Modeling the Total Hydrologic-Sociologic Flow System of Urban Areas - Phase II

Wade H. Andrews
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INTERIM REPORT

MODELING THE TOTAL HYDROLOGIC-SOCIOLOGIC FLOW SYSTEM OF URBAN AREAS - PHASE II

by

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The work reported by this interim report was supported in part with funds provided by the Department of the Interior, Office of Water Resources Research, under Project Number C-4364, Agreement Number 1431-0001-9053, Investigation Period September 1, 1972 to August 1, 1974

Submitted by

Utah Center for Water Resources Research

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SECTION I

Introduction and Overview

This is an interim report on Phase II of the three phase study. The objectives covered in this phase were:

1. To gather social and hydrologic data needed to calibrate and test the model.
2. To expand the physical model to include the rural part of the watersheds.
3. To test and improve techniques of the logical linking of the hydrologic and sociologic systems.
4. To begin adapting the model to the computer.

During the second phase for the hydrologic component of the model major emphasis was placed on the expansion of the hydrologic area and the collection and analysis of additional physical data. The major emphasis for the sociologic part of the model was on the gathering of social data by the re-designing and testing of an improved research instrument (schedule or questionnaire) and administration of this schedule to a random sample of the general population in the urbanized area. The urbanized area is related to the physical hydrologic area of the study. The data were collected to improve the basic methodology and conceptualizations for linking the hydrologic and sociologic systems together in one model.

Division of this report

Section II of this interim report deals with development of the physical
component of the hydrologic-sociologic model. It describes the expansion of the hydrologic to include the rural parts of the watershed and tests for validation of the physical submodel.

Section III reviews the type of work done in Phase II of the sociologic work. This consisted of: (1) reviewing the accomplishments and limitations of the first phase; (2) redesigning the questionnaire to correct deficiencies in the one used in the first study, to measure additional variables thought to perhaps be relevant to the problem, and where desirable, to adapt them to the general population of the area rather than to specialized populations; (3) pretesting of component parts of the revised schedule; (4) drawing of a random sample from the population; (5) interviewing of the sample; (6) coding and processing of data for analysis; and (7) preliminary analysis of the results of the data.

Progress made in the mathematical formulations of social elements is vital. The refinement of measurement of the population data for use in the model is of central importance since the effectiveness of the testing, verification, and consequent improvement of the model depends on the accuracy of the measurement of the variables involved.

Section IV shows some details on the work performed in interrelating the sociologic and hydrologic components of the model, and on one possible mathematical formulation which shows some of the interrelationship between these components. It is hoped that the formulation achieved will be useful to planners, not only in increased understanding of the total system, but also in the analysis of the merits of flood-control proposals relative
to the social characteristics of particular areas.

Section V discusses the purposes of the work of Phase II and the objectives expected to be met during the coming phase.
SECTION II

The Physical Component of the Model

Work on the hydrologic or physical component of the total model was directed primarily at meeting the following two objectives:

1. To expand the physical submodel to include the rural parts of the watersheds within the study area (Figure 1).

2. To test, validate, and improve the model components on the basis of field data from the rural parts of the watersheds.

The various tasks which were performed in connection with the hydrologic submodel during the period of Phase II are set out briefly as follows:

1. Important differences were identified between the hydrologic system associated with rural and urban watersheds. The hydrologic component of the model for urban areas was developed and tested under Phase I (Andrews, et al. 1973). Many of the same fundamental concepts of the urban model were applied in the application of the hydrologic model to rural areas. In addition, experience and knowledge was applied which was developed through earlier studies (Shih and Hawkins, 1972). In the formation of the hydrologic model for rural areas, factors were emphasized which affect runoff rate and those which are subject to change by human activities.

2. The rural portions of the study were defined. The major drainages are Parley's Creek, Mill Creek, Big Cottonwood Creek, and Little Cottonwood Creek (Figure 1). The rural part of the Mill Creek drainage
Figure 1. Map showing watershed boundaries, streamflow gages, and location of climatological stations within both the rural and urban portions of the study area.
was selected as a preliminary test area, and needed hydrologic data were calibrated and processed.

3. Models containing two degrees of resolution in the time dimension were applied to Mill Creek. One model is based on a daily time increment and is capable of continuous simulation of streamflow throughout a water year. The other model uses an hourly time increment to simulate runoff hydrographs associated with storms of a short duration. Flow charts of the two models are shown by Figures 2 and 3, respectively. Specific details of the models and the computer programs will be presented in the final report following Phase III of this study. Figure 4 shows a sample of output for the hourly model associated with particular storm events on the rural portion of the Mill Creek drainage.

4. Using the principal of hydrologic homogeneity, values of model parameters which were developed for watersheds with observed data were used for interpolating respective values for ungaged watersheds (Figures 5 and 6).

5. The models were used to predict runoff hydrographs for particular events at various levels of watershed urbanization and antecedent soil moisture within the root zone. Graphical results from this part of the study are presented by Figures 5, 6, and 7.

6. Data for the rural portions of other drainages, namely Parley's, Big and Little Cottonwood Creeks, were collected and processed. Typical physiographic data for some of the watersheds within the study area are shown by Table 1. On the basis of these data, and from appropriate
Figure 2. Flow chart showing the various hydrologic processes represented within the daily time increment model.
Figure 3. Flow chart showing the various hydrologic processes represented in the hourly time increment model.
Figure 4. Hydrographs of observed and computed streamflow at gaging station No. 1700 on Mill Creek for the storm of August 28, 1971.
Figure 5. Hydrographs of runoff from Olympus Cove area (0.6 sq. mi.) for various degrees of urbanization.
Figure 6. Graph of peak runoff against the causative storm recurrence interval as influenced by antecedent soil moisture level, Neffs Canyon watershed (3.5 sq. mi.).
Figure 7. Graph showing relation between storm frequency, antecedent soil moisture, degree of urbanization, and peak runoff for the Olympus Cove area.

Peak runoff from an area of 0.6 sq. mi. (CFS)

Recurrence interval

900 600 400 200 100 70 50 40 30 20 15 10 5 3 2 1 0.5
0.2 0.1 0.05 0.01

ASML = 4 in.

0.5 m 1 m 3 m 5 m
Table 1. Physiographic data for the watersheds involved in the study.

<table>
<thead>
<tr>
<th></th>
<th>Mill Creek Sub-watershed 1</th>
<th>Mill Creek Sub-watershed 2</th>
<th>Parley's Creek</th>
<th>Big Cottonwood Creek</th>
<th>Little Cottonwood Creek</th>
<th>Neffs Canyon</th>
</tr>
</thead>
<tbody>
<tr>
<td>drainage area (sq. mi.)</td>
<td>7.7</td>
<td>14.0</td>
<td>50.7</td>
<td>50.0</td>
<td>27.4</td>
<td>3.5</td>
</tr>
<tr>
<td>channel length (mi.)</td>
<td>4.8</td>
<td>5.2</td>
<td>18</td>
<td>10</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>channel slope (ft./mi.)</td>
<td>530</td>
<td>320</td>
<td>200</td>
<td>485</td>
<td>470</td>
<td>1,100</td>
</tr>
<tr>
<td>mean watershed elevation (ft. - msl)</td>
<td>8,200</td>
<td>7,000</td>
<td>6,700</td>
<td>8,400</td>
<td>9,000</td>
<td>7,800</td>
</tr>
<tr>
<td>headwater elevation (ft. - msl)</td>
<td>9,200</td>
<td>-</td>
<td>8,050</td>
<td>10,500</td>
<td>11,000</td>
<td>8,600</td>
</tr>
<tr>
<td>aspect</td>
<td>WNW</td>
<td>W</td>
<td>WSW</td>
<td>WNW</td>
<td>W</td>
<td>NW</td>
</tr>
</tbody>
</table>
Table 2. Optimized parameter values* for Subwatersheds 1 and 2 of Mill Creek.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mill Creek</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Subwatershed 1</td>
<td>Subwatershed 2</td>
</tr>
<tr>
<td>SFC</td>
<td>Field capacity of soil</td>
<td>6.00</td>
</tr>
<tr>
<td>TBF</td>
<td>Base flow decay constant</td>
<td>.004</td>
</tr>
<tr>
<td>GLL</td>
<td>Groundwater storage level above which sub-surface outflow occurs</td>
<td>4.8</td>
</tr>
<tr>
<td>TGW</td>
<td>Interflow decay constant</td>
<td>.04</td>
</tr>
<tr>
<td>QK</td>
<td>The fraction of outflow from soil moisture that becomes interflow</td>
<td>.15</td>
</tr>
<tr>
<td>SMR</td>
<td>Snow melt rate</td>
<td>.11</td>
</tr>
<tr>
<td>ETF</td>
<td>Evapotranspiration factor</td>
<td>.59</td>
</tr>
<tr>
<td>TAUSW</td>
<td>Surface runoff decay constant</td>
<td>.30</td>
</tr>
<tr>
<td>SI</td>
<td>Upper limit of interception storage</td>
<td>.40</td>
</tr>
<tr>
<td>FC</td>
<td>Minimum value of infiltration</td>
<td>2.0</td>
</tr>
<tr>
<td>FO</td>
<td>Infiltration decay constant</td>
<td>2.0</td>
</tr>
<tr>
<td>SS</td>
<td>Saturated soil level</td>
<td>12.8</td>
</tr>
<tr>
<td>WILT</td>
<td>Wilting point of the soil</td>
<td>1.0</td>
</tr>
<tr>
<td>ROS</td>
<td>Factor related to snow melt by rain</td>
<td>.01</td>
</tr>
<tr>
<td></td>
<td>Neffs Canyon</td>
<td></td>
</tr>
</tbody>
</table>

*Parameters are shown in decreasing order of sensitivity.
Table 2 Cont. Optimized parameter values for Subwatersheds 1 and 2 of Mill Creek.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Mill Creek</th>
<th>Big Cottonwood Creek</th>
<th>Little Cottonwood Creek</th>
<th>Neffs Canyon</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Sub-</td>
<td>Sub-</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>watershed 1</td>
<td>watershed 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRAIN</td>
<td>Temperature above which all precipitation falls as rain</td>
<td>35.0</td>
<td>35.0</td>
<td>38.0</td>
<td>38.0</td>
</tr>
<tr>
<td>CPF</td>
<td>Channel precipitation factor</td>
<td>.003</td>
<td>.003</td>
<td>.003</td>
<td>.003</td>
</tr>
<tr>
<td>FNGM</td>
<td>Factor related to ground melt in snow pack</td>
<td>.02</td>
<td>.023</td>
<td>.02</td>
<td>.02</td>
</tr>
<tr>
<td>TFWSN</td>
<td>Temperature of free water in snow pack</td>
<td>.10</td>
<td>.18</td>
<td>.15</td>
<td>.25</td>
</tr>
<tr>
<td>Mean value of the objective function (ins per unit area)</td>
<td></td>
<td>1.53</td>
<td>3.24</td>
<td>5.75</td>
<td>12.82</td>
</tr>
<tr>
<td>Mean annual stream flow (ins per unit area)</td>
<td></td>
<td>6.97</td>
<td>10.15</td>
<td>19.96</td>
<td>33.43</td>
</tr>
<tr>
<td>Ratio of mean objective function to mean annual stream flow</td>
<td></td>
<td>.22</td>
<td>.32</td>
<td>.29</td>
<td>.38</td>
</tr>
</tbody>
</table>
Figure 8. A comparison between observed and computed runoff rates from the rural portion of Little Cottonwood Creek at station 1685 (see Figure 1) for the 1967 water year.
precipitation and runoff information, the daily time increment model was calibrated for each watershed. Values of the model parameters as optimized through the calibration process are shown by Tables 1 and 2. Figure 8 indicates typical model output for Little Cottonwood Creek, and shows the agreement which was achieved between computed and observed runoff rates for this watershed.

For any watershed within the study area the hydrologic model is now capable of predicting runoff from both the rural and urban drainages, and of combining these flows and of routing them through the urban area to the Jordan River. The model also is capable of predicting changes in the hydrologic responses and flooding patterns associated with various management practices, such as urbanization and the development of flood control structures. Thus, the hydrologic model now represents a useful component of the total hydrologic-sociologic model within the study area.
SECTION III

Data for Calibrating and Testing the Sociological Component of the Model

The principal objective of the work done in this part of the second phase of research was directed toward data gathering and the refinement of data measures for the variables expected to be important in the equations used in the sociologic model. After completion and analyses of first phase results, attention was focused on techniques to improve the schedule used to measure the social factors. Specifically, it is desirable in quantifying social data to place respondents at different points on a continuum for any particular variable. Therefore, changes were made to avoid dichotomies (such as for sex of respondent) except when required. At the same time, it was desirable to have as much comparability as possible between the two questionnaires. Consequently, attempts were made to construct questions to permit data from the second phase schedule to be collapsed to the same categories as the responses to the questionnaire used in the first phase (Andrews, et al. 1973). Almost all of the variables found to be significant for either of the two special populations surveyed in the first phase are included in the second phase survey. The complete list of variables measured in this year's field study is shown as Appendix A, and the questionnaire itself is Appendix B.

Expansion and testing of the second phase schedule

New variables were added to the schedule. Some of these were
demographic information obtainable from census data (Appendix A, variables 258-267). These were included because they would simplify application of the model if found since significant demographic data are readily available anywhere in the United States.

Other new variables include a group of questions for obtaining a respondent's attitude toward each of a comprehensive list of flood control methods (Appendix A, variables 146-165). The list of twenty-two methods was pretested locally to determine if people distinguished between the various methods. Analysis of pretest results dictated that all but two of the flood control methods be retained on the list.

Analysis of second phase data indicated new measures which were obtained from groups of items. As an example, from the responses to the list of flood control methods two additional measures were obtained. One was the mean differentiation of response to the methods (Appendix A, variable 167); this indicates the extent to which a respondent varies in his response to these items which may be useful later as an indicator of attitude toward flood control methods collectively.

Special groups of questions were asked of all those who had heard of proposed flood control plans for the local area. In addition to asking whether the respondent had heard of the proposed local flood control plans, the respondent was asked to rate each one according to variables: cost, effectiveness, effect on recreation, appearance, and the ecological effect (variables 1968-208). This was done to determine the relative importance of the respondent's perceptions and his expressed feeling about
these proposals and to compare the relative importance of these factors.

**Attitude measurement**

Special attention was given to the development of attitude scales to measure attitudes which were likely to be important for the evaluation equation. Appendix C shows eight scales that were developed. These are titled as follows:

I. Perception and Concern for Flooding as a Problem in the Respondents Area

II. Attitude Toward Effect of Man-Made Objects Upon Beauty of Nature

III. Leisure Orientation

IV. Outdoor Recreation Orientation

V. Willingness to Pay for Government Expenditures

Among these measurement scales were variables related to the respondent's perceptions. The method used forms called Likert summated score scales (Appendix C shows the method, the variables, and the questions constituting each scale on the main questionnaire). Each of the items composing a scale may itself be treated as a variable in addition to its contribution to the total scale.

Because of the probable significance of some of the measurement scales and need for additional testing, several additional questions were asked for each scale of specified limited sub-samples to permit strengthening these attitude scales for future use. Items for two additional scales were also tested: Outdoor Natural Aesthetic Orientation and Attitude
Toward Pollution Control.

The items composing each scale were not chosen arbitrarily, but rather were derived from the results of a pretest of a large list of related items administered to a pretest sample (N = 37) of the same population area from which the main sample was drawn. Several techniques were used to analyze the results of the pretest to select items for the main schedule. These were item analysis, factor analysis, and a tentative measure herein called a discrimination index, which is a measure of the ability of an item to discriminate respondents into different groups or to order respondents in ranked categories.

These efforts were made to improve the measurement of social variables in the population. Other actions taken to improve the measurement of the social variables included the pretesting of questions for clarity and consistency of meaning. Some items were found unusable, even though considerable effort was used on improving the interviewing. One of these was the feasible length of questionnaire.

The measurement of social variables is often complex (Torgenson, 1958; Lazerfield and Henry, 1968; Stouffer, et al., 1950) because of the number of types of variables that may be measured (attitudes, needs, values, goals, beliefs, characteristics and behavior of various types). It is expected that refinement of the model resulting from this research project may largely occur through the development of improved measures of social variables.
Interviewing and the sample population

The schedule was given to the sample obtained from the population described in the introduction by use of 1970 census information. Each block in the area had a proportionate chance of being selected on a given draw to the number of households listed in the 1970 census. Within a block each household had an equal chance of being chosen. This was done by counting a randomly selected number of households clockwise from a randomly designated corner. A map was made of the household location of each member of the sample in order to aid interviewers in locating the right house or apartment. Interviewers were instructed to interview a previously assigned sex of respondent at each household, unless an adult of that sex did not live at that residence in which case the interviewer could interview the occupant. The total number interviewed in this sample was 395.

Interviewers were given training and instruction regarding the questionnaire. Interviewers took practice interviews, not included in the survey results, to insure that the schedule would be properly understood, standardized, and presented the same way by all field workers. The interviewing required nearly three months. A great effort was made to interview all those designated in the sample. The interviewer tried three or more times to interview a designated respondent. The non-completion rate due to refusals, language barrier, inability to locate, or other problems was about ten percent.
Data processing

After the interviewing was completed, a number of steps were necessary to prepare the data for initial analysis. The response to each item was coded on the questionnaire and then punched on cards for computer processing.

One way tabulations were first run on each item. These were then analyzed for distribution and number of "no" answers. A second set of card decks was then made to be used for cross-tabulations. Special analyses of some of the scales were also performed.
A unique objective of this research is to integrate the determined hydrologic and sociologic components in one model of the entire system. Some connections such as the effect of likelihood of flooding (a function of the hydrologic system) upon the flood experience of people and upon their concern about flooding, or the effect of urban development (functions of the sociologic system) upon surface water runoff and upon likelihood of flooding are direct. This type of interrelationship was discussed in the first phase report and was evident in some cases in secondary equations (Andrews, et al., 1973).

In the second phase further attention was also given to this usual type interactive relationship. However, the major thrust was on the development of an effective description of the total hydro-social system in one set of equations. The groundwork for this was laid in the first phase (Andrews, et al., 1973). A review of some of the basic concepts from the first phase, a description of the basic equation that may be used, a discussion of some possible ways in which the model may have utility to planners, and some comments on modeling in general follow.

Basic concepts

The mathematical model of the sociologic-hydrologic system was
conceived as the interaction of four principal sets or types of components. They are:

1. Pertinent social characteristics of populations (including groups) related to the area.

2. Agency characteristics - both action and planning agencies. ¹

These are characteristics which can be assigned a value and are related to the decision made. The categories of characteristics for the various types of agencies involved will largely be the same, but the appropriate values of these characteristics need to be determined.

3. Physical construction characteristics of the proposed flood-control methods.

4. Hydrologic system characteristics.

Two of the above sets of characteristics are essentially social, and two are essentially physical. Interactions between subsets will be determined and subsystems combined to form a model of the total sociologic-hydrologic system.

The type of relationships in the submodels and the total model can be directly linear, of a form that can be made linear, or of a non-linear form. It is desirable, if possible, to use a model which is linear or can be made linear. A linear form is generally much easier to work with, although appropriate limits of applicability need to be set (Narayana, et al., 1970).

¹ The planning and action agencies may be the same.
The terms or factors in the equations (i.e., the sets of characteristics) need to be operationally defined in a manner that permits alternative flood control proposals to be compared on the same basis. For modeling purposes a method needs to be developed for assigning numerical values to the significant characteristics of flood control proposals and of pertinent social groups to form scales that may be treated as interval or ratio. This is difficult for social and socially related physical factors such as aesthetics where no direct or standardized measures exist but needs to be determined or designed.

Once consistent measures are established, the relationship between a cause and result can be established. Coefficients and constants of the general equation will be determined by considering each factor individually and collectively. Regression analysis and computer techniques will be used to make the determination (Narayana, et al., 1970). Single variable relationships are readily established, even with limited data. However, multivariable relationships come much more complicated. The complexity increases very rapidly with the size of the set. If the set is too large, it becomes necessary for operational reasons to decompose the set into simpler concepts. When the mathematical relationships are specified, a mathematical model can be made. The model can then be improved by comparison of the simulation to reality and correcting the model for a better fit in a continuing process.

A set of variables for a proposed project which has been hypothesized to be significant are:
1. Ability to control flooding.
2. Outdoor recreation provided or destroyed.
3. Outdoor aesthetics provided or destroyed.
4. Ecological impact (disturbance or improvement of natural conditions).
5. Cost per capita.

Discussion of these variables may be found in the first phase report (Andrews, et al., 1973). Resolution of operational, consistent, and workable measures of the socially related factors of flood control problems is a particularly difficult problem on which work is continuing. These variables can be used in the computer model and to determine the most desirable plans through combination with other concepts such as bar graphs.²

Characteristics of flood-control proposals and other sets (agency, population, hydrologic systems) will be used in various subroutines. Population characteristics, for instance, are needed in several places in the system (Andrews, et al., 1973).

Equations using largely the same factors will be formed for public opinion and public reaction. Public opinion occurs initially and is later followed by public reaction. One equation for "public opinion" will represent the demand for flood control by a particular population. Operationally this should be related directly to the pressure exerted on the agencies to "do something about" flood control. An equation will be formed to indicate

²See subsection following entitled "Utility for Planners."
a negative or positive value for the mean public reaction to particular plans. Favorable and unfavorable reaction indicators should consider the effect that each has upon the other (they are not mutually independent) and the likelihood of organized opposition or advocacy appearing.

Hopefully, the significant factors needed for the public will be found in the list of variables of the questionnaire which was administered during the second phase (see Appendix B). Analysis of these factors will provide a basis for relationships of various factors found to be significant.

Utility for planners

One way of identifying values for the factors is to use an operationally defined set of characteristics of a flood control proposal that are related to a set of values in the population. Assuming the definitions of the factors involved are consistent so that different proposals can be compared; the following concepts should be useful. As an example, the general variable recreation will be used.

\[ Q_{nr} = \text{Quantity of (potential) recreation provided by project } n. \]

\[ K_{rp} = \text{Value rating by population, } p, \text{ for recreation (Andrews, et al., 1973)} \]

The definition of recreation must be the same in each of the above for these concepts to be related and therefore usable. The determination

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3" means "is defined as"
of each should be independent of the other, however.

\( R_{np} \) is the benefit index for population, \( p \), from project, \( n \), for recreation and is equal to the value of the acceptance function for recreation.

The reason for the name "Benefit Index" will become clearer as the discussion proceeds. It is figured according to the following formula:

\[
R_{np} = Q_{nr} \cdot K_{fp}
\] (1)

The benefit index is the algebraic product of \( Q_{nf} \) and \( K_{fp} \) (\( f \) represents the particular factor under consideration). This means that if both \( Q_{nf} \) and \( K_{fp} \) are positive, the benefit index will be also. If \( K_{fp} \) is positive, i.e., the value rating of the population, \( p \), is favorable toward a particular factor, and \( Q_{nf} \) is negative, i.e., the project destroys some of the particular factor, the benefit index would be negative. In the case of recreation, it can be assumed that the value rating would be positive generally; if this were true and the project destroyed recreation, the benefit index for recreation would be negative, which is realistic. The equation is also logical in the unlikely cases where \( K_{fp} \) and \( Q_{nf} \) are both negative, i.e., when the project eliminates what people do not want, producing a positive effect;

\[ \text{It is preferable to determine the quantity of recreation (or other factors) involved by some other means than by reference to the population in order to avoid the possibility that the value ratings of the people about a particular factor will affect their perceptions of the quantity of that factor. If the quantity is specified by the population, then it is a perceived quantity and relates only to specific populations. It is desirable to define the quantities in terms of the proposals themselves. Using the population to determine } Q_{nf} \text{ (} f \text{ represents the particular factor under consideration) would limit the utility of concepts involving } Q_{nf} \text{ as proposed project affecting different populations would not have a consistent measure of } Q_{nf} \text{ as } Q_{nf} \text{ would depend on the perceptions of the population, which may vary.} \]
and where $K_{fp}$ is negative and $Q_{nf}$ is positive, i.e., the effect is negative if the project provides a factor the people have negative feelings about. It may be better to limit the value rating to the positive range, as this would be generally realistic (for instance, how many people have strong feelings against recreation, aesthetics, or ecology?) in which case the last two possibilities are eliminated.

The benefit index may be graphed by itself or used in the development of further indices. For example, if availability is the ability of the population to use a particular factor provided by a proposed project and $r_{pn}$ is the availability of recreation provided by the project, $n$, to population, $p$, then the benefit to population from project can be defined as the product of the benefit index for the factor under consideration and the availability of that factor provided by the project to the population. For recreation, this is:

$$B_{rnp} = R_{np} \cdot r_{pn}$$

where

$B_{rnp}$ = the benefit of recreation provided by project $n$ to population $p$.

$R_{np}$ and $r_{pn}$ are defined as before.

Substituting (1) in (2)

$$B_{rnp} = Q_{nr} \cdot K_{rp} \cdot r_{pn}$$

The above concept could be useful particularly in evaluating alternative projects affecting the same population. If one wishes to consider the number of people affected (i.e. number in population $p$) then one side of equation (2) can be multiplied by the population to
form a new value useful for this purpose:

\[ V_{rnp} = \text{Value to population } P \text{ of recreation } r \text{ provided by project } n. \]

\[ P_p = \text{population (no.) of population } p. \]

\[ V_{rnp} = B_{rnp} \cdot P_p \]

or (substituting (2) on (4))

\[ V_{rnp} = R_{np} \cdot r_{pn} \cdot P_p \]

or

Substituting (1) in (5)

\[ V_{rnp} = Q_{nr} \cdot K_{rp} \cdot r_{pn} \cdot P_p \]

The concept of Value would be useful in comparing flood projects in different areas (different \( P_p \)) to determine which would provide the greatest benefit considering the number of people benefited. When one does not desire or does not need to consider population numerical differences, then the Benefit is a useful concept. \( V_{fnp} \) and \( B_{fnp} \) can both be graphed to provide profiles for alternative proposals. This could be done with \( V_{fnp} \) in considering which proposal to fund in different areas with limited funds for maximum value for the factor under consideration, or with \( B_{fnp} \) when considering alternative flood control measures affecting the same population.

**Comments on modeling**

The following three facts should be remembered about mathematical models of any type:

1. Operational definitions of variables need to be specified.
2. Analysis of data is necessary to formulate mathematical relationships, as well as to verify them.
3. Models are always tentative in the sense that they are subject to
changes when more information is obtained. These changes can be both in the weightings or values of equations or in the form of the equation itself in order to match the mathematical construction more closely to reality.

Equations within a model form subsystems (or subroutines). The subroutines can be calibrated using subsystem data if available. One would have to be able to measure the output of the subsystem (dependent variable in an equation) in order to do this.

**Basic equation for a model of social and physical elements**

The basic dependent variable in the following equation is the evaluation of flood control proposals by a particular group. This group may be an agency or a defined population. The reaction to a specific flood control proposal is predicted by putting the characteristics of that proposal into the equation. The values of the variables should be adjusted to the characteristics of each type of group to which it is applied. A general form of this equation is:

\[ y_g = b_0 + b_1 x_{10} + b_2 x_{20} + b_3 x_{30} + b_4 x_{41} + b_5 x_{50} z_{50} + b_6 x_{60} z_{60} + b_7 x_{70} z_{70} + b_8 x_{80} z_{80} + b_9 x_{90} z_{90} + E \]  

(7)

where:

- \( y_g \) = predicted evaluation of a specific flood control proposal by a particular group
- \( b_0 \) = regression constant for model (1)
- \( b_1 \) . . . \( b_{10} \) = regression coefficients
- \( x \) = factors from population or agency
- \( z \) = factors from flood control proposal
v = factor from other source of influence on flood control proposal evaluation

E = Error variance of model

These variables are discussed below.

The terms shown in this model equation are simplified. For instance, although only simple linear relations are expressed in the first three terms of the equation. It is expected that the analyses of data will reveal non-linear relationships and that this will be reflected in the terms of the equations used in the computer model. The other terms in the final results may also be more complex than shown in Equation (7).

There are four general types of relationships represented among the independent terms of Equation (7) 5.

1 - Terms in which no interaction occurs ($b_1 - b_3$). These are expected to be factors in the population or agency which are found to influence the predicted reaction to a proposal but whose effect is independent of anything else. The characteristics of a particular proposal or the opinions of others would have no effect on it, or, in other words, this term has the same influence on the attitude toward a flood control proposal regardless of the proposal being evaluated. Terms of this type may be considered as factors related to a tendency to accept or reject flood control proposals in general. This tendency has been called the underlying disposition to accept or reject flood control proposals (Andrews, et al., 1973).

2 - Terms in which the variables are all from one type of component

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5 Equation (7) above is different from Equation (4.4) in the first phase report (Andrews, et al., 1973) in that the variables in this equation are general rather than specific and variables of types I and II (see following) are used directly in the equation.
but more than one of these factors appear in the same term of the equation. Terms of this type are expected to consist of combinations of social variables. They would occur when a variable has an effect on evaluation only when and to the extent that another variable is also present. An example of this type is the term beginning with $b_4$ in Equation (7).

Also as mentioned in the first phase annual report (Andrews, et al., 1973), variables from the agency or population which do not account for some of the differences between groups in perception of particular flood control proposals but rather influence the attitude toward all flood-control proposals collectively affect the value of $b_o$ in an equation of form (1). The more of these types of variables that contribute to the explanation of the dependent variable, the less the value of the remaining $b_o$ term in equation (7). This can be seen from the following:

$$b_o' = b_o + b_1x_{10} + b_2x_{20} + b_3x_{30} + b_4x_{40}x_{41}$$

Substituting (2) in (1), equation (1) becomes

$$y = b_o' + b_5x_{50}z_{50} + b_6x_{60} + b_7x_{70}z_{70} + b_8x_{80}z_{80} + b_9x_{90}v_{90} + E$$

Equation (8) is possible and logical because all terms on the right hand side of the equation are constant at a given time. No proposal characteristics or other external factors are present.

It can be seen from this that if the amount of variance explained by Equation (8) is increased that the value of $b_o$ in Equation (7) would be decreased. If there were no explanatory terms in (2), $b_o$ and $b_o'$ would be the same; it is the addition of these terms that partially explains $b_o$ and consequently reduces $b_o$. As one finds additional factors useful in
Equation (8), this would be increasingly true.

Another implication is that the model can be calibrated without knowing the values of the variables contained in terms of types one or two. This could be done by using Equation (9) which contains none of these terms.

3 - Terms in which a factor from a proposed project and a factor from the population or agency appears \((b_5 - b_8)\) in Equation (7). These reflect the differences in characteristics between flood control proposals. The \(z\) factors or factors from the proposal should be measurable descriptors of features of flood control proposals which make a difference in the reaction to proposals. The \(x\) factors or factors from the population are values or attitudes which are related to the respective \(z\) factors. For a given population or agency these are set at a given time. The differences in reaction to different flood control proposals can be seen by inserting the values for the different proposal factors in the equations of the model. This also may have bearing on other remaining interaction terms discussed in type 4 below.

Ideally, the proposal factors should completely describe all differences in flood control proposals which make a difference in people's reactions to them. For this research project, it has tentatively been decided that the factors of cost, effectiveness, effect on recreation, aesthetics, and possibly ecology would be used. Related attitudes in the population have been measured (Appendix C).

Numerical values for various flood control proposals for each of
these five factors will provide data for use in equations of this type. Another way of describing the function of these proposal characteristics is that just as the differences in reaction specific to a proposal depends on differences between populations, the differences in reaction of a particular population depends on differences between proposals. Both types of differences must be described mathematically to develop this model. Work is being continued to derive these needed values.

One could also, for a given proposal, insert various x values in equations of type (1) to determine differences in reaction to the same proposal of different populations.

The interaction terms of the proposal project and the population, those with both x and z, have been called acceptance functions (Andrews, et al., 1973). It is expected that a minimum value, perhaps negative, may have to be obtained for each of these regardless of the total value of the equation to achieve acceptance. These could also be graphed separately and should have value to the planner particularly when the relationships between these are known; these relationships could be determined from the regression equation involving these terms.

4 - Other interaction terms. This is shown in the example as the term involving x and v; there can and probably will be more than one of these terms in the equations of the model. It is expected that among these terms will be some that represent the relationships between the attitudes of a population or other group toward "significant others or other people that affect the situation and the opinions of those others," respectively, toward the proposal being evaluated. If the flood control agency
or other experts favor or approve a proposal, for instance, and this influences the opinion of the population or other agencies toward that proposal, these terms reflect this fact.

The value for the opinion of the significant other, the $v$, would be the output or dependent variable of another equation in the model similar to Equation (7) above but representing the reaction for that agency or other group. The reaction of the parts of a system are linked to the reaction as a whole, and vice-versa.

A diagram of the conceptualization of Equation (1) is shown as Figure 9. A somewhat simplified version of the basic equation using specific variables is described in the first phase report, and is there diagramed as Figure 4 (Andrews, et al., 1973).

It is proposed that equations similar to Equation (1) be prepared for each population, subpopulation, agency or subagency needed for modeling the system. Work is progressing on creating a model based on this type of equation. Alternative methods are also being considered.
Figure 9. Diagram of conceptualization of basic equation for modeling evaluation of flood control proposal by agency or population group (see text for definitions and explanation).
SECTION V

Conclusions and Objectives

In Phase II work was completed on the "collection of both physical and sociological data to calibrate and test the models" (Andrews and Riley, 1972). This will allow the testing of mathematical calculations used for the formulation of the model "by applying the model to a particular urbanized area and by observing the degree of agreement achieved between predicted response functions and actual results as they are observed in the field" (Andrews and Riley, 1972).

This study has provided the sociological data that will be used for simulating the hydrologic-sociologic elements as one system. This data was gathered through interviews of a random sample of individuals and included "the measurement of attitudes, felt needs, social values, goals or objectives, actions taken and other behavioral information related to variables and relationships included within the model" (Andrews and Riley, 1972).

Substantial progress has been made in meeting the goals of the study as described in the preceding sections of this report. The basic approach has been "the development of a general method of analysis based upon fundamental relationships and concepts which will, therefore, be applicable to a wide variety of problems dealing with urban drainage" (Andrews and Riley, 1972).

Phase II of this project has added to the preliminary work of the
first phase through the collection of data that tested and refined previous information and provided additional and different data for both components of the model. This phase has also helped in developing a possible way of expressing the interrelationships of the elements of the two components for use in a mathematical model that may be of use to planners (Andrews and Riley, 1972). The basic equation described in this report is aimed at meeting this latter objective.

This material is intended to help implement Phase Three. The objectives of Phase III are:

1. Integrate the submodels and components and develop the data to accomplish this.

2. Simulate, by use of the computer, the hydrologic and social systems associated with flooding within a metropolitan area, and thus identify alternatives for action.

3. Improve the submodels in terms of the simulation of the total system.

4. Demonstrate by simulation methods the applicability of the model to a specific site.


The means of realizing the above goals can now be seen. The work performed in this and in the first phase should permit the next phase to move ahead.
APPENDIX A

LIST OF VARIABLES FROM THE
SECOND PHASE SCHEDULE
1. Experienced flood damage or inconvenience during lifetime (Question 1)

2. Proximity of closest location where experienced flooding to present residence (Question 1A)

3. Proximity of location where maximum damage or inconvenience accrued from flooding (Question 1A)

4. Cost of damage from flooding (Question 1A)

5. Perceived likelihood of flooding at personally owned property in Salt Lake area (Question 2A)

6. Perceived main source of flooding threat to personally owned property in Salt Lake area (Question 2A)

7. Expressed concern about flooding in Salt Lake area (Question 3)

8. Most preferred group to pay for flood control (in order of "higher" governmental authority) (Question 4)

9. Heard about flooding problems in Salt Lake area (Question 5)

10. Closeness of information of main source(s) of information about flooding (Question 5A)

11. Perception of snowmelt as a flooding threat (Question 5A)

12. Perception of flash flood rains as a flooding threat (Question 5A)

13. Perception of long heavy rains as a flooding threat (Question 5A)

14. Perception of rain and snowmelt as a flood threat (Question 5A)

15. Perception of stream or creek as flooding threat (Question 5A)

16. Perception of other flooding threat to residence or other personally owned property in Salt Lake area (Question 5A)

17. Expressed perception of seriousness of flooding problems in Salt Lake area (Question 6)

18. Expressed awareness of neighborhood flooding problems (Question 7)

19. Expressed length of awareness of neighborhood flooding problems (Question 7A)

20. Expressed perception of seriousness of flooding problems in neighborhood (Question 8)

21. Discuss flooding problems (Question 9)

1Questions are shown in Appendix B in the second phase schedule.
22. Closeness of group of persons with whom discuss flooding problems (Question 9A)

23. No. of type of groups (Question 9A)

24. Persons with whom most frequently discuss flooding problems (Ques. 9B)

25. Main daily Salt Lake area newspapers received (Question 10)

26. Perceived proximity to stream (Question 11)

27. Perceived adequacy of number of public parks in Salt Lake City or County (Question 12)

28. Respondent visitation of public parks in Salt Lake City or County (Question 12B)

30. Picnicking activity (Question 13)

31. Walking activity (Question 13)

32. Horseback riding activity (Question 13)

33. Cycling activity (Question 13)

34. Boating activity (Question 13)

35. Fishing activity (Question 13)

36. Actual expressed frequency of participation in six outdoor recreation activities (Question 13)

37. Relative expressed participation in six outdoor recreation activities (Question 13)

38. Perception of flooding as a pressing problem in Salt Lake area (Question 14A)

39. Expressed difficulty of answering 38. (Question 14B)

40. Perception of flood control in Salt Lake area as investment (Question 15A)

41. Difficulty of answering 40 (Question 15B)

42. Perception of recommendation of government agencies (Question 16A)

43. Expressed difficulty of answering 42 (Question 16B)

44. Perception of desirability of people following the advice of experts more. (Question 17A)
45. Expressed difficulty of answering 44. (Question 17B)
46. Perception of need to modify environment for man. (Question 18A)
47. Expressed difficulty of answering 46. (Question 18B)
48. Perception of danger of serious flood damage in Salt Lake Area in next five years. (Question 19A)
49. Expressed difficulty of answering 48. (Question 19B)
50. Perception of relative ability of agencies to make correct decisions in the fields of their responsibility and anybody else. (Question 20A)
51. Expressed difficulty to answering 50. (Question 20B)
52. Perception of relative enjoyment of outdoor recreation activities to anything else. (Question 21A)
53. Expressed difficulty of answering 52. (Question 21B)
54. Perception of desirability of great reliance on experts. (Ques. 22A)
55. Expressed difficulty to answering 54. (Question 22B)
56. Perception of seriousness of flooding as problems in the Salt Lake area. (Question 23A)
57. Expressed difficulty of answering 56. (Question 23B)
58. Perception of level of taxes in Salt Lake County (Question 24A)
59. Expressed difficulty of answering question 58. (Question 24B)
60. Perception of need to do more to protect our environment. (Question 25A)
61. Expressed difficulty of answering 60. (Question 25B)
62. Perception of relative knowledge of experts to average person. (Question 26A)
63. Expressed difficulty of answering 62. (Question 26B)
64. Perception of desirability of increased personal participation in outdoor recreation. (Question 27A)
65. Expressed difficulty of answering 64. (Question 27B)
66. Perception of effect of man upon appearance of areas. (Question 28A)
67. Expressed difficulty of answering 66. (Question 28B)
68. Perception of cost of government projects. (Question 29A)
69. Expressed difficulty of answering 68. (Question 29B)
70. Perception of relative enjoyment provided by a well paved road into wilderness to anything else (Question 30A)

71. Expressed difficulty of answering 70.

72. Perception of effect of man-made objects upon beauty of nature (Question 31A)

73. Expressed difficulty of answering 72.

74. Perception of adequacy of flood control management in the Salt Lake area (Question 32A)

75. Expressed difficulty of answering 74.

76. Perception of desirability of preserving much more land in its natural state (Question 33A)

77. Expressed difficulty in answering 76.

78. Perception of benefit to people of being outdoors (Question 34A)

79. Expressed difficulty in answering 78.

80. Perception of concern of government about expenditures (Question 35A)

81. Expressed difficulty in answering 80.

82. Perception of desirability of increased leisure time (Question 36A)

83. Expressed difficulty in answering 82.

84. Perception of whether government will always waste money if it can (Question 37A)

85. Expressed difficulty in answering 84.

86. Perception of importance of being in harmony with nature (Question 38A)

87. Expressed difficulty in answering 86.

88. Perception of need for increased control by people over decisions of government agencies (Question 39A)

89. Expressed difficulty in answering 88.

90. Perception of desirability of increased play and decreased work (Question 40A)

91. Expressed difficulty in answering 90.

92. Perception of frequency of correct decisions by experts (Question 41A)
93. Expressed difficulty in answering 92.

94. Perception of whether would personally participate in outdoor recreation alone (Question 42A)

95. Expressed difficulty in answering 94.

96. Perception of desirability of flood control work other than emergency in Salt Lake area (Question 43A)

97. Expressed difficulty in answering 96.

98. Perception of desirability of people spending much more of their recreation time outdoors (Question 44A)

99. Expressed difficulty in answering 98.

100. Perception of relative desirability of lower taxes to better protection for the public (Question 45A)

101. Expressed difficulty in answering 100.

102. Perception of effect of buildings upon beauty of area (Question 46A)

103. Expressed difficulty in answering 102.

104. Perception of whether main personal satisfaction is working (Question 47A)

105. Expressed difficulty in answering 104.

106. Perception of relative importance of industrial growth to preservation of natural areas (Question 48A)

107. Expressed difficulty in answering 106.

108. Perception of effect of flood control and similar projects upon beauty of areas in which they are located (Question 49A)


110. Perception of need for stronger laws to protect environment (Question 50A)

111. Expressed difficulty in answering 110.

112. Perception of guilt feelings when personally enjoying leisure for more than a short time except when on vacation (Question 51A)

113. Expressed difficulty in answering 112.

114. Perception of desirability of government agency responsible making decisions in fields such as flood control (Question 52A)

115. Expressed difficulty in answering 114.
116. Perception of need for increased emphasis on opinion of experts (Question 53A)

117. Expressed difficulty in answering 116.

118. Perception of relative desirability of additional government services to taxes (Question 54A)

119. Expressed difficulty in answering 118.

120. Perception of desirability of forming own opinions rather than listening to experts (Question 55A)

121. Expressed difficulty in answering 120.

122. Perception of relative enjoyment of indoor activities to outdoor activities (Question 56A)

123. Expressed difficulty in answering 122.

124. Perception of adequacy of control of flooding in Salt Lake area (Question 57A)

125. Expressed difficulty in answering 124.

126. Perception of relative enjoyment of developed areas to undeveloped areas (Question 58A)

127. Expressed difficulty in answering 126.

128. Perception of definite need to further control flooding in the Salt Lake area (Question 59A)

129. Expressed difficulty in answering 128.


132. Attitude toward effect of man made objects upon beauty of nature score (Questions 28A, 31A, 46A, 49A)

133. Strength of feeling score about 132. (Questions 28B, 31B, 46B, 49B)

134. Leisure orientation score (Questions 36A, 40A, 47A, 51A)

135. Strength of feeling about 134 (Question 36B, 40B, 47B, 51B)


139. Strength of feeling about 138 (Questions 24B, 29B, 35B, 37B, 45B, 54B)


142. Willingness to follow advice of experts (Questions 17A, 22A, 26A, 41A, 53A, 55A)

143. Strength of feeling about 142 (Questions 17B, 22B, 26B, 41B, 53B, 55B)

144. Willingness to follow government agencies score (Questions 16A, 20A, 39A, 52A)

145. Strength of feeling about 144 (Questions 16B, 20B, 39B, 52B)

146. Feeling about a small earth dam 50 feet wide or less (Question 70)

147. Feeling about cleaning and deepening of a river (Question 71)

148. Feeling about a developed streamside park (Question 72)

149. Feeling about a high concrete bank or dike over 3 feet in height (Question 73)

150. Feeling about a small reservoir (Question 74)

151. Feeling about straightening of a stream (Question 75)

152. Feeling about a large wide earth dam more than 50 feet wide (Question 76)

153. Feeling about a streamside area left undeveloped (Question 77)

154. Feeling about a rock lining in a stream (Question 78)

155. Feeling about a large reservoir (Question 79)

156. Feeling about a high earth bank more than 3 feet in height along a stream (Question 80)

157. Feeling about a stream bank protection at critical points (Question 81)

158. Feeling about an underground storm sewer (Question 82)

159. Feeling about a small concrete dam up to 50 feet high (Question 83)
160. Feeling about a low concrete bank or dike under 3 feet or less in height (Question 84)
161. Feeling about an unlined or dirt canal (Question 85)
162. Feeling about concrete lining in a stream (Question 86)
163. Feeling about a low earth bank or dike 3 feet or less in height along a stream (Question 87)
164. Feeling about a concrete lined canal (Question 88)
165. Feeling about a large concrete dam more than 50 feet high (Question 89)
166. Mean feeling about flood control methods (Questions 70-89)
167. Mean differentiation of response to flood control methods (Question 70-89)
168. Heard or retention basin parks plan (Question 90)
169. Heard of Jordan River parkways plan (Question 91)
170. Heard of master storm drain system plan (Question 92)
171. Heard of concrete and rock lining of streams plan (Question 93)
172. Heard of straightening and dredging of Jordan River plan (Question 94)
173. Number of flood control proposals in Salt Lake area heard of score (questions 90-94)
174. Feeling about retention basin parks (Question 95A)
175. Perceived cost of retention basin parks (Question 95B)
176. Perceived effectiveness of retention basin parks (Question 95C)
177. Perceived recreation effect of retention basin parks (Question 95D)
178. Perceived appearance of retention basin parks (Question 95E)
179. Perceived ecological effect of retention basin parks (Question 95F)
180. Knew about retention basin parks (Question 95G)
181. Feeling about Jordan River Parkways (Question 96A)
182. Perceived cost of Jordan River Parkways (Question 96B)
183. Perceived effectiveness of Jordan River Parkway (Question 96C)
184. Perceived recreation effect of Jordan River Parkways (Question 96D)
185. Perceived appearance of Jordan River Parkways (Question 96E)
186. Perceived ecological effect of Jordan River Parkways (Question 96F)
187. Knew about Jordan River Parkway (Question 96G)
188. Feeling about master storm drain system (Question 97A)
189. Perceived cost of master storm drain system (Question 97B)
190. Perceived effectiveness of master storm drain system (Question 97C)
191. Perceived recreation effect of master storm drain system (Question 97D)
192. Perceived appearance of master storm drain system (Question 97E)
193. Perceived ecological effect of master storm drain system (Question 97F)
194. Knew about master storm drain system (Question 97G)
195. Feeling about concrete and rock lining of streams (Question 98A)
196. Perceived cost of concrete and rock lining of streams (Question 98B)
197. Perceived effectiveness of concrete and rock lining of streams (Question 98C)
198. Perceived recreation effect of rock and concrete lining of streams (Question 98D)
199. Perceived appearance of rock and concrete lining of streams (Question 98E)
200. Perceived ecological effect of rock and concrete lining of streams (Question 98F)
201. Knew about rock and concrete lining of streams (Question 98G)
202. Feeling about straightening and dredging of the Jordan River (Question 99A)
203. Perceived cost of straightening and dredging of the Jordan River (Question 99B)
204. Perceived effectiveness of straightening and dredging of the Jordan River (Question 99C)
205. Perceived recreation effect of straightening and dredging of the Jordan River (Question 99D)
206. Perceived appearance of straightening and dredging of the Jordan River (Question 99E)
207. Perceived ecological effect of straightening and dredging of the Jordan River (Question 99F)

208. Knew about straightening and dredging of the Jordan River (Question 99G)


210. Respondent or spouse attendance at flood control meeting (Question 100)

211. Extent of respondent attendance at flood control meeting (Question 100A)

212. Extent of spouse attendance at flood control meeting (Question 100A)

213. Respondent membership in flood control group (Question 101)

214. Respondent or spouse active promotion of flood control proposal (Question 102)

215. Flood control proposals promoted actively by respondent (Question 102A)

216. Flood control proposals promoted actively by spouse (Question 102A)

217. Respondent or spouse active opposition to flood control proposal (Question 103)

218. Flood control proposals opposed actively by respondent (Question 103A)

219. Flood control proposals opposed actively by spouse (Question 103A)

220. Social participation score (Question 104)\(^2\)

221. Expressed perceived control by local citizens over what happens in community (Question 105)

222. Expressed perception of adequacy of pollution controls by government agencies (Question 106)

223. Knowledge score for flood control agencies in Salt Lake area (Question 107)

224. Knew of County flood control commission (Question 107)

225. Knew of Corps of Engineers (Question 107)

\(^2\) The social participation score was computed from the responses to question 104 by summing the following:

a. 1 point for each organization in which respondent was a member

b. 1 point for 1/4 participation in an organization, or

2 points for 1/2 participation, or

3 points for 3/4+ participation

c. 1 point for each committee position or office held
226. Expressed communication with public official in last four years to let him know personal opinion on issue (Question 108)
227. Expressed active participation in political campaign in last four years (Question 109)
228. Expressed contribution of money for political purposes in last four years (Question 110)
229. Expressed participation by voting in either of last two elections (Question 111)
230. Political activity score (Questions 108, 109, 110, 111)
231. Expressed belief in method other than voting that people like respondent can influence actions of government (Question 112)
232. Expressed belief in personal ability to understand politics and government (Question 113)
233. Expressed belief whether people like respondent have any say about what the government does (Question 114)
234. Expressed belief whether public officials care much what people like respondent think (Question 115)
235. Political anomie score (Question 112, 113, 114, 115)
236. Length of residence at present home (Question 116)
237. Length of residence in Salt Lake County (Question 117)
238. Age (Question 118)
239. Number of children (Question 119)
240. Number of children at home (Question 119A)
241. Number of children under 6 (Question 119B)
242. Present marital status (Question 120)
243. Occupation of respondent (Question 121)
244. Occupation of spouse (Question 122)
245. Education of respondent (Question 123)
246. Education of spouse (Question 124)
247. Buying or renting home (Question 125)
248. Income of family (Question 127)
249. Sex of respondent (Question 128)
250. Type of structure in which family lives (Question 129)
251. Overall evaluation by interviewer of conditions of respondent’s home (Question 130)
252. Lawns evaluation by interviewer of conditions of respondent’s home compared to typical residence in Salt Lake area (Question 130)
253. Flower gardens evaluation by interviewer of conditions of respondent’s home compared to typical residence in Salt Lake area (Question 130)
254. Shade and ornamental trees evaluation by interviewer of conditions of respondent’s home compared to typical residence in Salt Lake area (Question 130)
255. House exterior evaluation by interviewer of conditions of respondent’s home compared to typical residence in Salt Lake area (Question 130)
256. House interior evaluation by interviewer of conditions of respondent’s home compared to typical residence in Salt Lake area (Question 130)
257. Neighborhood rating evaluation by interviewer of conditions of respondent’s home compared to typical residence in Salt Lake area (Question 130)
258. Percent in block under 18 in 1970 (Question 133)
259. Percent in block over 62 in 1970 (Question 134)
260. Percent of one unit housing structures in block in 1970 (Question 135)
261. Percent in structures in block of ten or more units in 1970 (Question 136)
262. Percent of housing units in block owned by resident in 1970 (Question 137)
263. Mean value of house in block in 1970 (Question 138)
264. Percent of housing units in block which were rented in 1970 (Question 139)
265. Average contract rent of rental units in block in 1970 (Question 140)
266. Percent of one person household in block in 1970 (Question 141)
267. Percent of housing units in block with female head of household in 1970 (Question 142)

268. Social class score (Questions 121, 123, 138)

3 In phases two and three the components of social class score have the following relative effects on the maximum total social class score:

- Occupation has an effective importance of 48
- Education has an effective importance of 30
- Residence has an effective importance of 28
APPENDIX B

SCHEDULE USED FOR SURVEY OF POPULATION -

PHASE II
MODELING THE HYDROLOGIC-SOCIOLOGIC SYSTEM

Phase II

Project WC-109

Conducted by

Institute for Social Science Research
on Natural Resources

and

Utah Resources Laboratory
Utah State University

Address of Respondent

Interviewers Name

Schedule Number
Deck

(1-2)

(3-5) Schedule Number
First, I would like to ask some questions concerning experience you might have had with flooding. Flooding may be caused by several different factors. For instance, snowmelt floods occur in the spring and early summer when streams overflow due to the melting of winter snows. Another cause may be cloudburst or flash floods, while still another may be long and heavy rains. Sometimes flooding may result from several factors.

Another type of water problem is seepage, but we are not concerned with this unless it is related to one of the other types that I mentioned.

1. Have you ever experienced damage or inconvenience due to flooding (in your lifetime, at any place)?

   0. None  1. Inconvenience  2. Damage only

   (IF NONE, SKIP TO QUESTION #2)

A. Where did this occur? (CHECK ALL APPLICABLE ANSWERS)

   00. DNA
   01. Outside of Salt Lake area
   02. Property other than a residence in Salt Lake area
   03. Another residence(s) in Salt Lake area
   04. At present home

   (1) (IF IN MORE THAN ONE AREA) In which of the above places did you receive the most inconvenience or damage?

   00. DNA
   01. Outside of Salt Lake Area
   02. Property other than residence in Salt Lake area
   03. Another residence(s) in Salt Lake area
   04. At present home

   (10-11)
2A. (CARD 1)

What do you feel is the likelihood that you will experience flooding at your present residence or other personally owned property in the Salt Lake area in the next five years? Could you please give this in percentage of likelihood where

0% is no likelihood of flooding and 100% is absolutely sure of flooding

(WRITE PERCENT) ____________________________

(IF ANSWER TO 2A IS MORE THAN ZERO PERCENT, ASK THE FOLLOWING QUESTION:)

2B. (CARD 2) What do you feel is the main source (or sources) of flooding threat to your residence or other personal property?

___00. DNA
___01. Snowmelt
___02. Flash flood rains
___03. Long heavy rains
___04. Rain and snowmelt
___05. Stream or creek
___06. Other (specify) ____________________________

3. (CARD 3) What would you say is the degree of concern or worry you have about flooding in general in the Salt Lake area?

___0. None
___1. Low
___2. Moderate
___3. High
4. (CARD 4) Who do you think should pay for flood control in a particular area? (ACCEPT ONLY ONE ANSWER)

  0. Only those who receive damage from floods
  1. District within the county
  2. City or town
  3. County government
  4. Multicounty District
  5. State government
  6. Federal government
  7. Other (specify) ________________________________

5. In the past year have you heard anything about flooding problems or flood control projects in the Salt Lake City or County area?

  0. No   1. Yes

A. (IF YES, CARD 5) From what source or sources did you hear about this? (CHECK ALL APPROPRIATE CATEGORIES)

  000. DNA
  001. TV, Radio
  002. Newspaper
  003. Official source
  004. Meeting
  005. Work associates
  006. Friends not in neighborhood
  007. Friends in neighborhood
  008. Family members
  009. Personal observations
  010. Other (specify) ________________________________

6. (CARD 6) How serious do you feel flooding problems are in the Salt Lake area?

  0. None
  1. Not serious
  2. Moderately serious
  3. Very serious

7. Have you ever been aware of flooding problems in your neighborhood?

  0. No
  1. Yes
7A. (IF YES) How long (in years) have you been aware of flooding problems in your neighborhood?

__________________________ years

8. (CARD 7) How serious do you feel flooding problems are in your neighborhood?

- 0. None
- 1. Not serious
- 2. Moderately serious
- 3. Very serious

9. Some people discuss flooding problems with other persons. Do you discuss flooding problems with others?

- 0. No
- 1. Yes

A. (IF YES, CARD 8) With whom do you discuss flooding problems? (CHECK ALL APPROPRIATE CATEGORIES)

- 00. DNA
- 01. Friends not in the neighborhood
- 02. Friends in the neighborhood
- 03. Work associates
- 04. Family and close relatives
- 07. Other (specify)

B. (CARD 9) With whom do you discuss flooding problems most frequently? (ACCEPT ONLY ONE ANSWER)

- 0. DNA
- 1. Friends not in the neighborhood
- 2. Friends in the neighborhood
- 3. Work associates
- 4. Family and close relatives
- 5. Other (specify)

10. What daily newspapers do you regularly receive? (CHECK ALL APPLICABLE NEWSPAPERS)

- 0. None
- 1. Tribune
- 2. Deseret News
- 3. Other (specify)

__________________________
11. Do you live adjacent to or within two blocks of a stream?
   
   0. No
   1. Within two blocks
   2. Adjacent

12. Do you feel that the number of public parks in Salt Lake City and County (not including mountain canyons) is adequate or not adequate?

   0. Not adequate
   1. Adequate

A. Do you visit public parks in Salt Lake City or County?

   0. No
   1. Yes

B. Are the public parks in this area satisfactory to you?

   0. No
   1. Yes

C. (IF NO TO B) Is there any particular reason why the public parks are not satisfactory?

13. (CARD 10) I am going to read a short list of outdoor recreation activities. As I read each one would you please indicate the approximate number of times you participated in it during the past twelve (12) months.

   1. Picnicking
   2. Walking or hiking for pleasure
   3. Horseback riding
   4. Cycling motor or bike
   5. Boating
   6. Fishing
We have a series of statements on which we would like to have your opinion. They are about several different factors related to flooding and different aspects of flood control.

(CARD 11) As I read the statements, please tell me how you feel about each one according to the categories shown on card 11: Strongly agree, Agree, Undecided, Disagree, or Strongly Disagree. After you reply to each question, please tell me how hard it was for you to make your judgement on the statement. The possible responses are also shown on card 11. They are: Very hard, Hard, Easy, Very easy.

(INTEVIEWER SHOULD REPEAT QUESTIONS AND ANSWERS AS NECESSARY)

14. The problem of flooding is one of the most pressing problems that faces people in the Salt Lake area.

A. Do you strongly agree, agree? Are you undecided or neutral? Do you disagree, or strongly disagree?

5 SA 4 A 3 U 2 D 1 SD

B. How hard was it for you to answer this question? Was it very hard, hard, easy, or very easy?

1 VH 2 H 4 E 5 VE

15. Flood control in the Salt Lake area is an excellent investment.

A. 5 SA 4 A 3 U 2 D 1 SD

B. 1 VH 2 H 4 E 5 VE

16. Recommendations by government agencies are often wrong.

A. 1 SA 2 A 3 U 4 D 5 SD

B. 1 VH 2 H 4 E 5 VE

17. People should follow the advice of experts more.

A. 5 SA 4 A 3 U 2 D 1 SD

B. 1 VH 2 H 4 E 5 VE
18. The environment must be modified to meet the needs of man.

A. 1 SA 2 A 3 U 4 D 5 SD

B. 1 VH 2 H 4 E 5 VE

19. There is real danger of serious flood damage in the Salt Lake area in the next five years.

A. 5 SA 4 A 3 U 2 D 1 SD

B. 1 VH 2 H 4 E 5 VE

20. Agencies are much better able to make correct decisions in the fields of their responsibility such as flood control than anybody else.

A. 5 SA 4 A 3 U 2 D 1 SD

B. 1 VH 2 H 4 E 5 VE

21. Outdoor recreation activities are the most enjoyable activities one can do.

A. 5 SA 4 A 3 U 2 D 1 SD

B. 1 VH 2 H 4 E 5 VE

22. People who rely a lot on experts are generally people who can't think for themselves.

Deck 02

A. 1 SA 2 A 3 U 4 D 5 SD

B. VH 2 H 4 E 5 VE

23. Flooding is not really a serious problem in the Salt Lake area.

A. 1 SA 2 A 3 U 4 D 5 SD

B. 1 VH 2 H 4 E 5 VE
24. Taxes in Salt Lake County are very high.
   A. 1 SA 2 A 3 U 4 D 5 SD
   B. 1 VH 2 H 4 E 5 VE

25. Not nearly enough is being done to protect our environment.
   A. 5 SA 4 A 3 U 2 D 1 SD
   B. 1 VH 2 H 4 E 5 VE

26. Experts know considerably more than the average person.
   A. 5 SA 4 A 3 U 2 D 1 SD
   B. 1 VH 2 H 4 E 5 VE

27. I would like to participate in much more outdoor recreation.
   A. 5 SA 4 A 3 U 2 D 1 SD
   B. 1 VH 2 H 4 E 5 VE

28. Man generally improves the appearance of areas.
   A. 5 SA 4 A 3 U 2 D 1 SD
   B. 1 VH 2 H 4 E 5 VE

29. Government projects are too expensive.
   A. 1 SA 2 A 3 N 4 D 5 SD
   B. 1 VH 2 H 4 E 5 VE
30. Nothing makes a trip into the wilderness more enjoyable than a well paved road.
   A. 1 SA  2 A  3 U  4 D  5 SD
   B. 1 VH  2 H  4 E  5 VE

31. The beauty of nature is not destroyed by the presence of man-made objects.
   A. 5 SA  4 A  3 U  2 D  1 SD
   B. 1 VH  2 H  4 E  5 VE

32. Flood control management in the Salt Lake area is very adequate.
   A. 1 SA  2 A  3 U  4 D  5 SD
   B. 1 VH  2 H  4 E  5 VE

33. Much more land should be preserved in its natural state.
   A. 5 SA  4 A  3 U  2 D  1 SD
   B. 1 VH  2 H  4 E  5 VE

34. If people were outdoors more, they would not be much better off.
   A. 1 SA  2 A  3 U  4 D  5 SD
   B. 1 VH  2 H  4 E  5 VE

35. The government cares how much of my money it spends.
   A. 5 SA  4 A  3 U  2 D  1 SD
   B. 1 VH  2 H  4 E  5 VE
36. Most people don't spend enough time just enjoying themselves.
   A. 5 SA 4 A 3 U 2 D 1 SD
   B. 1 VH 2 H 4 E 5 VE

37. The only way government won't waste money is if it doesn't have money to waste.
   A. 1 SA 2 A 3 U 4 D 5 SD
   B. 1 VH 2 H 4 E 5 VE

38. Being in harmony with nature is extremely important.
   A. 5 SA 4 A 3 U 2 D 1 SD
   B. 1 VH 2 H 4 E 5 VE

39. More control by the people is needed over the decisions of government agencies.
   A. 1 SA 2 A 3 U 4 D 5 SD
   B. 1 VH 2 H 4 E 5 VE

40. People should play more and work less.
   A. 5 SA 4 A 3 U 2 D 1 SD
   B. 1 VH 2 H 4 E 5 VE

41. Experts are wrong nearly as often as they are right.
   A. 1 SA 2 A 3 U 4 D 5 SD
   B. 1 VH 2 H 4 E 5 VE
42. I wouldn't participate in outdoor recreation if someone weren't with me.

A. 1 SA 2 A 3 U 4 D 5 SD 
B. 1 VH 2 H 4 E 5 VE

43. Only emergency flood control work should be done in the Salt Lake area.

A. 1 SA 2 A 3 U 4 D 5 SD 
B. 1 VH 2 H 4 E 5 VE

44. People should spend much more of their recreation time outdoors.

A. 5 SA 4 A 3 U 2 D 1 SD 
B. 1 VH 2 H 4 E 5 VE

45. Taxes should be raised if necessary to cover the cost of better protection for the public.

A. 5 SA 4 A 3 U 2 D 1 SD 
B. 1 VH 2 H 4 E 5 VE

46. Buildings near an outdoor recreation area ruin the beauty of the area.

A. 1 SA 2 A 3 U 4 D 5 SD 
B. 1 VH 2 H 4 E 5 VE

47. Generally speaking, the main satisfaction I get out of life is working.

A. 1 SA 2 A 3 U 4 D 5 SD 
B. 1 VH 2 H 4 E 5 VE
48. Industrial growth is as important as preserving natural areas.
   A. 5 SA 4 A 3 U 2 D 1 SD
   B. 1 VH 2 H 4 E 5 VE

49. Flood control and similar projects destroy the beauty of the areas in which they are located.
   A. 1 SA 2 A 3 U 4 D 5 SD
   B. 1 VH 2 H 4 E 5 VE

50. Stronger laws are needed to protect our environment.
   A. 5 SA 4 A 3 U 2 D 1 SD
   B. 1 VH 2 H 4 E 5 VE

51. I generally feel guilty when I enjoy leisure for more than a short time except when on vacations.
   A. 1 SA 2 A 3 U 4 D 5 SD
   B. 1 VH 2 H 4 E 5 VE

52. Major decisions in fields such as flood control should be left to the government agency responsible.
   A. 5 SA 4 A 3 U 2 D 1 SD
   B. 1 VH 2 H 4 E 5 VE

53. Not enough emphasis is placed on the opinion of experts.
   A. 5 SA 4 A 3 U 2 D 1 SD
   B. 1 VH 2 H 4 E 5 VE
54. Additional government services are worth additional taxes.
   A. 5 SA 4 A 3 U 2 D 1 SD
   B. 1 VH 2 H 4 E 5 VE

55. People should form more of their own opinions rather than listen to experts.
   A. 1 SA 2 A 3 U 4 D 5 SD
   B. 1 VH 2 H 4 E 5 VE

56. Indoor activities are as much fun as outdoor activities.
   A. 1 SA 2 A 3 U 4 D 5 SD
   B. 1 VH 2 H 4 E 5 VE

57. The control of flooding in the Salt Lake area is adequate.
   A. 1 SA 2 A 3 U 4 D 5 SD
   B. 1 VH 2 H 4 E 5 VE

58. Developed areas are more enjoyable than undeveloped areas.
   A. 1 SA 2 A 3 U 4 D 5 SD
   B. 1 VH 2 H 4 E 5 VE

59. Something definitely needs to be done to further control flooding in the Salt Lake area.
   A. 5 SA 4 A 3 U 2 D 1 SD
   B. 1 VH 2 H 4 E 5 VE
Engineers have suggested different ways in which flooding may be controlled. We would like to know how strongly you approve or disapprove of the potential use of the following flood control measures in the Salt Lake area.

(CARD 12) The possible responses are shown on Card 12 they are: strongly approve, approve, undecided, disapprove, or strongly disapprove.

Please remember as I read each possible flood control measure that we are considering flood control and streams in the Salt Lake area.

How do you feel about: (REPEAT AS NEEDED)

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<tbody>
<tr>
<td>70. A small earth dam (50 feet wide or less)</td>
<td>5 SA 4 A 3 N 2 D 1 SD</td>
<td>19</td>
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<td>71. Cleaning and deepening of a river</td>
<td>5 SA 4 A 3 N 2 D 1 SD</td>
<td>20</td>
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<td>72. A developed streamside park</td>
<td>5 SA 4 A 3 N 2 D 1 SD</td>
<td>21</td>
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<td>73. A high concrete bank or dike over 3 feet in height</td>
<td>5 SA 4 A 3 N 2 D 1 SD</td>
<td>22</td>
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<td>74. A small reservoir</td>
<td>5 SA 4 A 3 N 2 D 1 SD</td>
<td>23</td>
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<td>75. Straightening of a stream</td>
<td>5 SA 4 A 3 N 2 D 1 SD</td>
<td>24</td>
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<td>76. A large wide earth dam more than 50 feet wide</td>
<td>5 SA 4 A 3 N 2 D 1 SD</td>
<td>25</td>
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<td>77. A streamside area left undeveloped</td>
<td>5 SA 4 A 3 N 2 D 1 SD</td>
<td>26</td>
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<td>78. A rock lining in a stream</td>
<td>5 SA 4 A 3 N 2 D 1 SD</td>
<td>27</td>
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<td>79. A large reservoir</td>
<td>5 SA 4 A 3 N 2 D 1 SD</td>
<td>28</td>
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<td>80. A high earth bank more than 3 feet in height along a stream</td>
<td>5 SA 4 A 3 N 2 D 1 SD</td>
<td>29</td>
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<tr>
<td>81. Stream bank protection at critical points</td>
<td>5 SA 4 A 3 N 2 D 1 SD</td>
<td>30</td>
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</tbody>
</table>
82. An underground storm sewer

83. A small concrete dam up to 50 feet high

84. A low concrete bank or dike under 3 feet or less in height.

85. An unlined or dirt canal

86. Concrete lining in a stream

87. A low earth bank or dike 7 ft. or less in height along a stream

88. A concrete lined canal

89. A large concrete dam more than 50 feet high

PLANS FOR FLOOD CONTROL

(CARD 13) On card 13 is a list of some of the plans for the physical control of flooding which have been proposed in the Salt Lake Valley. They are:

1. Retention Basin Parks
2. Jordan River Parkways (i.e., a riverside park)
3. Master Storm Sewer Drain System
4. Concrete or Rock Lining of Section of Millcreek, Big Cottonwood, and Little Cottonwood Creeks.
5. Straightening and Dragging of the Jordan River.

Have you heard of any of these plans? If so, which ones?

(CHECK "1")

90. Retention Basin Parks

0. No, has not heard
1. Yes, has heard
91. Jordan River Parkways Plan (i.e., a riverside park)
   ___ 0. No, has not heard  ___ 1. Yes, has heard  

92. Master Storm Sewer Drain System
   ___ 0. No, has not heard
   ___ 1. Yes, has heard

93. Concrete or Rock lining of lower sections of Millcreek, Big Cottonwood and Little Cottonwood Creeks.
   ___ 0. No, has not heard
   ___ 1. Yes, has heard

94. Straightening and dredging of the Jordan River
   ___ 0. No, has not heard
   ___ 1. Yes, has heard

(IF RESPONDENT HAS NOT HEARD OF ANY PLANS, SKIP TO QUESTION 100)

(ASK QUESTIONS 95-99, ONLY IF THE PERSON HAD HEARD ABOUT THE PLAN).

We would like to know how you feel about each plan(s) and certain aspects of the plan(s) about which you have heard.

95. RETENTION BASIN PARKS

A. (CARD 14) How do you feel about Retention Basin Parks. Do you: strongly favor, moderately favor, undecided, moderately oppose or strongly oppose this plan.

   5 SF  4 MF  3 U  2 HO  1 SO

I would like to read five statements about Retention Basin Parks. Please select the statement completion from the cards which comes closest to expressing your feeling.
B. (CARD 15) The cost of Retention Basin Parks would be

1. very inexpensive
2. inexpensive
3. neither inexpensive nor expensive
4. expensive
5. very expensive

C. (CARD 16) Retention Basin Parks would be

1. very ineffective in controlling flooding
2. ineffective in controlling flooding
3. neither ineffective nor effective
4. effective in controlling flooding
5. very effective in controlling flooding

D. (CARD 17) Retention Basin Parks would be

1. very detrimental to outdoor recreation
2. detrimental to outdoor recreation
3. have no effect on outdoor recreation
4. beneficial to outdoor recreation
5. very beneficial to outdoor recreation

E. (CARD 18) Retention Basin Parks would be

1. very ugly
2. ugly
3. neither ugly nor beautiful
4. beautiful
5. very beautiful

F. (CARD 19) Retention Basin Parks would have

1. a very detrimental ecological effect
2. a detrimental ecological effect
3. no ecological effect
4. a beneficial ecological effect
5. a very beneficial effect

G. Finally, how do you think Retention Basin Parks would control flooding?

1. Correct answer given  0. Incorrect answer given

(Correct answer: Retention Basin Parks—used as reservoir during floods, and at other times as recreational parks.)
96. THE JORDAN RIVER PARKWAY

A. (CARD 14) How do you feel about the Jordan River Parkway. Do you: strongly favor, moderately favor, undecided, moderately oppose or strongly oppose this plan

5 SF 4 MF 3 U 2 UN 1 SO

I would like to read five statements about The Jordan River Parkway. Please select the statement completion from the cards which comes closest to expressing your feeling.

B. (CARD 15) The cost of the Jordan River Parkway would be

1. very inexpensive
2. inexpensive
3. neither inexpensive nor expensive
4. expensive
5. very expensive

C. (CARD 16) The Jordan River Parkway would be

1. very ineffective in controlling flooding
2. ineffective in controlling flooding
3. neither ineffective nor effective
4. effective in controlling flooding
5. very effective in controlling flooding

D. (CARD 17) The Jordan River Parkway would be

1. very detrimental to outdoor recreation
2. detrimental to outdoor recreation
3. have no effect on outdoor recreation
4. beneficial to outdoor recreation
5. very beneficial to outdoor recreation

E. (CARD 18) The Jordan River Parkway would be

1. very ugly
2. ugly
3. neither ugly nor beautiful
4. beautiful
5. very beautiful
F. (CARD 19) The Jordan River Parkway would have

1. a very detrimental ecological effect
2. a detrimental ecological effect
3. no ecological effect
4. a beneficial ecological effect
5. a very beneficial effect

G. Finally, how do you think the Jordan River Parkway would control flooding?

1. Correct answer given
2. Incorrect answer given

(Correct answer:
The Jordan River Parkway Plan... would include an enlarged river channel with terraces, desilting or catch basins and connections to large storm drain.)

97. MASTER STORM SEWER DRAIN SYSTEM

A. (CARD 14) How do you feel about the Master Storm Sewer Drain System. Do you: strongly favor, moderately favor, undecided, moderately oppose or strongly oppose this plan.

5 SF 4 MF 3 U 2 NO 1 SO

I would like to read five statements about the Master Storm Sewer Drain System. Please select the statement completion from the cards which comes closest to expressing your feeling.

B. (CARD 15) The cost of the Master Storm Sewer Drain System would be

1. very inexpensive
2. inexpensive
3. neither inexpensive nor expensive
4. expensive
5. very expensive

C. (CARD 16) The Master Storm Sewer Drain System would be

1. very ineffective in controlling flooding
2. ineffective in controlling flooding
3. neither ineffective nor effective
4. effective in controlling flooding
5. very effective in controlling flooding
D. (CARD 17) The Master Storm Sewer Drain System would be

1. very detrimental to outdoor recreation
2. detrimental to outdoor recreation
3. have no effect on outdoor recreation
4. beneficial to outdoor recreation
5. very beneficial to outdoor recreation

---

E. (CARD 18) The Master Storm Sewer Drain System would be

1. very ugly
2. ugly
3. neither ugly nor beautiful
4. beautiful
5. very beautiful

---

F. (CARD 19) The Master Storm Sewer Drain System would have

1. a very detrimental ecological effect
2. a detrimental ecological effect
3. no ecological effect
4. a beneficial ecological effect
5. a very beneficial ecological effect

---

C. Finally, how do you think the Master Storm Sewer Drain System would control flooding?

1. Correct answer given
5. Incorrect answer given

(Correct answer: Master Storm Sewer Drain System—Several underground pipes large enough to contain flood waters.)

---

98. CONCRETE OR ROCK LINING OF STREAMS

A. (CARD 14) How do you feel about Concrete or Rock Lining of Streams. Do you: strongly favor, moderately favor, undecided, moderately oppose, or strongly oppose this plan.

5 SF 4 MF 3 U 2 MO 1 SO

---

I would like to read five statements about Concrete or Rock Lining of Streams. Please select the statement completion from the cards which comes closest to expressing your feeling.
B. (CARD 15) The cost of Concrete or Rock Lining of Streams would be

1. very inexpensive
2. inexpensive
3. neither inexpensive nor expensive
4. expensive
5. very expensive

C. (CARD 16) Concrete or Rock Lining of Streams would be

1. very ineffective in controlling flooding
2. ineffective in controlling flooding
3. neither ineffective nor effective
4. effective in controlling flooding
5. very effective in controlling flooding

D. (CARD 17) Concrete or Rock Lining of Streams would be

1. very detrimental to outdoor recreation
2. detrimental to outdoor recreation
3. have no effect on outdoor recreation
4. beneficial to outdoor recreation
5. very beneficial to outdoor recreation

E. (CARD 18) Concrete or Rock Lining of Streams would be

1. very ugly
2. ugly
3. neither ugly nor beautiful
4. beautiful
5. very beautiful

F. (CARD 19) Concrete or Rock Lining of Streams would have

1. a very detrimental ecological effect
2. a detrimental ecological effect
3. no ecological effect
4. a beneficial ecological effect
5. a very beneficial effect

Deck 04

U. Finally, how do you think Concrete or Rock Lining of Streams would control flooding?

1. Correct answer given  0. Incorrect answer given

Correct Answer:
Concrete or Rock Lining of Streams---Harden Stream banks and bottoms.
99. STRAIGHTENING AND DREDGING OF THE JORDAN RIVER

A. (CARD 14) How do you feel about Straightening and Dredging of the Jordan River. Do you: strongly favor, moderately favor, undecided, moderately oppose or strongly oppose this plan.

5 SF 4 MF 3 U 2 MO 1 SO

I would like to read five statements about Straightening and Dredging of the Jordan River. Do you: strongly favor, moderately favor, undecided, moderately oppose or strongly oppose this plan.

B. (CARD 15) The cost of Straightening and Dredging of the Jordan River would be

____ 1. very inexpensive
____ 2. inexpensive
____ 3. neither inexpensive nor expensive
____ 4. expensive
____ 5. very expensive

C. (CARD 16) Straightening and Dredging of the Jordan River would be

____ 1. very ineffective in controlling flooding
____ 2. ineffective in controlling flooding
____ 3. neither ineffective nor effective
____ 4. effective in controlling flooding
____ 5. very effective in controlling flooding

D. (CARD 17) Straightening and Dredging of the Jordan River would be

____ 1. very detrimental to outdoor recreation
____ 2. detrimental to outdoor recreation
____ 3. have no effect on outdoor recreation
____ 4. beneficial to outdoor recreation
____ 5. very beneficial to outdoor recreation

E. (CARD 18) Straightening and Dredging of the Jordan River would be

____ 1. very ugly
____ 2. ugly
____ 3. neither ugly nor beautiful
____ 4. beautiful
____ 5. very beautiful
F. (CARD 19) Straightening and Dredging of the Jordan River would have

____ 1. a very detrimental ecological effect
____ 2. a detrimental ecological effect
____ 3. no ecological effect
____ 4. a beneficial ecological effect
____ 5. a very beneficial effect

13

G. Finally, how do you think Straightening and Dredging of the Jordan River would control flooding?

____ 1. Correct answer given  ____ 0. Incorrect answer given

14

Correct answer: Straightening and Dredging of the Jordan River—Enlarge the channel by widening and deepening.

100. Have you or your spouse attended a meeting or public hearing since 1965 in which flood control projects or problems were the main topic discussed? (IF YES) who attended?

____ 0. No  ____ 1. Yes, Spouse only  ____ 2. Yes, Respondent only
____ 3. Yes Both

15

A. (IF YES) How many meetings did you or your spouse attend? (SPECIFY S-Spouse, R-Respondent, B-Both

Respondent ____________________________

Spouse ____________________________

16 17

8 18 19

B. What group(s) sponsored the meeting(s)?

______________________________

______________________________

C. When were the meetings held?

______________________________

101. Since 1965 have you or your spouse belonged to a citizen group or other organization that was mainly interested in flood control projects? (IF YES) who belonged?

____ 0. No  ____ 1. Yes, Spouse only  ____ 2. Yes Respondent only
____ 3. Yes, Both

20
A. (IF YES) Which group(s) have you or your spouse belonged to? (SPECIFY S-Spouse, R-Respondent, B-Both)

B. (IF A CITIZEN GROUP) Who are the Leaders?

102. Have you or your spouse worked to promote any flood control proposals or ideas since 1965 by petitioning, calling on people, writing letters, or by other means? (IF YES) who worked?

0. No  1. Yes, Spouse  2. Yes, Respondent  3. Yes, Both

A. (IF YES) Which proposal(s) or idea(s)? (SPECIFY S-Spouse, R-Respondent, B-Both)

00. DNA 01. Retention Basin Parks 02. Jordan Parkway 03. Master Storm Sewer Drain System 04. Rock and Concrete Channelization of lower sections of Big and Little Cottonwood and Millcreek Streams. 05. Straightening and Dredging of the Jordan River 06. Watershed Management 07. Flood Plain Zoning restrictions 08. Other (Specify)

B. What did you or your spouse do? (SPECIFY S-Spouse, R-Respondent, B-Both)

0. DNA 1. Petition 2. Letter 3. Vocal protest 4. Other (Specify)
103. **Have you or your spouse opposed any flood control proposals or ideas since 1965 by petitioning, writing letters, vocal protests, or other means? (IF YES) who?**

- _0. No_  
- _1. Yes, Spouse_  
- _2. Yes, Respondent_  
- _3. Yes, Both_

A. **(IF YES) which proposal(s) or idea(s)? (SPECIFY S-Spouse, R-Respondent B-Both)**

- _00. DNA_
- _01. Retention Basin Parks_
- _02. Jordan River Parkway_
- _03. Master Storm Sewer Drain System_
- _04. Rock and Concrete Channelization of lower sections of Big and Little Cottonwood and Millcreek Streams_
- _05. Straightening and dredging the Jordan River_
- _06. Watershed management_
- _07. Flood Plain Zoning restrictions_
- _08. Other (Specify)_

B. **What did you or your spouse do? (SPECIFY S-Spouse, R-Respondent B-Both)**

- _0. DNA_
- _1. Petition_
- _2. Letter_
- _3. Vocal Protest_
- _4. Other (Specify)_

In order to understand how community decisions are made it is important to us to know something about the number and kinds of contacts people have and what they do in the community
104. To what groups, clubs or organizations do you belong? I need this information for you only and not your family

We are interested in organizations such as lodges, civic, educational, religious groups, neighborhood groups and others.

<table>
<thead>
<tr>
<th>104.</th>
<th>Name of Organization</th>
<th>No. of meetings held per year</th>
<th>What proportion Reg. Meetings attended in Past Two Years</th>
<th>What Committees or Offices in Past Two Years</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>1/4</td>
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<td>8</td>
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</tbody>
</table>

105. (CARD 20) To what extent do you feel that the local citizens have control over what happens in this community?

0. DK
1. No control
2. Little control
3. Some control
4. Quite a bit of control
5. Almost complete control

106. (CARD 21) A number of government agencies have been established to regulate and monitor different forms of air, water and land pollution. In general, how strict do you feel the standards set by these agencies are?

0. Much too strict
1. Too strict
2. About right
3. Too lenient
4. Much too lenient
107. Do you know of any governmental agencies in this area whose **main purpose** is flood control?  
(WRITE NAMES OF ANY AGENCIES MENTIONED)

A. 1.  
2.  
3.  

B. 0. Respondent did not mention either the Corps of Engineers or the Salt Lake County Flood Control Department.  
1. Respondent mentioned the Corps of Engineers but not the Salt Lake County Flood Control Department.  
2. Respondent mentioned the Salt Lake County Flood Control Department but not the Corps of Engineers  
3. Respondent mentioned both the Corps of Engineers and the Salt Lake County Flood Control Department.

For comparative purposes information on some of your other opinions and activities will also be of value to us.

108. In the last four years have you written or talked to your Congressman or any other public official to let him know what you would like him to do on a public issue in which you were interested?

0. No 1. Yes

109. In the last four years have you worked for the election of any political candidate by doing things like distributing circulars or leaflets, making speeches, or calling on voters?

0. No 1. Yes

110. In the last four years have you contributed money to a political party or to a candidate for a political office?

111. Have you voted in either of the last 2 elections? (Includes election at the local level)  
0. No 1. Yes 2 Was under age or non-citizen
I would like to have your opinion on a few more statements. Please tell me whether you strongly agree, agree, are undecided, disagree, or strongly disagree.

SCHEDULES 476-525

1. The government is run as economically as can be expected.
   5 SA 4 A 3 U 2 D 1 SD

2. The government should spend money on some services and projects other than necessities.
   5 SA 4 A 3 U 2 D 1 SD

3. Government projects usually cost a lot more money than they should.
   1 SA 2 A 3 U 4 D 5 SD

4. The government feels its only solution to problems is to spend more money.
   1 SA 2 A 3 U 4 D 5 SD

5. The government spends too much on projects.
   1 SA 2 A 3 U 4 D 5 SD

6. Better government services are worth additional taxes.
   5 SA 4 A 3 U 2 D 1 SD

7. The government thinks it can go into debt or raise taxes if it gets in financial trouble.
   1 SA 2 A 3 U 4 D 5 SD

8. Recommendations of government agencies in their fields can be depended on.
   5 SA 4 A 3 U 2 D 1 SD

9. Recommendations by government agencies are often wrong.
   1 SA 2 A 3 U 4 D 5 SD
On the following statements, please indicate whether you agree or disagree.

112. There is no way other than voting that people like me can influence actions of the government.

____ 0. Agree ______ 1. Disagree

113. Sometimes politics and government seem so complicated that I can't really understand what's going on.

____ 0. Agree ______ 1. Disagree

114. People like me don't have any say about what the government does.

____ 0. Agree ______ 1. Disagree

115. I believe public officials don't care much what people like me think.

____ 0. Agree ______ 1. Disagree

Finally for statistical purposes we would like to ask these general questions about you and your family.

116. Approximately how long have you lived in your present home? (To nearest year) ____________ Years

____ 54 55

117. How long have you lived anywhere in Salt Lake County, including Salt Lake City (To nearest year) ____________ years

____ 56 57

118. Please give me the year of your birth? (CODE LAST TWO DIGITS ONLY)

____ 99. NR

____ 58 59

119. How many children do you have?

____ 0. None ______ 5. Five
____ 1. One ______ 6. Six
____ 2. Two ______ 7. Seven or more
____ 3. Three ______ 8. DNA (includes never married, etc.)
____ 4. Four

____ 60
A. (IF CHILDREN) How many of these live at home at least 8 months of the year? (USE SAME CODE AS 119) 61

B. (IF CHILDREN) How many of these are under 6 years of age? (USE SAME CODE AS 119) 62

120. What is your present marital status?
   ___ 0. Never Married
   ___ 1. Separated or divorced
   ___ 2. Widowed
   ___ 3. Married 63

121. What is the principle kind of work that you do?
   A. Respondent's major occupation
      1. Job title ____________________________________________ 64
      2. Brief Description ______________________________________
      3. Industry _____________________________________________ 65

122. What is the principle kind of work that your spouse does?
   A. Spouse's major occupation
      1. Job title ____________________________________________ 67
      2. Brief description ______________________________________
      3. Industry _____________________________________________ 68
   ___ 0. Not married 69

123. What was the last grade of school that you completed?
   (CIRCLE ONE)  Deck 05
   Grammar 0 1 2 3 4 5 6 7 8
   High School 1 2 3 4
      (9) (10) (11) (12)
   College 1 2 3 4
      (13) (14) (15) (16)
   Graduate
   17. Masters
   19. Doctorate
   DNA (not married) (80)
124. What was the last grade of school that your spouse completed? (CIRCLE ONE)

Grammar
1 2 3 4 5 6 7 8
High School
1 2 3 4
(9) (10) (11) (12)

College
1 2 3 4
Graduate
(13) (14) (15) (16)

17. Masters
19. Doctorate

125. Are you buying or renting your home?

0. Renting
1. Buying or own home

126. (USE CARD 22) Taking into consideration all sources of income for you and your spouse which category on this card best represents your total income before taxes in 1972?

0. $0-$999
1. $1,000-$1,999
2. $2,000-$2,999
3. $3,000-$3,999
4. $4,000-$4,999
5. $5,000-$5,999
6. $6,000-$6,999
7. $7,000-$7,999
8. $8,000-$8,999
9. $9,000-$9,999
10. $10,000-$11,999
11. $12,000-$13,999
12. $14,000-$15,999
13. $16,000-$17,999
14. $18,000-$19,999
15. $20,000-$23,999
16. $24,000-$29,999
17. $30,000 or over

127. Are there any other ideas or comments that you would like to make concerning anything we have discussed? ____________________________________________
(QUESTIONS FOR INTERVIEWER ONLY)

128. Sex of respondent

___ 0. Female  ___ 1. Male

129. Type of structure in which family lives: (CHECK ONE)

___ 0. None, DNA
___ 1. Rooming house
___ 2. Apartments in partially commercial structure
___ 3. Apartment house (4+ units)
___ 4. Row houses (4+ units)
___ 5. Apartment house (2-3 units)
___ 6. Condominium
___ 7. Trailer or mobile home
___ 8. Detached single family house

130. Describe conditions or respondent's home, yard, and neighborhood compared to typical residence in Salt Lake County.

<table>
<thead>
<tr>
<th></th>
<th>HAS</th>
<th>POOR OR LOW</th>
<th>FAIR</th>
<th>AVERAGE</th>
<th>GOOD OR ABOVE AVERAGE</th>
<th>VERY GOOD OR HIGH</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. overall</td>
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</tr>
<tr>
<td>B. lawns</td>
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<td></td>
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<tr>
<td>C. flower gardens</td>
<td></td>
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<tr>
<td>D. shade and ornamental trees</td>
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<tr>
<td>E. house exterior</td>
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<tr>
<td>F. house interior</td>
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<tr>
<td>G. neighborhood rating</td>
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</tbody>
</table>

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131. Thumbnail Sketch: Anything else about the respondent, the interview situation, the house, or the neighborhood that seems important? Some factors to consider are interest, apparent ability, suspicions, others present, in a hurry or not, etc.

132. Other notes:
<table>
<thead>
<tr>
<th>Question</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>133. Percent in block under 18</td>
<td>23</td>
</tr>
<tr>
<td>134. Percent in block over 62</td>
<td>27</td>
</tr>
<tr>
<td>135. Percent of structure that are one unit in block</td>
<td>30</td>
</tr>
<tr>
<td>136. Percent in structures of ten or more units in block</td>
<td>33</td>
</tr>
<tr>
<td>137. Percent of housing units which are owned by resident in block</td>
<td>36</td>
</tr>
<tr>
<td>138. Mean value of house in block</td>
<td>41</td>
</tr>
<tr>
<td>139. Percent of housing units which are rented in block</td>
<td>44</td>
</tr>
<tr>
<td>140. Average contract rent of rental units in block</td>
<td>49</td>
</tr>
<tr>
<td>141. Percent of one person households in block</td>
<td>52</td>
</tr>
<tr>
<td>142. Percent of housing units in block with female head of household</td>
<td>55</td>
</tr>
</tbody>
</table>
APPENDIX C

STATEMENTS FOR MEASUREMENT SCALES

FROM THE SECOND PHASE SCHEDULE
The respondent was asked to answer two questions about each of the statements in the following scales. The first question asked the respondent to state the degree on a five point scale of agreement or disagreement to the statement. The responses to the items on each scale to the first question are summed to form scale scores for each respondent's attitudes.

The second question asked about each statement was the difficulty of answering the question. This has been found to be equivalent to the question "How strongly do you feel about it?" (referring to the statement). (Suchman, 1973.) Consequently, the responses to the second question are added to form intensity of feeling scores for each scale. There were four possible response categories to the second question.

The correlation coefficient of each item with the total score of the scale to which the item belongs and the significance level of this correlation coefficient are listed next to the respective items. All were significant to at least the .001 level.

It may appear that some of the variables are almost identical. However, this is not so; and indeed these variables were chosen partly on this fact on the basis of the pretest. The results from the main survey justify the divisions made. For instance, the intercorrelation between EXPT (Willingness to Follow Advice of Experts) and AGEN (Willingness to Follow Government Agencies) is .4498 (sig. = .001), the correlation coefficient between LEI (Leisure Orientation) and REC (Outdoor Recreation
Orientation) is .2070 (sig. = .001) and between ECOL (Ecological Orientation) and MAN (Attitude Toward Effect of Man-Made Objects Upon Beauty of Nature) is .3745 (sig. = .001).

I. PERCEPTION AND CONCERN FOR FLOODING AS A PROBLEM IN THE RESPONDENTS AREA

1. The problem of flooding is one of the most pressing problems that faces people in the Salt Lake area (Question 14) C = .5518

2. Flood control in the Salt Lake area is an excellent investment (Question 15) C = .5470

3. There is danger of serious flood damage in the Salt Lake area in the next five years (Question 19) C = .7024

4. Flooding is not really a serious problem in the Salt Lake area (Question 23) C = .7237

5. Flood control management in the Salt Lake area is very adequate (Question 32) C = .6695

6. Only emergency flood control work should be done in the Salt Lake area (Question 43) C = .4644

7. The control of flooding in the Salt Lake area is adequate (Question 57) C = .7269

8. Something definitely needs to be done to further control flooding in the Salt Lake area (Question 59) C = .7622

II. ATTITUDE TOWARD EFFECT OF MAN MADE OBJECTS UPON BEAUTY OF NATURE

1. Man generally improves the appearance of areas (Question 28) C = .5482

2. The beauty of nature is not destroyed by the presence of man made objects (Question 31) C = .6757

3. Buildings near a recreational area ruin the beauty of the area (Question 46) C = .6113

4. Flood control and similar projects destroy the beauty of the areas they are in (Question 49) C = .4738
III. LEISURE ORIENTATION

1. Most people don't spend enough time just enjoying themselves (Question 36) \( C = .4618 \)

2. People should play more and work less (Question 40) \( C = .6250 \)

3. Generally speaking, the main satisfaction I get out of life is working (Question 47) \( C = .6664 \)

4. I generally feel guilty when I enjoy leisure for more than a short time except when on vacations (Question 51) \( C = 5689 \)

IV. OUTDOOR RECREATION ORIENTATION

1. Outdoor recreation activities are the most enjoyable activities one can do (Question 21) \( C = .6178 \)

2. I would like to have much more recreation outdoors (Question 27) \( C = .6249 \)

3. If people were outdoors more, they would not be much better off (Question 34) \( C = .5195 \)

4. I wouldn't participate in outdoor recreation if someone weren't with me (Question 42) \( C = .4856 \)

5. People should spend much more of their recreation time outdoors (Question 44) \( C = .5413 \)

6. Indoor activities are as much fun as outdoor activities (Question 56) \( C = .6607 \)

V. WILLINGNESS TO PAY FOR GOVERNMENT EXPENDITURES

1. Taxes in Salt Lake County are very high (Question 24) \( C = .6011 \)

2. Government projects are too expensive (Question 29) \( C = .5799 \)

3. The government cares how much of my money it spends (Question 35) \( C = .5535 \)

4. The only way government won't waste money is if it doesn't have money to waste (Question 37) \( C = .4877 \)

5. Taxes should be raised if necessary to cover the cost of better protection for the public (Question 45) \( C = .6465 \)

6. Additional government services are worth additional taxes (Question 54) \( C = .6178 \)
VI. ECOLOGICAL ORIENTATION

1. The environment must be modified to meet the needs of man (Question 18) $C = .4372$

2. Not nearly enough is being done to protect our environment (Question 25) $C = .6213$

3. Nothing makes a trip into the wilderness more enjoyable than a well paved road (Question 30) $C = .5392$

4. Much more land should be preserved in its natural state (Question 33) $C = .5841$

5. Being in harmony with nature is extremely important (Question 38) $C = .3397$

6. Stronger laws are needed to protect our environment (Question 50) $C = .5470$

7. Developed areas are more enjoyable than undeveloped areas (Question 58) $C = .5351$

VII. WILLINGNESS TO FOLLOW ADVICE OF EXPERTS

1. People should follow the advice of experts more (Question 17) $C = .6218$

2. People who rely a lot on experts are generally people who can't think for themselves (Question 22) $C = .5945$

3. Experts know considerably more than the average person (Question 26) $C = .5972$

4. Experts are wrong nearly as often as they are right (Question 41) $C = .6642$

5. Not enough emphasis is placed on the opinion of experts (Question 53) $C = .5479$

6. People should form more of their own opinions rather than listen to experts (Question 55) $C = .6480$

VIII. WILLINGNESS TO FOLLOW GOVERNMENT AGENCIES

1. Recommendations by government agencies are often wrong (Question 16) $C = .5887$
2. Agencies are much better able to make correct decisions in the fields of their responsibility such as flood control than anybody else (Question 20) $C = .6723$

3. More control by the people is needed over the decisions of government agencies (Question 39) $C = .4718$

4. Major decisions in fields such as flood control should be left to the government agency responsible (Question 52) $C = .7371$
SELECTED REFERENCES


