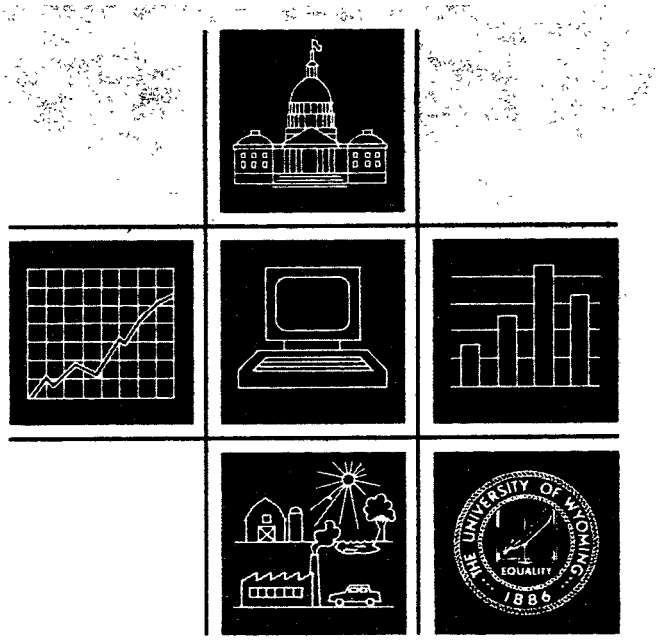
The Institute for Policy Research



. . . addressing public policy issues for the ‘80’s.

Volume II

EXPERIMENTAL APPROACHES FOR VALUING ENVIRONMENTAL COMMODITIES

DISCLAIMER

Although prepared with EPA funding, this report has neither been reviewed nor approved by the U.S. Environmental Protection Agency for publication as an EPA report. The contents do not necessarily reflect the views or policies of the U.S. Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER I

OVERVIEW

A. INTRODUCTION

This study is a final report for research conducted under a grant from the U.S. Environmental Protection Agency (EPA)[1] concerning "Methods Development in Measuring Benefits of Environmental Improvements." This study replaces and extends earlier draft reports submitted to the EPA as a part of the Methods Development research project.[2]

The Methods Development project was intended to focus primarily on the development and assessment of the Contingent Valuation Method, referred to hereafter as CVM (or CV for contingent valuation), as a means for estimating social benefits attributable to environmental improvements. The CVM involves a process whereby individuals--study participants--are asked to place values on specific environmental improvements within the context of a contingent market. Valuations offered by study participants are referred to as a "bid" for the environmental improvement; the specified environmental improvement is referred to as an environmental "commodity," or the CV commodity. The study participant "sees"--has described to him/her--a particular good or service and is asked to offer a bid for this commodity which represents his/her maximum willingness to pay for that commodity; in some cases, a process of continuous bidding takes place as a part of the CVM.

Interest in the CVM as a means for valuing environmental commodities arises from the nature of such commodities: actual markets do not exist for these commodities and, therefore, market values which reflect social values do not exist for these commodities. The essence of the CVM is that of simulating market conditions, thereby deriving measures that are akin to those observed in actual markets.

Inasmuch as values derived from the CVM are for contingent claims in a hypothetically specified state of the world to a specific environmental commodity, and given that bids are not in fact "paid"--payments of CV bids are hypothetical in nature--a number of questions arise as to how meaningful or reliable CV measures can be vis-a-vis "true" social values attributable to environmental improvements. Of course, these questions, which are discussed below in some detail, provide the raison d'etre for this study. Before turning attention to the purposes of this study, however, brief mention is warranted of two issues: the relationship of this study to earlier, draft reports and, secondly, the authors' intentions for the Overview section of this report.

In a final report, one generally finds little more than a "cleaning up" of the data and presentations given in draft reports. Such is not the case here. Basic to the Methods Development project has been a heuristic process: discovery, learning, efforts intended to provide data and insights which might guide further investigation. This process has continued through the preparation of the final report. Thus, in earlier reports concerning research progress, expositional emphasis was given to the manner in which individuals must search their preferences in arriving at meaningful contingent values. As the authors have attempted to push the discovery process further, it has become evident that experiments related to "preference research" have broader implications of importance for the validation of CV measures: they provide means by which CV responses can be compared with observed, or deduced, market-related responses which reflect the preference research process. In this final report, therefore, concern with market comparisons replaces--subsumes--our earlier studies' concern with preference research per se. As a further example, in earlier progress reports expositional emphasis was given to possible relationships between how a commodity was defined--specified--and the level of aggregation implicit to a given commodity. As the learning/discovery process has continued, considerable progress was made in understanding and clarifying these relationships. The critical importance of distinguishing between many types of aggregation became manifest. The parallel between Lancaster-type "attributes" of goods and ends soughts in specifying CV commodities, and the potential of this parallel for providing criteria for "specificity," became well understood, Thus, this final report includes the authors' "final" efforts to shape and improve the logic underlying hypotheses design and data interpretation.

All of the above is intended to encourage readers of earlier, draft reports concerning the Methods Development project to consider the final report in a different light from the usual: the effects of restructuring data and hypotheses in the final report provide, in many cases, insights as to the workings of the CVM that may be as important for cur understanding of the method as "new" experimental results.

Finally, the Overview section of this report is designed to provide the reader with more than simply a comprehensive summary of results from all experiments in the Methods Development project. In addition to a report of research accomplishments, discussions will be given to non-accomplishments. This is to say that the efforts to respond to a given set of questions/issues concerning the CVM, the authors have encountered still more issues and questions which were unrecognized or obscure at the time that the project was initiated. Thus, for a report on experimental, heuristic research such as this study, an open discussion of unresolved issues which remain as (often, frustrating) challenges to researchers concerned with the CVM will hopefully be of interest to the reader. Therefore, the Overview section is lengthy. It is hoped that the readers patience in this regard will be rewarded by a comprehensive grasp of the lessons learned by the authors as those lessons related to an assessment of the CVM's potential for serving as 2 method for valuing environmental improvements.

A.1 Purpose of the Study

As suggested above, the purpose of the Methods Development project is that of developing and assessing the CVM as a means for estimating benefits attributable to environmental improvements. By "development" reference is made to heuristic inquiry as to methods for obtaining CV values, problems encountered in framing CV instruments, and methods for assessing and validating CV measures as meaningful measures of society's willingness to pay for environmental improvements. To these ends, a group of experiments (described below in sub-section A.2) is designed in efforts to address the following, four sets of issues.

Validation Issues. Three methods which are relevant for efforts to validate CV measures are developed and applied in this study. The first method involves comparisons of CV measures for the value of an environmental improvement (reduced ozone concentrations in the Los Angeles, California area) with those derived by the Hedonic Price (Property Value) method.

The second effort to validate CV measures involves tests of heuristic hypotheses based on individual market behavior deduced from received economic theory as well as from observed behavior in auction settings. Thus, in an auction setting, an individual's valuation for a commodity (or service) to be auctioned may, initially, be imprecisely defined in terms of a maximum willingness to pay. A low, initial bid is offered for at least two reasons: rent (or consumer surplus) is maximized by paying the lowest possible price; secondly, an individual's initial preference search may only define a range of values "appropriate" for the good in question; only as the auction--bidding--proceeds does it become necessary for the process of preference research to focus sharply on a maximum willingness to pay. This is not to deny the possibility that some individuals may initially determine their maximum willingness to pay; however, this value is made manifest only through the bidding process. Thus, one market-like test draws on the analogy between the valuation process observed in the auction setting and that relevant for valuing environmental commodities within the context of a contingent market. At issue in the test are heuristic hypotheses related to the question: is individual behavior in the CVM consistent with behavior observed in auction settings?

It should be noted that the notion of consumer uncertainty as to his/her valuation of any given commodity may not be limited to the auction setting, nor is it new in the economics literature. In 1936 Georgescu-Roegin introduced the concept of a "demand penumbra,"[3] which he more recently defines as "...a stochastic distribution of the quantity demanded at every price."[4] Georgescu-Roegin argues that consumers are imperfect as decision (choice) making instruments--that choices are made stochastically. The existence of thresholds in utility comparisons results in a range of indeterminateness vis-a-vis an individuals choice of the quantity desired of a good, given the goods' price.[5] Thus, the arguments given above represent the "inverse" of Georgescu-Roegins' arguments concerning the demand penumbra: there exists a range of indeterminateness

vis-a-vis an individual's price (valuation) of a good, given the "quantity" (extent of environmental change) of the good.

Another market-related test of CV measures draws from the theory of consumer behavior. From received theory, individual valuations of goods and services reflect a consideration of trade-offs imposed by a budget constraint--additional purchases of any one commodity implies, with fixed income-- lesser purchases of some other commodity(s) (or reduced savings). At issue in this market-related test then are hypotheses directed at the question: In offering CV bids, are individual cognizant of reduced expenditures on other, private, market goods implied by the budget constraint?

A third, and final, market-related test of CV measures again draws on received theory of consumer behavior. Given an individuals' allocation of income across a fixed consumption set, axiomatic behavioral responses to a change in the consumption set exist. Thus, given that consumption sets are altered, there also exists a basis for designing testable hypotheses to look for market-consistent behavior of individuals (in offering contingent values for an environmental good). In these regards, experiments are then conducted where consumption sets are altered via the introduction of other environmental and public goods. The effects of such alterations on contingent values provide data for hypothesis testing as to effects which are consistent with market behavior.

The third method used in this study in efforts related to the validation issue involves analyses of preference effects on CV measures. Thus, based on a priori reasoning one can deduce the expected relationship between CV measures and the characteristics of study participants. Characteristics of interest include household income, whether or not children are in the household, education, etc. Hypotheses relating bids to characteristics are tested in efforts to assess the consistency of CV values with preference-related characteristics which are deduce a priori.

Aggregation Issues. The second set of issues considered in this study relate to aggregation. There are many kinds of aggregation which may be relevant for assessments of the CVM; in this regard, the following, four classes of aggregation warrant mention.

(1) Aggregation over "attributes." Following Lancaster,[6] any good X can be described in terms of a vector of utility-satisfying attributes Y_i, $X : (Y_1, \ldots, Y_n)$. Attributes of the commodity "a house" may include: bedrooms, bathrooms, security, prestige, as well as site-specific attributes such as air quality, neighborhood quality (crime rates, etc.) and distance to shopping centers. A second example, which will be of interest in this study, is the commodity: preservation of visibility (via preserved air quality) in the Grand Canyon National Park. Attributes of this commodity and, therefore, values subsumed in a "preservation bid" (an individuals maximum willingness to pay for preserved visibility in the Park), may include: user values, option values, existence values and bequest values.

(2) Aggregation over commodities. As something of an extension of the "attributes" argument, for some purposes it is useful to think about aggregation over commodities. Thus, the budget analyst may work with the commodity "food" which has as its components the commodities bread, milk, fruit, etc. The commodity "air quality in the U.S.," will include the commodity "air quality (visibility) in National Parks" which, in turn, includes the commodity "air quality (visibility) in the Grand Canyon National Park" (which may include a commodity: visibility at Hopi Point in the Grand Canyon National Park).

Before continuing to other types of aggregation, it is important for the reader to fully appreciate the implications of (1) and (2) for assessments of the CVM. These aggregation issues pose an important, and thus far unanswered, question relevant for efforts to derive and interpret CVM measures of social values attributable to environmental improvements, viz., for a public good such as an environmental improvement, what is an "appropriate" commodity for use in CV studies? In other words, how do people think of environmental "goods"--in terms of subjective valuations, can (do) individuals distinguish between (as examples): visibility in the Grand Canyon National Park, visibility in all National Parks or national air quality; reduced environmental risk (to health and safety) from hazardous waste disposal, reduced environmental risk from all possible causes (e.g., air/water pollution) and reduced mortality/morbidity risks per se (from, as examples, cancer, air travel, heart disease, etc.). These questions related to the "mental accounts" notion, discussed below in sub-section A.3, which suggests that individuals may make subjective valuations for groups of commodities (entertainment, food, etc.) rather than for specific commodities (a movie, a loaf of bread, etc.).

The critical importance of this set of aggregation issues for assessments of the CVM is made manifest by the following. Suppose that a CV measure is obtained for the following three commodities: visibility in the Grand Canyon National Park; improved (or preserved) water quality in all of the nation's lakes, rivers and streams; the total containment of hazardous (toxic) wastes; denote the corresponding willingness to pay measures obtained from the CVM as V_G, V_W, and V_H, respectively. If, e.g., V_G is to be used as a measure of social benefits attributable to a policy to improve air quality in the Park--in the sense that it is to be compared with all costs associated with the policy--it must be the case that V_G does indeed measure individual valuations for this specific commodity; similar arguments hold for V_W and V_H. But this implies that V_G, V_W and V_H can be summed--if i = 1, . . ., n denotes all possible kinds of environmental improvements, the sum of derived CV measures for these improvements, $\sum_{i=1}^{n} V_i$, would measure the aggregative social value for improving "the environment." In contrast, suppose that in offering a contingent value for preserved visibility in the Grand Canyon National Park, the individual thinks of this "commodity" in terms of visibility in all Parks, national air quality or environmental quality in the aggregate. In this case, V_G (or, for that matter, perhaps V_W and/or V_H as well)

will measure $\sum_{i=1}^{n} V_i$, the aggregate rather than the specific commodity.

The question as to whether CV bids for a specific environmental improvement are disaggregative values or, in fact, are more likely values associated with some broader, environment (or "good cause")-related, aggregative "account" raises an issue of particular concern given that (to our knowledge) no researcher would be willing to defend the summation of CV values that have been obtained in various studies for many types of environmental effects; indeed, the summation of average CV values for public goods thus far available in the literature would exhaust the budget of the average individual. The bottom line then becomes apparent: if one cannot sum--aggregate--commodity-specific CV values, how does one interpret the value? Put another way, if one cannot aggregate over commodity-specific CV values, one must then determine that "commodity" for which the obtained value is relevant--one must determine that minimum level of aggregation at which individuals can meaningfully differentiate (in valuation terms) between commodities.

Given the obvious need for insights as to the commodity-aggregation issue demonstrated above, this issue will be given a great deal of attention in this study. Methods used to study this issue are detailed in subsection C. Attention is now returned to a consideration of still other types of aggregation.

(3) Aggregation over geography. In most cases, the EPA's ultimate interest is in measures of national benefits attributable to environmental standards which are nation-wide in scope; examples include ambient air quality standards and national regulations pertaining to hazardous waste disposal. Benefit estimates for improved water quality in (e.g.) the Rio Puerco in New Mexico are of little relevance in this regard unless one assumes that household benefits for all other lakes, rivers and streams are in some sense identical to those obtained for the Rio Puerco--an assumption that is hardly palatable. Moreover, one would ideally want valuations of improved water quality in the Rio Puerco from all residents in the U.S. as well as the Rio Puerco area residents' valuation of improved water quality in all other areas. Thus, unless one wishes to apply the CVM in every community in the U.S., one's interest is focused on means for generalizing CV measures obtained in one or more geographic areas to the U.S. as a whole. The issue of interest then is the extent to which site-specific variables are significant in explaining individual's formulations of contingent values for given environmental commodities. This issue is examined as a part of this study.

(4) Aggregation over individuals. Related to (3) above, national benefit estimates for environmental improvements requires the aggregation--summation--of individual values for the environmental inprovements, If one accepts, as is common, the appropriately summed, maximum willingness to pay of individuals as a measure of social benefits,[8] one follows established econometric procedures for obtaining significant determinants of CV bids (the most important of which is, generally,

household income), the results of which are used for the process of aggregation, ceteris paribus.

The importance of aggregation over individuals lies not in methods for such aggregation, but in the interpretation of average bids which result from aggregation, however accomplished. In virtually all studies based on the CVM, average values for the CV commodity in question have associated with them variances which are typically quite large. The variance in CV measures is most often as large, or larger, than the mean itself--it is not unusual to find variances in mean CV values that are 200 percent to 300 percent of the mean. Some scholars are troubled by experimental results which produce large variances such as those that typify results from CV studies.[9] The rationale for this concern with large variances is puzzling to the authors of this report for the simple reason that, in aggregating over individuals, one would expect large variances except in cases where one has reason to believe that individuals will have identical (or similar) preferences/tastes for the commodity in question. If, for any commodity, individuals have different tastes vis-a-vis the commodity, these differences will be reflected in large variations around a mean value. If one were studying the consumption of green beans, one would surely expect considerable variance reflecting differing tastes for the commodity; the same logic, and therefore expectations, would seem to apply to individual valuations reflecting tastes for environmental commodities.

Perceptions of CV Commodities. The third set of issues which are examined in this study concern the manner in which individuals perceive the CV commodity. The commodities used in CV studies are not tangible commodities, rather, the CV "commodity" is actually a description of a posited change in the study participants environment. Therefore, it becomes most important that individuals have the same perception of the commodity which is offered in the contingent market--all study participants must "see"--bid for--the same commodity.

The perception issue is considered in this study within the context of two classes of environmental commodities. The first class consists of an environmental commodity which is strongly associated with risk and uncertainty, viz, and EPA regulation on the disposal of hazardous wastes. If hazardous wastes are not contained--i.e., they are allowed to enter the environment--a potential risk/threat to public health and safety exists. There is considerable uncertainty as to the nature of the risk, however. Indeed, in considering, e.g., any hazardous waste containment policy imposed by the EPA, risk/uncertainty, expressed interms of probabilities, enter the problem in at least three related ways: the probability of containment; the probability that health or other environmental damages will occur given non-containment; and, perhaps subsumed in the above, the probability that a given containment is, in fact, effective.[10]

More is involved here, however. Ideally, the relevant environmental improvement--our CV commodity--would be the change in environmental risk associated with an EPA policy. Given the present state of knowledge, one can define neither risks associated with current waste disposal policies nor, obviously then, changes in risk associated with an EPA policy. In the

latter regard, a possible exception would be a "total containment" policy which, ceteris paribus, would eliminate (subject to the third probability cited above) all existing risks, whatever those risks might be. Since one cannot define those environmental risks, changes in risk cannot serve as the commodity in a CV study.

One way around this problem might be to use the EPA policy itself--couched in terms of a hedge against uncertain risks--as the CV commodity; experiments with this approach are conducted in this study. This approach cannot be totally satisfactory for an obvious reason, however. Given individual bids for a total containment policy, for example, and ignoring for the moment the "effectiveness" problem, such bids will measure the desired valuation for a hedge against risk as well as (undesirable) individual perceptions of the risk level against which the policy "hedge" is to operate. If the CV commodity is a hedge, the relevant question becomes: a hedge against what? With "what"--current risk levels--unspecified, bids must vary according to individual perceptions of "what" the hedge is to affect.

Acknowledging this weakness in using the EPA policy as a CV commodity--discussions of conceptual issues related to this problem are extended below in subsection A.4--the "policy bid" approach serves as a basis for a number of what the authors regard as interesting experiments in terms of providing insights to guide future research. Of particular interest in these experiments is the manner in which the policy commodity is perceived by study participants. Two sets of experiments are conducted in this regard. The first set will involve efforts to test hypotheses which relate CV bids to changes in the probability of containment as well as to changes in the probability of damages in the non-containment case. The second set of experiments will involve the structuring of individual "bid curves" which are then compared with the structure of bid curves drawn from axiomatic propositions (see Appendix A for discussions of these theoretical propositions).

The second class of commodities which are examined in terms of individual perceptions consist of environmental improvements for which risk and uncertainty are not major characteristics, viz., preserved visibility in the Grand Canyon Rational Park, and air quality improvements (reduced ozone levels) in the Los Angeles area. For this class of commodities, the "bid curve" analysis referred to above is used in efforts to speak to the perception issue.

We must acknowledge that this second class of goods is not necessarily free of uncertainties or risk considerations. In the case of the national parks visibility experiments, Desvousges and Smith[11] argue that the relevant CV commodity is not a particular level of visibility, but a probability of encountering a given level of visibility such time as an individual visits an area. Thus, bids for a "certain" change in visibility may be, in fact, a bid for an individuals perception of a change in the probability of access to a particular environmental condition (visibility level); in such cases, one encounters the problem of distinguishing between

valuations and perceived probabilities reflected in contingent values, noted above in the hazardous waste problem.

While Desvousges and Smith's (D-S) "access" argument has pedagogical appeal, one must wonder if it does not impute to individuals a mental, valuation process that is extraordinarily unwieldly. When asked to choose between two average levels of visibility, would, in fact, an individual translate this choice into the probability of encountering one or the other visibility level on his/her future visits, or would he/she accept that one or the other levels would be encountered with certainty? The authors are unaware of data that would establish either position. If on nothing more than eclectic grounds, however, the authors find the latter position intuitively appealing and adopt its use in this study. To the extent that individuals do indeed base their offered, contingent values on the numerative, "access" model of D-S, the CV values will be subject to the weaknesses ascribed to them by D-S.

There is still another potential source for risk and uncertainty to enter valuations for our second class of commodities. Related somewhat to the attribute-aggregation issue described above, as well as to the mental accounts notion discussed below in subsection A.3, we do not understand precisely how individuals perceive questions related to specific kinds of (or effects from) environmental quality improvements. It may be the case, for example, that individuals, when asked to value preserved visibility, think of air quality as a gestalt which includes many effects: visibility, as well as mortality and morbidity. Similarly, the ozone experiment, described below, stated effects are related to morbidity, but mortality and visibility effects may be reflected in the bid. Thus, perceptions of effects and relevant probabilities of effects, that individuals may attach to posited environmental changes may underlie contingent values.

Other Experimental Issues. The final set of issues addressed in this study include the following. First, experiments are designed to determine the effects of cost information on contingent values. Related to the commodity-aggregation issue, an individuals offered bid for an environmental improvement is, theoretically, made within a context which includes consideration of current outlays for environmental goods. In other words, the contingent valuation must be an expenditure for a marginal change in the existing environmental state. The extent to which CV measures are appropriately "marginal" in this sense is the topic of this set of experiments.

A final issue considered relates to solicitation modes for acquiring CV measures. In this regard, CV results from mail, door-to-door, and pre-arranged interview modes are compared. Motivation for this set of experiments is provided by the markedly different costs of administering the CV study by these modes: mail is much cheaper than door-to-door which, in turn, is much cheaper than the pre-arranged interview mode.

In summary, the purpose of this study is to examine four, broad sets of issues which the authors regard as being particularly important for efforts to develop and assess the CVM as a means for valuing environmental

changes. The vehicle for these examinations is a set of experiments which is described in the following subsection. The discussion of experiment designs in subsection A.2 is followed (subsection A.3) by a discussion of the relationships between these experiments and those reported in other works. Conceptual and sampling issues which are relevant for the study's experiments are discussed in subsection 8.4, after which (subsection A.5) the plan of the study (and the balance of Chapter I) is described.

A.2 Design of Study Experiments

In this sub-section, attention is focused on the design of experiments used in this study as a means for accomplishing the study purposes described above in A.1. We begin by setting out criteria used in selecting CV commodities to be used in the study; after which the specific experiments are described. To avoid unnecessary clutter in this Overview section, only the essential elements of each experiments' design is described here; greater detail is given in later sections of the report. This sub-section concludes with a summary wherein each experiments' contributions to study purposes are reviewed.

Choosing the CV Commodities. The authors' choice of CV commodities reflects, a one might expect, the major ends (purposes) sought in the study. The greatest challenge in terms of commodity selections was posed by Purposes 2 and 3: Aggregation Issues and Perceptions of CV commodities. For these purposes, it was necessary to have a mix of commodities consisting of: differing levels of aggregation over attributes and commodities; differing mixes of risk and uncertainty; differing standards by which individual perceptions of the CV commodity might be assessed.

For obvious reasons, it would be most difficult to design a single commodity which would allow for comprehensive analyses of all issues included in the study purposes, thus the need for a mix of commodities. Consideration of these purposes lead to the selection of the following commodities to be used in the study.

The first commodity is: preservation of visibility in the Grand Canyon National Park. Bids for this commodity can be argued a priori as an aggregation of values associated with four, specific commodity attributes: option, user, existence, and bequest values. Further, this commodity is readily amenable to extensions to higher levels of aggregation; other regional National Parks--all National Parks--national air quality levels.

The second commodity is: Improvements in National Water Quality. Choice of this commodity reflects three considerations. First, it serves as an example of a commodity which represents three levels of aggregation; aggregation over attributes (swimming, fishing, boating, etc.) commodities (site specific lakes, rivers and streams), and geography. Secondly, it is amenable to still further aggregation; national water and air quality. Thirdly, its use as a commodity in an earlier study[12] provides useful data for comparative and validation analysis.

The third commodity is: an EPA-imposed "total containment" policy (regulation) for (on) hazardous waste disposal. This commodity is included for two major reasons.[13] First, it is representative of a broad range of potential environmental changes which involve indirect and uncertain environmental risks; other examples include policies which affect air quality-related mortality, nuclear power plant siting, nuclear waste management and CO_2 accumulations in the upper atmosphere. Secondly, it represents a commodity which is amenable to aggregation with other commodities and over geography.

The fourth and final commodity used in the study is: reduced ozone levels in the Los Angeles area. This commodity was chosen based on the following considerations. First, air quality in general is a reasonably well understood "commodity" in the Los Angeles area--residents are well aware of differences in air quality in different parts of the Los Angeles area. Effects of one component of "air quality"--ozone levels--can be differentiated and defined with a considerable degree of clarity. Further, reasonably good historical data exists for ozone levels in this area. Secondly, use of this commodity provides an exceptional opportunity for testing the consistency of contingent values with relevant, individual behavior as such behavior relates to the "perception" issue. If individuals do, in fact, perceive the effects of ozone levels as they are described in the CV study, measures for an individuals' elasticity of substitution of income for reduced ozone levels should be consistent with individual choices of residence: one would expect a concentration of individuals with small (large) elasticities in areas with high (low ozone concentrations. Finally, the authors' earlier property value studies in the Los Angeles area provided a relatively inexpensive data base which could be used for <u>one</u> aspect of the studys' validation purposes; viz., the derivation of hedoic (property value) prices for reduced ozone concentrations which can be compared with values drawn from the CVM.

With the above described choices for CV commodities, attention can now be turned to an overview of the studys' experiments. For each experiment, a sketch will be given for the following for characteristics of the experiment design; the experiments are described in greater detail in section II - V of the report.

(a) Description of the commodity: how the commodity is described to study participants.

(b) Payment Vehicle: the method by which contingent payments are to be "paid" in the experiment.

(c) Method for obtaining initial bids.

(d) Values obtained: "willingness to pay" questions asked and values obtained in the experiments. Within each major experiment, sub-experiments make use of differing combinations of these questions. All average values are income-adjusted.

(e) Location of the CV study(s).

The National Parks Visibility Experiment (Visibility Experiment).

(a) Describing the commodity: study participants were shown a rather elaborate set of photographs depicting differing visibility levels (levels A, B, C and D) at selected vantage points in the Grand Canyon National Park (GCNP; see Figure 2.1 in section II). Referring to the photographs, individuals are asked willingness to pay questions for preserving current visibility conditions (Level C in the photographs) rather than allow them to deteriorate to the next worst level, Level B in the photograph.

(b) Payment Vehicle: higher electric utility bills. This vehicle was chosen given participants general familiarity with (i) the fact that their major source for electricity is power plants in the Four Corners area, in close proximity to the GCNP; (ii) the publicized fact that pollution abatement equipment for power plants adds to electric bills.

(c) Method for obtaining initial bids: Payment Card.

(d) Values obtained:

SB: initial, "starting" bid from Payment Card for preserving air quality in the GCNP.

MB: "maximum" bid obtained via a bidding process ("would you pay $1.00 more, etc.")

SBY: starting bid for the commodity when individuals are asked, prior to the bid, to indicate their monthly take-home income, its allocation over expenditure categories, and which expenditure category will be reduced in order to facilitate payment of the bid. The letter Y indicates bids obtained within the context of this budget information.

MBY: the "maximum bid" obtained within the context of the individuals budget, as above.

AMB: an "adjusted" maximum bid (MB). The individual is asked if he/she wishes to change--adjust--the MB value given that he/she might wish to pay some amount for a different environmental change: air quality improvements in the Denver area (the location for the experiment).

SBG(Y); MBG(Y): "starting" and "maximum" bids (SB, MB) (with and without use of the budget context, Y) for preserved air quality in the GCNP (identified by G) when the participant is asked to simultaneously give his/her maximum willingness to pay for preserved air quality in five other National Parks in the Rocky Mountain region (Zion, Bryce, Mesa Verde, Glen Canyon and Canyonlands National Parks); i.e., the study participant offers a contingent value for preserved visibility in the GCNP (SBG(Y), MBG(Y) values) and a separate contingent value for preserved visibility in the other five National Parks.

SBR(Y); MBR(Y): From the above, starting and maximum bids (with and without use of budget context) for preserved visibility in the five, regional (denoted R) National Parks.

AMBG(Y), AMBR(Y): Maximum bids (MB, with and without use of budget context, Y) for preserved visibility in the GCNP (G) and in the five Regional (R) parks which are "adjusted" (denoted A) by the individuals' consideration that he/she might wish to pay some amount to preserve visibility in all other National Parks in the U.S.

SB-C (UV, OV, EV, BV): SB-C is the starting bids for preserving visibility in the GCNP--obtained in the "component" experiment (C); this value is identical to the SB; referred to above in other experiments. Individuals are asked to indicate that part of this SB-C value that is seen by him/her as appropriate for a user value (UV), option value (OV), existence value (EV) and bequest value (BV).

(e) Location of experiments: Denver, Colorado.

The National Water Quality Experiment.

(a) Description of the commodity: after a brief discussion of water quality problems in the U.S., the individual is shown a "Water Quality Ladder" (Figure 3.1 in section III), which shows five alternative levels of water quality. Water quality ranges from a best level, which may serve drinking water, swimming, game fish habitat and boating purposes, to a worst level which can serve none of these purposes. Willingness to pay questions relate to an improvement in national water quality from current levels (Level C, which serves boating and game fish habitat purposes only) to the next highest level (Level B, which serves boating, game fish habitat and swimming purposes).

(b) Payment Vehicle: higher taxes and/or higher prices for goods and services.

(c) Method for obtaining initial bids: Payment Card.

(d) Values obtained:

SB: initial, "starting" bid from payment card.

MB: "maximum" bid, which results from the bidding process.

SBY: starting bid obtained with the budget context described above.

SBY-W; SBY-A: individuals are shown an "Air Quality Ladder" (Figure 3.3 in section III) identical inform to the above-described "Water Quality Ladder," along with the Water Quality Ladder. Starting bids, using the budget context (SBY),

are simultaneously obtained for a Level C to B improvement in national water quality (as above, denoted SBY-W) and a Level C to B improvement in national air quality (SBY-A).

SB(Y)-WA: A single starting bid (with (SBY) and without (SB) use of the budget context) is obtained for the combined (aggregated) commodity: Level C to B improvements in national water and air quality.

(e) Location of experiment: Denver, Colorado.

The Hazardous Waste Experiment (Policy Bid Experiment).

(a) Description of the commodity: Following a discussion of problems associated with the disposal of hazardous wastes, the nature of uncertainties surrounding risks associated with hazardous waste disposal is explained to the study participant. The following "horns of the dilemma" is stressed. We can impose more stringent regulations today, and accept the associated costs, and later find that: (i) the action was justified, real risks associated with hazardous waste disposal warranted the costs, or (ii) the action was not justified, the severity of the problem did not warrant the costs paid. Alternatively, we can not regulate "today," and later find that: (i) the action (no regulation) was justified, real risks were not serious enough to have warranted the costs, or (ii) the action was not justified--we should have regulated--the lack of regulation has exacerbated risks. Thus, regulation "today" in the face of existing uncertainties takes the form of a "hedge" against potential health threats. The willingness to pay questions relate to the imposition of a "total containment" policy (regulation) by the EPA.

(b) Payment Vehicle: higher taxes and/or higher prices for goods and services.

(c) Method for obtaining initial bids: Payment Card.

(d) Values obtained:

SB(Y): starting bid for a totally (100%) effective containment policy, with (Y) and without use of the budget context.

MB(Y): "maximum" bid for a totally effective containment policy derived via the bidding process, with (Y) and without use of the budget context.

FB: the maximum bid (MB) for a containment policy that is but 50% effective in containing hazardous wastes (as imposed to 100% effective for all other values).

SB_I, SB_{II}: SB_I is identical to SB; starting bids are obtained for the totally effective containment policy where, as a part of the discussion of hazardous waste problems (part a above), potential threats to the environment are described, but examples

of actual occurrences of cases where hazardous wastes have eaten the environment (and resulting effects) are not given to the study participant. In a sub-experiment, a group of participants are given examples of such cases; SB_{II} denotes this groups' starting bid.

AMB: the "adjusted" maximum bid. After obtaining MB, individuals are allowed to adjust--change--their own bid in light of the fact that there are other sources of environmental risk (5 are discussed), more stringent regulations for which would require that they "pay" more in the form of higher taxes and/or higher prices for goods and services.

AMB-1: the adjusted maximum bid as above; in discussing other "goods," however, discussions focus on the 5 environmental goods (as for AMB) and 2, non-environmental public goods: improved national defense and improved highway safety.

SB-A: for one major sub-experiment, the discussion of other environment goods, which in other experiments follows the elicitation of MB, takes place prior to the elicitation of the starting bid--the "other goods" discussion precedes willingness to pay questions rather than occurring at the end of the valuation sequence whereby one obtains SB, the MB, then AMB. Starting bids obtained within the context of discussing other goods is denoted SB-A. One should note that all SB-A values are obtained with the use of the budget context.

SB-AC: for this sub-set of the study participants from which SB-A values are elicited, prior to obtaining the SB-A valuation, individuals are told the average amount that households in their income class now pay, in taxes and higher prices for goods and services, for the existing state of EPA regulations (air, water quality standards, as well as existing regulations on hazardous waste disposal).

(e) Location of experiments: Albuquerque, New Mexico; Houston, Texas and New Haven, Connecticut.

The Ozone Experiment - CVM.

(a) Description of the commodity: the potential sub-clinical health effects of various levels of ozone concentrations are discussed with study participants --individuals are reminded of a "memorable day" when Los Angeles residents experienced a peculiarity in ozone levels: just before and during the 1982 Labor Day Weekend (which received widespread news average given its coincidence with the U.S. Festival, a major outdoor concert). Participants are then shown a graph (Figure 4.1 in section IV) depicting actual, daily ozone concentrations in their area during selected weeks in August and September, 1982. Four concentration levels (Good, Fair, Poor, Very Poor) are identified on a "ladder" along with possible morbidity and "discomfort" effects associated with each concentration

level. Willingness to pay questions relate to reducing ozone concentrations, on a day at which "peak" ozone concentrations might (have) occurred in the individuals' community, from Poor (or Very Poor, depending on the individuals neighborhood) to Fair (or to Good).

(b) Payment Vehicle: higher prices (with emphasis on higher operating costs for vehicles due to pollution abatement equipment).

(c) Method for obtaining initial bids: Payment Card.

(d) Values obtained:

SB-(•)(•): Denoting ozone concentration levels as A (Good), B (Fair), C (Poor) and D (Very Poor). Starting bids are obtained for various changes in ozone concentrations, e.g., from D to B or from D to A, which are then denoted SB-DB and SB-DA, respectively.

ACT: An index of level of participation in outdoor activities.

TEN-R: length of time (tenure) that the individual has lived at present residence.

TEN-LA: length of time (tenure) that the individual has lived in the Los Angeles area.

(e) Location of experiment: two communities in each of the San Gabriel Valley, San Fernando Valley, and Coastal Orange County areas of the Los Angeles Basin.

The Ozone Experiment-Hedonic Property Value Study

Along with the contingent valuation experiment, a hedonic property value study was conducted. The principle objective was to attempt to isolate the effect of ozone on property values as opposed to a general effect of air pollution which has been obtained in several previous studies. Thus, the objective was to regress home sale price against home attributes (e.g., square feet, bathrooms, fireplaces, and swimming pools), community attributes (e.g., school quality, crime and distance to work and beach) and air pollution variables (TSP or extinction coefficient and ozone) to determine the impact of each attribute with special emphasis on ozone. This would conceptually allow a comparison of the value of reduced ozone concentrations as capitalized in home sale price with survey bids obtained from the CVM method. The location of the study incorporated home sales in the entire Los Angeles Basin.

For reasons outlined earlier, each of the four major experiments sketched above are used in efforts to analyze various sets of the issues which relate to the intended purposes of the Methods Development project. By way of a summary of this sub-section, Table 1.1 sets out the intended contribution of each major experiment to each of the sets of issues that form the study purposes.

TABLE 1.1

OVERVIEW OF THE CONTRIBUTION OF STUDY EXPERIMENTS TO STUDY PURPOSES

Experiment	Validation Issues	Aggregation Issues	Perceptions of CV Commodities	Other	Experimental Issues
The National Parks Visibility Experiment	X	X	X		
National Water Quality Experiment	X	X			
The Hazardous Waste Experiment	X	X	X		X
Ozone Experiment	X		X		X

A.3 Relationship to Other Studies

The Methods Development project draws, in one way or another, on a number of earlier works that relate to assessments of the CVM. No attempt is made here to review all of these earlier works. Three of these are of particular importance for the present study and warrant mention, however.

The first work that should be mentioned is that by Kahneman and Tversky.[14] In that work it is suggested that, in making assessments of valuations, individuals' think of goods and services in terms of "groups" or accounts" of goods and/or services; i.e., individual "mental accounts" are relevant entities in valuation decisions. As an example, rather than allocating $100.00 to a movie and $20.00 to a night of bar-hopping, the individual would allocate $30.00 to an "entertainment account.

Other than noting that observations of individual behavior suggest decision-making processes within a mental account framework, Kahneman and Tversky do not pursue this notion further. Unanswered are a number of critical questions if the mental accounts notion is to be tested empirically to the end of developing meaningful axioms concerning individual behavior. As examples of these questions: what determines the composition of any one account--are accounts hedonic in nature (pleasure, pain, safety, etc.), or perhaps, functional (housing, transportation, food, etc.)? Is the structure of accounts more or less the same for all individuals? Are "account" lines more or less rigid--i.e., with but $10.00 in the entertainment account, and faced with the desirable opportunity to attend a concert costing $20.00, may not the individual reallocate income <u>across</u> account lines and, if so, what is the <u>meaning</u> of an account?

Given that the mental accounts notion is just that--a notion, an intuitive argument--at this point in time, it could be tempting to dismiss the notion as a curiosity. There are, however, a number of perplexing problems encountered in efforts to assess results from the CVM which <u>could</u> be explained by the mental accounts notion. Moreover, the implications of the mental accounts notion for the CVM, should the "notion" turn out to be substantive, are of such a large order of magnitude that one should be hesitant in dismissing it out of hand. These two arguments are briefly developed in the following.

In terms of earlier CV studies, one of the most serious problems with the CVM which begs for resolution concerns the <u>additivity</u> of CV measures. Thus, let $V_1, \ldots, V_n$ be CV measures from a n-different CV studies focusing on n-different commodities (clean air, lower ozone levels, cleaner water, preserved wilderness areas, hazardous waste management, preserved visibility in the Grand Canyon National Park, enhanced emergency cardiac treatment facilities, etc.). If, <u>as is usual</u>, the V_i's are attributed to all households (segregated or adjusted, perhaps, by such things as household income, household size, etc.), one acts as if the "representative" household might be willing to pay $\sum_{i=1}^{n} V_i$ for these

n-public goods. Something akin to this additive process is implied when the EPA uses the value V_j as a measure for social benefits attributable to some policy j (and another division of EPA use V_k for evaluating policy k). Virtually no investigator would argue that one can add the V_j's, however--indeed in some cases the sum of the V_i's could equal or exceed household income.

While the fact that the V_i's are not additive may be attributed to a number of possible causes (e.g., the V_i's may be additive if the individual places a value on each the commodity j, j = 1, . . ., n, when faced with all options), a lingering suspicion exists that study participants in the CVM may be "willing to pay" for virtually any "good cause"--a "good cause" account? Thus, despite the fact that V_A is "offered" for cleaner air, one must be hesitant in using V_A as a measure of social value inasmuch as the individual might offer the value V_A for any other public good.

One must be aware of the danger of masking instrument design and other theoretical issues with the "mental accounts" rubric in addressing the "good cause" problem. The problem may be more usefully addressed via concentration on: extensions of separable utility theory, instrument design wherein wider ranges of options are presented, etc. Efforts to at least partially address some of these issues are made in the present study. Thus, one sees in the above discussions of Aggregation Issues (sub-section A.1) the relationships between this studys' objectives and the works of Kahneman and Tversky.

A second, major set of earlier works of particular relevance for the present study are those by Slovic et al. (1977) and others.[15] Slovic et al.'s focus on perceptions of risk relate to this study's the Hazardous Waste Experiment which involves reductions in uncertain risks associated with the disposal of hazardous wastes. A finding by Slovic et al. which is especially relevant for, and is used in, this Experiment concerns the role of information in the forming of risk perceptions: frequency of news coverage (information) of a risky event is seemingly associated with higher risk preceptions of the event.

Still another finding by Slovic et al., supported by results reported by other authors, is relevant for the perceived risk issue. In this regard, a particularly important finding is that individuals, when faced with low probability, high consequence alternatives, tend to ignore probabilities (perceived risk is 1.0?) and base decisions solely on the magnitude of consequence.[16] Thus, to the extent that health threats from hazardous waste disposal are viewed as low risk-high consequence events, contingent values for hazardous waste containment may be insensitive to posited changes in containment probabilities--a phenomenon that would contrast sharply with axioms drawn from expected utility theory where from contingent values are shown to increase with increases in containment probabilities.[17] The Hazardous Waste Experiment will attempt to address some dimensions of this issue.

The third set of earlier works of importance to the present study is the work reported in Schulze et al.[18] This work, which focuses directly on

the CVM, provides a survey of research results relating to traditional biases commonly attributed to CV measures: strategic bias, starting point bias, information bias and payment vehicle bias. Referring to this set of biases, the authors conclude that "Biases do not appear to be an overriding problem."[19] Strategic bias was not found in any of the reviewed studies. Vehicle and starting point biases were found in but one of the six reviewed studies. The authors suggest that these "traditional" biases may generally be avoided with the establishment of precise contingent markets and well defined environmental commodities.[20]

While the study by Schulze et al. cannot be viewed as having irrevocably dismissed as irrelevant the above set of biases, the evidence presented therein is viewed by the authors of the present study as sufficiently compelling to warrant this study's shift in focus away from concern with "traditional" biases. Thus, this study moves beyond concern with such things as strategic bias in its focus on validation, aggregation and perception issues.

A.4 Conceptual and Sampling Issues

Somewhat related to the above, there are a number of more theoretical and sampling issues which deserved mention prior to our discussion of experimental results derived in the present study. The first of these concerns the "state dependent" utility function[21] (SDUF). Basic to the SDUF argument is that, especially in cases where uncertainty is involved, the individuals' utility function and, therefore, his/her valuation of any (e.g., environmental state) will depend upon the state at which an individual finds him/herself; as a crude but stark example, an individuals' valuation of a Cancer Clinic when he/she is in good health will differ from that obtained if he/she had cancer. The notion that preference structures may change as states of the world change surely has appeal on intuitive grounds. The implications of the SDUF argument for CVM are not clear, however. One can read into the SDUF argument the (obvious, it would seem) conclusion that ex ante valuations of an environmental improvement may be biased vis-a-vis an ex post valuation. But this would seem to be simply a more elegant, in terms of simplicity, restatement of the ongoing--and unresolved--issue concerning the optimality of competitive equilibrium under uncertainty set out by Radner[22] and expanded by, as examples, Starr[23] and Svensson.[24] In the few cases amenable to analysis, optimal, ex ante equilibrium that is also an optimal, ex post equilibrium is shown to obtain under only the most restrictive assumptions; e.g., in the case of a "spot market" economies, such equilibrium requires: unanimous agreement among consumers as to the spot market vector (which is in fact realized) that will occur with certainty in any state of the environment[25] (i.e., under conditions of perfect certainty). Under conditions of uncertainty, an optimal, competitive equilibrium (and, therefore, equilibrium market prices) is different than that equilibrium (and its associated prices) which is optimal ex post. This axiomatic potential bias in using any current (supposedly equilibrium and optimal) value (CV or market) as a measure of values relevant for different states (ex post) is well known; means for equilibrating these values are not understood. If the intended contribution of the SDUF argument goes beyond

this observation, that contribution is simply not understood by the authors of this report.

A second conceptual issue of relevance for this study concerns, once again, the notion of individual perceptions. It was argued above that, particularly in the case of the Hazardous Waste Experiment, individual perceptions of risk (and/or, more generally, uncertainty) will underlie CV values; thus, variations in CV values reflect differing risk perceptions as well as differing preference-related values. As stated above, no attempt is made in this study to measure individual perceptions of risk. While the potential importance of such measures is recognized by the authors, the focus of this study is on heuristic inquiry designed to provide the insights and data requisite for the formulation of informed questions and hypotheses that will be important in later efforts to measure and explain risk perceptions that are relevant for applications of the CVM.

Notwithstanding the fact that perceptions per se are not directly measured in this study, the authors of this study have considered the implications of risk perceptions at some length.[26] From these considerations, two observations may be of passing interest. First, one must not be sanguine in terms of expectations from research focused on risk perceptions. Earlier works[27] point to the rapidity of changes in risk perceptions and the confounding ways in which they may be affected by myriad variables. Somewhat related to the SDUF argument sketched above, risk perceptions may be particularly state dependent,[28] thereby introducing complex problems as to the relevance of ex post vs. ex ante valuations. All of this is to suggest the critical importance of efforts to measure risk perceptions with careful thought as to the proposed end use of such perceptions once measured.

Inextricably related to this "use" question is the following issue which warrants early concern by social science researchers at the EPA. Suppose that risk perceptions associated with, as examples, air quality or hazardous waste disposal, are obtained; they are "good" measures. In most, if not all, cases, "actual" risks are not known (hazardous waste disposal) or existing, "scientific" estimates for risk will be shrouded with uncertainty and controversy (health effects from air pollution, nuclear waste disposal).[29] "Actual" risk estimates will virtually always be orders of magnitude smaller than perceptions of these risks, and the social scientist must anticipate the frustrated physical scientists' question: What is the meaning, and relevance, of perceived risks if such perceptions are "wrong"? In responding to this question, appeal to a basis for "education" vis-a-vis the relevance of risk perceptions must be cautious: to "educate," one must have the "truth," and, in many case, "truths" regarding these risks will not exist.[30] Nor can the social scientist look for solice in providing alternative benefit estimates based on actual and perceived risk estimates to "bound" social values given the extraordinarily large range which can be anticipated to result. Thus, risk perceptions exist, they surely affect CV measures, and are a source for legitimate interest and concern for the social scientist. Their use in analyses of social benefits assessments, may be fraught with problems that the wary scientist must anticipate and deal with early on.

A third issue of particular importance for the CVM concerns the "commodity" which is to be valued in the CVM's contingent market. As noted above, it seems apparent on intuitive grounds that this commodity be well-defined--that it be described to study participants with a higher degree of specificity. A problem which has defied resolution by the authors is that of defining criteria for specificity: what are the measurable characteristics, or manifestations of a "specific" commodity, or what sorts of CV bid characteristics are indicative of a specific commodity? In the quest for specificity criteria, one might begin (as did the authors) with Lancasters' "attributes" argument,[31] where a commodity Y is described by the vector of attributes $(Y_1, \ldots, Y_n)$ and describe "specificity" by, for example, the percent of attributes given to an individual. Two, interrelated and perplexing issues arise, however. First, attributes may be unknown or, more seriously, may involve judgments--one chooses to include Y_i as an attribute--which then removes objectivity form the choice of n (and, therefore, any percentage measure). As examples, are (and to what extent) reductions in mortality rates an attribute of reduced ozone levels; is "more federal regulations" logically included as an attribute to the hazardous waste commodity; are types of damages potentially caused by, for example, hazardous wastes an attribute of a policy to contain wastes (and, if so, can one enumerate all potential types)? Secondly, if m is the number of described attributes, we have no a priori basis for relating the specificity measure m/n, however, n is defined, to individual valuations of Y. Consider an automobile, for example. The automobile mechanic or engineer may define n characteristics for a given automobile, only n of which are "known" by the lay buyer--n is orders of magnitude less than n. Our problem is made manifest by the question: is the buyers valuation of the automobile somehow faulty given n/n "small"? Here again the perception issue arises in its most robust form. In virtually any CV study, one can expect that individual perceptions of n may vary substantially, regardless of the number of attributes described to him/her by the investigator. Some efforts to speak to the elusive specificity issue are made in this study but the authors acknowledge at the outset that the issue of defining criteria for measures of specificity remains in the author's view, as a conundrum.

The final set of issues to be addressed in this sub-section concern sampling techniques used in this studys' CV experiments. As suggested by above descriptions of the intended scope for this study, it is hoped that one of the studys' strengths will be the breadth and comprehensiveness of issues considered which are of importance in efforts to assess the CVM. The study, by design, is exploratory and heuristic in character; further, it is free-wheeling in the sense that as the authors encountered new ideas, issues and/or methods of relevance for CVM assessment, efforts were made to develop these ideas/methods via experiments. To the extent that new insights as to the structure of CVM studies provided in this study are a part of its strengths, requisite methods for obtaining them gave rise to its major weaknesses. Thus, in this regard, sample sizes will vary substantially across the studys' many sub-experiments. In efforts to tentatively probe one issue or another, sample sizes will be small and, in such cases, "conclusions" must be accepted in the sense that they are offered: observations that are indicative of the potential existence of

behavioral responses that warrant further development in efforts to bring the CVM to full flower as an effective tool in benefits assessments.

Further, in the studys' drive to develop and test new hypotheses, limited resources and time, as well as the intended thrust of the study, made impractical the structuring of sample designs that one would expect in non-experimental applications of the CVM which have as their central purpose the derivation of "final," or perfected, measures of social value. Thus, as implied in sub-section A.3, for many sub-experiments we eschew extensive pre-tests of CV instruments designed to address questions related to information/interviewer biases--the substance of earlier works by Schulze et al. (1981) discussed in A.3.[32] Little attention is allocated to correcting samples for possible stratification and/or non-respondent biases. Thus, the studys' experimental results must be interpreted within the context of experiments concerning economic behavior of study participants; obviously, extentions of the CVM to applications designed to estimate values for use in policy formulations will require considerably more attention to issues related to survey design.

A.5 Plan of the Study

The purposes of the Methods Development project are now understood as those of developing and testing hypotheses concerning four, broad sets of issues: validation issues, aggregation issues, issues concerning individual perceptions of CV commodities, and "other" issues. Hopefully, at this point the reader has some feel for the substance of experiments which this study uses in addressing these issues--the National Parks Visibility Experiment, the National Water Quality Experiment, the Hazardous Waste Experiment and the Ozone Experiment--as well as for the relationship between this studys' purposes and experiments to earlier works by other authors. Finally, earlier discussions have established the experimental context of this study and have alerted the reader to conceptual and sampling issues which form the basis for caveats which one must keep in mind in interpreting the studys' results.

Attention is now turned to an overview of these results. In sub-section B, results from all study experiments which pertain to validation issues are summarized. Similarly, sub-sections C, D and E include summaries of experimental results which pertain to aggregation, perception and "other" issues, respectively. This Overview section concludes with sub-section F wherein the authors' conclusions as to the implications of study results for assessing the viability of the CVM as a useful tool in evaluating benefits attributable to environmental change are offered.

B. VALIDATING CV MEASURES

B.1 Comparing Hedonic and Contingent Valuation Measures of Benefits Attributable to Environmental Changes

Two sets of issues complicate the comparison of a CVM measure of the benefits of reducing ozone levels in the Los Angeles area with measures derived from property values.

First the CV instrument obtains bids for reducing ozone on a daily basis. To develop an annual bid for an improvement in the ozone air quality distribution over an entire year raises questions both of perception (see Section D below) and requires the assumption that utility functions are additive and separable over time in ozone air pollution (see Chapter V Section B) if daily bids are to be simply added up linearly over the change in air quality distribution. One a priori point in favor of simply adding up daily bids is that there is little evidence either of cumulative health problems or of health tolerance for the known sub-clinical health effects of ozone. Thus, from the perspective of a household health technology, there is little reason to reject additivity of bids. However, preferences over the sub-clinical health effects might show some non-separable effects over time.

Second, the property value study (reported in detail in Chapter V, Section D) showed severe multicollinearity problems arising from the high correlation between the distance to beach, ozone and visibility (as measured by extinction or TSP) variables. Note that this collinearity problem is likely not accidental, but may well result from the air chemistry in the basin, wherein, hydrocarbons and nitrogen oxides are exposed to sunlight. Distance to beach is a good proxy for time of exposure to sunlight creating a simultaneous equation system leading to collinearity in our single equation property value model. Unfortunately, no one has yet successfully specified a basin wide air chemistry model nor is hydrocarbon data available at the current time. The most stable and plausible estimates made, to date, rely on an instrumental variable approach using principal components. This approach has poorly understood economic and statistical implications as an estimation procedure, so our results should be interpreted with caution. However, as an example, an average annual bid for an improvement of ozone air quality from that typical of the San Gabriel Valley (Poor) to that typical of the San Fernando Valley (Fair) is $502 ($1,166) from the interview survey analysis and $397 ($231) to $1,340 ($794) from the property value analysis depending on whether TSP or extinction, respectively, is used as the variable representing visibility in the estimated equation (standard errors are given in parenthesis). These values are also roughly consistent with previous hedonic and CVM research done in the Los Angeles Basin.

B.2 Market Criteria for CV Responses

In this sub-section attention is focused on hypotheses that relate CV measures (bids, responses) to criteria deduced from markets. Three sets of hypotheses are tested: those deduced from auction settings, those related to budget constraints and those related to altered consumption sets.

The Auction Process

(i) Motivation and Hypotheses. An issue of some concern for the CVM is the extent to which bids offered in the CV process are indicative of attitudes or intended behavior.[33] Ceteris paribus, use of CV measures for benefits assessments purposes presupposes the latter: individuals will in fact be willing to pay the proffered bid for proposed environmental commodities. The attitude vs. behavior problem may be restated as inquiry as to whether or not individual participants in the CV study consider the commodity in terms of monetary values--what they will pay for the commodity. One method for responding to this question involves moving beyond a single valuation question (what is your maximum willingness to pay . . .) to an auction-like process--if the commodity cannot be provided at "price" p, will you pay $1.00 more? The auction, or bidding, process may serve at least two purposes. First, it emphasizes monetary, payment, behavioral requirements for obtaining the commodity. Secondly, to those familiar with auction settings, it places the contingent market in a more familiar context. If initially offered bids--referred to as "starting bids," SB--are simply expressions of attitudes, there is no a priori reason to expect that individuals would significantly alter their attitudinal expression in response to the simulated auction. On the other hand, if the individual considers the commodity within the context of intended behavior--how much will he/she in fact pay for the commodity--we would expect SB to be significantly affected by the bidding process for the two reasons discussed in section A.1: initial (SB) values are low to maximize rents; considerable introspective search of preferences are required to arrive at a maximum willingness to pay. Denoting MB as the individuals' "maximum" bid resulting from the bidding process, the null hypothesis of interest then becomes

$$H_o : SB < MB, \tag{1.1}$$

and the alternative hypothesis is

$$H_A : SB = MB. \tag{1.2}$$

(ii) Study Results. SB and MB values from the National Parks Visibility, National Water Quality and the Hazardous Waste Experiments are given in Table 1.2. Differences in SB and MB values across experiments are expected, of course, due to differences in commodities to which they apply. In terms of the hypothesis of interest, we fail to reject--we "accept"[34] --the hypothesis SB < MB in the National Parks Visibility and the Hazardous Waste Experiments; we reject the hypothesis in the National Water Quality Experiment. Thus, in two of our experiments the bidding, auction-like process results in contingent values that are significantly higher than initial, starting (payment card) bids.

All else equal, from this we might infer the consistency of the valuation process in the CVM with that process observed in behavioral, auction-like process. This inference is weakened, of course, by results from the National Water Quality Experiment. For this experiment, the bidding process results in average bids which are higher, in absolute terms, than initial, starting bids, but bid differences are not

TABLE 1.2

TESTS OF AUCTION HYPOTHESES

Experiment	Average Value For: (Standard Deviation) SB	MB	Accept (Reject) Hypothesis: SB < MB	Sample Size
	($ per month)			
The National Parks Visibility Experiment	$5.69 (7.21)	$9.20 (11.54)	"Accept"	64
National Water Quality Experiment	$6.50 (8.48)	$8.71 (11.11)	Reject	56
The Hazardous Waste Experiment[1]	$16.02 (20.78)	$25.85 (36.43)	"Accept"	163

[1] Values are those obtained from pooling (intensive) experiment data from Houston and Albuquerque components.

statistically significant at 90 percent and 95 percent levels (the relevant t-statistic is 1.3, lower than the critical value of 1.65).

(iii) Caveats/Comments. Obviously, a demonstration that the valuation process in CV studies is consistent with other valuation processes which actually culminate in behavioral responses (actual payment) does not, in itself, establish that behavioral intent underlies CV measures. Little imagination is required to conjure alternative, and perhaps conflicting, implications of the inequality between SB and MB. This demonstration, however partial, is, however, on a piece of what will be shown to be a larger picture which, taken together, has interesting implications for the potential behavioristic character of CV responses.

Budget Constrained Bids

(i) Motivation and Hypotheses. From received economic theory, individual valuations of goods/services entails the introspective process of sorting through ones' preferences and allocating a fixed budget across the consumption set. The equilibrium, "equi-marginal" allocation of that fixed budget such that the ratio of marginal utility to price is the same for all goods/services purchased implies individual awareness of trade-offs between goods/services implied by their price and the fixed budget. As an extension of the argument set out above in discussion of the auction process, if CV bids are indeed considered in value--intended payment behavior-- terms as opposed to attitudinal terms, it must be true that, in offering the valuation, individuals are cognizant of opportunity costs, vis-a-vis foregone purchases of goods/services (or savings), implied by the bid. In other words, the budget constraint must be effective in the individuals determination of his/her bid.

In subsection A.2 a method was described for inquiring as to the effectiveness of budget constraints on bids offered by participants in CV studies. SB values are elicited from one group of participants. A second group is asked to reveal their monthly, take-home income and how that income is expended or saved prior to the willingness to pay (WTP) question. The WTP question is then posed, along with the request that the participant indicate that (those) current expenditure item(s) that will be reduced in order to facilitate payment of the offered contingent value. The resulting "budget constrained" bid is denoted SBY. If contingent values are considered with a value context wherein budget constraint-related trade-offs are considered, one would expect no difference between SB and SBY. Thus the hypothesis of interest here:

$$H_o : SB = SBY \qquad (1.3)$$

$$H_A^o : SB \neq SBY. \qquad (1.4)$$

(ii) Study Results. Values for SB and SBY obtained in the National Parks Visibility, National Water Quality and the Hazardous Waste Experiments are given in Table 1.3, along with results from tests of the hypothesis SE = SBY. The null hypothesis is "accepted" in all three experiments-- those participants given explicit budget information have

TABLE 1.3

TESTS OF BUDGET CONSTRAINT HYPOTHESES

Experiment	Average Value For: (Standard Deviation) SB	SBY	Accept (Reject) Hypothesis: SB = SBY	Sample Size
	($ per month)			
The National Parks Visibility Experiment	$5.69 (7.21)	$6.77 (6.16)	"Accept"	64
National Water Quality Experiment	$6.50 (8.48)	$13.40 (13.65)	"Accept"	89
The Hazardpus Waste Experiment	$16.67 (22.91)	$17.93 (21.03)	"Accept"	88

[1]Data are for pooled Albuquerque-Houston, intensive data.

differing, income adjusted bids than those not given such information, but bid-differences are not statistically significant.

(iii) Caveats/Comments. Failure to reject the hypothesis SB = SBY lends credence to the notion that CV measures are couched in terms of values which, in turn, gives support to their interpretation as indicative of intended behavior.

Altering the Consumption Set

(i) Motivation and Hypothesis. Received economic theory suggests that, analogous to a fall in the price of 2 substitute good, the introduction of a substitute good (along with its price) into the individuals' feasible consumption set will result in ex post consumption levels of previously consumed goods (for which the "new" good(s) is (are) a substitute) that are less than or equal to ex ante levels. Let P_1, q_1 and P_2, q_2 refer to price/value and consumption levels of the ex ante-consumed and "new" commodities, respectively. By implication, if, with the introduction of the substitute good q_2, the quantity q_1 is fixed, equilibrium can be obtained only if P_1^2 (ex post) is less than or equal to P_1(ex ante).

For the moment, hold P_i, q_i constant for all goods and services presently consumed by the individual other than goods 1 and 2, with q_1 and q_2 fixed; superscripts a and b denote ex ante and ex post values, respectively. A much stranger axiom is implied by the above, viz., $P_1^a > P_1^b$ if $MUq_1/P_1^a < MUq_2/P_2$. Thus, the ex post (after introduction of the "new," substitute good) valuation of q_1 must be strictly less than the ex ante value if, given the new good q_2 and the individuals valuation of q_2, P_2, the new good is "worth" as much or more of the "old" good (and, therefore, the new good is purchased).

All else equal, this axiom suggests an interesting, testable hypothesis for efforts to contrast the valuation process in the CVM with theoretical axioms based on market behavior. Consider a CV commodity, Q_1, for which an MB value (P_1^a above) has been obtained. Let a new environmental commodity (or other public good), Q_2, that potentially substitutable for Q_1 be introduced to the study participant. The participant is asked if he/she remains willing to pay MB for Q_1 in light of his/her valuation of Q_2. If the response is negative, acquire the individuals "adjusted" bid for Q_1, denoted AMB ("adjusted maximum bid" analogous to P_1^b above). We would then posit: AMB < MB if Q_2 is consumed, AMB = MB otherwise.

When the assumption $q_i^a = q_i^b$ for all other goods i is relaxed, however--i.e., consumption of goods other than good 1 can be substituted for Q_2--the proposition becomes weaker: AMB < MB if Q_2 is consumed--AMB < MB when Q_1 is traded off for Q_2 and AMB = MB when Q_2 is consumed exclusively at the expense of goods other than Q_1.

The hypothesis AMB < MB remains interesting, particularly in cases where Q_2 is a reasonably close substitute for Q_1, and is used in this work.

As described in sub-section A.2, following the MB bid, groups of study participants are introduced to environmental goods that may be close substitutes for the primary CV commodity and are asked if they wish to revise--or "adjust"--their MB bid. We then test the hypothesis:

$$H_o : AMB < MB \quad (1.4)$$
$$H_A^o : AMB = MB. \quad (1.5)$$

(ii) Study Results. The effects of altered consumption sets of contingent values for primary CV commodities are examined in the National Parks Visibility and the Hazardous Waste Experiments; results are given in Table 1.4. In both Experiments, the effect of altering the consumption set is to lower the average bid for the primary CV commodity--the absolute value of AMB is lower than MB, reflecting downward adjustments in bids as study participants consider the primary CV commodity within a broader context which includes other substitute, environmental goods. Given the large variances surrounding mean values, however, tests for differences between mean values for AMB and MB in the Hazardous Waste Experiment but not so in the case of the National Parks Visibility Experiment.

(iii) Caveats/Comments. In our continuing search for manifestations that are indicative of CV measures as reflecting valuation processes, results given in Table 1.4 are somewhat encouraging. In a valuation process (as contrasted to an attitudinal, "I like" statement), altered consumption sets via the introduction of substitute goods would lead to downward adjustments in values as seen in results from the National Parks Visibility and the Hazardous Waste Experiments. The fact that the lower (50 percent lower) AMB value does not differ from MB in the "statistically significant" sense weakens any effort to draw definitive conclusions from the experiments. As is shown below, however, when viewed within the context of the totality of experimental results from the Methods Development Project, these results prove to be most useful in assessing the potential of the CVM.

B.3 Indirect Indicators of Intended Behavior in CV Responses

(i) Motivation and Hypotheses. For completeness, we conclude our efforts to validate CV measures by examining hypotheses which relate CV values to value-related characteristics of study participants. Thus, if CV values are indicative of intended behavior, if study participants are viewing the CV commodity in value terms, we would expect preference-related determinants of value to be reflected in CV bids.

Consider the following regression equation.

$$SB = \alpha_0 + \alpha_1 Y + \alpha_2 E + \alpha_3 S + \alpha_4 N + \alpha_5 A, \quad (1.6)$$

where:

Y: household income
E: education of respondent
S: sex of respondent