate a cost function, C(P,Z). This is done by relating estimated expenditures by individuals to individual observations of characteristics, Z. Note that since interest at this point is only with obtaining estimates for λ, the hedonic prices, it is not necessary to actually obtain information on market prices, P, in order to obtain estimates of λ. Partially differentiating the estimated cost function with respect to each characteristic will provide λ_i (^denotes estimates, and i indexes a characteristic).

In simple cases, where the technology is nonjoint and linear homogeneous, C(P,Z) will be linear in Z [Pollak and Wachter, 1975]. However, when the technology is joint, it will be the case the C(P,Z) will be nonlinear in Z. When this is true, differentiation of the estimated cost function with respect to the characteristics yields a set of hedonic prices which are functions of the characteristics themselves. It is therefore possible at this point to estimate individual hedonic prices, Z_{ik}, for each individual user k in the sample (see A.3 in List 2.1). Now that individual prices have been obtained, characteristic demand functions can be estimated by relating individual observations for characteristics to estimated individual hedonic prices and incomes (see A.4 in List 2.1) 14/

There would appear to be at least three problem areas in this approach. First, it must be noted that the procedure is estimating a system of characteristic demand functions. Standard econometric procedures suggest that the two-stage least squares estimation technique be utilized. This procedure will yield consistent but not unbiased estimates of hedonic prices [Theil, 1971].

Second, an identification problem exists in that the data utilized in the estimation procedures is simultaneously determined by supply and demand considerations. 15/ Thus, even considering that there is a system of demands to estimate, there is also a system of characteristic supply curves for which, unfortunately, it appears there is not enough information to allow a solution to the identification problem to be devised. Work will be undertaken on this problem in the hope of identifying an additional set of information that could be obtained from the substitution portion of the questionnaire which will allow solution of the identification problem.

Finally, there is some apprehension with respect to the step which estimates individual hedonic prices on the basis of individual characteristic demands, and then turns around to estimate demand curves using the same information. This procedure seems to be somewhat circular, and may seem somewhat more questionable in the case when C(P,Z) is estimated to be linear in Z. In this case, how is the expenditure equation approach able to estimate characteristic demand curves since there would be no

List 2.1

PROCEDURE OUTLINE

A. Expenditure Equation:

1. Estimate C(P,Z) by relating expenditures to Z.
2. $\partial C/\partial Z = \hat{\lambda}$; C nonlinear in Z → $\hat{\lambda} = f(Z)$.
3. Estimate $\hat{\lambda}_{ik} = f(Z_{ik})$ where k represents individual observations and i represents characteristics.
4. Estimate $Z = Z(\lambda, I)$ by relating Z_i to $\hat{\lambda}_i$ and I_i.

B. Expenditure Function:

1. Estimate $Z = F(X)$ by relating Z_i to X_i to obtain technology for representative household.
2. Assume U(Z).
3. 1 and 2 → specific form for $M(\lambda, \bar{U})$ and $Z^* = Z^*(\lambda, \bar{U})$, both of which are derived.

C. Cost Function:

1. Estimate C(P,Z) by relating expenditures to Z_i and P_i.
2. Define marginal rate of substitution between Z_i and Z_j, as $R_{ij}(Z) = -\frac{\partial C(P,Z)}{\partial Z_i} / \frac{\partial C(P,Z)}{\partial Z_j}$ and $R_{i1}(Z)$ $R_i(Z)$, i = 2,3, . . .,n.
3. If $R_i(Z)$ is continuously differentiable, and $\frac{\partial R_i}{\partial Z_1} R_j - \frac{\partial R_j}{\partial Z_1} R_i + \frac{\partial R_i}{\partial Z_j} - \frac{\partial R_j}{\partial Z_i} = 0$, i, j = 2,3, . . .,n, then U(Z) is the solution to $dZ_1 + R_2(Z)dZ_1 + R_3(Z)dZ_3 + \ldots + R_n(Z)dZ_n = 0$.
4. From 1, $Z = F(X)$ can be inferred in form by picking a $\bar{Z}$ and graphing the isocost line $C(\bar{Z}, P)$ for different prices P'. This procedure will trace out an isoquant.
5. From 3 and 4, $M(\lambda, \bar{U})$ and $Z^* = Z^*(\lambda, \bar{U})$ can be derived.

variation in P? The expenditure function approach is primarily, involved in deriving income compensated characteristic demand curves. The first step in this procedure involves estimation of the household technology. Information on the technology is derived from the substitution questionnaire. The method by which the technology is to be estimated is to relate individual observations on characteristics with individual input observations. This will result in a representative household technology (B.1 in List 2.1).

The second step in this procedure is to assume various forms for utility functions, U(Z). It is, of course, necessary to either obtain information on reasonable utility functions or to assume forms for the utility function in order to derive compensated demand functions. Given a utility function and an estimated technology, compensated characteristic demand functions are derived by solving the problem represented by equation set (2.22) above.

There appears to be two major problem areas in this approach. First, the necessity of having to assume forms for U(Z) weakens the approach in terms of believability and applicability. This approach could be strengthened by estimating marginal rates of substitution between the characteristics in order to limit the possible class of utility functions which is consistent with the empirical results. The second problem is, of course, an identification problem with regard to estimating the household technology. The data observations which will be obtained from the household substitution questionnaire will embody both demand considerations and technology since they are presumed to be equilibrium data. Again, additional work now must be initiated, providing an information set which will allow solution of the identification problem.

The motivation for the cost function approach is increased generality. By using duality theory [Shepherd, 1970; Uzawa, 1964; Hall, 1973; Diewert, 1974] in combination with the theory of integrability of demand, [Samuelson, 1950; Hurwicz, 1971] it is hoped that fewer *a priori* assumptions will have to be made in generating income compensated characteristic demand functions. The first step in this approach is to estimate C(P,Z) by relating expenditures to characteristics and input market prices, P. This is similar to step 1 in the expenditure equation approach, except that in that approach it was not necessary to include P in the estimation procedure. Utilizing P in estimating C(P,Z) is necessary in this approach if it is. to be later possible to identify the form of the household technology (see C.4 in List 2.1].

Given an estimated C(P,Z), it is possible to derive marginal rates of substitution between the characteristics which can be defined as:

$$R_{ij}(Z) = -\frac{\frac{\partial C(P,Z)}{\partial Z_i}}{\frac{\partial C(P,Z)}{\partial Z_j}} \tag{2.28}$$

Note that $\frac{\partial C(P,Z)}{\partial Z_i}$ is nothing more than the hedonic price for characteristic i. From traditional consumer theory it is known to be the case that the marginal rate of substitution between any two characteristics will be equal to the ratio of the characteristics prices at an optimum. Once $R_{ij}(Z)$ are calculated across all characteristics entering the utility function, this approach turns to the theory of integrability of demand in order to infer a utility function up to a monotonic transformation from information about the marginal rates of substitution.

Defining $R_{i1}(Z) \equiv R_i(Z)$ for $i = 2,3, \ldots, n$, if the $R_i(Z)$ are continuously differentiable and if:

$$(\partial R_i/\partial Z_1)R_j - (\partial R_j/\partial Z_1)R_i + (\partial R_i/\partial Z_j) - (\partial R_j/\partial Z_i) = 0 \qquad (2.29)$$

$$i,j = 2, \ldots, n,$$

then U(Z), up to a monotonic transformation, is the solution to the following equation [Hori, 1975].

$$dZ_1 + R_2(Z)dZ_2 + R_3(Z)dZ_3 + \ldots + R_n(Z)dZ_n = 0 \qquad (2.30)$$

If one assumes input-output separability, the utility-maximizing level of Z does not change. The problem is then to find the dollar expenditure necessary to maintain the given, utility-maximizing level of Z, which is simply $\partial C(\bullet)/\partial$public good.

The fourth step in this approach is to derive the form of the technology from C(P,Z). This is done by picking a $\overline{Z}$ or output level, i.e., level of characteristics, and varying the vector of prices. This essentially causes variation in an isocost line. The envelope of such line will trace out an isoquant and therefore provide information on marginal rates of technical substitution from which the structure of the household technology can be inferred.

Finally, now that both the structure of utility and technology have been inferred from C(P,Z), derivation of income compensated characteristic demand curves can be derived from the problem represented by equations (2.22) above.

This approach is quite general in that duality theory of cost and production function have derived a series of propositions which hold regardless of the particular form of the technology [Hall, 1973; Diewert, 1974]. This allows specification of a class of cost functions which are reasonable forms for such functions to take. This not only simplifies empirical estimation, since certain forms for C(P,Z) are not reasonable, it also strengthens the empirical results such that the possibility of specification error may be lessened.

Although this approach perhaps allows more generality by not imposing a set of restrictive assumptions for empirical application, the approach concurrently requires considerably more information which is very difficult to obtain. That is, it is necessary not only to know expenditures and quantities of characteristics, but prices must also be known.

Table 2.1 contains a summary of each approach, its information requirements, and derivable results. The most costly approach in terms of information requirements is the cost function approach, which must obtain information on the prices of input goods. However, the cost function approach has the advantage of not requiring the assumption of a specific utility function in order to obtain an estimated $Z^* = Z^*(\lambda,\bar{U})$. However, its exact specification limits the domain of possible forms of utility functions. Such an assumption is crucial to the expenditure function approach. The expenditure equation approach, while not necessarily having to assume $U(Z)$, is aided by such an assumption because it facilitates derivation of estimable forms for $Z = Z(P,I)$. In addition, derivation of $Z^* = Z^*(\lambda,U)$ cannot be obtained without a form for $U(Z)$. In each approach it is possible to derive $Z^* = Z^*(\lambda,\bar{U})$ which, of course, will be where consistency of the approach is ultimately to be tested.

Blank, et.al., (1977) set forth the basic methodology for obtaining the necessary information for the substitution approaches. Three steps can be delineated in this process. First, the respondent's initial situation is established. This is the current level of activities, locations, and expenditures (fixed and variable). Second, the respondent is presented with the contingency such as either an increase or decrease in environmental quality. Third, the respondent is asked how, if any, expenditures or activity patterns would change as a result of a change in environmental quality. Steps 2 and 3 are then repeated. From this information the analyst is able to perform the necessary estimation procedures. The actual survey instrument employed for this study will be described in Chapter IV.

2.3 Iterative Bidding Techniques

The iterative bidding technique involves a direct determination of economic values from data which represent responses of economic actors to contingencies posited to them via a survey instrument. Assuming that the good under question is of the public good variety, the individual himself has no choice as to the amount he consumes. Thus, of the four Hicksian measures of consumers surplus, only the surpluses are relevant in valuing changes in air quality. The individual's problem is then one of responding to proposed contingencies. Two types of responses can be delineated: willingness to pay (WTP) and willingness to accept compensation (WTA). Thus the bid offered to the individual and the subsequent welfare position for the WTP can be represented as:

$$U(Q,Y - B) = U(Q',Y) \tag{2.31}$$

and for the WTA as:

$$U(Q,Y) = U(Q',Y + C), \tag{2.32}$$

where $U(\cdot)$ is the individual's utility function, Q is air quality, Y is

Table 2.1

Summary of Information Requirements and Results for Each Approach

Approach	Information	Estimate	Assumptions	Result
Expenditure Equation	Y^{a} Z	$C(P,Z)^{b}$	$u(z)$	$Z = Z(\lambda,I)$ $Z^* = Z^*(\lambda,\bar{U})^{c}$
Expenditure Function	z X	$Z = F(X)$	$u(z)$	$A^*(\lambda,\bar{U})$
cost Function	Y^{a} P z	$c(P,z)^{d}$ $R_{ij}Z)$		$u(z)$ $Z = F(X)$ $Z^* = Z^*(\lambda,\bar{U})$

[a] Y denotes expenditures on market input goods.

[b] Relate C to Z only.

[c] In order to derive $Z^* = Z^*(\lambda,I)$, it is necessary that a form for U(Z) be assumed.

[d] Relate C to Z and P.

concave and B or C are bids made or compensation received. Inherent in the consumer surplus measures represented in equations (2.31) and (2.32) are the notions of initial position of the consumer (i.e. the current situation) and the individual's rights structures in relation to the good in question (i.e. the current level of air quality). Depending upon the relationship of the individual's initial endowment (Y], position (Q), the rights (either Q' or Q), the delineation between equivalent and compensating surpluses for WTP and WTA can be set forth. Thus, the Hicksian compensating and equivalent measures are conceptually different in that the reference welfare level is different. The compensating measure is defined as the amount of compensation, paid or received which would keep the consumer at his initial welfare level assuming the change takes place. The equivalent measure is the amount of compensation, paid or received, which would bring the consumer to his subsequent welfare level in the absence of the change. To this extent that the different Hicksian measures are empirically different, except in the quite unlikely circumstance that the two alternative quantities, Q' and Q", of the public good Q, where Q" is larger and ceteris paribus preferred. The four relevant measures of value are the following:

1. **Willingness to pay to avoid Q'**

   $WTP^{E}_{Q',Y;\ Q'',Y',\ Q''}$

2. **Willingness to pay to obtain Q"**

   $WTP^{C}_{Q',Y;\ Q',Y;\ Q''}$

3. **Willingness to accept compensation and take Q'**

   $WTA^{C}_{Q'',Y:\ Q'',Y;\ Q'}$

4. **Willingness to accept compensation and forego an offer of Q"**

   $WTA^{E}_{Q'',Y;\ Q',Y;\ Q'}$

where the superscript E indicates the equivalent measure, and C indicates the compensating measure, the first subscript specifies the individual's rights in terms of the bundle of goods (Q' or Q") and his endowment of the numeraire, Y, the second subscript indicates the starting bundle of goods and endowment, and the third subscript indicates his final bundle of goods after he has paid his WTP or accepted his WTA. His final endowment will be Y plus or minus the amount he actually pays or accepts, respectively.

The four measures of value bear the following quantitative relationship, in absolute value terms: 16/

$$WTP^{E}_{Q',Y;\ Q'',Y;\ Q''} = WTP^{C}_{Q',Y;\ Q',Y;\ Q''} \leq WTA^{C}_{Q'',Y;\ Q'',Y;\ Q'} = WTA^{E}_{Q'',Y;\ Q',Y;Q'} \quad \ldots(2.33)$$

How then are the relevant measures to be obtained? The Randall, et.al. (1974 a and b) study introduced several features which have for the most part been retained in later iterative bidding studies. "The hypothetical market is defined and described in substantial detail:

a. The alternative levels of provision of the air quality are described in quantity; quality, location and time dimensions verbally and wherever possible depicted in photograph sets to ensure uniform perception across the respondent population.

b. A hypothetical market is created in a substantial degree of institutional detail. Exclusive mechanisms are often expressly introduced or alternatively the respondent is assured that all users of the good will pay equally (e.g., through tax increments, increments in the price of associated services, or charges collected in special funds). The method of payment, called the payment vehicle, is specified and is chosen for its feasibility, its familiarity to respondents, preferably as a result of its customary use in similar contexts in the real world, and sometimes for its policy relevance.

c. The respondent reacts to prices posed by an enumerator, indicating whether he would, in a WTP case, pay the price or go without the good. The price is varied iteratively, until the price at which the respondent is indifferent is identified. The procedure simulates the respondent's typical market experience, where he is confronted with specified goods at stated prices and must decide to buy or not to buy."[17] The iterative bidding process represents an attempt to establish a hypothetical market having many of the features of existing markets. Chapter IV will discuss in detail the iterative bidding format employed in this study.

2.4 Biases and Limitations of the Contingent Valuation Approaches[18]

Since the seminal article by Samuelson (1954), general agreement among economists suggests that any effort to value public goods will be plagued by the incentive structure facing individual consumers thus encouraging them to misrepresent their true preferences. That is, the consumer would believe himself to be better off by not paying for provision of a public good while at the same time enjoying consumption of the public good because others have paid for its provision. This point of view represents the classic argument for why markets fail to provide public goods, and why valuation methods are expected to reveal values that are biased.

Certain specific concerns have been identified in pertinent literature that all contingent valuation studies must address. These concerns can be of the following types: biased valuations resulting from incentives in the survey instrument producing biased responses and structural characteristics of the survey instrument inducing biased responses. The former includes information bias, vehicle bias and starting point bias. Let us consider the nature of each bias in turn and its empirical evidence to date.

Strategic Behavior

The substitution approach is an indirect method of eliciting willingness to pay for the public good. It would not be expected that the substitution game would be subject to problems of strategic behavior, believing that the consumer has insufficient information on alternatives to misrepresent his preferences. Even the consumer who may be perceptive enough to realize that the method is designed to infer values from his pattern of activities would be unable to determine, with any accuracy, the relative values that he is revealing by his pattern of activities. The consumer could thus only confound, not bias the resulting valuation.

The iterative bidding approach, however, is a direct valuation method that would be expected to be characterized by significant incentives to misrepresent true preferences. Strategic bias exists in revealed valuations when the consumer attempts to influence the outcome of the valuation process by his announced valuation. The particular case of the free-rider problem occurs when the individual underrepresents his bid, hoping to pay as little as possible and still have the desired level of the public commodity provided. Incentives for strategic behavior appear to depend on the mechanism by which the public commodity is to be provided. In the context of iterative bidding for environmental quality incentives to misrepresent preferences should depend on how an individual's tax share is hypothetically determined, on the individual's desire to have changes in environmental quality, and on his belief as to the extent which others desire to have changes in environmental quality.

In order to examine influences on strategic behavior in the context of iterative bidding formats, a typical game structure which has had empirical use [Brookshire, Randall, et.al., 1977; Blank, et.al., 1977] will be discussed. The consumer is asked to reveal his willingness to pav for changes in a public good given that, if changes in the provision level are actually provided, the consumer will have to pay as his tax share the mean of all bids, as will all other members of the community. Kurz (1974) discussed this game structure as his "Experiment 2." He argues that if consumers act as though they are perfect competitors, in the sense that they do not believe that their bid will influence the mean bid and thus their payment, then they will reveal their true valuations.

In order to examine the incentives that a consumer might have under this game framework, let us look at any one individual i. 19/ Assume that there are n individuals in a community which is considering changing the level of provision of environmental quality, Q, to Q'. The cost of having all n individuals reveal their demands would be too costly, so only k individuals are to be sampled on their preferences for Q'. Let ℓ denote the number of individuals sampled before individual i, and m denote the number of individuals sampled after i. The following notation will be. used:

B_j = bid revealed by individual j ($j = 1,2, \ldots, \ell$; $\ell \leq k - 1$)

B_h = bid revealed by individual h ($h = 1,2, \ldots, m$; $m = k - \ell - 1$)

$\hat{B}_i$ = bid revealed by individual i

B_i = individual i's true bid

The mean bid for the total sample can be represented as:

$$\bar{B} = \frac{\sum_{j=1}^{\ell} B_j + \sum_{h=1}^{m} \hat{B}_h + \hat{B}_i}{k} \qquad (2.34)$$

The mean bid for the sample prior to the bid by individual i is:

$$\bar{B}_i = \frac{\sum_{j=1}^{\ell} B_j}{\ell} \quad (\ell \leq k - 1). \qquad (2.35)$$

Assume individual i is asked to reveal his bid for Q'. He is informed that he must pay the eventual mean bid as seen in (2.34). A reasonable assumption about i's motives would be to suppose if he desires Q', and if individual i desires to play strategically for a level of Q', he will attempt to influence $\bar{B}$ to be equal to B_i, his true bid. Certainly no attempt would be made to influence the outcome such that $\bar{B} > B_i$ occurs If individual i knew that he was the final bidder and that the mean for the sample before he was sampled was as in (2.35), then he would determine his hid to be:

$$\hat{B}_i = kB_i - \sum_{j=1}^{\ell} B_j \quad (\ell = k - 1). \qquad (2.36)$$

However, only one individual i could ever be so fortunate to know the mean of the sample thus far and be the last bidder.

If individual i is not the last individual, he would have to know ℓ, m, and $(\sum_{j=1}^{\ell} B_j + \sum_{h=1}^{m} B_h)$ in order to bid strategically to set $\bar{B} = B_i$. In case he had such information, he would determine his bid to be:

$$\hat{B}_i = \frac{(\ell + m + 1)B_i}{\sum_{j=1}^{\ell} B_j + \sum_{h=1}^{m} B_h} \qquad (2.37)$$

This is a great deal of information to have available. Perhaps individual i could ask to be given $\bar{B}_i$ before he would make his bid, but there would be no way for him to know $\sum_{h=1}^{m} B_h$, even if he were also told m. The point is, a great deal of information is needed for any individual i to be effective in strategic bidding under this payment framework, assuming of course that the individual would desire the sample mean bid to represent his true bid.

What if individual i wanted to be a free-rider and wanted to pay nothing for Q′? If he bids zero, what does he gain? He risks pulling $\bar{B}$ down somewhat, perhaps even jeopardizing acceptance of Q′, and still if Q' were accepted he will have to pay some positive amount. Perhaps individual i "succeeds" in paying less, but he cannot be a free-rider in the true sense.

What this discussion has attempted to point out is that this type of iterative bidding structure implies information requirements far too great for any individual to effectively bid strategically. In the face of such information requirements, it would appear reasonable for the individual to reveal his true bid. 20/ Note that individuals can misrepresent their bids, but they could not be certain as to the extent they would be acting in their favor (whatever they perceive that to be), or whether their actions could really alter the outcome for B perceptibly. In other words, consumers would have the "incentives" to behave as perfect competitors when confronted with this bidding framework.

Another reason for discussing this particular bidding game experiment is that Brookshire, et.al., (1976), and Blank, et.al., (1977), have used this framework to test for strategic behavior. Both studies were attempting to place a monetary value on changes in environmental quality, which was defined in terms of changes in visibility resulting from changes in emissions from coal-fired electric generating plants. Both. studies concluded that strategic bias was. not evident in the sample data generated where the consumer was told hee would have to pay the mean of the sample. Further, Blank, et.al., (1977) specifically developed a set of bidding formats that attempted to provide the consumer with information that he might use in bidding strategically. Specifically, individuals were allowed to reveal their bids, but were then told that the mean values based on other studies in similar communities was $X. The individuals were then allowed to revise their bids. Only one out of every 40 individuals revised their bids. Even given additional information that would be potentially useful in formulating strategic bids, the consumers did not revise their bids. This suggests the absence of strategic behavior tendencies.

A number of other studies provide empirical information on the existence of strategic behavior in revealing the valuation for public commodities . Bohm (19.72] utilized an experimental approach which forces actual payment for the publicly provided commodity (public television). Bohm's conclusion was that strategic behavior was an insignificant part of this experiment. However, in a hypothetic context he did discover significant strategic bias in elicited bids. 21/ An interesting attempt at examining strategic behavior and mechanisms designed to dispel motives toward such behavior was that of Babb and Scherr 1975). Babb and Scherr used an experimental setting and three alternative mechanisms to reveal the valuation for two publicly provided commodities: a concert fund and a library fund. They utilized the Clarke tax mechanixm, a less familiar valuation mechanism associated with Loehman and Whinston (1971), and a "control" mechanism in which the individual would pay his actual bid. The third mechanism was called a “voluntary" mechanism and was the control mechanism because strategic behavior was expected to be present under such a system. Babb and Scherr found little evidence supporting the existence of strategic behavior. In fact, the lowest valuations tended to be generated under the Clarke tax mechanism rather than the voluntary mechanism as would have been expected. 22/ In debriefing sessions, it was discovered that very few individuals attempted to free ride. The respondents indicated the following reasons for not being a free-rider: (1) feeling of being cheap; (2) funds were worthwhile; and (31) altruistic reasons. This set of empirical results is consistent with recent conjectures by Johansen (1977) and Smith (1917) as to why the free-rider problem may not be of the importance traditionally attached to it by economists.

It is not being suggested that strategic behavior may not generally be a problem in the valuation of public commodities. The empirical evidence to support such a conclusion is really not available as yet, although it could certainly be considered suggestive. However, contingent valuation methods, especially properly structured bidding formats; seem to provide a reliable framework within which to reveal values for public commodities. These methods, at least in the studies to date, are not plagued by the problem of strategic behavior.

Vehicle Bias

Iterative bidding formats, unlike the substitution approach, require some form of payment mechanism by which the good in question is valued. Early studies of the iterative bidding process, [Randall, et.al., 1974], suggested the need for a realistic payment mechanism to mechanistically create a market. Devices employed to date have included entrance fees, tax structures and utility bills as a form of payment,

Essentially; vehicle bias arises when the valuation results demonstrate that either the mean bids or the number of protest votes varies significantly across vehicles. Reasons for this type of result lie potentially in the respondent interpreting the vehicle as anything but a form of payment. A manner of misinterpretation is when the vehicle itself represents a change in the rights structure facing the respondent. In this case the responses could be a confounding between a dollar estimate of the public good in question and a “vote" via dollar amounts on the proposed rights or institutional change.

Additionally from economic theory, an individual’s substitution possibilities associated with. alternative payment mechanisms are different, When a payment vehicle allows the individual to substitute over a wider range of current commodities purchased, then the bid should be higher or compensation should be related to adjustments in disposal income or wealth, where the individual has the greatest latitude for potential substitution. Practically, however, a believable payment mechanism related to income adjustment cannot, in general, be applied. For example, surveys are often taken at recreational sites away from the recreationists' locale or state. In this case, a wage tax (or income compensation) may not be viewed as realistically payable by the recreationist. Thus, there is a tradeoff between accuracy associated with a less than ideal method of payment and the believability of the vehicle for payment or compensation. The reduction in substitution possibilities for a more believable payment vehicle is likely to reduce the contingent expenditure or increase the contingent compensation estimate.

Randall, et.al., (1978), Brookshire, Randall, et.al., (1977) failed to observe vehicle bias at statistically significant levels. However, Blank, et.al., (1977) did report the existence of vehicle bias.

Starting Point Bias

The contingent valuation approach commences with questions on payment (and/or compensation for hypothetical changes in environmental attributes. It has been found in most sample surveys that it is better to ask the recreationist (or any type of interviewee) a question with a “yes” or “no” answer than a question requiring explicit calculations [see Randall, 1974; Brookshire, et.al., 1977]. It is presumed the recreationist can more accurately respond to the yes/no question framework, although to our knowledge this proposition has not been analytically tested for responses to contingent valuation questions. Given the proposition that yes/no responses are desirable, it is necessary to suggest a starting bid or minimal level of compensation. The potential bias arises with starting points from at leas-t two possible sources. First, the bid itself may suggest to the individual the approximate range of appropriate bids, Thus, the individual may respond differently depending on the magnitude of the starting bid. Second, if the individual values time highly, he may become “bored” or irritated with going through a lengthy bidding process. In consequence, if the suggested starting bid is substantially different from his actual willingness to pay, the bidding process may yield inaccurate or only roughly approximate results. The effect of these two types of starting point biases may substantially influence the accuracy of contingent valuation and therefore the usefulness of the approach for assessment of preferences.

Several studies have explored whether starting point bias exists [Brookshire, Randall, et.al., 1977; Thayer and Schulze, 1976; Randall, et.al., 1978; Blank, et.al., 1977]. Only in Blank, et.al., (1977) has starting point bias been observed in the valuation results.

Limitations in the Structural Characteristics of the Contingent Framework

Let us turn to the possible confounding of the iterative bidding process stemming from the structural characteristics of the contingency framework. 23/ These problems have in the past been termed hypothetical bias problems. Essential to the contingent framework is a clear, concise survey instrument incorporating the points made earlier. Not only must it fulfill certain requirements from the economist’s perspective, but the public commodity must be defined in cognitive and comprehensive terms. If these requirements are fulfilled, there remains a question of how contingent a contingency can be set forth to a respondent and still receive a valuation response that is dependable and interpretable. This potential problem can be viewed in terms of rights and initial endowments as presented in Section 2.3.

Iterative bidding processes propose contingencies to individuals, often in terms of proposed reallocation of rights or increasing the price of maintaining an existing right. However, survey instruments to date have typically proposed small changes in the rights structure or in the price of maintaining existing situations.

Psychologists, Ajzen and Fishbein (9771), have specified the conditions under which behavioral intentions should predict behavior. The behavioral intention and the actual behavior should correspond, in terms of the action, its context, its target and its time frame. The iterative bidding format meets these conditions remarkably well. The only major problems that may be expected to arise relate to context: if the context in the bidding format departs from the policy context in the real world, one may expect some difference between stated behavioral intention and actual behavior.This provides a warning for researchers who want their data to be predictive. On the other hand, it introduces a major difficulty in evaluation and validation of the results of contingent valuation efforts. Lack of correspondence between stated behavioral intention (e.g. “I would sacrifice for clean air”) and actual behavior {e.g., I drive an old clunker without emissions controls) is often explained by differences in context. That is, in the real world, there is no effective market in which one can directly obtain cleaner air without the cost of some increase in motoring expenses. Opportunities to treat contingent valuation data as testable and thus refutable hypotheses are hard to find.

While one of the important advantages of contingent valuation techniques is that they permit exploration of new and different situations, there are some limits to their value for this purpose. Extremely large departures from known and familiar contexts may impede cognition and comprehension, reduce the credibility or plausibility of the hypothetical market, and in extreme cases, introduce an element of confusion in the interpretation of responses.

For instance, if a large change in endowents or rights was proposed yet the contingency is still anchored in the existing rights and endowment structure, a change in the individual’s production relationship would most likely require readjustment. This question would then arise as to the production relationship or the subsequent one served as the basis of valuation. Further, is there a relationship between the two values or are the two valuations from the contingencies noncomparable?

The problem that arises in choosing which. value or discerning the linkage, given the contingencies were anchored in the existing rights and endowment structure, is that, in the large contingency case, a reallocation of fixed equipment expenditures would seem to be necessary to validate the response to the proposed contingency. That is, by posing a large contingency change, the individual is forced relative to the small change into possibly a costly exchange. It is reasonable to assume that, faced with a charge of $20-.$50 in a utility bill, the respondent may be able to make adjustments in disposal income easily, but it is difficult to envision such a process taking place when faced with a $1,000 adjustment.

Setting aside issues of partial versus general equilibrium adjustments and exchange costs, one must ask the reliability of a proposed contingency which is not readily linkable to the respondents existing endowments and/or rights structure. Under these circumstances, an extreme contingency anchored yet far removed from the initial endowments and rights may induce disorientation in the bidding format and thus in the bids. The bid could be “noise,” or a “vote” on the contingencies themselves much like certain vehicles elicit a “vote.”

In fact, iterative bidding frameworks to date have assumed implicitly zero exchange costs. Current iterative bidding processes have relied on a partial equilibrium framework and assumed that the proposed contingencies had an effective zero exchange cost. Leaving aside how a general equilibrium iterative bidding format might be designed, the current processes arrive at a value that is not necessarily "true." 24/ However, the current iterative bidding practitioner merely takes refuge in the standard assumptions of benefit-cost analysis and assumes a partial equilibrium framework.

Setting aside the general equilibrium bidding problem and examining briefly, as simply as possible, the effect of exchange costs on bids, the Bradford bid curve framework implicitly assumes a world of frictionless contingent markets, and thus a bid is void of any exchange costs. However, when large contingencies are proposed, the assumption that a bid is void of the potential exchange costs becomes unrealistic. To examine the effect of exchange costs on a Bradford bid curve, let us assume the following simple utility relationship:

$$U(E,Y) = U(E,Y-B-Z),$$

where E is the public good, Y is income, B is the bid, and Z is exchange cost associated with a contingency. Assuming $U_E > 0$; $U_y > 0$, the derived bid curve is:

$$B = \frac{a + by(E' - E) - bE'Z}{(bE' + c)},$$

if $Z = f(\Delta E)$, where $f' > 0$ and $f'' > 0$, then $\partial B/\partial Z < 0$ where $b > 0$ and $c > 0$.25/ Thus, as the proposed contingency is further from the initial endowment or the existing rights, B decreases as Z increases. If B represents the respondent's bids in a frictionless world of zero exchange costs, the greater the underestimate of the aggregate bid will be, the greater is Z.

Randall, et.al., (1974b), Blank, et.al., (1977), and Brookshire, Randall, et.al., (1977}, using iterative bidding techniques, and Hammack and Brown (1974), using open-ended questions, found differsnces between WTP and WTA many times greater than those predicted by equation (2.33). In addition, many respondents were simply unwilling to respond to WTA questions, preferring instead to make a statement to the effect that "there is no amount of compensation large enough . . ." This seems to be another case of the context correspondence problem whereby the initial rights and endowments as well as the terminal rights and endowments are far removed from the existing situation.

Since consumer surplus measures are tied to initial rights and endowments, it is plausible to argue proposed contingencies and thus bids must be anchored in the existing rights and endowment structure to be reliable. In this case, a person's responses to a contingency are path dependent in that previous experience and preferences “direct" the response. Thus, if the individual is in a state of the world, $SOTW^A$, whereby the preference set is formed by t-1 experiences, responses to contingency will be forthcoming from the perspective of tastes, production, and exchange costs of $SOTW^A$. For small contingency changes, the individual may view the adjustment as costless and employ "familiar" preferences in answers.

However, some bidding formats to achieve certain surplus measures place the respondent in contingencies that are not a small deviation from some $SOTW^A$ to some reasonable close contingency but which in fact represents a discrete movment to a $SOTW^B$. In this situation the individual has no realistic t-l experiences to draw upon. Furthermore, a confounding might arise in that responses that will be forthcoming might rely upon the $SOTW^A$ information. Now this potentially will present a confounding because there exists no a priori reason why tastes and exchange and production costs are necessarily identical or even map in a systematic manner into a $SOTW^B$ relative to a $SOTW^A$. In this case there is no basis to assume that preferences are also identical. The contingency posed in terms of $SOTW^B$ is possibly being answered in terms of information from $SOTW^A$ with no reason to assume the information is relevant in terms of posited contingency based on the $SOTW^B$. Thus, where the payent of compensation is not customary in the real world and the rights in the real world are opposite to those posited in the hypothetical market, answers to WTA (or $SOTW^B$) questions seem highly unreliable.

Finally, WTP^E questions also may not be immune from context correspondence difficulties. Questions asking willingness to pay to avoid a threatened welfare loss may generate some responses protesting the imposition of the welfare loss, if that imposition is seen as violating either the existing structure of rights or the respondent’s perception of what is right in the sense of being "ethically proper.” Again, a subset of respondents may interpret the question as an opportunity to vote “no” to a referendum on the threatened imposition of the welfare loss, rather than a command to indicate what adjustments would be made to the threatened narrowing of the opportunity set.

Iterative bidding studies have recognized the possibility of protest votes arising from objections to context, whether it be a change in rights or a welfare loss. However, identified protest votes may be only the beginning. It is possible that a bidding format which generates a high proportion of identifiable protest votes may also elicit responses which are biased downward. Bidding formats which elicit a high proportion of protest votes should be screened out at the pretest stage.

The above considerations suggest that, a priori, WTP^C questions, which introduce a hypothetical market in which the respondent can buy improved situations not currently provided and not expected to be provided free of charge, may be considered the most promising within limits. **Pretesting of WTA^C and WTP^E questions is highly important, with** high incidence of protest votes and unexpected differences between the **means obtained and the mean responses to WTP^C questions being indicators** of context correspondence problems. In this respect, the existence of a rigorous method of deriving the expected differences between alternative value measures, as presented in equation (2.33), is of value. It provides a test of the null hypothesis that actual differences do not differ from expected differences, and a method of deriving, where necessary, the policy relevant value measure from the measure which provides the most accurate empirical data. How is the latter measure to be identified? It is the measure which is derived from the hypothetical market which exhibits the highest degree of context correspondence. This answer is not entirely satisfactory, since it is based on the notion that the best method guarantees the best results, rather than a rigorous test of the results as refutable hypotheses.

Let us reiterate that contingent valuation techniques have several distinct advantages. over the alternative methods which are available for the valuation of non-market goods. Contingent markets minimize transactions costs, permit "trade" in non-exclusive and public goods, and generate data in a form totally consistent with theoretical models of valuation for public goods. The use of contingent markets introduces the possibility of a variety of influences which may bias or otherwise distort the results obtained.

We are of the opinion, supported by considerable but admittedly inconclusive evidence, that these distorting influences are not endemic to well designed contingent markets, and that careful pretesting will expose poorly designed contingent markets. Nevertheless, we recognize that, for the very same reason that contingent valuation techniques are used (i.e., the absence of observable markets in the good under study), testing of contingent valuation data as refutable hypotheses is usually not possible.' Replication, however, is possible using the same methods with different samples or several different conceptually sound methods to value the same good. Replication, while unable to provide conclusive evidence of validity, is to be encouraged and the results of replication attempts thus far are encouraging, cf. Randall, et.al., (1974a and b), and Brookshire, et.al., (1976).

2.5 Advantages in Using Survey Instrument 26/

Introduction

Contingent valuation approaches are soundly grounded in economic theory, however, a major point of contention among economists has been the use of survey instruments for gathering data. 27/ An additional area of concern has been whether individuals exhibit strategic behavior when responding to survey instruments. In spite of practically no empirical evidence to support the existence of strategic behavior by individuals when responding to a survey instrument about environmental and aesthetic phenomena, economists have expended enormous intellectual energies in devising ways to cause individuals to reveal their behavior and their preferences truthfully when responding to questions about these and other non-marketed goods. 28/ perhaps because of their complexity few of these devices have found their way into actual survey instrument construction. Nevertheless, the sheer volume of papers devoted to the issue of obtaining accurate revelations of preferences for non-marketed goods gives weight to any assertion that economists distrust empirical results based on data generated by survey instruments.

The purpose of this section is not to debate the reality of strategic behavior or other biases. Instead, the intent is to raise the possibility that economists, by their near-exclusive devotion to the strategic behavior problem, may, at their own apparently unrecognized cost, have neglected many of the analytical and empirical advantages to be reaped through the use of survey instruments. That is, they may have concentrated on the costs while disregarding the benefits.

Need Survey Instruments be Hypothetical?

From (1968) and many other economists strongly believe that hypothetical questions generate fictional and therefore inaccurate answers. These inaccuracies, if one judges by the relative literature emphasis, are caused by incentives the individual has to give untruthful answers. The incentives stem from the perceived advantages which would be accrued to the individual if he behaves strategically. One knows, presumedly, that the answers are untruthful because the individual's observed behavior and the preferences this behavior reveals are often not. consistent with the indivdual's statements about his preferences. If one believes that hypothetical statements are imaginary (fictional), then he would hardly be surprised by these discrepancies. Another interpretation is, however, possible.

The dictionary defines a hypothetical proposition as a conditional proposition, i.e., an "if X, then Y" statement. A hypothetical question would then be a conditional statement in the subjective mood, an "if X were . . . ., then . . .?" statement. In a survey setting, the hypothetical question is posed by the interviewer to the respondent; the respondent then states how he intends to behave in the posited situation. Thus, for example, as is frequently done in surveys, the respondent might be shown a number of pictures of different landscapes and be asked his expectations about his budget and/or time allocations for each of the depicted landscapes.

Formally, the problem set before the respondent seems no different than the problem he faces when he plans on the basis of a weather forecast to spend tomorrow afternoon at a picnic. The respondent's ultimately realized activities and his planned activities are neither instantaneous nor coincidental. If an updated forecast is received that alters the expected weather, lie may change his plans so that he spends only enough time at the picnic to each lunch. Realizing that meteorology is an inexact and conditional science, he will be prepared to change his plans again on receipt of new information.

It would indeed be surprising then if frequent discrepancies did not occur between responses to hypothetical questions and eventually observable behavior. The answer provided to a hypothetical question is tentative and contingent, just as the potential picnicker's plans are tentative and contingent. Both the picnicker and the respondent will adapt their plans according to the information they receive and the changes in their circumstances. The key point is that the contingent answer is still acceptable given the well defined circumstances that were presented to the respondent. The question of inaccuracy is not whether given a change in circumstances the observable behavior pattern changes but whether the contingent answer can be observed when the defined circumstances have not changed. Only if the answers relate to the past rather than intended behavior will a simple comparison of answers with actual behavior suffice to ascertain the accuracy of the answers. Otherwise, one must explain how the individual responds to new information and circumstances in order to perform the comparison.

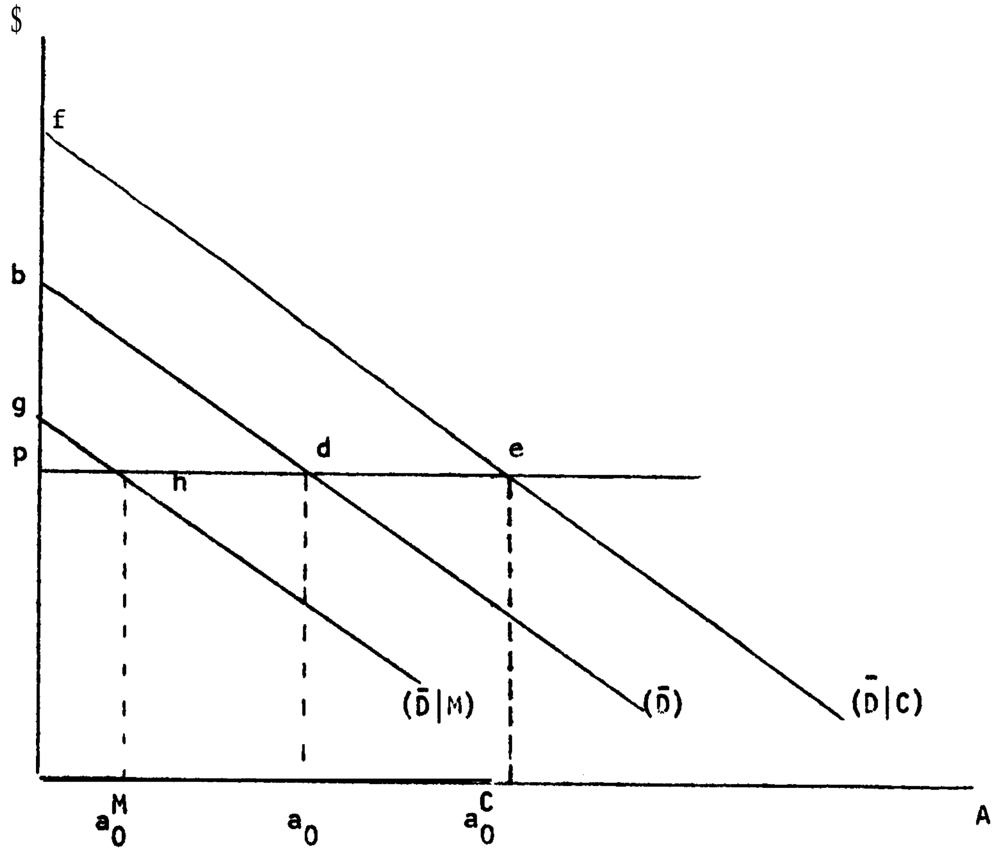
Even if the previous argument is accepted, the question remains as to how contingent answers fit into the consumer's surplus framework. This framework provides the analytical engine by which economists attach values to non-marketed goods.

Assuming for simplicity that the respondent's demand for an activity is weakly complementary in the non-marketed good of interest, it is easy to illustrate the relation between a hypothetical environmental or aesthetic state and consumer's surplus. 29/ In Figure 2.2, participation in the activity with which the non-marketed good is associated is assumed to have an invariant opportunity cost of p. This opportunity cost is independent of the level of availability of the non-marketed good. The $\bar{D}$ curve in Figure 2.2 gives the individual's income-compensated demand function for an activity, A, averaged over all possible levels of the non-marketed good. For example, A might be a fishing activity and the non-marketed good might be atmospheric visibility.

The ability to see distant mountains from the fishing location is assumed to enhance the utility obtained from the fishing activity. As shown in the figure, the efficient plan for the individual with no forecast of the availability of the non-marketed good is to look forward to undertaking the activity at level a_0.30/ At this level, the marginal value he attaches to an additional planned unit of the activity just

Figure 2.2

Effect of An Improvement in Information
on Consumer's Surplus



equals his opportunity cost. The consumer surplus he expects to obtain from the activity, once he actually participated in it, is the area above the opportunity cost line and beneath the demand function. In short, the area under the "average demand" function $\bar{D}$, is the individual's mathematical expectation of the valuation he will attach to his planned activity levels, once realized.

Now suppose the individual receives additional information about the availability of the non-marketed good. Again for simplicity, assume that the additional information will indicate whether the atmosphere will be clear, C, or murky, M, on the day he plans to undertake his fishing activity. The manner in which the fisherman will revise his estimates about the probability of clear or murky conditions can be described by Bayes' (1764) rule. 31/ For instance, if the improved information predicts clear atmospheric conditions, the fisherman's subjective evaluation of his average compensated demand function will be $(\bar{D}|C)$. The level of the activity he will then plan to undertake will increase to a_0^C. Moreover, the area (b-d-e-f) gives the increase in expected utility if "clear" is the forecast of atmospheric visibility. Similarly, if the forecast is "murky," the fisherman's expected utility level will be reduced to a_0^M, and the area b-d-h-g) gives the loss in expected utility due to the forecast.

In essence, the consumer surplus an individual expects to obtain from the availability of a non-marketed good can be extremely sensitive to the state of his information about this availability. It is this expectation that determines his commitment of resources and time -- his observable behavior.32/ Customary treatments of consumer surplus refer to the surplus an individual obtained from actually participating in an activity, given (implicitly) his state of information at the instant of the actual participation decision. His information at this instant need not be complete. When dealing with a hypothetical situation involving a public good, the consumer surplus measure refers to the value the individual expects to obtain. This decision is dependent on the state of information about the availability of the public good at the time he is deciding whether to participate in the activity. The former situation refers to the surplus associated with $\bar{D}$; the latter situation refers to surpluses associated with demand functions similar to $(\bar{D}|C)$ and $(\bar{D}|M)$. Expectations can, in principle, be equally disappointed or fulfilled with D ; as with $(D|C)$ or $(D|M)$. The substance of consumer surplus is not at all altered by increasing the possibility of information acquisition. This dismissal of the use of survey instruments because of their hypothetical nature seems little more than an insistence that reality conform to analytical habit and convenience of the economist.

Survey Instruments and Benefit-Cost Analysis

By attributing discrepancies in stated and realized choices solely to strategic behavior, economists, as the preceding discussion argues, may have often misconstrued the meaning of data acquired by survey techniques. In addition to strategic behavior and the acquisition of information, there exists another and potentially more important reason for these discrepancies: for non-marketed goods, the hypothetical world circumstances posited in instruments differ from the circumstances in the world of observable behavior. In this subsection, it will be argued that the circumstances in the world of the instruments correspond more closely to the analytical foundations of benefit-cost analysis. That is, data gathered by survey instruments may often, for non-marketed goods, be more consistent with economic theory than is data generated by observable, realized behavior.

Benefit-cost analysis is an attempt to ascertain the quantity of some numeraire (i.e., current dollars) that the gainers and losers from some proposed public investment will consider equivalent in value to their respective gains and losses. The price structure, where price is a sufficient measure of social as well as private value, represents the only terms with which the world with or without a public investment is evaluated. Prices, as generated by market exchange and adjusted in proportion to excess demand, embody all relevant information about relative economic scarcities and are a sufficient means of allocating resources of their socially most highly valued uses.33/ The benefit-cost analyst is trying to ascertain what individuals are willing to pay and/or would have to he paid for the public investment in a world where markets are pervasive.

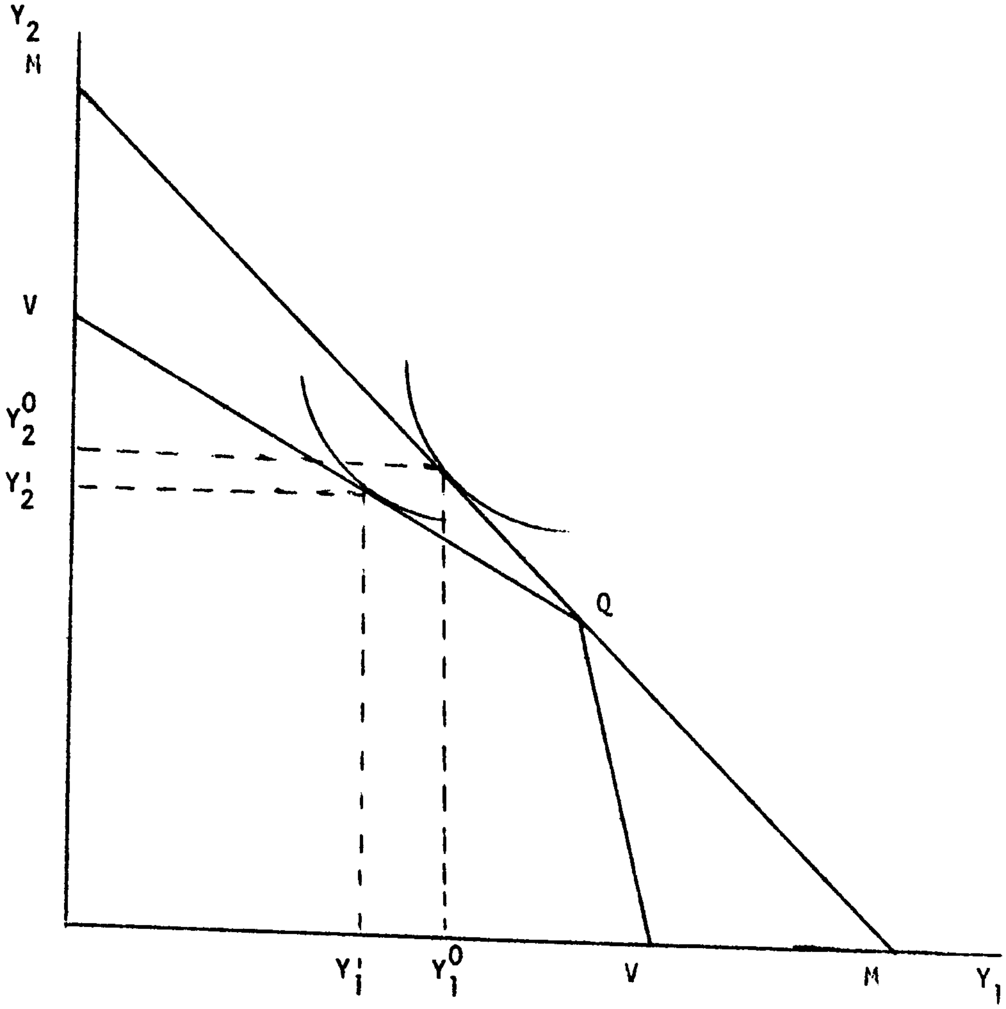
If realized market behavior is used as the data base to establish these valuations, the analyst uses propositions from economic theory for two purposes: (1) to infer what the price structure would be in a world of pervasive markets; and (2) to reason from the pervasive market price structure to the implied consumer valuations. When survey instrument responses are employed for the data base, the first step can be avoided if the conditions posited in the instrument correspond to a world of pervasive markets. One might reasonably question whether the conditions corresponding to a world of pervasive markets are sufficiently close to a respondent's experiences to be meaningful to him. This justifiable doubt must be weighed, however, against the difficulties of carrying through the analytical exercises. necessary to construct a pervasive market price structure from initial knowledge of the price structures. of a world where markets for many goods are not pervasive. The way in which this difficulty is customarily avoided when using observable, realized prices is to assume (for simplicity) that the observed prices <u>correspond</u> to those in a world of pervasive markets.

It is a relatively easy task to construct examples that make apparent the difficulties of reasoning to pervasive markets from observations on non-pervasive markets. Consider costs of exchange, a phenomenon present whenever valuable resources (e.g., time, information, legal and police services, etc.) must be expended to perform the exchange process.

In Figure 2.3 the individual's initial endowment of Y_1 and y_2 is at Q. When exchange processes become costly, the individual's budget constraint will vary according to his initial endowment. This is because the costs of the act of exchanging Y_1 for Y_2 differ from the costs of exchanging Y_2 for Y_1. For example, from the perspective of a single individual, the cost of

Figure 2.3

Effects of Costly Exchange



engaging in a transaction in which he is to exchange automobiles that he owns for clean air may differ from these same costs in a transaction where lie is exchanging clean air for automobiles. If the exchange act is costly, an initial endowment of Q implies a budget constraint of VQV, whereas if the exchange act is costless, the budget constraint is MM, the customary form which is an integral part of derivations of demand functions and their associated consumer surpluses. When the individual completes his exchanges during the period, he will select Y_1^0 and Y_2^0 as an optimum if MM is operative. If VQV is the operative budget constraint, he will select Y_1' and Y_2'. If some point on MM other than Q constitutes the intiial endowment, costly acts of exchange will mean that a budget constraint different from either VQV or MM may be operative because the costs of exchange acts may differ by the relative quantities of the goods in the initial endowment as well as by types of goods. Thus, the individual's budget constraint may vary according to the form in which his initial endowment was accumulated, although. the market value of this endowment may be identical for many combinations of Y_1 and Y_2. Since costs of the exchange act differ' according to the original (Y_1,Y_2) combination, each combination will result in a different and generally nonlinear budget constraint. It follows that, from the individual's perspective, a dollar is not an invariant pecuniary measure. Instead, the subjective value of an additional dollar depends on the <u>form</u> of the income change, i.e., on the good in which the increment is embodied. Moreover, it appears that realized market behavior is dependent not only on money incomes and relative prices of goods, but also upon the combination of goods the individual starts with and the relative and absolute costs of exchange ‘associated with those goods. These costs of exchange acts are probably neither trivial nor similar across individuals.

The huge sums spent on industries (law, middlemen, etc.) whose major or sole purpose is to facilitate exchanges attests to the non-trivialness. In addition, if exchange act inputs, including native intelligence and training, are not distributed equally across the population, and if these inputs contribute positively to the effectiveness of an individual in producing exchanges, then costs of exchange acts will not be similar across individuals.

If realized market behavior depends on the costs of the exchange act for the bundle of goods an individual holds, if, for the same bundle of goods, these costs differ across individuals, and if individuals do not hold similar goods bundles, then the analytical effort required to infer what the price structure would be in a world of pervasive markets must clearly be greater (probably much greater) than when all individuals have no exchange act costs and when budge constraints are therefore invariant with respect to the bundle of goods held. Rather than facing these and similar analytical complexities directly in order to construct the price structure of a world of pervasive markets, or rather than simply dismissing the problem as an offensive bother, it may often be more effective to question the individual about his responses where he is to assume that markets are pervasive. That is, the individual is allowed to respond directly to a perturbation in a hypothetical world of pervasive markets rather than having the investigator try to infer what the individual would do in a world of this sort from information about a world where markets are not pervasive.

An individual may be able to state his preferences for a particular state-of-the-world quite clearly. However, if markets are nonexistent or incomplete (as they in fact are for a great many aesthetic and environmental goods), the individual may have no means to communicate these preferences. The very lack of markets is due to the costs of forming and maintaining them and the costs of the act of exchange. In a survey instrument, a hypothetical (contingent} world can be constructed in which costless means of communication are available. On occasion, therefore, the individual’s preferences are perhaps more readily inferred from his statements rather than from his behavior. The individual who drives a 1965 Plymouth Valiant and states that he is “for” clean air has no market in which he can directly exchange his old heap for some clean air. The survey instrument provides this market.

Can Survey Instruments Reduce A Priori Assumptions?

The ability of the human mind to cope with complex reality is limited. Successful grappling requires that the dimensionality of reality be reduced. When trying to establish. the collection of values individuals place upon non-marketed goods, there are at least two general ways to reduce drastically a number of parameters that must be estimated. First, one can draw upon *a priori* restrictions from the economic theory of the consumer. Second, an experimental approach to the question of data can be adopted.

Economists who have ever seriously worked with problems of consumer analysis are thoroughly familiar with three fruitful *a priori* restrictions (additivity, homogeneity, and symmetry] that come from the neo-classical demand theory of Slutsky(1915) and Hicks (1934). Further reductions in dimensionality of the parameter space in which estimation is to be carried out can be achieved by judicious invocation of various seperability conditions. 34/ Finally, some recent developments in the application of mathematical duality principles to consumer theory sometimes allow one to reduce the number of parameters to be estimated without having to impose particular monotonicity and curvature properties upon the consumer's maximization problem. 35/

The second general class of means for reducing the parameter space includes experimental as well as survey techniques. These techniques are advantageous, even though widely neglected in economics, because they permit the investigator to control the number and levels of different physical contexts and adaptation opportunities to which. the individual must respond. 36/ Disturbances imposed by confounding variables upon the responses of interest are therefore at least partially controlled for in the data generating exercise. This contrasts with the standard practice of placing sole reliance in an *ex post* fashion upon the application of multi-variate parametric estimation techniques. For a given number of observations, survey instruments increase degrees of freedom and the efficiency of estimators.

The use of experimental and survey techniques to reduce the parameter space may be advantageous in addition to statistical considerations. Often, as noted above, the investigator imposes, ex post, various separability conditions upon market-generated data in order to make it more tractable. These separability conditions may imply, for example, that beer drinking at the local tavern is not a substitute for cross-country skiing. The conditions are imposed without consulting the individuals. whose responses are registered in the market data. They are instead generated by what the investigator intuitively feels to be “reasonable,” and required for analytical convenience. It is not obvious that the investigator’s “feelings” and the framework he uses in accounting for what is and what is not important is to be preferred to actually providing the respondent with the opportunity to state how he would respond to alternative contingencies. The details to be abstracted from are presented to the respondent rather than being left to the fertile and usually clever mind of the investigator. In both situations, simplifications are made that will permit the investigator to work with the data. In the survey instrument case, however, the respondent gets the opportunity to weigh the importance of these confounding variables in making his choices. In the observed behavior case, the investigator is presuming he knows as well as the respondent, from the respondent’s perspective, what is and is not an irrelevant alternative. Survey instruments allow the domain in which the response data is generated to conform to the structures of the underlying analytical model rather than forcing, via a set of possibly tenuous assumptions (e.g., the absence of jointness, the presence of perfect competition, etc.), the real world generated data to conform to the preconceptions of the model.

A slightly different facet of the above point arises with the recognition that much market data used by economists for empirical analysis is collected by possibly untrained agents many times removed from the economist-user. Often, this data is collected as by-products of the activities of organizations whose interests are far removed from and possibly much less disinterested than the research economist. 37/ The old saw about lying with statistics can just as readily refer to the manner in which data are organized for presentation as to the manner in which already organized data are employed for estimation purposes. Except possibly in the case of direct investigator observation of market responses, the generation of response data via survey instruments or experimental means can make the specific connection between the reporting of data and its uses for testing hypotheses more strong and certain. The investigator then has no choice but to accept the responsibility for the survey data generated under his direction. He must accept ultimate responsibility for the origin of the data, as well as the analytical model and the estimation procedures used to test hypotheses.

Survey Instruments and Property Right Structures

Market prices acting as devices to signal and coordinate the purchases and activities of disparate individuals work well where resource contributions are easily ascertained and reciprocated by rewards. For example, the spot exchange of two currencies requires no statement of the terms other than the exchange ratio. When cardinally measurable and perfectly homogeneous commodities such as currencies are exchanged, the parties to the enterprise need only count the quantities exchanged to establish what they have obtained.

In valuing environmental goods, there are two issues at hand. First, given an existing property right structure and assignment, what is the value of the good? Second, what would be the value of the environmental good if the property rights to the good were to be reassigned or restructured? The first issue, while important, can be assumed accomplished if the second issue can be answered.

The problem in answering the second issue is that for most environmental and aesthetic goods, the costs of exchange cannot be assumed to be as trivial as in the currency exchange ratio example. If one adopts an economic efficiency perspective, there are harsh impediments to tracing the parties initially responsible for the environmental or aesthetic effect, detailing the actual levels of the effect, and finally ascertaining the contributions of each perpetrator of the effect.

When these costs of the act of exchange exist, the economic structure itself becomes a variable of the decision problem. The problem can be viewed as one of finding a set of obligations for each individual's behavior pattern so that his costs and rewards are made less dependent on his joint relations with other individuals using the same non-marketed good. Rules of evidence and procedure are established for all users. Likely and important contingencies will be specified and appropriate responses will be stipulated. The objective being that easily measured performance standards will be formulated. In short, the assignment of property rights as well as the property rights structure itself is changed. These reassignments and restructurings of property rights have been a major means by which environmental and aesthetic insults have been controlled. It is likely they will continue to be so.

There exist analytical devices in economics that allow one to ascertain the effect of property rights reassignments of an environmental or aesthetic good upon consumer valuations. 38/ These valuations can be established with time and budget allocation data obtained by everyday behavioral observations or by survey instruments. However, where the conditions of use, exclusion, or alienation are altered (i.e., property rights are restructured), there is no everyday behavior to observe, except insofar as one is willing to draw analogies from observed behavioral responses to changes in the property rights structures of other goods. If one knew what the availability of the environmental good would be under the property rights restructuring, it might seem possible, if one had everyday behavioral observations on consumer time and budget allocations at the same level of availability, to determine the change in consumer valuation due to the property right restructuring. However, the purpose of the restructuring is to reduce the costs of the act of exchange and, as we argued this reduction can alter the value the consumer attaches to a given level of availability. Furthermore, since consumer valuations will, through either the market or the political process, influence the level of availability, how is one going to reason from the level of availability to consumer valuations for the restructured property right? Economic analysis does not yet have a sufficient understanding of the reciprocal relations between costs of the act of exchange and property rights structures, nor between these costs and various demand phenomena, to permit the ready testing of detailed empirical generalizations in a wide variety of settings. Thus the only really sound way of obtaining an estimate of whether the net benefits of restructuring a particular property right is positive, if one insists upon employing observed everyday behavior, would be to perform the restructuring and observe the results. In some circles, this is simply known as trial and error. To measure is not necessarily to understand. Trial and error can be an extremely costly way to perform research because the errors are real rather than hypothetical. In contrast, survey instruments allow one to investigate the behavioral responses to a tide variety of property rights structures without involving the citizenry in the traumas of what often is euphemistically termed social experimentation.

One obviously directly cannot observe everyday behavioral responses to property rights structures that have never existed. Similarly; one cannot directly observe the everyday behavioral responses of individuals who have never participated in activities involving the environmental or aesthetic good at the levels at which the good has been historically available. If some of the proposed levels of availability have not been historically available, and if some former non-participants would become participants- at these new levels, the use of data on observed behavior to ascertain valuations would mean that the valuations of the would-be participants play no part in determining the valuation. For each proposed level of availability, the use of observed, realized behavior to establish valuations will mean that only historical participants are to count. Those who have not participated historically have no opportunity to communicate their preferences. Survey instruments, because they allow the researcher to introduce ranges of availability of the environmental or aesthetic good that are broader than historical experience, allow the values of historical non-participants to become relevant.

Conclusions

The preceding is a taxonomic discussion of some reasons why survey instruments may often be a superior means of generating data with which to value environmental and aesthetic goods. We have argued that economists have erred in viewing the situations these instruments posit as necessarily fictional; that the data generated by survey instruments may, for non-marketed goods and the activities with which they are associated, accord more closely with the condition of received economic theory; that survey instruments can make it easier to remove the difficulties of estimation and interpretation introduced by confounding variables; and that survey instruments often permit one to deal more readily with phenomena that have not been in the range of historical experience. These are indeed substantial advantages that economists have not adequately recognized or appreciated. Nevertheless, whatever the advantages; a major disadvantage remains. Until detailed analytical knowledge is acquired of the manner in which expectations are formed, there exists no way to refute empirical . propositions- established from survey instruments that inquire into expected behavior. In this sense, survey instruments are non-scientific.

2.6 A Summary of Recent Case Studies

This section reports, in chronological order, four studies which have attempted to value environmental quality, and thus form the basis for much of the current report. The first two studies, the Lake Powell Experiment and the Farmington Experiment attempted to value air quality near existing or proposed coal-fired powerplants. The third study, the Geotherml Experiment, examined the impact of proposed geothermal powerplant development on an existing recreation area, calculating possible damages. The fourth and most recent study, the Wildlife Experiment, examined the value of wildlife to recreators in areas which may be impacted by strip mining of coal.

The Lake Powell Experiment

Lake Powell, with an annual visitation now approaching two million visitor days, is an excellent example of the tradeoff mentioned above. The lake was formed by the filling of Glen Canyon and retains the steep cliffs, rugged terrain features, and scenic vistas one associated with the Grand Canyon, but are here available to pleasure boaters and other recreators. Construction of the Navajo generating station located at the southern end of Lake Powell, was completed in 1976. Another larger powerplant, the Kaiparowits Project, was also proposed for construction near Lake Powell and became an issue of substantial public concern if not the primary issue for environmental groups in the Southwest.

As part of the Lake Powell research project, during the summer of 1974 recreators at Lake Powell were interviewed in an attempt to determine the aggregate willingness to pay to prevent construction of the proposed Kaiporowitz plant [see Brookshire, et.al., 1976]. Photographs of the existing Navajo powerplant which all of the recreators had seen, (stacks remain visible more than 20 miles Up the lake), were shown to recreators both with visible pollution emanating from the stacks and with the stacks alone. Recreators were then asked what entrance fee they would be willing to pay to prevent construction of another similar plant; first, where only pollution would be visible from the lake itself, and second, where both stacks and pollution would be visible.

The analysis of the data attempted primarily to deal with strategic bias. As noted above, if recreators believed that a uniform entrance fee might actually be set on the basis of the average bid of the sample survey to prevent construction, or believed that construction plans might be affected by the research results, then “environmentalists” might well bid very high, and "developers" might well bid zero dollars in an attempt to bias the results. A theoretical model of strategic bias was constructed to explain the distribution of obsserved bids which would likely be bimodal rather than normally distributed if strategic bias was present. The fact that the actual distribution of bids was noramlly distributed was thus taken as evidence that strategic bias was not present. It was conjectured by Brookshire, et.al., (1976), that the absence of strategic bias was due to the hypothetical nature of the experiment; few respondents felt that their answers would effect real world outcomes. The remainder of the research was devoted to specifying an econometric model of the bidding game results to estimate income effects by group. Recreators were divided into four categories, developed and remote campers, and visitors and residents of the nearby town of Page, Arizona. Although the effect of individual income by group on bids was statistically significant at the 99% level, the income effects were all very small. It was shown then that both theoretically and empirically the small income effect implied: (1) that a compensated variation measure would not differ practically from the equivalent variation measure used in the experiment; and (2) that income redistribution between groups- would not significantly effect the aggregate bid.

The average bid per family or recreator group was $2.77 in additional entrance fees in 1974 dollars, and the total annual bid, which can be interpreted as an aggregate marginal willingness to pay to prevent one additional powerplant near Lake Powell, was over $700,000. Two points should be made about these results. First, they show impressive consistencies both with the one previous bidding game study [Randall, et.al., 1974] in the region as well as with the succeeding Farmington experiment discussed below. Second, if the results are accepted as indicative of recreator preferences in general for the entire region, the canyon lands of southeastern Utah, and if the bids are extrapolated to all the effected recreation areas as well as Lake Powell, the aggregate bid would approach $20 million per year since there are some 15 national parks and recreation areas within a 100-mile radius of the proposed Kaiporowitz site.

The Farmington Experiment 39/

This study attempted to establish the economic value of visibility over long distances within the Four Corners Region. The southwest is characterized by vast spaces and open vistas unencumbered by industrial-commercial development, urban development, or airborne pollutants. The major focus of the study was to attempt to establish how recreationists and residents value continuing to be able to see over long distances. Clearly, the ability to observe long distances is an almost pure public good. The use by anyone does not interfere with use by anyone else. In addition, efforts were made to examine the extent of certain biases including: information, strategic, starting point, and vehicle bias on compensating and equivalent variation measures of consumer surplus. The Farmington Experiment also included a (first) attempt to examine contingent behavior changes in response to visiblity changes, i.e., how people allocated time between indoor and outdoor activities.

A survey questionnaire was given to recreationists and residents in the Four Corners Region of New Mexico and Arizona. The interviewee was shown a set of pictures depicting visible ranges from 25 to 75 miles and asked to bid across them. The pictures were taken at the same location.

Two rather distinct methodologies were used to examine contingent valuations for visibility. The first assumed a utility function with arguments of visibility and income and asked the respondent a sequence of questions on maximum willingness to pay and minimum compensation. The second utilized a utility function with time spent on indoor and outdoor recreation as the relevant arguments. With this function in mind, a sequence of questions were asked the respondent on adjustments in time allocations. by activity where changes occurred in visibility. Thus, the first approach is an attempt to measure the left-hand side of equation (2.4) or (2.5), while the second, based on contingent behavioral changes, attempts to measure components of the right-hand side of these equations.

As part of the contingent expenditures approach, direct tests were made for strategic bias, information bias, vehicle bias, and starting point bias. Strategic bias was evaluated by two means. First, the "game" was structured so the individual presumed that he would have to pay the "average" bid, not his own. The presumption was that if his bid were below the mean bid and he desired to increase the magnitude of the aggregate bid, he would bid higher. Alternatively, if his goal were to reduce the mean bid, he would revise his bid downward. Only in the extreme case when the individual's maximum bid is identical to the mean bid would there be no incentive for the individual to change. In addition to this process, the individual was questioned about his bid being too low. It was suggested that his bid was not sufficient to keep powerplant emissions at present levels for sustained high quality ambient air, and was then asked if he would revise his bid. In only one case did we observe an individual acting strategtcally and it turned out to be an Economics Professor from the local Junior College! However, fully one-third revised their bid when confronted with the possibility that their bid was insufficient. Whether this latter result is indicative of the presence of strategtic dowward bias in initial bids or the effect of new information cannot be ascertained. Individuals may be acting strategically by subjectively forming their preferences as to the effect of their maximum bid, selecting the bid appropriately; and then not revising it. However, it appears to be an additional indication along with the results of Brookshire, et.al., (1976) that individuals generally do not act strategically, at least in a meaningful manner to bias the outcome of the result.

In addition to the tests on strategic bias, analysis was made of various forms of information bias, essentially trying to establish influences of various aspects of the game. It was observed that the higher the starting bid suggested by the interviewer, the higher the maximum willingness to pay (equivalent variation) estimate derived from the study. Thus, if the interviewer suggested a bid of $1.00 higher, on the average individuals would bid about $.60 more at a maximum. Also, the choice. of the method of payment influenced the magnitude of the bid significantly, as would be anticipated from economic theory. The bid should increase, the greater the number of substitutions there are in the form of the vehicle used to make payment; and this was observed in the results, i.e., individuals were willing to bid higher when confronted with a "payroll tax" than with an increase in entrance fees. Finally, it was observed that whether the individual was given previous information on average bids or not, had a substantial impact on the maximum bid. We do not wish to suggest these results indicate any final conclusions with regard to the information bias problem with contingent valuations approach, but they are suggestive that for these approaches to be accurate, one must be very careful with the vehicle used for payment and the amount and quality of information given to the interviewee upon initiation of the questionnaire.

The contingent behavior component of the questionnaire attempted through. contingent changes in time allocation to infer an expenditure function and compensated demand relation for visibility. Various procedures were utilized to approximate the compensated demand curve, primarily by postulating an exact form of a utility function and estimating a time related household technology.

The mean bid per recreationist family per month was $4.06 while their minimum compensation per month was $17.40. The compensated substitutions approach led to estimates ranging from approximately $5.00 per month for the case where the receptor had no entitlement to clean air to approximately $280.00 per month with complete entitlement. However, these estimates are not directly comparable because the contingent behavior estimates include residents in addition to recreationists which should increase the magnitude of the estimate.

Both the Randall, et.al., (1974) and Brookshire, et.al<, (1976) studies only obtained equivalent variation bids. The following comparisons are therefore limited to the EV bids. Using the sales tax as a vehicle, Randall, et.al., (1974) reported yearly mean bids of $85.00 (A to C) and $50.00 (B to C] per household. Our yearly mean bids for the most comparable situations were $82.20 and $57.00. If one considers that the Randall, et.al., (1974) figures should be increased by 37 percent to account for inflation between 1972 and 1976 and that, on the other hand, the Randall, et.al., (1974) figures should be higher as respondents are also bidding on soil banks and transmission lines, these figures are very comparable.

The overall mean for situation A to C in the Brookshire, et.al., (1976) study was $2.77 per month with standard error of the mean ($.19). Adjusted for the 6.6 percent inflation between the time periods of the studies; the comparison values are $2.95 and ($.20). The overall mean for recreationists for the comparable situation was $4.56 ($1.11), which is considerably different. However, the mean bid ($2.44 and $.23] for $1.00 starting bids in the Farmington Experiment, while still statistically different, is much closer.

The Farmington Experiment demonstrated reasonable replicative consistency with other studies, It also demonstrated that questionnaire biases may be serious in attempting to utilize contingent valuation methodologies. Extrapolating the equivalent variation measures to all recreationists using the Navajo reservoir, an annual estimate of $916,000 is obtained which is an estimate roughly consistent with that in the Lake Powell Experiment.

Geothermal Experiment 40/

The Jemez Mountains of New Mexico are both scenic - characterized by brightly colored rock outcropping and forest areas - and a major recreation resource with fishing, camp grounds, hiking trails, and hot springs all located on U.S. Forest Service lands. However, the Jemez Mountains also contain one of the major geothermal resources in the southwest. Geothermal leases have been let by the U.S. Forest Service on land which is now used solely by recreators.

Both a bidding game and a contingent site substitution approach were used to estimate environmental damages to recreators from possible geothermal development [see Thayer and Schulze, 1977]. Recreators were shown both photographs of geothermal development in similar mountainous terrain and a map of the location of possible development relative to recreation areas. Noise levels and emissions characteristics were described in detail. A bidding game was then conducted with a vehicle which was a uniform entrance fee to prevent development. Alternatively, respondents were asked to indicate what their contingent recreation plan would be (what sites would they visit including new substitute sites and how often) if development were to occur. The subsample which responded to the site substitution question, was then also asked what they would bid in the form of a uniform entrance fee to prevent development. Finally, starting point for the bidding game was varied from $1.00 to $10.00 in various subsamples. Thus, the study was structured to test: (1) if the bidding game and site substitution results were consistent; (2) if information on alternative new substitute sites would effect bidding game results; and (3] for starting point bias.

A set of theoretical models was constructed to estimate a consistent measure of willingness to pay to prevent development from both measures, the bidding game and additional travel costs associated with alternative recreation plans. Additionally, the model was modified to explain information bias; how changes in perceived costs of alternative (driving costs) should affect bids, and to explain starting point bias, individuals either tradeoff their honest bid against the length of the bidding process or wish to “please” the interviewer by trading off their honest bid against what they perceive as the “desired” response.

The results of the experiment were as follows: Thirty-five percent of the respondents indicated they would no longer visit the Jemez area if development occurred. This resulted in about a 50% contingent decrease in visitation. About 65% of the respondents indicated they would visit alternative sites more frequently, usually the Pecos Forest area. Bids averaged $2.35 per visitor party day while the site substitution measure yielded a range of $2.03-$2.84 depending on the assumed driving cost per mile. The results appear to be consistent for the two approaches and imply an annualized aggregate bid to prevent construction of about $300,000 for a 50 megawatt plant.

More surprising, however, were the results for information and starting point bias experiments. Neither bias was statistically significant. The obvious question is: Why are these results different from those of the Farmington experiment? - which indicated that both information and starting point would likely be serious problems. The best explanation that can be given at this point is that the value of the change in an environmental quality proposed in the two studies was more precisely perceived by respondents in the geothermal experiment than in the Farmington experiment. In other words, respondents would more easily relate the costs to themselves of “losing” in part a recreation area than they could determine the costs of a change in visibility.

The Wildlife Experiment[41/]

Through contingent expenditure and behavior approaches, this study attempted to develop a methodology for valuing wildlife experiences. The valuations were developed to enable policymakers to judge which sites may be reserved from energy developments that would seriously impinge on wildlife. Hunters and wildlife observers were queried as to their willingness to pay for "encounters" with various types of wildlife. The species examined, all within Wyoming, were elk (Cerrus Canadensis), cottontail (Sylvilagus Spp.), coyote (Lanis Latrans), grizzly bear Urrus Horribilis), bighorn sheep (Ovis Canadensis), trout (Salmo Spp.), dipper (Circulus Mexicanus) and brown creeper (Certhia Familiars). The assumed utility function had as arguments the number of encounters and length of activity. Thus, the study attempted to measure both the left and (components of] the right-hand side of equations (2.4) and (2.5]. Prices for purchase of private goods for the hunting, fishing, or observation experience were presumed to be constant, which appears, except for inflationary factors, to be a reasonable assumption.

A type of vehicle bias was observed as bids were recorded on license or access fees and also utility bill adjustments. Difficulties were encountered in convincing some respondents that competition between energy development and wildlife herds would be sufficient reason for utility bill adjustments to be a plausible payment mechanism. Starting point bias was tested for, but was not found to substantially affect the bids on species commonly hunted. Thus, this additional evidence appears to substantiate the comparison between the Lake Powell and Farmington Experiments which led us to propose that the more clearly identified the change in environmental attribute is, the lower the probability of encountering starting point bias.

This experiment also examined contingent valuation approaches applied to the concept of option demand for grizzly and bighorn sheep hunting. Preliminary evaluation of the responses indicated, this may be an effective approach. for obtaining option value and existence value estimates. Valuation analyses have not been fully exploited in this study as yet. But, preliminary results indicate that for elk the average compensating surplus measure is $72.00 per year to increase expected encounters from Q to 5 per day of elk hunting. Some private clubs which specialize in elk hunting in Wyoming charge entrance fees ranging from $85.00 to $150.00 per year or roughly equivalent to the compensating surplus measure for elk obtained through contingent valuation approaches.

The four case studies discussed above have shown an impressive consistency both in results and in the evolution of techniques to deal with the bias problem. Bias is, of course, inherent in using contingent responses to value environmental quality. The view of these researchers is that problems of strategic, information, vehicles, and starting point bias are all surmountable with proper questionnaire design, modeling, and econometric analysis.

FOOTNOTES - CHAPTER 11

[1] The dictionary defines a hypothetical proposition as a conditional proposition, i.e., an "if X, then Y" statement. A hypothetical question would then be a conditional statement in the subjective mood, an "if X, then . . . ?" statement. In a survey setting, the hypothetical question is Posed by the interviewer to the respondent; the interviewee then states how he would alter his activities in response to the posited situation. Formally, the problem set before the respondent seems no different than the problem he faces when he plans on the basis of a weather forecast to spend tomorrow afternoon at a picnic [Blank, et. al., 1977].

[2] See Schulze and d'Arge (1978).

[3] See Brookshire, et. al. (1976) which produced similar values to these presented in Randall, et. al. (1974a).

[4] See Brookshire, et. al. (1976); Blank, et. al. (1977); Thayer and Schulze (1977); Randall, et. al. (1977); and Brookshire, Randall, et. al.,) (1977).

[5] See Blank, et. al. (1977) and Brookshire, Randall, et. al. (1977).

[6] An exception to this is the study by, Brookshire, Randall, et. al. (1977) which employed an iterative bidding procedure and also obtained data necessary for a travel cost comparison. Additionally, Blank, et. al. (1977) and Brookshire, Randall, et. al. (1977) employed the substituion approach and an iterative bidding approach in separate questionnaires.

[7] This is equivalent to the compensating variation measure of consumer surplus where the initial level of utility is maintained. See, for example, Mishan (1971).

[8] Distributional effects are ignored at this point.

[9] Preliminary analysis of the substitution data set does suggest that the number of substitutions of activities was not great when faced with a contingent change in air quality.

[10] In what follows, the time constraint is omitted but adds little difficulty except in the dimensions of characteristics and user production functions.

[11] Although implicit here, technology also influences the form of the input demand functions. Changes in technology will change these functions.

[12] A large body of literature exists which explores the dual relationship between cost functions and production functions or technologies. See, for example, Shephard (1970), Uzawa (1964), Hall (1973), and Diewert (1974).

[13] It should be noted that if $C(P, \bar{Z})$ is nonlinear in Z, then λ will be a function of both P and Z, i.e., $\lambda = \lambda(P, \bar{Z})$. For discussions of the hedonic price approach see Rosen (1974), Muellbauer (1974), Lucas (1975), and Crocker (1975). Empirical application of this approach is not as simple as it would appear primarily because of an identification problem. On this point see Rosen (1974) and Crocker (1975).

[14] It must be pointed out that income compensated characteristic demand functions are not estimated in this approach. The reason is that there is no reason to believe. that the estimated expenditures which represent the dependent variable in estimating C(P,Z) are generated with utility held constant.

[15] See Crocker (1975) for a more detailed discussion of the nature of the identification problem.

[16] A complete discussion of the surplus measures in relation to rights structure and starting points is in Brookshire and Randall (1978). Surplus measures and their relationship to Bradford bid curves which have been a focal point in non-market valuation is thoroughly discussed. Randall and Stoll (1978), extended the analysis of Willig (1976) to permit its application to the valuation of changes in commodity space.

[17] This description is quoted from Brookshire and Randall (1978).

[18] Certain arguments presented in this section draw heavily upon Brookshire and Randall (1978). These are designated throughout the section.

[19] This discussion is taken from Brookshire and Eubanks (1978).

[20] If this is not the case then we are at a loss as to the incentive structure the rational individual is operating under.

[21] Individuals were not confronted with the prospect of paying the mean bid, thus a definitive statement in the context of our discussion is impossible in terms of strategic bias.

[22] A number of respondents indicated an incentive to behave strategically under the Clarke tax mechanism that may have been overlooked. Several of the respondents stated “that they attempted to reveal demands slightly lower than the other participants” to achieve a negative variable charge under the Clarke system. [Babb and Scherr, 1972, p. 46].

[23] This subsection explicitly reproduces pages 19-26 from Brookshire and Randall (1978).

[24] An effort reported here from the South Coast Air Basin survey indicates a more generalized framework is possible.

[25] The assumption of $b > 0$ represents the case of convex indifference curves.

[26] This section is a paper presented at the EDRA 9 Environmental Aesthetics Symposium, the University of Arizona, Tucson entitled “The Use of Survey Instruments in Economic Valuations of Environmental Goods” by David S. Brookshire and Thomas D. Crocker.

[27] The following statement by Fromm (1968) exemplifies the attitude: “Furthermore, it is well known that surveys that ask hypothetical questions rarely enjoy accurate responses.” (p. 174) A lengthy discussion of the use of questionnaires in the paper on which the Fromm. (1968) effort is a commentary is summarily dismissed with this single unsupported statement.

[28] Originally set forth by Wicksell in 1869, the public goods preference revelation problem was rediscovered by Samuelson (1955). The first reasonably complete preference revelation device is in Clarke (1971). Smith (1977) provides an up-to-date review of the problem and its suggested solutions.

[29] According to Mäler (1974, pp. 183-189), weak complementarily exists if the quantity demanded of a private good or activity is zero when the marginal utility of the public good is zero. The condition permits one to avoid having to solve for utility and expenditure functions when trying to establish the demand for a public good by exploiting its connections with private, marketed goods.

[30] A good elementary presentation of Bayes' (1764) rule is available in Raiffa (1970, pp. 17-21).

[31] Adaptive behavior, once having committed one’s self and experiencing unanticipated regret or satisfaction thereby, can be treated as the acquisition of further information,

[32] As used here, “social” refers solely to a world in which all voluntary gains from exchange, given the initial distribution of income, are exhausted. Only under classical conditions (an absence of nonconvexities, irreducible uncertainty, coordination costs leading to externalities, and less than complete contingent claims markets), does current economic knowledge demonstrate that market prices alone would be sufficient to make efficient (Pareto-optimal) allocations attainable.

[34] Perhaps the best overall review of the state of demand theory from the perspective of the development of a priori restrictions to assist in estimation problems is Goldberger (1967).

[35] Diewert (1974) reviews the applications of duality theory to economic problems.

[36] An illustration of this technique can be found in Blank, et. al. (1977) and Brookshire and Randall, et, al. (1977). In the former, picture sets presented to individuals represened pre-determined levels of visibility (defined in terms of visible range). This allows the linkage of physical parameters to valuation estimates. In the latter case, landscape types were classified for an elk hunting experience.

[37] Even with Census Bureau data, the economist does not know all the “adjustments” that have been undertaken to make the data presentable.

[38] If there is an increase in pollution, the amount the sufferer would have to be paid in order to be willing to accept the increase is consistent with the. polluter being liable for the. damages he causes. The amount the consumer would be willing to pay to prevent the increase implies that the polluter has zero liability for any harm he imposes upon the sufferer.

[39] This study was supported by the Electric Power Research Institute, Palo Alto, California, to the University of Wyoming. EPRI does not assume ‘any liability for the completeness of research, or usefulness of the results.

[40] The, research reported here was supported by a NSF grant entitled, “An Economic and Environmental Analysis of Solar and Geothermal Energy Sources.”

[41] Portions of this study were funded by the U.S. Fish and Wildlife Service contract numbers 14-16-0009-77-002 and 14-16-0009-77-003 with the University of Wyoming.

CHAPTER III

PAIRED SAMPLE METHODOLOGY: THE SOUTH COAST AIR BASIN

3.1 Rationale for Paired Sampling

The previous chapter presented an overview of the theoretical and conceptual structure of various non-market valuation techniques. In order to enable a cross-check between the iterative bidding technique and the substitution approach involving primary data collection and a secondary data property value study, a common sampling methodology is needed. Given the variable of perturbation is air quality, an ideal sample methodology would control for all the factors influencing the valuation. This, of course, is impossible. The approach settled upon was to form pairs of census tracts in the South Coast Air Basin (SCAB) holding socioeconomic type characteristics constant yet allowing a variation in air quality across pairs. Throughout the SCAB are located air monitoring stations providing readings on Ozone (0_3), Nitrogen Dioxide ($N0_2$), Nitric Oxide (NO_x), Carbon Monoxide (CO), Hydrocarbons (HC), Sulfur Dioxide ($S0_2$), particulate matter, wind and in some cases lead (Pb), and oxidant levels. Our aim in this sampling procedure was to relate as closely as possible the readings of these constituents of air pollution to the surrounding census tract populations.

Given the locations of the air monitoring stations in the SCAB, we were able to identify surrounding census tracts. For these census tracts the Department of Commerce provides excellent demographic information. This information is used for three specific purposes: (1) define the census tract parameters and characteristics; (2) designate census tracts representative of the SMSA as a whole; and (3) provide the means for matching census tracts in the test areas to similar census tracts in the control area. The goal was to control, by careful choice of the study areas, for as many potential influencing factors that might explain differences in preferences toward environmental health and amenity levels.

Thus the aim of the sampling procedure was to determine paired areas in the SCAB that are similar in all relevant characteristics except air quality. If the mean values of the relevant characteristics are not significantly different across areas, the difference in valuation of amenities and environmental health effects given by an individual household in an area characterized by clean air, versus the valuation given by an individual in an area characterized by diminished air quality, should only be due to the existence of pollution in their environment.

3.2 Socioeconomic Control Considerations

Certainly many variables affect an individual's valuation of a public good such as air quality: Variable of influence that should be considered are: (1) median income; (2) mean income; (3) percent high school graduates; (4) total population; (5) percent non-white; (6) percent 0-19 years old; (7) percent 20-34 years old; (8) percent 35-64 years old; (9) percent 65 and older; (10) percent male; (11) percent in construction industry; (12) percent in manufacturing industry; (13) percent in other jobs; (14) median school years completed; (15) number of persons per household; (16) median housing value; (17) median age of structures; (18) structural density, i.e. percent private residences; (19) average temperature; (20) miles to beach; (21) miles to Los Angeles International Airport; and (22) miles to major interchange. Each variable represents a characteristic of the census tract. The characteristics provide information as to the demographic profile of a census tract both in a qualitative (pertaining to the population) and quantative (measures of a physical or structural nature) sense.

Consider education as a necessary control variable. Education is a valuable and expensive commodity. It allows people potentially a greater appreciation and awareness of life, its alternatives, and its shortcomings, among other things. Furthermore, education possibly could make one aware of the effects of air pollution on one's health and enjoyment of life, make one more aware of the interdependencies and externalities of the problem, and may make one more demanding that something be done to alleviate the problem. To control for these and other possible effects from educational "differences among households, we used the variable of percent high school graduates over the age of twenty-five years. This measure gives the general level of education of the inhabitants of a census tract.

Certain people are physically affected by air pollution more than are others. The older one is the less able are one's physical defenses to neutralize the effects of diminished air quality. Also, the younger the child, there are more years he must live in a polluted environment and therefore he is more likely to develop, for example, asthma or other bronchial complications. Thus we controlled for the age distributions across census tracts where possible.

The following age groups were used: (1) 0-19 years: the age which children are most likely still at home and still dependent upon the head of the household; (2) 20-34 years: newly established households; child bearing age; (3) 35-65 years: this age group is representative of more established households, usually couples whose children are growing up or may have already left home; and (4) 65 years and older.

General social and cultural factors were controlled for by using census data on percentage white, percentage black, and percentage other. Such influences may enter through risk preferences and time horizons, and attitude toward one's health.

Lave and Nagin (1974) in their study of various influences on mortality discovered that certain occupations have a higher mortality rate than others. Since job environments expose individuals to varying levels of diminished air quality, three categories were considered: (1) exposure to air pollution -- percent employed in the construction industry; (2) occupational hazards unrelated to ambient air pollution -- percent employed in the manufacturing industry; and (3) absence of air pollution -- all other jobs not considered above with the exception of farming. The percentages of each were found to be heterogeneous in the census tracts. Therefore, occupational exposure is a question that was explored with the survey instrument rather than from the census tract data.

The most complicated of categories has to do with residential location. There are many factors that enter into a locational decision, some being more specific than others in determining the exact location. The value an individual places on the health and amenity effects from air pollution gives an indication of his incentive to change his place of residence. Those with high preference for avoiding the problems and dangers of polluted air will have expressed this preference by moving to a census tract with clean air.

There are many reasons why people choose to locate in one area as opposed to another and air quality is just one of a whole myriad of considerations. One of the most important considerations is the job location. Another consideration is the type of community. The study focuses upon households so we therefore desire to sample in areas with a high concentration of private residences, or the so-called “bedroom communities.” A private residence is defined as limited to one family homes on less than 10 acres of land and with no business on the property. A third consideration is a set of convenience factors that might determine location as the distance from physical points of importance. Among these are miles to the beach, miles to an airport and miles to a major interchange. Proximity to a recreational center is usually an important consideration. The main recreational activities in Southern California center around the beaches. Miles to the airport is important because of its transportation and also to avoid the noise that affects a very wide portion of Los Angeles. Miles to a major interchange is important for getting anywhere in the Los Angeles area, such as schools, jobs, shopping centers, and recreational areas.

Income allows for a greater variety of lifestyles and expressions. Differences in income also result in many of the behavioral differences attributed to the other variables such as education, race, and age. For our income variable we used the mean income for each census tract. We also separated the responses into income classes to see if the marginal valuations with respect to income are constant across income classes.

3.3 Census Tract Pairings

In the preceding section our aim was to suggest those variables that may affect the value an individual gives in response to the air quality survey instrument. We desired to control for as many of these variables as possible in advance of the actual survey. These variables were considered when pairing census tracts. Each variable is a characteristic of the census tract and of its inhabitants, characteristics that in some way are expected to influence people’s valuations. By looking at the differences in these characteristics, homogeneous pairs of census tracts were identified to the extent possible.

From 1970 census data (U.S. Bureau o Census 1970) we have values for 22 variables for each of the census tracts.[2/] The total number of census tracts in the South Coast Air Basin number in the thousands. The principle criteria in the area selection process for our sample plan was to include some areas with clean air and other areas with various levels of diminished air quality.

In choosing the preliminary sample pairs of areas, an attempt was made to to include some areas ‘that not only met the above criterion but that also had a view of some natural or man-made phenomena that is in some way unique and outstanding. The existence of this "view” is not subject to quality measure but is treated as a binary variable; either it exists or it doesn’t. To determine areas with a view and those without, the researchers did an onsight inspection of the South Coast Air Basin.

There was a preliminary choice of 77 census tracts. The differences between the 77 census tracts for each variable in the data set were calculated. From an original set of 22 variables, nine were considered of major importance in determining the similarity of census tracts: (1) mean income; (2) percent high school graduates; (3) percent non-white; (4) median housing value; (5) number of persons per household; (6) percent private residences; (7) median year structure built; (8) total census tract population; (9) percent over 60 years old. Table 3.1 presents the values by paired area for the chosen variable.

Much of the preliminary sample pairing was done by comparing the relevant variables across census tracts in the manner indicated above. However, it became apparent that the most efficient method of obtaining final sample areas would be to conduct field observations with whatever information was currently available and pick several potential sample areas during these field examinations. This set of sample areas was then subjected to the same test procedures as had been conducted in the previous sample area selection efforts to determine final pairs.

3.4 Description of Paired Areas

The results of this pairing effort are summarized in the following pages. Each of the sample areas is described with the area with which it was matched. The match was made on the basis of differing air quality and constant control variables.

1. Canoga Park and El Monte

Canoga Park: Northern half of census tract #1345

Boundaries: North: Saticoy Street
East: Variel Avenue
South: Sherman Way
West: Topanga Canyon Boulevard

Air Quality: Fair

Table 3.1

U.S. Census Information for the Paired Areas

City	Tract Number	Total Population	Mean Income	Median Housing Value	Number of Persons Per Household	Percent High School Graduates	Percent Private Residences	Median Year Structure Built	Percent Over Sixty Years Old	Percent Non-White	Air Quality
I. Canoga Park	1345	5012	8821	20,800	2.44	46	15	59	15	10	fair
El Monte	4334	7516	8211	17,900	2.82	38	25	59	13	3	poor
II. Culver City	7026	7372	15,750	30,800	3.50	76	69	59	7	6	good
Montebello	5301.02	3868	13,808	27,500	3.10	60	56	59	19	4	poor
	5300.02	3478	18,858	38,400	3.10	74	54	64	10	24	poor
III. Newport Beach	630.01	7421	25,592	50,000+	2.83	90	49	64	10	0	fair
Pacific Palisades	2627.02	3915	35,419	50,000+	3.10	89	76	49	18	0	good
IV. Irvine	525	9337	14,059	33,100	2.63	86	76	70	28	4	fair
Palos Verdes	6704.02	8088	26,118	50,000+	3.86	93	82	68	3	3	good
V. Encino	1396	3593	36,242	50,000+	3.32	83	55	59	9	2	fair
La Canada	4607	5070	30,647	50,000+	3.29	87	89	59	14	1	poor
VI. Huntington Beach	993.03	4091	9,859	18,800	2.22	60	42	59	20	2	poor (exotics and sulfates)
Redondo Beach	6205.01	6608	11,815	23,600	3.28	63	56	59	6	2	good
	6205.02	7179	10,501	23,000	3.13	59	32	59	6	2	good

El Monte: Census tract #4334

Boundaries:
North: Garvey Avenue to Peck Road and north on Peck to Valley Boulevard.
East: southeast on Valley to Mountain View, southern boundary.
South: Schmidt Road
West: Edwards Avenue

Air Quality: Poor

This is a pairing of the lowest income communities in the sample plan. Both are inland and subject to high summer temperatures. The census data show that the pairing is a good match, with the exception that Canoga Park has ten percent fewer private residences. Field observations indicated that the areas are very similar in appearance.

2. Culver City and Montebello

Culver City: Census tract #2026

Boundaries:
North: Cota Street to Jefferson Boulevard, Jefferson to Overland Avenue, Overland to Northgate Street.
East: City Line
South: San Diego Freeway, Jefferson and Boulevard and Playa Street.
West: Banana Creek

Air Quality: Fair

Montebello: Census tract #5301.02 part of #5300.02 in the northeast part of the area.

Boundaries:
North: Lincoln Avenue
East: Montebello Boulevard
South: Whittier Boulevard
West: Wilcox Avenue

Air Quality: Poor

This grouping involves areas of upper low income population. Montebello is farther inland, hence subject to higher summer temperatures. Census data show that Montebello has slightly fewer private residences, somewhat newer homes and more people over age 60. The greater percentage of non-white population in tract 5300.02 is concentrated outside the area chosen for sampling. In general, the data show a fairly good match and the field check confirmed this. Nevertheless, the difference in summer temperatures is a source of potential difficulty for the empirical analysis.

3. Newport Beach and Pacific Palisades

Newport Beach: central portion of census tract #630.01 (West Cliff section)

Boundaries: Northwest: Irvine Avenue
Northeast: Nottingham Drive
Southeast and Southwest: Westcliff Drive and Santiago Lane

Air Quality: fair

Pacific Palisades: northeast portion of census tract #2627.02, area southwest of intersection Sunset Boulevard and Chautauqua Boulevard bordering both sides of Pampas Ricas.

Boundaries: North: Toyopa Drive
East: Toyopa Drive
South: Corona del Mar
West: Alma Real Drive

Air Quality: good

The Pacific Palisades neighborhood appears to be solidly middle class with homes somewhat on the large side, with a mixture of styles, including some that are two and three stories. These homes are generally 20 to 25 years old and trees and shrubbery are well developed, affording some degree of seclusion. The lots are not very large relative to the size of the homes. There are no ocean views, but the area is fairly close to the bluffs. The neighborhood in Newport Beach is on top of a hill and the backs of at least some of the homes on Nottingham Street overlook upper Newport Bay. The area also appears to be solidly middle class. The homes are somewhat newer but compare favorably in terns of their size and lot size. Census data indicate substantial differences in mean income, percent private residences, median age of structures and percent of population over 60 years old in the whole tracts. Field observations show that these differences are not as strong in the actual neighborhoods chosen, except in the age of the homes. Both areas have easy access to beaches, are somewhat removed from commercial/industrial areas and are comparable in terms of income levels and lifestyle.

4. Irvine and Palos Verdes

Irvine: Greentree homes, small portion of census tract #525.

Boundaries: Northwest: Culver Road
Northeast: Walnut Avenue
Southeast: Yale Avenue
Southwest: boundary of the development

Air Quality: fair

Palos Verdes: Beechgate Drive area, portion of census tract #6704.02.

Boundaries: North: Silver Spur
South: Crest Road

Air Quality: Good

The census data on this pair does not match well in terms of income, persons per household or percentage of people over 60 years old. However, the Irvine tract, #525, is a very large tract encompassing much agricultural land and several retirement communities. Therefore, census data do not accurately reflect the situation in the chosen area. The Greentree Homes development is two to three years newer than in Palos Verdes; the houses may be slightly smaller but the lots are of similar size. Inspection showed that the two areas are comparable in terms of lifestyle and age structure. Both are upper middle class areas, have about equal accessibility to beaches and are in areas of similar temperatures. Also, both are located very close to “classy” shopping centers and main arteries. They differ in that Palos Verdes is hilly, while Irvine is flat. Greentree Homes is unenclosed development, where the Palos Verdes area is not. The field observations indicated that this was one of the better pairings.

5. Encino and La Canada

Encino: portion of census tract #1396.

Boundaries:
North: Ventura Freeway
East: Balboa Road
South: Rancho Street
West: White Oak Avenue

Air Quality: fair

La Canada: south-central portion of census tract #4607, vicinity of Chevy Chase Drive and Berkshire Drive.

Boundaries:
North: Foothill Boulevard
East: Foothill Freeway
South: Highland Drive
West: hills west of Chevy Chase Drive and south of Descanso Drive

Air Quality: poor

Encino has a commercial strip (Ventura Boulevard) through the center, while the La Canada area has a similar development around the fringe. The Encino area consists mainly of ranch style houses with fenced yards and gates across the driveways. It is hilly, the homes are secluded because of trees and bushes, and there are several private roads scattered throughout. La Canada has a very similar appearance. Both are inland with similar summer temperatures and incomes are comparably high. The census data show significant differences only in the percentage of private residences. However, the areas chosen are almost entirely private residences; this should not be a problem. This is a very good match as seen in both the field experience and in the census data.

6. Huntington Beach and Redondo Beach

Huntington Beach: central portion of census tract #993.03.

Boundaries: North: Adams Avenue
East: Beach Boulevard
South: Frankfort Avenue
West: Alabama Street

Air Quality: poor

Redondo Beach: eastern portions of census tracts #6205.01 and 6205.02.

Boundaries: North: Manhattan Beach Boulevard
East: Inglewood Avenue
South: Artesia Boulevard
West: Rindge Lane

Air Quality: good

Both areas are in beach communities with similar income levels and temperatures and about equal accessibility to beaches. Both border closely to commercial strips. The Redondo Beach area is very homogeneous in the type and quality of houses. Most are small, stucco block houses with 800 to 1000 square feet of floor space. They have small yards and are moderately well kept. There are a few duplexes and apartments mixed in with the single family dwelling units. The Huntington Beach area is not as homogeneous as Redondo Beach. The average house and lot size is about the same but the variance is greater. Railroad tracks run close to the western boundary (Alabama Street) and that vicinity was avoided in the sampling. The census data match well except that Huntington Beach area has more older people and fewer persons per household. These two measures are probably related and are reflected in the areas chosen. The field observations indicated that this is a fairly good match and probably the best available in the two communities.

3.5 Ambient Concentrations for the Paired Areas

Employing the data from monitoring stations in the South Coast Air Basin, Table 3.2 was constructed. Consideration was given to the basic wind patterns in the area.

Focusing on total oxidants, nitrogen dioxide and total suspended particulates, isopleth maps were constructed for each pollutants. Finally, an average isopleth was constructed. Figures 3.1-3.4 represent these maps. Finally, Table 3.3 presents the arithmetic average for 1975 for the daily maximum hourly average concentrations for the sample areas employed in Figures 3. 1 - 3.4.

Table 3.2

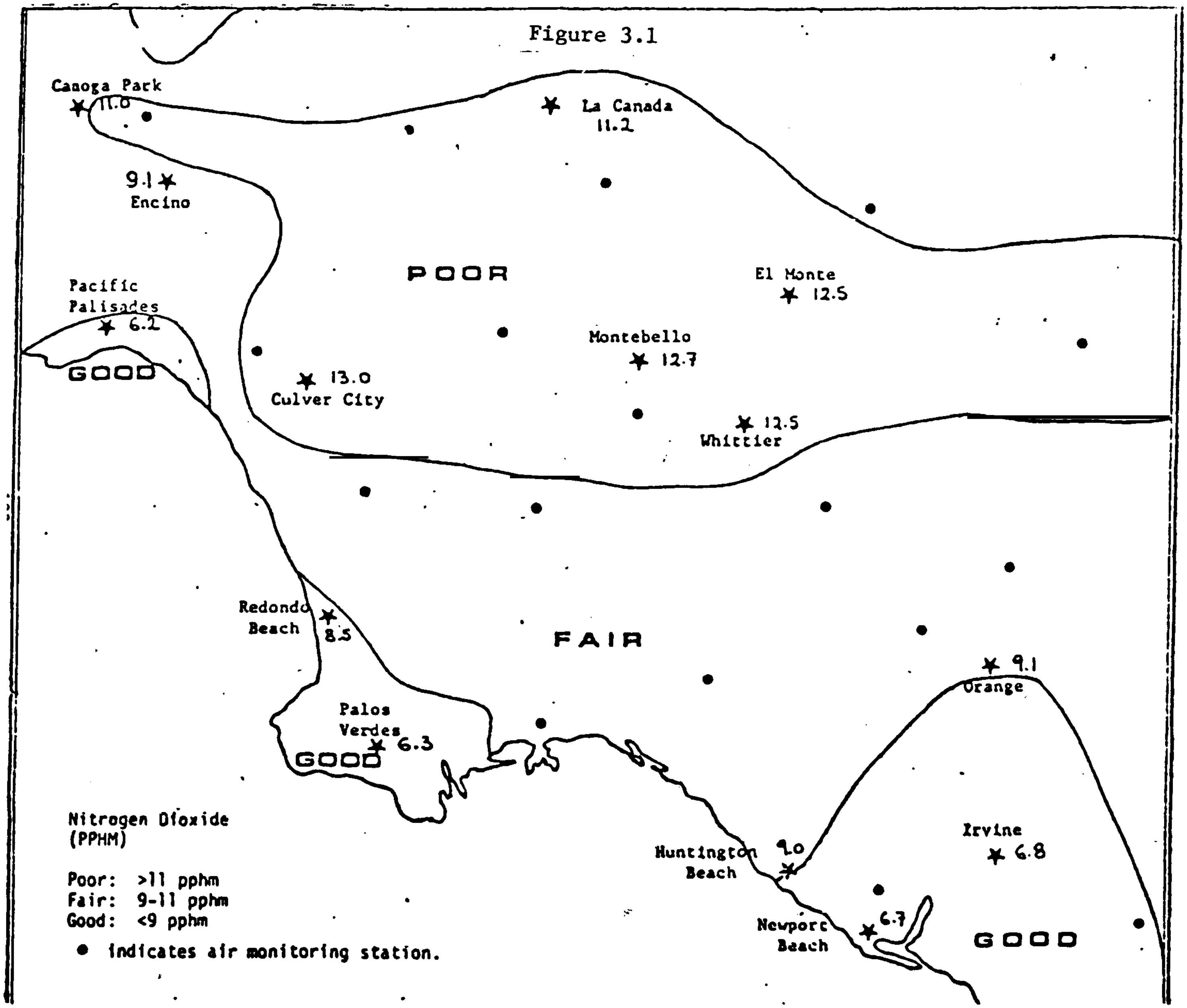
South Coast Air Basin Pollutant Information

Pollutant / Station	Daily Maximum Hourly Average Concentration of Various Pollutants in South Coast Air Basin) (Arithmetic Average - 1975)					Hourly Average Concentration of Various Pollutants in South Coast Air Basin (Arithmetic Average - 1975)					Total Suspended Particulates by Hi-Volume Method Fiberglass Filter) (Arithmetic Mean - 1975)
	Total Oxidant (pphm)	Carbon Monoxide (ppm)	Sulfur Dioxide (pphm)	Nitrogen Dioxide (pphm)	Total Hydrocarbons (ppm)	Total Oxidant (pphm)	Carbon Monoxide (ppm)	Sulfur Dioxide (pphm)	Nitrogen Dioxide (pphm)	Total Hydrocarbon (ppm)	Total Suspended Particulate (μ g/m^3)
Anaheim	3.7	6.5		9.2	4:6	1.2	2.9	.6	5.4	2.9	112.0
Azusa	10.7	5.6	; : :	10.6	5.0	3.6	3.7	1.5	6.0	3.7	125.9
Burbank	8.6	10.7	2.4	12.7	6.2	3.0	5.8	1.5	7.4	3.8	-
Cosca Mesa	4.3	11.4	2.6	6.5	-	1.8	4.8	.9	3.0	-	83.9
El Toro	1.9*	3.4*	1.1*	6.7*	1.7	.9*	1.7*	.2*	3.8*	1.3	64.9
La Habra	6.4	8.1	2.9	10.9	3.8	1.8	3.3	.8	6.4	2.2	120.3
Laguna Beach	3.3	4.5	1.8	9.8	-	.9	2.3	.5	3.9	-	77.1
Lennox	3.8	10.4	5.1	10.1	5.3	1.7	4.2	2.0	5.6	2.9	101.1
Long Beach	3.3	7.2	5.2	11.0	-	1.5	4.2	2.1	6.2	-	-
Los Angeles	8.0	10.0	3.3	12.9	4.4	3.0	4.7	2.0	6.7	2.8	113.7
Lynwood	4.2	11.1	3.9	9.2	-	1.9	5.9	1.9	5.2	-	-
Newhall	9.0	5.0	1.8	5.6	3.9	3.5	2.7	1.2	3.2	2.6	-
Pasadena	10.5	8.9	2.5	14.1	4.2	3.6	3.9	1.6	8.2	2.9	108.2
Pomona	9.8	6.1	2.8	11.9	4.0	3.3	3.3	1.4	7.2	3.3	-
Reseda	9.9	7.6	1.6	11.8	3.7	4.2	3.7	1.1	6.4	2.1	123.8
West Los Angeles	5.9	7.9	2.6	13.4	5.3	2.5	2.9	1.5	6.8	2.9	86.2
Whittier	6.1	6.7	5.8	12.5	5.1	2.3	3.0	2.5	7.2	3.2	-
Redondo Beach	-	-	3.2	-	-	-	-	1.4	-	-	-
Santa Ana Canyon	-	-	.4	-	-	-	-	.1	-	-	98.3
Los Alamitos	-	-	5.3	-	3.4	-	-	1.3	-	1.9	110.8

● Indicates 1974 data.

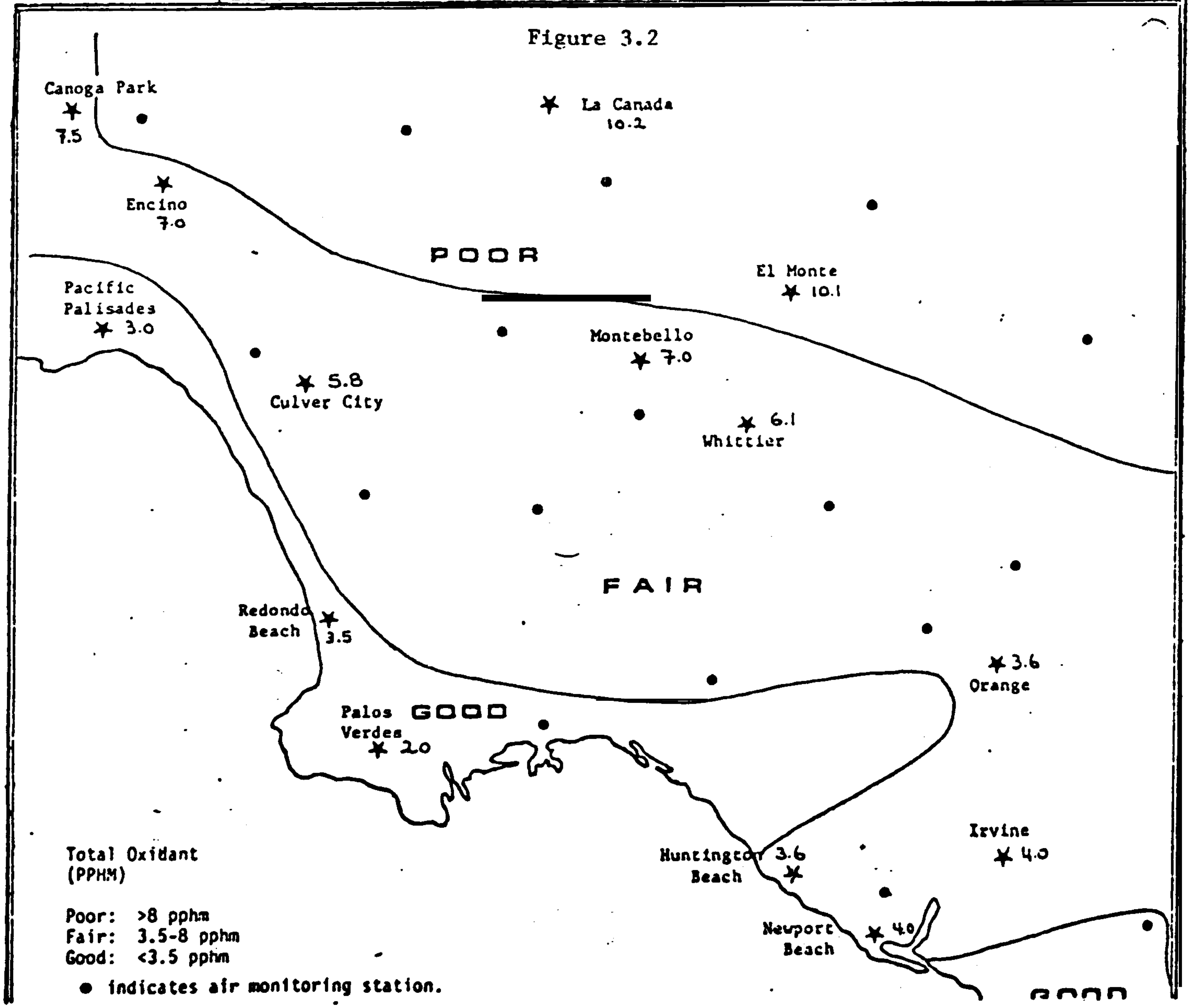
——— - Isopleths for Nitrogen Dioxide Levels in the South Coast Air Basin

Figure 3.1



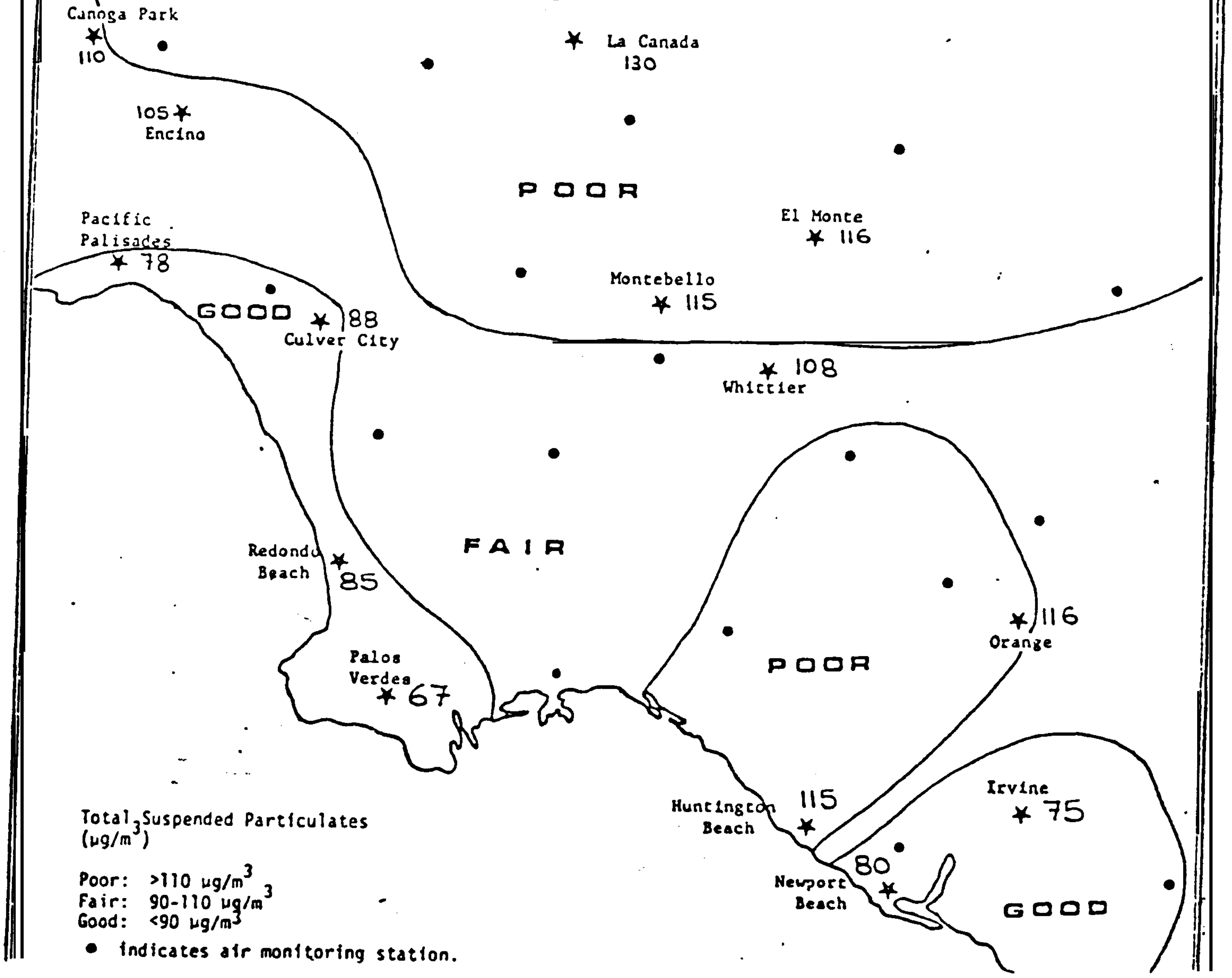
Isopleths for Total Oxidant Levels in the South Coast Air Basin

Figure 3.2

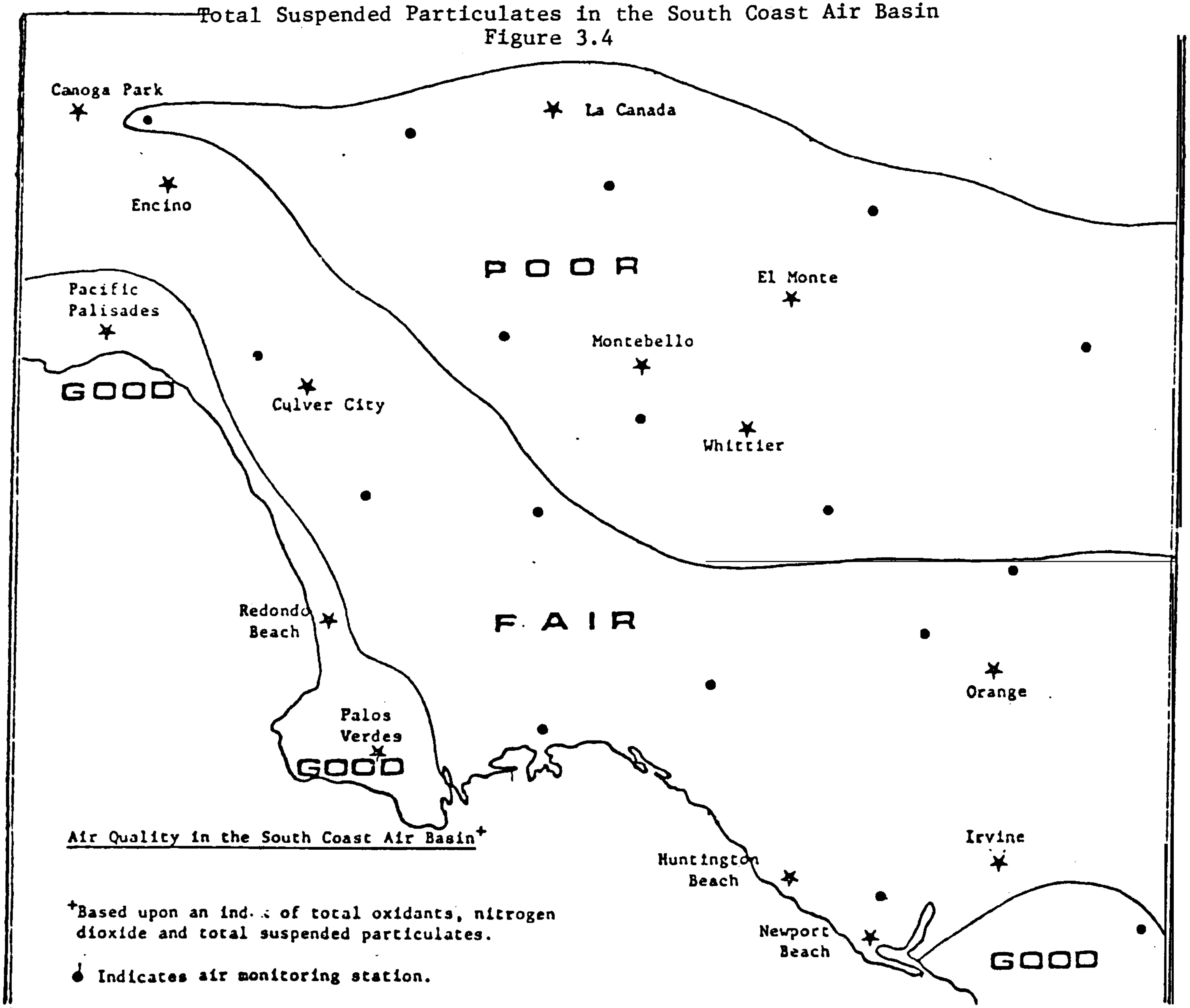


Isopleths for Total Suspended Particulates in the South Coast Air Basin

Figure 3.3



Isopleths for Nitrogen Dioxide, Total Oxidant and Total
Total Suspended Particulates in the South Coast Air Basin
Figure 3.4



Air Quality in the South Coast Air Basin+

+Based upon an index of total oxidants, nitrogen dioxide and total suspended particulates.

● Indicates air monitoring station.

Table 3.3

Daily Maximum Hourly Average Concentrations of Various Pollutants in the South Coast Air Basin

(Arithmetic Average - 1975)

	Total Oxidants (pphm)	Nitrogen Dioxide (pphm)	Total Suspended Particulates ($\mu g/m^3$)
Montebello	7.0	12.7	115
Culver City	5.8	13.0	88
Canoga Park	7.5	11.0	110
El Monte	10.1	12.5	116
Encino	7.0	9.1	105
Pacific Palisades	3.0	6.2	78
Newport Beach	4.0	6.7	80
Irvine	4.0	6.8	75
Pales Verdes	2.0	6.3	67
Redondo Beach	3.5	8.5	85
Huntington Beach	3.6	9.0	115
La Canada	10.2	11.2	130

CHAPTER IV

THE SOUTH COAST SURVEY QUESTIONNAIRE STUDY

4.1 Survey Instrument Design

Chapter 11 reviewed the theoretical and conceptual state of the art in employing the contingent claims mechanisms. The essential questions addressed implicitly in the discussion with regard to aesthetics and health effects in the South Coast Air Basin are: whether a valuation for an environmental good can be disaggregate into characteristic parts, the relative efficacy and consistency of bidding and substitution formats in accomplishing this task, and whether a survey instrument can be properly designed enabling the estimation of the overall contingent valuation equation. This chapter will present the structural design of the survey instrument, the method of choosing the accompanying photographs, the survey implementation procedure, and preliminary statistical results from the iterative bidding component of the survey instrument.

The structural components and the directional flow of the survey instrument are presented in Figure 4.1. Many types of information are sought by the survey instrument. The first component can be viewed as establishing baseline information about the respondent. The respondent's current indoor and outdoor recreational activities, costs of both types of activities, location of the activities, the frequency and duration of activities, and the importance of the activities are established. The respondent is held to a "typical week" time budget for indoor and outdoor activities that was initially established in the questioning process.1/ This information was then entered on the indoor/outdoor activity and cost lists in Tables 4.1 and 4.2.

At this point the interviewer presented information relating to either aesthetic effects of visibility or health effects in the South Coast Air Basin. Recalling the earlier discussion about information bias, the alternative initiation points for beginning the valuation process were a potential factor in the final results. That is, in disaggregating an environmental good down into characteristic components, does the order in which the characteristics are presented affect not only the final summed valuation of the good but the characteristic parts valuation? In order to test this hypothesis, information was obtained as presented in Figure 4.2. First, the sample population was broken into two groups: those mailed a health brochure (as in Appendix B) and those provided no additional aesthetic or . health information other than that presented in the survey instrument. Sec-

Information Collective Flow for Survey Instrument

Figure 4.1

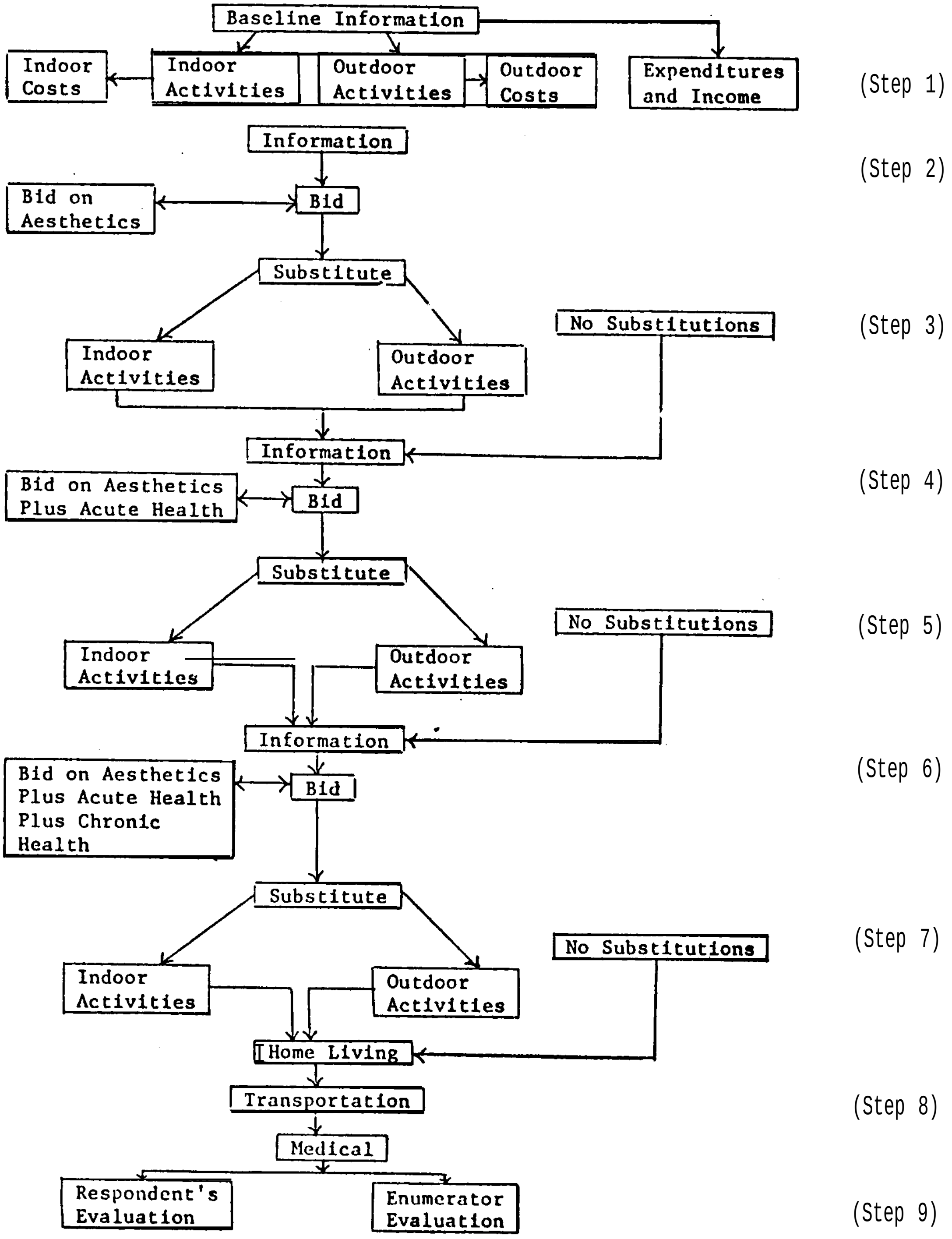


Table 4.1

Outdoor Activity and Cost List

Activity	√	Hours Per Week				Times Per Week				Location (Map Grid)				Miles Traveled				Direct Costs				% Day	Equipment Replacement Costs	Importance
		A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D			
Outdoor Spectator Sports																								
Tennis																								
Biking																								
Beach Activities																								
General Exercise																								
Fishing																								
Swimming																								
Sailing																								
Jogging/Walking																								
Hobbies, Arts & Crafts																								
Outdoor Gardening or Fixing up House																								
Golf																								
Hiking																								
Camping																								
Organized Sports Events																								
Individual Sports Events																								
Other (specify)																								

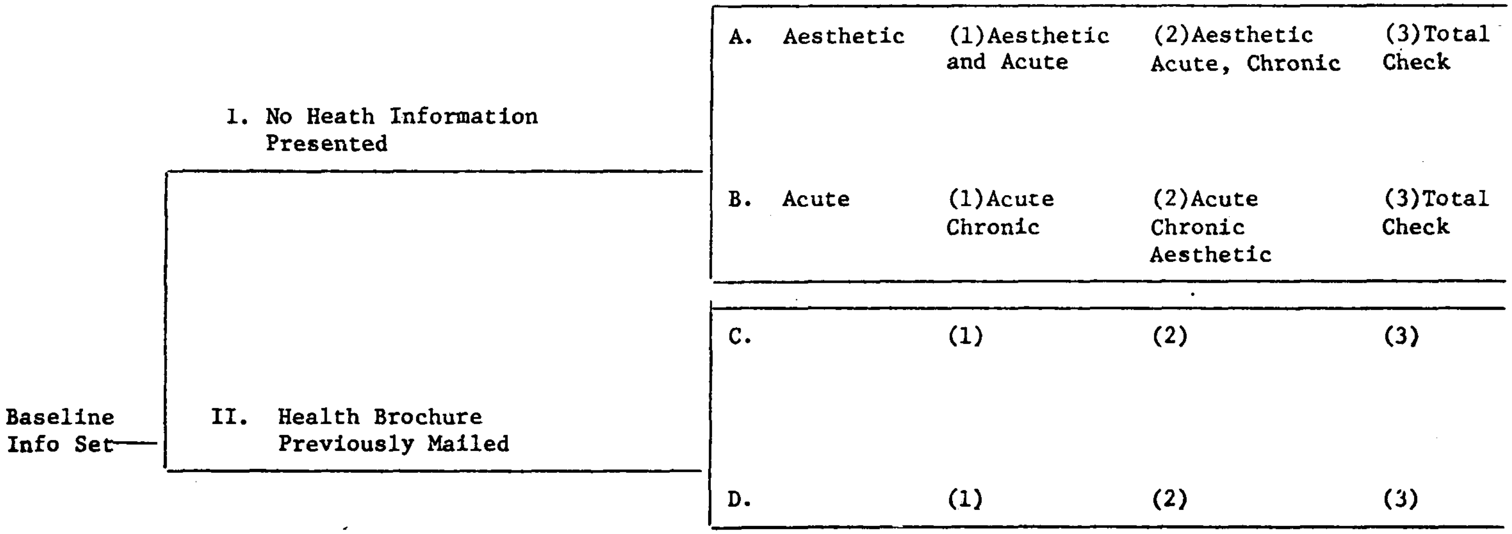
Table 4.2

Indoor Activity and Cost List

Activity	√	Hours Per Week				Times Per Week				Location (Map Grid)				Miles Traveled				Direct Costs				% Day	Equipment Replacement Costs	Importance
		A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D			
Indoor Spectator Events																								
Indoor Tennis																								
Raquetball, Handball																								
Table Tennis																								
Bowling																								
Indoor Gardening or Fixing up House																								
General Exercise																								
Organized Sports Events																								
Reading																								
Television																								
Movies																								
Club Activities, Organizations																								
Individual Sports																								
Swimming																								
Visiting Neighbors or Friends																								
Other (specify)																								

Figure 4.2

Information Sequence in Survey Instruments



end, these two groups were further subdivided into two additional categories according to the sequence of information presented in the survey instrument. Either a single individual was asked valuation questions about air quality characteristics in an aesthetic affects, aesthetic plus acute health affects and aesthetic plus acute plus chronic heath affects sequence or acute health affects, acute plus chronic health affects, and acute plus chronic health plus aesthetic affects. Data collected in this manner would allow a statistical test of ordering and initiation point effects in the overall valuation effort.2/

An iterative bidding format was administered based on a contingency perturbation from the existing conditions presented to the respondent. This represented an improvement from the original condition in the resident's air (i.e., poor to fair, etc.). The bid was established using either a utility bill or a lump sum monthly payment as the vehicle. Further, in order to be able to observe any individual time discounting, the clean-up period was set forth as either 2 or 10 years. Additionally, three alternative starting points of $1, $10, $50 were employed to initiate the actual bidding process. Finally, some respondents were handed a "life table" that would show the total amount they would pay as long as they lived in Los Angeles depending upon their bid. Thus, the iterative bidding format within the survey instrument employed structural characteristics that allowed for eventual testing of all the potential bias discussed earlier.

After the recording of the maximum bid, the interviewer moved to step 3. This step initially established the following: (1) the respondent had stated a willingness to pay for improvements in air quality (even if zero); (2) the respondent had less money overall as a result; and (3) thus (1) and (2) indicate they value clean air and thus they have traded income for clean air. Then the respondent was queried as to whether the improved air quality conditions would alter their current activity patterns in any or all categories (i.e., time, duration, place and/or type). Thus column B of Tables 4.1 and 4.2 were filled out with the time constraint being checked.3/

The beginning of step 4 essentially repeated steps 2 and 3 in procedure, however, the information content was different. Consider previous bidding games as a focal point. Typically, the process would involve yet another perturbation of the environmental good in question. However, we are interested in attempting to disaggregate the characteristic parts of the environmental good air quality into aesthetic affects, and acute and chronic health affects. Thus step 4, depending on whether step 2 begins with information on aesthetic or acute affects, presented either acute health affects information for the former point or chronic health affects information for the latter initiation point. The same initial vehicle was employed. If the "life table" was used earlier it again was made available. The bidding began with the last maximum stated bid of the previous step. Step 5 again repeated earlier conditions (i.e., the trade of income for less health effect) and the outdoor and indoor activity/cost lists were filled in for column C.

At the initiation of step 6, information regarding the last remaining characteristic of the "good" air quality was provided which was either health affects for the aesthetic initiation point or aesthetic effects for the acute initiation point. Then the procedure for the iterative bidding was repeated. Similarly, step 7 represented a repetition of the substitution sections.

Finally, at the termination of step 7, a final review of bidding structure and the substitution answers were reviewed. The respondent was allowed any adjustments that were deemed necessary.4/

Upon completing the iterative bidding and substitution sections, a series of general information questions covering socioeconomic information, property value information of the residence, type of residence (i.e., number of stories, pool, rooms, etc.), reasons for current locational choice, health related questions (i.e., heart trouble, medication, etc.), and attitudinal questions relating to air quality were administered. This is step 8 in Figure 4.1.

Finally, step 9 involved a respondent's evaluation of the survey (i.e., relevant, policy oriented, etc.) and an enumerator evaluation.

4.2 The Photographs Accompanying the Survey

The survey instrument in depicting air quality in the South Coast Air Basin employed picture sets. This section will discuss the underlying considerations in constructing the picture set employed in the South Coast Air Basin.

Visibility is dependent on light. Light is a form of energy, made up of electromagnetic energy, and is really a form of matter made up of individual particles (photons). Light travels in streams and is subject to any interference in its path. Light waves can bend, spread, interfere with one another, and react with obstacles. Visibility is the state or quality of being perceivable to the eye. It is a subjective term in its common usage, referring to the general clarity of the air. In its more strict use, visibility is defined as the farthest distance that any object of suitable size can be visually identified without the aid of magnifying instruments. Both the common and strict definitions of visibility suffer from lack of precise meaning because of the many variables which are difficult to control. Therefore, it is important that more precise definitions of visibility be explored in order to use the concept accurately.

There are three characteristics of a light wave that are of concern: (1) its intensity, which is related to the height of the wave crests and indirectly determines brightness of the light; (2) the wave length, which depends on the distance between crests and largely determines color; and (3) its polarization, the angular orientation of the crests. These three characteristics are influenced by what happens when the light waves come in contact with other matter. In particular, we are concerned with how these characteristics affect changes in visibility as light waves interact with particulate matter in the atmosphere.

There are two issues in the way light affects visibility. First is the ability of an object to reflect light in such patterns as define the visual characteristics of the object. Second is the ability of that reflected light to reach the observer in such a way as to differentiate the characteristics of an object from the background. First, let us assume that every object except a perfectly black object, reflects light some distance. Further, if the light reflected from an object reaches an observer and that object is distinguished from the background, it is said that the object is visible to that observer. Visibility is not only dependent on light but upon the distance between the object and the observer. As the distance increases, less and less light reflected from the object reaches the observer until the object is no longer distinguished from the background. When the observer can no longer distinguish the object from the background, the object is said to be beyond the visible range. In summary, the visibility of an object illuminated by light depends upon the apparent contrast between the object and its background, the ability of the observer to distinguish the object from its background, the size of the object and the angle of reflection, and the condition and technique of observing.

Three definitions of visibility are commonly found in the literature.

Visual Range: A dark object is moved through the atmosphere toward the horizon sky. As the distance between the object and observer increases, contrast between the object and horizon sky decreases. At some distance the contrast between object and horizon sky becomes too small to be distinguished, and the object "vanishes." The distance between the observer and the object at the "vanishing point" is the visual range.

Prevailing Visibility: The greatest visibility which is obtained or surpassed around at least half of the horizon circle, but not necessarily in continuous sectors.

Meteorological Range: The distance at which the contrast of an object is reduced to the point where the human eye can no longer distinguish it from the background, or that distance for which the contrast transmittance of the atmosphere is two percent.

It is possible under a certain set of circumstances to measure visibility by using photography. Stephens (1949) developed a method for measuring photographically the "extent to which visual range has been reduced by haze."

Briefly, the technique involves photographing (on black and white film) black objects that are far enough away to be obscured. Then the photographic densities of the objects and the adjacent sky are measured on the negative. Calculated from these relative densities are the visual range, distance of the object, and contrast of the film.

The theory of photographic photometry, used to calculate long-range visibility, as in Roberts', et. al. (1974) study of visibility measurements in the Painted Desert, states that if a "black object of sufficient size is moved through the atmosphere away from the observer, the object will appear to become brighter as the distance from the observer increases, even though the level of illumination remains constant." The apparent increase in brightness is the result of light being scattered as it moves toward the observer by suspended aerosol particles in the air between the object and the observer. The effect of an apparent increase in brightness illustrates the reduction of light as it moves through air that contains particulate. It is this effect that is detected by the technique of photographic photometry.

The apparatus utilized in photometry is very simple. All that is needed are a camera, a positive gray scale, some means of measuring the distance from the observation point to the object photographed, and a densitometer. A densitometer is the devise by which the relative densities on the negative are measured.

Unfortunately, photographic photometry has various problems which may cause problems in insuring reliable results. First, for the purposes of this study, it is crucial to differentiate between visibility reductions due to natural haze and polluted haze. We are attempting to measure the increase in haziness (the decrease in visibility) made by pollution. Photometry simply measures the visible range, without regard to the differentiation of natural and polluted haze.

There are interrelations among the specifications for the object, the densitometer, and the camera. The size of the image on the negative whose density is to be measured depends on the size and distance of the object and on the focal length of the lens. The minimum size of the image that can be used depends on the characteristics of the densitometer utilized. To further complicate the interrelation, since with any ordinary lens the illumination at the focal plane rapidly decreases toward the edges of the frame, it is necessary to find what area of the negative is satisfactorily uniform in relation to the particular camera utilized. This illumination function is found by trial and error and is beyond the scope of our present efforts.

Ideally, data should be obtained by photographing distinct objects in each possible direction once each hour from each sample area and from one general area.[5/] At least two distinct objects should be included in each observation path to insure that, regardless of the atmospheric conditions, data can be obtained from the photographs. It is desirable to include views in all quadrants because of visibility and meteorological differentials across areas. Observation points were chosen with these criteria.

We define "object" as some unique natural or man-made phenomenon in the landscape that is distinct from its immediate surroundings. "Observation path" is the line of sight. It is important to properly identify and locate objects in the observation path, certainly if accurate measurements are to be made. It further helps the respondent gain perspective when viewing the picture set. Proper identification and measurement of objects in each observation path chosen was accomplished using city and topological maps as well as visual inspection.

"Observation point" is simply the place in each area from which photographs were taken. Earlier in this report we noted that one criteria in the selection of some sample areas in the SCAE was a view. Therefore, observation points in the sample that are with a view were chosen with the aim of representing to respondents within each sample area a scene that they typically observe. In this way, it was intended that the photographs would merely serve as a reminder to respondents of the changes in visibility due to air quality.

Certainly the most important consideration is what is contained in each observation path and therefore in each picture. Ideally, each observation path should have at least two readily recognizable objects with which the majority of respondents are familiar, allowing them to estimate easily visibility by the contrast of those objects. The observation paths and the objects therein should be concerned foremost with the portrayal of a visibility gradient (in our study, “good,” “fair,” and "poor”), and should be very careful to exclude objects that may trigger bias in the respondent in responding to something besides visibility (or health affects). For example, a freeway interchange in the picture may stir up negative feelings in the respondent even before the respondent considers the impact of changes in visibility. Such undesirable characteristics in the observation paths may increase the chance for bias in the valuation procedure.

Another very important consideration was to insure consistency in field operations. There was a standard operating procedure at each observation point. Each photograph was taken with identical equipment. In order to as closely as possible duplicate the quality of photographs from each location, each photograph was taken with the same model Minolta SLR camera, 135 mm lens (used for the photographs the respondents saw), 55 mm lens (to record on film the local weather conditions for future reference), and the same high quality professional color film.6/

Crucial to the photographic data collection effort and the standardization of field operations was for each photograph to be accurately logged. Thus, each frame of exposed film was logged and each step in the procedure was carefully recorded so as to minimize discrepancies between observation points.

For each exposed frame, the researcher kept a record of various characteristics. The time and date of exposure is important in order to coordinate the data the research team collects in the field with the data collected by the local airports and local air monitoring stations. The F-Stop (aperature opening) and shutter speed were recorded so as to further estimate changes in visibility. Since the photographs were going to be shown to respondents as well as analyzed, it was important to insure the quality of the photographs. By quality, we mean that each photograph must be an accurate rendition of the air quality as prevailed during each exposure. In order to insure a proper exposure, each photograph was “bracketed.” That is, for each photograph one frame was taken with a normal meter reading, then one frame of the same observation path was “underexposed” (meaning one F-Stop above normal keeping the same shutter speed as for the normal photograph), then one frame "overexposed.” In this way we were assured that the best possible representation on film of each observation path was produced.

It should be emphasized that the objective of these photographs is to portray to respondents changes in visibility due to changes in air quality. Observation points and observation paths were chosen primarily on the criteria already listed, but once these sites were chosen, pictures could only be used if the changes in air quality were such as to represent the range from clarity to visual obscurity that is typical for each area during the year. Of course, changes in visibility due to changes in air quality is quite out of our control. Therefore, we could only use those photographs in the survey instrument portion of this study that were indeed representative of the typical range of visibility for any one area. Such photographs could only be obtained if the air quality was “right.” The results of this effort are summarized below.

Photographs were taken from seven sample area observation points and from one general site observation point. By “general site” we mean some area or view that would likely be familiar to most of the respondents no matter where they lived in the South Coast Air Basin.

Figure 4.3 entitled “Los Angeles Observation Paths” depicts the seven sample areas and the Griffith Park Observatory. The map is scaled as shown and each vector eminating from specific observation points represents fifteen miles.

The Griffith site afforded three excellent observation paths: (1) toward downtown Los Angeles, with large buildings approximately five miles from the observation point; (2) down Western Avenue toward large buildings approximately four miles away and toward two sets of hills in the background; and (3) southwest toward large buildings near Beverly Hills.

Recall that we have six pairs of sample areas:

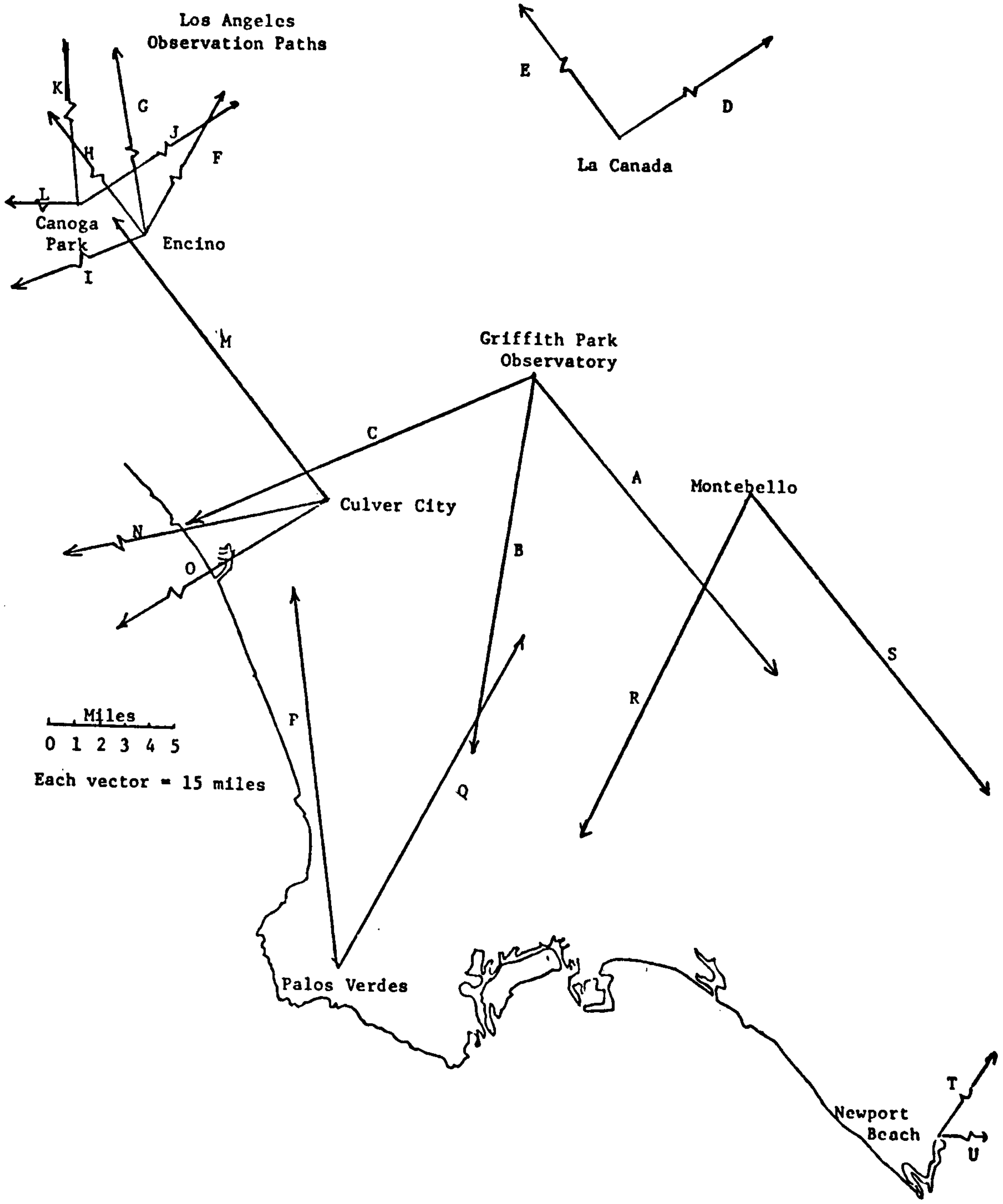
1) Canoga Park*	El Monte
2) Culver City*	Montebello*
3) Newport Beach*	Pacific Palisades
4) Irvine	Palos Verdes*
5) Encino*	La Canada*
6) Huntington Beach	Redondo Beach

Those areas marked with an asterik (*) were chosen as tentative sites for observation points. A brief description of each observation path from each site is as follows:

La Canada: (4) northeast across the basin toward mountains; and (5) northwest through the basin toward the mountains.

Encino: (6) northeast toward large buildings with mountains in the background; (7) north toward two sets of large buildings at different distances with mountains in the background; (8) north-northwest toward large buildings with mountains in background; and (9) west down Ventura

Figure 4.3
Observation Paths in the South Coast Air Basin



Boulevard toward the mountains.

Canoga Park: (10) north-northeast toward large buildings with mountains in the background; (11) north toward sets of large buildings with mountains in the background; and (12) west toward a set of large buildings with mountains in the background.

Culver City: (13) northwest toward a set of large buildings with mountains in the background; (14) west toward buildings in Santa Monica; and (15) southwest toward two large buildings in Marina Del Ray.

Palos Verdes: (16) north toward buildings in Beverly Hills; and (17) north-northeastern toward large buildings in downtown Los Angeles with mountains (Griffith Park) in the background.

Montebello: (18) south-southwest toward buildings; and (19) southeast toward Whittier with hills on one side of the observation path.

Newport Beach: (20) northeast toward buildings with two sets of mountains in the background; and (21) east across the Bay toward hills with mountains in the background.

On numerous occasions, photographs were taken from the eight observation points and the twenty-one observation paths. For each observation path, of course, the attempt was to photograph “good,” “fair,” and “poor” days of visibility. This was successfully accomplished for the Griffith Park site, but was unsuccessfull for all specific sample areas except Encino. For the other areas, we were unable to obtain the necessary gradients in the photographs that would represent the typical range of visibility for each area.

The photographs used in the asking games for each sample area were the observation paths from Griffith Park toward downtown Los Angeles and down Western Avenue. Figures 4.4a-c present the actual photographs in a black and white version. The visibility for picture set A (poor) was estimated at 2 miles, for picture set B (fair) at 12 miles, and for picture set C (good) at 28 miles.

The researchers were unable to obtain a poor air quality picture set for the Griffith Park area with the same light and color characteristics as the good and fair picture sets, although pictures were obtained for this location of approximately 2 miles. Inconsequence, the researchers substituted a picture set with similar foreground and light and color characteristics taken at approximately the same time in Orange County, California.

4.3 The Surveying Procedure

This section will detail the actual sampling procedures given the sample plan discussed earlier. The, first task was to identify a group in each paired area to receive a health brochure. The second task was the actual administering of the survey instrument.

Figure 4.4a
(Good)
Photograph Depicting Observation Paths for "Good" Visibility

Figure 4.4b

(Fair)

Photograph Depicting Observation Paths for “Fair” Visibility

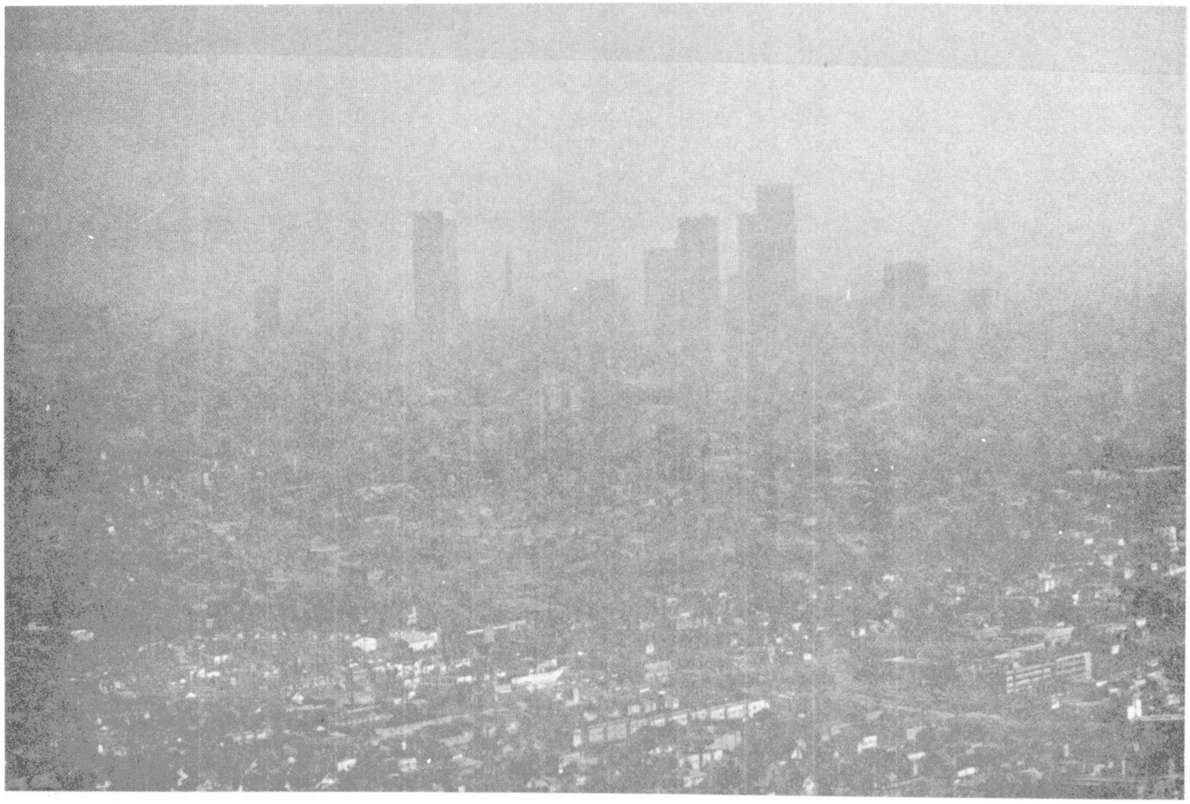
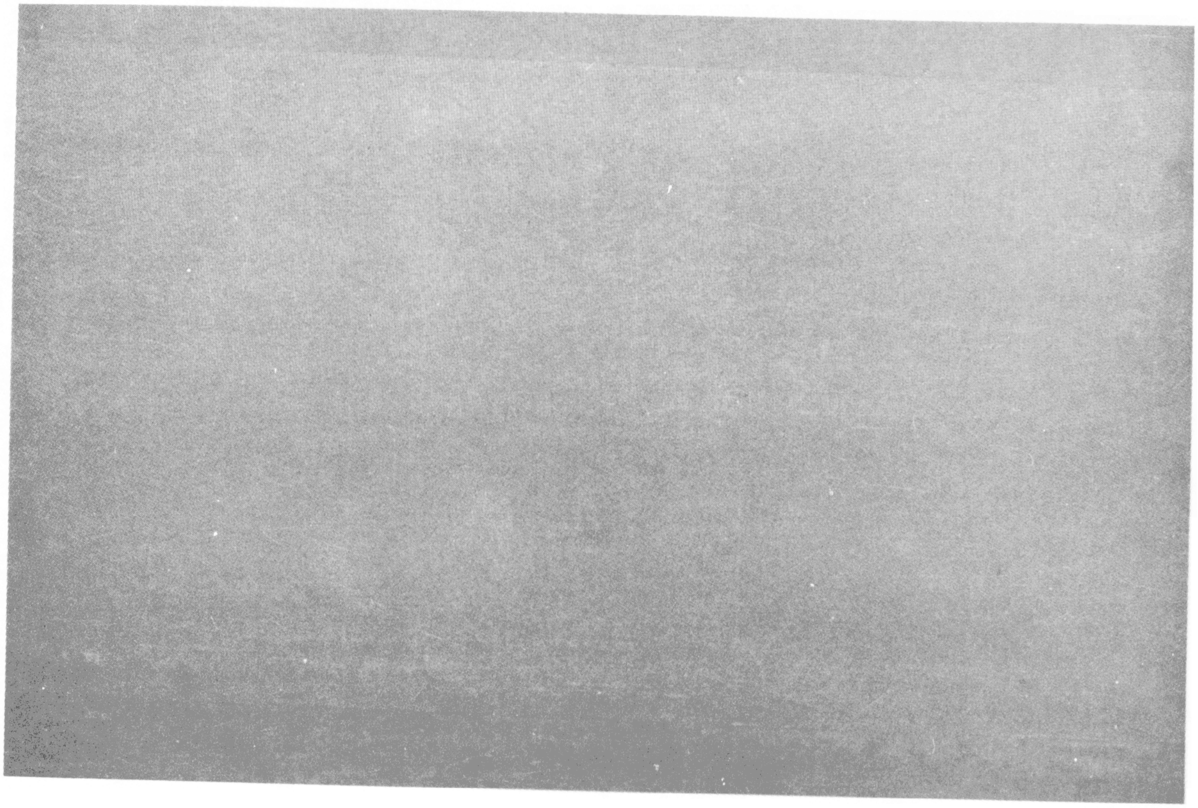
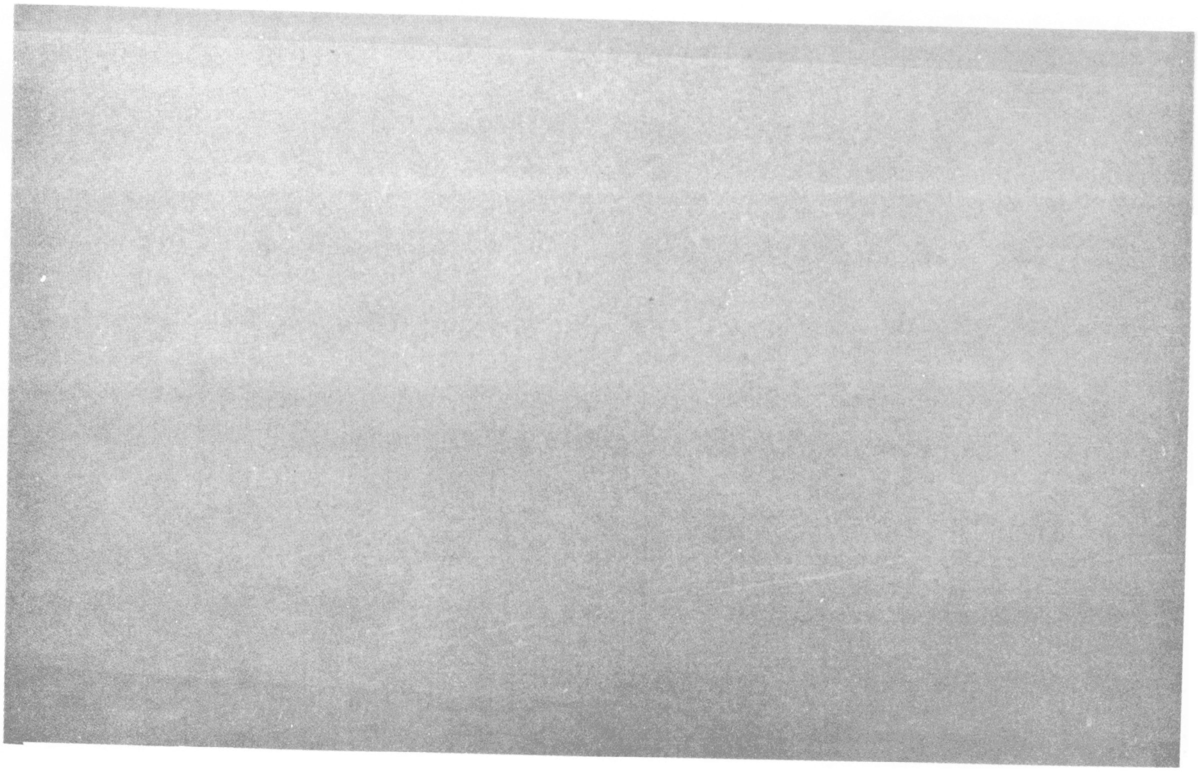


Figure 4.4c
(Poor)
Photograph Depicting Observation Paths for “Poor” Visibility





Late in September 1977, a team of University of Wyoming and University of Southern California personnel contacted by telephone a random sample of the population in each of the twelve final sample areas. The team was equipped with reverse telephone directories (i.e., phone directories listing people by address instead of by name) which enabled accurate isolation of names and addresses of potential respondents within the boundaries of each sample area. Once streets and addresses were located within each sample area, a random number generating table was utilized to pick the names of potential respondents from each street.1/ This was done to insure that no bias would be introduced into the telephone sampling process.

People were then randomly contacted by telephone until at least thirty people per area had agreed to cooperate with the research team in the air quality study. Thus a minimum of 360 people, distributed over twelve sample areas in the Los Angeles Basin, were to be the respondents in the asking game portion of the study.

Then in Spring 1978; half of the potential respondents were sent a health pamphlet entitled "Air Pollution and Health," The half of the potential respondents receiving this pamphlet was to be the group upon which we would test a learning hypothesis of the asking games. Approximately 180 potential respondents comprised this group.

In early March 1978, a research team comprised of staff and graduate students from the University of Wyoming and a similar team from the University of New Mexico went to Los Angeles to begin the survey instrument portion of the study. The two teams were divided into four groups in order to sample each of the twelve sample areas most efficiently.

The first order of business was to contact each of the potential respondents by telephone and set up appointments with them. Although most of the potential respondents could be reached by telephone, an unexpectedly high percentage of persons who had previously agreed to cooperate with us in the study declined the interview. This drastically cut the potential respondent list and forced alternative methods of sampling.

Because of this setback, the sampling process was broken into three parts. First, of course, we arranged interviews with those respondents from our original lists who had said they were willing to cooperate and who were still interested. Second, we once again utilized the reverse telephone directories to set up new appointments with people in each sample area. Third, each sample area was canvassed by members of the research team by a door-to-door method. By this procedure the sample size was approximately 345 interviews successfully completed by the research team. Table 4.3 presents the breakdown of the resulting sample by type of survey instrument.

4.4 Preliminary Empirical Results for the Iterative Bidding Portion of The Survey Instrument Study

This section will present preliminary results of the iterative bidding format portion of the contingent valuation study. Initial bias tests will be presented including vehicle bias, starting point bias, and the potential

Table 4.3

Survey Instrument Type Breakdown

Questionnaire Type / Location	Health Pamphlet				No Health Pamphlet				Total by Area by Type
	Aesthetic		Acute		Aesthetic		Acute		
	Male	Female	Male	Female	Male	Female	Male	Female	
La Canada (A → B)	1	1	1	1	2	7	4	1	18
La Canada (A → C)		4			2	5	3	4	14
El Monte (A → B)					2	5	6	3	16
El Monte (A → C)					5	7	2	6	20
Montebello (A → B)		1	1		3	5	4	4	18
Montebello (A → C)	2	3	1		3	5	2	4	20
Canoga Park (B → C)			4		6	4	3	3	20
Encino (B → C)		1	1	2	8	6	5	5	28
Culver City (B → C)	1	1	1	2	4	8	4	9	30
Pacific Palisades (C → C*)	3		1	2	5	3	1	6	21
Redondo Beach (C → C*)	3	1	3	2	5	5	4	4	27
Palos Verdes (C → C*)		3		2	1	7		7	20
Huntington Beach (B → C)	1	2		1	5	8	7	16	40
Newport Beach (B → C)		4	3		4	7	2	2	22
Irvine (B → C)	1	3			7	7	4	5	27
TOTALS	12	24	16	12	62	89	51	79	345

for sequencing effects. Additionally, some preliminary regression results will be discussed in Appendix D.

Table 4.4a,b presents the mean total bids by area partitioned by proposed clean-up date. The results in Table 4.4a range from $47.75 per month for the Pacific Palisades area to $4.50Per month in the Newport Beach area 8/. This difference in mean bids between Pacific Palisades and Newport Beach is not fully understood at this time. As was set forth in the theoretical Chapter II, these results are not commensurate with economic expectations. This problem can be investigated when the substitution results are integrated into the analysis.

Appendix C presents tables for cumulative mean bids by sequence where either aesthetic or acute information is presented first by area and differentiating between a 2 or 10 year clean up time horizon. All other potential effects such as biases are assumed zero. The results presented in the appendices form The basis of some simple statistical tests. The tests to be considered are whether:

1. the area mean bids are significantly different from zero;
2. the aesthetic, acute, chronic and total bids for the paired areas are significantly different;
3. the results indicate the existence of starting point, vehicle or sequencing bias; and
4. the results indicate different bidding behavior when individuals were offered different completion dates for cleanup.

The results of the t-tests regarding the equality of area mean bids being statistically different from zero are presented in Table 4.5. Of interest is whether the results of the test allow the null hypothesis to be rejected. In all but the one case of Montebello area for the chronic bid, the null hypothesis is rejected with 90% confidence. Some cases suggest higher levels of confidence. Thus, we can initially infer that in all areas, the values individuals place on the three characteristics of air quality under consideration tend to be non-zero.

In Table 4.6, the equality between bids between the paired areas is tested for the three characteristics and the total bid. Only two pairs reject the null hypothesis that the two areas' mean bids are equal: Pacific Palisades/Newport Beach and Culver City/Montebello. The former was for aesthetic, acute, and the total bid while the latter was for the acute health bid only. The purpose of this test can be seen in reference to the discussion in the contingent valuation theory section. At issue was the difference between a bid from the property value study in comparison to the iterative bidding study. Recall that a contingency proposed to an individual was moving him along an indifference curve. "Assuming that each area represents a homogeneous set of preferences which differ across areas, the test in Table 4.6 asks whether the movement in dollar amount is the same across the paired areas.

Table 4.4a

Mean Bids by Area by Type*
(Completion Date of Cleanup, 2 Yrs.)

Area	Mean Bids ($/month)			
	Aesthetic Bid	Acute Health Bid	Chronic Health Bid	Total Bid
El Monte (A → B)	1.50 (0.67)** (10)***	6.10 (2.58) (10)	1.20 (0.66) (10)	8.80 (2.99) (10)
El Monte (A → C)	3.61 (6.14) (7)	3.14 (1.40) (7)	3.36 (2.07) (7)	16.11 (8.30) (7)
La Canada (A → B)	9.43 (9.61) (7)	1.29 (0.75) (7)	1.57 (1.41) (7)	12.29 (6.83) (7)
La Canada (A → C)	11.30 (7.48) (10)	5.20 (2.06) (10)	11.00 (5.91) (10)	27.50 (7.50) (10)
Montebello (A → B)	2.56 (1.16) (9)	5.67 (2.92) (9)	1.22 (1.10) (9)	9.44 (4.01) (9)
Montebello (A → C)	19.90 (14.53) (10)	6.18 (2.36) (11)	5.09 (4.51) (11)	29.80 (19.04) (10)
Canoga Park (B → C)	4.50 (2.55) (8)	13.44 (3.87) (8)	3.00 (1.82) (8)	20.94 (5.82) (8)
Culver City (B → C)	5.81 (3.04) (16)	16.81 (6.36) (16)	7.75 (3.35) (16)	30.38 (9.97) (16)
Encino (B → C)	8.41 (2.08) (17)	8.74 (3.37) (17)	1.68 (0.79) (17)	18.82 (3.06) (17)
Huntington Beach (B → C)	9.68 (3.66) (19)	7.10 (1.82) (20)	3.42 (1.36) (19)	20.26 (5.71) (19)
Irvine (B → C)	5.17 (1.50) (15)	13.53 (5.04) (15)	2.87 (1.23) (15)	21.57 (4.79) (15)
Newport Beach (B → C)	3.10 (0.97) (10)	0.70 (0.40) (10)	0.70 (0.48) (10)	4.50 (1.11) (10)
Pacific Palisades (C → C*)	18.00 (11.86) (8)	21.00 (12.46) (8)	8.75 (6.03) (8)	47.75 (29.41) (8)
Palos Verdes (C → C*)	2.41 (1.23) (8)	9.97 (5.89) (8)	1.13 (0.64) (8)	13.50 (5.58) (8)
Redondo Beach (C → C*)	5.29 (2.64) (14)	10.07 (4.17) (14)	2.21 (1.54) (14)	17.57 (6.14) (14)

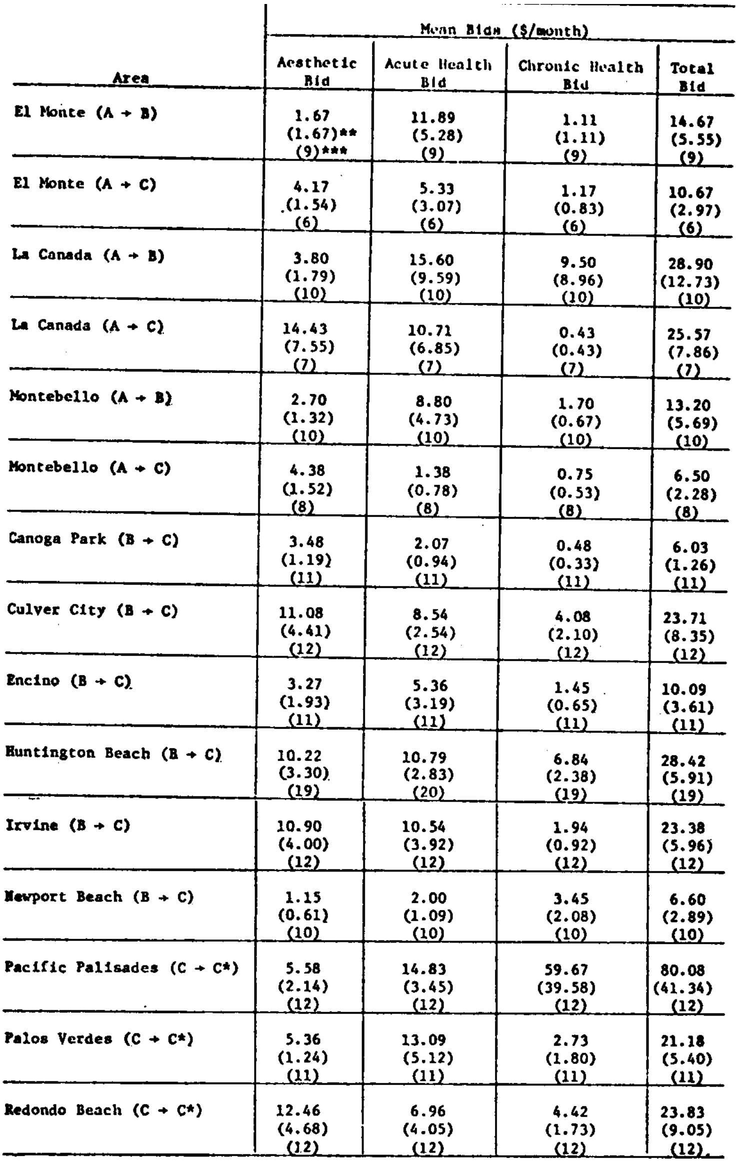
* The implicit assumption in this table has been that of strict additivity of bids for each air quality effect. In obtaining the mean bids: (1) no differentiation has been made with respect to the bidding sequence; (2) no differentiation has been made whether a health pamphlet has or has not been sent to the respondent in advance of the interview; (3) no differentiation has been made with respect to the different proposed vehicles for the collection of bids; and (4) no differentiation has been made whether a life table has or has not been shown to the respondent during the interview. A life table depicts the "stock" counterparts of the elicited monthly bids for various expected lifespans.

** Standard error of the mean bid in all cases.

*** Sample size of each case in all cases.

Table 4.4b

Mean Bids by Area by Type *
(Completion date of Cleanup: 10yrs.)



Area	Mean Bids ($/month)			
	Aesthetic Bid	Acute Health Bid	Chronic Health Bid	Total Bid
El Monte (A → B)	1.67 (1.67)** (9)***	11.89 (5.28) (9)	1.11 (1.11) (9)	14.67 (5.55) (9)
El Monte (A → C)	4.17 (1.54) (6)	5.33 (3.07) (6)	1.17 (0.83) (6)	10.67 (2.97) (6)
La Canada (A → B)	3.80 (1.79) (10)	15.60 (9.59) (10)	9.50 (8.96) (10)	28.90 (12.73) (10)
La Canada (A → C)	14.43 (7.55) (7)	10.71 (6.85) (7)	0.43 (0.43) (7)	25.57 (7.86) (7)
Montebello (A → B)	2.70 (1.32) (10)	8.80 (4.73) (10)	1.70 (0.67) (10)	13.20 (5.69) (10)
Montebello (A → C)	4.38 (1.52) (8)	1.38 (0.78) (8)	0.75 (0.53) (8)	6.50 (2.28) (8)
Canoga Park (B → C)	3.48 (1.19) (11)	2.07 (0.94) (11)	0.48 (0.33) (11)	6.03 (1.26) (11)
Culver City (B → C)	11.08 (4.41) (12)	8.54 (2.54) (12)	4.08 (2.10) (12)	23.71 (8.35) (12)
Encino (B → C)	3.27 (1.93) (11)	5.36 (3.19) (11)	1.45 (0.65) (11)	10.09 (3.61) (11)
Huntington Beach (B → C)	10.22 (3.30) (19)	10.79 (2.83) (20)	6.84 (2.38) (19)	28.42 (5.91) (19)
Irvine (B → C)	10.90 (4.00) (12)	10.54 (3.92) (12)	1.94 (0.92) (12)	23.38 (5.96) (12)
Newport Beach (B → C)	1.15 (0.61) (10)	2.00 (1.09) (10)	3.45 (2.08) (10)	6.60 (2.89) (10)
Pacific Palisades (C → C*)	5.58 (2.14) (12)	14.83 (3.45) (12)	59.67 (39.58) (12)	80.08 (41.34) (12)
Palos Verdes (C → C*)	5.36 (1.24) (11)	13.09 (5.12) (11)	2.73 (1.80) (11)	21.18 (5.40) (11)
Redondo Beach (C → C*)	12.46 (4.68) (12)	6.96 (4.05) (12)	4.42 (1.73) (12)	23.83 (9.05) (12)

* The implicit assumption in this table has been that of strict additivity of bids for each air quality effect. . In obtaining the mean bids: (1) no differentiation has been made with respect to the bidding sequence; 2) no differentiation has been made whether a health pamphlet has or has not been sent to the respondent in advance of the interview; (3) no differentiation has been made with respect to the different proposed vehicles for the collection of bids; and (4) no differentiation has been made wherher a life table has or has not been shown to the respondent during the interview . A life table depicts the "stock" counterparts of the elicited monthly bids for various expceted lifespans.

* * Standard error of the mean bid in all cases.

* ** Sample size of each case in all cases.

Table 4.5

Results of the t-tests Regarding the Equality of Area Mean Bids to Zero*

H_o: The mean bid is equal to zero**

H_1: The mean bid is greater than zero

Name of Area	Type of Contingency	n	Aesthetic Bid	Acute Health Bid	Chronic Health Bid
El Monte	(A → B)	20	Reject H_o at 95%	Reject H_o at 95%	Reject H_o at 95%
El Monte	(A → C)	13	Reject H_o at 95%	Reject H_o at 95%	Reject H_o at 95%
La Canada	(A → B)	17	Reject H_o at 95%	Reject H_o at 90%	Accept H_o
La Canada	(A → C)	17	Reject H_o at 95%	Reject H_o at 95%	Reject H_o at 95%
Montebello	(A → B)	19	Peject H_o at 99%	Reject H_o at 99%	Reject H_o at 95%
Montebello	(A → C)	19	Reject H_o at 90%	Reject H_o at 99%	Accept H_o
Canoga Park	(B → C)	19	Reject H_o at 99%	Reject H_o at 99%	Reject H_o at 95%
Culver City	(B → C)	28	Reject H_o at 99%	Reject H_o at 99%	Reject H_o at 99%
Encino	(B → C)	28	Reject H_o at 99%	Reject H_o at 99%	Reject H_o at 99%

(continued)

Table 4.5
(continued)

Name of Area	Type of Contingency	n	Aesthetic Bid	Acute Health Bid	Chronic Health Bid
Huntington Beach	(B → C)	38	Reject H_o at 99%	Reject H_o at 99%	Reject H_o at 99%
Irvine	(B → C)	27	Reject H_o at 99%	Reject H_o at 99%	Reject H_o at 99%
Newport Beach	(B → C)	20	Reject H_o at 99%	Reject H_o at 95%	Reject H_o at 95%
Pacific Palisades	(C → C*)	20	Reject H_o at 95%	Reject H_o at 95%	Reject H_o at 90%
Palos Verdes	(C → C*)	19	Reject H_o at 99%	Reject H_o at 99%	Reject H_o at 95%
Redondo Beach	(C → C*)	26	Reject H_o at 99%	Reject H_o at 99%	Reject H_o at 99%

*The bids for each air quality effect are assumed to be strictly separable. In obtaining the mean bids, no differentiation is made with respect to: (a) different bidding sequences; (b) vehicle used; (c) starting bid; (d) health pamphlet versus no health pamphlet; or (e) life table versus no life table (f) completion date of cleanup.

**One-tail $t_{n-1} \frac{\mu}{\hat{s}/\sqrt{n}}$ where μ = area mean bid for a certain air quality effect

$\hat{s}$ = sample standard deviation

n = sample size

Table 4.6

Results of the Bid Equality Tests of the Paired Communities*

H_o: The two mean bids are equal

H_a: The two mean bids are unequal

Paired Areas	N	Aesthetic Bid	Acute Health Bid	Chronic Health Bid	Total Bid
Pacific Palisades Newport Beach	20 20	Reject H_o at 99%	Reject H_o at 99%	Accept H_o	Reject H_o at 95%
Canoga Park El Monte	19 33	Accept H_o	Accept H_o	Accept H_o	Accept H_o
Irvine Palos Verdes	27 19	Accept H_o	Accept H_o	Accept H_o	Accept H_o
Encino La Canada	28 34	Accept H_o	Accept H_o	Accept H_o	Accept H_o
Huntington Beach Redondo Beach	40 26	Accept H_o	Accept H_o	Accept H_o	Accept H_o
Culver City Montebello	28 38	Accept H_o	Reject H_o at 95%	Accept H_o	Accept H_o

*The statistical test employed was a two-tailed t-test of the null hypothesis (H_o) that the mean bids for each of the paired communities were equal. The test also used a pooled variance estimate in the calculation of the test-statistic. The information in the major cells of the table reports the level of significance for the statistical tests. Rejection of H_o at the reported significance level means that the test failed to reject H_o at a higher level of significance. Only three significance levels were tested: 90%, 95%, and 99%. Failure to reject H_o means that H_o could not be rejected at the 90% level or greater. The purpose of the above tests is to check if there is a statistically significant difference between the mean bids of the areas within the same pair. Throughout this analysis, the bids for each air quality effect are assumed to be strictly separable. In obtaining the mean bids no differentiation is made with respect to: (a) bidding sequence; (b) vehicle used; (c) starting bid; (d) health pamphlet versus no health pamphlet; or (e) life table versus no life table (f) completion date of cleanup.

In an iterative bidding format, various types of biases might be introduced by the structure of the survey instrument. In this study, the types of biases selected for examination were vehicle bias, starting point bias, and information sequence bias.

A test of means was conducted between the monthly utility bill and the lump sum payment mechanism for the areas by characteristic bid and for the total bid. Table 4.7 presents the results. The null hypothesis set forth was that the mean bids. were equal irrespective of the bidding vehicle. For Montebello, Canoga Park, Encino, Huntington Beach, Newport Beach, Pacific Palisades, Palos Verdes, and Redondo Beach, the null hypothesis is accepted for the total bid. However, for Irvine, Culver City, La Canada, and ElMonte, we reject the null hypothesis, at least at the 90% confidence level, for the total bid. No obvious reason exists at this point in time for this result. The principle problem area then appears to be in the aesthetic bids.9/

A second bias of concern is that of starting point bias. Recall from previous discussions that starting point bias results from the final bid being definitely related to the starting bid, i.e., the higher the starting point, the higher will be the final bid, thus suggesting a type of information bias. Table 4.8 presents the results of a test for starting point bias. The structure of the test was as follows. Three starting points of $1, $10, and $50 were employed in the survey instrument. This results in three potential comparisons of starting points for the resulting mean bids: (1) $1 to $10; (2) $1 to $50; and (3) $10 to $50. The null hypothesis was whether the total mean bids were equal within the three combinations of mean bids ignoring all other potential effects. For the $1 to $10 pair, the null hypothesis of no effect was rejected in La Canada and Encino. The $1 to $50 pair was rejected for La Canada and Montebello. Finally, the $10 to $50 pair was rejected only for Redondo Beach.

To fully understand why the isolated cases indicate starting point bias, a greater understanding would require consideration of other systematic effects in the data set. However, Preliminary evidence based on Table 4.8 suggests that starting point bias is not a major problem for all of the iterative bidding results.

Another area of consideration is the question of sequencing of information affecting the bid structure not only for the air quality characteristic bids, but also the final bid. Recall that bids were collected according to the following sequences:

1. aesthetic, aesthetic Plus acute, and aesthetic plus acute plus chronic, or,

2. acute, acute plus chronic, and acute plus chronic plus aesthetic.

The question of sequencing is whether the ordering of the bidding process effects the size of the bid. For instance, will individuals bid a different amount for aesthetic effects if it is first, as in (1) above, compared to being last as in (2) above. Similarly, will the acute bids vary? Additionally, we are interested in whether the orderings presented in (1) and (2)

Table 4.7

Results of the t-tests for the Equality of the Mean Bids by Sample Area by Bidding Vehicle*

H_0: The two mean bids are equal

H_1: The two mean bids are unequal

Name of Area	n_1**	n_2**	Aesthetic Bid	Acute Health Bid	Chronic Health Bid	Total Bid
El Monte	20	13	Accept H_0***	Accept H_0	Accept H_0	Reject H_0 at 90%***
La Canada	22	12	Accept H_0	Accept H_0	Accept H_0	Reject H_0 at 90%
Montebello	21	17	Accept H_0	Accept H_0	Accept H_0	Accept H_0
Canoga Park	7	12	Accept H_0	Accept H_0	Accept H_0	Accept H_0
Culver City	17	11	Reject H_0 at 95%	Accept H_0	Accept H_0	Reject H_0 at 90%
Encino	14	14	Accept H_0	Accept H_0	Accept H_0	Accept H_0
Huntington Beach	18	22	Accept H_0	Accept H_0	Accept H_0	Accept H_0
Irvine	9	18	Accept H_0	Reject H_0 at 90%	Accept H_0	Reject H_0 at 95%

(continued)

Table 4.7
(continued)

Name of Area	n_1**	n_2**	Aesthetic Bid	Acute Health Bid	Chronic Health Bid	Total Bid
Newport Beach	13	7	Accept H_o	Accept H_o	Accept H_o	Accept H_o
Pacific Palisades	11	9	Accept H_o	Accept H_o	Accept H_o	Accept H_o
Palos Verdes	12	7	Reject H_o at 95%	Accept H_o	Accept H_o	Accept H_o
Redondo Beach	17	9	Accept H_o	Accept H_o	Accept H_o	Accept H_o

*Throughout the questionnaires, two different vehicles of payment are employed. Some Respondents are proposed to pay their bids in separate monthly payments, and some others in additions to their utility bills. This table is prepared to check if the choice of the payment vehicle has any statistically significant effect on the mean of the bids.

The bids for each bidding stage are assumed to be strictly separable. In obtaining the mean bids no differentiation is made with respect to: (1) starting bid; (2) bidding sequence; (3) health pamphlet versus no health pamphlet; and (4) life table versus no life table.(5) completion date of cleanup.

**n_1: Sample size of the interviews in which the respondent was proposed to pay his bids in separate monthly payments.

**n_2: Sample size of the interviews in which the respondent was proposed to pay his bids as additions to his utility bills.

***The tests are done for $\alpha = 0.01$, $\alpha = 0.05$, and $\alpha = 0.10$. "Accept H_o" means H_o is accepted for $1-\alpha = 0.90$ and higher, i.e., for $\alpha \leq 0.10$. "Reject H_o at X%" means H_o is rejected at the given X% but is accepted at the next higher $1-\alpha$ value, i.e., if x% = 90%, then H_o is accepted at $1-\alpha = 95\%$.

Table 4.8

Test of Means for Starting Point Bias*

H_0: Mean bids are equal

H_1: Mean bids are unequal

Name of Area	Sample Sizes n_1	n_2	Starting Point Pairs	Totals
El Monte	8 8 15	15 9 9	1-10 1-50 10-50	Accept H_0 ** Accept H_0 Accept H_0
La Canada	13 13 12	12 9 9	1-10 1-50 10-50	Reject H_0 at 95% Reject H_0 at 90% Accept H_0
Montebello	16 16 12	12 9 9	1-10 1-50 10-50	Accept H_0 Reject H_0 at 90% Accept H_0
Canoga Park	7 7 6	6 6 6	1-10 1-50 10-50	Accept H_0 Accept H_0 Accept H_0
Culver City	9 9 11	11 8 8	1-10 1-50 10-50	Accept H_0 Accept H_0 Accept H_0
Encino	9 9 11	11 8 8	1-10 1-50 10-50	Reject H_0 at 90% Accept H_0 Accept H_0
Huntington Beach	8 8 15	15 15 15	1-10 1-50 10-50	Accept H_0 Accept H_0 Accept H_0
Irvine	7 7 12	12 8 8	1-10 1-50 10-50	Accept H_0 Accept H_0 Accept H_0

(continued)

Table 4.8
(continued)

Name of Area	Sample Sizes n_1	n_2	Starting Point Pairs	Totals
Newport Beach	9	6	1-10	Accept H_0
	9	5	1-50	Accept H_0
	6	5	10-50	Accept H_0
Pacific Palisades	7	6	1-10	Accept H_0
	7	7	1-50	Accept H_0
	6	7	10-50	Accept H_0
Palos Verdes	2	9	1-10	Accept H_0
	2	8	1-50	Accept H_0
	9	8	10-50	Accept H_0
Redondo Beach	10	10	1-10	Accept H_0
	10	5	1-50	Reject H_0 at 95%
	10	5	10-50	Reject H_0 at 90%

*The purpose of this table is to check if there is any significant influence of the starting bid offered by the interviewer on the total bid of the respondent. In calculating the mean total bids: (1) no differentiation has been made with respect to the sequence that the air quality effects are presented; (2) no differentiation has been made whether a health pamphlet has or has not been sent to the respondent in advance of the interview; (3) no differentiation has been made with respect to the different proposed vehicles for the collection of bids; and (4) no differentiation has been made whether s life table has or has not been shown to the respondent during the interview. A life table depicts the "stock" counterparts of the elicited monthly bids for various expected lifespan. No differentiation has been made with respect to the different dates of cleanup.

**Accept $H_0 \rightarrow H_0$ is accepted for $1 - \alpha = 0.90$ and higher; i.e., for $\alpha < 0.10$.

will give different total bids. Ideally, the sequencing or ordering of bidding information will not affect the results. In an attempt to test for sequencing affects, two separate tests of means were conducted. The first test involved a comparison by area by bid type of the mean values of the observed bids against the derived bids. If an assumption of additivity is made in the bids, then we can obtain an aesthetic observed bid (from 1 above) and a derived aesthetic bid (from 2 above). The question is then whether the two bids differ.10/ That is, does the order in which we obtain bids affect the magnitude for the bid. Table 4.9 presents the results of this test. For aesthetic bids, El Monte (A → B), 11/ La Canada (A → C), Canoga Park, Encino, Huntington Beach, Irvine Palos Verdes, and Redondo Beach the null hypothesis was rejected. The null hypothesis was rejected for the acute bids in La Canada (A → C), Culver City, Encino, Huntington Beach, Newport Beach, and Palos Verdes.

The null hypothesis was rejected for chronic bids for La Canada (A → C) and Newport Beach. Finally, the null hypothesis was rejected for the total mean bids only in Newport Beach and Pacific Palisades. What can be concluded from this set of results? First, the test does not completely resolve the issue of sequencing. In some cases, the mean bids that were observed are statistically different under the assumption of linear additivity. Second, keeping the first point in mind, we note that the total bid does appear to be insensitive to the bidding across different orderings of characteristics of the environmental good air quality.

A second test to further investigate the extent of sequencing effects is to compare each step of the bidding process irrespective of the subject (i.e., acute or aesthetic information) of the bid. The null hypothesis is then to compare the mean values of step 1, the mean differences in values of step 2 from step 1, the mean difference in values from step 2 to step 3, and the total bid. Table 4.10 presents these results. For the first bidding step, only Palos Verdes had the null hypothesis rejected. The null hypothesis for the second bidding step was rejected for Pacific Palisades, Newport Beach and Irvine. For the third bidding step only El Monte was rejected. Finally, the null hypothesis was rejected for Pacific Palisades and Newport Beach.12/ What can we conclude about sequencing from this test? First, again no definitive statement can be made regarding the existence or non-existence of sequencing. The results suggest that regardless of the information being bid upon, the step size (i.e., bid difference from the last step) is independent of the information underlying the bid. Second. irrespective of the bidding order, the total bid is insensitive to order effects.13/

The results of the t-tests comparing the effects of different completion dates of cleanup for each area are presented in Table 4.11. Additionally, Table 4.12 presents similar results for each of the paired areas. The null hypothesis of this test was that the bids are equal no matter the completion date for the cleanup. The null hypothesis was rejected only in isolated cases such as Canoga Park in Table 4.11. The implication of this result is that individuals appear not to view the magnitude of their bid being significantly determined by the proposed cleanup date.

Table 4.9

Results of the t-tests for the Equality of the Mean Bids for Observed versus Derived Bids by Sample Area*

(Two-tail test; Pooled Variance Estimate)

H_0: The two mean bidS are equal

H_1: The two mean bids are unequal

Name of Area	Type of Contingency	No. of n_1	Obs. n_2	Aesthetic Bid	Acute Health Bid	Chronic Health Bid	Total Bid
El Monte	(A → B)	7	13	Reject H_0 at 90%	Accept H_0	Accept H_0	Accept H_0
El Monte	(A → C)	10	3	Accept H_0	Accept H_0	Accept H_0	Accept H_0
La Canada	(A → B)	11	6	Accept H_0	Accept H_0	Accept H_0	Accept H_0
La Canada	(A → C)	11	6	Reject H_0 at 90%	Reject H_0 at 90%	Reject H_0 at 95%	Accept H_0
Montebello	(A → B)	10	9	Accept H_0	Accept H_0	Accept H_0	Accept H_0
Montebello	(A → C)	12	6	Accept H_0	Accept H_0	Accept H_0	Accept H_0
Canoga Park	(B → C)	9	10	Reject H_0 at 95%	Accept H_0	Accept H_0	Accept H_0
Culver City	(B → C)	13	15	Accept H_0	Reject H_0 at 90%	Accept H_0	Accept H_0
Encino	(B → C)	15	13	Reject H_0 at 99%	Reject H_0 at 99%	Accept H_0	Accept H_0

(continued)

Table 4.9
(continued)

Name of Area	Type of Contingency	No. of n_1	Obs. n_2	Aesthetic Bid	Acute Health Bid	Chronic Health Bid	Total Bid
Huntington Beach	(B $\rightarrow$ C)	16	22	Reject H_0 at 90%	Reject H_0 at 90%	Accept H_0	Accept H_0
Irvine	(B $\rightarrow$ C)	18	9	Reject H_0 at 95%	Accept H_0	Accept H_0	Accept H_0
Newport Beach	(B $\rightarrow$ C)	14	6	Accept H_0	Reject H_0 at 95%	Reject H_0 at 95%	Reject H_0 at 95%
Pacific Palisades	(C $\rightarrow$ C*)	10	10	Accept H_0	Accept H_0	Accept H_0	Reject H_0 at 90%
Palos Verdes	(C $\rightarrow$ C*)	11	8	Reject H_0 at 99%	Reject H_0 at 90%	Accept H_0	Accept H_0
Redondo Beach	(C $\rightarrow$ C*)	14	12	Reject H_0 at 95%	Accept H_0	Accept H_0	Accept H_0

*Across the questionnaires, the effects of air quality are introduced in two different sequences: (1) Aesthetic → Acute Health → Chronic Health; (2) Acute Health + Chronic Health + Aesthetic. The bids for each effect are assumed to be separable. The purpose of the above tests is to check if there is any significant influence of the sequence of presentation of the air quality effects on the mean bids for each effect. For example, the mean aesthetic bid obtained by the first sequence for some area is compared with the mean aesthetic bid obtained by the second bidding sequence for the same area. These tests of significance are repeated for each mean bid and for each area co find out the "sequencing effect" on bids. In obtaining the mean bids, no differentiation is made with respect to: (a) vehicle used; (b) starting bid; (c) health pamphlet versus no health pamphlet; and (d) life table versus no life table (f) completion date of clean-up.

Table 4.10

Results of the t-tests for Comparing the Sequencing Effects in Each Step of the Bidding Process

(Two-tailed test; Pooled Variance Estimates)

H_o: The bids are equal

H_1: The bids are unequal

Name of Area	n_1*	n_2*	First Bid	Second Bid	Third Bid	Total Bid
El Monte	17	16	Accept H_o**	Accept H_o	Reject H_o at 90%	Accept H_o
La Canada	22	12	Accept H_o	Accept H_o	Accept H_o	Accept H_o
Montebello	22	16	Accept H_o	Accept H_o	Accept H_o	Accept H_o
Canoga Park	9	10	Accept H_o	Accept H_o	Accept H_o	Accept H_o
Culver City	13	15	Accept H_o	Accept H_o	Accept H_o	Accept H_o
Encino	15	13	Accept H_o	Accept H_o	Accept H_o	Accept H_o
Huntington Beach	16	24	Accept H_o	Accept H_o	Accept H_o	Accept H_o
Irvine	18	9	Accept H_o	Reject H_o at 90%	Accept H_o	Accept H_o

(continued)

Table 4.10
(continued)

Name of Area	n_1*	n_2*	First Bid	Second Bid	Third Bid	Total Bid
Newport Beach	14	6	Accept H_0	Reject H_0 at 95%	Accept H_0	Reject H_0 at 95%
Pacific Palisades	10	10	Accept H_0	Reject H_0 at 90%	Accept H_0	Reject H_0 at 90%
Palos Verdes	11	8	Reject H_0 at 95%	Accept H_0	Accept H_0	Accept H_0
Redondo Beach	14	12	Accept H_0	Accept H_0	Accept H_0	Accept H_0

*This table presents the results of the t-tests done to determine whether or not there is a significant difference between the means of the first bid, the difference between the first and second bids, and the second and third bids irrespective of bidding sequence (i.e., whether the Aesthetic or Acute bid was asked first in the questionnaire).

**n_1 = those questionnaires which ask Aesthetic question first. n_2 = those questionnaires which ask Acute question first.

Table 4.11

Results of the t-tests for Comparing the Effects of Different completion Dates of Cleanup in Each Step of the Bidding Process a,b

(Two-tailed test; Pooled Variance Estimates)

H_0: The bids are equal.

H_1: The bids are unequal.

Area	Type of Contingency	Number of Observations		Mean Bids			
		n_1*	n_2*	Aesthetic Bid	Acute Health Bid	Chronic Health Bid	Total Bid
El Monte	A → B	10	9	Accept H_0	Accept H_0	Accept H_0	Accept H_0
El Monte	A → C	7	6	Accept H_0	Accept H_0	Accept H_0	Accept H_0
La Canada	A → B	7	10	Accept H_0	Accept H_0	Accept H_0	Accept H_0
La Canada	A → C	10	7	Accept H_0	Accept H_0	Accept H_0	Accept H_0
Montebello	A → B	9	10	Accept H_0	Accept H_0	Accept H_0	Accept H_0
Monntebello	A → C	11	8	Accept H_0	Accept H_0	Accept H_0	Accept H_0
Canoga Park	B → C	8	11	Accept H_0	Reject H_0 at 99%	Accept H_0	Reject H_0 at 9S%
Culver City	B → C	16	12	Accept H_0	Accept H_0	Accept H_0	Accept H_0
Encino	B → C	17	11	Accept H_0	Accept H_0	Accept H_0	Reject H_0 at 90%
Huntington Beach	B → C	19	20	Accept H_0	Accept H_0	Accept H_0	Accept H_0
Irvine	B → C	15	12	Accept H_0	Accept H_0	Accept H_0	Accept H_0
Newport Beach	B → C	10	10	Accept H_0	Accept H_0	Accept H_0	Accept H_0
Pacific Palisades	C → C*	8	12	Accept H_0	Accept H_0	Accept H_0	Accept H_0
Palos Verdes	C → C*	8	11	Accept H_0	Accept H_0	Accept H_0	Accept H_0
Redondo Beach	C → C*	14	12	Accept H_0	Accept H_0	Accept H_0	Accept H_0

[a] The bids for each bidding stage are assumed to be strictly separable. In obtaining the mean bids, no differentiation is made with respect to: (1) bidding sequence; (2) starting bid; (3) bidding vehicle; (4) health pamphlet versus no health pamphlet; and (5) life table versus no life table.

[b] The tests are done for $\propto = 0.01$, $\propto = 0.05$, and $\propto = 0.10$. "Accept H_0" means H_0 is accepted for $\propto = 0.01$, $\propto = 0.05$, and $\propto = 0.10$. "Reject H_0 at X%" means that H_0 is rejected at X%, but is accepted at the next higher 1 - $\propto$ value; e.g., if X% = 90%, then H_0 is rejected for $\propto = 0.10$ but is accepted for $\propto = 0.05$ and $\propto = 0.01$.

*n_1 = sample size of interviews with proposed completion date of cleanup of 2 years.

*n_2 = sample size of interviews with proposed completion date of cleanup of 10 years.

Table 4.12

Results of the t-tests for "Comparing the Effects of Different Completion Dates of Cleanup in Each Step of the Bidding Process a,b, c

(Two-tailed test; Pooled Variance Estimates)

H_0: The bids are equal.

H_1: The bids are unequal.

Paired Areas	Number of Observations		Mean Bids			
	n_1*	n_2*	Aesthetic Bid	Acute Health Bid	Chronic Health Bid	Total Bid
El Monte-Canoga Park	25	26	Accept H_0	Accept H_0	Accept H_0	Accept H_0
Montebello-Culver City	35	30	Accept H_0	Accept H_0	Accept H_0	Accept H_0
La Canada-Encino	34	28	Accept H_0	Accept H_0	Accept H_0	Accept H_0
Huntington Beach-Redondo Beach	33	32	Accept H_0	Accept H_0	Accept H_0	Accept H_0
Newport Beach-Pacific Palisades	18	22	Accept H_0	Accept H_0	Accept H_0	Accept H_0
Irvine-Palos Verdes	23	23	Accept H_0	Accept H_0	Accept H_0	Accept H_0
Aggregate Data Set	169	161	Accept H_0	Accept H_0	Accept H_0	Accept H_0

[a] In obtaining the results, the total number of interviews in each paired area is divided into two parts with respect to their proposed completion dates of cleanup (i.e., 2 years versus 10 years) and the t-tests are done to test whether this difference has any significant influence on the mean bids.

[b] The tests are done for $\propto = 0.01$, $\propto = 0.05$, and $\propto = 0.10$. "Accept H_0" means H_0 is accepted for all three of the $\propto$ levels.

[c] The bids for each bidding stage are assumed to be strictly separable. In obtaining the mean bids no differentiation is made with respect to: (1) bidding sequence; (2) starting bid; (3) bidding vehicle; (4) health pamphlet versus no health pamphlet; and (5) life tabls versus no life table.

*n_1 = sample size of interviews with proposed completion date of cleanup of 2 years.

*n_2 = sample size of interviews with proposed completion date of cleanup of 10 years.

The previous results presented rely in many cases on small sample sizes for the statistical tests due to the partitioning required. Recall that several types of bias as well as game structure questions had to be examined. In view of the small sample sizes for a few areas, additional questionnaires were administered. Table 4.13 presents the mean bid results of these additional interviews. Before integrating into the basic data set, it was decided to test whether the "New" data was significantly different from the “old" data in terms of mean values. Results of the tests are presented in Table 4.14. Culver City for the total bid category is the only significantly different result from the “old” data set. This is due to one of the individuals bidding an exceptionally larger sum than others as noted in the footnote in Table 4.13.

Table 4.13

Mean Bids by Area by Type for the "New" Data Set*

Area	Completion Date of Cleanup	MeanBid ($/Month)			
		Aesthetic B	Acute H.B.	Chronic H.B.	Total Bid
Canoga Park (B →C)	2 years	3.20 (1.29)** (10)***	9.18 (2.12) (10)	8.00 (3.27) (10)	20.30 (3.41) (10)
Canoga Park (B →C)	10 years	3.00 (2.00) (5)	9.00 (2.92) (5)	10.00 (5.70) (5)	22.00 (8.15) (5)
Culver City (B →C)	10 years	6.25 (6.25) (4)	27.50 (8.29) (4)	28.75 (16.25) (4)	62.50**** (21.07) (4)
Encino (B →C)	2 years	6.67 (6.67) (3)	13.33 (7.26) (3)	1.67 (1.67) (3)	21.67 (12.02) (3)
Encino (B →C)	10 years	4.17 (1.54) (6)	6.67 (3.07) (6)	8.33 (6.41) (6)	19.17 (6.76) (6)
Pacific Palisades (C →C*)	2 years	6.00 (3.70) (6)	9.17 (2.71) (6)	6.67 (2.98) (6)	22.67 (6.31) (6)
Pacific Palisades (C →C*)	10 years	16.67 (23.58) (9)	12.89 (5.75) (9)	6.67 (2.89) (9)	35.11 (13.35) (9)

*The bids for each bidding stage are assumed to be strictly separable. In obtaining the mean bids no differentiation has been made with respect to 1) bidding sequence, 2) starting bid, 3) bidding vehicle, 4) health pamphlet versus no health pamphlet, and 5) life table versus no life table. A life table depicts the "stock" counterparts of the elicited monthly bids for various expected life spans.

**Standard error of the mean bid in all cases.

***Sample size of each case in all cases.

****Individual total bids for Culver City were as follows:

	Aes.	Ac.	Ch.
I: $100	0	25	75
II: $ 75	0	50	25
III: $ 25	0	10	15
IV: $ 50	25	25	0

Table 4.14

Results of the t-tests for Comparing the Equality of the Mean Bids Obtained from the "Old" and the "New" Data Sets in Each Step of the Bidding Process[a,b]

(Two-tailed test; Pooled Variance Estimate)
H_0: The bids are equal.
H_1: The bids are unequal.

Area	Type of Contingency	Completion Date of Cleanup	Number of Observations N_1	N_2	Mean Bid: Aesthetic Bid	Acute Health Bid	Chronic Health Bid	Total Bid
Canoga Park	B → C	2 years	8	10	Accept H_0	Accept H_0	Accept H_0	Accept H_0
Canoga Park	B → C	10 years	11	5	Accept H_0	Reject H_0 at 95%	Accept H_0	Reject H_0 at 90%
Encino	B → C	2 years	17	3	Accept H_0	Accept H_0	Accept H_0	Accept H_0
Encino	B → C	10 years	11	6	Accept H_0	Accept H_0	Accept H_0	Accept H_0
Pacific Palisades	C → C*	2 years	8	6	Accept H_0	Reject H_0 at 95%	Accept H_0	Accept H_0
Pacific Palisades	C → C*	10 years	12	9	Accept H_0	Accept H_0	Accept H_0	Accept H_0
Culver City	B → C	10 years	12	4	Accept H_0	Reject H_0 at 95%	Accept H_0	Accept H_0

---

[a] The bids for each bidding stage are assumed to be strictly separable. In obtaining the mean bids, no differentiation is made with respect to: 1) bidding sequence, 2) starting bid, 3) bidding vehicle, 4) health pamphlet versus no health pamphlet, and 5) life table versus no life table. The "old" and "new" data sets are a result of additional interviewing that was carried out to supplement the sample size in a few areas.

[b] The tests are done for $\propto = 0.01$, $\propto = 0.05$, and $\propto = 0.10$. "Accept H_0" means H_0 is accepted for $\propto = 0.01$, $\propto = 0.05$, and $\propto = 0.10$. "Reject H_0 at X%" means that H_0 is rejected at X%, but is accepted at the next higher 1- $\propto$ value; e.g., if X% = 95%, then H_0 is rejected for $\propto = 0.10$, and $\propto = 0.05$ but is accepted for $\propto = 0.01$.

n_1 : Sample size of interviews from the "old" data set.

n_2 : Sample size of interviews from the "new" data set.

FOOTNOTES: CHAPTER IV

[1] Some questions have been raised about employing a "typical week" as the time period upon which to base the analysis. However, in a previous study valuing wildlife, various time units were employed (last trip, typical, dairy formats)for hunting experience. No statistical difference was found in the activity responses. See Brookshire, Randall, *et. al.* (1977).

[2] Note when the acute initiation point was employed the picture sets were not made available until the bidding on the aesthetic characteristic was begun.

[3] Note holding the respondent to the original time constraint for their current situation implies no leisure-work tradeoff possibilities. Arguments can be presented for or against this assumption. However, we note that in Blank, *et. al.* (1977) that when this tradeoff was offered as part of the substitution format, few respondents did make the trade.

[4] In a few cases the respondents bid their maximum willingness to pay initially rather than on the characteristic points.

[5] The equipment used was a 135 mm Minolta single lens reflex camera (SLR), 135 mm telephoto lens, 55 mm lens, tripod, Kodak Vericolor II professional color film, log sheets and a small ice chest.

[6] It should be noted that film is affected a great deal by even mild variations in temperature, especially heat. Thus, it is critical for the film to be protected before, during, and after use. The film used for our study was kept in a small portable ice chest until used; once the roll or film was used, it was put back into its air tight container and then back into the cooler until ready for processing. As a further aid in protecting the film, the researchers used rolls of twenty rather than 36 frames in an effort to minimize the time the film was exposed to heat.

[7] Appendix E details the exact streets in the sample plan.

8/ Note the Pacific Palisades bid is for a C → C* contingency, thus implicitly employing a bid for a basin-wide improvement, not involving this location directly.

[9] Further examination of vehicle bias will require breaking out aesthetic observed versus aesthetic derived bids and conducting a t-test.

[10] Note this applies to acute and aesthetic bids, however, the chronic bids are entirely derived.

[11] The (A → B) and (A → C) notation refers to type of contingency moves for residents of the A (poor) air quality area. The principle reason for administering two types was to avoid an overly long survey instrument.

[12/] This is the identical result noted in the first sequencing test which by the structure of the tests must be the case.

[13/] A follow-up on this thesis would be a test of the total step size 1 against total for step 2 against total for step 3.

Chapter V

THE SOUTH COAST PROPERTY VALUE STUDY

5.1 Overview

Many different methodologies for valuing non-market or environmental goods and services have been proposed. However, none of these approaches’ is universally accepted and debate remains over which methodology is most appropriate. New valuation methods such as the contingent valuation approach, are marked by uncertainty and criticism from both professional and non-professional audiences, and thus require replication and evidence of internal consistency in order to demonstrate validity.

The purpose of the research on property values presented here is to provide the necessary comparison for the contingent valuation approach which is described in detail above. This is accomplished through an analysis of the housing market within the sample plan communities of the South Coast Air Basin located in Los Angeles and Orange Counties. Specifically, this research asks if households-will actually-pay for cleaner air in the form of higher property values for homes in clean air communities and if this willingness to pay is comparable to the hypothetical willingness to pay expressed in the survey instrument.

Valuation of reductions in urban air pollution concentrations based upon housing value differentials is the most common form of the hedonic price procedure as developed by Rosen (1974), the basis of which is Lancaster's (1966) consumption theory. This procedure assumes that access to environmental (dis)amenities is capitalized in property values. This assumption is based on the premise that households are willing to pay a premium for an otherwise identical home located in a clean air area versus that located in a polluted area. The capitalization can be discovered by isolating the impact of air quality in two alternative ways: (1) by developing a sample pairing system which minimizes the variation in housing and community variables other than air quality and comparing housing values; or (2) by regressing housing value data on air quality and other variables. In the latter method, the resulting empirical relationship is the basis for a determination of the value of the environmental good.

Previous housing value studies have concentrated on the regression procedure. The first significant empirical study of air quality and property values was done by Ridker and Henning (1967). The authors applied a least squares regression model to cross-sectional data (compiled by census tract) for the St. Louis area. In order to fully specify their model of property values, variables corresponding to housing, location, neighborhood, political jurisdiction and individual characteristics were included with air pollution measures as independent variables. A significant negative relationship was found between the sulfation level (annual geometric mean) and median property values. Further, a property value increase of between $83 and $245 was associated with each .25/mg./100cm^2/day reduction in the sulfation level. This translates into total benefits of approximately $83 million if sulfation levels are reduced by .25 mg., or to an ambient concentration level of .49 mg.

This research was followed by a similar study by Anderson and Crocker (1971) who analyzed the impact of air pollution on both renter and owner occupied properties for St. Louis, Kansas City and Washington, D.C. As in the Ridker-Henning work, the basic unit of observation was the census tract and cross–sectional data which was employed in a non-linear regression model. The Anderson-Crocker results confirmed the Ridker-Henning finding of a negative and statistically significant relationship between air pollution (annual arithmetic mean concentrations of sulfur oxide and suspended particulate) and property values. The same result was also found for rental property.

Deyak and Smith (1978), in an effort to generalize these empirical conclusions utilized an updated data base (1970 census) gathered from representative SMSA'S. Their results provided added support for the findings of Ridker-Henning and Anderson-Crocker. However, in another paper, Smith-Keyak (1975), using data on owner and renter occupied central city housing in eighty-five cities, which also formulated a residential location model that included location public services and tax effects, found that air quality did not significantly affect property values. This conclusion was in accordance with the results found by Steele (1972) and later Wieand (1978) . Both authors found no statistically significant relationship to exist between air pollution and property values. The Wieand findings are especially surprising since he employed essentially the same data base as Ridker-Henning. The major change was substituting monthly rent per acre in place of median property value as the dependent variable.

These results indicate that an analysis of housing markets can yield information on the value of non-market goods. However, they also demonstrate the fragility of the methodology. That is, all assumptions outlined in Chapter 11 must be met and extreme care is required in model specification and interpretation of the results.

The analysis undertaken here encompasses three separate but related approaches, with benefits from reduced air pollution in bid equivalent terms (e.g., terms comparable to the contingent valuation results) specified at each level. The first approach involves a straightforward comparison of average housing values in the sample pair communities, standardizing only for house size (square feet of living area). The resulting differential in sale price between paired communities, which are theoretically identical except with respect to ambient air pollution concentrations, is then attributed to the disparity in air quality. It should be noted that this methodology relies quite heavily on the successful operation of the sample plan. That is, the variation across pairs in all other housing and neighborhood characteristics (excepting air quality) must be minimal if the sale price differential assigned to air pollution is to reflect accurately individuals true willingness to pay for clean air.

In the second procedure we utilize an econometric estimate of the impact of air quality on housing values to determine benefits of reduced air pollution. This portion of the study corresponds to the traditional econometric analysis of the housing market and is an attempt to estimate a linear relationship between a home's sale price and its supply of housing and community attributes. "The value of an improvement in air quality is then deduced from the resulting hedonic housing value equation.

The final approach is a further refinement of the above methods and consists of a multi-step procedure which makes allowance for air pollution abatement to be valued differently by households with varying income and initial pollutant concentrations. This methodology was developed recently in a paper by Harrison and Rubinfeld (1978). The first step is to estimate a hedonic housing value equation, similar to the second approach, but allowing for non-linearities where appropriate in the functional form. The second step is to calculate the marginal willingness to pay for individuals in each of the sample communities for a small change in air quality. The third step is to estimate a marginal willingness to pay equation as a function of income and other household variables. By integrating individual marginal willingness to pay estimates, we at least partially overcome the problems pointed out in Section 2.1. Finally, we employ this latter relationship to determine benefits of air quality improvements.

Each of the three approaches as described above can be viewed as a part of a systematic analysis of housing market data in the communities which comprise the sample plan. Further, each procedure yields pollution abatement benefit estimates which can be used to compare to the contingent valuation experiment. In addition to its usefulness as a comparability exercise, this housing value analysis has advantages over previous studies in that data is drawn as part of the sample plan which by its nature controls for many exogenous factors not wholly explained in the standard treatment. This, for example, tends to explain why our statistical "fit" is superior to previous studies. However, it should be kept in mind that sampling is therefore appropriate for comparison to the contingent validation experiment but is non-random and may lead to biased estimates of basin-wide damages.

The remainder of this chapter is organized as follows. Section 5.2 describes the data base and sources utilized in the study. In Section 5.3, the three approaches and their associated results are presented. Section 5.4 concludes the analysis.

5.2 Data Characteristics

The area under investigation is defined as the South Coast Air Basin. However, this study utilizes data for the sample plan communities only (see Chapter IV). In this regard, the sample chosen for study is not entirely random but rather a function of a pre-testing scheme. This may not be a major restriction on either the methodology or results since the paired communities are representative of the entire spectrum of living conditions in Los Angeles and Orange Counties. It should also be noted that this study is restricted to single family residences and the results are therefore only possibly applicable to other housing types (mobile homes, apartments, condominiums). Further, we concentrate on the owner market to the exclusion of other markets (rental, leasing, etc.].

Focusing upon the paired communities then, the data base was constructed to enable the impact of air quality differentials on housing sale price to be isolated. Thus, the dependent variable in the analysis is the sale price of owner occupied single family residences. The independent variable set consists of variables which correspond to three levels of aggregation: house, neighborhood, and community. The data base contains 719 independent observations. Table 5.1 describes further the data employed in the study.

The housing characteristic data, obtained from the Market Data Center (a computerized appraisal service centered in Los Angeles), pertains to homes sold in the January, 1977 - March, 1978 time period and contains information on nearly every important structural and/or quality attribute. Table 5.2 provides summary statistics for many of the housing characteristic variables for each of the sample communities. It should be emphasized that housing data of such quality (e.g., micro level of detail) is rarely available for studies of this nature. Usually outdated data which is overly aggregate (for instance census tract averages) is employed. These data yield functions are relevant for the “census tract" household and are only marginally relevant at the micro level. However, in this study it was imperative that data comparable to that used in the contingent valuation experiment be utilized. That is, since pollution abatement benefit estimates were calculated at the household level in the contingent study, it was necessary to generate similar estimates based on comparable data in this validation exercise.

In addition to the immediate characteristics of a home, other variables which significantly affect its sale price are those that reflect the condition of the neighborhood and community in which it is located. That is, the local tax and public goods expenditure rates, school quality, ethnic composition, crime rates, proximity to employment centers (and in the South Coast Air Basin, distance to the beach), and measures of the ambient air quality which have a substantial impact on sale price. Therefore, in order to capture these impacts and to isolate the independent influence of air quality, these variables are included in the econometric modeling.

The measures of air quality used in the empirical analysis were obtained from California Air Resources Board publications (1977). This agency is responsible for monitoring pollution levels in the Basin. The South Coast Air Shed, because of the existence of a large number of both mobile and stationary sources combined with meteorological and topographical conditions which limit the area’s ability to disperse pollutants, has a long history of pollution problems. A relatively complete regional network of monitoring stations has been developed. This allows the measurement of ambient air pollution levels rather than concentrations on isolated hotspots. A detailed exposition of air pollutants by area was given in Chapter III.

In conclusion, we view the data base assembled for the housing value study as appropriate for comparability testing of the contingent valuation

Table 5.1

Variables Used in Analysis of Housing Market

Variable	Definition (assumed effect on housing sale price)	Units	Source
Dependent			
Sale Price	Sale price of owner occupied single family residences.	($1,000)	Market Data Center
Independent-Housing			
Sale Date	Month in which the home was sold (positive indicator of inflation)	January 1977=1 March 1978=15	Market Data Center
Age	Age of home (negative indicator of obsolence and quality of structure)	Years	Market Data Center
	Number of bathrooms (positive indicator of quality)	Number	Market Data Center
Living Area	Living area (positive indicator of the quantity of home)	Square feet	Market Data Center
Pool	Zero-one variable which indicates the presence of a pool (positive indicator of quality)	Zero=no pool One=pool	Market Data Center
Fireplaces	Number of fireplaces (positive indicator of quality)	Number	Market Data Center
Independent-Neighborhood			
Distance to Beach	Distance to the nearest beach (negative indicator of relative proximity to main recreational activity)	Miles	Calculated

(continued)

Table 5.1

(continued)

Variable	Definition (assumed effect on housing sale price)	Units	Source
Quality	School quality as measured by student percentile scores on the California Assessment Test-12th grade math	Percentile *100	Local School files in sample communities
Ethnic	Ethnic composition-percent white in census tract(s) which contain sample community (positive).	Percent *100	1970 Census
Population Density	Population density in surrounding census tract (negative indicator of crowding)	People per square mile	1970 Census
Housing Density	Housing density in surrounding census tract (negative indicator of crowding)	Houses per square mile	1970 Census
Distance to Employment	Weighted distances to eight employment centers in the South Coast Air Basin (negative indicator of proximity to employment)	Miles/Employment Density	Calculated
NO_2	Nitrogen dioxide concentrations	Parts per hundred million (pphm)	California Air Resources Board
TSP	Concentrations of total suspended particulates	Micrograms per cubic meter ($\mu g/m^3$)	California Air Resources Board

(continued)

Table 5.1

(continued)

Variable	Definition (assumed effect on housing sale price)	Units	Source
Independent-Community			
Public Safety Expenditures	Expenditures on public safety per capita (positive indicator of attempt to stop criminal activity)	$/People	1976-77 Annual Report Financial Transactions Concerning Cities of California
Crime	Local crime rates (negative indicator of peoples' perception of danger)	Crime/People	FBI (1976)
Tax	Community tax rate (negative measures cost of local public services]	$/$1,000 of home value	1976-77 Annual Report Financial Transactions Concerning Cities of California

Table 5.2

Average Housing Characteristics

City	Sale Price ($)	Sale Price/ Sq. Ft.	Living Area (Sq. Ft.)	Number of Bathrooms	Number of Fireplaces	Age of Home (Years)
Canoga Park	43,914	40.299	1089.68	1.16	.227	32.9
El Monte	34,273	32.1	1067.68	1.18	.18	35.6
Culver City	82,916	58.03	1428.73	1.54	.56	26.1
Montebello	63,957	43.48	1470.95	1.67	.67	
Orange	70,368	46.89	1500.58	1.98	.73	16.4
Whittier	67,647	41.64	1624.67	1.64	.95	32.3
Redondo Beach	64,817	58.6	1104.18	1.28	.30	27.0
Huntington Beach	77,214	53.239	1450.32	1.95	.71	13.3
Pacific Palisades	257,383	91.05	2826.67	3.14	1.78	28.1
Newport Beach	141,473	68.5	2065.41	2.43	1.20	15.5
Palos Verdes	165,016	64.98	2539.44	2.72	1.24	13.5
Irvine	83,054	50.97	1629.49	2.13	.95	4.4
Encino	209,158	70.95	2947.84	3.04	1.44	16.2
La Canada	153,804	59.91	2567.17	2.6	1.45	33.3
Population	99,719	58.07	1717.1	1.99	.86	19.2

The property value study includes two more communities in the data base then did the contingent valuation study: Orange and Whittier.

experiments. The reasons are threefold. First, the housing characteristic data is extremely detailed at the household level of aggregation, and extensive in that a relatively large number of observations are considered. Second, we have assembled a variety of neighborhoods and community variables which enable the isolation of the air quality influence on housing values. Third, the air pollution data is comprehensive.

5.3 Empirical Analysis

As outlined in the introduction, each of the three stages of empirical analysis undertaken in this study constitutes a separate attempt to capture the monetary impact which air quality differentials have on housing values. Once discovered, these monetary estimates of the air quality effects are translated into the value of improving air quality in the South Coast Air Basin. These calculations are later utilized to test the validity of the contingent valuation experiment.

The following household benefit equation is used and shows the interrelationships or common characteristics of the three approaches;

$$AHB = [(\sum_{i=1}^{N} AQI_i * NH_i * AD_i) / \sum_{i=1}^{N} NH_i] * CRF \qquad (5.1)$$

where

AHB = average annual benefits per household for a reduction in air pollution concentration.

AQI = air quality improvement in area i (poor-fair, fair-good).

NH_i = number of homes in area i affected by the air quality change.

AD_i = average home sale price differential attributed to a one unit improvement in air quality.

CRF = capital recovery factor. This is the rate necessary to transform an initial capital investment into a series of equivalent annual charges including payment of both capital and interest. In this study the CRF is assumed to be .0995 which corresponds to a .0925 interest rate and a payback period of 30 years.

N = number of specific areas affected by air quality improvement. In this study N is restricted to two as benefits are calculated for upgrading the air quality in the poor areas to fair and in the fair areas to good (see Chapter III).

The number of homes in the affected areas (see Table 5.3) and the air quality improvement are common to each of the three methodologies. Table 5.4 illustrates both the present air quality classifications, the reductions in nitrogen dioxide (NO_2), and total suspended particulate (TSP) which are required to achieve significant improvement as measured by the relative quality indicators. This analysis was not able to effectively separate out

Table 5.3

Number of Homes in South Coast Air Basin by Air Quality Categories

Air Quality	Number of Homes in South Coast Air Basin (Los Angeles and Orange Counties)
Poor	1,056,325
Fair	804,823
Good	228,772
Total	2,089,920

Table 5.4

Air Quality Definition - NO_2

Air Quality (Arithmetic Average 1975 - pphm)	Classification
> 11	Poor
9-11	Fair
<9	Good

12.38	> 26%	Average Poor
9.55	> 32%	Average Fair
6.9		Average Good

Air Quality Definition - TSP

Air Quality (Arithmetic Average 1975 - μ g/m3)	Classification
> 110	Poor
90-100	Fair
< 90	Good

118.4	> 17%	Average Poor
100.0	> 24%	Average Fair
78.8		Average Good

the independent effects of each of the pollutant due to collinearity in the data set. Therefore, all calculations employ only one pollutant measure as a proxy for the general air quality situation. Nitrogen dioxide is usually that variable, however, results are also presented for TSP for purposes of comparison.

The final element of equation (5.1), the sale price differential attributable to differences in ambient air quality (which can be interpreted in this context as the willingness to pay for improved air quality) is determined by the particular approach. The first method determines this parameter in the simplest manner, through comparison of sale prices in the paired communities, and relies almost exclusively on the sample plan. The second is intermediate in complexity and employs traditional property value analysis to determine the monetary effect of air quality differentials. The third approach is the most involved, attempting to account for variation in preferences in the determination of willingness to pay through statistical means. In this manner the air quality impact on individuals is explicitly specified. These methods are addressed in detail in the following three subsections.

Before discussing in detail the empirical investigation and corresponding results, a few notes pertaining to the theoretical underpinnings of the analysis are in order. First, the capitalization of environmental goods into housing values can be captured through such empirical work only if certain assumptions concerning the economic behavior of individuals and the functioning of the housing market are accepted. These are: (1) consumers must perceive differences in housing and neighborhood characteristics, expect them to remain unchanged and act on these perceptions; (2) housing markets should function reasonably well and be in short run equilibrium; (3) environmental quality must be exogenously determined and differences in environmental quality must be capitalized only in housing prices; and (4) all relevant hedonic price functions should be continuous with first and second derivatives that exist (e.g., there must be sufficient variation in both housing and neighborhood characteristics, including air quality, to permit continuity). Second, it should be noted that this housing market analysis is consistent with and indeed a substudy within the general theoretical treatment developed in detail above.

Paired Sample Methodology

The paired sample approach is limited by the ability of the sample plan to pair communities which are virtually identical in every respect including air quality. No explicit effort is made to account for differences in sale price induced by other housing or neighborhood characteristics. This is admittedly a naive approach, yet it produces two positive outputs. First, because this methodology only implicitly compensates for many home and community variables, the resulting benefit estimates can be considered an upper bound on the population's willingness to pay for reduced air pollution. Second, if these benefit numbers closely parallel those of the other, more refined econometric methods can be considered successful.

Table 5.5 presents average sale prices in each of the sample communities and air quality regions. These figures are standardized for house size with

Table 5.5

Sale Price Differentials Attributed to Air Quality

Paired Sample Methodology

Community	Air Quality	Avg. Home Sale Price - 1717 Sq. Ft. Home	Sale Price Differential (%)	Avg. Sale Price Differential Poor-Fair, Fair-Good ($) (%)
Canoga Park	Fair	69,198	25.5	
El Monte	Poor	55,116		
Culver City	Fair	99,645	33.5	
Montebello	Poor	74,655		
Orange	Fair	80,516	12.6	19,371 (25%)
Whittier	Poor	71,491		
Encino	Fair	121,826	18.4	
La Canada	Poor	102,868		
Redondo Beach	Good	100,790	10.3	
Huntington Beach	Fair	91,412		
Pacific Palisades	Good	156,342	32.9	
Newport Beach	Fair	117,608		27,498 (28%)
Palos Verdes	Good	111,573	27.3	
Irvine	Fair	87,622		

each assigned the population average 1717 square foot home. The illustrated sale price differentials are calculated utilizing the community with the poorer air quality as the base. Further, the figures indicate that the value associated with an improvement in air quality from poor to fair is approximately 25% of the average poor community home price (for the same sized home). A similar upgrade in classification from fair to good is valued at about 28% of the value of the average fair region home. Translated into monetary terms these figures represent approximately $19,000 and $27,000 per home, respectively.

As all other components were specified previously, these price figures complete the information" required to compute annual household benefits using the paired sample approach. These benefits are presented in Table 5.6. As illustrated, the capitalized benefits are in excess of $39 billion for an approximate 25-30 percent reduction in urban air pollution concentrations (poor-fair, fair-good). This translates into nearly $4 billion in annual terms evaluated at 9.95 percent capital recovery factor, which is equivalent to how much individuals would be willing to pay for cleaner air in the form of higher house payments-. In order to transform these figures into bid equivalent terms, they are weighted by the total number of affected homes and the days in a year. Thus, based on the paired sample methodology, each household is willing to pay $4.50/day or $135 per month for the stated air quality improvement. Although it is expected that this method produces high benefit estimates, the above figure seems a reasonable amount when one considers the variety of impacts (health, aesthetic, etc.) associated with deteriorated air quality.

Although these willingness to pay figures seem interesting and reasonable, this methodology possesses a number of obvious shortcomings which may negate their significance. These can he classified as follows. First, this methodology attributes the entire differential in average sale price to the variation in air quality. This explicitly neglects a variety of other possible differences which could account for the disparity in sale price (although at least partial compensation for these factors is incorporated in the sample plan). That is, this approach, at least to some extent, is using air quality to proxy for many relevant neighborhood and community variables. Isolation of the independent influence of air quality may not be complete.

The second problem with this methodology is that each household, regardless of its characteristics, is assumed to place an identical value on the reduction in air pollution. Thus no allowance is made for household differences which would imply varying valuations. In the next subsection we employ traditional property value analysis and attempt to solve the first category of shortcomings. However, the latter problem is not effectively addressed until the following subsection.

Econometric Approach - Linear Equatation

The underlying structure of the econometric approach is a single equation empirical model which purports to explain the variation in sale prices of homes located in the South Coast Air Basin. The basic operational

Table 5.6

Benefits - Paired Sample Methodology

Change in Air Quality	Capitalized Benefits (Billion Dollars)	Annualized Benefits (Billion Dollars) R = .0925, CRF = .0995
Poor to Fair	20.46	2.04
Fair to Good	19.34	1.92
Total	39.8	3.96

	Capitalized Benefits ($)	Annualized Benefits ($) R = .0925, CRF = .0995
Per Home	21,385	2.30
Per Home Per Day		4.50
Per Home Per Month		135.00

tool is ordinary least squares (OLS]. The procedure is to regress the full independent variable set (see Table 5.1 for a complete description of these variables and their expected relationship to housing price) on the vector of home sale prices. The result of this econometric analysis of housing market data is a hedonic housing value equation. The estimated coefficients of such an equation provide information on the relative significance and value of each of the independent variables. That is, the coefficients specify the effect that a unit change in a particular independent variable has on sale price.

In reference to the air quality variable, this procedure allows one to focus on its impact while separating out the influence of other extraneous variables. Therefore, this analysis yields two outputs concerning the relationship of air quality differentials to housing price. First, the relative significance of air quality variations is determined and second, the estimated coefficient pertaining to air quality implicitly measures its monetary value.

The initial objective then is to estimate a linear hedonic housing equation which best fits the data. However, there exist a number of empirical problems which could prevent efficient estimation of the desired relationship. For instance, two problems which generally arise in property value studies are misspecification bias (the independent variable set is incorrectly specified] and multicollinearity (members of the independent variable set are highly correlated. Either of these may produce biased estimates. Furthermore, it is essential that these biases be avoided since the estimated coefficients become the basis for the benefit calculations.

Misspecification can be adequately countered by including in the equation all relevant independent variables without including Variables which have no *a priori* (on theoretical grounds) relationship with the dependent variable. The data set used in this study is relatively complete in that it contains a large number of housing and neighborhood characteristics. Further discussion of this subject, however, is postponed until the next section where experiments which demonstrate the effect of specification error are performed.

Multicollinearity is a common problem in studies of this nature. This occurs since many of the independent variables are integrally linked. and therefore possess extremely high correlation coefficients. For instance, with respect to housing characteristics, living area, number of rooms, number of bedrooms, etc.; they are so interconnected (each representing size of home) that least squares estimation techniques cannot determine the independent impacts that these variables have on housing values. Therefore, living area was chosen as the proxy variable for house size. Note that home quality is measured by the inclusion of fireplaces, pools, and number of bathrooms.

Similarly, the air pollution variables showed a high degree of correlation. Again the estimation procedures were unsuccessful, in separating out the independent influence of each of the pollutants. Thus only one pollution variable, usually NO_2 was utilized as a proxy for the general state of air variables and accessibility to beaches. However, this collinear relationship was effectively broken by the structure of the sample pairings. Thus, the simple correlations between NO_2, TSP, and distance to beach do not exceed .37.

Our concern about multicollinearity among the neighborhood and community variables was also warranted when it was found that housing density and population density were so highly correlated (.96 simple correlation) that they were essentially measuring the same phenomena. The solution was to allow only one of these variables in any equation. These empirical problems aside, we next proceed to discuss the estimated hedonic housing value equations. However, it should be re-emphasized that the estimation was accomplished within the bounds of these empirical difficulties.

The equations which provided the best statistical fit of the data are presented in Table 5.7. The relatively high R^2's ($\approx$.83) indicate that a large proportion of the variation in housing price is explained by the variation in the independent variables. Except for two aberrations all coefficients possess the expected sign and are statistically significant. The exceptions are age, which is positive related to house value and significant, and local tax rates which have the anticipated relationship but are statistically insignificant. The former may occur since age may not be an adequate measure of housing condition since many older homes in the Los Angeles are of high quality. The insignificance of local tax rates seems puzzling. However, this is probably a result of the linear functional form since in the next subsections we find that taxes become significant when non-linearities are introduced. Furthermore, the age variable assumes the proper relationship in the non-linear equations.

Further examination of Table 5.7 gives added insight into the determinants of house value. The air pollution variables both perform as expected and are highly significant. In addition, the coefficients on the pollution variables are quite similar (-316.89 for TSP and -260.4 for $N0_2$ when $N0_2$ is converted to μg/m3 units) signifying that each, as a proxy for pollution, has a similar impact on house price. The stability of the coefficients on the non-pollution variables (they are virtually identical) is also striking. This result suggests that households are averse to pollution generally rather than to any single pollutant.

The quantitative significance of a unit change in any of the independent variables is obtained by examining the coefficient values. For instance, an increase of 100 square feet of living area would cause a $2866.8 increase in the house price. Likewise, the coefficient on sale date shows that sale prices were increasing by nearly $1,900/month over the study period. Employing this same type of analysis, benefits from a reduction in either $N0_2$ or TSP can be calculated. Therefore, using $N0_2$ as the proxy, an improvement in air quality from poor to fair infers capitalized benefits of $14,445/home while a change from fair to good is valued at $13,526/home. As in the previous methodology, these figures together with data previously generated (number of affected homes, etc.) become the basis for calculating average annual benefits [see equation (5.1)]. These benefit computations are completed in Table 5.8 for both $N0_2$ and TSP (in parentheses).

Table 5.7

Estimated Econometric Equations (Linear)*

Dependent Variable = Home Sale Price in Dollars

Independent Variable	NO_2 Equation	TSP Equation
Sale Date	1897.8 (7.0041)	1944.6 (7.0946)
Age	313.3 (2.8236)	192.41 (1.7823)
Living Area	28.665 (13.516)	28.558 (13.272)
Bathrooms	21.856 (9.2552)	22.378 (9.3117)
Pool	10213 (3.216)	11375 (3.5566)
Fireplaces	14107 (7.1613)	13187 (6.6648)
Distance to Beach	-436.55 (-.19769)	761.27 (-3.4148)
Distance to Employment	-22597. (-9.635)	-18370 (-6.3776)
Crime	-564090. (-2.7727)	-674680 (-3.0476)
School Quality	208.91 (2.7353)	171.94 (2.1777)
Ethnic Composition	4178.3 (2.7697)	7442.9 (5.5327)
Housing Density	-5.5248 (-1.9503)	-7.9192 (-2.6061)
Tax	-8.7207 (-.68288)	-3.0441 (-.22507)
Public Safety Expenditure	59.189 (6.7578)	56.278 (5.6769)
TSP		-316.89 (-2.7845)
NO_2	-5104.3 (-4.8851)	
Constant	-324820 (-2.2395)	-652150 (-5.0917)
R^2	.832	.828
Sum of Squared Residuals	496900	508200
Degrees of Freedom	703	703

*t-statistics are in parentheses.

Table 5.8

Benefits - Linear Econometric Methodology
NO_2 (TSP)

Change-in Air Quality	Capitalized Benefits (Billion Dollars)	Annualized Benefits (Billion Dollars) R = .0925, CRF = .0995
Poor to Fair	15.3 (6.2)	1.52 (.61)
Fair to Good	10.9 (5.4)	1.08 (.54)
Total	26.2 (11.6)	2.6 (1.15)

	Capitalized Benefits ($)	Annualized Benefits ($) R = .0925, CRF = .0995
Per Home	14077. (6233)	1401. (620)
Per Home Per Day		3.84 (1.70)
Per Home Per Month		115.20, (51.0)

The benefit figures dictate discussion on two counts. First, the large discrepancy between the NO_2 based and TSP based benefits is a result not of the respective regression coefficients but rather from the fact that present NO_2 concentrations are much higher and demonstrate greater variability than those for TSP. For instance, the average poor community has an ambient NO_2 level of 242.7 $\mu g/m^3$ whereas the TSP concentration for a similar community is 118.4 $\mu g/m^3$. Also, the gap between the quality indicators (poor-fair, fair-poor) and therefore the required improvement is much greater for NO_2 than TSP in percentage terms. Thus, since TSP concentrations are both lower and more ubiquitous than NO_2 concentrations, the benefits on reducing the latter are correspondingly higher.

Second, the linear econometric methodology yields benefit estimates which are somewhat lower ($\approx$ 15% for NO_2 calculations, $\approx$62% for TSP calculations) than those presented for the paired sample approach. This is an expected occurrence since the linear econometric study explicitly accounts for the variation in non-pollution variables through statistical means. Therefore, this method can be considered an improvement over the previous examination of mean housing values.

However, this approach is not without its associated problems. Specifically, there has been much discussion in the property value literature that benefits based on a linear equation coefficient tend to overstate the true willingness to pay for air pollution reductions (see Section 2.1 and preferences 1, 4, 5, 10, 11). That is, it is generally accepted that the air pollution coefficient may be employed to value marginal change but its applicability for total benefit calculations (non-marginal changes) requires that further assumptions be made. For example, the linear equation method contains the implicit assumption that every reduction in air pollution is valued identically by all households. This neglects variations in average benefits which may accrue to particular population groups identified by income or susceptibility to present pollution concentrations. In effect, household preferences are assumed to be identical. This limits the acceptability of the linear econometric approach. In the next subsection we further refine this approach and address remaining issues.

Econometric Approach - Non-linear Equation[1/]

The non-linear methodology is a multi-stage procedure, the objective of which is to determine the benefits of air pollution abatement while allowing different values for various individuals. In essence, this method addresses the major criticisms of the previous approaches but must effectively assume the mathematical form of individual preferences. The first step involves the estimation of a hedonic housing value equation. This is similar to the previous analysis except that in this case we do not arbitrarily restrict the functional form to be linear. Non-linearities are to be expected in an analysis of housing market data because: (1) the market may not be in long-run equilibrium; (2) there may exist disequilibrium supply conditions; or (3) there are indivisibilities among housing and neighborhood characteristics. Therefore, in this step an attempt is made to find the functional form which provides the best statistical fit for the data.

The second step is to determine the marginal willingness to pay for small changes in the air pollution data. This is done by taking the derivative of the hedonic housing value equation (obtained from the initial step) with respect to air pollution and evaluating for each of the fourteen sample communities. Calculated for each community, this derivation yields the within community average household willingness to pay for marginal improvements in air quality. Determination of the marginal willingness to pay is accomplished at the community level of aggregation based on the assumption that the individual households within the community are completely homogeneous.

In the third step the marginal willingness to pay figures (obtained in previous step) are regressed on a set of community characteristics (income and present pollution level) in order to estimate a marginal willingness to pay schedule. The resulting estimated equation provides information on how various communities identified by these characteristics value reductions in air quality. Thus, differentiation along community preference can be accounted for. For instance, it is a widely held belief that marginal willingness to pay increases with income. This hypothesis is tested in this step.

The final step employs this latter estimated relationship to determine the home sale price differential attributable to the previously specified air quality improvements. Mathematical integration of the relevant marginal willingness to pay equation (a function of the stated community characteristics) accomplishes this task. This final information component is then inserted into equation (5.1) to derive average household benefits in bid comparable terms.

The results of the hedonic housing value equation estimation are presented in Table 5.9. As measured by R^2, the non-linear functional form performs somewhat better than the linear equation. In the NO_2 equation all independent variables conform to our a priori expectations concerning the relationship to sale price and all except ethnic composition are statistically significant at the 5% level ($|t| \geq 1.645$). A similar statement holds for the TSP equation except that crime replaces ethnic composition as the only insignificant variable. In their respective equations, the air pollution variables are highly significant. Note also that squared pollution terms were utilized in the estimation. It was found that these performed better than either the first-order or cubic terms. However, the performance difference was not significant. Therefore, further analysis (benefit calculations, etc.) based on the equations containing the first or third order terms was completed and is discussed below.

The non-linear specification prevents straightforward analysis of the quantitative impact of a unit change in an independent variable since the effect depends upon the level of all other variables. However, if NO_2 and the other variables are assigned these mean values than a unit improvement in NO_2 (one pphm) is valued at $2,010.

Before proceeding to the next procedural step, a few comments concerning the effect of misspecification bias are in order. That is, we conducted experiments to see what would happen to the coefficient on air pollution if

Table 5.9

Estimated Econometric Equations*

Dependent Variable = Log (Home Sale Price in $1,000)

Independent Variable	NO_2 Equation	TSP Equation
Sale Date	.018439 (10.108)	.018924 (10.427)
Age	-.0027044 (-3.5185)	-.0031401 (-4.1178)
Living Area	.00019976 (14.024)	.00019688 (13.896)
Bathrooms	.14777 (9.2661)	.15285 (9.6443)
Pool	.089959 (4.2096)	.092764 (4.389)
Fireplaces	.10355 (7.8325)	.099225 (7.5833)
Distance to Beach	-.014037 (-9.1443)	-.013132 (-9.1824)
Distance to Employment	-.26979 (-11.663)	-.23201 (-9.1314)
Crime	-2.2798 (-2.3574)	-1.5245 (-1.5444)
School Quality	.00099327 (2.0286)	.0010087 (2.0792)
Ethnic Composition	.0081532 (1.2523)	.027307 (4.5564)
Population Density	-.000067145 (-7.8422)	-.000061627 (-7.2705)
Log (Tax)	-.030991 (-1.8253)	-.046438 (-2.7565)
Public Safety Expenditures	.00032792 (5.1487)	.00028288 (4.8582)
$(TSP)^2$	-	-.000015702 (-4.1798)
$(NO_2)^2$	-.0010374 (-2.6935)	-
Constant	4.2297 (6.2304)	2.3602 (3.8836)
R^2	.877	.878
Sum of Squared Residuals	22.62	22.29
Degrees of Freedom	703	703

certain neighborhood variables were omitted from the equation. For example, if distance to beach is excluded then the air pollution coefficient increases from .0010374 to .0034176. Similarly, if population density is omitted then the pollution coefficient increases to .0024284. In each of these cases the air pollution term serves as a measure of pollution and other neighborhood disamenities as well. These specification errors would eventually result in biased benefit estimates. Therefore, a fully specified equation is crucial.

The estimated equations shown in Table 5.9 yield the marginal willingness to pay for improvements in air quality by taking the derivative with respect to the relevant air pollution variable. This procedure supplies information on the amount of money the average household in each community would be willing to pay for small changes in pollution levels. This information, in conjunction with community average income and pollution levels, are the basic inputs to the third methodological step - estimation of the willingness to pay equation. Table 5.10 presents two formulations of this equation for NO_2. The first assumes a linear relationship while the second postulates a log-log form. As is indicated by the coefficients both income and pollution are positively related to marginal willingness to pay. Thus, higher income communities in poor air quality regions have the greatest willingness to pay. Similar results were discovered for the TSP based equations but they are not presented.

Given this analysis it then becomes possible to complete the multi-step procedure and calculate: (1) the average sale price differential attributable to changes in air quality; and (2) benefits derivable from these changes in per home, per day units, through use of equation (5.1). The first calculation is accomplished by integrating the willingness to pay equations (assigning the income variable its mean value) over the range of air quality improvement.[2/] In this manner, the reduction in pollution consistent with the poor to fair improvement is valued at $5,793/home for the linear NO_2 willingness to pay equation and $6,134/home for the log-log NO_2 equation. The values which correspond to the fair-good change are $4,244/home and $4,468/home, respectively. If TSP is used as the measurement criteria then poor-fair is valued at $6,053/home (linear) and $6,033/home (log-log) while fair-good is valued at $5,677/home (linear) and $5,964/home (log-log).

The above figures are translated into average benefits illustrated in Table 5.11 through application of equation (5.1). As can be seen from examination of Table 5.11, daily household benefits calculated using the multi-step procedure range from $1.40/day/home to $1.48/day/home or $42.00 and $44.40 per month, respectively for NO_2. These are considered our “best” estimates since the technique used as their specification at least addresses known methodological problems. We correspondingly place the most faith in them. Further, the TSP based calculations remain fairly constant at about $1.60/day/home, so the daily household willingness to pay to achieve the specified air quality improvements are relatively insensitive to the pollutant used in the willingness to pay equation. The TSP results are also insensitive to the specification of the hedonic housing equation, the first link in this methodology. That is, whether the first or third order TSP term was used in this equation (rather than the squared term)

Table 5.10

Estimated Willingness to Pay Equations (NO_2)*

Dependent Variable = Marginal Willingness to Pay in Dollars

Independent Variable	Coefficient	t-statistic
Constant	-1601.3	-2.7622
Income**	.050051	8.2662
NO_2 level	162.67	3.7832

$R^2 = .864$
Degrees of Freedom = 11

Dependent Variable = Log (Marginal Willingness to Pay in Dollars)

Independent Variable	Coefficient	t-statistic
Constant	-6.4845	-5.7025
Log (Income**)	1.1473	13.092
Log (NO_2)	.87283	6.1051

$R^2 = .942$
Degrees of Freedom = 11

*These equations are based on the hedonic housing value equation which utilizes $(NO_2)^2$ as the air pollution measure.

**The income variable is defined as average community income and in dollars.

Table 5.11

Benefits - Multi-Step Econometric Methodology*

(A) $N0_2$ (TSP) - Linear Willingness to Pay Equation

Change in Air Quality	Capitalized Benefits (Billion Dollars)	Annualized Benefits (Billion Dollars) R = .0925, CRF = .0995
Poor to Fair	6.12 (6.4)	.61 (.637)
Fair to Poor	3.42 (4.6)	.34 (.458)
Total	9.56 (11.0)	.95 (1.095)

	Capitalized Benefits ($)	Annualized Benefits ($) R = .0925, CRP = .0995
Per Home	5136 (5910)	511 (588)
Per Home Per Day		1.40 (1.61)
Per Home Per Month		42.00 (48.30)

(B) $N0_2$ (TSP) - Log-Log Willingness to Pay Equation

Change in Air Quality	Capitalized Benefits (Billion Dollars)	Annualized Benefits (Billion Dollars) R = .0925, CRF = .0995
Poor to Fair	6.5 (6.4)	.645 (.64)
Fair to Poor	3.6 (4.7)	.355 (.47)
Total	10.1 (11.1)	1.0 (1.1)

	Capitalized Benefits ($)	Annualized Benefits ($) R = .0925, CRF = .0995
Per Home	5427 (5964)	540 (593)
Per Home Per Day		1.48 (1.63)
Per Home Per Month		44.40 (48.90)

*Note that in the estimated hedonic housing equation (step 1) the second order pollution terms were used.

had little effect on the eventual benefit calculations. However, this was not the case for NO_2. In this instance, daily household benefits fluctuated from a low of $.87/day/home or $26.10 per month [$(NO_2)^3$ used in hedonic housing equation and linear willingness to pay equation] to a high of $2.09/day/home or $62.70 per month (first order NO_2 term used in housing equation and linear willingness to pay equation).

In comparing these figures to the simpler property value approaches, we again find an adjustment downward as the methodology becomes more refined. This is consistent with our conjecture that the paired sample approach would yield upper bound benefits. This result also provides further support for the hypothesis that the linear econometric approach overestimates the total willingness to pay for pollution reductions. This overestimation can be partially corrected by employing the final procedure posited here.

In conclusion, we have attempted to describe and utilize a multi-step approach to the determination of air pollution abatement benefits. Each of the steps is linked to those that preceed it. Therefore, benefit calculations are a function of a hedonic housing value equation, the resulting marginal willingness to pay data, and an estimated willingness to pay schedule which yields the sale price differential attributable to air quality. Finally, our “best” estimates of daily household benefits was $1.40/day/home calculated using the second order NO_2 term in the hedonic housing equation and a linear willingness to pay equation. However, benefits could easily range from $.87/day/home to $2.09/day/home.

5.4 Summary

This paper began with the premise that valuation of non-market commodities constitutes a socially desirable objective on efficiency and equity grounds. However, no methodology, which is generally accepted, exists to accomplish this goal. Therefore, any new experimental valuation technique requires validation. The analysis undertaken here is an attempt to satisfy this requirement for the contingent valuation approach.

This study can be viewed as a systematic investigation of housing market data within the communities which comprise the sample plan. It consists of three separate approaches. The first, the paired sample methodology, is primarily based on the sample plan. In this procedure we attempted to determine the benefits derivable from air quality improvements through a comparison of sale price averages in the paired communities. This approach was found to be beset with a number of problems, yet the upper bound of $4.50/home/day for a poor-fair, fair-good improvement was determined.

The second approach, a linear econometric methodology, was an attempt to utilize traditional property value analysis to develop benefit estimates. The ordinary least squares regression technique was the basic tool used to estimate a linear hedonic housing value equation. The benefit calculations derived from this equation were considered an improvement over the paired sample approach since explicit account was made for a number of housing and neighborhood variables. Thus, this analysis provided more refined benefit figures but they were still considered an overestimate since no allowance was made for varying valuations of air quality changes dependent on houshold characteristics.

In the final approach, multi-step econometric methodology, we addressed the criticisms which plagued the earlier approaches and developed more refined benefit estimates. Our best estimate of willingness to pay for the specified air quality change (about a 30% reduction in average ambient levels) was approximately $1.40/day/home ($42.00 per month). This amount is based on a hedonic housing equation which allows non-linearities [including using $(NO_2)^2$ as a proxy for air pollution] and either a linear or a log-log willingness to pay equation. However, this figure is not precise and therefore we put the possible range of benefits at between $.87/day/home ($26.10 per month) and $2.09/day/home ($62.70 month).

FOOTNOTES: CHAPTER V

[1/] This analysis follows closely the procedure developed by Harrison and Rubinfeld (1978).

[2/] The formula used in these calculations is:

$$\int_{\text{Pollution after}}^{\text{Pollution before}} (\text{WTP}_i)\, d\ \text{Pollution}$$

where $\text{WTP}_i = f(\text{income, pollution})$.

Chapter VI

PRELIMINARY COMPARISONS BETWEEN PROPERTY VALUES AND ITERATIVE BIDDING RESULTS

The South Coast Air Basin experiment consisted of an attempt to value air quality through examination of differences in property values and through an interview survey instrument to measure willingness to pay. Six pairs of neighborhoods were selected for comparative purposes. The pairings were made on the basis of similarities of housing characteristics, socioeconomic factors, distance to beach and services, average temperature, and subjective indicators of the "quality" of housing. Thus, for each of the pairs, an attempt was made to exclude effects on property values other than differences in air quality.

While the sample paired methodology was an attempt to establish comparability between results of the research designs, certain cautions should be kept in mind. These additional assumptions are that:

1. an implicit hypothesis exists such that there is a directional consistency between the types of biases of the two research designs;

2. in a theoretical sense, each research design is measuring the same “good;”

3. the groups being sampled are identical within the paired areas;

4. the time frames from which the valuation estimates are derived are assumed constant (i.e. , equilibrium versus non-equilibrium contexts for individuals and markets); and

5. a problem exists in assigning proper weighting for a set of diverse samples.

With these difficult qualifications in mind, let us turn to a preliminary comparison of results obtained from the property value and sample survey results. Table 6.1 provides some <u>extremely</u> preliminary results on monthly valuations by households of an arbitrary improvement in air quality in the Los Angeles Basin of approximately 30%. For the paired comparisons property value study, the estimate per household with no adjustments for household differences except in an areal and subjective sense (see Chapter III), is approximately $135 per month. Extrapolated the results to the basin as a whole yields an annual benefit from an improved air quality improvement of 30%, a value of approximately $4 billion dollars.

Table 6.1

Alternative Estimates of Monthly Bids by Household, Total Benefits for Air Quality Improvement in the South Coast Air Basin

(Approximate 30% Improvement in Ambient Air Quality)

	Property Value Study			Survey Study	
	Paired Communities	Linear Regression	Non-Linear 3-Step	Mean Bid	Preliminary Regression Results
Average ($) bid per household per month	$135	$51-115	$42*	$29**	$26***
Annual benefits (selected areas and groups of the South Coast Air Basin) in billions of $'s)	$3.96	$1.25-2.6	$.95	$.65	$.58

*Best estimate, possible range, $26-63 per month.

**Based on maximum total bid with an adjustment for years to achieve improvements in air quality.

***Based on maximum total bid equation with an adjustment for the amount of air pollution information available to the household.

The other extreme is an estimate of its value of improved air quality per month by household utilizing the preliminary results in Appendix D from the survey. This value is approximately $26 per month per household. This yields-a rough estimate of annual benefits from an approximate 30% improvement in air quality of slightly more than $.5 billion dollars.

Further, intermediate estimates are calculated on the basis of various economic assumptions delineated in Chapters II and V. By making various assumptions with regard to the change of air quality in the Los Angeles Basin, other estimates of improvements can be derived. For example, if it can be presumed that the various areal groups, when bidding from a reasonably poor air quality to a reasonably good air quality, were bidding on the basis that their area would be totally cleaned up, an alternative estimate of the mean bid on an annual benefits basis is $1.07 billion dollars. This is comparable with the linear estimate derived from the property value study. For the reasons given earlier, these researchers believe that, depending on assumptions, a range of willingness to pay for both studies anywhere from a low of approximately $20-30 to a high of approximately $140-150 per month per household is obtained.

It appears from these preliminary results and comparisons that contingent valuation studies will tend to give a lower valuation of air quality improvement than observing at the margin what happens in an extremely volatile property market. However, only after substantial in-depth statistical examination and comparability checks between the two studies will the researchers be able to state unequivocally how these valuations may turn out. The results compiled in this study suggest that survey instruments, when compared to property value techniques, provide a reasonable mechanism to obtain environmental quality benefit estimates. The survey approach has the advantages that: (1) data can be collected at low cost on specific environmental problems (the investigator is not tied to the availability of existing data sets); (2) benefit measures can be disaggregated across individuals and sources of benefits from various characteristics such as aesthetic experiences and perceived health can be obtained; and (3) a voluntary consumer statement of willingness to pay gives some justification in and of itself for expenditures on air quality and perhaps more generally on environmental quality programs.

As a final caution, it should be kept in mind that the South Coast Air Basin studies were conducted in an area where individuals have both an exceptionally well-defined pollution situation that they have encountered and a well-developed hedonic price-property value market for clean air. The effect of clean air on property values, and in turn, on the degree to which people are aware of increased housing prices in high air quality areas appears to be exceptionally well specified at this time in the South Coast Air Basin. Note further that 1970 property values on the basis of several studies have shown a much weaker association with air quality than those that were obtained utilizing the 1977-78 air quality data set applied here. We feel that this change reflects a substantial shift in tastes and concern over air quality for this regional population. Therefore, it should be recognized that the results of this experiment may well not be generalizable to other situations where the environmental commodity, i.e., air quality; is not so well specified, either through actual market prices or human perception.

APPENDIX A

This appendix presents the basic survey instrument employed in the South Coast Air Basin study. As discussed, the initiation point for the survey instrument was either acute health effects or aesthetic effects. Three basic areas existed (good, fair, bad). Thus the following combinations existed for survey instrument types.

1. Format for A area moving to B (Aesthetic]
2. Format for A area moving to B (Acute)
3. Format for A area moving to C (Aesthetic)
4. Format for A area moving to C (Acute)
5. Format for B area moving to C (Aesthetic)
6. Format for B area moving to C (Acute]
7. Format for C area to C* (Aesthetic)
8. Format for C area to C* (Acute)

The structure of the different combinations was identical. Combination 1 is presented for illustrative purposes.

Table A.1

INDOOR ACTIVITY AND COST LIST

Activity	√	Hours Per Week				Times Per Week				Location (Map Grid)				Miles Traveled				Direct Costs				% Day	Equipment Replacement Costs	Importance
		A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D			
Indoor Spectator Events																								
Indoor Tennis																								
Raquetball, Handball																								
Table Tennis																								
Bowling																								
Indoor Gardening or Fixing up House																								
General Exercise																								
Organized Sports Events																								
Reading																								
Television																								
Movies																								
Club Activities, Organizations																								
Individual Sports																								
Swimming																								
Visiting Neighbors or Friends																								
Other (specify)																								

Table A.2

ACTIVITY AND COST LIST

Activity	✓	Hours Per Week				Times Per Week				Location (Map Grid)				Miles Traveled				Direct Costs				% Day	Equipment Replacement Costs	Importance
		A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D			
Outdoor Spectator Sports																								
Tennis																								
Biking																								
Beach Activities																								
General Exercise																								
Fishing																								
Swimming																								
Sailing																								
Jogging/Walking																								
Hobbies, Arts & Crafts																								
Outdoor Gardening or Fixing up House																								
Golf																								
Hiking																								
Camping																								
Organized Sports Events																								
Individual Sports Events																								
Other (specify)																								

GAME FOR A AREA MOVING TO B, AESTHETIC

Questionnaire #____
Interviewer #____

INTRODUCTION

1. In a typical week how much day and night leisure time do you have available? This includes both weekdays and weekends. By leisure, I mean the time you do not spend eating, sleeping, or working to earn a living. ____ hours

2. Has air pollution influenced where you have chosen to live? Yes[ ] No[ ]

3. Has air pollution influenced where you have chosen to work? Yes[ ] No[ ]

4. Would you classify the air quality in the area where you live as: Good[ ] Fair[ ] Poor[ ]

5. Would you classify the air quality in the area where you work as: Good[ ] Fair[ ] Poor[ ]

5a. What is your occupation?________________________________

6. Are you aware of any health hazards due to air pollution? Yes[ ] No[ ]

7. How long have you lived in the Los Angeles area? ____________________

8. How much longer do you plan to live in the Los Angeles area?____________

9. Do you think automobile emission standards should be: Increased[ ] Decreased[ ] Kept the Same[ ]

ADMINISTER INDOOR AND OUTDOOR ACTIVITY AND COST LISTS (TYPICAL WEEK) CHECK THE TOTAL TIME CONSTRAINT

Bidding Game for Residents of Area A

Here are three photographs representing average levels of visibility for the three different regions of the Los Angeles Area shown on this map. Picture A represents poor visibility; Picture B represents fair visibility; and Picture C represents good visibility.

Public officials are strongly considering the possibility of trying to reduce the levels of emissions throughout the Los Angeles Area. Such action could require additional funds which might be generated by (a monthly charge, an extra charge in your utility bill) for as long as you live in the Los Angeles area. These funds will be used to help finance air quality improvements in the Los Angeles area.

Aesthetic

The Los Angeles area has some very beautiful background scenery. Because of automobile and industrial emissions, there is a haze which reduces and distorts the ability to see this scenery. This means that many people have to leave Los Angeles and travel long distances to be able to enjoy views which could be visible from their homes if these emissions were reduced.

As indicated by the map, you live in an area which has been classified as having poor air quality relative to the rest of the Los Angeles area. Picture A represents the visibility level which typically occurs in your area. I am only interested in how you value being able to see long distances.

If the level of emissions could be reduced in the Los Angeles area so that visibility conditions would be represented by Picture B instead of A, not only in the B area but also in your area, and if the air would be cleaned up to this level in (2, 10) years, would you pay (a monthly charge, an extra charge in your utility bill) of ($1, $10, $50) for as long as you live in the Los Angeles area?

☐ DO FOLLOWING ONLY IF CHECKED

LIFE TABLE: Here is a table that might help you. It shows the total amount you would pay for as long as you live in Los Angeles for various amounts of monthly payments.

RECORD MAXIMUM BID__________

Would you consider moving to a new location in the Los Angeles area if air quality were like Picture C everywhere? Yes☐ No☐

IF YES:

Where would you move? (GRID LOCATION ON MAP)__________________

Bidding - Aesthetics and Acute Health

The questions I asked earlier were only concerned with your perception of visibility. This section deals with not only visibility but with short term health effects which may be aggravated by air pollution. Some pollutants in high concentrations cause eye irritation for many individuals. Studies have shown that about half of the population experiences eye irritation under conditions represented by Picture A; about one-fourth experiences eye irritation under conditions represented by Picture B; while no one experiences these irritating effects when conditions are represented by Picture C.

Since you reside in area A, which has been classified as having poor air quality, there is reduced visibility as well as irritating health effects as compared with B. If the level of emissions could be reduced in the Los Angeles area so that visibility and irritating health effects were represented by Picture B not only in the B area but also in your area, and if the air would be cleaned up to this level in (2, 10) years, would you pay a (a monthly charge, an extra charge in your utility bill) of (START BIDDING WITH PREVIOUS MAXIMUM BID) for as long as you live in the Los Angeles area?

[ ] DO FOLLOWING ONLY IF CHECKED

Life Table: Here is a table that might help you. It shows the total amount you would pay for as long as you live in Los Angeles for various amounts of monthly payments.

RECORD MAXIMUM BID______

REVISIONS IF NECESSARY_______

Would you consider moving to a new location in the Los Angeles area if air quality were like Picture C everywhere? Yes[ ] No[ ]

IF YES:

Where would you move? (GRID LOCATION ON MAP)________

Substitutions

Aesthetic; Original Position A; Movement to B

NON-ZERO BIDS:

You stated that you would pay $_____ per month for as long as you live in the Los Angeles area if visibility improved from A to a condition like that shown in B, if this could be accomplished in (2, 10) years. If you actually paid this amount in order to help finance air pollution control programs, you would have less money to spend overall. However, because you said you would pay some amount of money, you are indicating that clearer air is something you value. Consequently, when conditions like B are achieved, even though you have paid money to help improve the visibility, this does not mean that your standard of living is worse than before because now you will be living and recreating in a less polluted area.

If the visibility conditions were to improve from A to B in your area, would the improved conditions change the pattern of your leisure activities? This could be changes in time per week, location, or frequency. Yes[ ] No[ ]

IF NO, GO TO NEXT BIDDING GAME
IF YES, THEN:

A. Administer indoor and outdoor activity and cost list
B. Check time constraint____

ZERO BIDS:

Although you told me that you would not pay anything to have visibility improve throughout the Los Angeles area to like that shown in Picture B, would the improved conditions change the pattern of your leisure activities? This could be changes in time per week, location, or frequency. Yes[ ] No[ ]

IF NO, GO TO NEXT BIDDING GAME
IF YES, THEN:

A. Administer indoor and outdoor activity and cost lists
B. Check time constraint______

Substitutions

Aesthetic + Acute; Original Position A; Movement to K

NON-ZERO BIDS:

With the extra information on possible short term health effects when conditions are like A, you said that you would pay $_____ per month for as long as you lived in the Los Angeles area if conditions improved from those associated with Picture A to conditions shown in Picture B; and if this could be accomplished in (2, 10] years. As before, because you said you would pay some amount of money, you are indicating that clearer air is something you value. Consequently, when conditions like A are achieved, even though you have paid money to help improve the visibility and to lessen short term health effects, this does not mean that your standard of living is worse than before because now you will be living and recreating in a less polluted area.

If conditions improved so that Picture B were representative of the entire area, with no visibility problems or irritating effects, would the improved conditions change the pattern of your leisure activities? Yes[ ] No[ ]

IF NO, GO TO NEXT BIDDING GAME
IF YES, THEN:

A. Administer indoor and outdoor activity and cost lists
B. Check time constraint_____

ZERO BIDS:

Although you told me you would not pay anything to have visibility conditions and short term health effects improve throughout the area to like those shown in Picture B, would the improved conditions change the pattern of your leisure activities? Yes[ ] No[ ]

IF NO, GO TO NEXT BIDDING GAME
IF YES, THEN:

A. Administer indoor and outdoor activity and cost lists
B. Check time constraint_____

Substitutions

Aesthetic + Acute + Chronic; Original Position A; Movement to B

NON-ZERO BIDS:

Given the information that continued exposure to levels of air pollution like those shown in picture A could actually reduce your life expectancy, you said you would pay $____ per month for as long as you lived in the Los Angeles area if conditions improved from those in A to those frown in B, and if this could be accomplished in (2, 10) years. Once again, I would like you to think of this expenditure as leaving you as well off as before you paid the money, since you are now living and recreating in a less polluted area.

If conditions improved so that Picture B were representative of the entire area, with no visibility problems or short and long term health effects, would the improved conditions change the pattern of your leisure activities Yes[ ] No[ ]

IF NO, PROCEED TO GENERAL INFORMATION SECTION
IF YES, THEN:

A. Administer indoor and outdoor activity and cost lists
E. Check time constraint_____

ZERO BIDS:

Although you told me that you would not pay anything to have visibility or short and long term health effects improve throughout the Los Angeles area to like those shown in Picture B, would the improved conditions change the pattern of your leisure activities? Yes[ ] No[ ]

IF NO, GO TO GENERAL INFORMATION SECTION
IF YES, THEN:

A. Administer indoor and outdoor activity and cost lists
B. Check time constraint_____

Bidding - Aesthetic, Acute Health and Chronic Health Effects

The quality of the air may also affect your long term health. There is evidence that high concentrations of emissions as represented in Pictures A and B have lasting effects upon the respiratory and circulatory systems in addition to eye irritation and reduced visibility. Evidence shows that, on the average, people who live in areas with concentrations like those in Picture A can expect a reduced lifespan of up to 2 years compared with people who live in conditions represented by B, and up to 3 years when compared with people who live in conditions represented by Picture C.

If the level of emissions could be reduced in the Los Angeles area so that visibility, short and long term health conditions would be represented by Picture B instead of A, not only in the B area but also in your area, and if the air would be cleaned up to this level in (2, 10] years, would you pay (a monthly charge, an extra charge in your utility bill) of (START BIDDING WITH PREVIOUS BID) for as long as you live in the Los Angeles area?

[ ] DO FOLLOWING ONLY IF CHECKED

Life Table: Here is a table that might help you. It shows the total amount you would pay for as long as you live in Los Angeles for various amounts of monthly payments.

RECORD BID________

REVISION IF NECESSARY__________

Is there some other payment scheme besides (a monthly charge, an extra charge in your utility bill) that you would prefer? Yes[ ] No[ ]

IF YES:

What would it be?____

Would you consider moving to a new location in the Los Angeles area if air quality were like Picture C everywhere? Yes[ ] No[ ]

IF YES:

Where would you move? (GRID LOCATION ON MAP)________

GENERAL INFORMATION SHEET: WOULD YOU PLEASE FILL OUT THE FOLLOWING?

1. Age_____

2. Sex: Male[ ] Female[ ]

3. Marital status: Single[ ] Married[ ]

4. Number of persons in your household?_____

5. Your education: _____ years Highest degree obtained:
High School[ ] College[ ] Vocational] Advanced[ ]

6. Address of employment:____

7. Location of employer(s) (GRID LOCATION ON MAP)__________

8. Are there any environmental hazards associated with your job, such as noise, health, or sight? Yes[ ] No[ ] IF YES: What are these hazards?
____

9. What is the percentage of your work time indoors?_______%

10. In a typical work week how much time do you spend on the job?_____hours

11. If you received our pamphlet last week, did you read:

    [ ] 0-5 pages
    [ ] 5-10 pages
    [ ] more than 10 pages

If you live in area A or B:

How much would you pay for this same house (apartment) today if it were located in an area where the air pollution levels were like those shown in Picture C? $____________

If you live in area C:

Do you believe that any part of the value of your home is because you live in a relatively unpolluted part of Los Angeles? Yes[ ] No[ ]
IF YES: How much (% or dollars) __________________

If you live in area B or C:

Would you consider moving if the air pollution problem were as bad as A throughout the entire area? Yes[ ] No[ ]
IF YES: Where would you most likely move? (GRID LOCATION ON MAP)
____

How much do you think it would cost to clean up air pollution in the Los Angeles area to a condition like that shown in Picture C?
$______________

If all citizens were billed equally, how much do you think it would cost each person in order to achieve conditions like that shown in Picture C?
$______________

1. Characteristics of home:

Living Area: ________ square feet

Number of Rooms: _____

Number of Bedrooms: _____

Number of Bathrooms: _____

Other Rooms: (PLEASE CHECK)

[ ] Den
[ ] Family room
[ ] Dining room
[ ] Enclosed porch
[ ] Attic
[ ] Basement
___ % Basement finished
[ ] Utility room

Scenic View: Yes[ ] No[ ] IF YES: Specify_______________

Number of Stories: (INCLUDE BASEMENT) ______

Remodeled: Yes[ ] No[ ] Don’t know[ ]

IF YES: Specify previous style and date________________________________

2. Equipment: (PLEASE CHECK)

[ ] Dishwasher
[ ] Disposal
[ ] Central Air Conditioning
[ ] Trash Compactor
[ ] Central Heating

Pool: Yes[ ] No[ ]

IF YES: Circle whether heated, enclosed, or other (specify) ________

Fireplace: Yes[ ] No[ ]

Age of home: _____years (when constructed)

IF YOU LIVE IN AN APARTMENT, GO TO QUESTION 4

3. a) Year of purchase: ______

b) Could you please indicate what the purchase price was: $__________

c) What are your monthly payments: $__________

d) What do you feel your home is worth in today’s market? $__________

e) What are your property tax payments per year? $__________

f) How long have you been living in this house? ______ years

GO TO QUESTION 5

4. a] How long have you been living in this apartment: _____ years

b) Would you indicate your monthly rent? $________

5. What are your insurance payments per year? $________

6. What do you pay monthly for general upkeep around your home (apartment)?

____

7. Why have you chosen to live in this area? RANK IN ORDER OF IMPORTANCE, WHERE ONE IS MOST IMPORTANT. CHOOSE TOP FIVE.

☐ Attractiveness of area in general
☐ Close to work
☐ Close to recreation activities
☐ Close to friends
☐ Close to schools
☐ Close to services
☐ Close to transportation routes
☐ Air quality
☐ Affordability of home
☐ Low crime rate
☐ Prestige of area
☐ Quiet neighborhood
☐ Other

8. What are your average expenditures per month for food: $___________

9. What are your average expenditures per year for clothing? $___________

10. Please mark the box corresponding to your annual household income.

☐ 0-$5,000
☐ $5,000-$10,000
☐ $10,000-$15,000
☐ $15,000-$20,000
☐ $20,000-$25,000
☐ $25,000-$30,000
☐ $30,000-$35,000
☐ $35,000-$40,000
☐ $40,000-$50,000
☐ $50,000-$60,000
☐ $60,000-$80,000
☐ Over $80,000

1. Do you own or share in the ownership of a motor vehicle? Yes[ ] No[ ]

   Type of Vehicle(s) __________Model ______ Year

   __________Model ______ Year

   __________Model ______ Year

2. How many licensed drivers are in your family?_______

3. How many miles per gallon do you get for each car in the city?

   ________mpg

   ________mpg

   ________mpg

   How many miles do you and your family typically travel in your automobile per week? ______miles

4. How many hours do you and your family spend in a typical week commuting to:

   Work or school ______ hours

   Shopping ______ hours

   Recreational activities ______ hours

5. Do you participate in a car pool? Yes[ ] No[ ]

6. How much do you spend each month on:

   a) Gasoline costs $______

   b) Maintenance costs $______

   c) Public transportation fares $______

   d) Insurance payments $______

7. Did you take a vacation within the last year where you were away from home for more than 4 days? Yes[ ] No[ ]

   IF YES: About how much were your expenditures on this trip? $_________

1. Have you ever had any of the following? (PLEASE CIRCLE)

   a) High blood pressure
   b) Heart trouble
   c) Stroke
   d) Chronic bronchitis
   e) Asthma
   f) Chronic nervous trouble
   g) Cancer
   h) Tuberculosis

2. Have you ever had trouble with the following? (PLEASE CIRCLE)

   i) Pain in the heart or tightness or heaviness in the chest
   j) Trouble breathing or shortness of breath
   k) Frequent headaches
   l) Constant coughing or frequent heavy chest colds
   m) Frequent eye irritations
   n) Allergies
   o) Nose and throat irritation

3. Are any of these (the above) conditions aggravated (or made worse) by heavy air pollution? Yes[ ] No[ ]

   IF YES: Which ones? (LIST LETTERS CIRCLED) ______________________

4. Do you suffer from any other diseases which could be made worse by poor air quality? Yes[ ] No[ ] Specify ______________________________

5. Do you or any member of your family have any physical disabilities which limit your activities? Yes[ ] No[ ]

6. Would conditions like those in Picture C, if they occurred over the entire area?

   a) Make your life more pleasant — Not at all[ ] To some degree[ ] Greatly[ ]

   b) Require you to spend less money on drug items or doctor's fees — Not at all[ ] To some degree[ ] Greatly[ ]

   c) Make it easier to do your work? — Not at all[ ] To some degree[ ] Greatly[ ]

7. Do you enjoy doing your leisure activities more during the day or during the night? Day Night Makes no difference

8. Do you smoke? Yes[ ] No[ ] IF YES: How many packs per day?________

9. Do you take medication regularly? Yes[ ] No[ ]
   IF YES: Monthly expense on this medication? $_____/month

10. How much do you spend monthly on medical problems associated with air pollution effects? $_____/month

11. How much do you spend yearly for doctor's fees? $_________/year

12. How much do you spend yearly on medical and life insurance?
$_____________/year

13. Have you purchased any items to reduce your exposure to air pollution (such as carbon filters)? Yes[ ] No[ ]
IF YES: What items? ____

1. Which one of these statments applies to you? (CHECK ONE)

   [ ] I have <u>not</u> been bothered by air pollution.
   [ ] I have been <u>somewhat</u> bothered by air pollution.
   [ ] I have been bothered <u>quite a lot</u> by air pollution.

2. Do you believe that air pollution in Los Angeles: (CHECK ONE]

   [ ] Has become worse since you have lived here.
   [ ] Has stayed about the same since you have lived here.
   [ ] Has gotten better since you have lived here.

3. What do you think should be done about air pollution? (CHECK ONE)

   [ ] Ignored
   [ ] Reduced

4. Please rank the following problems in terms of importance (most to least) as the major issues facing the community. (CHOOSE TOP FIVE)

   [ ] Juvenile delinquency
   [ ] Communicable disease
   [ ] Unemployment
   [ ] Air pollution
   [ ] Car accidents
   [ ] Crime
   [ ] Nuclear energy
   [ ] Alcoholism
   [ ] Water pollution
   [ ] Energy
   [ ] Congestion
   [ ] Other

5. Do you believe that air pollution in the Los Angeles area:

   [ ] Cannot be reduced below its present level
   [ ] Can be reduced below its present level
   [ ] Can be almost completely eliminated

6. What do you think the words “air pollution” mean to most people in the Los Angeles area? Do they mean:

   a) Frequent bad smells in the air Yes[ ] No[ ]
   b) Too much dirt and dust in the air Yes[ ] No[ ]
   c) Frequent haze or fog in the air Yes[ ] No[ ]
   d) Frequent irritation of the eyes Yes[ ] No[ ]
   e) Frequent nose or throat irritation Yes[ ] No[ ]
   f) Other Yes[ ]

7. Have you read or seen anything in the newspaper recently about air pollution? Yes[ ] No[ ]

8. When you read the newspaper, do you generally choose to read articles on air pollution? Yes[ ] No[ ]

9. Do you consult the daily air pollution index before engaging in any activities? Yes[ ] No[ ]

IF YES: What kind of activities? ____________________________________

____

1. If you received our health pamphlet, what do you think about it?

   ☐ Did not read
   ☐ Very informative
   ☐ Hard to understand
   ☐ Scientific mumbo-jumbo
   ☐ Made me more concerned about health effects
   ☐ Had no influence on me

2. Here is a list of words and phrases. Select two which describe how you feel about your participation in this survey.

   ☐ Stimulating
   ☐ Just tolerable
   ☐ A waste of time
   ☐ Educational
   ☐ Boring
   ☐ An invasion of privacy
   ☐ Interesting
   ☐ Kind of fun
   ☐ Hard to take seriously

3. Here is a different list of words and phrases. Select two which describe how you feel about the questionnaire.

   ☐ Relevant
   ☐ Credible
   ☐ Likely to influence air quality control
   ☐ Unrealistic
   ☐ Pretty flakey
   ☐ Unlikely to have any effect on air quality control
   ☐ Irrelevant

4. Finally, here is another list of words and phrases. Select one from each column to describe how you feel about your answers to the questionnaire.

   Column 1

   ☐ Quite accurate

   ☐ There was no way I could come up with accurate answers.

   ☐ Accurate in a "ball park" kind of way.

   Column 2

   ☐ A fairly good guide for valuing air quality

   ☐ A good guide for valuing air quality.

   ☐ A poor guide for valuing air quality.

THANK YOU FOR YOUR COOPERATION.

APPENDIX B

The following represents the health pamphlet that was sent to half of the respondents who were contacted by phone and agreed to participate in the study.

AIR POLLUTION AND HEALTH

This pamphlet will try to answer some questions about air pollution and human health. How do the major pollutants affect the body? What is known scientifically about these effects? What kinds of real life studies have been carried out to test facts learned in the laboratory? This information is provided so that you can draw your own conclusions about the health effects of air pollution.

Nearly every day in the Los Angeles area a chemistry of air and sunlight gives rise to toxic gases known as photochemical oxidants. These, together with carbon monoxide, Sslphur dioxide, nitrogen oxide, hydrocarbons, aldehydes, and ketones, make up the haze, account for its aroma, and may impair human health.

Environmental standards like those in Table B.1 attempt to protect the public. When the concentration of any pollutant exceeds the standard, acute, short term, irritating symptoms may be noticed. These acute effects, such as chest tightness, eye irritation, slowing of response time, and attention loss, are not experienced by everyone, but people with pre-existing heart condition and lung disease are particularly vulnerable.

In addition to acute health effects, chronic effects of long term exposure to low and average levels of the oxides, aerosols, particulate, and other elements of the haze are a particularly challenging question. Does air pollution cause influenza sometimes, or does it merely make it more of a problem? Links between oxides of nitrogen and cancer have been investigated. Finally, it is possible that years of continuing exposure could have some influence on total lifespan.

The Major Pollutants

Carbon Monoxide

The major sources of carbon monoxide pollution are automobiles, trucks, buses, and, to the habitual smoker, cigarettes. Peak hourly readings of carbon monoxide from 1963 to 1970 averaged 10.8 ppm* in the Los Angeles area, and exposure in the California Central Valley was about half this figure for the same period. [11]

Carbon monoxide has a very direct effect on the human body. Entering the lungs, it diffuses into the blood, where it is absorbed by red blood cells and displaces and competes with oxygen. Carbon monoxide reduces the oxygen carrying capacity of the blood. Low concentrations cause tiredness and listlessness.

The heart is doubly affected. Its oxygen supply is reduced, but at the same time it must exert more effort to increase its output if body oxygen transport is to be maintained. And so, at relatively low concentrations of carbon monoxide (10-50 ppm for one hour exposure), [19] patients with heart disease may experience adverse effects.

During heavy muscular exercise, the oxygen consumption rate of the body increases to as much as 20 times the rest rate. Consequently, carbon monoxide exposure reduces maximum exercise performance.

In controlled experiments with humans, researchers have projected the maximum levels and exposure times shown in Table B.2. Normal healthy individuals are unlikely to experience any of the above effects until the threshold concentration is 21-72.5 ppm. [19] Individuals with emphysema, bronchitis, and asthma are more sensitive, perhaps experiencing effects at 17.5-52.5 ppm, and heart patients are extremely sensitive to carbon monoxide, as noted above. [19] All these effects are _acute_, occurring at high concentrations. The effects of exposure over long periods to low carbon monoxide levels are not known at this time.

Sulphur Dioxide

Los Angeles has not had a deadly pollution episode such as those observed in Belgium; Donora, Pennsylvania; London; or New York, but an ingredient of Los Angeles air pollution, sulphur dioxide, is held responsible for high death tolls in these places.

A well known air pollution episode occurred December 1-5, 1930 when several hundred persons became ill in the Meuse Valley, Belgium. There were 63 deaths. It was estimated that sulphur dioxide and sulphuric acid, which may have reached a level of 9 ppm, were the chief causes of illness.[30]

---

*ppm denotes the number of pounds of pollutant for each million pounds of air.

During late October, 1945, Donora, Pennsylvania, was blanketed by dense fog. Forty-three percent of the population was affected. Twenty persons died. Ten percent of the residents were severely affected. Again, sulphur dioxide was held to be responsible.[30]

In London, England during December, 1952, the world's worst air pollution incident occurred, causing about 4,000 more deaths than would be expected in the Greater London Area for a month's period. Marked increases in deaths both from lung and heart disease were observed. Detailed investigations of 1,280 post-mortem reports of persons who had died before, during, or shortly after the episode indicated all such fatalities could be explained by previous health problems among the victims. The elderly and persons with already existing lung and heart disease were most susceptible. During this time in London, daily sulphur dioxide and smoke measurements were from two to four times higher than typical winter levels. [30]

Sulphur dioxide, as is well known, has an odor. It is readily soluble in water and, when breathed, is absorbed quickly in the upper airways of the nose. In Table B.3 are recorded laboratory observations of throat and lung effects from sulphur oxides. In air with small dust particles, sulphur dioxide is partially converted into sulphuric acid, which may be a severe problem of its own. The Los Angeles area currently has relatively low levels of sulphur dioxide.

Photochemical Oxidants

Along with carbon monoxide, gasoline engines produce nitric oxide* and hydrocarbons. Secondary products of these emissions, photochemical oxidants - ozone, nitrogen dioxide, and peroxyacetylnitrate (PAN), may be more toxic than the original compounds.

Early morning car traffic produces exhaust with large quantities of nitric oxide and hydrocarbons. In the presence of sunlight these products react, converting nitric oxide into nitrogen dioxide but low nitric oxide levels. Then nitrogen dioxide breaks down into ozone during the afternoon. Late afternoon automobile traffic again emits large amounts of nitric oxide, which reacts with ozone, removing most of the ozone.

Ozone is among the most poisonous of gases. Relatively insoluble in water, when inhaled, ozone can damage the central airways and other passages of the lung.

Health studies of certain occupations have provided understanding of the effects of exposure to oxidants. A 51 year old welder who was working in a poorly ventilated area, developed a kind of pneumonia which lasted for six days.[9] A crane operator working above a tank into which ozone was bubbled developed a dry cough and frontal headache after two hours

---

*Nitric oxide is also a byproduct of natural gas combustion and the processing of nitric acid industrially.

Table B.1

Pollution Levels and Standards (Parts Per Million)**

	Ozone	Carbon Monoxide	Nitrogen Dioxide	Sulphur Dioxide
National Standard for one hour exposure	0.03	40.0	0.25*	0.50
Average peak hourly level in Lennox, 1973-75	0.04	12.1	0.99	0.06
Average peak hourly level in Costa Mesa Harbor, 1973-75	0.05	3.6	0.07	0.03
Average peak hourly level in Pasadena, 1973-75	0.11	9.53	0.13	0.03

Source: Three Year Summary of California Air Quality Data: 1973-1975, Air Analysis Branch and EDP Management Section (January 1977), State of California Air Resources Board.

*State of California hourly standard.

**Parts per million denotes the number of pounds of pollutant found in a million pounds of air.

Table B.2

Carbon Monoxide Effects[a]
(National Standard: 40 parts per million/one hour exposure)

Concentration ppm	Exposure Time	Effects
Acute Effects		
50	2 hours	Shortened average time to a heart attack among individuals with heart disease[b]
53	1.5 hours	Shortened average time to a heart attack among individuals with heart disease.
100	0.5 to 2 hours	Loss of physical and mental coordination among healthy subjects.
500	1 hour	Mild to throbbing headache among healthy subjects.[c]
1,000	--	Vomiting, unconsciousness and death among healthy subjects.

Sources: [a] Leung, Goldstein and Dalkey, Final Report: Human Health Damages from Mobile Source Air Pollution 1975, California Air Resources Board.

[b] W.S. Aronow and M.W. Isbell, "Carbon Monoxide Effect on Exercise-Induced Angina Pectoris," Annals of Internal Medicine 79 (1973), 392-395.

[c] J. Koch-Weser, “Common Poisons,” in Harrison (ed.), Principles of Internal Medicine, Ch. 166 (1970), 652-653.

Table B.3

Sulphur Dioxide Effects
(National Standard: .5 parts per million/one hour exposure)

Concentration ppm	Exposure Time	Effects
Acute Effects		
1	0.5 hour	Choking sensation in some individuals.
5	3-10 minutes	About 80% of healthy individuals will have difficulty in breathing.
5-10	--	Deep gasping feeling, severe choking in some individuals.

Source: National Pollution Control Administration, Air Quality for Sulphur Dioxides, 1969, U.S. Department of Health, Education and Welfare, Public Health Service, Consumer Protection and Environmental Health Service.

exposure. In attempting to leave the crane, the employee nearly lost consciousness. After administration of oxygen, he improved, and 48 hours later showed no adverse symptoms. [11]

Other studies have confirmed these effects. A long term study over the period October, 1961, to June, 1964, recorded daily symptoms in student nurses in good health from two Los Angeles nursing schools. The nurses kept diaries for 868 days on appearance of cough, chest discomfort, and headaches. For the same period hourly peak concentrations of photochemical oxidants, carbon monoxide, and daily temperature were measured at stations within two miles of the schools.

Cough and chest discomfort increased with higher hourly concentrations of ozone. Headaches had some association with ozone levels but less than other symptoms. Eye discomfort, not a direct effect of ozone, although often associated with photochemical oxidants, was the most strongly noted symptom. When the oxidant level reached 0.5 ppm, a third of the nurses reported eye irritation. Temperature, carbon monoxide, and nitrogen dioxide levels did not explain the results found. Because all participants were young, healthy adults, relatively free from chronic disease, the effects on elderly persons or on those with chronic heart or lung disease could be expected to be more severe. [22]

During the period 1963-1970 peak hourly readings of oxidants averaged .104 ppm in the Los Angeles area, and again readings in the California Central Valley were about half this figure. [19]

According to a panel of experts,

> “the oxidant threshold in normal individuals ranges from 0.05 to 0.20 ppm. The threshold concentration is lowered among young and old individuals, and also those with underlying disease. Those with respiratory and chronic obstructive diseases are most sensitive to the photochemical oxidants, and the threshold levels for these population groups range from O to 0.20 ppm.” [19]

In addition to discomfort and aggravation of existing lung disorders, ozone and other photochemicals can cause changes in behavior. Automobile accidents, for example, were recorded in each daylight hour of each weekday in the “high smog” months of August through November for two years. A relationship between Los Angeles oxidant concentrations and the number of car accidents was found. [22 1 Attention span and visual performance were reduced. Lethargy is reported as well as difficulty concentrating. [18]

Because lung function is impaired, evidence suggests photochemical smog increases individual vulnerability to acute throat or lung infections. Studies with experimental animal populations have reported changes in the makeup and working of the lung as well as lung–tumor acceleration. [25] Whether ozone is a cancer causing agent is currently an important topic for research. Human white blood cells exposed to ozone exhibited chromosome breakage and genetic abnormality. [12] In Table B.4 a summary of ozone effects is given.

Table B.4

Summary of Experimental Data on Ozone Effects[a]
(National Standard: .08 parts per
million/one hour exposure)

Concentration ppm	Exposure Time	Effects
Acute Effects		
0.15-0.30	--	Eye irritation due to some photochemical products.
0.37-9.70	2 hours	Cough, nose and upper throat irritation, chest soreness, chest tightness, symptoms made worse by exercise, headache in 50% of normal subjects.
0.25	--	Less than 6% of asthmatics may have attacks when this level is reached.
0.5	--	Formation of fluid in the lungs among healthy subjects.
0.8-1.7	--	Lung congestion.
1.0-2.0	--	Incapacitating illness among normal subjects.

Sources: [a] Leung, Goldstein and Dalkey, Final Report: Human Health Damages ~~from Mobile Source Air Pollution, 1975,~~ California Air Resources Board.

[b] G.E. Schoettlin and E. Landau, “Air Pollution and Asthmatic Attacks in the LA Area,” Public Health Report 76 (1961), 545-548.

Nitrogen dioxide, a by-product of auto emissions, has effects similar to ozone but at higher levels of concentration. Originally, exposure to nitrogen dioxide was known as "silo-filler's syndrome," since extremely high concentrations of nitric oxide and nitrogen dioxide are generated within farm silos. Documented deaths from a kind of pneumonia and acute throat and lung ailments were traced to this type of exposure.

Like ozone, nitrogen dioxide's low water volubility allows it to penetrate deeply into the lung, where it damages tissue. At low concentrations, it impairs breathing. At higher levels it increases the risk of an individual having a throat or lung ailment. At 25-100 ppm, it causes acute (but quickly remedied) symptoms of pneumonia and bronchitis.

A study of the environmental health effects of nitrogen dioxide was conducted in four residential areas, each containing three elementary schools, in greater Chattanooga, Tennessee. One area, close to a large TNT plant (which processes nitric acid), had high nitrogen dioxide and low particulate exposure. Another area had high suspended particulate and low nitrogen dioxide concentrations. The other two areas were "clean" and used for comparisons. Careful monitoring of particulate matter, nitrates, sulphates, and gaseous nitrogen dioxide concentrations was conducted in 1968 and 1969 in these four areas.

Two possible health effects of nitrogen dioxide exposure were investigated: (1) difficulty breathing in elementary school children; and (2) increased frequence of respiratory illness in family groups. It was established that second grade school children in the high nitrogen dioxide area were consistently higher than those in the two control areas during the study period. However, the researchers could not establish a relationship between chronic bronchitis and the levels of nitrogen dioxide. [26]

In the period 1963-1970, nitrogen dioxide levels in the Los Angeles Area averaged .28 ppm and therefore constituted a potential health hazard given the estimates of effects in Table B.5

The air pollution health problem of the Los Angeles Area is far more complex than brief accounts of the hazards of carbon monoxide, sulphur dioxide, and two photochemical oxidants can indicate. For one thing, literally hundreds of hydrocarbon compounds are present in the Los Angeles air, each with its own characteristics and products. A group of secondary organic aerosols may be responsible for adverse health effects and undoubtedly contribute to visibility loss. Little, however, is known of the mechanism and health impact of these compounds.

However, there is evidence that the pollutants discussed have health effects at levels experienced within Los Angeles and other urban areas. These pollutants cause irritation and stress within the lungs and heart.

Acute effects range from eye, nose, and throat irritation, headache, chest tightness, difficulty in breathing to the aggravation of bronchitis, asthma, emphysema, other lung ailments and heart disease. A relationship between episodes of sulphur dioxide and particulate pollution and increased

Table B. 5

Nitrogen Dioxide Effects[a]

(National Standard: .05 parts per million/one hour exposure)

Concentration ppm	Exposure Time	Effects
Acute Effects		
0.7-2.0	10 minutes	Difficulty expelling air from the lungs increased by 15% and difficulty breathing air into the lungs increased by 50% in normal subjects.
4-5	10 minutes	Half hour after exposure, difficulty breathing, increased by 77% to 92%.
4-5	1 hour	Decrease in oxygen in the blood.
6-40	5 minutes	Increased difficulty breathing by 24% in normal subjects.
greater than 25	1 hour or less	Bronchiolitis and pneumonitis in normal subjects.[b]
150-200	--	Disintegration of the lung.[c]
greater than 200	--	Lung fluid formation and death.

Sources: [a] Leung, Goldstein and Dalkey, Final Report: Human Health Damages from Mobile Source Air Pollution, 1975, California Air Resources Board.

[b] D.V. Bates, "Air Pollution and the Human Lung," American Review of Respiratory Disorders 105 (1972), 1-13.

[c] H.E. Stokinger and D.L. Cottin, "Biologic Effects of Air Pollutants," in A.C. Stern, cd., Air Pollution and Its Effects, Ch. 13, New York: Academic Press (1968), 445-546.

death rates is accepted. The chronic effects of photochemical oxidants lower general resistance to infections of the respiratory tract and lung since they cause damage to the lung. Behavioral changes associated with carbon monoxide, ozone, and nitrogen dioxide have been documented. Activity levels are depressed and overall work ability is impaired through visual and chemical intervention.

These air pollutants may also shorten the lifespan by aggravating existing health problems, particularly those problems associated with the respiratory tract.

BIBLIOGRAPHY

1. Abe, Matsuo, “Effects of Mixed NO_2-SO_2 Gas on Human Pulmonary Functions,” Bulletin, Tokyo Med. Dent. University 14 (1967], pp. 415-433.

2. Anderson, E.W., R.J. Andelman, J.M. Strauch, N.J. Fortain, and J.H. Knelson, “Effects of Low-Level Carbon Monoxide Exposure on Onset and Duration of Angina Pectoris: A Study in Ten Patients with Ischemic Heart Disease,” Ann. Intern. Med. 79, 46, 50 (1973).

3. Aronow, W.S. and M.W. Isbell, “Carbon Monoxide Effect on Exercise-Induced Angina Pectoris,” Ann. Int. Med. 79 (1973), pp. 392-395.

4. Bates, D.V., “Air Pollution and the Human Lung,” American Review of Respiratory Disorders 105 (1972), pp. 1-13.

5. Bates, D.V., G.M. Bell, C.D. Burnham, M. Hazucka, J. Mautha, L.D. Penselly, and F. Silverman, “Short-Term Effects of Ozone on the Lung,” Journal of Applied Physics 32 (1972), pp. 176-181.

6. Beard, R.R. and G.A. Wertheim, “Behavioral Impairment Associated with Small Doses of Carbon Monoxide,” American Journal of Public Health 57 (1967), pp. 2052-2022.

7. “Behavioral Toxicology Looks at Air Pollutants,” interview with C. Xintaras, Environ. Sci. Tech. 2 (1968), pp. 731-733.

8. California Department of Public Health, Clean Air for California, Initial Report of the Air Pollution Study Project, Berkeley (March 1955, March 1956, and February 1957).

9. Challen, P.J.R., D.E. Hickish, and J. Bedford, “Investigation of Some Health Hazards in Inert-Gas, Tungsten Arc Welding Shops," British Journal Ind. Med. 15 (1958), pp. 276-282.

10. Committee on Medical and Biologic Effects of Environmental Pollutants, Division of Medical Science, Assembly of Life Sciences, National Research Council, Ozone and Other Photochemical Oxidants, National Academy of Sciences, Washington, D.C. (1977).

11. Coordinating Committee on Air Quality Studies, National Academy of Sciences, National Academy of Engineering, Air Quality and Automobile Emission Control, Vol. 3, The Relationship of Emissions to Ambient Air Quality, U.S. Government Printing Office, Washington, D.C. (1974).

12. Fetner, R.H., “Ozone-Induced Chromosome Breakage in Human Cell Cultures,” Nature 194 (1962), pp. 793-794.

13. Haagen-Smit, A.J. and L.G. Wayne, “Atmospheric Reactions and Scavenging Processes, Ch. 6,” in A. C. Stenn, ed., Air Pollution and Its Effects, New York: Academic Press (1968), pp. 149-186.

14. Hammer, D.I., V. Hasselblad, R. Portnor, and P. Wehrle, “Los Angeles Student Nurse Study, Daily Symptom Reporting and Photochemical Oxidants,” AEH 28 (1974), pp. 255-260.

15. Hazacha, M., F. Silverman, C. Parent, S. Field, and D.V. Bates, “Pulmonary Function in Man After Short Term Exposure to Ozone," Arch, Envinson, Health 27 (1973), pp. 183-185.

16. Kelly, F.J. and W.E. Fill, “Ozone Poisoning,” AEH 10 (1965), pp. 517-519.

17. Koch-Weser, J., “Common Poisons,” in Harrison (ed.), Principles of Internal Medicine, Ch. 166, 6th Edition (1970), pp. 652-653.

18. Lagerwertt, J.J., “Prolonged Ozone Inhalation and Its Effects on Visual Parameters,” Aerospace Med. 34 (1963), pp. 479-486.

19. Leung, Steve, Elliot Goldstein, and Norman Dalkey, Human Health Damages from Mobile Source Air Pollution: Final Report, California Air Resources Board (March 1975).

20. Lowry, T. and L.M. Schumann, “Silo-Fillers Disease Syndrome Caused by Nitrogen Dioxide,” JAMA 162 (1956), pp. 153-160.

21. Mert, T.H., H.A. Bender, H.D. Kerr, and T.J. Kulle, “Observations of Abberations in Chromosomes of Lymphocytes from Human Subjects Exposed to Ozone at a Concentration of 0.5 ppm for 6 to 10 Hours,” Mutat. Res. 31 (1975), pp. 299-302.

22. Proceedings of the Conference on Health Effects of Air Pollutants, Assembly of Life Sciences, National Academy of Science, National Research Council, Oct. 3-5. Prepared for the Committee on Public Works, U.S. Senate (1973).

23. Ramirez, R.J. and A. R. Dovell, “Silo-Fillers Disease: Nitrogen Dioxide Induced Lung Injury, Long Term Follow-up and Review of the Literature,” Ann. Int. Med. 74 (1971), pp. 569-576.

24. Ruffin, J.B., “Functional Testing for Behavioral Toxicity: A Missing Dimension in Experimental Environmental Toxicology,” J. Occup. Med. 5 (1963), pp. 117-121.

25. Schoettlin, C.E. and E. Landau, “Air Pollution and Asthmatic Attacks in the LA Area,” Public Health Report 76 (1961), pp. 545-548.

26. Shy, C.J., J.P. Creason, M.E. Pearlman, K.E. McClain, F.B. Benson, and M.M. Young, “The Chattanooga School Study: Effects of Community Exposure to Nitrogen Dioxide, II, Incidence of Acute Respiratory Illness,” Journal of the Air Pollution Control Association 20(9) (September 1970), pp. 582-588.

27. Shy, C.J., J.P. Creason, M.E. Pearlman, “The Chattanooga School Children Study-II. Incidence of Acute Respiratory Illness.” Journal of the Air Pollution Control Association 20” (1970); pp. 582-588.

28. Stokinger, H.E. and D.L. Cottin, "Biologic Effects of Air Pollutants," in Air Pollution and Its Effects,, A.C. Stern (ed.], New York: Academic Press, Ch. 13 (1968), pp. 445-546.

29. U.S. Department of Health, Education and Welfare, Public Health Service, Consumer Protection and Environmental Health Service, Air Quality Criteria for Sulphur Oxides (January 1969).

30. U.S. Department of Health, Education and Welfare, Pulbic Health Service, Consumer Protection and Environmental Health Service, Air Quality Criteria for Sulphur Oxides (January 1969).

31. Ury, H.K., "Photochemical Air Pollution and Automobile Accidents in Los Angeles: An Investigation of Oxidant and Accidents, 1963 and 1965," AEH 17 (1968), pp. 334-342.

32. Von Nieding, G., "Studies of the Acute Effects of NO_2 on Lung Function, Influence of Differsion, Pertusion, and Ventilation in the Lungs," Int. Trde. Arbeits Med. 31 (1973), pp. 61-72.

33. Young, W.A., D.B. Shaw and D.V. Bates, "Pulmonary Function in Welders Exposed to Ozone," AEH 7 (1973), pp. 337-340.

APPENDIX C

The following tables have the following underlying assumptions.

1. The mean bids within each area are differentiated with respect to the sequence that the air quality effects are presented, i.e., whether those effects are Introduced in “Aesthetic → Acute Health → Chronic Health” or “Acute Health → Chronic Health → Aesthetic” order. In the graphs, “Ae” denotes the mean bid for aesthetic effects; “Ac” denotes the mean bid for acute health effects; and “Ch” denotes the mean bid for chronic health effects.

2. The mean bids within each “A” area are differentiated with respect to the range of the hypothetical improvement, i.e., whether the improvement is from A to B or from A to C. Since there is only one range of improvement for the “B” and the “C” areas, i.e., from B only to C and from C only to C*, no such differentiation is made for these areas.

Taking into consideration the variations in (l), each A area requires four different graphs, and each B“ and C area requires two different graphs.

A denotes poor air quality

B denotes fair air quality

C denotes good air quality

3. The mean bids within each area are differentiated with respect to the proposed completion date of cleanup; i.e., 2 years versus 10 years.

4. The bids from each respondent are obtained as follows: First, his maximum bid is elicited following a certain hypothetical improvement in the aesthetic (acute health) effects of air quality. Second, he is asked how much he would increase his bid if the acute health (chronic health) effects are also taken into consideration. Finally, he is asked to revise his bid for the additional inclusion of the chronic health (aesthetic) effects.

The implicit assumption throughout this procedure is the linear additivity of bids for each effect.

No differentiation has been made whether a health pamphlet has or has not been sent to the respondent in advance of the interview.

No differentiation has been made with respect to the different proposed vehicles for the collection of bids.

No differentiation has been made with respect to the different starting bids offered by the interviewer.

No differentiation has been made whether a life table has or has not been shown to the respondent during the interview. A life table depicts the “stock” counterparts of the elicited monthly bids for various expected lifespans.

Table C.1

Mean Bids by Area by Type*
(Completion Date of Cleanup: 2 yrs.)

Area**	Mean Aesthetic Bid ($/month)		Mean Acute Health Bid ($/month)		Mean Chronic Health Bid ($/month)		Mean Total Bid ($/month)	
	Type I	Type II	Type I	Type 11	Type I	Type II	Type I	Type II
El Monte (A → B)	2.00 (0.95)*** (5)****	1.00 (1.00) (5)	3.00 (1.55) (5)	9.20 (4.76) (5)	2.00 (1.22) (5)	0.40 (0.40) (5)	7.00 (3.00) (5)	10.60 (5.45) (5)
El Monte (A → C)	13.40 (8.15) (5)	0.13 (0.13) (2)	1.40 (0.93) (5)	7.50 (2.50) (2)	3.60 (2.91) (5)	2.75 (2.25) (2)	18.40 (11.75) (5)	10.38 (4.63) (2)
La Canada (A → B)	13.20 (9.37) (5)	0.00 (0.00) (2)	1.20 (0.97) (5)	1.50 (1.50) (2)	2.20 (1.96) (5)	0.00 (0.00) (2)	16.60 (9.03) (5)	1.50 (1.50) (2)
La Canada (A → C)	22.60 (13.70) (5)	0.00 (0.00) (5)	2.40 (1.12) (5)	8.00 (3.74) (5)	1.00 (1.00) (5)	21.00 (10.30) (5)	26.00 (12.69) (5)	29.00 (9.54) (5)
Montebello (A → B)	1.60 (0.93) (5)	3.75 (2.39) (4)	0.20 (0.20) (5)	12.50 (4.79) (4)	0.20 (0.20) (5)	2.50 (2.50) (4)	2.00 (0.84) (5)	18.75 (6.57) (4)
Montebello (A → C)	26.43 (20.69) (7)	4.67 (2.60) (3)	3.57 (1.71) (7)	10.75 (5.45) (4)	7.86 (7.06) (7)	0.25 (0.25) (4)	37.86 (27.21) (7)	11.00 (1.00) (3)
Canoga Park (B → C)	10.00 (5.77) (3)	1.20 (0.97] (5)	10.17 (7.58) (3)	15.40 (4.71) (5)	1.67 (1.67) (3)	3.80 (2.84) (5)	21.83 (14.14) (3)	20.40 (5.89) (5)

(continued)

Table C.1
(continued)

Area	Mean Aesthetic Bid ($/month)		Mean Acute Health Bid ($/month)		Mean Chronic Health Bid ($/month)		Mean Total Bid ($/month)	
	Type I	Type 11	Type I	Type II	Type I	Type II	Type I	Type II
Culver City (B → C)	3.00 (1.22) (5)	7.09 (4.40) (11)	3.20 (1.24) (5)	23.00 (8.70) (11)	2.60 (0.81) (5)	10.09 (4.75) (11)	8.80 (0.73) (5)	40.18 (13.64) (11)
Encino (A → C)	15.33 (1.80) (9)	0.63 (0.62) (8)	1.11 (1.11) (9)	17.31 (5.81) (8)	2.67 (1.40) (9)	0.56 (0.39) (8)	19.11 (2.52) (9)	18.50 (6.12) (8)
Huntington Beach (B → C)	14.38 (6.16) (8)	6.27 (4.42) (11)	3.38 (3.10) (8)	9.58 (2.01) (12)	4,13 (3.06) (8)	2.91 (0.95) (11)	21.88 (11.69) (8)	19.09 (5.60) (11)
Irvine (B → C)	7.89 (1.99) (9)	1.08 (0.82) (6)	14.33 (5.98) (9)	12.33 (9.57) (6)	2.22 (1.38) (9)	3.83 (2.39) (6)	24.44 (5.67) (9)	17.25 (8.75) (6)
Newport Beach (B → C)	3.00 (1.08) (9)	4.00 (0.00) (1)	0.67 (0.44) (9)	1.00 (0.00) (1)	0.78 (0.52) (9)	0.00 (0.00) (1)	4.44 (1.24) (9)	5.00 (0.00) (1)
Pacific Palisades (C → C*)	25.80 (18.73) (5)	5.00 (2.89) (3)	31.60 (18.94) (5)	3.33 (1.67) (3)	12.00 (9.70) (5)	3.33 (1.67) (3)	69.40 (45.82) (5)	11.67 (6.01) (3)

(continued)

Table C.1

(continued)

	Mean Aesthetic Bid ($/month)		Mean Acute Health Bid ($/month)		Mean Chronic Health Bid ($/month)		Mean Total Bid ($/month)	
Area	Type I	Type II	Type I	Type II	Type I	Type II	Type I	Type II
Palos Verdes (C → C*)	4.31 (2.10) (4)	0.50 (0.50) (4)	2.19 (1.29) (4)	17.75 (10.96) (4)	1.75 (1.18) (4)	0.50 (0.50) (4)	8.25 (4.11) (4)	18.75 (10.48) (4)
Redondo Beach (C → C*)	6.29 (3.39) (7)	4.29 (4.29) (7)	4.86 (2.13) (7)	15.29 (7.85) (7)	0.00 (0.00) (7)	4.43 (2.94) (7)	11.14 (5.07) (7)	24.00 (11.12) (7)

*The implicit assumption in this table has been that of strict additivity of bids for each air quality effect. In obtaining the mean bids, differentiation has been made with respect to: (1) the completion date of cleanup; (2) the bidding sequence. In “Type I” questionnaires, the air quality effects are introduced in “Aesthetic →Acute Health →Chronic Health” order. In “Type II” questionnaires, the air quality effects are introduced in “Acute Health →Chronic Health →Aesthetic” order. In obtaining the mean bids, no differentiation has been made with respect to: (1) different proposed vehicles for the collection of bids; (2) whether a health pamphlet has or has not been sent to the respondent in advance of the interview; and (3) whether a life table has or has not been shown to the respondent during the Interview. A life table depicts the “stock” counterparts of the elicited monthly bids for various expected lifespans.

**The notation in parentheses represents the change in air quality for which the respondents are bidding. For example, (A →B) denotes that the respondent is bidding to change air quality from poor to fair, (B →C) denotes that the respondent is bidding to change air quality from fair to good, and (C →C*) denotes that the respondent is bidding to change air quality to good across the entire region.

***Standard error of the mean bid in all cases.

****Sample size of each case in all cases.

Table C.2

Mean Bids by Area by Type*
(Completion Date of Cleanup: 10 yrs.)

Area**	Mean Aesthetic Bid ($/month)		Mean Acute Health Bid ($/month)		Mean Chronic Health Bid ($/month)		Mean Total Bid ($/month)	
	Type I	Type II	Type I	Type II	Type I	Type II	Type I	Type II
El Monte (A → B)	7.50 (7.50)*** (2)****	0.00 (0.00) (7)	2.50 (2.50) (2)	14.57 (6.49) (7)	0.00 (0.00) (2)	1.43 (1.43) (7)	10.00 (10.00) (2)	16.00 (6.83) (7)
El Monte (A → C)	5.00 (1.58) (5)	0.00 (0.00) (1)	6.40 (3.53) (5)	0.00 (0.00) (1)	1.40 (0.98) (5)	0.00 (0.00) (1)	12.80 (2.54) (5)	0.00 (0.00) (1)
La Canada (A → B)	6.33 (2.54) (6)	0.00 (0.00) (4)	15.83 (14.84) (6)	15.25 (11.80) (4)	0.83 (0.83) (6)	22.50 (22.50) (4)	23.00 (15.56) (6)	37.75 (23.81) (4)
La Canada (A → C)	16.83 (8.47) (6)	0.00 (0.00) (1)	4.17 (2.39) (6)	50.00 (0.00) (1)	0.50 (0.50) (6)	0.00 (0.00) (1)	21.50 (7.96) (6)	50.00 (0.00) (1)
Montebello (A → B)	4.00 (2.45) (5)	1.40 (0.98) (5)	12.40 (9.58) (5)	5.20 (1.56) (5)	1.80 (0.97) (5)	1.60 (1.03) (5)	18.20 (11.39) (5)	8.20 (1.80) (5)
Montebello (A → C)	6.00 (1.97) (5)	1.67 (1.67) (3)	2.20 (1.11) (5)	0.00 (0.00) (3)	1.20 (0.80) (5)	0.00 (0.00) (3)	9.40 (2.86) (5)	1.67 (1.67) (3)

(continued)

Table C.2

(continued)

Area	Mean Aesthetic Bid ($/month)		Mean Acute Health Bid ($/month)		Mean Chronic Health Bid ($/month)		Mean Total Bid ($/month)	
	Type I	Type II	Type I	Type 11	Type I	Type II	Type I	Type II
Canoga Park (B → C)	5.58 (1.64) (6)	0.95 (0.95) (5)	0.92 (0.58) (6)	3.45 (1.86) (5)	0.88 (0.58) (6)	0.00 (0.00) (5)	7.38 (1.75) (6)	4.40 (1.69) (5).
Culver City (B → C)	12.88 (6.30) (8)	7.50 (4.79) (4)	7.25 (3.51) (8)	11.13 (3.23) (4)	4.50 (3.02) (8)	3.25 (2.36) (4)	24.63 (12.07) (8)	21.88 (9.21) (4)
Encino (B → C)	6.00 (3.21) (6)	0.00 (0.00) (5)	0.50 (0.50) (6)	11.20 (6.32) (5)	1.00 (0.68) (6)	2.00 (1.22) (5)	7.50 (3.10) (6)	13.20 (7.26) (5)
Huntington Beach (B → C)	16.38 (5.83) (8)	5.75 (3.43) (11)	7.63 (2.05) (8)	12.90 (4.50) (12)	6.88 (4.20) (8)	6.82 (2.94) (11)	30.88 (8.31) (8)	26.64 (8.52) (11)
Irvine (B → C)	13.08 (5.12) (9)	4.33 (2.96) (3)	7.72 (1.97) (9)	19.00 (15.63) (3)	2.58 (1.15) (9)	0.00 (0.00) (3)	23.39 (6.03) (9)	23.33 (18.56) (3)
Newport Beach (B → C)	1.10 (0.51) (5)	1.20 (1.20) (5)	0.20 (0.20) (5)	3.80 (1.91) (5)	0.40 (0.40) (5)	6.50 (3.83) (5)	1.70 (0.54) (5)	11.50 (5.04) (5)

(continued)

Table C.2

(continued)

Area	Mean Aesthetic Bid ($/month)		Mean Acute Health Bid ($/month)		Mean Chronic Health Bid ($/month)		Mean Total Bid ($/month)	
	Type I	Type II	Type I	Type II	Type I	Type II	Type I	Type 11
Pacific Palisades (C ⟶ C*)	7.40 (4.21) (5)	4.29 (2.30) (7)	13.60 (5.87) (5)	15.71 (4.56) (7)	139.20 (87.30) (5)	2.86 (1.49) (7)	160.20 (92.16) (5)	22.86 (4.21) (7)
Palos Verdes (C ⟶ C*)	7.29 (1.38) (7)	2.00 (1.22) (4)	7.71 (5.45) (7)	22.50 (9.46) (4)	1.14 (0.77) (7)	5.50 (4.86) (4)	16.14 (5.91) (7)	30.00 (10.21) (4)
Redondo Beach (C ⟶ C*)	20.64 (6.46) (7)	1.00 (0.77) (5)	9.57 (6.88) (7)	3.30 (1.76) (5)	4.14 (2.26) (7)	4.80 (3.01) (5)	34.36 (14.35) (7)	9.10 (3.85) (5)

*The implicit assumption in this table has been that of strict additivity of bids for each air quality effect. In obtaining the mean bids, differentiation has been made with respect to: (1) the completion date of cleanup; (2) the bidding sequence. In "Type 1" questionnaires, the air quality effects are introduced in "Aesthetic ⟶ Acute Health ⟶ Chronic Health" order. In "Type II" questionnaires, the air quality effects are introduced in "Acute Health + Chronic Health ⟶ Aesthetic" order. In obtaining the mean bids, no differentiation has been made with respect to: (1) different proposed vehicles for the collection of bids; (2) whether a health pamphlet has or has not been sent to the respondent in advance of the interview; and (3) whether a life table has or has not been shown to the respondent during the interview. A life table depicts the "stock" counterparts of the elicited monthly bids for various expected lifespans.

**The notation in parentheses represents the change in air quality for which the respondents are bidding. For example, (A ⟶ B) denotes that the respondent is bidding to change air quality from poor to fair, (B ⟶ C) denotes that the respondence is bidding to change air quality from fair to good, and (C ⟶ C*) denotes that the respondent is bidding to change air quality to good across the entire region.

***Standard error of the mean bid in all cases.

****Sample size of each case in all cases.

APPENDIX D

Preliminary Regression Relationships, for Selected Variables on the South Coast Experiment

Introduction

The following Tables present a very preliminary set of regression results on examining the raw data for bid relationships in the South Coast Air Basin. These data sets must be viewed as a preliminary set to give the researchers further guidelines on how to statistically analyze the data set. They are not meant to be viewed as definitive in either a computational or final set sense. However, they should indicate to other researchers the degree of variation in both the estimates and the sets of relationships hypothesized for computation. It is anticipated that it will take a least four to five months for all such relationships to be adequately statistically analyzed.

Table D-1 contains a preliminary set of regression equations across all areas and bid types. Aesthetic, acute and chronic health bids, along with a total bid, were regressed against various variables of possible interest. One of these variables was the interviewer, to find out whether a detectable bias might exist in terms of the interview selected. In most instances, no interviewer bias was discovered; however, for the acute health bid, chronic health bid, total bid, when related to a small number of variables, there was an indication of a detectable interviewer bias. The researchers will continue to explore this possibility to discover whether, in fact, such a bias is present and how it might be removed from further statistical computations. A further test was to examine whether years of education in some significant way influenced the amount of the bid. In no circumstances was a significant relationship (at the 95% level of confidence) discovered. A third possible premise was that the duration of years lived in Los Angeles would influence the bid. The results here are mixed, although in almost all circumstances, statistically nonsignificant. Both positive and negative effects of years living in Los Angeles was discovered. Finally, as a general variable to examine, individuals who had read the health pamphlet and those who had not were examined. Again, the results were mixed. However, in each circumstance, those who had read the health pamphlet tended to bid significantly higher (at the 95% level) than those who had not. Alternatively, the bids on aesthetic and chronic health effects appeared to not be related in any reasonable way to whether the individuals had, in fact, had access to additional information on health effects.

Dummy variables were inserted for each of the locational sites of the experiment. In almost all circumstances, with a few exceptions, the site-specific dummy variables were nonsignificant, indicating at least in a preliminary way that site-specificity would not significantly influence the bid. The pollution variable in every circumstance but one was insignificant at the 95% level of confidence. This would be anticipated on the basis of the conceptual research reported in Chapter 2. That is, when one nets out all the effects on the various bids with the exception of pollution, inclusive of income, then the pollution variable itself may or may not be statistically significant. For example, if preferences are nonhomogeneous and nonidentical, we could presume that those willing to pay a higher price for clean air

TABLE D-1

PRELIMINARY REGRESSION EQUATIONS FOR BIDS[a, b, c, d]

Dependent Variable	Constant	Independent Variables																					N	R^2	SE
		IC	YE	LA	HP	Z1	Z2	Z3	Z4	Z5	Z6	Z7	Z8	Z9	Z10	Z11	P	P1	P2	P3	Y				
Aesthetic Bid	-13.798	0.221 (0.251)	-0.111 (0.494)	-3.66E-2 (0.102)	1.852 (1.213)	-1.13E-4 (1.33E-4)	-3.91E-4 (3.51E-4)	-3.48E-4 (3.10E-4)	-5.21E-5 (3.32E-4)	9.80E-6 (9.33E-5)	9.15E-6 (1.81E-4)	4.47E-4 (1.09E-4)	5.74E-4 (2.14E-4)	2.31E-4 (1.67E-4)	-5.59E-5 (1.76E-4)	3.94E-4 (1.88E-4)	2.895 (1.19)						110	0.26	17.850
Acute Health Bid	-18.179	0.290 (0.253)	0.730 (0.497)	3.45E-3 (0.103)	2.734 (1.221)	-8.86E-5 (1.34E-4)	1.27E-6 (3.54E-4)	-1.82E-4 (3.12E-4)	-1.87E-4 (3.34E-4)	2.61E-4 (9.39E-5)	5.03E-5 (1.82E-4)	3.28E-4 (1.10E-4)	2.33E-4 (2.15E-4)	1.37E-4 (1.68E-4)	-1.17E-4 (1.78E-4)	1.20E-4 (1.89E-4)	1.311 (1.20)						110	0.25	12.933
Chronic Health Bid	-26.076	0.359 (0.839)	1.113 (1.767)	-0.273 (0.366)	-1.078 (4.339)	2.50E-4 (4.77E-4)	-3.34E-4 (1.26E-3)	-2.10E-4 (1.11E-3)	2.83E-5 (1.19E-3)	9.07E-6 (3.34E-4)	-6.93E-5 (6.47E-4)	1.29E-3 (3.89E-4)	3.69E-4 (7.64E-4)	8.37E-5 (5.96E-4)	2.23E-6 (6.31E-4)	5.21E-4 (6.73E-4)	2.599 (4.262)						110	0.23	45.933
Total Bid	-56.052	0.840 (0.931)	1.734 (1.948)	-0.307 (0.434)	3.908 (4.784)	4.05E-5 (5.25E-4)	-5.98E-4 (1.39E-3)	-7.40E-4 (1.22E-3)	-2.11E-4 (1.31E-3)	2.80E-4 (3.68E-4)	-5.79E-6 (7.13E-4)	2.07E-3 (4.29E-4)	1.18E-3 (8.42E-4)	4.52E-4 (6.57E-4)	-1.71E-4 (6.96E-4)	1.04E-3 (7.42E-4)	6.805 (4.698)						110	0.34	50.663
Aesthetic Bid	1.658	-0.270 (0.134)	-0.131 (0.493)	-5.93E-2 (9.96E-2)	2.974 (1.187)													0.954 (1.80E+7)	1.550 (2.97E+7)	8.086 (9.76E+7)			110	0.10	13.578
Acute Health Bid	-2.935	-7.93E-2 (0.174)	0.705 (0.493)	-4.61E-2 (9.95E-2)	2.549 (1.186)													-0.141 (1.30E+7)	0.125 (2.97E+7)	2.520 (9.76E+7)			110	0.10	13.565
Chronic Health Bid	-1.860	-1.554 (0.657)	1.860 (1.694)	-0.434 (0.342)	-0.514 (4.090)													0.843 (6.18E+7)	0.810 (1.02E+8)	70.544 (3.36E+8)			110	0.12	46.679
Total Bid	-23.149	-2.004 (0.779)	2.434 (1.978)	-0.539 (0.400)	5.009 (4.762)													3.786 (7.22E+7)	6.000 (1.19E+8)	42.700 (3.92E+8)			110	0.16	54.486
Aesthetic Bid	10.632	-0.116 (0.204)	-0.361 (0.507)	-3.20E-2 (9.62E-2)	2.974 (1.169)												-0.317 (0.607)				1.35E-4 (7.64E-5)		110	0.12	13.372
Acute Health Bid	-5.035	0.158 (0.194)	0.244 (0.480)	-2.64E-2 (9.26E-2)	2.532 (1.124)												-0.109 (0.564)				2.38E-4 (7.33E-5)		110	0.18	12.867
Chronic Health Bid	12.564	-1.070 (0.710)	1.220 (1.766)	-0.283 (0.335)	-0.479 (4.070)												-2.550 (2.115)				4.43E-4 (2.66E-4)		110	0.12	46.361
Total Bid	18.181	-1.036 (0.813)	1.102 (2.021)	-0.342 (0.383)	5.027 (4.658)												-2.985 (2.421)				8.15E-4 (3.05E-4)		110	0.19	53.290

[a] Independent Variables:

IC = Interviewer code
YE = Years of education
LA = Years lived in L.A.
HP = Amount of health pamphlet read
Z1 = Dummy variable for La Canada
Z2 = Dummy variable for El Monte
Z3 = Dummy variable for Montebello
Z4 = Dummy variable for Canoga Park
Z5 = Dummy variable for Encino
Z6 = Dummy variable for Culver City
Z7 = Dummy variable for Pacific Palisades
Z8 = Dummy variable for Redondo Beach
Z9 = Dummy variable for Palos Verdes
Z10 = Dummy variable for Newport Beach
Z11 = Dummy variable for Huntington Beach
P = Pollution variable
P1 = Pollution variable for the A areas
P2 = Pollution variable for the B areas
P3 = Pollution variable for the C areas
Y = Income

-0-

N = Number of cases
R^2 = Goodness of fit
SE = Standard error of regression

[b] Values in parentheses are coefficient standard errors. (E - n ≑ 10^{-n}; i.e., E-2 ≑ 10^{-2})

[c] Observations are aggregated without any differentiation with respect to 1) Different areas, 2) Range of hypothetical improvement in air quality, 3) Bidding sequence, 4) Starting bid, 5) Vehicle used, 6) Health pamphlet vs. no health pamphlet, 7) Life table vs. no life table

[d] Bids for each air quality effect are assumed to be strictly separable.

TABLE D-2

PRELIMINARY REGRESSION EQUATIONS FOR THE AGGREGATED "A" AND "B" AREAS

Dependent Variable	Constant	Independent Variables											N	R^2	SE
		LA	HP	Y	ΔP	ΔP^2	$Y\Delta P$	LLA	LHP	LY	$L\Delta P$				
Aesthetic Bid	8.682	-5.66E-2 (8.769E-2)	0.662 (1.161)	-5.58E-5 (6.79E-5)	0.145 (0.600)								75	0.02	10.385
Acute Health Bid	3.327	-2.47E-2 (7.59E-2)	1.166 (1.005)	1.49E-4 (5.87E-5)	-0.442 (0.518)								75	0.12	8.986
Chronic Health Bid	-0.896	-8.12E-2 (0.111)	2.745 (1.466)	1.34E-4 (8.57E-5)	1.231 (0.757)								75	0.10	13.112
Total Bid	11.112	-0.162 (0.166)	4.573 (2.203)	2.27E-4 (1.29E-4)	0.934 (1.136)								75	0.11	19.698
Aesthetic Bid	5.153				5.953 (21.245)	-0.562 (2.110)	-9.53E-6 (2.31E-5)						75	0.00	10.400
Acute Health Bid	11.943				-21.849 (19.020)	2.088 (1.889)	2.53E-8 (2.07E-5)						75	0.05	9.311
Chronic Health Bid	0.205				13.246 (26.681)	-1.404 (2.650)	7.06E-5 (2.90E-5)						75	0.09	13.061
Total Bid	17.301				-2.650 (41.657)	0.123 (4.138)	6.11E-5 (4.52E-5)						75	0.02	20.392
log (Aesthetic Bid)	3.475							-0.283 (0.186)	-4.72E-2 (0.390)	-0.159 (0.110)	7.70E-2 (0.155)		75	0.06	1.271
log (Acute Health Bid)	0.387							-0.248 (0.179)	0.191 (0.377)	0.152 (0.107)	-2.33E-2 (0.150)		75	0.07	1.227
log (Chronic Health Bid)	1.597							-0.143 (0.168)	0.387 (0.354)	-5.48E-2 (0.100)	8.82E-2 (0.141)		75	0.03	1.153
log (Total Bid)	3.447							-0.283 (0.186)	0.223 (0.391)	-4.11E-2 (0.111)	5.25E-2 (0.156)		75	0.04	1.275

[a] Independent variables:
LA = Years lived in L.A.
HP = Amount of health pamplet read
Y = Income
ΔP = Change in pollution level, i.e. ΔNO_2
ΔP^2 = One half times the change in the squared values of pollution levels, i.e. $1/2(P_j^2-P_i^2)$
$Y\Delta P$ = Income times the change in pollution level
LLA = log (Years lived in L.A.)
LHP = log (Amount of health pamphlet read)
LY = log (Income)
$L\Delta P$ = log (Change in pollution level)
-0-
N = Number of cases

[b] Values in parentheses are coefficient standard errors ($E\text{-}n \rightarrow 10^{-n}$; i.e. $E\text{-}2 \rightarrow 10^{-2}$)

[c] Observations are aggregated without any differentiation with respect to 1) Bidding sequence, 2) Starting bid, 3) Vehicle used, 4) Health pamphlet vs. no health pamphlet, 5) Life table vs. no life table.

[d] Bids for each air quality effect are assumed to be strictly separable.

TABLE D-3

PRELIMINARY REGRESSION EQUATIONS FOR THE PAIRED AREAS[a, b, c, d]

(NEWPORT BEACH-PACIFIC PALISADES)

Dependent Variable	Constant	Independent Variable									N	R^2	SE
		LA	HP	Y	ΔP	LLA	LHP	LY	LΔP				
Aesthetic Bid	-49.578	0.728 (0.735)	13.773 (4.884)	7.89E-4 (2.94E-4)	-41.709 (26.624)						13	0.65	19.466
Acute Health Bid	-30.484	0.451 (0.812)	13.777 (5.397)	5.713 (3.25E-4)	-44.660 (29.421)						13	0.57	21.512
Chronic Health Bid	179.120	-5.765 (5.386)	-26.756 (35.810)	-1.12E-4 (2.15E-3)	24.615 (195.197)						13	0.22	142.720
Total Bid	99.057	-4.586 (5.837)	0.794 (38.808)	1.25E-3 (2.33E-3)	-61.754 (211.543)						13	0.27	154.672
log (Aesthetic Bid)	-21.328					0.155 (0.861)	0.795 (0.856)	2.067 (1.146)	3.965 (2.626)		13	0.54	1.235
log (Acute Health Bid)	-5.907					-0.118 (-6.06E-2)	1.144 (0.632)	0.798 (0.847)	5.468 (1.940)		13	0.66	0.912
log (Chronic Health Bid)	0.184					-1.657 (1.263)	-0.590 (1.256)	0.624 (1.682)	-0.164 (3.854)		13	0.43	1.812
log (Total Bid)	-3.303					-0.956 (0.902)	0.263 (0.896)	0.846 (1.201)	3.376 (2.750)		13	0.57	1.293

---

[a] Independent variables:

LA = Years lived in L.A.
HP = Amount of health pamphlet read
Y = Income
ΔP = Change in pollution level, i.e. ΔNO_2
LLA = log (Years lived in L.A.)
LHP = log (Amount of health pamphlet read)
LY = log (Income)
LΔP = log (Change in pollution level)
-0-
N = Number of cases
R^2 = Goodness of fit
SE = Standard of error regression

[b] Values in parentheses are coefficient standard errors (E-n → 10^{-n}; i.e. E-2 → 10^{-2})

[c] Observations are aggregated without any differentiation with respect to 1) Bidding sequence, 2) Starting bid, 3) Vehicle used, 4) Health pamphlet vs. no health pamphlet, 5) Life table vs. no life table)

[d] Bids for each air quality effect are assumed to be strictly separable.

TABLE D-4

PRELIMINARY REGRESSION EQUATIONS FOR THE PAIRED AREAS[a, b, c, d]

(IRVINE-PALOS VERDES)

Dependent Variable	Constant	Independent Variables									N	R^2	SE
		LA	HP	Y	ΔP	LLA	LHP	LY	LΔP				
Aesthetic Bid	1.086	-8.48E-2 (6.58E-2)	0.457 (1.014)	1.01E-4 (9.65E-5)	2.661 (3.231)						26	0.15	4.446
Acute Health Bid	6.420	0.187 (0.191)	3.055 (2.942)	-2.48E-5 (2.80E-4)	-3.591 (9.375)						26	0.08	12.900
Chronic Health Bid	0.332	-1.29E-2 (5.67E-2)	0.197 (0.873)	3.13E-5 (8.31E-5)	2.252 (2.782)						26	0.04	3.828
Total Bid	7.838	8.90E-2 (0.201)	3.709 (3.102)	1.071 (2.95E-4)	1.322 (9.886)						26	0.07	13.603
Log (Aesthetic Bid)	-8.095					-0.340 (0.205)	0.145 (0.688)	0.940 (0.602)	-0.517 (1.186)		26	0.22	1.083
Log (Acute Health Bid)	-1.046					-4.48E-2 (0.245)	0.516 (0.823)	0.265 (0.720)	0.330 (1.418)		26	0.04	1.295
Log (Chronic Health Bid)	-4.534					-0.132 (0.161)	0.448 (0.541)	0.505 (0.473)	-0.506 (0.933)		26	0.13	0.852
Log (Total Bid)	-6.527					-4.99E-2 (0.183)	0.468 (0.613)	0.862 (0.536)	-0.205 (1.057)		26	0.16	0.965

[a] Independent variables:

LA = Years lived in L.A.
HP = Amount of health pamphlet read
Y = Income
ΔP = Change in pollution level, i.e. ΔNO_2
LLA = log (Years lived in L.A.)
LHP = log (Amount of health pamphlet read)
LY = log (Income)
LΔP = log (Change in pollution level)
-0-
N = Number of cases
R^2 = Goodness of fit
SE = Standard of error regression

[b] Values in parentheses are coefficient standard errors (E-n → 10^{-n}; i.e. E-2 → 10^{-2})

[c] Observations are aggregated without any differentiation with respect to 1) Bidding sequence, 2) Starting bid, 3) Vehicle used, 4) Health pamphlet vs. no health pamphlet, 5) Life table vs. no life table)

[d] Bids for each air quality effect are assumed to be strictly separable.

TABLE D-5

PRELIMINARY REGRESSION EQUATIONS FOR THE PAIRED AREAS[a, b, c, d]

(LA CANADA-ENCINO)

Dependent Variable	Constant	Independent Variables										N	R^2	SE
		LA	HP	Y	ΔP	$ΔP^2$	YΔP	LLA	LHP	LY	LΔP			
Aesthetic Bid	19.224	-0.225 (0.229)	-3.122 (2.838)	-1.72E-4 (1.14E-4)	0.977 (1.298)							22	0.19	13.241
Acute Health Bid	2.220	-3.70E-2 (0.165)	3.066 (2.049)	2.37E-4 (8.26E-5)	-1.581 (0.937)							22	0.42	9.559
Chronic Health Bid	-4.03E-2	-0.280 (0.372)	6.971 (4.611)	1.30E-4 (1.86E-4)	3.005 (2.109)							22	0.24	21.514
Total Bid	21.384	-0.542 (0.420)	6.915 (5.207)	1.95E-4 (2.10E-4)	2.401 (2.382)							22	0.23	24.292
Aesthetic Bid	12.099				-30.489 (48.614)	3.257 (4.872)	-5.62E-5 (4.27E-5)					22	0.10	13.574
Acute Health Bid	6.569				24.025 (40.736)	-2.589 (4.083)	1.94E-5 (3.58E-5)					22	0.12	11.375
Chronic Health Bid	-5.559				29.340 (80.346)	-2.771 (8.053)	5.30E-5 (7.05E-5)					22	0.13	22.435
Total Bid	13.101				22.877 (94.111)	-2.103 (9.433)	1.62E-5 (8.26E-5)					22	0.04	26.279
log (Aesthetic Bid)	5.589							-0.640 (0.582)	-1.249 (0.759)	-0.246 (0.126)	0.246 (0.287)	22	0.29	1.323
log (Acute Health Bid)	0.770							-0.408 (0.572)	0.717 (0.745)	0.171 (0.124)	-0.247 (0.282)	22	0.20	1.300
log (Chronic Health Bid)	4.477							-0.732 (0.632)	0.413 (0.824)	-0.160 (0.137)	0.486 (0.312)	22	0.20	1.437
log (Total Bid)	6.322							-0.910 (0.681)	0.335 (0.887)	-0.113 (0.147)	0.184 (0.336)	22	0.13	1.547

[a] Independent variables:

LA = Years lived in L.A.
HP = Amount of health pamplet read
Y = Income
ΔP = Change in pollution level, i.e. $ΔNO_2$
$ΔP^2$ = One half times the change in the squared values of pollution levels, i.e. $1/2(P_i^2-P_j^2)$
YΔP = Income times the change in pollution level
LLA = log (Years lived in L.A.)
LHP = log (Amount of health pamphlet read)
LY = log (Income)
LΔP = log (Change in pollution level)

-0-

N = Number of cases
R^2 = Goodness of fit
SE = Standard error of regression

[b] Values in parentheses are coefficient standard errors (E-n → 10^{-n}; i.e. E-2 → 10^{-2})

[c] Observations are aggregated without any differentiation with respect to 1) Bidding sequence, 2) Starting bid, 3) Vehicle used, 4) Health pamphlet vs. no health pamphlet, 5) Life table vs. no life table.

[d] Bids for each air quality effect are assumed to be strictly separable.

TABLE D-6

PRELIMINARY REGRESSION EQUATIONS FOR THE PAIRED AREAS[a, b, c, d]
(HUNTINGTON BEACH-REDONDO BEACH)

Dependent Variable	Constant	Independent Variables									N	R^2	SE
		LA	HP	Y	ΔP	LLA	LHP	LY	LΔP				
Aesthetic Bid	-11.181	0.201 (0.367)	1.377 (2.992)	5.34E-4 (3.79E-4)	7.166 (11.066)						23	0.24	16.054
Acute Health Bid	-8.864	0.171 (0.305)	-1.180 (2.491)	5.47E-4 (3.15E-4)	0.764 (9.212)						23	0.17	13.365
Chronic Health Bid	-2.539	0.120 (0.237)	0.284 (1.934)	1.30E-4 (2.45E-4)	9.297 (7.155)						23	0.14	10.380
Total Bid	-22.584	0.491 (0.704)	0.480 (5.741)	1.21E-3 (7.27E-4)	15.700 (21.233)						23	0.25	30.804
log (Aesthetic Bid)	-8.499					0.330 (0.685)	-3.34E-2 (0.749)	0.851 (0.618)	-1.678 (1.578)		23	0.20	1.522
log (Acute Health Bid)	-8.424					0.793 (0.592)	-0.671 (0.647)	0.724 (0.534)	-1.096 (1.364)		23	0.18	1.316
log (Chronic Health Bid)	-2.636					0.285 (0.645)	0.332 (0.705)	0.240 (0.582)	-1.077 (1.485)		23	0.09	1.433
log (Total Bid)	-8.980					0.588 (0.694)	-0.308 (0.758)	0.932 (0.626)	-1.474 (1.598)		23	0.19	1.541

[a] Independent variables:

LA = Years lived in L.A.
HP = Amount of health pamphlet read
Y = Income
ΔP = Change in pollution level, i.e. ΔNO_2
LLA = log (Years lived in L.A.)
LHP = log (Amount of health pamphlet read)
LY = log (Income)
LΔP = log (Change in pollution level)
-0-
N = Number of cases
R^2 = Goodness of fit
SE = Standard of error regression

[b] Values in parentheses are coefficient standard errors (E-n → 10^{-n}; i.e. E-2 → 10^{-2})

[c] Observations are aggregated without any differentiation with respect to 1) Bidding sequence, 2) Starting bid, 3) Vehicle used, 4) Health pamphlet vs. no health pamphlet, 5) Life table vs. no life table)

[d] Bids for each air quality effect are assumed to be strictly separable.

TABLE D-7

PRELIMINARY REGRESSION EQUATIONS FOR THE PAIRED AREAS[a, b, c, d]
(MONTEBELLO-CULVER CITY)

Dependent Variable	Constant	Independent Variables											N	R^{-2}	SE
		LA	HP	Y	ΔP	ΔP^2	YΔP	LLA	LHP	LY	LΔP				
Aesthetic Bid	14.371	-3,40E-2 (0,103)	-1.277 (2.042)	-2,77E-4 (1,52E-4)	-0,256 (1,042)								14	0.30	5.139
Acute Health Bid	13.877	-8.32E-2 (0.141)	-2.853 (2.800)	-1.55E-4 (2.09E-4)	-0.313 (1.428)								14	0.17	7.045
Chronic Health Bid	13.164	-1.27E-2 (4.5E-2)	-1.229 (0.892)	-2.33E-4 (6.66E-5)	-1.150 (0.455)								14	0,66	2.244
Total Bid	41.411	-0,130 (0.190)	-5,359 (3.760)	-6,65E-4 (2.81E-4)	-1,719 (1.918)								14	0,46	9.461
Aesthetic Bid	2.018				17.058 (19.864)	-1,532 (1,970)	-7,31E-5 (5.92E-5)						14	0.18	5.256
Actute Health Bid	17.139				-55,831 (20,201)	5,574 (2,003)	-3,41E-5 (6.02E-5)						14	0.47	5.345
Chronic Health Bid	6.149				-8,323 (12.024)	0.815 (1.192)	-2,48E-5 (3.59E-5)						14	0.25	3.181
Total Bid	25.306				-47,096 (39.363)	4.857 (3.963)	-1,32E-4 (1.19E-4)						14	0.25	10.573
log (Aesthetic Bid)	22.984							6.11E-3 (0.639)	-0.701 (1.185)	-2.133 (1,008)	-0,294 (0,533)		14	0.36	1.078
log (Acute Health Bid)	8.958							-1.189 (0.664)	-2.123 (1.232)	-0.423 (1.048)	0.541 (0.554)		14	0.36	1.120
log (Chronic Health Bid)	19.392							-8.92E-2 (0.423)	-1.349 (0.784)	-1.773 (0.667)	-0.540 (0.353)		14	0.53	0.713
log (Total Bid)	25.998							-0.518 (0.683)	-1.798 (1.266)	-2.183 (1.077)	-0.159 (0.570)		14	0.40	1.152

---

[a] Independent variables:
LA = Years lived in L.A.
HP = Amount of health pamplet read
Y = Income
ΔP = Change in pollution level, i.e. ΔNO_2
ΔP^2 = One half times the change in the squared values of pollution levels, i.e. $1/2(P_i^2-P_j^2)$
YΔP = Income times the change in pollution level
LLA = log (Years lived in L.A.)
LHP = log (Amount of health pamphlet read)
LY = log (Income)
LΔP = log (Change in pollution level)
-0-
N = Number of cases
R^2 = Goodness of fit
SE = Standard error of regression

[b] Values in parentheses are coefficient standard errors (E-n → 10^{-n}; i.e. E-2 → 10^{-2})

[c] Observations are aggregated without any differentiation with respect to 1) Bidding sequence, 2) Starting bid, 3) Vehicle used, 4) Health pamphlet vs. no health pamphlet, 5) Life table vs. no life table.

[d] Bids for each air quality effect are assumed to be strictly separable.

TABLE D-8

PRELIMINARY REGRESSION EQUATIONS FOR THE PAIRED AREAS[a, b, c, d]

(EL MONTE-CANOGA PARK)

Dependent Variable	Constant	Independent Variables											N	R^2	SE
		LA	HP	Y	ΔP	ΔP^2	YΔP	LLA	LHP	LY	LΔP				
Aesthetic Bid	-0.407	-3.91E-2 (0.115)	-2.365 (2.073)	3.42E-4 (2.05E-4)	-0.185 (0.736)								12	0.31	5.070
Acute Health Bid	-0.188	-0.166 (0.160)	-2.020 (2.892)	3.97E-4 (2.87E-4)	0.986 (1.027)								12	0.37	7.074
Chronic Health Bid	-1.046	1.61E-2 (2.45E-2)	0.616 (0.442)	2.61E-5 (4.38E-5)	0.242 (0.157)								12	0.42	1.082
Total Bid	-1.642	-0.189 (0.103)	-3.769 (1.863)	7.65E-4 (1.85E-4)	1.043 (0.662)								12	0.78	4.558
Aesthetic Bid	2.545				1.762 (22.049)	-0.280 (2.160)	6.82E-5 (4.49E-5)						12	0.22	5.043
Acute Health Bid	9.557				-44.286 (25.030)	4.266 (2.452)	1.01E-4 (5.10E-5)						12	0.53	5.725
Chronic Health Bid	-1.774				10.810 (3.791)	-1.054 (0.371)	8.38E-5 (7.73E-6)						12	0.42	0.867
Total Bid	10.328				-31.714 (17.264)	2.932 (1.691)	1.77E-4 (3.52E-5)						12	0.81	3.948
log (Aesthetic Bid)	-5.207							-0.442 (0.591)	-1.379 (1.147)	0.783 (0.503)	-9.57E-2 (0.337)		12	0.32	1.083
log (Acute Health Bid)	-0.344							-0.196 (0.802)	0.259 (1.554)	0.151 (0.681)	0.479 (0.456)		12	0.14	1.468
log (Chronic Health Bid)	-1.536							0.115 (0.215)	0.574 (0.416)	0.130 (0.182)	0.184 (0.122)		12	0.40	0.393
log (Total Bid)	-4.068							-0.706 (0.429)	-0.530 (0.831)	0.831 (0.364)	0.277 (0.244)		12	0.51	0.785

[a] Independent variables:
LA = Years lived in L.A.
HP = Amount of health pamplet read
Y = Income
ΔP = Change in pollution level, i.e. ΔNO_2
ΔP^2 = One half times the change in the squared values of pollution levels, i.e. $1/2(P_i^2-P_j^2)$
YΔP = Income times the change in pollution level
LLA = log (Years lived in L.A.)
LHP = log (Amount of health pamphlet read)
LY = log (Income)
LΔP = log (Change in pollution level)
-0-
N = Number of cases
R^2 = Goodness of fit
SE = Standard error of regression

[b] Values in parentheses are coefficient standard errors (E-n ⇒ 10^{-n}; i.e. E-2 ⇒ 10^{-2})

[c] Observations are aggregated without any differentiation with respect to 1) Bidding sequence, 2) Starting bid, 3) Vehicle used, 4) Health pamphlet vs. no health pamphlet, 5) Life table vs. no life table.

[d] Bids for each air quality effect are assumed to be strictly separable.

years lived in L.A., amount of health pamphlet read, income and change in pollution indicating a reasonable relationship except for, perhaps, the sign on the number of pages read of the health pamphlet. The income variable is highly significant as is the years of residence in Los Angeles. However, only after substantial further experimentation on these pairs can we anticipate that reasonably defensible estimates of coefficients or elasticities will be forthcoming.

Conclusion

In this Appendix, we have attempted to indicate the rough orders of magnitude of variability of relationships between observed bids and some variables of interest. As yet, the regression results have only roughly illuminated possible further zones of research. Both signs and magnitudes seem to be highly insignificant when the data set is regressed totally. Thus, it is anticipated that substantial additional research from a statistical perspective and also incorporating well-defined theoretical hypotheses will need to be developed for this data set to be adequately exploited. Of particular importance is the examination of bias effects and disaggregation down to the paired comparisons. For our first estimate of the magnitude of bid in Los Angeles reported in Chapter 6, we selected the last equation total bid in the preliminary regression equations in Table D.1. From the coefficient for pollution and adjusting for the effect of the health pamphlet on bids along with adjustments for capital recovery factors and the length of time to achieve clean air, the numbers reported in Table D.1 of Chapter 6 were obtained. The researchers believe this is only a preliminary estimate of the value of the average bid for Los Angeles. It is anticipated that further research will have a highly significant impact on ultimate calculation of a reasonable, accurate value for citizens’ preferences associated with improved air quality.

APPENDIX E

This appendix presents the variable list for the non-market valuation experiment in the South Coast Air Basin.

Variable Name	Description	Column(s)	Format
MVFA	Would you move if like A everywhere (l=yes)	40	F1.0
APLV	Air pollution influenced where you live (l=yes)	41	F1.0
APWK	Air pollution influenced where you work (l=yes)	42	F1.0
AZLV1 AQLV2	Air quality where live (Good=00; Fair=0l; Poor=l0)	43 44	F1.0 F1.0
AQWK1 AQWK2	Air quality where work (Good=00; Fair=0l; Poor=l0)	45 46	F1.0 F1.0
ZNAZ	Are you aware of any health hazards of air pollution (l=yes)	47	F1.0
RESCOP	Respondent cooperative (l=yes)	48	F1.0
RESEV	Respondent evasive (l=yes)	49	F1.0
RESEN	Respondent enthusiastic (l=yes)	50	F1.0
RESSP	Respondent suspicious (l=yes)	51	F1.0
RESUN	Respondent understanding (l=yes)	52	F1.0
RESGM	Respondent playing games (l=yes)	53	F1.0
M.SVAL	Respondent giving true value (l=yes)	54	F1.0
PCTIN	Percent work time indoors	55-57	F3.0
INTTM	Minutes taken for formal interview	58-60	F3.0
DTINT	Date of interview (1=365)	61-63	F3.0
PSI	Pollution index by location and date	64-66	F3.0
EQBL	Cost/person/month for air cleanup if all billed equally	67-72	F6.0
APCLUP	Total figure for cleanup of pollution (100,000's of dollars)	73-80	F8.0

Card #1: Socioeconomic Information and Enumerator Evaluation

Variable Name	Description	Column(s)	Format
QNM	Questionnaire number	1-3	F3.0
CRONM	Card number	4-5	F2.0
QTYP	Questionnaire type: 1 = aesthetic first; no health; 2 = aesthetic first, health; 3= acute, no health; 4 = acute, health	6	FI.0
QCC	City code	7-8	F2.0
INTCD	Interviewer code	9-10	F2.0
TR4E	Time spent at leisure, (hours per week)	11-12	F2.0
WORX	Time speat at work (hours per week)	13-14	F2.0
AGE	Age of respondent	15-16	F2.0
NPER	Number of persons in household	17-18	F2.0
YRED	Years of education.	19-20	F2.0
LIVLA	Years lived in LA area	21-22	F2.0
PLLVLA	Years plan to live in LA area	23-24	F2.0
LOCEMX	X-coordinate, location of employment	25-26	F2.0
LOCEMY	Y-coordinate, location of employment	27-28	F2.0
LOCLVX	X-coordinate, location of home	29-30	F2.0
LOCLVY	Y-coordinate, location of home	31-32	F2.0
ADDCON	Additional conversation time (minutes)	33-34	F2.0
SEX	Sex of respondent (l=male)	35	F1.0
MARST	Marital status of respondent (l=married)	36	F1.0
DEG	Highest degree obtained (l=H.S. ; 2=Coll.; 3=Voc.; 4=Adv.; 0=no degree)	37	F1.0
ENHA2	Environmental hazards associated with job (l=yes)	38	F1.0
PAMP	How much of pamphlet did you read? (1=0-5 pages; 2=5-10 pages; 3=10 + pages; 0 = did not receive)	39	F1.0

Card #2: Bidding Game and Secret Ballot

Variable Name	Description	Column(s)	Format
QNM	Questionnaire number	1-3	F3.0
QTYP	Questionnaire type (l=aes. + no health; 2=aes. + health; 3=acute + no health; 4=acute + health)	4	F1.0
CRONM	Card number	5-6	F2.0
STBID	Starting bid	7-8	F2.0
CPDT	Completion date of cleanup	9-10	F2.0
ZMVIX	Where you would move, 1st stage, X-coordinate	11-12	F2.0
ZMVIY	Where you would move, 1st stage, Y-coordinate	13-14	F2.0
ZMV2X	Where you would move, 2nd stage, X-coordinate	15-16	F2.0
ZMV2Y	Where you would move, 2nd stage, Y-coordinate	17-18	F2.0
ZMV3X	Where you would move, 3rd stage, X-coordinate	19-20	F2.0
ZMV3Y	Where you would move, 3rd stage, Y-coordinate	21-22	F2.0
MAXBD1	Maximum bid, 1st stage	23-27	F5.0
MAXBD2	Maximum bid, 2nd stage	28-32	F5.0
MAXBD3	Maximum bid, 3rd stage	33-37	F5.0
VEH	Vehicle used (l=monthly charge; 2=utility bill)	38	F1.0
LFCK	Life table checked (l-yes)	39	F1.0
MVl	Would you move, 1st stage (l-yes)	40	F1.0
MV2	Would you move, 2nd stage (l-yes)	41	F1.0
MV3	Would you move, 3rd stage (l-yes)	42	F1.0
ZOTVEH	Is there another vehicle? (l-yes)	43	F1.0
SB1l	Secret ballot; question 1, bracket 1	44	F1.0
SB16	Secret ballot; question 1, bracket 6	49	F1.0
SB21		50	F1.0
SB29	(l=checked; 0=unchecked)	58	F1.0

Card #2 (continued)

Variable Name	Description	column(s)	Format
SB31		59	F1.0
SB37	Secret Ballot; question 3, bracket 7	65	F1.0
SB41	(l=checked; O=unchecked)	66	F1.0
SB46		71	F1.0
RVBD1	Reverse bid to B from C	72-75	F4.0
RVBD2	Reverse bid to A from B or C	76-80	F5.0

CARDS 3, 5, 7, 9, . . ., 67

ACTIVITIES : OUTDOOR THEN INDOOR

Variable Name	Description	Column (s)	Format
QNM	Questionnaire number	1-3	F3.0
QTYP	Questionnaire type	4	F1.0
CRDNM	Card number	5-6	F2.0
10PT	Activity participation (l=yes)	7	F1.0
l0IMP	Importance column checked (l=yes)	8	F1.0
10TMI	Was the activity only time important (l=yes)	9	F1.0
10SBB	Did a substitution occur at 1st stage (l=yes)	10	F1.0
10SBC	Did a substitution occur at 2nd stage (l=yes)	11	F1.0
10SBD	Did a substitution occur at 3rd stage (l=yes)	12	F1.0
10TMSB	Was there a time substitution (l=yes)	13	F1.0
10FQSB	Waa there a frequency substitution (l=yes)	14	F1.0
10LCSB	Was there a locational substitution ~l=yes)	15	F1.0
LOOTSB	Was there some other kind of substitution (l=yes)	16	F1.0
10PD	Percent of activity done during day	17-19	F3.0
10EQX	Equipment replacement expenditures	20-24	F5.0
1OHRA	Hours per week in activity	25-28	F4.0
10FQA	Frequency per week in activity	29-32	F4.0
10LCXA	X-coordinate location of activity	33-34	F2.0
10LCYA	Y-coordinate location of activity	35-36	F2.0
10MIA	Miles travelled	37-40	F4.0
10DCA	Direct costs	41-44	F4.0

CARDS 4, 6, 8, 10, ... 68

Variable Name	Description	Column(s)	Format
QNM	Questionnaire number	1-3	F3.0
QTYP	Questionnaire type	4	F1.0
CRDNM	Card number	5-6	F2.0
10HRB	Hours	7-10	F4.0
10FQB	Frequency	11-14	F4.0
10LCXB	X-Location	15-16	F2.0
10LCYB	Y-Location	17-18	F2.0
10MIB	Miles travelled	19-22	F4.0
10DCB	Direct costs	23-26	F4.0
10HRC	Hours	27-30	F4.0
10FQC	Frequency	31-34	F4.0
10LCXC	X-Location	35-36	F2.0
10LCYC	Y-Location	37-38	F2.0
10MIC	Miles travelled	39-42	F4.0
10DCC	Direct costs	43-46	F4.0
10HRD	Hours	47-50	F4.0
10FQD	Frequency	51-54	F4.0
10LCXD	X-Location	55-56	F2.0
10LCYD	Y-Location	57-58	F2.0
10MID	Miles travelled	59-62	F4.0
10DCD	Direct costs	63-66	F4.0

Card 69: Home Characteristics

Variable Name	Description	Column(s)	Format
QNM	Questionnaire number	1-3	F3.0
QTTP	Questionnaire type	4	F1.0
CRDNM	Card number	5-6	F2.0
LVAR	Living area (sq. ft.)	7-11	F5.0
NRM	Number of rooms	12-13	F2.0
NBDRM	Number of bedrooms	14	F1.0
NBTRM	Number of bathrooms	15	F1.0
DEN	Den (l=yes)	16	F1.0
FAM	Family room (l=yes)	17	F1.0
DIN	Dining room (l-yes)	18	F1.0
PCH	Enclosed porch (l=yes)	19	F1.0
ATTIC	Attic (l=yes)	20	F1.0
BASE	Basement (l=yes)	21	F1.0
UTRM	Utility room (l=yes)	22	F1.0
OTRM	Other room (l=yes)	23	F1.0
SCVW	Scenic view (l=yes)	24	F1.0
STOR	Number of stories (include basement)	25	F1.0
REMD	Remodeled (l-yes)	26	F1.0
DISH	Dishwasher (l=yes)	27	F1.0
DISP	Disposal (l=yes)	28	F1.0
CEAIR	Central air conditioning (l=yes)	29	F1.0
TRASH	Trash compactor (l=yes)	30	F1.0
CEHT	Central heating (l=yes)	31	F1.0
POOL	Swimming pool (l=yes)	32	F1.0
FRPL	Fireplace (l=yes)	33	F1.0

Card 69 (continued)

Variable Name	Description	Column(s)	Format
AGEHM	Age of home (years since construction)	34-35	F2.0
YRPC	Year of purchase (last two digits)	36-37	F2.0
LVHM	Length of time (years) living in home	38-39	F2.0
PCPR	Purchase price of home	40-45	F6.0
MTPY	Monthly payments (rounded to nearest dollar)	46-48	F3.0
TDYVL	Value of home in today's market	49-54	F6.0
PTYTX	Property tax payments per year	55-58	F4.0
LVAPT	Length of time (years) in apartment	59-60	F2.0
MTRT	Monthly rent	61-64	F4.0
INSPY	Insurance payments/year	65-68	F4.0
UPKP	Monthly upkeep around home	69-72	F4.0
PCTBST	Percent of basement completed	73-75	F3.0
STD	Automobile standards (l=increase; 2=decrease; 3=same)	76	F1.0

Card 70: Home Characteristics and Transportation

Variable Name	Description	Column(s)	Format
QNM	Questionnaire number	1-3	F3.0
QTYP	Questionnaire type	4	F1.0
CRDNM	Card number	5-6	F2.0
HC71 HC72 HC713	Why have you chosen to live in this area (O=not ranked; other ranked scale of 1 to 5 with 1 the best) 6 if only checked	7 19	F1.0 F1.0
AVGXFD	Average monthly expenditures for food	20-23	F4.0
AVGXCL	Average monthly expenditures for clothing	24-27	F4.0
INCOME	Annual household income (midpoint of groups)	28-33	F6.0
PYFC	How much would you pay for house if in area like C	34-39	F6.0
VLUNPL	How much of value of your home is due to no air pollution	40-44	F5.0
NMVEH	Number of vehicles in family	45	F1.0
LICDR	Licensed drivers in family	46	F1.0
HSTNPG	Highest average miles per gallon	47-48	F2.0
LWSTMPG	Lowest miles per gallon	49-50	F2.0
MLTVLD	Miles travelled per week	51-54	F4.0
HRCMWK	Hours per week spent commuting for work or school	55-56	F2.0
HRCMSP	Hours/week spent commuting for shopping	57-58	F2.0
HRCMREC	Hours/week spent commuting for recreation	59-60	F2.0
CRPOOL	Are you in a car pool (l=yes)	61	F1.0
GASCST	Gasoline costs/month	62-64	F3.0
MTCST	Maintenance costs/month	65-67	F3.0
RTD	Public transportation fares/month	68-70	F3.0
AUTOINS	Auto insurance/month	71-73	F3.0
ZVAC	Vacation within last year (l=yes)	74	F1.0
VACX	Vacation expenditures	75-80	F6.0

Card 71: Medical and Attitudes

Variable Name	Description	column(s)	Format
QNM	Questionnaire number	1-3	F3.0
QTYP	Questionnaire type	4	F1.0
CRDNM	Card number	5-6	F2.0
MD1A	Medical, question 1, part a	7	F1.0
MD1H	Medical, question 1, part h	14	F1.0
MD2I	Medical, question 2, part I	15	F1.0
MD2O	Medical, question 2, part O	21	F1.0
AGGAP	Conditions aggravated by air pollution (l=yes)	22	F1.0
DSAQ	Diseases which could be made worse by air pollution (l=yes)	23	F1.0
PHYDIS	Physical disabilities (l=yes)	24	F1.0
LFPL1 LFPL2	Life more pleasant (not at all=00; to some degree=0l; greatly=l0)	25 26	F1.0 F1.0
DRG1	Spend more on drug items (not at all=00; to some degree=0l; greatly=l0)	27 28	F1.0 F1.0
EASWK1	Make it easier to do your work (not at all=00; to some degree=0l; greatly=l0)	29 30	F1.0 F1.0
NGTRDY	Prefer night or day (l=day; 2=night; 3=no difference)	31	F1.0
SMOKE	Do you smoke (l=yes)	32	F1.0
PACKS	How many packs	33	F1.0
MEDCTN	Do you take medication regularly (l=yes)	34	F1.0
MEDX	Medication expenditures/month	35-37	F3.0
MEDXAP	Medical expenditures associated with air pollution	38-40	F3.0
DR	Yearly doctor’s fees	41-44	F4.0
MEDINS	Yearly payments on medical and life insurance	45-47	F3.0

CARD 71 (CONTINUED)

Variable Name		Column(s)	Format
DEFX	Have you ever purchased any item to reduce your exposure to air pollution? (Such as filter) (1 = yes)	48	F1.0
	Since living in Los Angeles:		
ATT11	I have not been bothered by air pollution. (1 = yes)	49	F1.0
ATT12	I have been somewhat bothered by air pollution. (1 = yes)	50	F1.0
ATT13	I have been bothered by air pollution. (l=yes)	51	F1.0
	Do you believe that air pollution in Los Angeles: (check one)		
ATT21	Has become worse since you have lived here.	52	F1.0
ATT22	Has stayed about the same since you have lived here.	53	F1.0
ATT23	Has gotten better since you have lived here.	54	F1.0
	What do you think should be done about air pollution? (Check one)		
ATT31	Ignored.	55	F1.0
ATT32	Reduced.	56	F1.0
	Rank the following problems in terms of importance (most to least) as the major issues facing the community. (Choose top five.)		
ATT41	Juvenile delinquency.	57	F1.0
ATT42	Communicable disease.	58	F1.0
ATT43	Unemployment.	59	F1.0
ATT44	Air pollution.	60	F1.0
ATT45	Car accidents.	61	F1.0
ATT46	Crime.	62	F1.0
ATT47	Nuclear Energy.	63	F1.0
ATT48	Alcoholism	64	F1.0
ATT49	Water pollution	65	F1.0
ATT410	Energy	66	F1.0
ATT411	Congestion	67	F1.0
ATT412	Other	68	F1.0

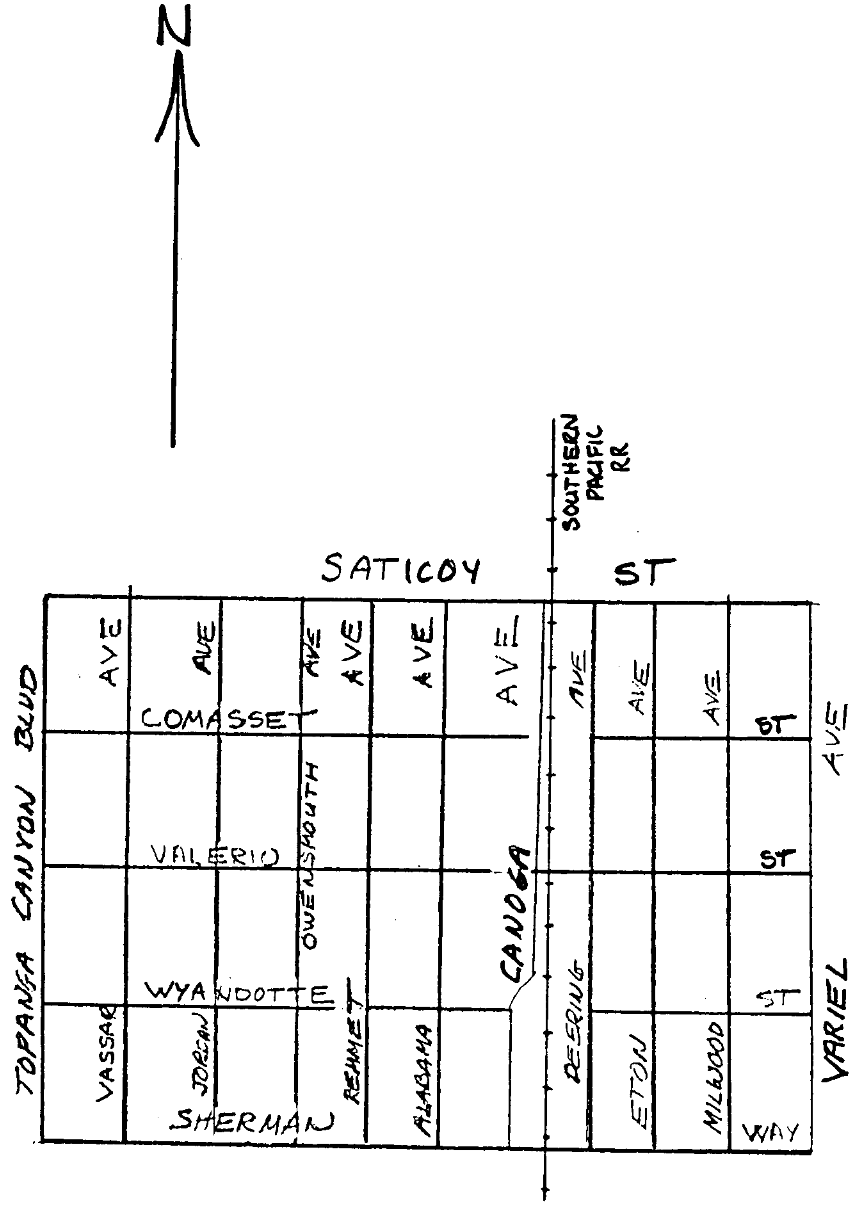
CARD 71 (CONTINUED)

Variable Name		Column (s)	Format
	Do you believe air pollution in the Los Angeles area:		
ATT51	Cannot be reduced below the present level.	69	F1.0
ATT52	Can be reduced below the present-level.	70	F1.0
ATT53	Can be almost completely eliminated.	71	F1.0
	What do you think the words air pollution mean to most people in the Los Angeles area? Do they mean:		
ATT61	Frequent bad smells in the air. (1 = yes; 0 = no)	72	F1.0
ATT62	Too much dirt and dust in the air. (l=yes; 0 = no)	73	F1.0
ATT63	Frequent haze or fog in the air. (1 = yes; 0 = no)	74	F1.0
ATT64	Frequent irritation of the eyes. (1 = yes; 0 = no)	75	F1.0
ATT65	Frequent nose or throat irritations. (1 = yes; 0 = no)	76	F1.0
ATT66	Other.	77	F1.0
ATT7	Have you read or seen anything in the newspaper recently about air pollution? (1 = yes; 0 = no)	78	F1.0
ATT8	When you read the newspaper, do you generally choose to read articles on air pollution? (1 = yes; 0 = no)	79	F1.0
ATT9	Do you consult the daily air pollution index before engaging in any activities? (1 = yes; 0 = no)	80	F1.0

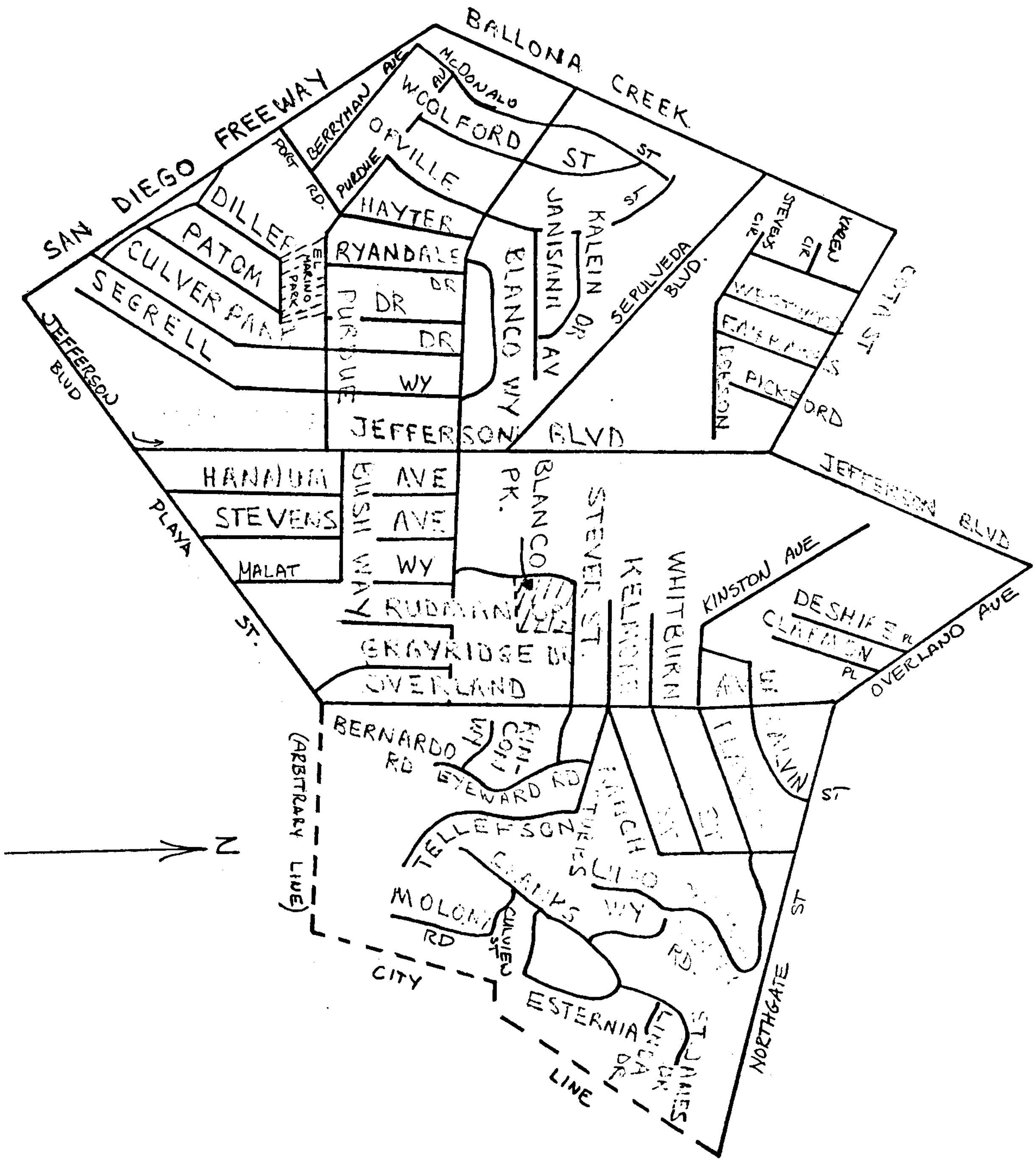
APPENDIX F

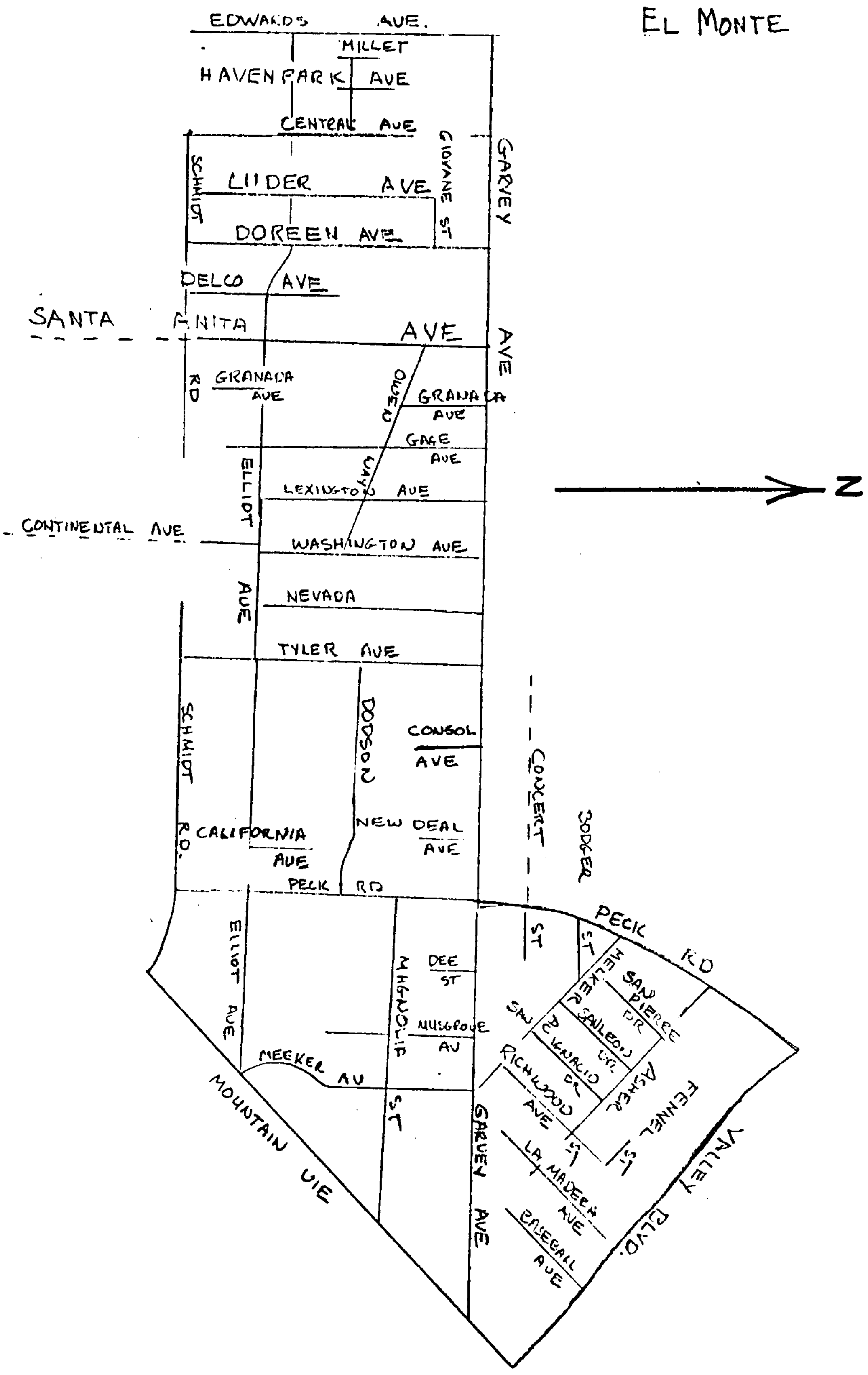
This appendix details the actual streets in the paired areas from which the respondent sample was drawn.

CANOGA PARK

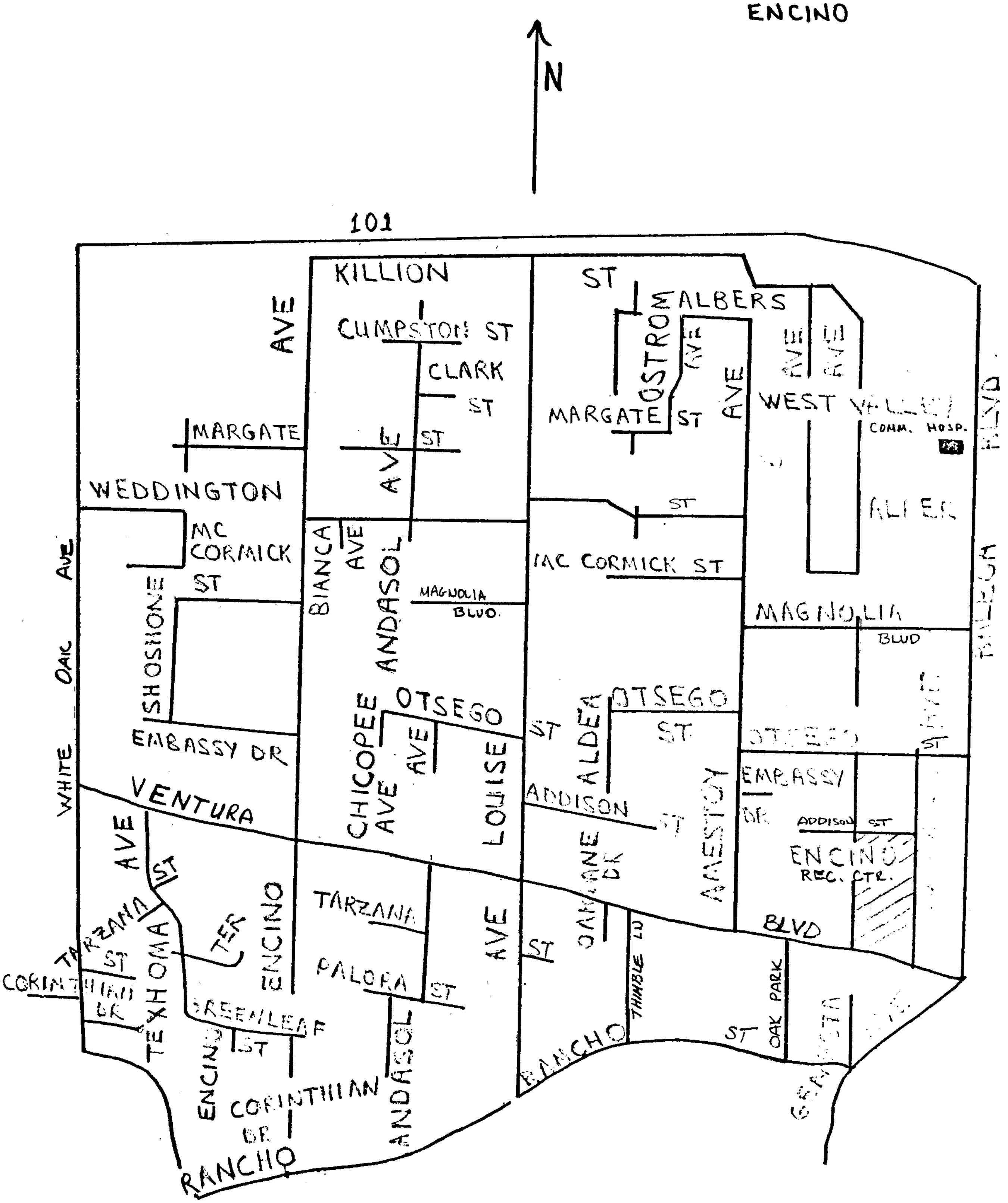

N
SOUTHERN PACIFIC RR
SATICOY ST
AVE
AVE
AVE
AVE
AVE
AVE
AVE
AVE
AVE
COMASSET
ST
VALERIO
ST
WYANDOTTE
ST
SHERMAN
WAY
TOPANGA CANYON BLVD
VASSAR
JORDAN
OWENSMOUTH
REMMET
ALABAMA
CANOGA
DEERING
ETON
MILLWOOD
VARIEL
AVE

CULVER CITY

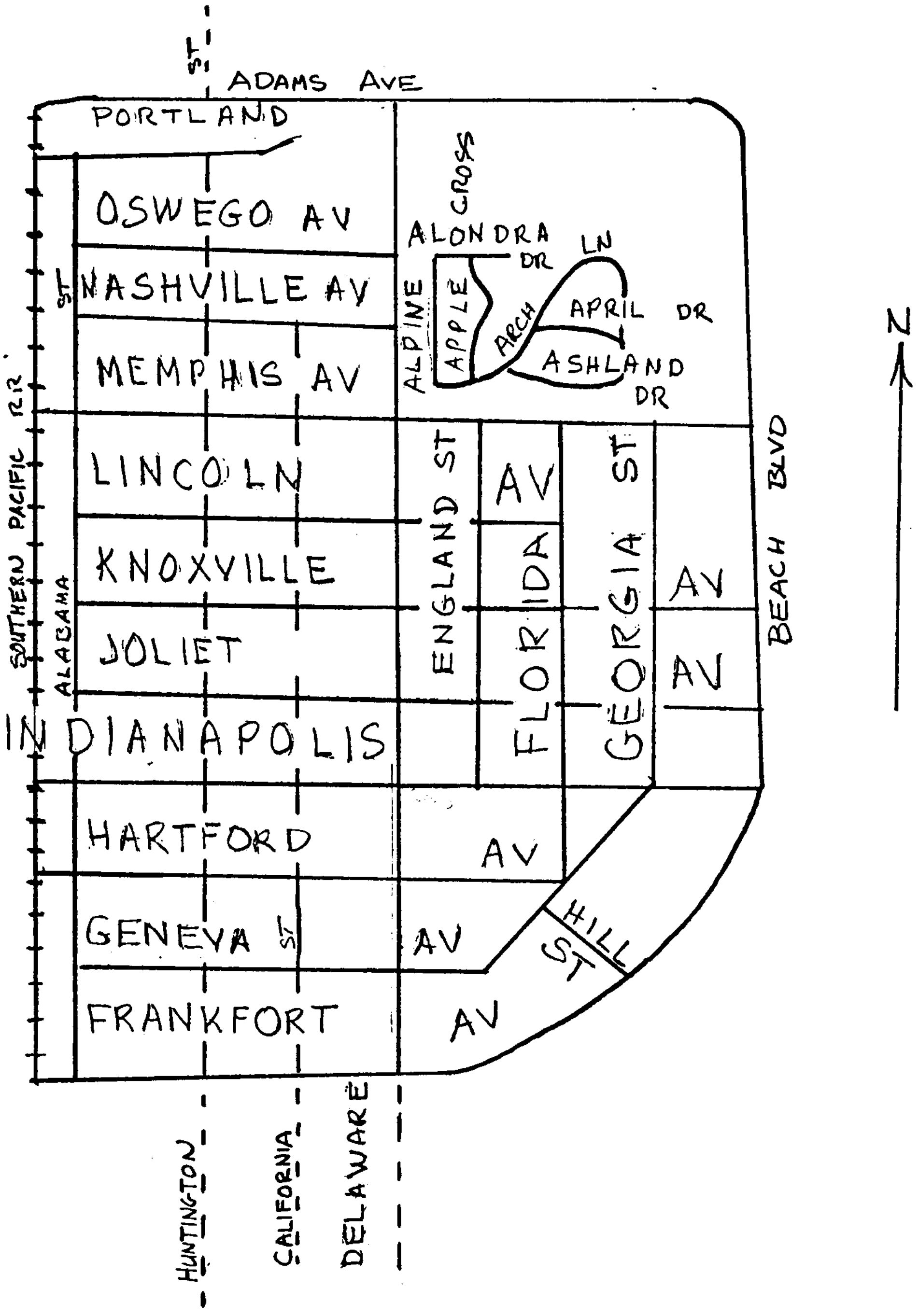

BALLONA CREEK
SAN DIEGO FREEWAY
BERRYMAN AVE
McDONALD AV
WOOLFORD ST
ST
ST
PORT RD.
PURDUE
ORVILLE
HAYTER
DILLER
PATOM
CULVER PARK
SEGRELL
EL MARINO PARK
RYANDALE DR
PURDUE
DR
DR
WY
BLANCO WY
JANISANN AV
KALEIN DR
SEPULVEDA BLVD.
STEVENS CIR
CIR
KREUJ
COTA ST
WESTWOOD
FAIRBANKS
DICKSON
PICKFORD
JEFFERSON BLVD
JEFFERSON BLVD
JEFFERSON BLVD
HANNUM AVE
STEVENS AVE
MALAT WY
BUSH WAY
BLANCO PK.
RUDMAN
GRAYRIDGE DR
OVERLAND
STEVER ST.
KELMORE
WHITBURN
KINSTON AVE
DESHIRE PL
CLARMON PL
OVERLAND AVE
AVE
PLAYA ST.
BERNARDO RD
WY
RINCON
EYEWARD RD
TELLEFSON
THIES
ENTCH
ST
ST
MELVIN ST
CRANKS WY
LIBO
RD.
MOLONY RD
CULVIEW ST
ESTERNIA
LINDA DR
ST JAMES
NORTHGATE ST
CITY LINE
(ARBITRARY LINE)
N

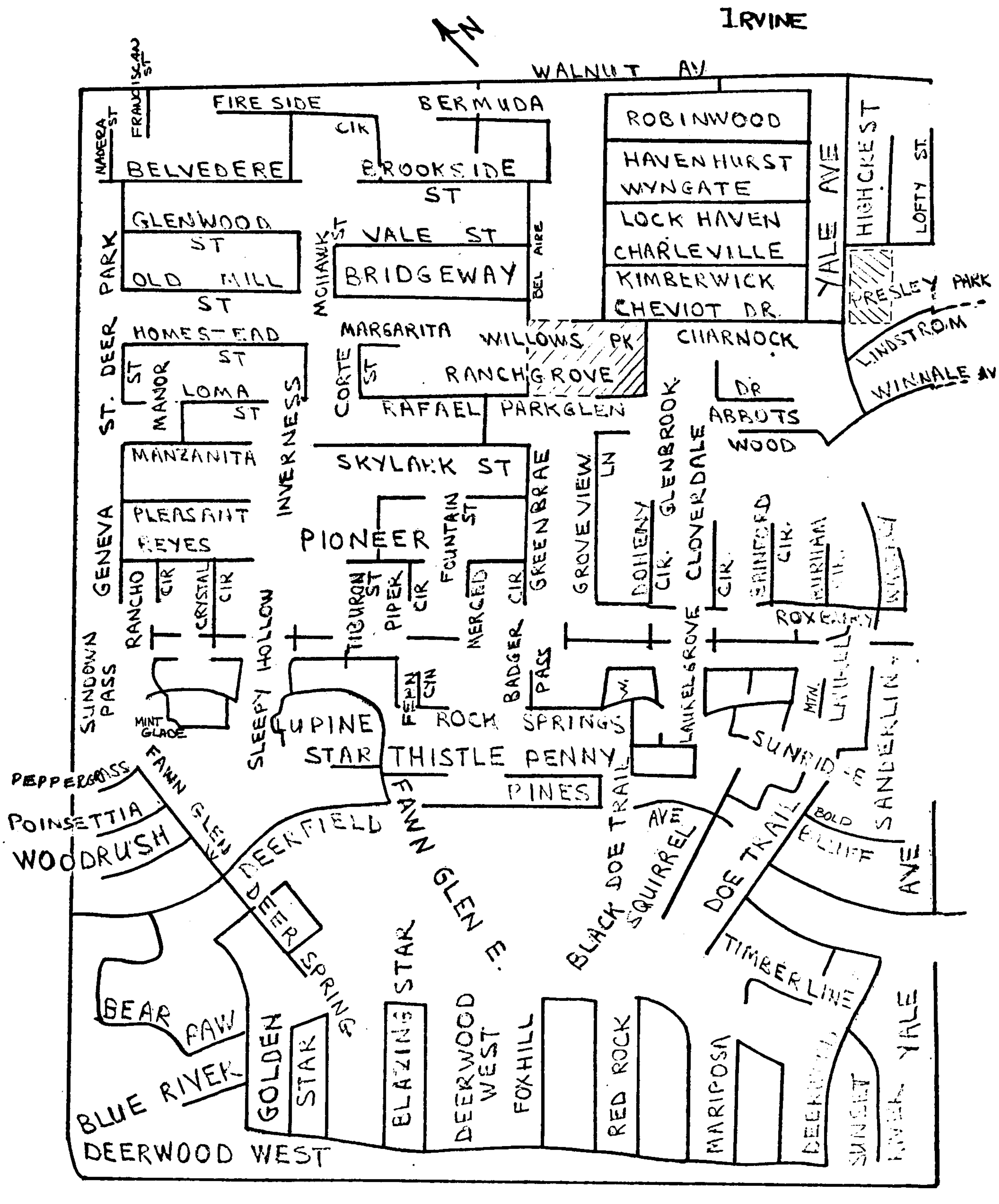

EL MONTE
EDWARDS AVE.
MILLET
HAVENPARK AVE
CENTRAL AVE
GIOVANE ST
GARVEY
SCHMIDT
LIDER AVE
DOREEN AVE
DELCO AVE
SANTA ANITA AVE
AVE
RD
GRANADA AVE
OWEN
GRANADA AVE
GAGE AVE
ELLIOT
WAY
LEXINGTON AVE
N
CONTINENTAL AVE
WASHINGTON AVE
AVE
NEVADA
TYLER AVE
SCHMIDT
DODSON
CONSOL AVE
CONCERT
BODGER
RD.
CALIFORNIA AVE
NEW DEAL AVE
PECK RD
PECK RD
ST
ST
ELLIOT AVE
MAGNOLIA
DEE ST
MELKER
SAN PIERRE DR
SAILEON ST.
SAN IGNACIO DR
ASHER
MUSGROVE AV
RICHWOOD AVE
FENNEL ST
MEEKER AV
ST
ST
MOUNTAIN VIE
GARVEY AVE
LA MADERA AVE
VALLEY BLVD.
BASEBALL AVE

ENCINO

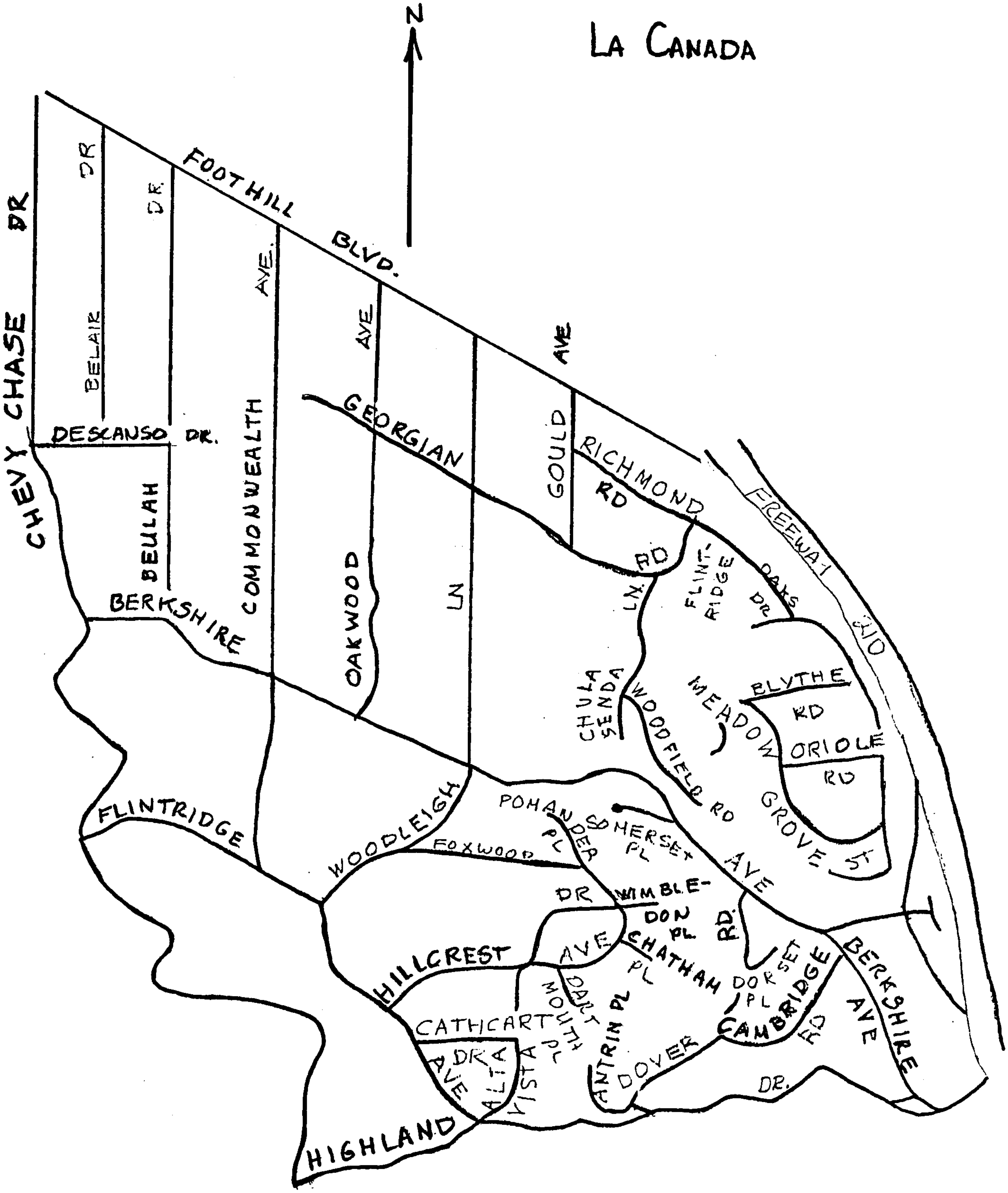

N
101
KILLION
ST
ALBERS
AVE
CUMPSTON ST
CLARK
ST
OSTROM
AVE
AVE
AVE
AVE
WEST VALLEY
COMM. HOSP.
BLVD
MARGATE
ST
MARGATE
ST
AVE
WEDDINGTON
ST
MC CORMICK
ST
BIANCA
AVE
ANDASOL
MAGNOLIA
BLVD.
MC CORMICK ST
MAGNOLIA
BLVD
BALBOA
SHOSHONE
OAK
WHITE
AVE
OTSEGO
CHICOPEE
AVE
AVE
LOUISE
ST
ALDEA
OTSEGO
ST
OTSEGO
AVE
ST
EMBASSY DR
ADDISON
ST
EMBASSY
DR
ADDISON ST
AMESTOY
ENCINO
REC. CTR.
VENTURA
BLVD
AVE
ST
TARZANA
TER
ENCINO
TARZANA
PALORA
ST
AVE
ST
OAKDALE
DR
THIMBLE LN
OAK PARK
ST
TARZANA
ST
CORINTHIAN
DR
TEXHOMA
GREENLEAF
ENCINO
ST
CORINTHIAN
DR
ANDASOL
RANCHO
RANCHO
GENESTA

HUNTINGTON BEACH

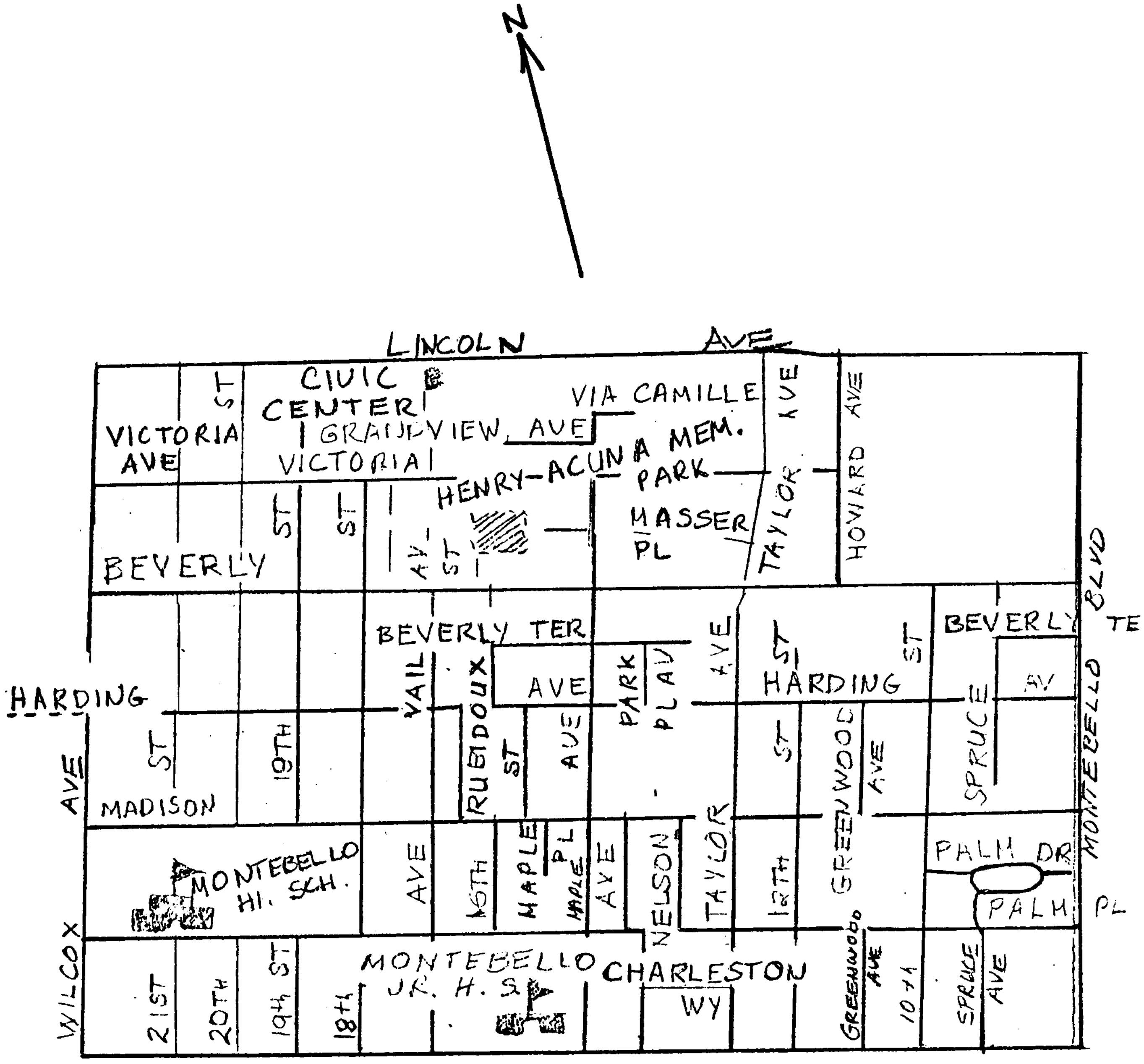



N
IRVINE
WALNUT AV
FRANCISCAN ST
NADEERA ST
FIRE SIDE
CIR
BERMUDA
BELVEDERE
BROOKSIDE
ST
ROBINWOOD
HAVENHURST
WYNGATE
LOCK HAVEN
CHARLEVILLE
KIMBERWICK
CHEVIOT DR
YALE AVE
HIGHCREST
LOFTY ST
PRESLEY PARK
LINDSTROM
WINNALE AV
GLENWOOD
ST
OLD MILL
ST
MOHAWK ST
VALE ST
BRIDGEWAY
BEL AIRE
PARK
HOMESTEAD
ST
MARGARITA
WILLOWS PK
CHARNOCK
DR
ST. DEER
ST
MANOR
LOMA
ST
INVERNESS
CORTE ST
RANCH GROVE
RAFAEL
PARKGLEN
GLENBROOK
ABBOTS
WOOD
MANZANITA
SKYLARK ST
GROVEVIEW
LN
CLOVERDALE
PLEASANT
REYES
PIONEER
FOUNTAIN ST
FOUNTAIN
GREENBRAE
DOHENY
CIR.
CIR.
BRINEFORD
CIR.
DURHAM
GENEVA
RANCHO
CIR
CRYSTAL
CIR
SLEEPY HOLLOW
TIBURON ST
PIPER
CIR
MERCED
CIR
BADGER PASS
LAUREL GROVE
ROXEBURY
SUNDOWN PASS
MINT GLADE
FERN CIR
ROCK SPRINGS
W.
MTN. LAUREL
SANDERLING
LUPINE
STAR
THISTLE
PENNY
PINES
SUNRIDGE
PEPPERGRASS
FAWN GLEN
POINSETTIA
WOODRUSH
DEERFIELD
FAWN GLEN E.
BLACK DOE TRAIL
AVE
SQUIRREL
DOE TRAIL
BOLD
BLUFF
AVE
DEER
SPRING
STAR
TIMBERLINE
BEAR PAW
GOLDEN
STAR
BLAZING
DEERWOOD WEST
FOXHILL
RED ROCK
MARIPOSA
DEERWOOD
SUNSET
RIVER
YALE
BLUE RIVER
DEERWOOD WEST

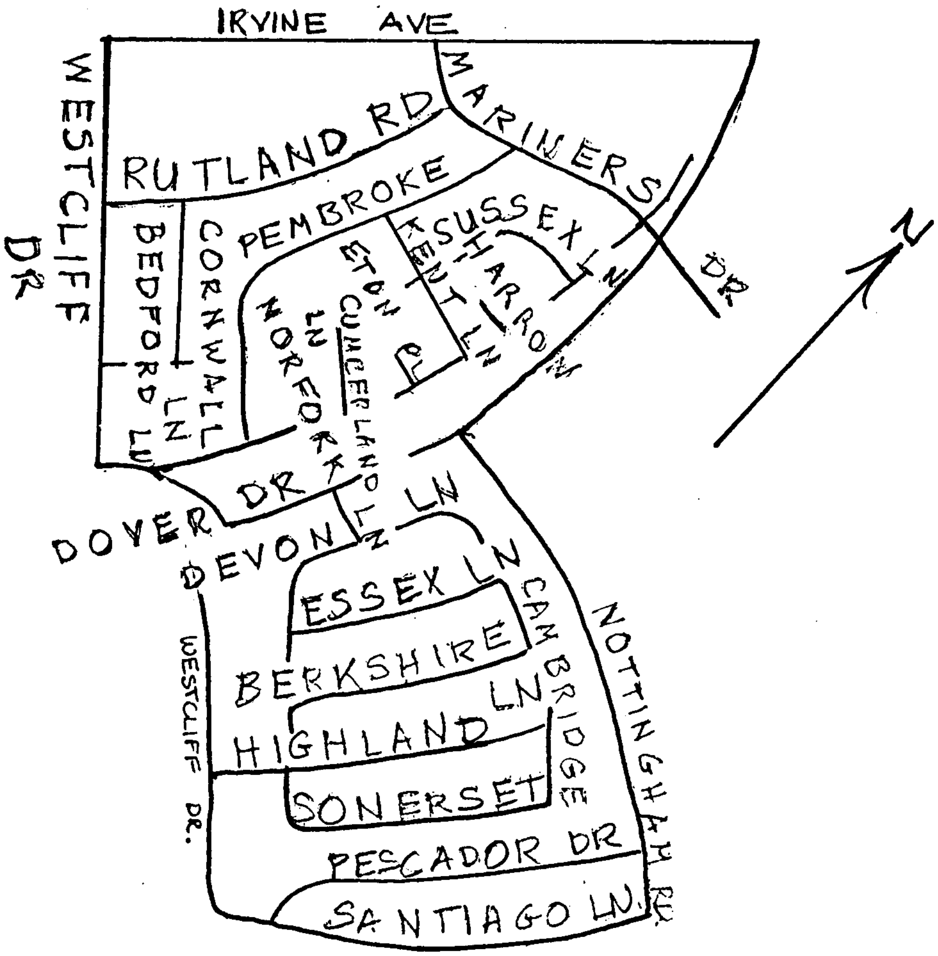
LA CANADA


N
FOOTHILL BLVD.
CHEVY CHASE DR
BELAIR DR
DR
COMMONWEALTH AVE.
AVE
AVE
DESCANSO DR.
BEULAH
GEORGIAN
GOULD
RICHMOND RD
RD
LN.
OAKWOOD
LN
FLINT-RIDGE
OAKS DR
FREEWAY 210
BERKSHIRE
CHULA SENDA
WOODFIELD RD
MEADOW GROVE ST
BLYTHE RD
ORIOLE RD
FLINTRIDGE
WOODLEIGH
POHANDER PL
SOMERSET PL
AVE
FOXWOOD
DR
WIMBLEDON PL
RD.
HILLCREST AVE
CHATHAM PL
DORSET PL
CAMBRIDGE RD
BERKSHIRE AVE
CATHCART DR
DARTMOUTH PL
ANTRIM PL
VISTA
ALTA AVE
DOVER DR.
HIGHLAND

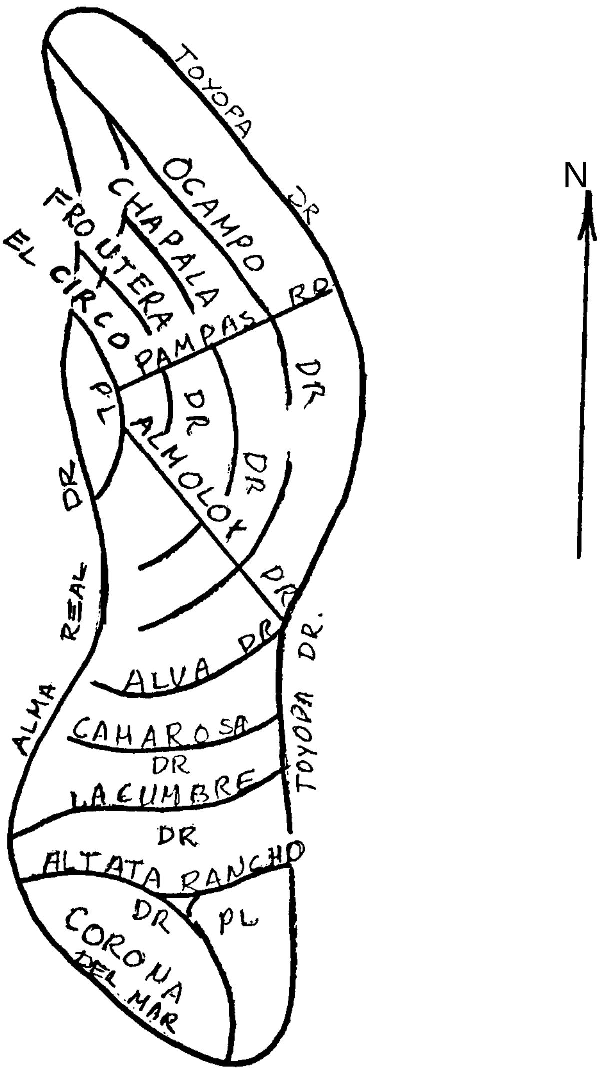
MONTEBELLO


N
LINCOLN AVE
CIVIC CENTER
VIA CAMILLE
GRANDVIEW AVE
VICTORIA AVE
VICTORIA
HENRY-ACUNA MEM. PARK
MASSER PL
TAYLOR AVE
HOWARD AVE
BEVERLY
ST
ST
ST
AV
ST
BEVERLY TER
BEVERLY TE
BLVD
HARDING
VAIL
RUBIDOUX
AVE
PARK
PL AV
AVE
HARDING
ST
ST
AV
ST
19TH
ST
AVE
GREENWOOD
AVE
SPRUCE
MONTEBELLO
AVE
MADISON
MONTEBELLO HI. SCH.
AVE
16TH
MAPLE
PL
MAPLE
AVE
NELSON
TAYLOR
12TH
GREENWOOD
PALM DR
PALM PL
WILCOX
21ST
20TH
19th ST
18th
MONTEBELLO JR. H. S.
CHARLESTON WY
GREENWOOD AVE
10TH
SPRUCE AVE

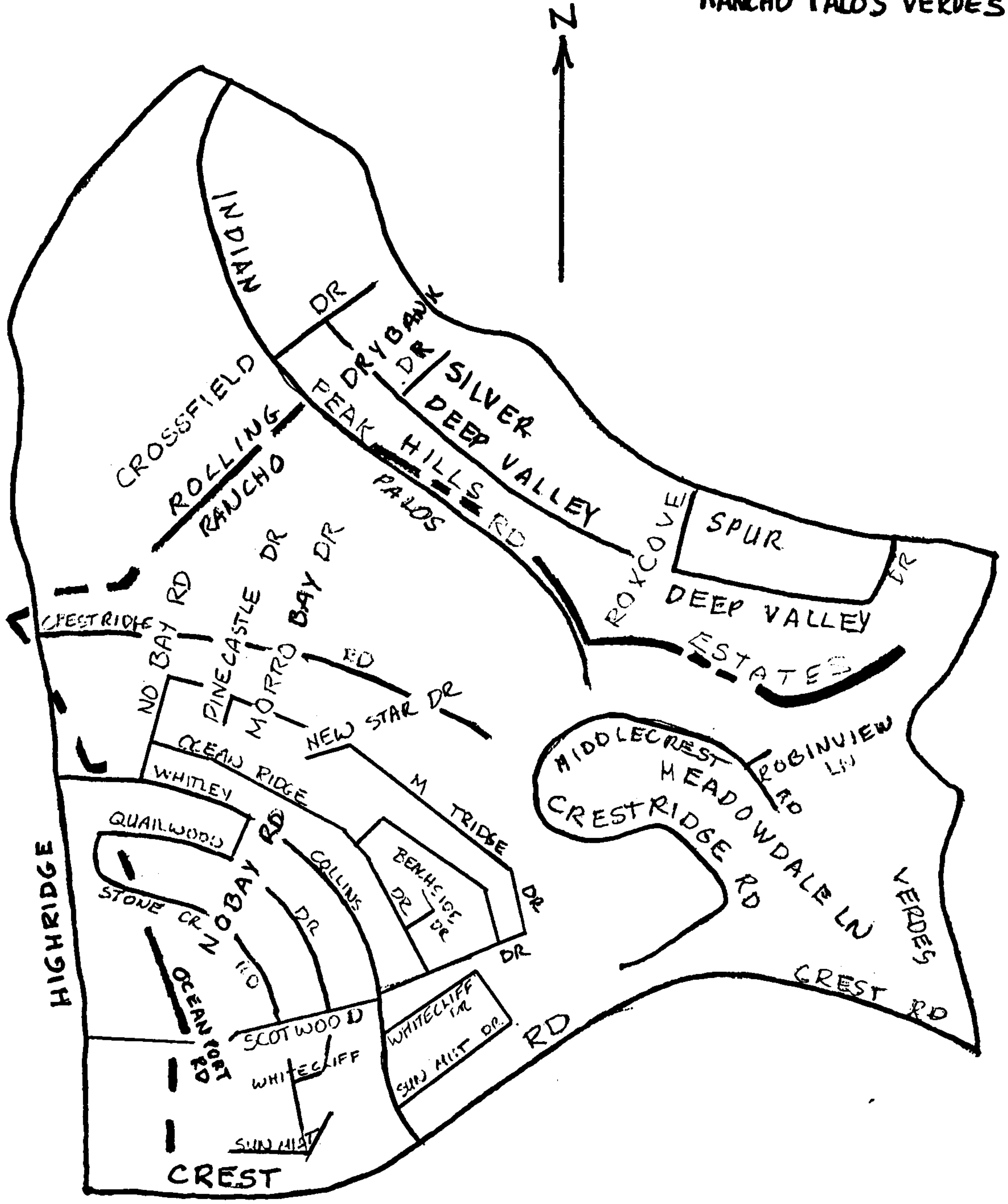
NEWPORT BEACH



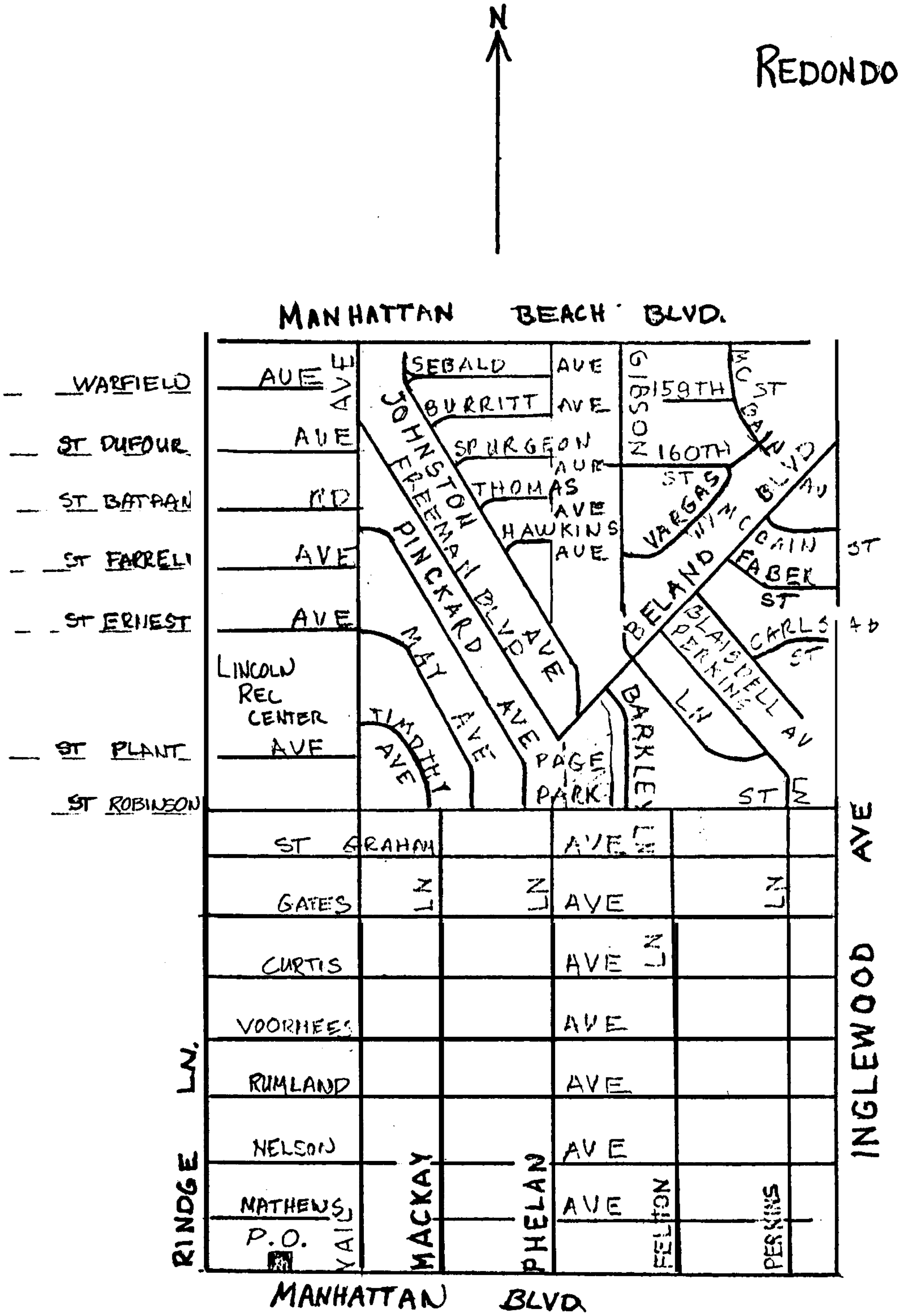
PACIFIC PALISADES



RANCHO PALOS VERDES



REDONDO BEACH



REFERENCES

Ajzen, I. and Fishbein, M., "Attitude-Behavior Relations: A Theoretical Perspective and Review of Empirical Research," Psychological Bulletin 84 (1977) 888-918.

Anderson, R.J., Jr. and Crocker, T.D. (1971), "Air Pollution and Residential Property Values," Urban Studies 8, 1971-180.

Babb, E.M., and Scherr, B.A. (1975), "Pricing Public Goods: An Experiment with Two Proposed Pricing Systems," Public Choice 23; 35-48.

Bayes, T., "An Essay Towards Solving a Problem in the Doctrine of Chances," in The Royal Society, Philosophical Transactions, Giving Some Account of the Present Undertakings, Studies, and Labours of the Ingenious in Many Considerable Parts of the World for the Year 1763, London: The Royal Society (1765).

Blank, F., et. al., "Valuation of Aesthetic Preferences: A Case Study of the Economic Value of Visibility," Research Report to the Electric Power Research Institute, Resource and Environmental Economics Laboratory, University of Wyoming (1977).

Bohm, P. (1971), "An Approach to the Problem of Estimating Demand for Public Goods," Swedish Journal of Economics 73.

Bohm, P. (1972), "Estimating Demand for Public Goods: An Experiment," European Economic Review 3; 111-130.

Bradford, D.F., "Benefit-Cost Analysis and Demand Curves for Public Goods," Kyklos, Vol. 23 (1970).

Brookshire, D., et. al., "The Valuation of Aesthetic Preferences," Journal of Environmental Economics and Management, Vol. 3 (1976).

Brookshire, D.S. and Crocker, T.D., "The Use of Survey Instruments in Economic Valuations of Environmental Goods," Paper #2, Resource and Environmental Economics Laboratory, University of Wyoming (1978).

Brookshire, D.S., and Eubanks, L.S., "Contingent Valuation and Revealing the Actual Demand for Public Environmental Commodities," Paper Presented at Public Choice Society, New Orleans, La. , 1978. Forthcoming in Proceedings.

Brookshire, D.S., and Randall, A.J., "Public Policy Alternatives, Public Goods and Contingent Valuation Mechanisms," Paper presented at the Western Economic Association Meeting, Honolulu, Hawaii, 1978.

Brookshire, D.S., and Randall, A., et. al., "Economic Valuation of Wildlife," Final report for U.S. Fish and Wildlife Service, Phase I, Resource and Environmental Economics Laboratory, University of Wyoming, (November 8, 1977).

Clark., E.. H.. (1971), "Multipart Pricing of Public Goods, " Public Choice 11, 17-33.

Classon, M. and Knetsch, J. L., (1966], Economics of Outdoor Recreation, Johns Hopkins: Press: Baltimore.

Crocker, T. , "National and Regional Models for the Estimation of Recreational Benefits Accruing from PL 92-500," Research Paper No. 126, Department of Economics, University of Wyoming (1975).

Davis, R. (1963), "Recreation Planning as an Economic Problem," Natural Resources Journal 3.

Davis, R.K. and Knetsch, J.L. (1966), "Comparisons of Methods for Recreation Evaluation" in Water Research, A. V. Kneese and S.C. Smith (.eds.), Johns Hopkins Press: Baltimore.

Deyak, T.A. and V.K. Smith, "Residential Property Values and Air Pollution: Some New Evidence," Quarterly Review of Economics and Business 14(4), (1978), 93-100.

Diewert, W.E., "Applications of Duality Theory," in M.D. Intriligator and D.A. Dendrick (eds.), Frontiers of Quantitative Economics, Vol. II, Amsterdam: North Holland Publishing Co. (1974), 106-160.

Freeman, A.M., III (1974), "On Estimating Air Pollution Control Benefits from Land Value Studies," Journal of Environmental Economics and Management 1, 74-83.

Fromm, G., "Comment," in S.B. Chase, Jr. (ed.) Problems in Public Expenditure Analysis, Brookings Institution, Washington, D.C., 166-176 (1968].

Goldberger, A.S., A Review of Consumer Demand Theory, Social Systems Research Institute, University of Wisconsin-Madison, Systems Formulation, Methodology, and Policy Workshop Paper 6703 (Oct. 1967).

Hall, R., "The Specification of Technology with Several Kinds of Output," Journal of Political Economy 81 (1973), 387-398.

Hammack, J. and Brown, G.M., Waterfowl and Wetlands: Toward Bioeconomic Analysis, Baltimore: Johns Hopkins University Press (1974).

Harrison, D., Jr. and D.L. Rubinfeld, "Hedonic Housing Prices and the Demand for Clean Air," Journal of Environmental Economics arid Management 5 (.1978) , 81-102.

Hicks, J.R., "A Reconsideration of the Theory of Value," Part 1, Economica 1 (Feb. 1934), 52-76.

Hori, H., "Revealed Preferences for Pubic Goods," American Economic Review, vol. 65 (1975].

Horst, R., Jr. (1978), Estimation of the Value of Visibility Through Application of the Expenditure Function, unpublished Ph.D. dissertation, University of Wyoming.

Hurwicz, L., “On the Problem of Integrability of Demand Functions,” in J. Chipman, et. al. (eds.), preferences, Utility and Demand, New York: Harcourt Brace Iovanovich, Inc. (1971), 174-214.

Johansen, L. (1977), “The Theory of Public Goods: Misplaced Emphasis?” Journal of Public Economics 7, 147-152.

Knetsch, J.L. (1963), “Outdoor Recreation Demands and Benefits,” Land Economics.

Kurz, M. (1974), “Experimental Approach to the Determination of the Demand for Public Goods,” Journal of Public Economics 3, 329-348.

Lancaster, K.J., “A New Approach to Consumer Theory,” Journal of Political Economy 74 (1966), 132-157.

Lave and Nagin, “Automobile Related Air Pollutants and Health," REF Working Paper No. 52-73-74.

Lucas, R.C., “Wilderness Perception and Use: The Example of Boundry Waters Canoe Area,” Natural Resources Journal 3 (3), 1964, 394.

Lucas, R.E.B., “Hedonic Price Functions,” Economic Inquiry 13(2), 1975, 157-178.

Mäler, K. (1974), Environmental Economics: A Theoretical Inquiry, Johns Hopkins Press: Baltimore.

Mishan, E.J. (1971), Cost-Benefit Analysis: An Introduction, Praeger Publishers: New York.

Muellbauer, J., “Household Production Theory, Quality, and the Hedonic Technique,” American Economic Review, Vol. 64 (1974).

Pearse, P.H., “A New Approach to the Evaluations of Non-Priced Recreational Resources,” Land Economics, 44 (February, 1968).

Pollak, R., and Wachter, M., “The Relevence of the Household Production Functions and Its Implications for the Allocation of Time,” Journal of Political Economy 83 (1975), 255-277.

Raiffa, H., Decision Analysis, Reading, Mass.: Addison-Wesley (1970).

Randall, A., et. al., “Bidding Games for Valuation of Aesthetic Environmental Improvements,” Journal of Environmental Economics and Management, Vol 1 (1974).

Randall, A., *et. al.*, *Estimating Environmental Damages from Surface Mining of Coal in Appalachia: A Case Study,* U.S. Environmental Protection Agency, EPA-600/2-78-003, Jan. 1978.

Randall, A., "Evaluating Non-Market Goods and Services: Some Conceptual Considerations,” presented to the Symposium on Evaluation of Non-Market Goods at the Annual Meetings of the American Agricultural Economics Association, San Diego, California (July 31-August 3, 1977).

Randall, A.: Ives, B.: and Eastman, E., “Bidding Games for-Valuation of Aesthetic Environmental Improvements,” *Journal of Environmental Economics and Management* 1 (1974a) 132-149.

______________ “Benefits of Abating Aesthetic Environmental Damage from the Four Corners Power Plant, Fruitland, New Mexico,” Bulletin 618, New Mexico Agricultural Experiment Station, Las Cruces (1974b).

Randall, A. and Stoll, J., “Consumer’s Surplus in Commodity Space,” Working paper, Department of Agricultural Economics, University of Kentucky (1978).

Ridker, R.B. and Henning, J.A. (1967), “The Determinants of Residential Property Values with Special Reference to Air Pollution,” *Review of Economics and Statistics* 49, 246-257.

Roberts, E.M., et. al., “Visibility Measurement in the Painted Desert through Photographic Photometry,” *Domes and Moore Engineering Bulletin* No. 47 (1974).

Rosen, S., “Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition,” *Journal of Political Economy,* Vol. 82 (1974).

Samuelson, P.A., “The Problem of Integrability in Utility Theory,” *Economica* 17 (1950), 355-385.

Samuelson, P.A., “The Pure Theory of Public Expenditures,” *Review of Economics and Statistics,* 36 (November, 1954).

Samuelson, P., “Diagrammatic Exposition of a Theory of Public Expenditure,” *Review of Economics and Statistics* 37 (Nov. 1955), 350-356.

Schulze, W.D. and d’Arge, R.C., “On the Valuation of Recreation Damages,” prepared for the Joint Session between the American Economic Association and the Association of Environmental and Resource Economists, New York (December 28, 1977).

Steele, W.J., “The Effect of Air Pollution on Value of Single Family Owner-Occupied Residential Property in Charleston, South Carolina,” Masters Thesis, Clemson University (1972)

Thayer, M. and Schulze, W., "Valuing Environmental Quality: The Contingent Substitution and Expenditure Approach," unpublished manuscript. (1977).

U.W. Bureau of the Census, Census of Population and Housing: 1970, Census Tract Final Report.

Wieand, K.F., "Air Pollution and Property Values: A Study of the St. Louis Area," Journal of Regional Science, Vol. 13, April 1973, 91-95.