UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

USE OF USGS EARTH-SCIENCE PRODUCTS BY COUNTY PLANNING AGENCIES IN THE SAN FRANCISCO BAY REGION, CALIFORNIA

by

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San Francisco Bay Region
Environment and Resources Planning Study
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ABSTRACT

An inventory of the use of USGS products in selected planning studies, plans, ordinances, and other planning activities was made for eight counties in the San Francisco Bay region--a region of almost five million people. This inventory was designed to determine and document the use of the 87 earth-science information products prepared as a part of the San Francisco Bay Region Environment and Resources Planning Study (SFBRS).

The inventory showed that: (1) all eight counties had planning staffs who were very familiar with SFBRS products and had made frequent use of such products; (2) all eight counties had prepared planning documents which cite SFBRS products; (3) the types of planning applications most often indicated were: geologic hazards studies, seismic safety and public safety plan elements, general reference, and the preparation and review of environmental impact reports and statements; (4) over 90 percent of the 87 SFBRS products were used at least once, and nine of the products were used over 30 times each for various

county planning activities; and (5) at least 85 other USGS products were also used for various county planning activities.

After the inventory, selected county officials, employees, and consultants were interviewed and asked--among other things--to indicate any problems in the use of the SFBRS products, to suggest improvements, and to identify any needed or desired earth-science information. The responses showed that: (1) the scales commonly used for working maps were 1:62,500 or larger and for plan implementation were 1:24,000 or larger; (2) only one county had a geologist on its planning staff, although six others had the benefit of geotechnical services from private consulting firms, county engineering staffs, or the State Division of Mines and Geology; (3) seven of the eight counties expressed some problems in using the products, primarily because of their small scale or lack of detail; (4) all eight counties expected to continue to use the products and expressed a need or desire for additional earth-science, engineering, or other information; (5) all eight counties suggested specific improvements to future products, primarily larger scale or more detail and fewer technical or more interpretive products; and (6) all eight counties received educational, advisory, and review services from USGS personnel.

Seventeen selected examples of the application of SFBRS products to various county planning activities are discussed and illustrated. These examples include four planning studies, seven plans, and two ordinances.

From the inventory and responses to the interviews, it is concluded that the counties in the Bay region are very familiar with, have made frequent use of, and will continue to use SFBRS products for a wide range of county planning activities.

Suggestions to ensure more effective use of earth-science information in the future include: (1) monitoring emerging critical issues and analyzing new state and federal laws and regulations so as to better anticipate and respond to county earth-science information needs; (2) creating a users advisory committee to help identify critical issues and user needs; (3) providing engineering interpretations and land- and water-use capability ratings to make earth-science information more readily usable; (4) giving priority to areas impacted by development so as to husband staff resources; (5) providing earth-science information at the larger scale and greater detail commonly used and needed by counties; (6) releasing earth-science information earlier and according to a formal distribution pattern; and (7) providing educational, advisory, and review services in connection with any earth-science information designed for planners and decisionmakers.

INTRODUCTION

The San Francisco Bay Region Environment and Resources Planning Study (SFBRS) is an experimental cooperative program begun in 1970 by the U.S. Geological Survey (USGS) and the U.S. Department of Housing and Urban Development (HUD). The goal of the program is to identify and provide basic and interpreted earth-science information needed in making land-use decisions for regional planning, to provide a comprehensive array of data at a regional scale, and to test and evaluate the ways in which these data are being used in the planning and decisionmaking processes.

The Study has resulted in the preparation, publication, and distribution of numerous earth-science information products; namely, 71 basic data contributions, six technical reports, seven interpretive reports, and several photographic and topographic products. These products are listed in appendixes A, B, C, and D, respectively.

Both the original "Program Design" (1971) and the "Plan For Completion of Study" (1974) provided for a report on the application of the earth-science products to planning. This report partially fulfills that provision.

Purpose and Objectives

The broad purpose of this report is to provide the U.S. Geological Survey and the U.S. Department of Housing and Urban Development with a measure of the use of SFBRS products for planning and decisionmaking and the effectiveness of such uses. The three objectives of this report are to:

1. Determine and document the use of SFBRS products by county planning agencies for land-use planning and plan implementation.

2. Evaluate the effectiveness of such uses and attempt to determine the reasons for nonuse, misuse, or ineffective use.

3. Suggest ways to achieve greater or more effective use of earth-science information in the future.

Scope

This report on the uses county planning agencies have made of SFBRS products is part of a larger study of selected governmental users of SFBRS products. It is released to the open-file to make the results immediately available. The final report will include the completed report on cities (Kockelman, 1975) and the results of our inventory of, and interviews with, selected regional, State, and Federal agencies having planning jurisdiction or responsibility in the San Francisco Bay region.

Structure

This report consists of five subject areas:

1. Discussion of potential users and uses; county planning agencies and selected planning activities; and the method used for the inventory and interviews.

2. Report on the results of the inventory by type of use and product; and a report on the comments of those interviewed.

3. Discussion and illustration of selected applications.

4. Summary and analysis of the type of planning applications inventoried, type of products identified, and the comments of those interviewed.

5. Conclusions, transfer value, future outlook, and suggestions for future SFBRS-type programs.

This report is formatted to be integrated with the completed report on cities. It can also be used as a framework on which to add, and with

which to integrate, subsequent inventories of earth-science applications to planning and decisionmaking by regional, State, and Federal agencies in the San Francisco region.

Acknowledgments

Preparation of this report required the support, cooperation, and assistance of many people. It is not practicable to acknowledge the help of everyone here, but the courteous cooperation received from county officials, employees, and consultants is acknowledged. Special mention should be made of the contribution of Connalie Danielson in tabulating and totaling the results of the inventory and interviews.

POTENTIAL USERS AND USES

Planning is the rational process of preparing plans and programs directed toward the achievement of certain goals or the solving or abating of existing and anticipated problems. Everyone is in the process of preparing plans either formally or informally, consciously or unconsciously.

Scientific data and interpretations concerning physical resources, physical hazards, and existing physical development are necessary for any intelligent physical planning. Almost all individuals, firms, and institutions performing physical planning are potential users of earth-science information, such as that provided by the SFBRS. Thus, many units and agencies of local, regional, State, and Federal government are potential users of earth-science data, and some agencies even have a responsibility to the public not only to use such data, but to make a serious effort to obtain it.

Such potential users of SFBRS products have been confirmed by an independent study of a planning consultant (Spangle, 1972); an examination of the SFBRS mailing lists; a review of the records of requests for SFBRS products; a perusal of 18 SFBRS quarterly progress reports; and the results of the background interviews with 44 members of USGS and HUD. Each of these sources indicated numerous uses by various agencies of government in the Bay region including counties. These sources are described in greater detail in the report on cities (Kockelman, 1975).

COUNTY USERS AND THEIR PLANNING ACTIVITIES

The eight counties in the San Francisco Bay region ranged in size from 79,140 to 1,073,184 people in 1970. All the counties experienced a growth of population between 1960 and 1970 ranging from 18.2 to 65.8 percent. Santa Clara County had the largest numerical and percentage increase in population during this period. The U.S. Bureau of the Census (1971) population figures for 1960 and 1970 and the percent of change for each county are shown on table 1 (p. 22). The location and extent of each county is shown on figure 1.

San Francisco County is not included in this report as it is coterminous, consolidated, and a single legal entity with the City of San Francisco whose use of USGS products was inventoried in the report on cities (Kockelman, 1975).

The powers and duties of counties related to planning, and the studies, plans, implementation devices, and other planning activities selected for inventory are discussed in this section of the report.

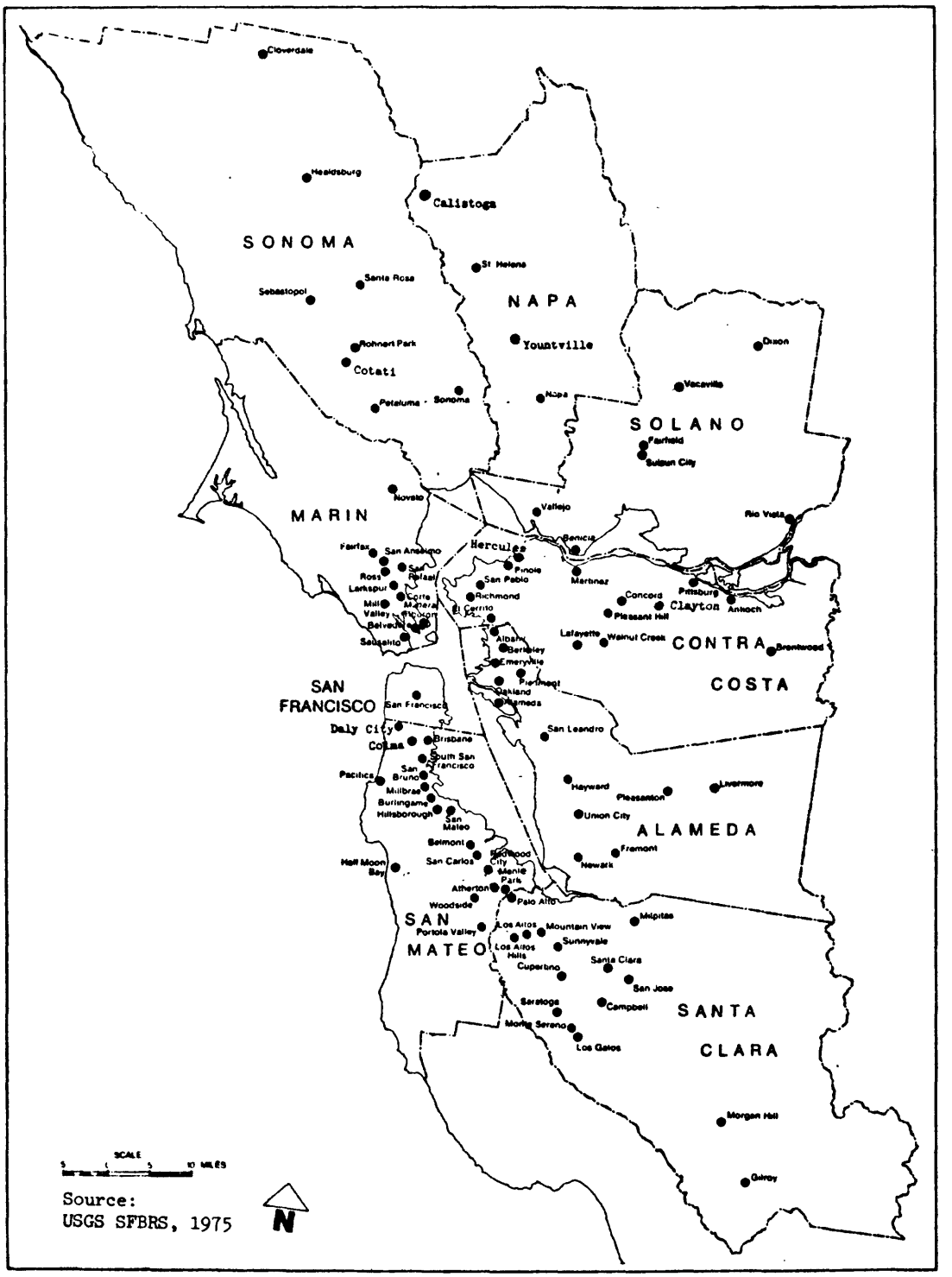
General Powers and Duties

Sections 1(b) and 7 of Article XI of the Constitution of the State of California 1879 (1976) provides that "The Legislature shall provide for county powers...", and that each county is empowered to "...make and enforce within its limits all local, police, sanitary, and other ordinances and regulations not in conflict with general laws."

Sections 65100 through 65202 of the California Government Code (1975) require each county to establish a planning commission; authorize the establishment of a planning department, the appointment of

FIGURE 1

Counties in the San Francisco Bay Region



officers and employees, and the use of planning consultants; and specifies the commission's functions. A county planning commission's functions are to: (1) develop and maintain a general plan; (2) develop such specific plans as may be necessary or desirable; (3) periodically review the capital improvement program; and (4) perform such other functions as its legislative body may provide.

Planning Studies

An important task before preparing any general plan or plan element is to make accurate, thorough, and appropriate studies. The word "studies" is used here to include the collection, analysis, and interpretation of data and the preparation of forecasts and projections. Legislative authority to perform the studies necessary to prepare the required general plan and plan elements is implicit in Sections 65102 through 65104 of the California Government Code (1966).

For the purpose of this report, the following planning studies were selected for inventory: circulation, geologic hazards, land use, physical resources, public building site evaluation, and sub-county area studies. The word "circulation" is used in the California Government Code to include the general location and extent of transportation routes and terminals.

Plans

The word "plans" is used here to include the development and adoption of goals, principles, and standards; the development and testing of alternate plans; and the adoption and detailing of the selected plan. Section 65300 of the California Government Code (1966) provides that:

> "Each planning agency shall prepare and the legislative body of each county ...shall adopt a comprehensive, long-term general plan for the physical development of the county..., and of any land outside its boundaries which in the planning agency's judgment bears relation to its planning."

It is the author's experience that good county planning practice requires a general plan that includes at least the following elements for those areas for which the county has planning jurisdiction or responsibility:

- Land-use plan
- Circulation plan
- County facilities plan including parks, storm-water drainage, waste disposal, and schools and other public buildings
- Resource conservation plan including flora, fauna, soils, water, minerals, energy, and historic, scientific and scenic areas.

The California State Legislature has specified in Sections 65302 and 65302.1 of the California Government Code (1975) those plan elements that must be included in the general plan. In addition, Section 66780 of the California Government Code (1975) requires each county to prepare and submit a comprehensive, coordinated solid waste management plan to the State Solid Waste Management Board. Section 65302.2 of the California Government Code (1975) provides that the seismic safety, noise, public safety, and scenic highway elements must be prepared and adopted no later than one year following adoption of guidelines by the California Council on Intergovernmental Relations (1973).

The required elements of the general plan and the "deadlines" for their adoption are:

Circulation	Required since 1955
Conservation	December 31, 1973

Housing	Required since 1969
Land use	Required since 1955
Noise	September 20, 1974
Open space	December 31, 1973
Public safety	September 20, 1974
Scenic highway	September 20, 1974
Seismic safety	September 20, 1974
Solid waste management	January 1, 1976

In addition, Section 65303 of the California Government Code (1975) authorizes counties to include elements in the general plan that provide for public sites, facilities, and standards; such as, beaches, parks, parkways, parking lots, building setback lines, harbors, airports, transit lines, sewerage, refuse disposal, drainage, local utilities, public schools, fire stations, community design standards, substandard dwelling elimination, redevelopment, historical preservation, and other subjects which in the judgment of the planning commission relate to the physical development of the county. The State Legislature recently enacted a surface mining reclamation law, which requires--among other things--counties to establish mineral resource management policies which will emphasize the conservation and development of mineral deposits and to incorporate such policies into their general plan (Calif. Public Resources Code, Sec. 2762 (1976)).

For the purpose of this report, the general plan and the following plan elements were selected for inventory: circulation, conservation, land use, open space, public safety, seismic safety, and sub-county area plans. The contents of these elements are set forth in Sections 65302 and 65302.1 of the California Government Code (1975). The California Council on Intergovernmental Relations in its "General Plan Guidelines" (1973) has discussed the authority, scope, and method of collecting and analyzing data, the relationship to other elements, and some implementation devices for each of these elements.

In addition, the solid waste management plan element was selected for inventory. The State Solid Waste Management Board has provided guidelines for the preparation of this element in the California Administrative Code (1975). The content of this element is set forth in Sections 17170-17179 of Title 14 of the California Administrative Code (1975).

Plan Implementation Devices

After the preparation and adoption of plans comes the task of implementing or executing them. The term "implementation devices" is used here to include all methods that may be available to a county to execute any plan. Such devices include capital improvement programs, utility extension policies, zoning ordinances, housing and building codes, subdivision regulations, acquisition of development rights, condemnation of public sites, special regulations for hazardous areas, assessment and taxation practices, official mapping in advance of acquisition, public works development policies, annexation, consolidation and incorporation policies, financing methods, and the monitoring and revision of adopted plans.

County planning commissions are authorized by Sections 65450 (1966), 65451 and 65452 (1975) of the California Government Code to prepare specific plans based on the general plan and drafts of such detailed regulations, programs, conditions, and legislation as may in their judgment be required for the execution of the general plan or a plan element. Examples of such specific plans and proposed regulations, conditions, programs, standards, legislation, and other measures are set forth in Section 65451 of the California Government Code (1975).

The adoption and administration of county zoning, subdivision,

building, and grading ordinances are authorized or required by the California Legislature (Calif. Government Code, Secs. 65800-65909 (1975), and 66411 (1975); Calif. Health and Safety Code, Secs. 17922 and 17958 (1975)).

For the purpose of this report, building, grading, subdivision, and zoning ordinances were selected for inventory as these devices are customarily used in the implementation of the required plan elements, and their application of USGS products can be easily documented. In addition, to be valid and effectively administered, ordinances must be clear, unequivocal, and based upon large-scale data or information which can be supported by precise data, field investigations, and expert testimony. The use of SFBRS products in the administration of, or in the evaluation of proposed amendments to, these ordinances was also inventoried.

Other Planning Activities

In addition to the plans, planning studies, and implementation devices selected to be inventoried, the following additional planning activities to which SFBRS products could be applied were selected: community assistance, environmental analysis, environmental impact statement (EIS) and report (EIR) preparation and review, general reference, and potential problem area. The term "community assistance" is used here to include the providing of certain planning services from the county to communities within the county.

The preparation and review of EIS's and EIR's is required by the National Environmental Policy Act of 1969 (U.S. Code, Title 42, Secs.

4321-4374 (1975)), and the California Environmental Quality Act of 1970 (Calif. Public Resources Code, Secs. 21000-21174 (1975)), respectively. The Supreme Court of California in the Friends of Mammoth v. Board of Supervisors of Mono County (1972) held that the California act also applied to private activities for which a public permit or similar entitlement was required.

Consistency Requirement

The California Legislature has provided that the county zoning ordinance shall be consistent with the county's general plan by July 1, 1975 and specified the criteria for consistency; (Sec. 65860(a), Calif. Government Code,1975). The Legislature also provided that any resident or property owner within the county may bring an action to enforce compliance (Sec. 65860(b), Calif. Government Code, 1975).

These statutory provisions should result in more effective implementation of a county's general plan and the various plan elements which comprise the general plan.

County plans without appropriate implementation devices for their execution are merely guides and usually have little legal effect on particular land (Hagman, 1971). However, when regulations must be consistent with plans, the plans begin to take on more importance to the landowners (Hagman, 1973), and the plans also begin to take on more importance to the decisionmakers and other county officials.

METHOD OF INVENTORY AND INTERVIEWING

The method of inventory and interviewing was developed especially for the SFBRS and was first used for the 91 Bay region cities' inventory and interviews. This method can be used for evaluating the effectiveness of applying earth-science data to planning and is transferable.

The conduct and results of this type of inventory and interview are influenced by the personality, thoroughness, and skill of the interviewers; and the competence, knowledge, and responsiveness of the person interviewed. Efforts to reduce the subjectiveness of the inventory and interview included the use of inventory and interview forms, use of three interviewers, systematic scheduling and recording, and subsequent review and verification. These efforts are discussed in the report on cities (Kockelman, 1975).

Interviews

Each of the eight counties was assigned to one of the two interviewers used for the cities. In addition, the author conducted a separate inventory of each county and interviewed additional county personnel.

The top planning official, usually the planning director, of each county was called by telephone, and an interview meeting was scheduled with the director or his designee. The designee was usually the staff person who was the most experienced in using SFBRS products or had a need for earth-science information. The meetings were usually confirmed by letter.

Several persons in each county were interviewed in the field. The

number of persons interviewed in each county ranged from 10 to 18. Most of the county officials and employees on the SFBRS mailing list were interviewed. During the interview with the county planners, several persons in other county departments were usually identified as using, or having used, SFBRS products. These persons were then interviewed. However, no attempt was made to systematically interview the staffs of other county agencies, such as public works, health, engineering, civil defense, and building departments. The name, title, and agency of the officials, employees, and consultants interviewed are listed in appendix E by county.

Inventory and Interview Forms and Records

The forms used for the city inventory were slightly modified for use in this inventory. Typical completed inventory and interview forms are shown in figures 2 and 3.

The methods used to record the inventory (see fig. 2) and the collecting, marking, and storing of selected planning documents were the same as those methods used for the cities. The documents available in the SFBRS files are listed in appendix F. The method used for recording the comments received during the interviews was the same as the method used for the cities (see fig. 3).

Review and Verification

Each completed inventory and interview form was reviewed and, if necessary, the recorded data were verified or clarified. Some counties were solicited for additional information or documents by telephone.

FIGURE 2

Typical Completed Inventory Form

COUNTY OF NAPA

Population 87,000 (1974)

Area 79.5 sq. mi.

1"=1,000',1"=2,000'
1"=5,000' Work Maps

1"=100',1"=200'
1"=500',1"=800' Implementation Maps

		Study, Plan, or Device	USGS Product Used	SFBRS Product Used	Products Used: Group a/ or Topic	Products Used: Map or Report No.
PLANNING STUDIES						
	Circulation	*				
	Geologic Hazards (part of Seismic Element)	0	/	X	F,FP,G,H,L,LU, M,WD,WQ,WS	BDC 5,7,9,11,15,33,37,52,54, 56,67, other USGS
	Land Use	0				
	Physical Resources	0	/	X	F,FP,L,G,H,LU,L, M,WQ,WS,Topo	BDC 7,9,11,15,21,24,25,50,51, 54,TR 3,4,IR 1,2, 7½ quad
	Public Site Evaluation					
	Sub-County Areas					
	OTHER					
PLANS						
	Circulation	*				
(Copy)	Conservation	0	/	X	F,FP,G,H,L, M	BDC 7,9,11,15,25, 54
(Copy)	General Plan	0	/	X	F,FP,G,H,L,M,WD,WQ, WS,Topo,Reg. Slope	BDC 4,5,9,11,15,32,37,47,50, 52,54,56,67, IR 4, 7½ quad
(Copy)	Land Use	0	/	X	F,FP,G,H,L,M,WD,WQ, WS,Topo,Reg. Slope	BDC 4,5,9,11,15,32,37,47,50, 52,54,56,67, IR 4, 7½ quad
(Copy)	Open Space	0	/	X	F,FP,G,H,L, M	BDC 7,9,11,15,25, 54
	Public Safety	*	/	X	F,FP,G,H,L, M	BDC 7,9,11,15,32,37, 52,54,56,67
	Scenic Routes	*				
(Copy)	Seismic Safety	0	/	X	F,FP,G,H,L, M	BDC 7,9,11,15,32,52, 54,56,67
	Solid Waste Management	*	/	X	7½ quad Reg. Slope	
	Sub-County Plans					
	OTHER-Housing, Noise	*				
ORDINANCES						
	Ordinance Administration	0	/	X	F,FP,G,H,L, M,WD,WQ,WS	BDC 4,5,7,8,9,11,15,25,32,37, 47,50,52,54,56,67,69, IR 4
	Building	0				
	Grading	0				
(Copy)	Subdivision	0				
(Copy)	Zoning	0				
(Copy)	OTHER-Riparian Woodland	0				
OTHER ACTIVITIES						
	Community Assistance	0				
(Copy)	EIS/EIR Preparation	0	/	X	Topo,Reg. Topo,F,FP, G,H,L,M,WD,WQ,WS	BDC 4,5,7,9,11,15,25,32,37,47, 50,52,54,56,67,69,IR4,Other USGS
	EIS/EIR Review	0	/	X	Topo,Reg. Topo,F,FP, G,H,L,M,WD,WQ,WS	BDC 4,5,7,9,11,15,25,32,37,47, 50,52,54,56,67,69,IR4,Other USGS
	Environment Analysis	0	/	X	Topo,Reg. Topo,F,Fp, G,H,L,M,WD,WQ,WS	BDC 4,5,7,9,11,15,25,32,37,47, 50,52,54,56,67,69,IR4,Other USGS
	General Reference	0	/	X	F,FP,G,H,L,M, WD,WQ,WS	BDC 4,5,7,8,9,11,15,24,25,32,37, 41,47,50,52,53,54,56,67,69, IR 4, TR 3
	Potential Problem Area					
	OTHER					

a/ These letters indicate the following SFBRS product groupings: F-Faults, FP-Flood-prone Areas, G-Geology, H-Hydrology, L-Landslides, LU-Land Use, M-Miscellaneous, WD-Waste Disposal, WQ-Watsr Quality, WS-Water Supply. * - Indicates "In Process", 0 - Indicates "Completed".

FIGURE 3

Typical Completed Interview Form

COMMENTS ON EARTH SCIENCE APPLICATIONS IN THE BAY REGION

1. Planning Staff
   (Number of professional planners 11 ; engineers 1 ; geologists 0 ; total staff 22)
   (Geologic, hydrologic or engineering background of professional staff) None

2. Receipt, Distribution and Custody of SFBRS Products
   Received, circulated, and filed by topic in Environmental Protection Section

3. Reasons for Failure to Use SFBRS Products
   (Not received, not distributed, not accessible, no staff capability, lack of interest, interdisciplinary communication, etc.)

   Unaware of orthophotos with contours
   Have more detailed flood data from the County Flood Control District

4. Problems in Using SFBRS Products
   (Map scale, legend or text; technical assistance; level of detail; local staff capability; planning area coverage; accuracy, etc.)

   Scale too small
   Three of 15' topographic quadrangles have been discontinued or are unavailable
   7½' quadrangles not up-to-date
   Photorevised 7½' quadrangles lack revised hypsography
   Most BDC's do not cover the County, e.g. landslide data is not available

5. Contacts with USGS Personnel to Obtain Products or Assistance
   (Name, topics, type of assistance)

   Ed Helley, Ken Fox; Information and review of seismic safety element
   Bill Brown; Information on sedimentation
   George Schlocker; Information and review of EIR
   Saul Rantz; Information and advice on precipitation
   Loren Young; Information on ground water yields

6. Anticipated Use of Published USGS/SFBRS Products in Future
   (Identify products and use)

   All topical interpretive reports except coastal processes
   Orthophotos with contours
   Old aerial photographs (1:12,000)

7. Data or Products Needed or Desired
   (Topic, scale, land uses, etc.) (Changes or improvements in future SFBRS products)

   Data Needed: Land-use capability, engineering interpretations, 1:62,500 topo maps, 1:24,000 slope maps, more detailed fault locations, liquefaction data, and landslide data.
   Suggestions: Keep text simple, conduct more cooperative studies with other agencies, use more color, provide UTM grid tick marks on slope and orthophoto maps, publish products at larger scale - at least 1:24,000 and explain the methodologies used.

8. Outstanding Illustrations of the Use of SFBRS Products
   (e.g., maps, methodology, ordinance wording, etc.)

   Multiple acetate overlays of geologic and hydrologic hazards and resources for the land-use element and general plan.
   Staff feels comfortable in using USGS data

9. County Officials, Employees, and Consultants Interviewed:

Lou Archeleta	Associate Planner	Planning
Bruce Baracco	Assistant Planner	Planning
Ronald Guderson	Civil Engineer	Flood Control
James Hickey	Director	Planning
Robert Jones	Civil Engineer	Flood Control
J. B. Klein	Associate Civil Engineer	Public Works
Anthony McClimmons	Senior Planner	Planning
James O'Loughlin	Associate Planner	Planning
Steve Rae	Associate Planner	Planning
John Stewart	Civil Engineer	Public Works
A. R. Van Woerkom	Sanitarian III	Environmental Health

Address: 1121 First St., Napa, CA 94558 Telephone: 707-224-8388
Interviewers: W. J. Kockelman, M. M. Trembley Dates: 1/19/75; 11/22/74

Applications of SFBRS products disclosed by the background interviews with USGS and HUD personnel were logged by county on the reverse side of the inventory sheet before the inventory and interviews were conducted. In most cases, these applications were confirmed during the inventory or interview.

All additional uses and products noted after completion of the field inventories and interviews were recorded on the appropriate inventory form up to November 30, 1975, and these uses have been included in tables 1 and 2.

INVENTORY OF USES

All eight county planning agencies inventoried are on the SFBRS mailing list and have planning staffs who are very familiar with SFBRS products. All eight counties are using SFBRS products in the preparation, administration, or conduct of their planning studies, plans, ordinances, and other planning activities.

All eight county planning staffs had prepared planning studies, plans, ordinances, or other documents which cite[1/] SFBRS products. Copies of these studies, plans, ordinances, and other documents were obtained and are listed in appendix F. Seventeen examples of these documents are discussed under the Selected Applications section of this report.

The results of the inventory of county planning activities in the San Francisco Bay region are presented in table 1 and are reported here by planning studies, plans, ordinances, and other planning activities.

Planning Studies

All eight counties indicated the use of SFBRS products in the preparation of 30 planning studies as follows:

Geologic hazards	8
Public site evaluation	5
Sub-county area	5
Land use	4
Physical resources	4
Circulation	2

Other planning studies included grading, environmental constraints, and waste management studies.

[1/] The use of the words "cite," "cited," and "citation" in this report refer to specific documentation and not merely verbal identification of a use during an interview.

TABLE 1

Use of SFBRS and Other USGS Products by County and Type of Planning Activity

COUNTY	POPULATION			STUDIES							PLANS									ORDINANCES						OTHER ACTIVITIES						
	1960	1970	Change 1960-1970	Circulation	Geologic Hazards	Land Use	Physical Resources	Public Site Evaluation	Sub-County Areas	Other	Circulation	Conservation	General Plan	Land Use	Open Space	Public Safety	Seismic Safety	Solid Waste Management	Sub-County Areas	Other	Administration	Building	Grading	Subdivision	Zoning	Other	Community Assistance	EIR/EIS Preparation	EIR/EIS Review	Environmental Analysis	General Reference	Potential Problem Area	Other
Alameda	908,209	1,073,184	18.2	*	X	/	X		X	X	*	X	X	X	0	*	X	X		X	X	0	0	0	0		X	X	X	X	X	X	X
Contra Costa	409,030	558,389	36.5	X	X	X		X	X		0	/	0	0	/	*	X	X	X	*	X	0	0	0	0		X	X	X		X	X	X
Marin	146,820	206,038	40.3	0	X			0	X	0	0	0	0	0	0	X	X	X	0	X	X	0	0	0	0		X	X	X	X	X	X	X
Napa	65,890	79,140	20.1	*	X	0	X				*	X	X	X	X	X	X	X		*	X	0	0	0	0	0	0	X	X	X	X		
San Mateo	444,387	556,234	25.2		X	X	X	X	X		X	X	0	X	X	X	X	X	X	*	X	0	0	0	X	0		X	X	X	X	X	X
Santa Clara	642,315	1,064,714	65.8	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	0	X	X	X	X	0	0	X	X	X	X	X	X	X
Solano	134,597	169,941	26.3		X	/		X		X	/	/	/	/	/	X	X	*	X	X	/	0		0	0			X	X	X	X		X
Sonoma	147,375	204,885	39.0	*	X	X	X	X			X	X	X	X	X	X	X	*		0	X	0	0	0	/		X	X	X	X	X		X

Legend

0 Indicates no identified use of SFBRS or other USGS products.

X Indicates identified use of SFBRS products.

/ Indicates identified use of other USGS products.

* Indicates preparation or major revision underway with no identified use of SFBRS or other USGS products.

[X] Indicates those examples illustrated under the Selected Applications section of this report.

Copies of those planning studies citing SFBRS products are on file and are listed in appendix F. Four of these studies are discussed under the Selected Applications section of this report.

Plans

All eight counties indicated the use of SFBRS products in the development of 46 general plans or plan elements as follows:

Seismic safety	8
Public safety	6
Solid waste management	6
Conservation	5
Land use	5
General plan	4
Open space	4
Sub-county areas	4
Circulation	3

Other plans included emergency operations, environmental quality, and civil defense plans.

Copies of those plan documents citing SFBRS products are listed in appendix F. Seven of these plans are discussed under the Selected Applications section of this report.

Ordinances

Although all eight counties have building, subdivision, and zoning ordinances, only two counties have incorporated specific references to SFBRS products; namely, San Mateo County in its zoning ordinance and Santa Clara County in its building, grading, and subdivision ordinances. However, seven counties make extensive use of SFBRS products in the administration of their land-use and development ordinances.

Copies of those ordinances citing SFBRS products are on file and are listed in appendix F. These ordinances are discussed under the Selected Applications section of this report.

Other Planning Activities

All eight counties indicated the use of SFBRS products for other planning activities as follows:

EIR/EIS preparation	8
EIR/EIS review	8
General reference	8
Environmental analysis	7
Community assistance	5
Potential problem area	5

Planning activities other than those listed above included search and rescue operations, map overlays, base mapping, public works design, industrial site evaluation, and public information. Copies of those documents citing SFBRS products are on file and are listed in appendix F. Three of these planning activities are discussed under the Selected Applications section of this report.

PRODUCTS USED AND THEIR USES

Of the 71 basic data contributions, 6 technical reports, 7 interpretive reports, and other photographic and topographic products prepared under the SFBRS to date, 65 basic data contributions, 5 technical reports, all interpretive reports, and all the photographic and topographic products were identified 1,257 times by the eight county planning agencies. The number of applications of each product to a specific study, plan, ordinance, or other planning activity are shown on tables 2 and 3.

All eight counties identified other USGS products; that is, USGS products not prepared under the SFBRS. These other USGS products are listed in appendix G.

For the purpose of this report, the SFBRS products have been grouped by topic as follows: faults, flood-prone areas, geology,[2/] hydrology, landslides, land use, miscellaneous, waste disposal, water quality, water supply, and photography and topography. The topical group of each product is indicated by the letter shown on tables 2 and 3. The title, date, author, scale, and description of each product are included in appendixes A, B, C, and D.

[2/] Most of the SFBRS geologic products contain some data on faults.

TABLE 2

Use of Basic Data Contributions by Type of Planning Activity

Basic Data Contribution No.	Group a/	STUDIES							PLANS									ORDINANCES						OTHER ACTIVITIES							Total
		Circulation	Geologic Hazards	Land Use	Physical Resources	Public Site Evaluation	Sub-County Areas	Other	Circulation	Conservation	General Plan	Land Use	Open Space	Public Safety	Seismic Safety	Solid Waste Management	Sub-County Areas	Other	Administration	Building	Grading	Subdivision	Zoning	Other	Community Assistance	EIR/EIS Preparation	EIR/EIS Review	Environmental Analysis	General Reference	Potential Problem Area	Other	
1	F		2		1				1		1	1		2	2				1						1	2	2	2	1	1		20
2	G													1	2					1	1	1			1				1			8
3	G																															0
4	WS	1									1	1				1			2							4	4	3	5	2		24
5	WD	1									1	1							3							3	3	3	5	2		22
6	G													1	1	2	1			1	1	1							2			10
7	F	1	4	1	1					2	1	1	3	2	4		1		4	1	1	1			1	4	4	3	5	2		47
8	G	1		1										1	1				1										4			9
9	M	1	3	1	2		2			3	1	1	2	3	5	1	2		3	1	1	1			1	4	4	4	6	2		54
10	M																															0
11	L	1	1	1	1					2	1	1	2	2	2		1	1	3							2	3	2	4	1		31
12	G		1		1				1		1	1	1	1	1				1						2	2	2	2	1	1		19
13	G	1	1			1									1					1	1	1			1	1	1	1	1	1		13
14	WQ	1		1													1												1			4
15	FP		1		1					1	1	1	1	1	1				1							1	1	1	2			14
16	FP								1	1	1	1	1						2						2	2	2	2	2	1		18
17	FP		1						1	1	1	1	1	1	1				2						2	2	2	2	2	1		21
18	FP		1						1	1	1	1	1	1	1				1						1	1	1	1	1			14
19	FP																		1						1				1			3
20	FP			1		1						1		1	1		1		1							1	1	1	2			12
21	WQ				1											1			1							2	2	2	3	1		13
22	H																1									1						2
23	M																															0
24	WQ				2	1				1																2	2	2	1	1		12
25	H				2			1		2			1			1			1							3	2	2	1			16
26	M																															0
27	G		1												1	1	1								1	1	1	1	1	1		10
28	G		1			1		1			1	1			2	1			2						1	3	2		2	1	1	20
29	G													1	1														1			3
30	F		1											2	3	1	2		3	1	1	1			1	1	1	1	4	2		25
31	L		1			1	1	1			1	1			1	1			2						1	1	2		2	1	1	18
32	H		1					1		1	1	1		1	1	1			2							4	3	2	1			20
33	M																															0
34	L							1			1	1							1						1	1	2		2	1	1	12
35	L		1					1		1			1		1		1		1								2		2			11

a/ The letters indicate the following SFBRS product groupings: F-Faults, FP-Flood-prone Areas, G-Geology, H-Hydrology, L-Landslides, LU-Land Use, M-Miscellaneous, WD-Waste Disposal, WQ-Water Quality, WS-Water Supply.

TABLE 2--continued

Use of Basic Data Contributions by Type of Planning Activity

Basic Data Contribution No.	Group a/	STUDIES							PLANS										ORDINANCES						OTHER ACTIVITIES							Total
		Circulation	Geologic Hazards	Land Use	Physical Resources	Public Site Evaluation	Sub-County Areas	Other	Circulation	Conservation	General Plan	Land Use	Open Space	Public Safety	Seismic Safety	Solid Waste Management	Sub-County Areas	Other	Administration	Building	Grading	Subdivision	Zoning	Other	Community Assistance	EIR/EIS Preparation	EIR/EIS Review	Environmental Analysis	General Reference	Potential Problem Area	Other	
36	WQ																															0
37	L		4								1	1	1	5	7				3							2	2	2	4	1		33
38	L		1			1		1			1	1			2	1			2						1	1	2		2	1	1	18
39	G							1			1	1			1	1			1	1	1	1			1	1	1		1	1	1	15
40	L	1				1		1			1	1				1				1	1	1			2	2	2	1	2	2	1	21
41	G					1		1						1	1	1	1		2							1	1	1	2			13
42	L					1	1	1	1			1		1	1		1		1							1	1	1	1		1	14
43	L					1	1	1	1	1		1	1	1	1		1		1				1			1	1	1	1		1	17
44	F					1	1	1	1	1		1	1	1	1		1		1				1			1	1	1	1		1	17
45	L	1				1										1				1	1	1			1	1	1	1	1	1		12
46	L	1	1			1										1				1	1	1			2	2	2	2	2	2		19
47	WS				1						1	1							2							3	3	2	4	1		18
48	G							1		1	1	1			1	1			1						1	1	1		1	1	1	13
49	WD	1				1										2													2			6
50	WS				1	1		2			1	1				1			2						1	3	3	3	5	2		26
51	WQ				1					1																2	2	2	2	2		12
52	FP		4	1	1	2		1	1	2	2	3	2	6	6	1	1	1	3						1	3	3	3	3	1	1	52
53	WS																												1			1
54	G		3		2	1		1		2	1	1	2	3	4	1	1		3						1	3	3	2	4	1		39
55	F		1			1								1	3	1			1								1		2			11
56	G		2		1				1		2	2		2	2				2						2	2	2	2	2	1		25
57	L		1			1	1	1			1	1			1	1			2						1	2	2		2	1	1	19
58	F													1	1														1			3
59	L		1				1	1			1	1			1				2						1	1	1		2	1	1	15
60	F		1			1									1	1			1							1	1		1			8
61	LU					1	1			1		1		1	1	2			1							1	1	1	1	1	1	15
62	LU			1							1	1		1																		4
63	L					1								1	1				1	1	1	1			2	2	2	2	4	2		21
64	G		2		1			1	1		2	2		2	2				3						2	3	3	2	3	2	1	32
65	G				1														1						1	1	1	1	1	1		8
66	L		1		1				1		1	1		1	1										1	1	1	1				11
67	L		3		1	1			1		2	2		2	3	1			3						2	3	3	3	3	1		34
68	G					1								1	1		1		1							1	1	1	1			9
69	H																		2							1	1	1	1			6
70	WQ																		1							1	1	1	3	1		8
71	WS																									1						1
Total		12	46	8	23	25	9	21	13	25	35	41	21	52	76	29	19	2	82	11	11	11	2	0	41	97	99	74	132	49	15	1081

a/ The letters indicate the following SFBRS product groupings: F-Faults, FP-Flood-prone Areas, G-Geology, H-Hydrology, L-Landslides, LU-Land Use, M-Miscellaneous, WD-Waste Disposal, WQ-Water Quality, WS-Water Supply.

TABLE 3

Use of Technical and Interpretive Reports,
Orthophotos, and Regional Topographic and Slope Maps
by Type of Planning Activity

Report Number	Group a/	STUDIES							PLANS										ORDINANCES						OTHER ACTIVITIES							
		Circulation	Geologic Hazards	Land Use	Physical Resources	Public Site Evaluation	Sub-County Areas	Other	Circulation	Conservation	General Plan	Land Use	Open Space	Public Safety	Seismic Safety	Solid Waste Management	Sub-County Areas	Other	Administration	Building	Grading	Subdivision	Zoning	Other	Community Assistance	EIR/EIS Preparation	EIR/EIS Review	Environmental Analysis	General Reference	Potential Problem Area	Other	Total
TR																																
1	WQ																1															1
2	M		1											1	1		1	1								1	1	1	1	1		10
3	H				1	.																							2			3
4	LU		1		1									1	1														1			5
5	M																															0
6	H						1																						1			2
TOTAL		0	2	0	2	0	1	0	0	0	0	0	0	2	2	0	2	1	0	0	0	0	0	0	0	1	1	1	5	1	0	21

IR																																
1	LU				2																				.	1	1	1	2			7
2	WQ				1																				1				1			3
3	H															1																1
4	FP		1		1	1		1	2	3	3	3	2	4	3	2	2	1	5				1		1	3	3	3	5	1		51
5	WQ				1														1							2	2	2	1	1		10
6	WD					1								1	1	2										2	2	2	1	2	1	15
7	H																		1							2	2	2	1	1		9
TOTAL		0	1	0	5	2	0	1	2	3	3	3	2	5	4	5	2	1	7	0	0	0	1	0	2	10	10	10	11	5	1	96

Slope		1	1	1			1		3	2	2	1	3		1	1	1	1	2				1						3		1	26
Ortho				1	1		1				1	1				1								1				1	3		1	12
Topog			1	1							1			1	1	2		1								2	2	1	5		3	21
TOTAL		1	2	3	1	0	2	0	3	2	4	2	3	1	2	4	1	2	2	0	0	0	1	1	0	2	2	2	11	0	5	59

a/ The letters indicate the following SFBRS product groupings: F-Faults, FP-Floodprone Areas, G-Geology, H-Hydrology, L-Landslides, LU-Land Use, M-Miscellaneous, WD-Waste Disposal, WQ-Water Quality, WS-Water Supply.

The number of products in each group and the total number of times the products were identified were:

16	Landslides	306
17	Geology	246
8	Flood-prone areas	185
7	Faults	131
5	Water supply	70
7	Miscellaneous	64
9	Water quality	63
8	Hydrology	59
3	Photography & topography	59
3	Waste disposal	43
4	Land use	31

The following discussions relate to the totals for these SFBRS groups and other USGS products and those applications most often identified. (See tables 2 and 3 for specific SFBRS products and applications identified.)

Fault Products

Of the seven SFBRS products grouped under faults, all were identified as being used a total of 131 times in the preparation, administration, or conduct of planning studies, plans, ordinances, or other planning activities by counties. The applications most often identified were:

General reference	15
Seismic safety element	15
Ordinance administration	11
EIR/EIS review	10
EIR/EIS preparation	9
Geologic hazards study	9
Public safety element	9
Environmental analysis	7
Potential problem area	5
Open-space element	4
Sub-county area plans	4

Flood-prone Area Products

Of the eight SFBRS products grouped under flood-prone areas, all were identified as being used a total of 185 times in the preparation, administration, or conduct of planning studies, plans, ordinances, or other planning activities by counties. The applications most often identified were:

General reference	18
Ordinance administration	16
Public safety element	14
EIR/EIS preparation	13
EIR/EIS review	13
Environmental analysis	13
Seismic safety element	13[3/]
Land-use element	11
Conservation element	9
General plan	9
Community assistance	8
Geologic hazards study	8
Open-space element	8

[3/] Potential Inundation by Tsunamis (BDC 52) was included in the flood-prone area group.

Geologic Products

Of the 17 SFBRS products grouped under geology, 16 were identified as being used a total of 246 times in the preparation and administration of planning studies, plans, ordinances, or other planning activities by counties. The applications most often identified were:

General reference	28
Seismic safety element	22
EIR/EIS preparation	20
EIR/EIS review	19
Ordinance administration	18
Community assistance	14
Public safety element	14
Environmental analysis	13
Geologic hazards study	11
Potential problem area	11
General plan	9
Open-space element	9
Solid waste management plan	8

Hydrologic Products

Of the 8 SFBRS products grouped under hydrology, all were identified as being used a total of 59 times in the preparation, administration, or conduct of planning studies, plans, ordinances, or other planning activities by counties. The applications most often identified were:

EIR/EIS preparation	11
EIR/EIS review	8
Environmental analysis	7
General reference	7
Ordinance administration	6
Conservation element	3
Physical resources study	3
Solid waste management plan	3

Landslide Products

Of the 16 SFBRS products grouped under landslides, all were identified as being used a total of 306 times in the preparation, administration, or conduct of planning studies, plans, ordinances, or other planning activities by counties. The applications most often identified were:

General reference	34
EIR/EIS review	29
EIR/EIS preparation	23
Ordinance administration	22
Seismic safety element	22
Environmental analysis	16
Community assistance	15
Geologic hazards study	15
Potential problem areas	15
Land-use plans	13
Public safety element	13
General plan	11
Public site evaluation	10

Land-Use Products

Of the four SFBRS products grouped under land use, all were identified as being used a total of only 31 times in the preparation, administration, or conduct of planning studies, plans, or other planning activities by counties. The applications most often identified were:

General reference	4
Physical resources study	3
Public safety element	3
EIR/EIS preparation	2
EIR/EIS review	2
Environmental analysis	2
Land-use element	2
Seismic safety element	2
Solid waste management plan	2

Miscellaneous Products

Of the seven SFBRS products grouped under miscellaneous, only 2 were identified as being used; these two were cited 64 times in the preparation, administration, or conduct of planning studies, plans, ordinances, or other planning activities by counties. The applications most often identified were:

General reference	7
Seismic safety element	6
EIR/EIS preparation	5
EIR/EIS review	5
Environmental analysis	5
Geologic hazards study	4
Public safety element	4
Conservation element	3
Ordinance administration	3
Sub-county areas plan	3

Waste-Disposal Products

Of the three SFBRS products grouped under waste disposal, all were identified as being used a total of only 43 times in the preparation, administration, or conduct of planning studies, plans, ordinances, or other planning activities by counties. The applications most often identified were:

General reference	8
EIR/EIS preparation	5
EIR/EIS review	5
Environmental analysis	5
Potential problem area	4
Solid waste management plan	4
Ordinance administration	3
Circulation studies	2
Public site evaluation	2

Water-Quality Products

Of the nine SFBRS products grouped under water quality, 8 were identified as being used a total of 63 times in the preparation, administration, or conduct of planning studies, plans, ordinances, or other planning activities by counties. The applications most often identified were:

General reference	12
EIR/EIS preparation	9
EIR/EIS review	9
Environmental analysis	9
Physical resources study	6
Potential problem area	6
Ordinance administration	3

Water-Supply Products

Of the five SFBRS products grouped under water supply, all were identified as being used a total of 70 times in the preparation, administration, or conduct of planning studies, plans, ordinances, or other planning activities. The applications most often identified were:

General reference	15
EIR/EIS preparation	11
EIR/EIS review	10
Environmental analysis	8
Ordinance administration	6
Potential problem area	5

Photographic and Topographic Products

Of the three easily available SFBRS photographic and topographic products, all were identified as being used a total of 59 times in the preparation, administration, or conduct of planning studies, plans, ordinances, or other planning activities by counties. The applications most often identified for the regional slope map, which was identified as being used a total of 26 times, were:

Circulation element	3
General reference	3
Open-space element	3
Conservation element	2
General plan	2
Ordinance administration	2

The applications most often identified for the regional topographic map, which was identified as being used a total of 21 times, were:

General reference	5
EIR/EIS preparation	2
EIR/EIS review	2
Solid waste management plan	2

The application most often identified for the orthophotos, which was identified as being used a total of only 12 times, was general reference.

Other USGS Products

At least 85 different specific published USGS products not prepared under the SFBRS were identified by all eight counties as having been used at least 126 times in planning activities by counties. These products are listed in appendix G.

Quadrangles in the USGS 7½-minute series (topographic) were most often identified as having been used in the preparation, administration, or conduct of various planning studies, plans, ordinances, or other planning activities. Other USGS products most often identified were, by topic group:

Faults	31
Water resources	26
Geology	25
Ground response	15
Land use	9
Landslides	7
Liquefaction	7

The uses of these USGS products were most often in connection with the preparation of:

Seismic safety elements	44
Geologic hazards studies	32
Physical resources studies	28

The specific USGS products most often identified were:

Radbruch, 1967 (Fault traces)	5
Radbruch, 1968 (Active faults)	5
Youd, 1973 (Liquefaction failures)	5
Barosh, 1969 (Ground response)	4
Gibbs & Eaton, 1971 (Ground response)	4
Radbruch & Case, 1967 (Engineering geology)	4
Youd & others, 1974 (Liquefaction potential)	4

COMMENTS FROM COUNTY PERSONNEL

In addition to conducting the inventory concerning how SFBRS products were used by the eight county planning agencies, certain specific questions were asked by the interviewers, and the responses recorded as shown on figure 3.

Over 100 county officials, employees, and consultants were interviewed including 57 planners, 9 engineers, 5 geologists, 5 consultants, 4 civil defense administrators, and 5 building and zoning inspectors. All county planning agencies had staffs composed of professional planners. Those planners interviewed included 7 planning directors, 4 assistant directors, and 18 chief, principal, senior, associate, or project planners. Those county personnel interviewed are listed in appendix E.

The questions addressed to the interviewees concerned the following subjects: map scales used; size of planning staffs; receipt, distribution, and custody of SFBRS products; reasons for limited use of the products; problems in using the products; anticipated use of the products; information needed or desired; suggestions for improving the products; and services received from USGS personnel. The responses to these questions are reported for each of these subjects.

Map Scales Used

The counties indicated that the scales most commonly used for their working maps were:

1" = 400' to 1,000'	(1:4800-12,000)	8
1" = 2,000'	(1:24,000)	8
1" = 4,000' to 8,000'	(1:48,000-96,000)	6

The counties indicated that the scales most commonly used for their implementation maps were:

1" = 100' to 400'	(1:1200-4800)	1
1" = 500' to 1,000'	(1:6,000-12,000)	8
1" = 2,000'	(1:24,000)	8

Size of Planning Staffs

All eight counties had planning staffs with several professional planners. Their total staff sizes ranged from 15 to 70 and averaged 42. Only Contra Costa County had a geologist on its planning staff, and only 3 county planning agencies had staff members who have had some courses or experience in earth sciences or engineering. However, six counties had the benefit of geotechnical services, either from retention of engineering geology firms, access to geologists on county engineering staffs, or through cooperative agreements with the State Division of Mines and Geology.

Receipt, Distribution, and Custody of USGS Products

All eight county planning agencies are on the SFBRS mailing list and either receive every product released or receive notice of its availability. All the planning staffs responded that they are receiving SFBRS products automatically, or they are requesting and receiving them as needed. After receipt, the SFBRS products are usually circulated among staff members and then placed in the agencies' libraries.

Certain products are often posted for easy reference. For example, the landslide susceptibility map (BDC 43) hangs on the wall in the office of the San Mateo County building department, and the regional

topographic map which is at a scale of 1:125,000 (1" = 2 mi.) is mounted in the emergency operations center of the San Mateo County civil defense and disaster agency.

Reasons for Limited Use of SFBRS Products

Solano County indicated that its limited use of some of the products was due to the completion of several studies and plans prior to the products being available. Two counties indicated they made only limited use of the flood-prone area and hydrologic products because more detailed data was available from other county agencies.

Problems in Using SFBRS Products

Seven counties expressed some problems in using SFBRS products. The problems expressed and the number of counties expressing a problem were:

Scale too small or not detailed enough	6
Insufficient data	5
Terminology too technical	3
Poor graphics	3
Inadequate coverage	1

Sometimes the interviewees were able to tie specific problems to specific products. The problems described and their products were:

Scale too small or not detailed enough	BDC 52, 11, 9, and the Regional slope map
Not up-to-date	BDC 5
Base data too light or absent	BDC 42, 62
Inadequate data	BDC 50, 62
Poor graphics	BDC 43, Regional slope map
Terminology too technical	BDC 64, 63
Inaccurate data	BDC 56, 12, IR 4

The graphic problems expressed were "fuzziness," "poor registration," or "difficulty in distinguishing lines."

Anticipated Use of SFBRS Products

All eight counties expressed an interest in continuing to use SFBRS products in the future, and all were able to identify specific SFBRS products and their uses. The products by topic group most often identified were hydrology, orthophotos with contours, water quality, waste disposal, and water supply.

The types of anticipated uses most often identified by counties for specific products were:

Conservation plan elements	6
Ordinance administration	5
Biotic communities studies	4
Flood inundation studies	4
EIR/EIS preparation or review	3
Solid-waste management plans	2

All eight counties indicated that the SFBRS earth-science topical interpretive reports would be useful for their planning activities. These reports by topic and the number of times indicated were:

Flatland materials	8
Flood-prone areas	8
Hillside materials	8
Slope stability	8
Erosion, transportation, and deposition	7
Pollution potential of land-based waste disposal	7
Seismic zonation	7
Coastal geologic processes	4

Information Needed or Desired

All eight counties expressed a need or desire for additional earth-science, engineering, or other information. The topics of the additional information and the number of times expressed were:

Ground response	7
Slope stability	7
Flood-prone areas	6
Ground water	6
Faults	5
Geology	5
Land capability	5
Land use	5
Erosion and sedimentation	3
Soils	3
Vegetative cover	3
Alternative energy sources	2
Waste disposal	2

The expression of a need or desire for specific data by the counties does not lend itself to grouping or weighting. Therefore, only examples of specific data indicated by the counties are given here:

Depth of bay muds
Erosional and depositional surveys of major streams
Fault maps at a scale of 1:24,000 (1" = 2000')
Fieldchecked photointerpretive landslide data
Flood-prone areas mapped at a larger scale
Impact of land-use changes on earth processes
Map of thickness of Cenozoic deposits
Landslide maps at a scale of 1:24,000
Land-use maps at a scale of 1:24,000
Location of ground-water recharge areas
More land-use categories
Physical and chemical properties of rocks
Quality and depth of ground water
Seismic zonation of geologic effects
Stability of bayland dikes and levees
Synthesized geologic hazards on one map
Update 7½-minute series (topographic) quadrangles

The geology work plan prepared by Huffman and Bishop (1975) for Sonoma County is illustrative of some of the types of specific data needed or desired by counties. The work plan, prepared by the California Division of Mines and Geology in cooperation with the Sonoma County Planning Department, sets forth specific proposals and estimated costs for continuing investigations of faults, slope instability, and ground response. The information from these investigations will be used by the county to implement its seismic safety and public safety plans and in making land-use decisions.

The investigations itemized in the work plan include geologic mapping, aerial photography, magnetometer surveys, gravity measurements, seismic refraction surveys, trenching, drilling, materials testing, and radiometric-age dating. The work plan specifies that the map and cross-section products of the investigations be at scales of 1:24,000.

Suggestions for Improving Products

All eight counties suggested specific improvements to SFBRS products. The improvements and number of times suggested are:

Larger scale or more detail	8
Slope maps at a scale of 1:24,000	7
More liaison with USGS personnel	4
Less technical or more interpretive reports	4
More engineering interpretations	4
Improve graphics	3
More background data and methodology	3
Make infrared photographs available	2
Update SFBRS products	2

An example of specific improvements suggested by only one county included:

> Reprint 7½-minute series (topographic) quadrangles that are out-of-stock

Increase the number of sediment measuring stations
Provide clear acetate overlays of the products
Use metric scales
Update orthophotos
Update the 7½-minute series (topographic) quadrangles for entire counties
Provide a "geologic hotline" to quell earthquake rumors and "debunk charlatans"
Provide a clearinghouse for C^{14} dating
Act as agent for ordering C^{14} dating services

Services Received from USGS Personnel

All eight counties indicated that they had contact with, and received educational, advisory, and review services from at least one USGS scientist or engineer concerning SFBRS products. Twenty-four different scientists and engineers were identified. This figure does not include the providing of SFBRS products by various members of the USGS in response to verbal, telephone, and written requests. The educational, advisory, and review services included providing information and materials on geology, seismicity, sedimentation, hydrology, faults, baylands, water resources, land use, base mapping, stream gaging, landslides, and liquefaction; providing technical advice, interpretations, engineering data, and field inspections; reviewing and commenting on various studies, plan elements, ordinances, EIR's and EIS's; and assisting in the selection of geotechnic consultants and in the use of certain SFBRS products.

In addition, all the counties are interested in developing, and cooperating in, programs with the USGS. For example, the Napa County Board of Supervisors formally approved a seismic safety policy to "Develop a geologic mapping program in cooperation with U.S.G.S. ... to identify geologic hazards...." (Co. Plan. Dept., 1975, p. 39)

SELECTED APPLICATIONS

Seventeen examples of the application of San Francisco Bay Region Study products to various county planning activities have been selected for discussion and illustration. These examples were selected from the county documents listed in appendix F. The following criteria were used in the selection of these applications:

1. Extensive, intensive, or unique uses of SFBRS products
2. Examples of different types of planning activities
3. Attractive formats and clear presentations
4. An example from each county (fig. 1 at p. 9)

The examples selected include four planning studies, seven plans, two ordinances, one ordinance administration, and three other planning activities. These examples were selected to illustrate a range of applications and do not imply USGS endorsement. These documents were prepared by the county's staff, consultants, or task force; by a consultant of an applicant for a construction permit; or by a State agency in cooperation with the county. A copy of each document is on file in the SFBRS office and is available from the county.

The examples are presented in alphabetical order grouped by studies, plans, ordinances, and other planning activities (See table 1 at p. 22). Figures illustrating the use of the SFBRS products are selected from the documents and reproduced here as close to their scale, color, and format as possible.

The following discussions generally identify the document and its authors. They list the U.S. Geological Survey products used and assistance provided, describe the methods of application, and comment on the significance of each application. The discussions are deliberately succinct in order to present numerous examples in the shortest space while still demonstrating various applications.

Geologic Hazards Study, Contra Costa County

A study of geologic hazards entitled Seismic Safety Element, Technical Background Report (1975) was prepared by the Contra Costa County Planning Department. This report is part of the county's comprehensive planning program and was prepared to provide the data necessary to support the county's seismic safety plan required by State law.

The report presents findings, policies, and recommendations under sections entitled general seismicity, local seismicity, structural safety, and implementation. Each recommendation implements a policy which is derived from the findings, which are in turn based upon the earth-science data discussed in the report.

Contra Costa County lies southeast of the San Pablo and Suisun Bays, covers 735 square miles, and had a population of over half a million in 1970. The report contains a statement that it is essential that "...existing and potentially hazardous conditions, ...be taken into account during planning in order to minimize the effects of... geologic conditions." (Plan. Dept., 1975, p. 11)

USGS Data

The report is based largely upon published and unpublished data of the USGS and contains over 150 references to Survey publications. Fifteen SFBRS products are referred to many times. The citations range from general reference to the Survey and the SFBRS, to specific published products including bulletins, open-file reports, basic data contributions, maps, professional papers, atlases, and circulars. An example of the extensive use of SFBRS data is shown on figure 4.

FIGURE 4

Geologic Hazards Summary

	POLICY PLANNING LEVEL (General Plan Components) Sub-regional (Countywide) Plans	Community (Area) Plans	PROJECT REVIEW LEVEL (Includes Environmental Impact Reports)	ORDINANCE ADMINISTRATION LEVEL (Includes Zoning and Subdivision Ordinance
BEDROCK GEOLOGY (Structure and Stratigraphy)	A Standard source: U.S.G.S. (Sacel 1:62,500) eastern County: BDC 28, 54 western County: (in press)	B Standard source (A) Larger scale than ideal but generally adequate. Supplement with detailed information when available.	C Field reconnaissance may be necessary in problem areas	D Some detailed mapping available in local areas, but site studies needed in problem areas
SOILS	E Standard source (F) may need to be generalized	F Standard source: SCS (Scale 1:24,000) Accompanying tables list capability factors	G Field reconnaissance may be necessary in problem areas	H Site studies needed in problem areas
FAULTS	I Standard source (A) U.S.G.S. (Scale 1:62,500)	J Standard sources include (A) and S.B. 520 maps (Alquist-Priolo Special Study Zones Act). Some detailed mapping available in local areas. See (K)	K Develop administrative map series delineating faults relying largely on U.S. Geological Survey maps and S.B. 520 mapping. (Scale 1:24,000)	L S.B. 520 has been enforced by resolution. An ordinance should now be developed.
GROUND SHAKING	M Standard source: none U.S.G.S. has prepared a digitized seismic ground response map of the S.F. Bay Region. (open file map, Gibbs and Eaton; Scale 1:250,000)	N U.S.G.S. map described in (M) not suitable for this level of planning. See (O)	O Develop administrative map series delineating areas requiring special management. (Scale 1:24,000)	Administrative Map Series Proposed: Geologic-seismic information is not sufficiently precise for ordinanc map
GROUND FAILURE (liquefaction)	Q Standard source: none	R Prepare map at planning area level of detail. See (S)	S Develop administrative map series delineating areas where based on existing information, a high liquefaction potential is believed to exist.	Text provisions needed. Incorporate consideration of seismic safety factors into subdivision and zoning ordinances
GROUND FAILURE (landsliding)	U Landslide Deposits inventory maps: U.S.G.S. (Scale 1: 62,500) BDC 31, 35, 38, 57, 59, 67)	V Landslide inventory maps are a crude index of slope stability. However, no truely satisfactory landslide potential map exists. See (W)	W Develop administrative map series delineating slope stability categories. Use existing landslide maps in interim. (Scale 1:24,000)	Data Available: Proposed administrative map series will identify problem areas. Applications subject to subdivision map act. Conduct appropriate on-site investigation
TSUNAMI	Y Standard source (Z) Appropriate level of detail for countywide of community planning	Z Standard source: U.S.G.S. (Scale 1:125,000) BDC [illegible]	Z Use (Z) as an administrative map	Other provisions: Site studies needed for all structures requiring a high degree of safety (including high occupancy structures) and for construction proposed in areas of substantial risk

Part of C. C. Co. Technical Background Report (Plan. Dept., 1975)

The topics of the SFBRS products referred to include landslide deposits, landslide susceptibility, basic geology, active faults, historic marshlands, and tsunami inundation. The topics of USGS products other than SFBRS include seismic intensity, worldwide faulting, basic geology, ground response, ground motion values, tectonic creep, active faults, engineering geology, and liquefaction potential. Diagrams are selected from published SFBRS products and are used to illustrate certain geologic hazards (fig. 5).

Several members of the Survey provided technical assistance to the county; and the report was reviewed by at least two Survey geologists.

The extensive and skillful application of the Survey's products by Contra Costa County resulted from the addition, over two years ago, of a full-time geologist to the Planning Department's staff. This geologist holds both a bachelor's and a doctor's degree in geology, is certified as an engineering geologist in California, and has had experience as a field geologist for a state survey and a large oil company.

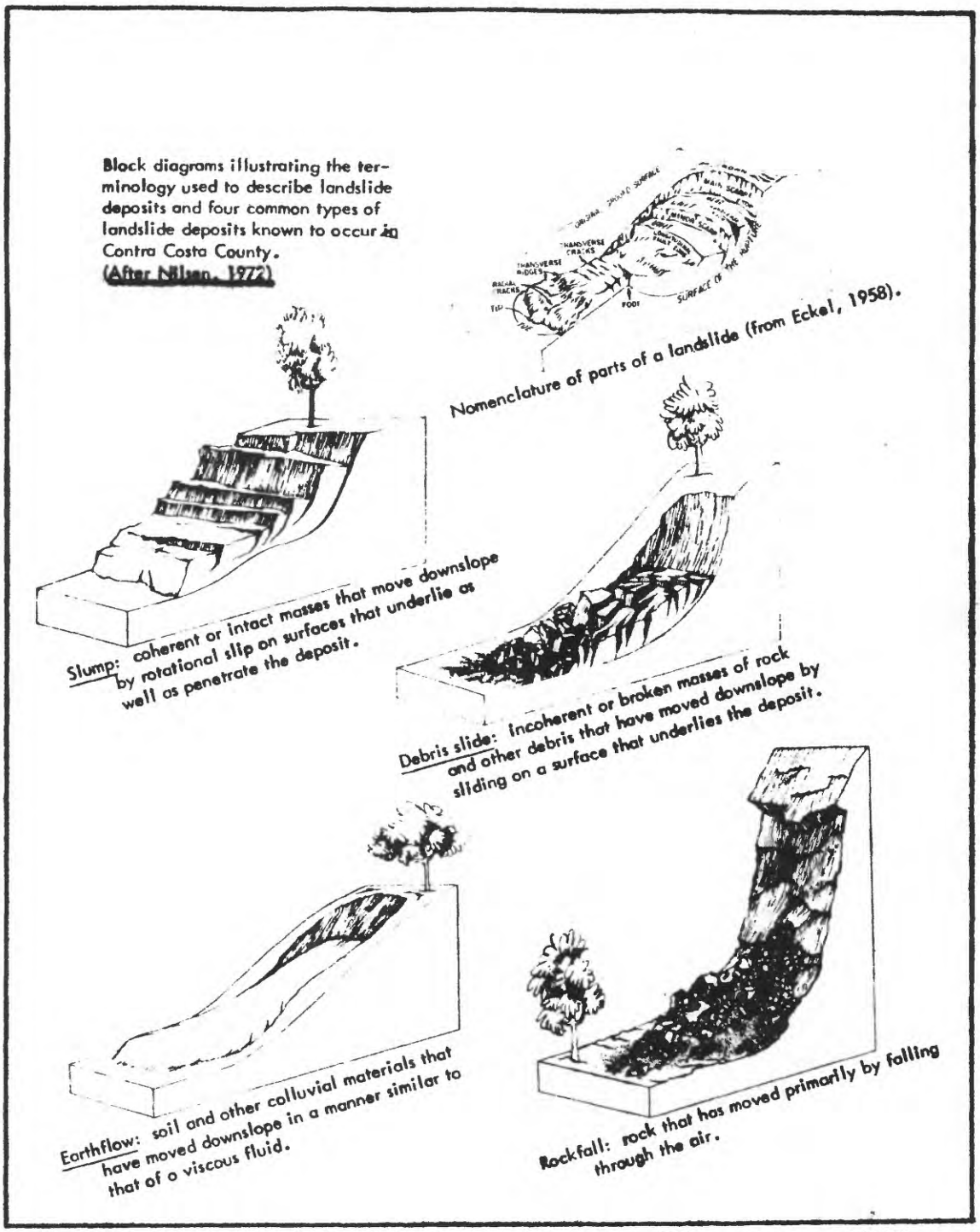
Method of Application

To facilitate relating the distribution of known or potentially hazardous conditions to the location of critical community facilities and utilities, a composite map at an original scale of 1:24,000 was developed by the County Planning Department.

The three types of hazardous areas shown on the composite map are major fault systems, areas of questionable slope stability, and areas of questionable ground stability. The delineation of all three areas and the evaluation of the hazards are based on SFBRS products.

FIGURE 5

Landslide Block Diagram



Part of C. C. Co. Technical Background Report (Plan. Dept., 1975)

The various critical facilities were then located on the composite map. These facilities included hospitals, schools, reservoirs, water transmission lines, petroleum and natural gas pipelines, refineries, bridges, airports, rapid transit lines, and railroads. An example of the composite hazards map with public and private school locations overlaid is shown on figure 6 at a reduced scale of 1:200,000.

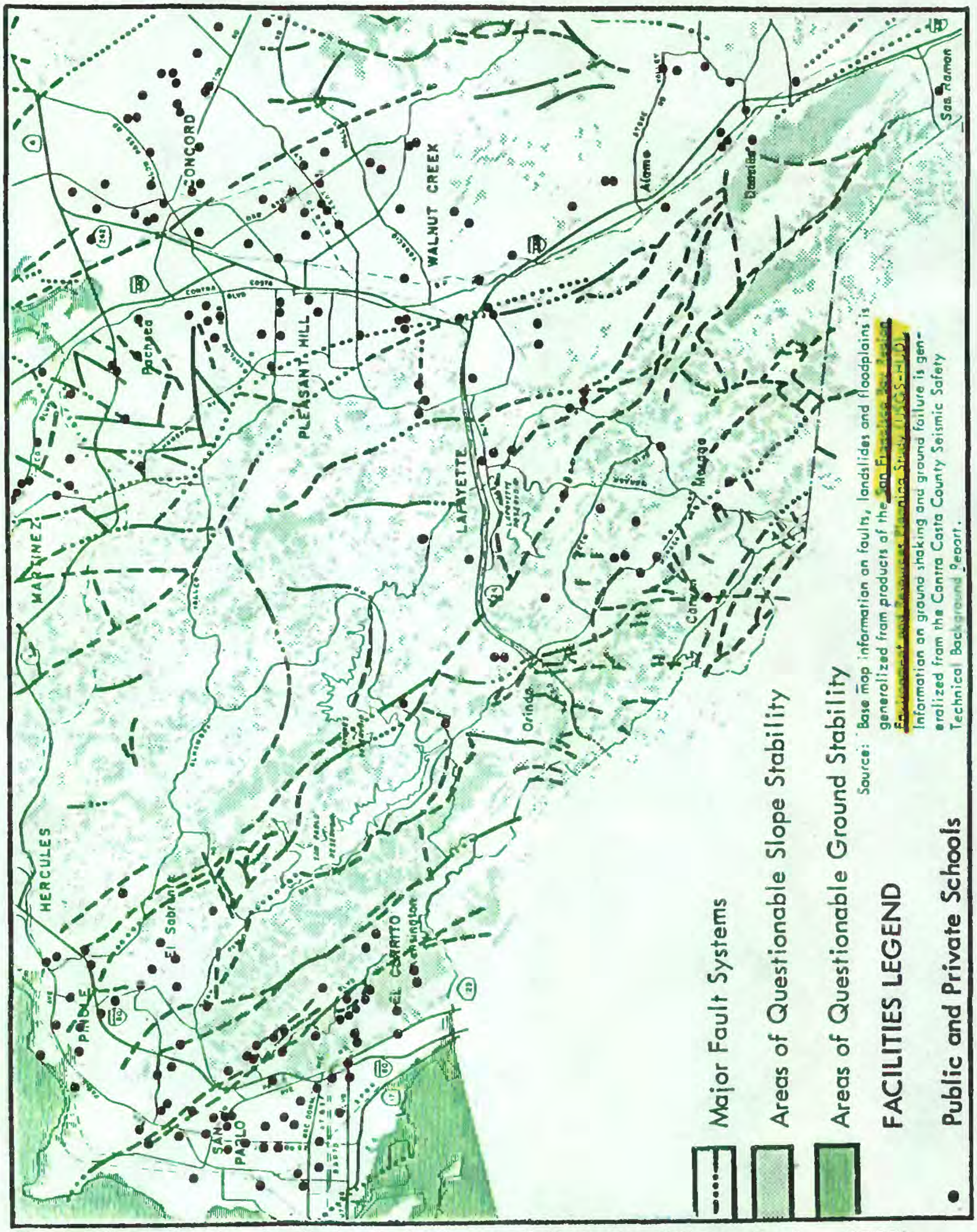
Comment

This geologic hazards report has made the most extensive use of Survey and SFBRS products yet identified and documented by our inventory.

This report served as the technical background for the County's Seismic Safety Element which was subsequently adopted by the County Planning Commission and Board of Supervisors.

FIGURE 6

Educational Facilities and Seismic Hazards



Part of C. C. Co. Technical Background Report (Plan. Dept., 1975)

Physical Resources Study, Sonoma County

A study of natural resources entitled Environmental Resources Management Element, Natural Resource Inventory (1974) was prepared by the Sonoma County Planning Department. The study was prepared as part of the county's "General Plan" and is being used in the preparation of the county's land-use, open-space, and conservation plans, all of which are required by State law.

The five natural resources considered of value in the county and which are described and illustrated in the study are geology, soils, climate, hydrology, and vegetation. Each natural resource, natural hazard, and those issues, goals, and policies related to such resources and hazards are discussed in the study.

The purpose of the study is to provide a guide for managing the county's resources and for making sound decisions about land use and development.

Sonoma County lies on the Pacific coast, abuts the north side of San Pablo Bay, includes 1,604 square miles, and had a population of less than a quarter million in 1970. The county is richly endowed with a variety of natural resources and scenic features.

USGS Data

The study is based in part upon data published by the USGS including seven SFBRS products. The topics of the SFBRS products include flood-prone areas, historic marshlands, water supply, water quality, and land use. In addition, the regional SFBRS topographic map (1:125,000) was used as the base for recording the resource and hazard data.

The topics of the USGS products referred to, other than SFBRS products, include water supply, sedimentation, hydrology for urban land use, water quality, topography, and the implications of seismic hazards for planning.

Method of Application

Data for each resource and hazard are compiled on a map followed by a discussion and an "environmental atlas" listing major references related to each resource. An example of this type of compilation and atlas is shown on figure 7 at a scale of 1:250,000 and figure 8.

SFBRS and other USGS products are acknowledged as the primary source for the hydrologic cycle; rivers and streams; marshlands, lakes, and ponds; seashores, bogs, and estuaries; ground water, water supply and demand; and water quality.

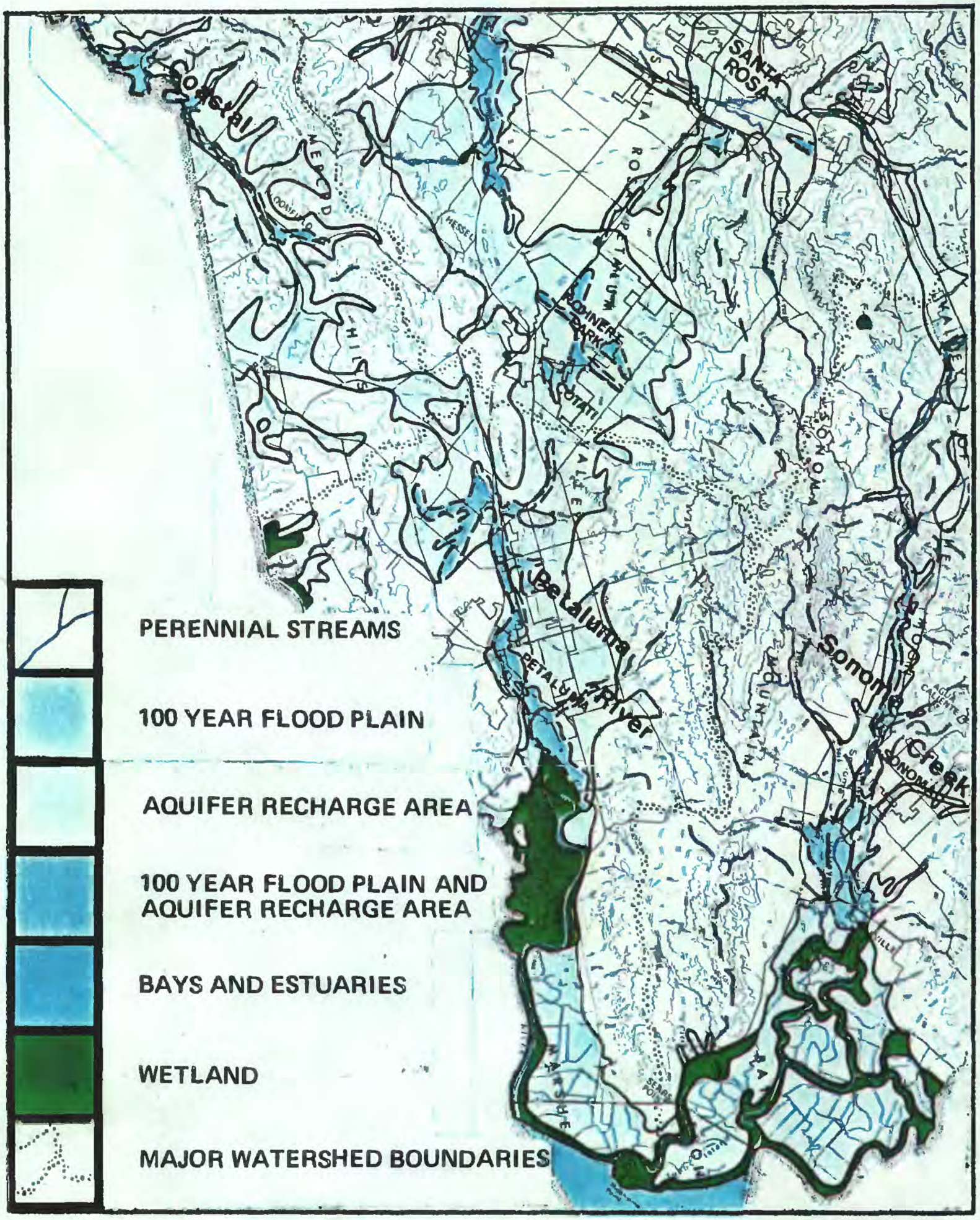
Each natural resource or hazard is then related to certain natural and human resource management goals and policies. For example, water-quality impairment is related to the preservation and restoration of ecological, recreational, and esthetic benefits of the county's natural waterways.

Comment

The Sonoma County natural resource inventory is well designed, attractively presented, and at least one of its resource maps is based primarily upon SFBRS and other USGS data. This particular inventory provides the basis for several other plan elements for the county. In addition, the data contained in the environmental atlases are being used by the county planning staff to prepare local area plans and by private developers for specific site evaluations.

FIGURE 7

Hydrologic Resources Inventory



Part of Sonoma Co. Natural Resource Inventory (Plan. Dept., 1974)

ENVIRONMENTAL ATLAS – HYDROLOGY

10. U. S. Geologic Survey; Availability of Data on Surface-Water Quantity and Quality in the San Francisco Bay Region, California, with a Summary of Beneficial Uses and Implications for Land Use; Miscellaneous Field Studies - 526; 1974.

11. U. S. Geologic Survey; Hydrology for Urban Land Planning - A Guidebook on the Hydrologic Effects of Urban Land Use; Circular 554; 1968.

12. U. S. Geologic Survey; Surface Water Supply of the United States 1961-1965, Part II; Pacific Slope Basins in California, Vol. 2: Basins from Arroyo Grande to Oregon State Line except Central Valley; Water Supply Paper 193; 1970.

13. U. S. Geologic Survey; A Summary View of Water Supply and Demand in the San Francisco Bay Region, California; open file report; 1972.

14. U. S. Geologic Survey; Turbidity and Suspended Transport in the Russian River Basin, California; open-file report; 1971.

15. U. S. Geologic Survey; Water Temperature of California Streams, San Francisco Bay Subregion; 1971.

27. U. S. Geological Survey; Flood-Prone Areas in the San Francisco Bay Region, California; open file report; 1973.

28. U. S. Geological Survey; Geology and Ground-Water in Napa and Sonoma Valleys, Napa and Sonoma Counties, California; Water Supply Paper 1495; 1960.

29. U. S. Geological Survey; Geology and Ground-Water in Russian River Valley Areas, and in Round, Laytonville, and Little Lake Valleys, Sonoma and Mendocino Counties, California; Water Supply Paper 1548; 1965.

30. U. S. Geological Survey; Geology and Ground Water in the Santa Rosa and Petaluma Valley Areas, Sonoma County, California; Water Supply Paper 1427; 1958.

31. U. S. Geological Survey; Index of Surface Water Records to Sept. 30, 1971, Part II; Pacific Slope Basins in Northern California; Circular 661, 1971.

32. U. S. Geological Survey; A Preliminary Investigation of Suspended-San Discharge of the Russian River, Sonoma County, California; open-file report, 1971.

33. U. S. Geological Survey; Preliminary Map of Historic Margins of Marshland, San Francisco Bay, California; 1971.

34. U. S. Geological Survey; Quality of Surface Waters of the United States, 1966, Parts 9-11: Colorado River Basin to Pacific Slope Basins in California; Water Supply Paper 1945; 1966.

35. U. S. Geological Survey; Role of Water in Urban Planning and Management; Circular 601-H; 1973.

FIGURE 8

List of References Related to Hydrology

Waste Disposal Zones Evaluation, Solano County

A study of solid waste disposal zones, entitled Report, Preliminary Geotechnical Services, Solid Waste Management Plan (1975), was prepared by a consultant for the Solano County Planning Department. The report is part of the county's solid waste management plan which is required by State law.

Solano County lies north of Suisun Bay and west of the Sacramento River, covers 823 square miles, had a population of almost 170,000 persons in 1970, ranks fourth in natural gas output in California, and contains hydrogeologic conditions that could result in ground- or surface-water pollution from improper land use or development.

USGS Data

The report's evaluations are based in part upon SFBRS basic geologic, landslide, flood-prone area, and hydrologic products which are cited in the report and on the map accompanying the report.

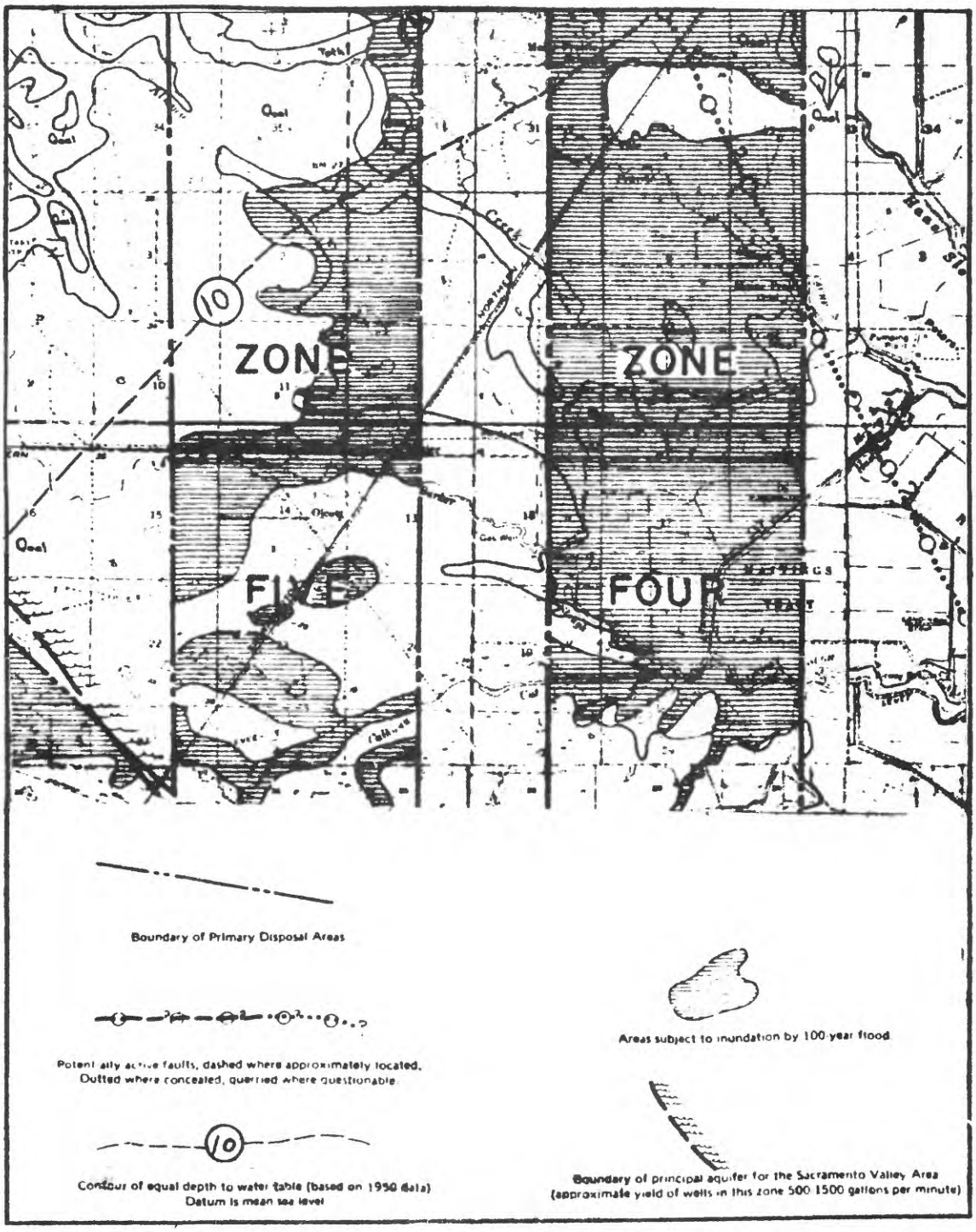
Method of Application

The data from these products were composited on a map entitled "Geologic Map showing Primary Disposal Zones and Selected Hydrographic Data" at a scale of 1:62,500 (1" = 1 mi.). A reduced portion of this map is shown in figure 9.

Seven potential zones suitable for solid waste disposal sites were then identified by the county planning staff and overlaid on the map. The consultant evaluated each zone and related "known geologic, seismologic, soil, and water constraints to waste disposal needs." An example of the evaluation of one of these potential zones is shown on figure 10.

FIGURE 9

Solid Waste Disposal Zones



Part of Solano Co. Report, Preliminary Geotechnical Services (Cooper-Clark & Assoc., 1975)

FIGURE 10

Solid Waste Disposal Zone Evaluation

ZONE FOUR

Zone Four, as shown on Plate 1, is east of State Route 113 and extends from the Montezuma Hills northward to the U. S. Government Naval Reservation in Section 9, T. 6N, R. 2E., M.D.M. Because of the area's low and relatively flat topography, about 80 percent of this zone is subject to 100-year flooding in the areas outlined on Plate 1.

Geologically recent alluvium (map symbol "Qal") covers most of this zone which appears to be underlain with somewhat more consolidated older alluvium deposits (map symbol "Qoal"). These alluvial deposits are mainly flood-plain and fan deposits consisting of unconsolidated and irregularly interstratified sands, gravels, silts and clays. Soils developed on these deposits which have a high clay content are moderately to highly expansive and relatively impermeable with poor surface drainage. There are no landslides within the zone.

The potentially active trace of the Midland fault traverses this zone, concealed beneath the alluvium deposits. Movement along this 60 mile long fault is believed to have produced the April 19 and 21, 1892 earthquakes casuing severe damage in Winters, Dixon, and Vacaville. This fault is considered to be capable of generating a 7.0 magnitude (Richter Scale) earthquake.

Zone Four overlies a major groundwater basin. Contours showing the elevation of the groundwater table, based on 1950 data, are shown on Plate 1. These data indicate that in the northern quarter of the area, the groundwater table is at elevation between 10 and 20 feet (mean sea level datum), and that the remainder of the area has groundwater within 10 feet of the ground surface. Yoder/Orlob Associates (January, 1970) state that, "In the Dixon Cove Area and in the area near the junction of Hay Road and the Rio-Dixon Road the groundwater has risen to within a foot of the ground surface due to the use of imported surface water for irrigation" There are many windmills and water wells throughout the area, and Webster (1972) estimates the probable maximum yield of wells within the area to be marginal to adequate for irrigation, heavy industry, and municipal uses. The maximum well yields are estimated to range from 500 to 1,500 gallons per minute.

Only the most northerly and southerly portions of this zone appear suitable for consideration as waste disposal sites due to the potential flood hazard. Development of a landfill in this zone would require extensive soils, geological, and hydrological investigations. It may also be necessary to establish a thick clay seal beneath any landfill to prevent leachate migration into the usable groundwater aquifer, and construct protective leveas around a proposed landfill site to prevent inundation.

COOPER-CLARK & ASSOCIATES
FOUNDATION ENGINEERS & ENGINEERING GEOLOGISTS

Part of Solano Co. Preliminary Geotechnical Services Report (Cooper-Clark & Assoc., 1975)

Comment

This preliminary geotechnical report is significant for the following reasons:

1. It is one of the first documented examples of the application of SFBRS data to solid waste management planning that was identified during the inventory of county planning activities.

2. A preliminary evaluation of solid waste disposal zones can be made at a scale of 1:62,500 although larger scales will be required for design studies of specific sites.

3. While only four SFBRS products are cited, these four are key basic data inputs and are extensively acknowledged.

Sub-County Study Area, Marin County

A study of basic geology, land stability, seismic risk, and commercial mineral resources entitled Geology For Planning was prepared for the Novato area by Rice (1975) for the California Division of Mines and Geology in cooperation with the County of Marin and the City of Novato. The report was intended to be useful as an areawide geologic framework for the broad county land-use planning required by state law.

Marin County lies directly northwest of the Golden Gate, covers 520 square miles, and had a population of less than a quarter million in 1970. The Novato area lies north of the Marin County Civic Center and west of San Pablo Bay, covers a small part of Sonoma County (fig. 11), and has a complex geologic environment that poses significant geologic hazards. The study concludes that many of these hazards can be mitigated by the appropriate use of engineering geology in planning and development for land use (Rice, 1975, p. 2).

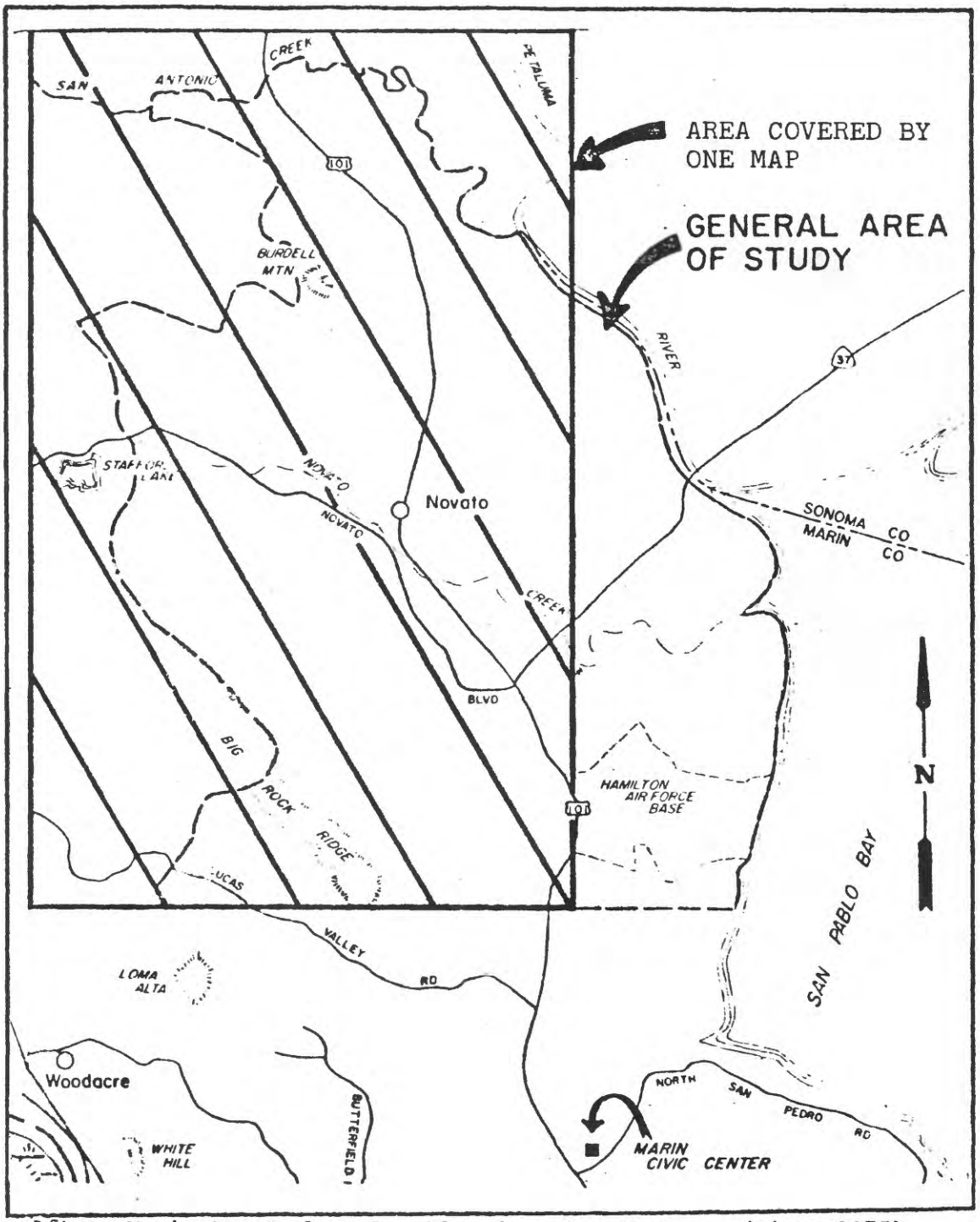
USGS Data

The report is based in part upon data published by the USGS including 16 SFBRS products. The topics of the SFBRS products used include historic marshlands, tsunami inundation, basic geology, active faults, landslides, flood-prone areas, hydrology, and radiocarbon samples.

Although only three products are cited in the report's "Annotated Bibliography," S. J. Rice has provided us with a list (fig. 12) of specific SFBRS products used. The base for the maps accompanying the report are the USGS 7½-minute quadrangle (topographic) series enlarged to a scale of

FIGURE 11

Novato Area



After Marin Co. Geology For Planning, Novato Area (Rice, 1975)

FIGURE 12

Products Used in the Novato Area Report

DEPARTMENT OF CONSERVATION
DIVISION OF MINES AND GEOLOGY
DIVISION HEADQUARTERS
RESOURCES BUILDING, ROOM 1341
1416 NINTH STREET
SACRAMENTO, CA 95814

December 12, 1975

W.J. Kockelman
Environmental Planner
U.S. Geological Survey
Menlo Park, CA 94025

Dear Bill:

Thanks very much for the copy of P.P. 941-A. It contains much of the useful discussion I've been waiting for regarding expected seismic responses of different local geologic materials, or settings.

I've forwarded a copy of my last Marin County co-op report, along with a sample of the maps that accompany it. Reviewing my bibliography given in that report, I find I only referenced three of the Basic Data Contribution, 9, 52, and 64. However, for background information in the Marin County studies, I also used the following, without having had need yet to quote them or otherwise reference them in reports: 1, 7, 10, 11, 12,16, 17, 25, 26, 33, 37, 45, and 65. All but one or two of these yielded valuable framework information, not reasonably available elsewhere, that helped me understand the complicated geologic setting of Marin.

In addition, I've had cause to refer many citizens and some planners (even a few geologists) to these and others of the series (for example, 29, 41, 42, 43, and 44) to answer questions of great importance to these people. This is because I occasionally (and informally) have close contact with the public at our Information Desk, a service that is quite enlightening in order to find out the wide public interest and needs in geological subjects. Thus I have found the Contribution series exceedingly useful, both for me and for the interested and "needy" nontechnical public. In fact, it is perhaps the most useful published series in the Survey repertoir.

We really need a geologist at our Information Desk for this purpose, and especially to aim people in the right direction for the explanatory documents they need. This is because the geologic needs of the public (planners included) must be interpreted from their questions; no cross filing of titles or index of publications can substitute for that service. In my opinion, obviously, the Survey should also have knowledgeable geologists available for public consultation in this context.

Very sincerely yours,

Salem

SALEM J. RICE
Geologist
San Francisco District Office

Part of Calif. Div. of Mines & Geo. Correspondence (Rice, 1975)

1:12,000. Members of the Survey were consulted during the study.

Method of Application

Rice's field mapping of the geologic features of the Novato area was supplemented by stereoscopic study of air photos, geophysical studies of subsurface characteristics of part of the bay plains, laboratory evaluation of road and soil samples collected in the field, research of pertinent literature, and numerous consultations with other geologists who had knowledge of the area. Rice compiled and evaluated the data on several maps at a scale of 1:12,000 such as:

1. A basic geology map upon which geologic units, nonmetallic mineral occurrences, landslides, and faults are delineated.

2. A slope stability map where four zones of varying stability are indicated.

3. An earthquake risk map where five damage zones based on estimates of general response to an earthquake of magnitude 8 are shown.

Reduced portions of two of these maps and their legends are shown on figures 13-16.

Comment

The report is significant for the following reasons:

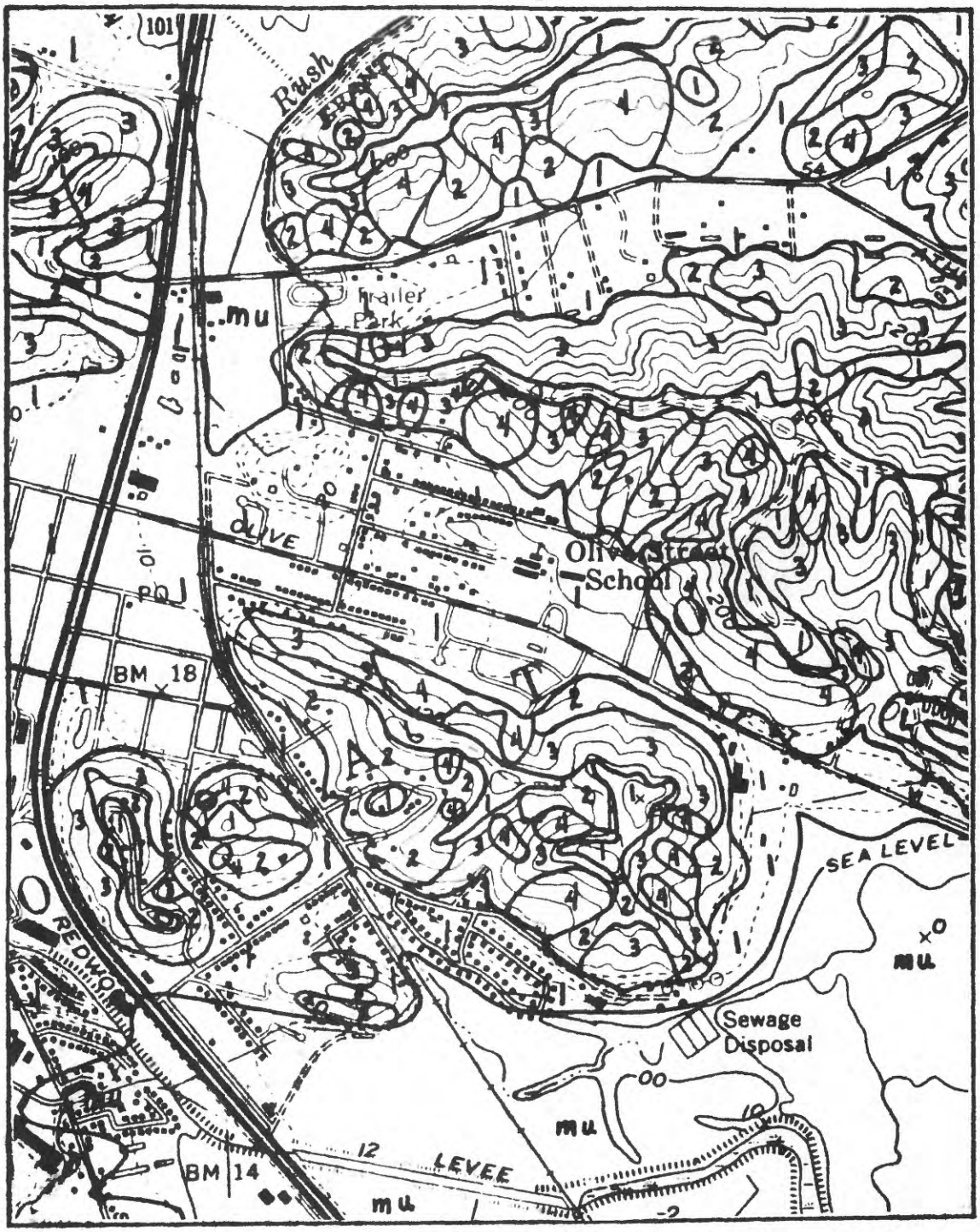
1. It is one of the first documented examples of the application of SFBRS data for general planning in a sub-county area.

2. The geologic, slope stability, and earthquake risk maps are at a large scale (1:12,000).

3. The geologic effects and damage ratings shown on the "Earthquake Risk" map illustrate a method similar to the principles and concepts described in one of the SFBRS interpretive reports (Borcherdt and others, 1975).

FIGURE 13

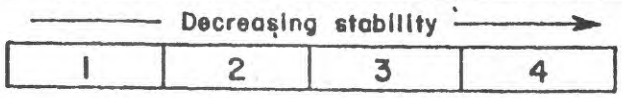
Relative Stability of Upland Slopes
(See fig. 14 for explanation)



Part of Marin Co. Geology For Planning, Novato Area (Rice, 1975)

FIGURE 14

Upland Slope Map Legend
(Explanation for fig. 13)



This map shows broad evaluations of land stability patterns which have been prepared to aid in general land use planning. It is not intended, nor suitable, for evaluation of individual sites. Such evaluations often require engineering geologic studies for proper planning of specific construction projects.

The principal factors considered in making the interpretations shown on this map are:

A. The broad apparent stability characteristics of geological materials underlying the slopes and flatlands, as expressed in their natural exposures and their observed responses to natural forces or man's influences. For example, slopes exhibiting abundant evidence of landsliding or downslope creep of the soil are considered oversteepened relative to the strength of the materials that underlie them.

B. Steepness of slopes, whether or not landsliding is apparent on them.

C. The presence of active or intermittent natural influences that tend to cause slope failure. These include gravity, the tendency of certain soils to swell or shrink under different moisture conditions, and potential earthquake vibrations.

These criteria were combined to yield the map's 4-value scale indicating the relative stability of slopes.

Zone 1 - The most stable category. This zone includes resistant rock that is either exposed or is covered only by shallow colluvium or soil. Also included in this zone are broad, relatively level areas along the tops of ridges or in valley bottoms that may be underlain by material that is quite weak (such as Franciscan melange matrix and alluvium) but occupies a relatively stable position. Some landslide deposits that have moved to relatively stable positions at or beyond the base of the slopes from which they were derived are also included in zone 1.

Zone 2 - Includes narrow ridge and spur crests that are underlain by relatively competent bedrock, but are flanked by steep, potentially unstable slopes.

Zone 3 - Areas where the steepness of the slopes approaches the stability limits of the underlying geological materials. Some landslide deposits that appear to have relatively more stable positions than those classified within zone 4 are also shown here.

Zone 4 - The least stable category. This includes most landslide deposits in upslope areas, whether presently active or not, and slopes on which there is substantial evidence of downslope creep of the surface materials. These areas should be considered naturally unstable, subject to potential failure even in the absence of man's activities and influences. Banks along deeply incised streams are also included in zone 4.

These judgments are interpretive, and apply generally to large areas. Within each area conditions may range locally in detail through all stability categories. Hence, an area designated 1 may locally contain unmapped landslides, and an area designated 4 may locally contain relatively stable sites.

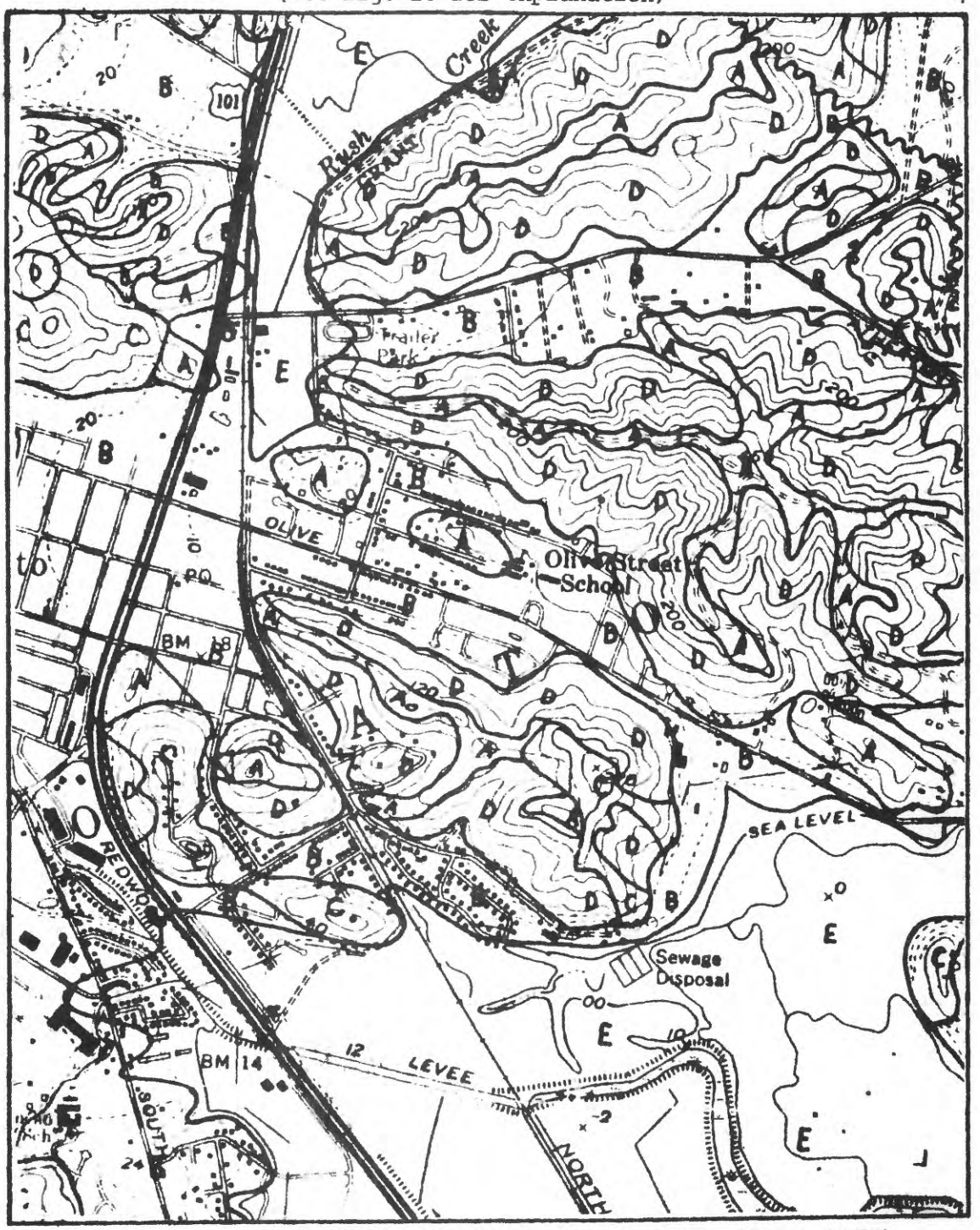
mu - The bay mud, underlying the bay plains, marshlands, and mudflats, has unique and severe stability problems that are not comparable to those of the uplands. Bay mud is unconsolidated, semi-fluid, and highly compressible. Thus it is highly sensitive to loads placed on it, reacting by compaction and lateral flow to cause settlement of the fill — often differential settlement — that continues for many decades where the thickness of the mud exceeds about 25 feet.

Note: Because of unstable and potentially unstable geologic conditions in areas designated 4, 3, and 2, it is strongly recommended that engineering geologic reports be required prior to tentative tract approval for any proposed land developments within those areas. Because of inherently unstable conditions within areas labeled mu, investigations and reports addressing the potential for differential settlement and ground failure should be required prior to tentative tract approval of proposed land developments within these areas.

Part of Marin Co. Geology For Planning, Novato Area (Rice, 1975)

FIGURE 15

Earthquake Risk
(See fig. 16 for explanation)



Part of Marin Co. Geology For Planning, Novato Area (Rice, 1975)

FIGURE 16

Earthquake Risk Map Legend
(Explanation for fig. 15)

Mainly adapted from evaluations of seismic response in different geologic settings as discussed by Borcherdt (1969). This map is a gross simplification of the very complex effects that would result from a nearby great earthquake in such a varied geologic and topographic setting. Although the physical characteristics of the geological materials underlying a site have a major influence in determining the frequency of vibrations, other factors, such as local topographic conditions and the orientation of the site with respect to the source, can have a major influence on the amplitude of vibrations--thus intensity of shaking. One and two story frame structures that comply with California building codes are likely to survive the effects of shaking alone in any of these zones. It is secondary effects of the shaking, such as landsliding and differential settlement of the ground, that are likely to be the principal causes of severe earthquake damage to such structures.

A Probable low damage areas underlain by firm, relatively unweathered bedrock (compact metamorphic rock, well cemented sedimentary rock, and volcanic rock) that crops out at the surface or is covered by only thin layers of soil or colluvium. Subject to relatively high frequency vibrations. Some very steep slopes in this zone are potentially subject to earthquake-induced rock debris avalanches or rock falls.

B Probable low to moderate damage areas, valleys underlain by relatively shallow compacted alluvium and colluvium on flat or gently sloping surfaces. Subject to relatively low frequency vibrations. In places may be threatened by landsliding derived from upslope area.

C Probable low to moderate damage areas underlain by sheared and disrupted zones in bedrock. Subject to lower frequency vibrations than in A, and possibly to landsliding on steep slopes as a result of failure of the relatively weak bedrock material.

D Potentially high damage areas underlain by deep upslope landslide deposits and by thick deposits of colluvium or deeply weathered bedrock on steep slopes. Subject to more intense shaking than A and C, and possibly to downslope movement, particularly if saturated.

E Probable high damage areas, underlain by bay mud ranging in thickness from a few feet to more than 100 feet. Subject to relatively low frequency vibrations whose amplitudes depend to a large extent on the thickness of unconsolidated, water saturated deposits overlying the bedrock. Damage to structures from shaking alone will be related to the natural periods of vibration of the structures, but in this setting is likely to be less for one-and two-story buildings than for multi-story structures that have not been specifically designed for the site (Seed, 1969, p. 96). Major damage in this setting is likely to result from secondary effects of the earthquake vibrations, especially from rapid differential settlement and disruption of the fill caused by accelerated compaction or lateral flow of the mud beneath the fill. Buried utility pipes in this setting are subject to disruption both from the low frequency vibrations and from differential displacements of the ground.

Part of Marin Co. Geology For Planning, Novato Area (Rice, 1975)

Conservation Plan, Santa Clara County

A Plan For the Conservation of Resources (1973) was prepared by the Santa Clara County Planning Department as an element of the county's general plan, both of which are required by State law. The report states that "With rapid growth of our urban areas and consequent threats to our resources, it has become even more necessary of late years to reappraise our resources and the need to conserve them."

The report, which discusses problems and recommends policies concerning the protection and wise use of land, water, flora, fauna, mineral, and cultural resources, was adopted by the County Planning Commission and Board of Supervisors.

Santa Clara County lies south of the San Francisco Bay, covers 1,300 square miles, includes the fertile Santa Clara Valley, had a population of over one million persons in 1970, and has one of the fastest growing populations in the United States.

USGS Data

The report's discussion of ground-water quality is based upon an SFBRS product, and the base for all the resource maps was developed from a special slope map (1:125,000) prepared for the county by the USGS Topographic Division.

Method of Application

The supply, quality, storage, and reclamation of the county's water resources are discussed, and areas with ground-water problems, marine fog, and "water percolation potential" are then shown on an attractive colored map reproduced in part on figure 17 at a scale of 1:250,000.

Symbols indicating concentrations of nitrate, boron, and dissolved solids which may be injurious to health, agriculture, or industrial processes are indicated on this map (fig. 17). The U.S. Public Health Service (1962, p. 7) recommends warning the public of potential dangers of using water for infant feeding where the nitrate content exceeds concentrations of 45 mg/l. Hem (1970, p. 329, after U.S. Salinity Staff) identified many nut, fruit, and citrus trees as being sensitive to water containing more than 1.0 mg/l of boron. Rainwater and Thatcher (1960, p. 269) note that few industrial processes will permit the use of water with more than 1,000 mg/l of dissolved solids. Ground water exceeding these concentrations exists in several areas of the San Francisco Bay region.

The following policy related to ground-water quality is included in the plan:

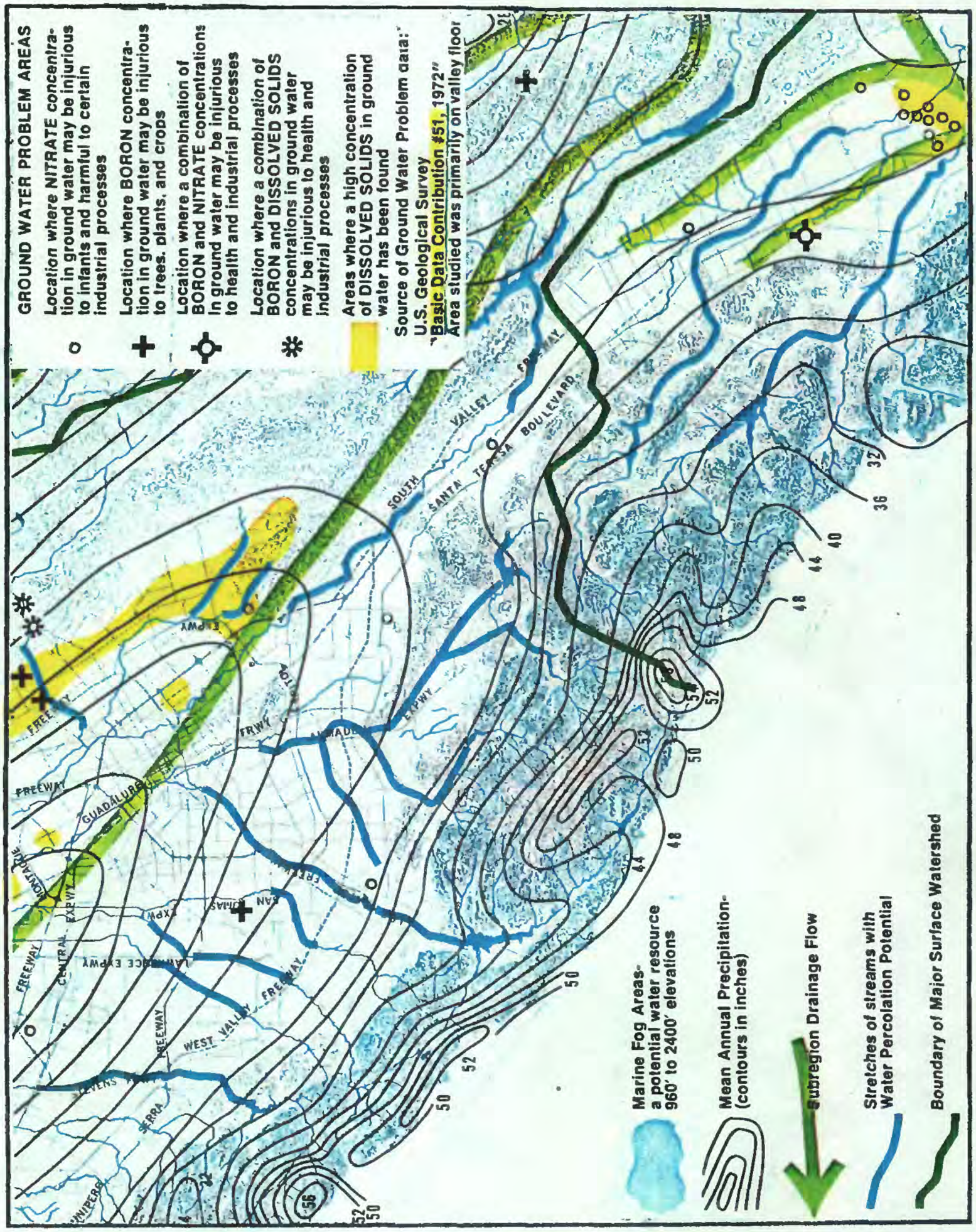
> "New development should not be allowed in areas in the County that have problems with well water quality and purity--nitrate, boron, and suspended solids--until a proven source of safe water can be assured."

Comment

The ground-water quality data and policy adopted by the County Planning Commission and Board of Supervisors are based solely upon an SFBRS product.

FIGURE 17

Water Resources



Part of S. C. Co. Plan For The Conservation of Resources (Plan. Dept., 1973)

General Planning, Sonoma County

A report of basic geology, seismicly induced ground motions, fault rupture hazards, tsunami hazards, and slope stability, entitled Geology for Planning in Sonoma County (1974), was prepared for the county by a State geologist. In addition, the State geologist from the California Division of Mines and Geology provided geologic data and recommendations for the county's "general plan" under a cooperative agreement with the County Planning Department. Sonoma County has a "diversity and abundance of geologic hazards comparable to the most hazardous counties in the state" (Huffman & Armstrong, 1974, p. 5).

The report and its accompanying maps were designed to be used to implement general planning goals, to assist in the creation of alternate land-use plans, as a planning tool to conserve open-space and natural resources, and as a guide in the preparation and review of EIR's and in making site evaluations.

USGS Data

The study is based upon many published and unpublished data of the USGS and contains over 60 references to the Survey. Ten of the SFBRS products, including work subsequently published in Studies For Seismic Zonation (Borcherdt and others, 1975), are referred to many times. The topics of the SFBRS products include basic geology, active faults, landslides, tsunami inundation, and flood-prone areas.

The topographic base used for the seismic shaking, slope stability, fault rupture, tsunami, and basic geologic maps was taken from the regional SFBRS topographic map (1:125,000) and enlarged to 1:62,500. The

assistance and cooperation of members of the Survey is acknowledged in the report.

Method of Application

Geologists from the California Division of Mines and Geology gathered available published and unpublished data to provide a broad overview and a county-wide synthesis of geologic hazards. These data were supplemented by interpretations of aerial photographs and limited field checking. All data were compiled on the 1:62,500 topographic base map used by the County Advanced Planning Division for general planning. The following maps were among those that resulted from the study:

1. "Relative Hazards From Seismic Shaking" upon which unconsolidated alluvium and terrace deposits, and semi-consolidated and consolidated rocks are delineated.

2. "Surface Fault Rupture and Tsunami Hazards" where potentially active faults, possibly active faults, the State's Geologic Hazards Special Studies Zones, and areas that may be inundated by tsunamis are shown.

3. "Landslides and Relative Slope Stability."

Reduced portions of two of these maps and their legend are shown on figures 18-21. Each map contains the following caveat:

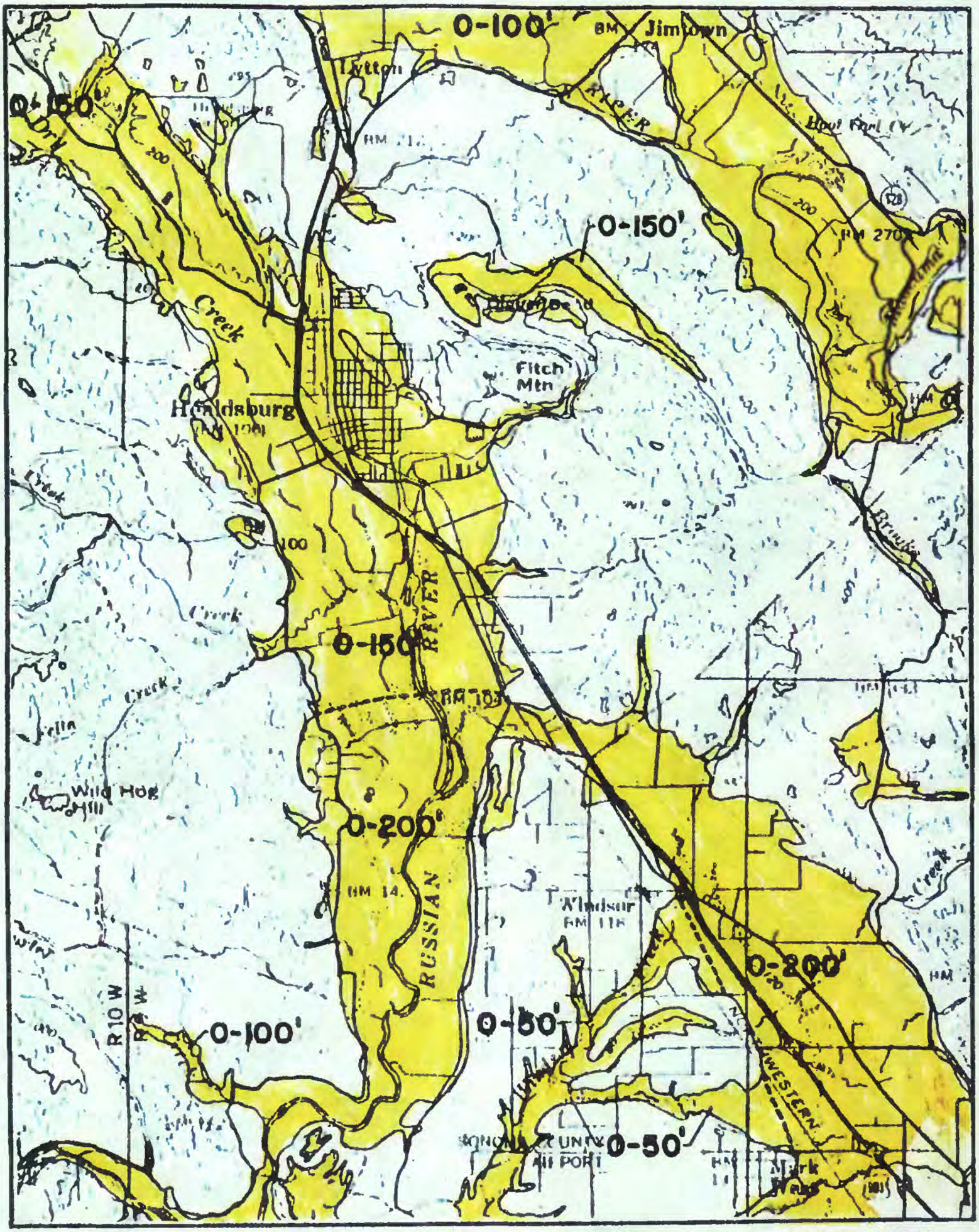
> "Data is for the purpose of regional planning and for the assessment of studies that are required for land use and development planning. Geologic and soil reports are required for land development plans and designs."

Comment

The report contains specific recommendations designed to mitigate the damage from geologic hazards. The recommendations include: "immediate implementation measures" to extend or strengthen the application of existing laws or practices; "further studies" to provide more

FIGURE 18

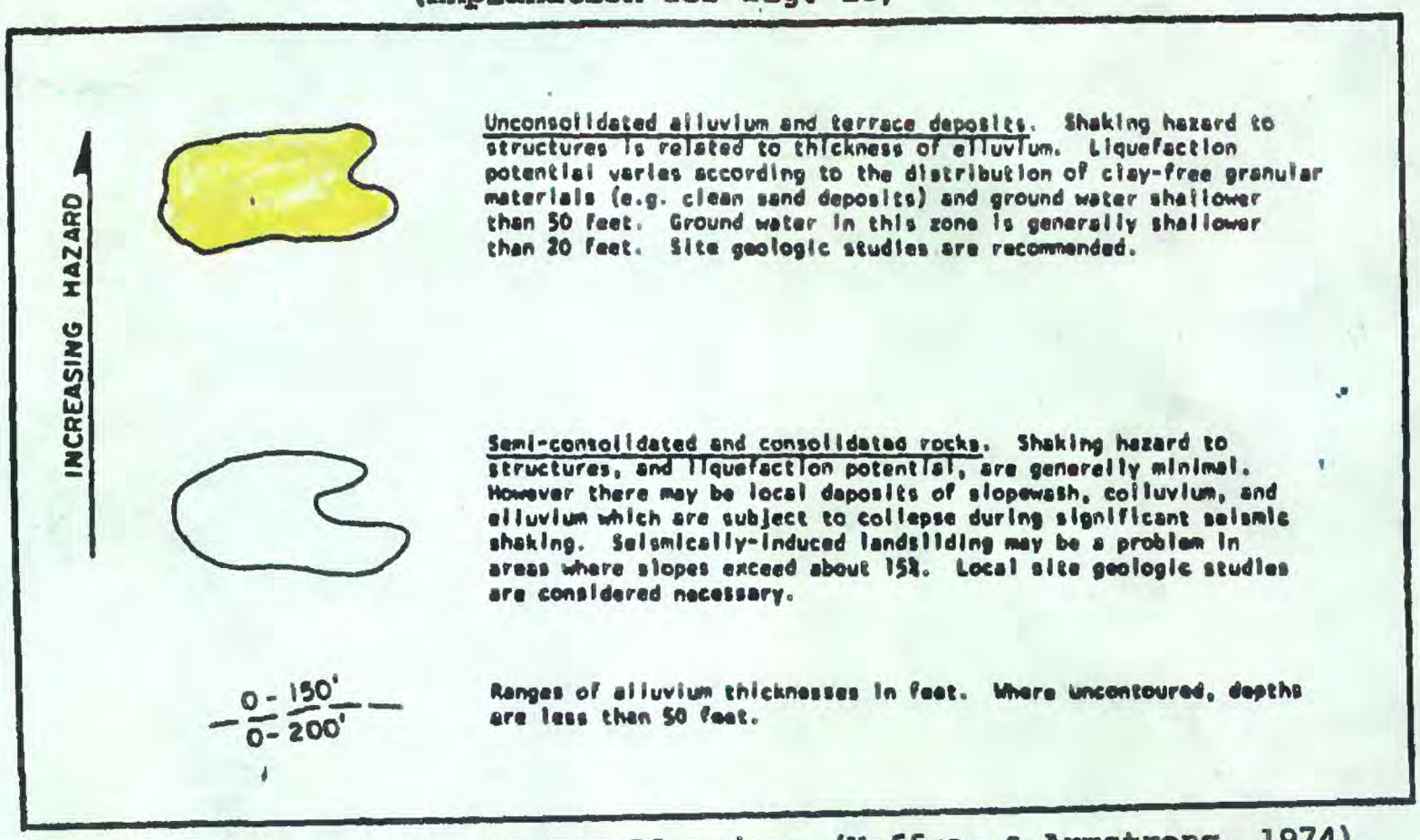
Relative Hazard from Seismic Shaking
(See fig. 19 for explanation)



Part of Sonoma Co. Geology For Planning (Huffman & Armstrong, 1974)

FIGURE 19

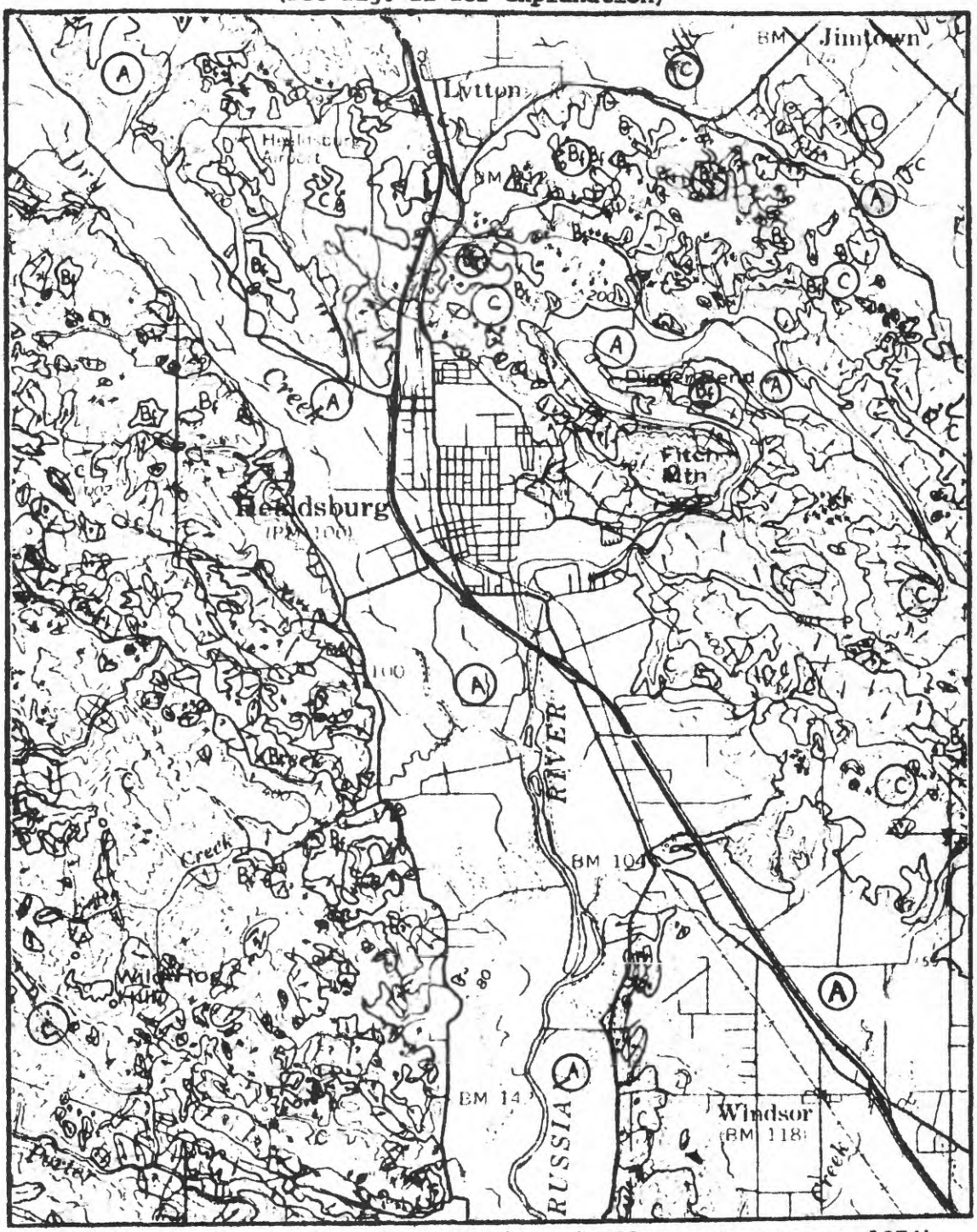
Relative Hazard from Seismic Shaking Legend
(Explanation for fig. 18)



Part of Sonoma Co. Geology For Planning (Huffman & Armstrong, 1974)

FIGURE 20

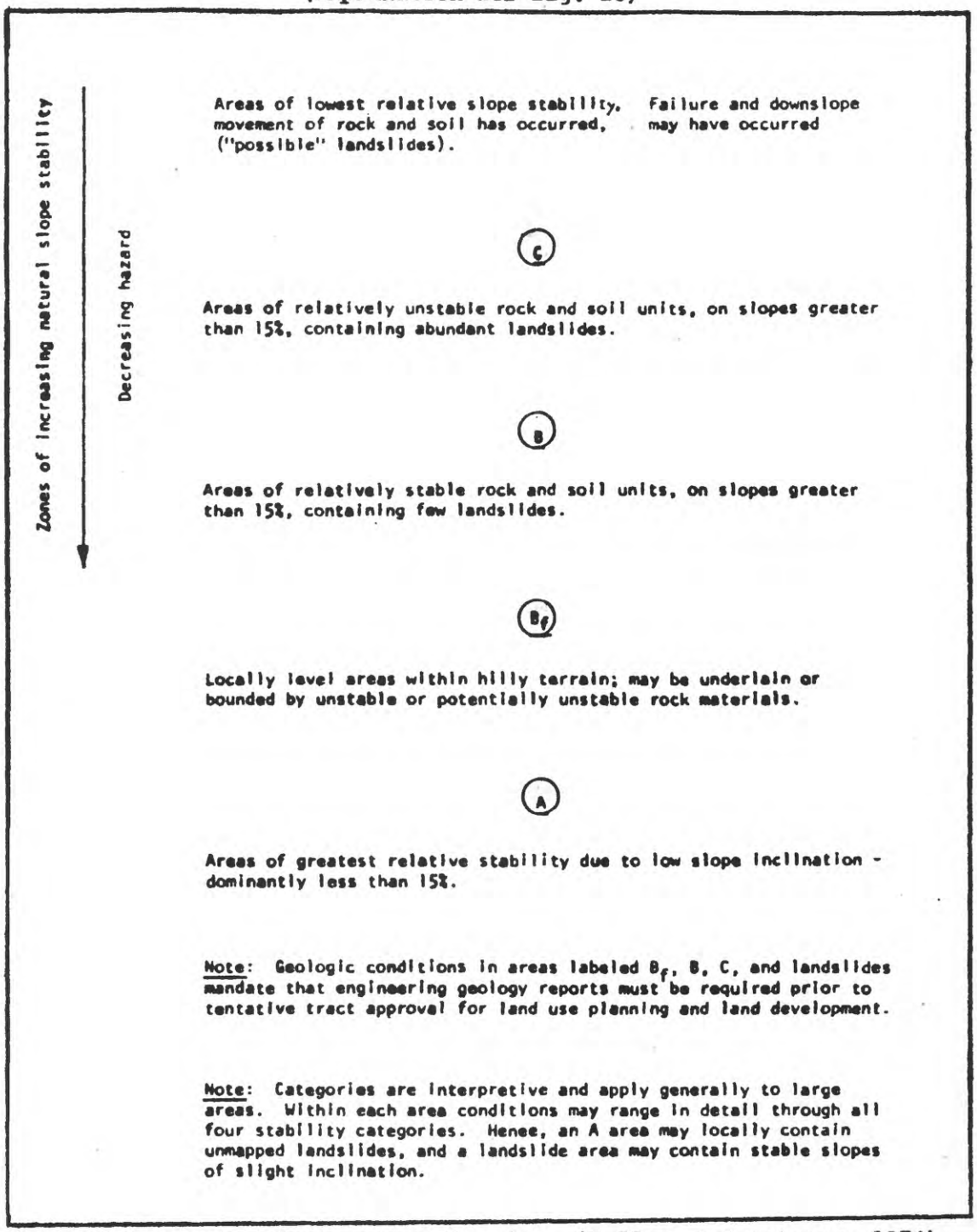
Landslides and Relative Slope Stability
(See fig. 21 for explanation)



Part of Sonoma Co. Geology For Planning (Huffman & Armstrong, 1974)

FIGURE 21

Relative Slope Stability Legend
(Explanation for fig. 20)



Part of Sonoma Co. Geology For Planning (Huffman & Armstrong, 1974)

information, including a request that the USGS "remeasure and extend laser instrumentation survey lines"; and "seismic safety engineering" steps leading toward adoption of new building, grading, and zoning provisions specifically directed to earthquake hazards.

The report is used for, and cited in, various elements of the county's "general plan" which is undergoing hearings.

Land Use Plan, Napa County

A plan entitled Land Use Element, Napa County General Plan (1975) was prepared by the County Conservation, Development and Planning Department.

Napa County lies north of the San Francisco and San Pablo Bays, covers 788 square miles, and had a population of less than 80,000 persons in 1970. Less than one-third of the land is level enough for conventional urban development (fig. 22). The combination of soil, microclimate, and vintner's art has produced varietal wines which have a world-wide reputation. Both the City and County of Napa have evinced concern over rapid population growth, natural hazards, natural resources, and the existing agricultural economic base.

In February 1974, a general plan summary was distributed throughout the county to provide an opportunity for all the registered voters to indicate their desire as to the size and character of any future development. Five thousand voters responded as follows:

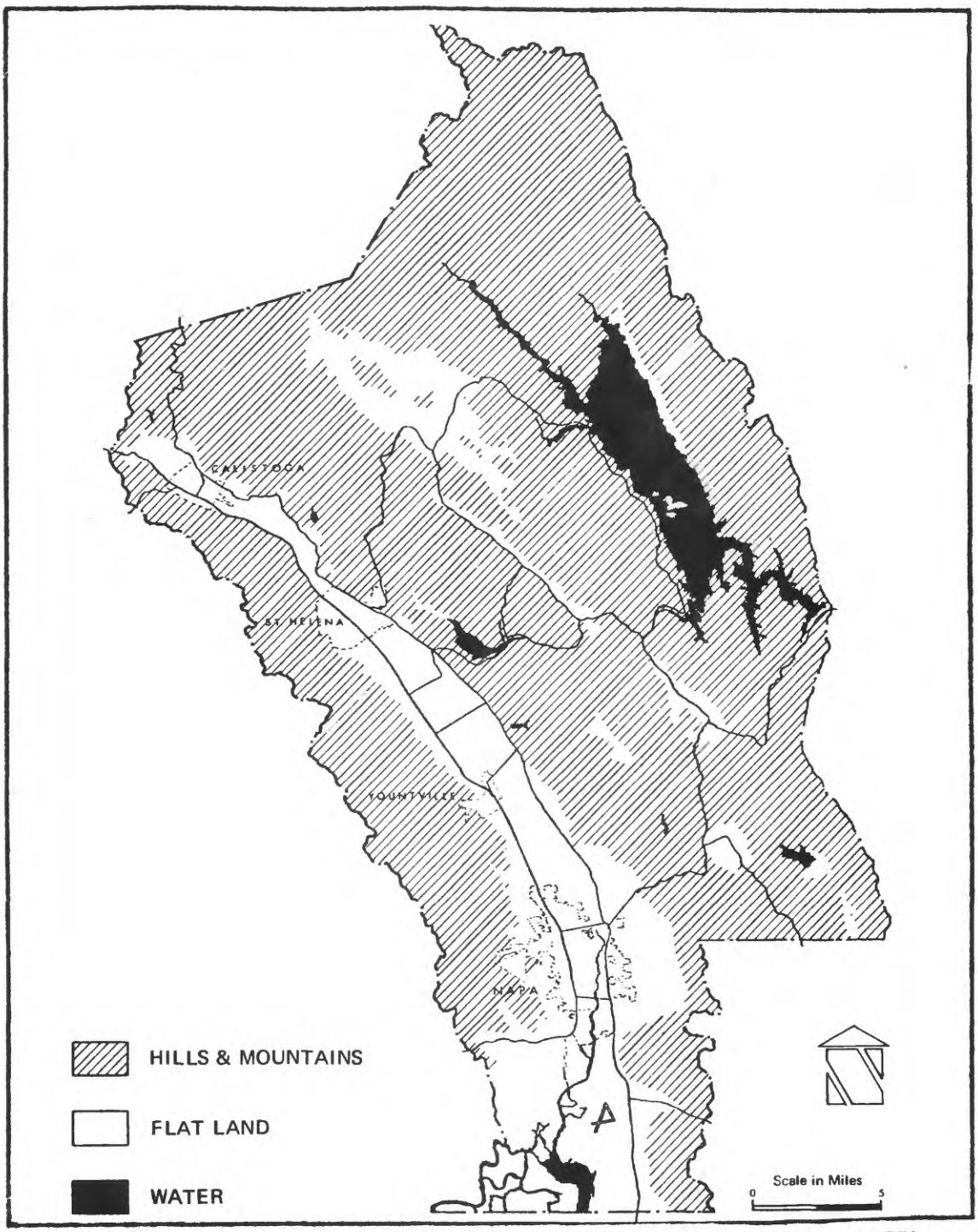
> 75% wanted the 2000-year population limited to 115,000,
> 78% wanted urban development limited to existing cities or areas having adequate water and sewers,
> 68% wanted to retain the open agriculture character, and
> 72% wanted to retain the existing unique qualities of living.

The County Board of Supervisors then unanimously adopted planning policies which reflected these responses.

In November 1974, the Board of Supervisors unanimously adopted a zoning ordinance amendment which provided for a minimum lot area of 40 acres in the County's "Agriculture, Watershed and Recreation" district. The County Conservation, Development and Planning Department

FIGURE 22

Major Physical Features



After Napa Co. Land Use Element (Cons., Dev., & Plan. Dept., 1975)

began preparing the Land Use Element that would reflect the adopted policies, and that would delineate those areas to be placed in the "40-acre" district.

The element was unanimously adopted by the County Planning Commission, and in September 1975, the Board of Supervisors adopted this element by a 4-1 vote and began the task of amending the zoning ordinance district map.

USGS Data

The land-use element refers to 14 SFBRS products. The topics include active faults, historic marshlands, basic geology, regional slope map (1:125,000), flood-prone areas, hydrology, water supply, and waste disposal. These SFBRS products are cited in a special memorandum prepared by the county setting forth all the sources of information used to develop the element.

Method of Application

The element was developed by overlaying a series of mylar map sheets (1:62,500) depicting hazards, resources, and other criteria. This process resulted in a "Development Determinants Composite" map (fig. 23). Some of the assumptions implicit in this mapping process were:

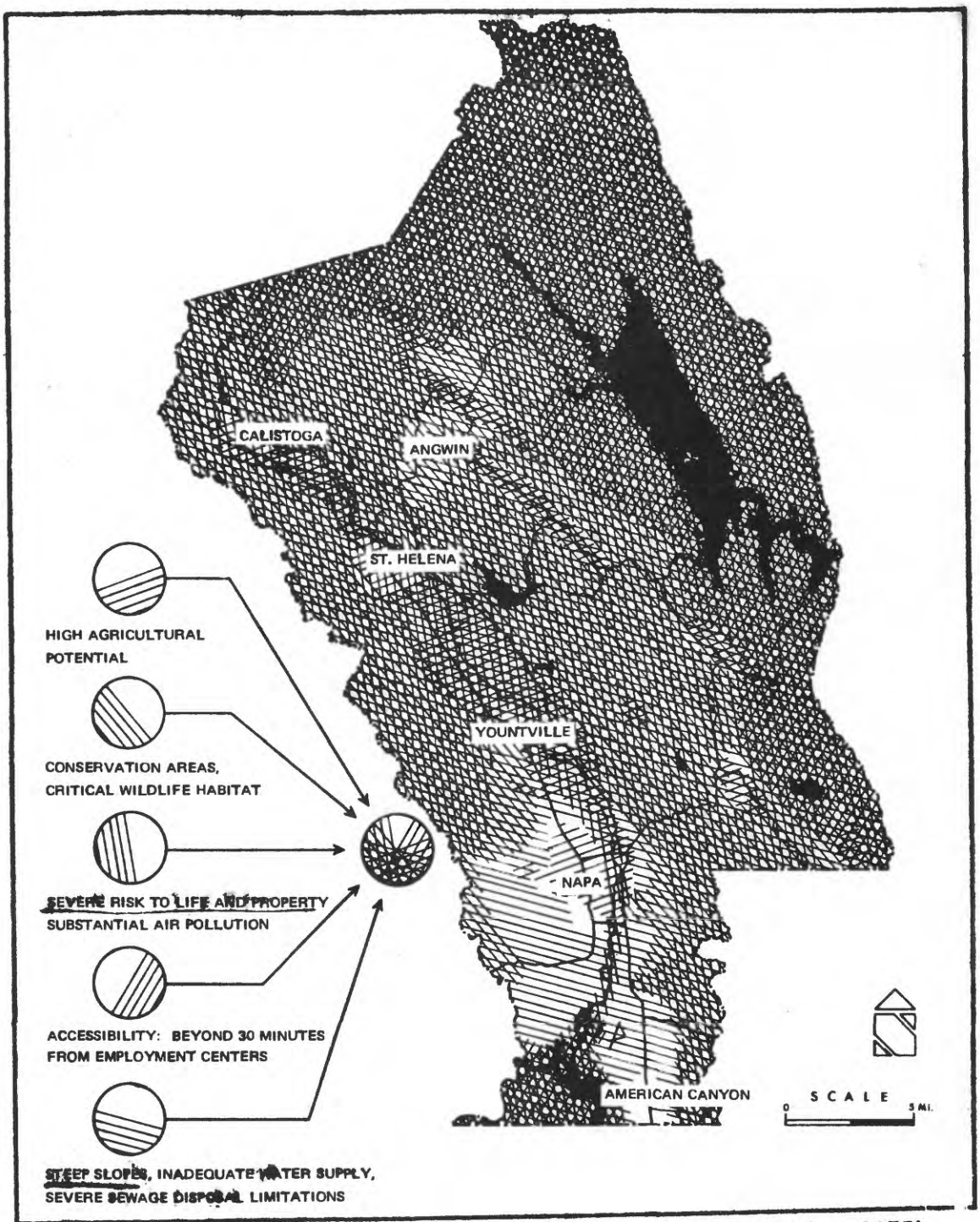
1. Agricultural potential is dependent primarily on a combination of natural soil conditions, the effect of water availability, and satisfactory climatic conditions.

2. The slope of the land in the county is not likely to change.

3. Erodible and irreplaceable soils, watershed needed for municipal water supplies, committed sewage disposal areas, sloughs, and estuaries all require protection from urban encroachment in order to maintain the proper ecological balance.

FIGURE 23

Development Determinants Composite



After Napa Co. Land Use Element (Cons., Dev., & Plan. Dept., 1975)

4. Risks to life and property created by possible liquefaction or subsidence, landslides, faults, and flooding are to be avoided or minimized.

5. Public health, safety, and welfare are best served by concentrating people where reliable public services are available.

The land-use plan for year 2000 (fig. 24) clearly reflects the land-use element's policies and development determinants.

An illustration of the relationship between the element's policies and the development determinants may be seen in figure 25. This figure has been modified to indicate those determinants which are based on USGS data.

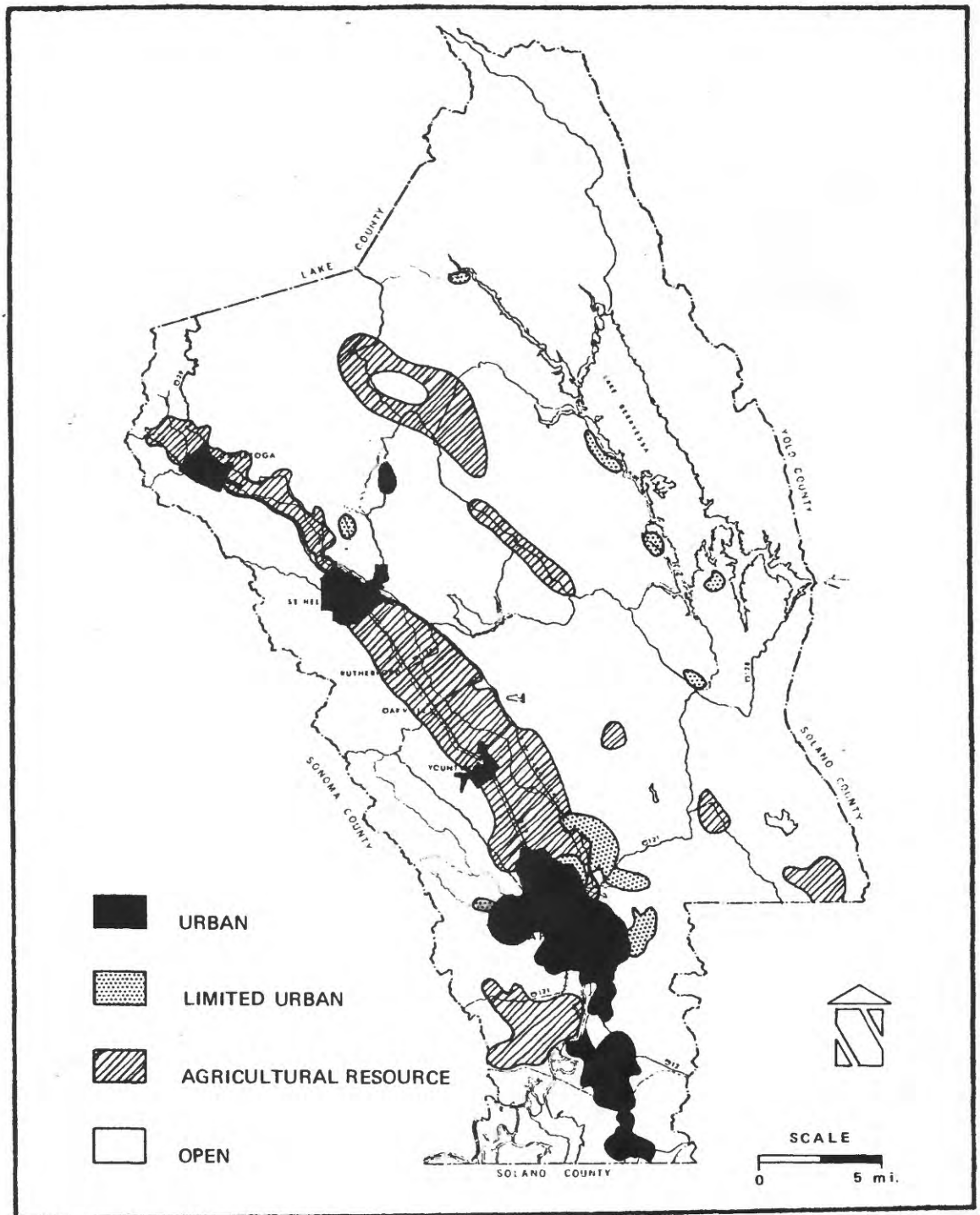
Comment

Although the adoption and enforcement of appropriate policies and ordinances varies with each unit of government, California is one of the few states whose legislation requires that not only must certain plans take into account geologic and hydrologic hazards and irreplaceable natural resources, but that local zoning ordinances must be consistent with such plans.

Napa County's Land Use Element and zoning ordinance amendments clearly illustrate not only the use of Survey products for county planning and decisionmaking, but the effective implementation of such plans through relatively stringent regulations.

FIGURE 24

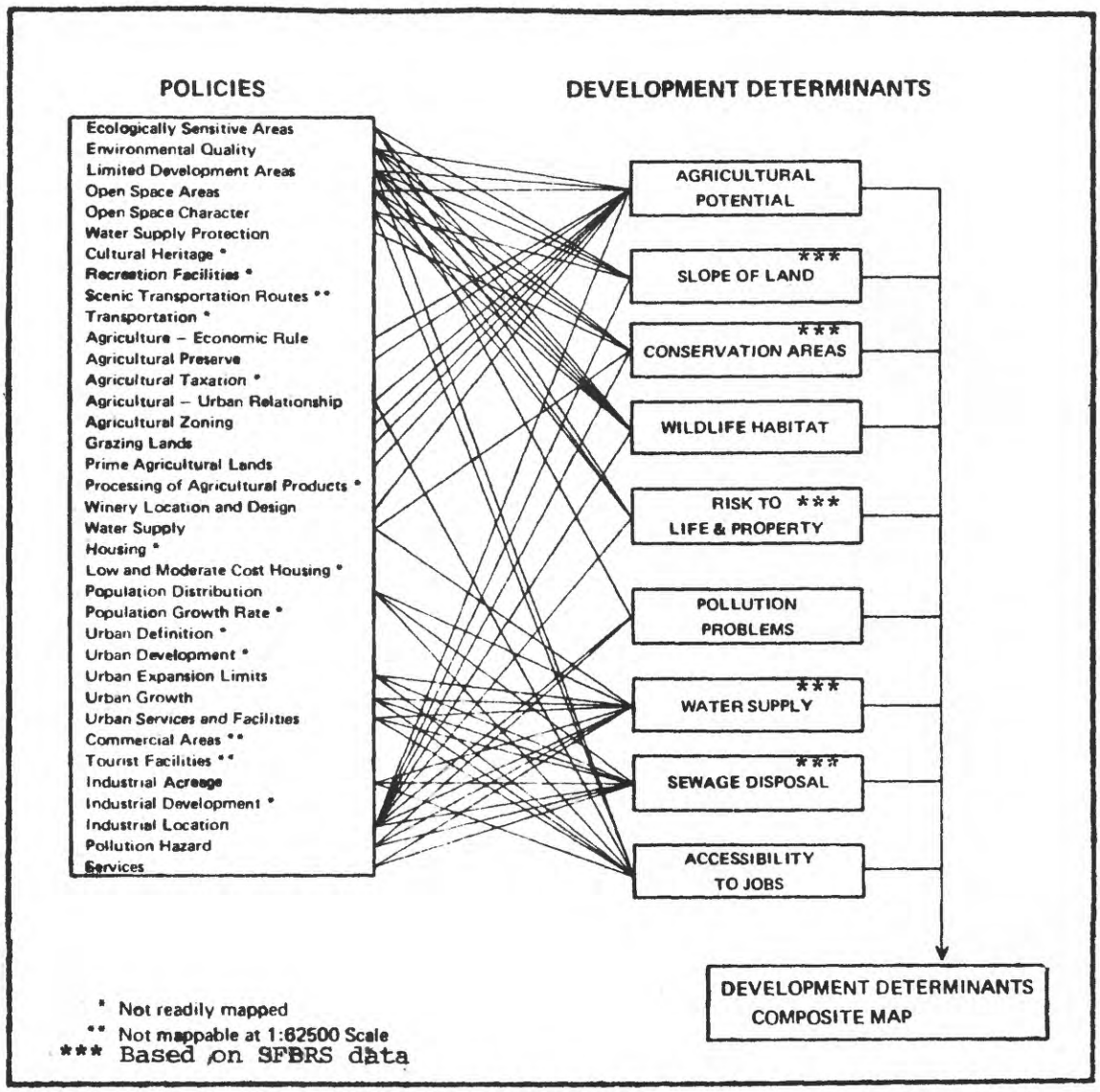
Land Use Concept Plan



After Napa Co. Land Use Element (Cons., Dev., & Plan. Dept., 1975)

FIGURE 25

Relationship between Policies and Development Determinants



Modified from Napa Co. Land Use Element (Cons., Dev., & Plan. Dept., 1975)

Open Space Plan, Sonoma County

A plan entitled Open Space Element, Phase II (1973) was prepared by the Sonoma County Planning Department with help from a computer services firm. It was adopted by the County Planning Department and Board of Supervisors.

The report, dealing with the analysis and synthesis of environmental data, was prepared to meet State law and was financed in part through a comprehensive planning grant from the Department of Housing and Urban Development.

USGS Data

The report is based upon, and refers to, the regional slope map (1:125,000) and tsunami, fault, flood, and basic geologic products of the SFBRS series. The Survey's data are specifically acknowledged by the County Planning Department (1973, p. 9).

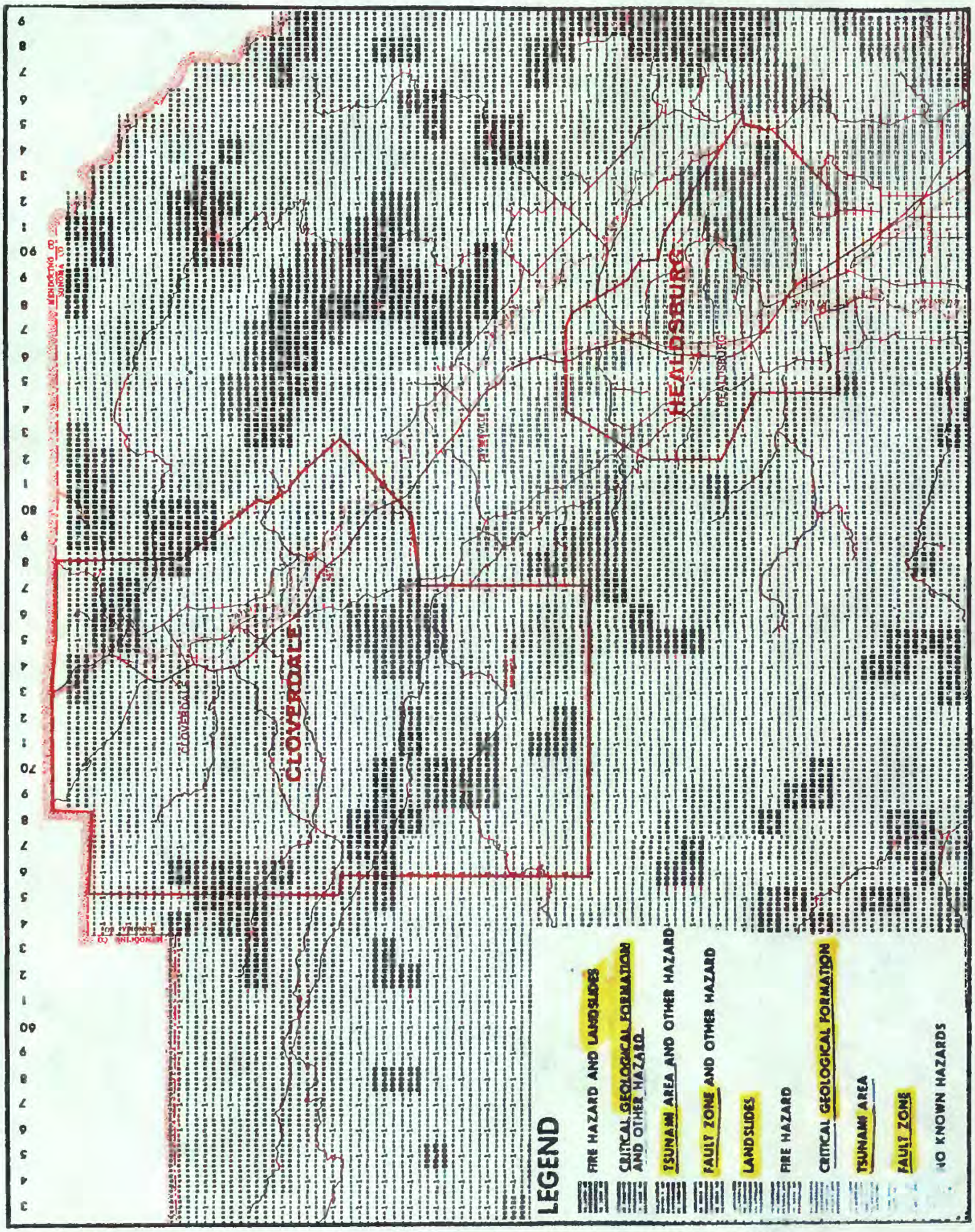
Method of Application

A grid system was superimposed over the SFBRS products consisting of 5,500 grid cells, 1,000 metres square (250 acres). The information on the SFBRS maps was coded numerically for each grid cell.

This information and information from other resource maps were weighted according to importance ratios assigned by planners and citizens. These ratios were combined to produce eleven "environmental source" maps, one of which was a hazards map (fig. 26) at a scale of 1:250,000. The "source" maps were then combined to produce three "environmental sensitivity" maps; namely, "Hazardous Areas," "Sensitive Areas," (fig. 27) and "Unique Areas," all at a scale of 1:250,000. Each "sensitivity" map is based, at least partially, on the regional slope map and several other SFBRS products.

FIGURE 26

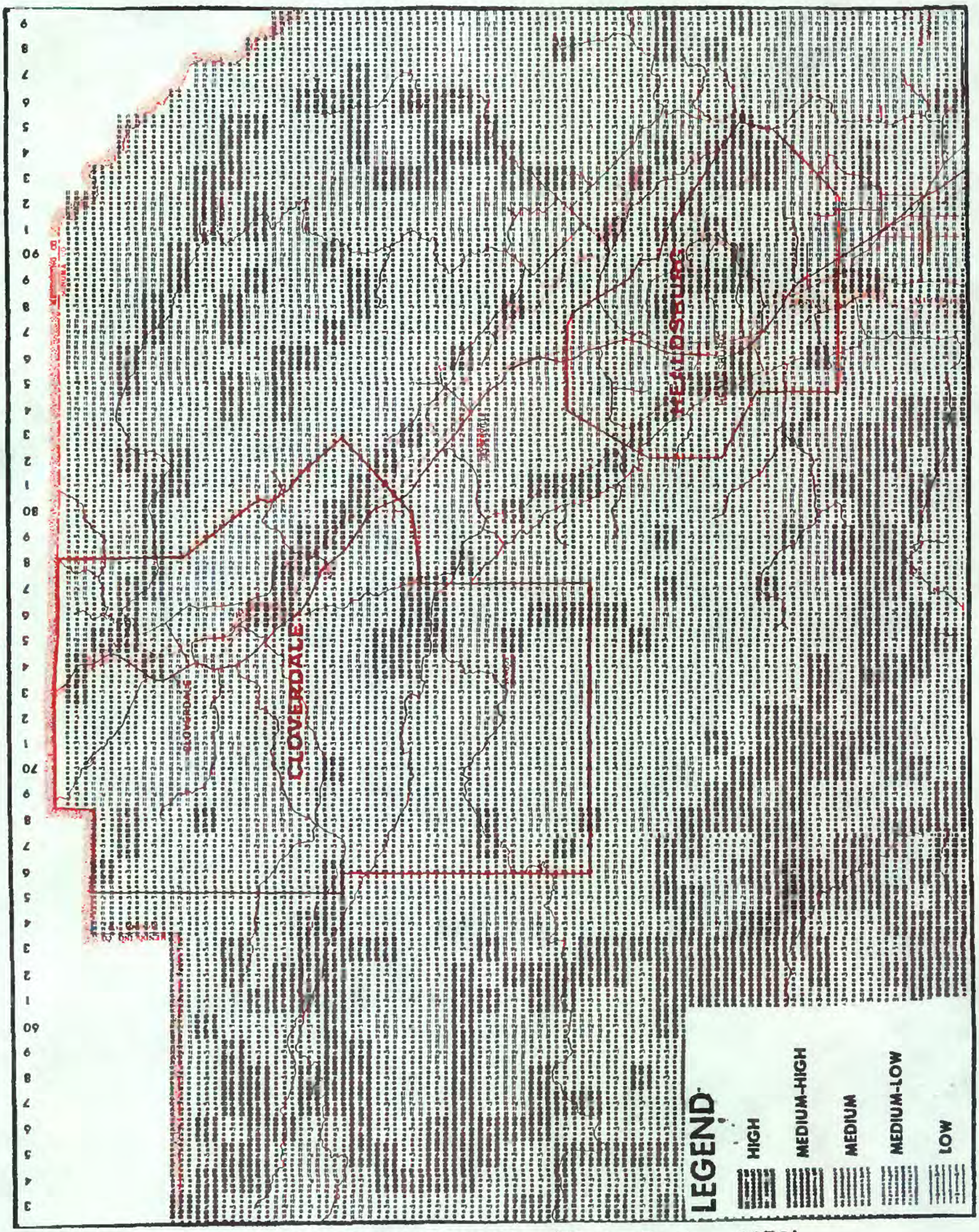
Environmental Hazards



Part of Sonoma Co. Open Space Element (Plan. Dept., 1973)

FIGURE 27

Sensitive Areas



Part of Sonoma Co. Open Space Element (Plan. Dept., 1973)

Comment

The county has set aside this computerized method of handling resource data because of its complexity. However, its application illustrates that SFBRS data can be digitized, weighted, combined with other resource data, and manipulated to produce the various composite maps necessary to prepare the open-space plans required by a California statute. This statute has particular significance in that it specifically requires every city and county to prepare and adopt a special open-space zoning ordinance consistent with their open-space plan.

Seismic Safety Plan, Santa Clara County

A Seismic Safety Plan (1975) was prepared by the Santa Clara County Planning Department in compliance with State legislation that requires all county planning agencies to prepare, and all county governing bodies to adopt, a general plan for the physical development of the county. The State legislature further requires that the general plan include a "seismic safety element" consisting of identification and appraisal of seismic hazards.

The plan contains specific recommendations concerning further study, public facilities, community services, circulation, and urban development. Some recommendations are unusually specific; for example, active fault zone mapping at a scale of 1:12,000, storage of "at least three-and-one half gallons of drinking water for each family member," and "duplicate records of utility systems."

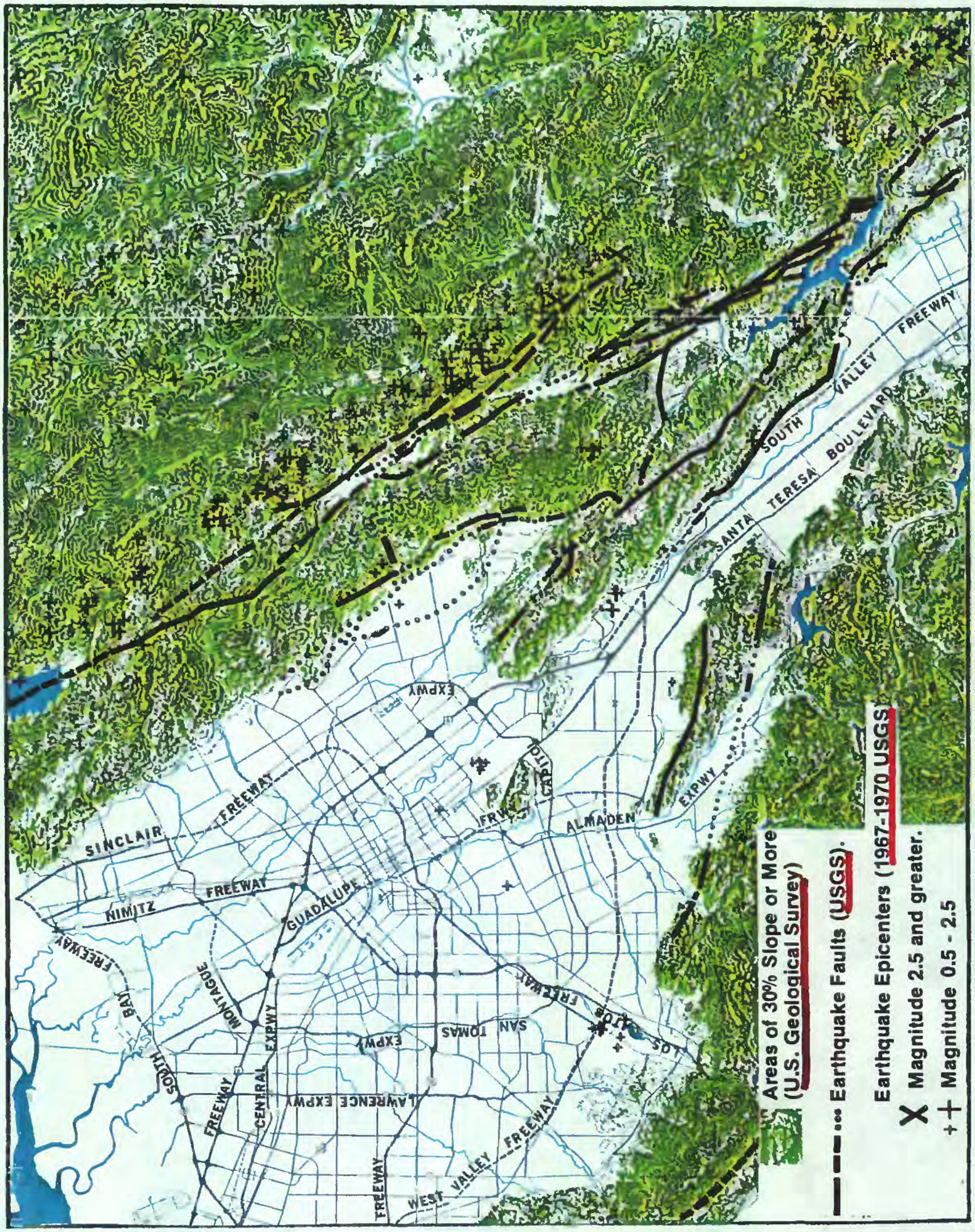
The plan was unanimously adopted by the County Planning Commission and Board of Supervisors, and has been implemented by the adoption of an amendment to the county's subdivision, building, and grading ordinances which is discussed in a later section of this report.

USGS Data

The plan is partly based upon data published by the USGS and contains over 70 references to the Survey, many of which are to SFBRS products. All figures are based upon USGS data although the sources are not cited on the figures. Figure 28 is derived from a slope zone map especially prepared for the county at a scale of 1:125,000 by the Topographic Division of the USGS.

FIGURE 28

Slope and Seismicity



Part of S. C. Co. Seismic Safety Plan (Plan. Dept., 1975)

The plan was prepared with assistance or contributions from the California Division of Mines and Geology, private consultants, and members of the Survey. The County Planning Department specifically acknowledges the contributions of various members of the Survey in the plan (1975, p. 107).

Method of Application

All the potential earthquake hazards, namely, ground shaking, ground failure, surface displacement, mass movement, tectonic creep, tsunami, dike failure, and seiche, were composited on a map (fig. 29) on which the relative hazards were divided into three zones. The zones are simply indicated by red, yellow, and green -- the requirements for geologic investigation varying with the level of hazard.

Although this map is at a scale of 1:125,000, a note appears on the map that more detailed maps at a scale of 1:62,500 are available.

Figure 29 is used as a base map for several other maps upon which utilities, transportation, structures, community facilities, and urban development have been overlaid (figs. 30 and 31). The visual impact on citizens and decisionmakers of pipelines, canals, power lines, freeways, railroads, bridges, hospitals, fire stations, and urban development lying on the "red" hazard zones is great.

Comment

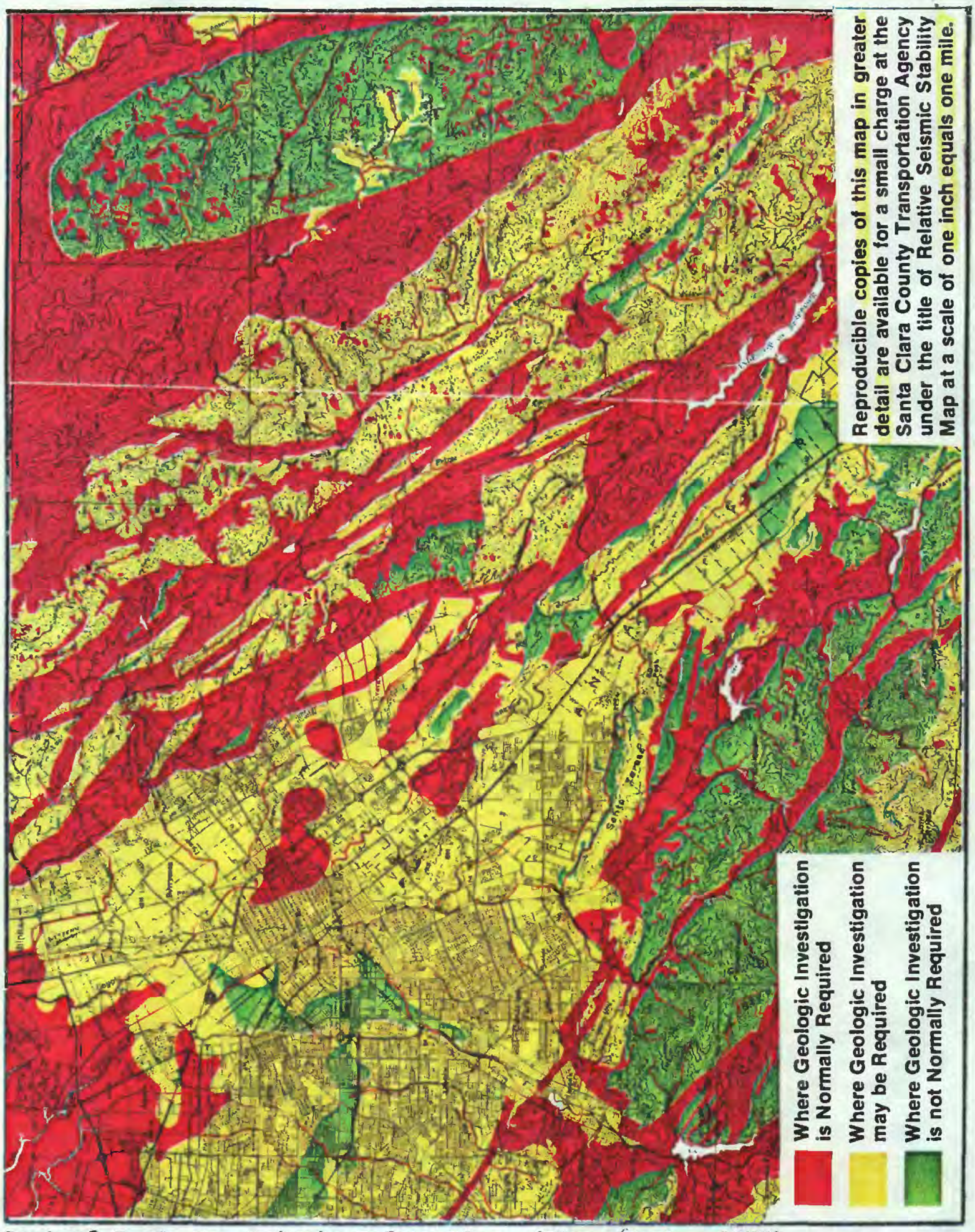
This seismic safety plan is significant for the following reasons:

1. Santa Clara County is one of the largest counties in the Bay region and has the fastest growing population (5.18 average annual percentage growth rate for 1960-1970).

2. It is a relatively undeveloped county, and the most hazardous areas are relatively undeveloped.

FIGURE 29

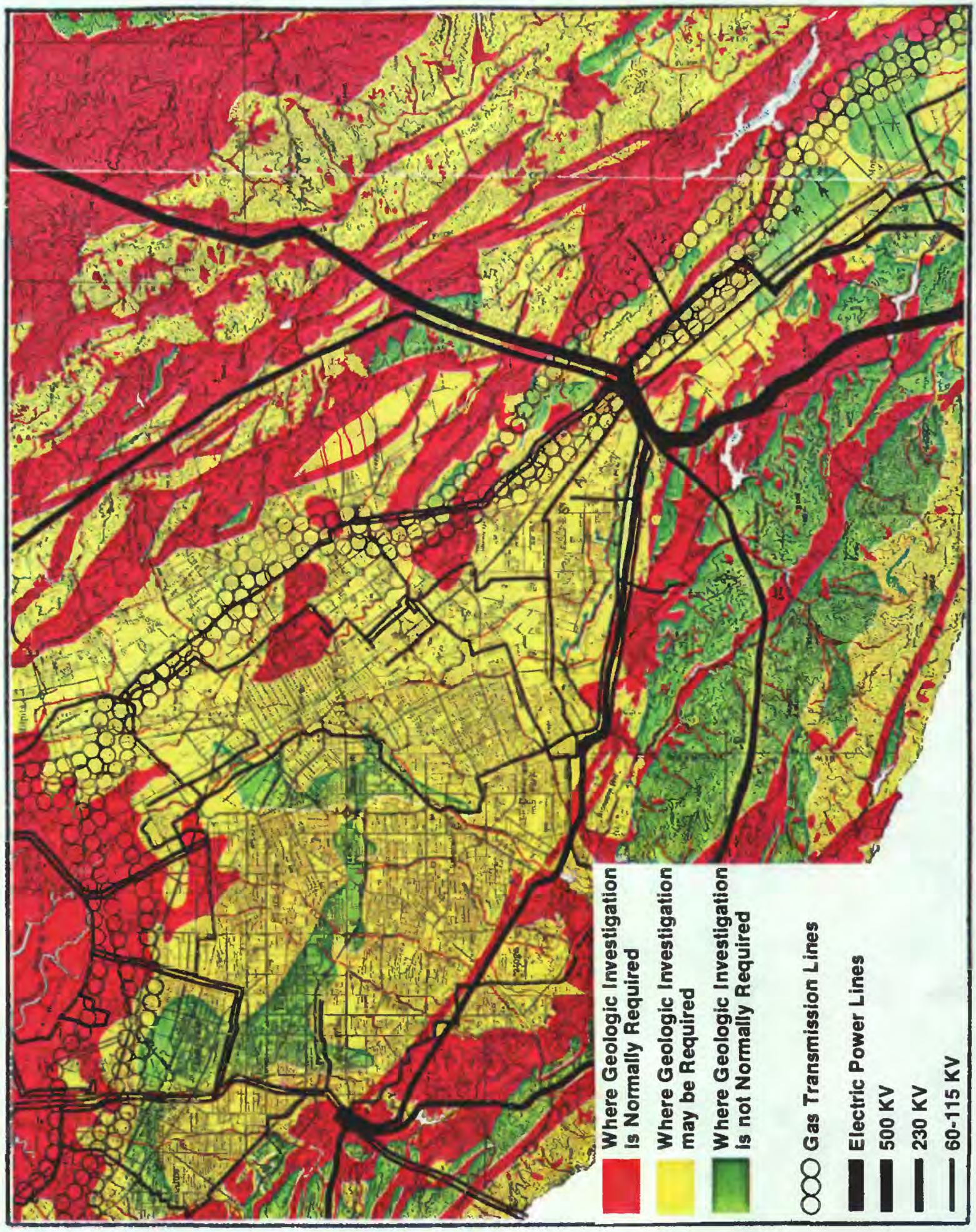
Seismic Safety Zones



Part of S. C. Co. Seismic Safety Plan (Plan. Dept., 1975)

FIGURE 30

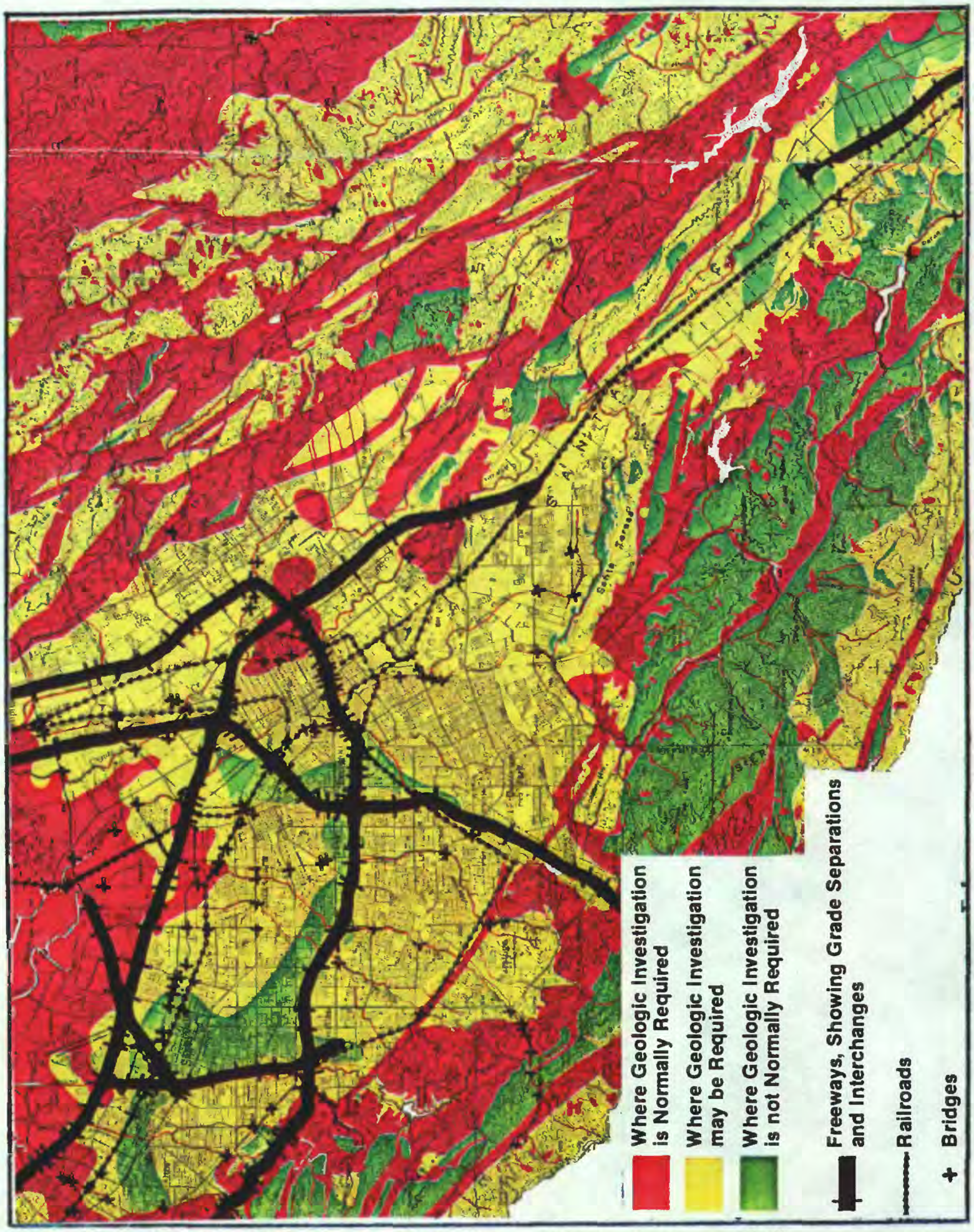
Major Gas and Electric Lines



Part of S. C. Co. Seismic Safety Plan (Plan. Dept., 1975)

FIGURE 31

Major Transportation Facilities



Part of S. C. Co. Seismic Safety Plan (Plan. Dept., 1975)

3. Most of the geologic hazards have been identified, mapped, composited, and placed in hazard zones which require varying levels of geologic investigations.

4. A seismic safety zones map has been adopted as the official "County Geologic Hazards" map in its subdivision, building, and grading ordinances.

5. The county has a state certified engineering geologist in its Land Development Engineering Department who participated in the development of the plan and the ordinance, and who has major responsibility for their day-to-day administration.

Seismic and Public Safety Plans, San Mateo County

Two plans, entitled Seismic and Safety Elements of the General Plan (1975), were prepared by the San Mateo County Planning Department with assistance from a geotechnical engineering firm.

These plans were undertaken by a joint task force composed of representatives of the county and 14 of the 18 cities lying in the county in order to:

1. Fulfill the requirements of State law
2. Identify, delineate, and evaluate potential natural hazards including geotechnical hazards
3. Identify policies and programs to reduce risk
4. Integrate hazard data into the decisionmaking process
5. Provide policy guidelines to decisionmakers

The plans were adopted by the County Planning Commission, and their adoption by the Board of Supervisors is anticipated. It is also anticipated that the 14 cities which participated in the preparation of the plans will adapt and implement those policies and programs applicable to their specific needs.

San Mateo County lies south of the City of San Francisco between the Pacific Ocean and the San Francisco Bay, covers 447 square miles -- 60 percent of which is undeveloped --, and had a population of over half a million persons in 1970.

USGS Data

The plans, published in two volumes, are based primarily upon 19 SFBRS products, and numerous references are cited both in the text and in the legend. The topics of the SFBRS products include landslides,

active faults, basic geology, flood-prone areas, tsunami inundation, hillside materials, flatland materials, coastal erosion, and historic marshlands. Passages from these products are quoted to describe geologic hazards (fig. 32).

In addition, other USGS products covering liquefaction, geology, quadrangle maps in the 7½-minute (topographic) series, and prediction of maximum earthquake intensity are cited. Significant reliance was placed upon the report by Borcherdt and Gibbs (1975) in discussing ground shaking and resultant damage for six of the cities discussed in volume one of the plans.

It was noted that although many references to SFBRS products were made on the two-sheet legend, no references were made on the five-sheet map. Both the County Planning Department and the engineering firm have indicated that an appropriate acknowledgement will be added.

Method of Application

An inventory of all geotechnical hazards, namely, faults, ground shaking, ground displacement and ground failure, landslides, expansive soils, erosion, coastal stability, subsidence, and inundation due to dam failure were composited onto a hazard map. Reduced portions of the map and legend are shown on figures 33-35. The map is intended to be used as an "analytical planning tool" for evaluating development, and to indicate areas where further studies should be undertaken prior to making land-use decisions. The composite map at a scale of 1:24,000 is composed of five sheets and a two-sheet legend.

In addition to a description of the geologic hazards and terrain

FIGURE 32

Landslide Discussion

Landslides are a relatively common phenomena in San Mateo County. U.S.G.S. has made major studies of both landslide potential (or susceptability) and landslide distribution throughout the County, utilizing data from such varied sources as photo-interpretation, field investigations, and public and private parties[1]. The following is taken from the text of U.S.G.S. Map MF-344:

> " 'Landslide deposits' are the products of the landslide or slope-failure process. They are composed of fresh and weathered rock fragments, sediment, soil, or any combinations thereof, that have been transported downslope by falling, sliding, slumping, or flowing. They vary in appearance from clearly discernible, largely uneroded topographic features to indistinct, highly eroded features recognizable only by their subtle topographic configurations. Thickness ranges from a few feet to perhaps several hundred feet. Larger deposits are generally thickest; many of the small deposits are thin and involve only the uppermost few feet of earth materials."

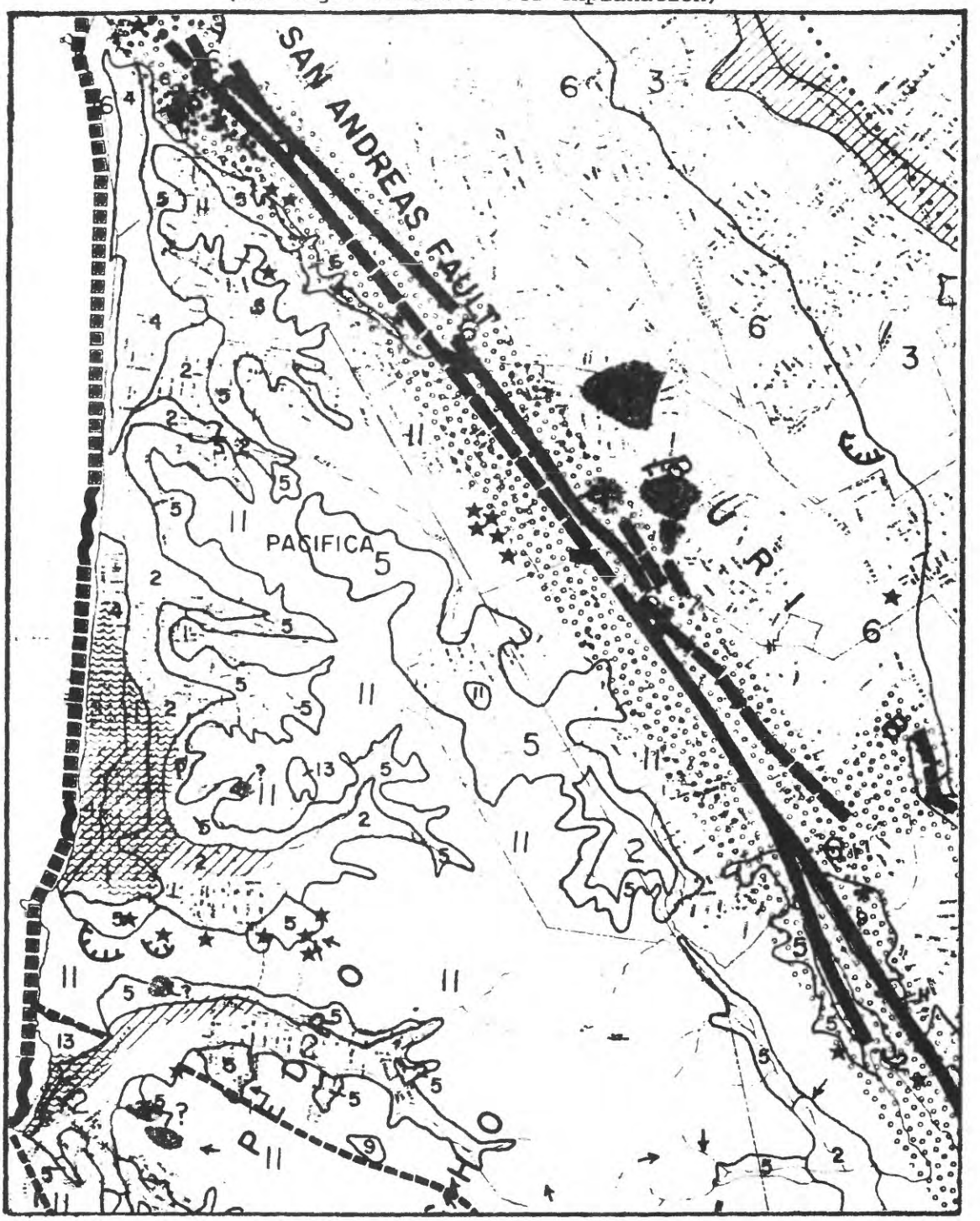
The intensely developed areas on the Bayside of the County fortunately have a minimal potential for landslide, with some exceptions. In contrast, hillside deposits in the southern portion of the County have a high susceptibility to landsliding. Earthquakes are one of the major causes for the activation of landslides, a great many of which occurred in the 1971 San Fernando earthquake (largely in the generally unoccupied arid mountain area). There were also massive landslides in the Alaska earthquake in 1974 [sic], often apparently associated with liquefaction. The economic loss was severe. Damaging landslides can also occur on gently sloping ground, such as the Juvenile Hall slide in the San Fernando earthquake.

1] Brabb, Pampeyan, and Bonilla: "Landslide Susceptibility in San Mateo County California", MF-360 and Brabb & Pampeyan, "Preliminary Map of Landslide Deposits in San Mateo County, Calif. "MF-344

Part of S. M. Co. Seismic & Safety Elements (Plan. Task Force, 1975)

FIGURE 33

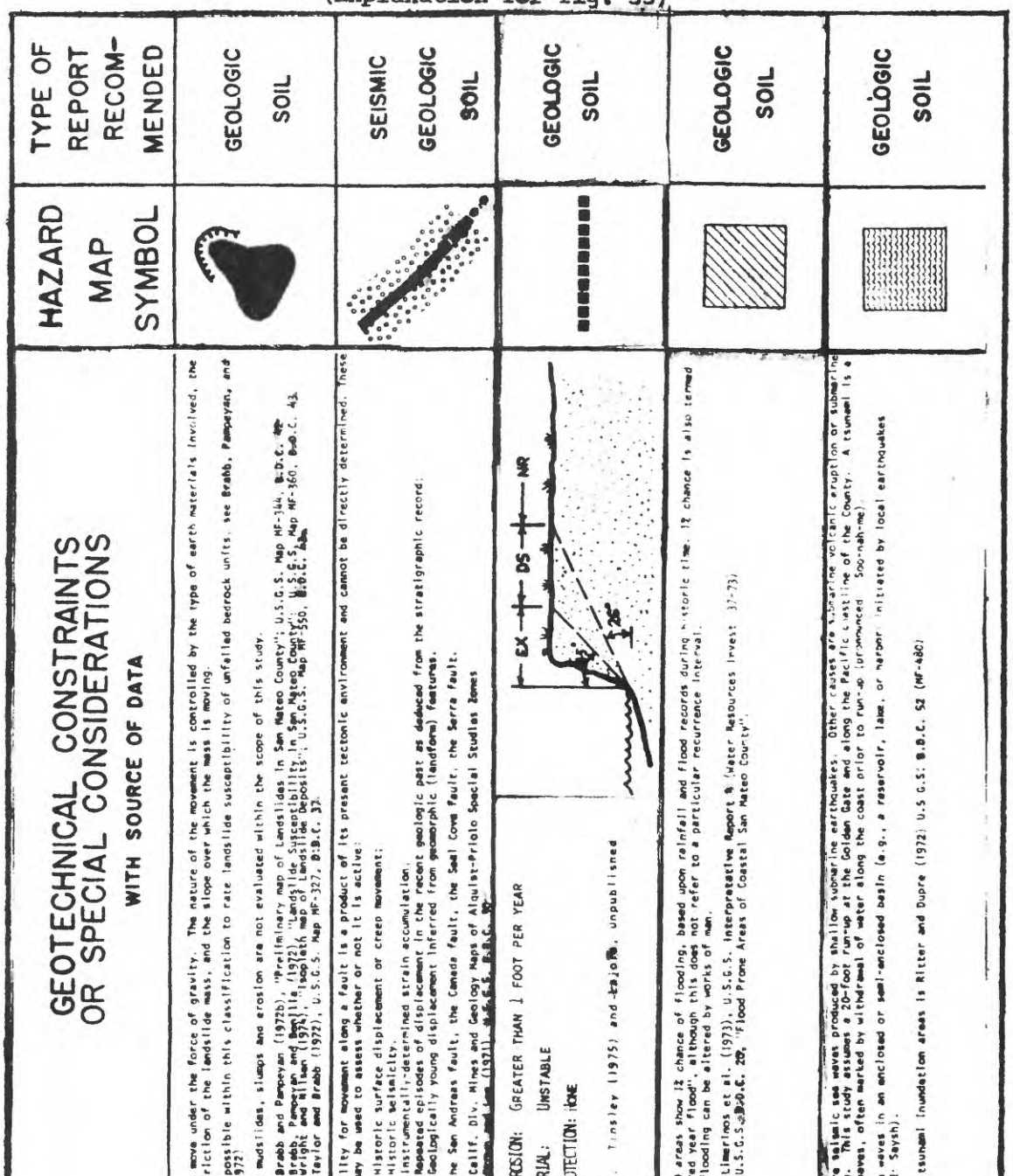
Geotechnical Hazard Synthesis
(See figs. 34 and 35 for explanation)



Part of S. M. Co. Seismic & Safety Elements (Plan. Task Force, 1975)

FIGURE 34

Geotechnical Hazard Synthesis Legend (Sheet 1)
(Explanation for fig. 33)



Part of S. M. Co. Seismic & Safety Elements (Plan. Task Force, 1975)

FIGURE 35

Geotechnical Hazard Synthesis Legend (Sheet 2)
(Explanation for fig. 33)

GEOTECHNICAL CONSTRAINTS OR SPECIAL CONSIDERATIONS WITH SOURCE OF DATA	HAZARD MAP SYMBOL	TYPE OF REPORT RECOMMENDED
Unconsolidated, water-saturated, dark, plastic, organic-rich clay and silty clay. Locally contains lenses and stringers of well-sorted silt and sand. Maximum thickness about 120 feet, but thins to less than one foot around margins of Bay. Interfingers with younger alluvial and basin deposits. Locally covered by artificial fill at solid-waste disposal sites. Much of the area of exposure is used as salt-water evaporating ponds. Undisturbed portions of marshes provide wildlife habitat. Sources: Lajoie and others (1974), Nichols and Wright (1971), Goldman (1971)	1	
Units are classified according to potential for liquefaction, after Youd et. al. (1973), principally based upon depth to water table See Lajoie et. al. (1974) for areal extent of lithologic units. Units have local shrink-swell problems. Fine-grained younger alluvial fan deposits: Unconsolidated, moderately-sorted, moderately-permeable fine sand, silt and clayey silt. Thickness varies from 0 to about 12 feet thick. occurs mostly in canyons as valley fill. Younger basin deposits: Unconsolidated plastic, moderately to poorly sorted, organic-rich silt and clay. Irregularly bedded, generally less than 10 feet thick. Found in poorly-drained, near-horizontal basins.	2 a	SEISMIC GEOLOGIC SOIL
Fine-grained older alluvial fan deposits: Weakly-consolidated, plastic, organic-rich clay and silty clay with occasional sand lenses exposed along margins of San Francisco Bay as old mudflats, underlies younger deposits. Coarse-grained younger alluvial fan deposits: Unconsolidated, moderately sorted, permeable sand and silt, with coarse sand and gravel toward fan heads and in narrow canyons. Well-bedded, 10 to 50 feet thick deposits in active terraces and as valley fills in narrow canyons.	2 b	
Serpentine consists principally of sheared serpentinite, blocks of ultramafic rock, schist, rodingite, and silica-carbonite rock. Generally fractured with borders of clayey gouge. The gouge material is soft to firm while many blocks are firm to hard. Permeability is very low at depth and low (a) clayey surficial mantle. Excavation is easy to moderate. fills may be weak and locally expansive, commonly with oversized hard blocks. Sheared rocks of the Franciscan assemblage are composed of gouge and variably shale and siltstone containing blocks of sandstone, greenstone, chert, and other Franciscan rocks, and graywacke-type sandstone. Source: Wentworth et al. (1975), Units H and I	5	GEOLOGIC SEISMIC SOIL
Colluvium is an unconsolidated, hetrogeneous, and very thick soil deposited by mass wasting on the lower portions of moderately steep slopes. Colluvium is subject to downslope creep. It probably covers most upland slopes in San Mateo County but it is restricted on this map to deposits at the base of steep slopes and in small gullies where it is likely greater than five feet thick. Locally, the colluvium may be as much as 30 feet thick. It may also contain organic debris. Overall composition depends upon the lithology of the underlying bedrock. Colluvium interfingers and grades into alluvial deposits in canyon bottoms at the base of slope. Additional colluvial deposits in the southern and eastern portions of the County have not been mapped to date. Source: Lajoie et al. (1974), U.S.G.S. B.D.C. 68	9	SOIL GEOLOGIC
Chert of the Franciscan assemblage is hard, but brittle, closely fractured, with distinct bedding. Limestone, marble, and hornfels are commonly hard (except hornfels weathers soft), close to wide fractures, variable bedding, occurs mainly as lenses or tabular bodies. Granitic rock, largely quartz diorite, locally weathered to granular decomposed granite to depths of 10 to 100 feet. Metamorphic rocks, principally glaucophane schist of the Franciscan assemblage. Source: Wentworth et al. (1975), Units U,V,W,X.	13	SOIL GEOLOGIC

Part of S. M. Co. Seismic & Safety Elements (Plan. Task Force, 1975)

units, the legend contains a discussion of geotechnical constraints for each hazard and unit, and the type of study and report recommended, such as seismic, geologic, and soil.

Comment

The County Planning Department is preparing a land-capability map based upon the hazard map. After the county is divided into areas having the same geotechnic hazards and the level of risk exposure is tied to various land uses, a matrix relating mitigation measures to land uses will be prepared.

Emergency Operations Plan, Alameda County

A civil defense manual entitled Emergency Operations Plan (1973) was prepared for Alameda County by their Office of Emergency Services. The plan, adopted by the County Board of Supervisors, has the following operational objectives:

1. Provide for the continuity of government
2. Provide a basis for direction and control of emergency operations
3. Save lives and protect property
4. Repair and restore essential systems and services
5. Provide for the protection, use, and distribution of remaining resources
6. Coordinate operations with the civil defense and emergency service organizations of other jurisdictions.

Alameda County lies east of the San Francisco Bay, covers 843 square miles of which 107 square miles are under the waters of the Bay, and had a population of over one million persons in 1970. Major transportation lines, food distribution warehouses, bulk petroleum terminals, and military facilities on the bay shores would be affected by a release of seismic energy.

USGS Data

The plan contains references to several USGS products and to one SFBRS product. The topics include fault traces, tectonic creep, and tsunami inundation.

Method of Application

The appendixes to the plan address certain topics, such as procurement for civil defense, promulgations by the Governor, and identification of Federal support personnel. Appendixes containing

a bibliography of USGS material on the Hayward fault, and a discussion of tsunami hazards are included. The discussions of the height of the runup, likelihood of occurrence and tsunami warnings, and the reduced portion of the map showing potential inundation (fig. 36) were taken entirely from an SFBRS product (BDC 52).

Comment

All of the counties' emergency service personnel interviewed were familiar with the Survey and maintained files of some of the SFBRS products. In addition, Alameda County had actually incorporated one SFBRS product in a formally adopted emergency plan.

FIGURE 36

Tsunami Inundation

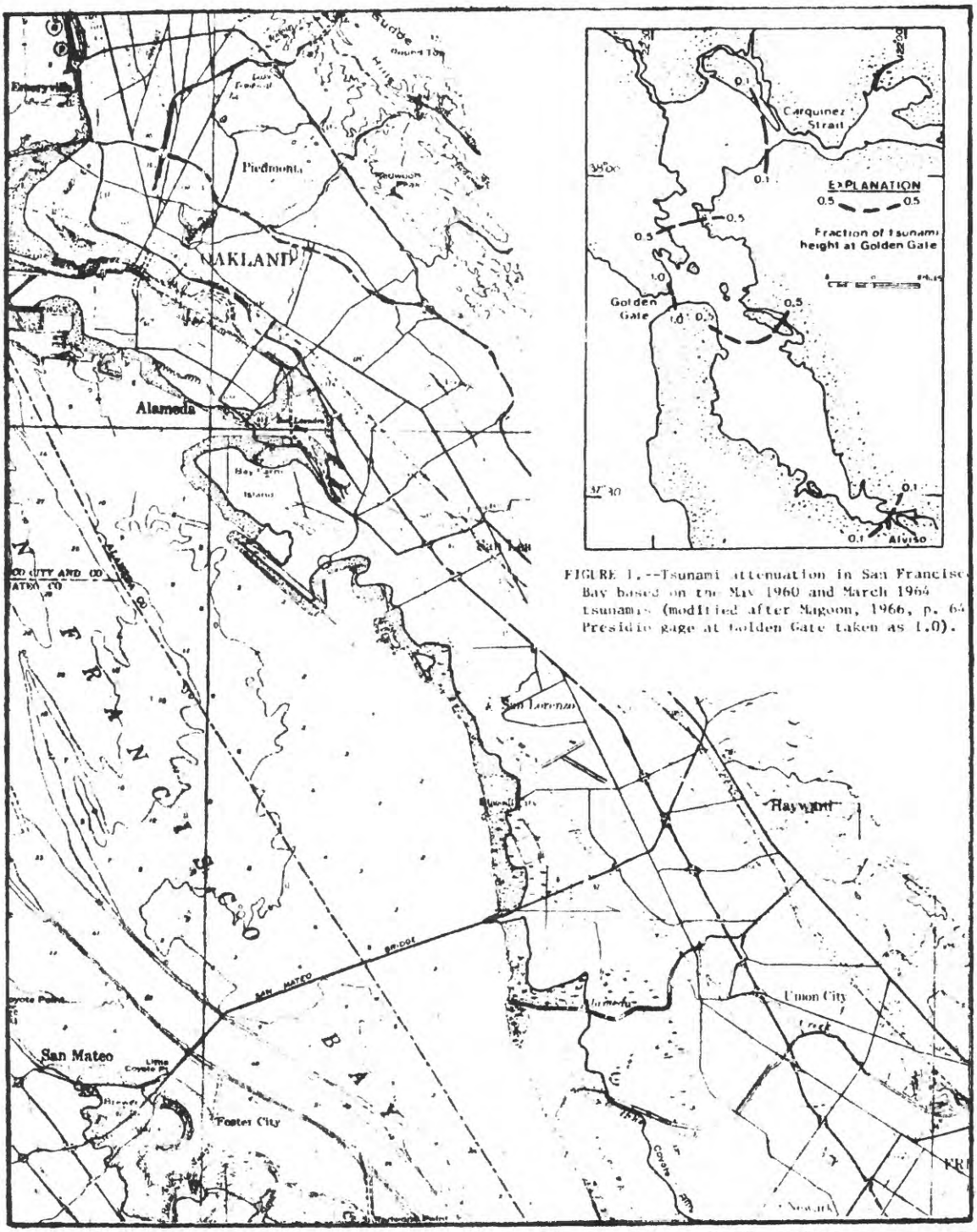


FIGURE 1.--Tsunami attenuation in San Francisco Bay based on the May 1960 and March 1964 tsunamis (modified after Magoon, 1966, p. 64; Presidio gage at Golden Gate taken as 1.0).

Part of the Alameda Co. Emergency Operations Plan (Off. of E. Serv., 1973)

Ordinance Administration, San Mateo County

At the request of San Mateo County, a geotechnical engineering firm prepared geotechnical guidelines and review procedure for the use of the County Planning Department and the Engineering and Road Department in administering the county's subdivision, grading, and timber harvesting ordinances.

USGS Data

The guidelines and procedure are based upon and cite several published and unpublished SFBRS products. The topics of the cited products include active faults, landslide susceptibility, flatland materials, flood-prone areas, coastal erosion, and tsunami inundation.

Method of Application

The guidelines (fig. 37) and procedure (fig. 38) are used by various members of the county staff to determine "when and where" geologic, soil, and engineering analyses are needed.

Comment

Although few units of government have adopted ordinances citing SFBRS data, all counties in the region make use of earth-science data in administering their building, grading, subdivision, zoning, or other land-use and development ordinances. This application is a good illustration of the method generally used.

FIGURE 37

Guidelines for Review of Private Construction Projects

Subsurface soils and bedrock conditions provide a variety of constraints to potential development over much of the area of the County. The purpose of this report is to provide the County planning and engineering staffs with a preliminary set of criteria to determine when and where engineering geologic and soils engineering analyses will provide valuable input in terms of dollar savings and safe developments, public and private.

Sources of Information

Geotechnical data and information are being developed jointly by the County of San Mateo and USGS-HUD-CDMG agencies. Bibliographic lists of geotechnical contributions are being prepared separately by this office. These will include maps, tables, aerial photos, significant case histories and other resource materials.

Geotechnical Hazards

Geotechnical hazards in San Mateo County run the gamut of hazards in California. They include the following:

1. Active Faulting and Seismic Shaking

   A discussion of the active and potentially active fault systems such as the San Andreas, Seal Cove, San Gregorio and Serra is beyond the scope of this report. These faults are treated by USGS Basic Data Contribution 44, "Active Faults, Probable Active Faults, and Associated Fracture Zones, San Mateo County, California" by Robert D. Brown, Jr., 1972.

2. Landslides and Potential Slope Failures

   Fully 30% of the hillside areas of San Mateo County have been mapped as existing landslides. In addition, about 50+ percent of the hillsides can be classified as susceptible to slope failure in their existing condition, and even stable areas can be rendered unstable by improper excavation, grading and filling

   Slope stability site determinations should be made jointly by the engineering geologist and soils engineer. The three-dimensional geometry of subsurface bedding, joints, faults, clay seams and other pertinent elements portrayed in cross-sections by the engineering geologist provide the basis for stability analyses by the soils engineer.

Part of S. M. Co. "Geotechnical Guidelines" (Leighton & Assoc., 1972)

FIGURE 37--continued

Guidelines for Review of Private Construction Projects

The recent USGS Basic Data Contribution 43, "Landslide Susceptibility in San Mateo County, California", by Brabb, Pampeyan and Bonilla, 1972, presents a generalized numerical stability rating for all areas of the county. Landslides are mapped and slopes are rated I through VI with the highest numbers most susceptible to failure. It is suggested that an engineering geologic report be required for all areas rated "L" and II - VI and that these reports be referred to the County Geotechnical Consultant for his review.

3. Flooding

Flood hazards are a threefold problem, including water damage, deposition-silting and erosion damage. Actual water damage is generally considered a civil engineering matter. Information on potential flood damage with the southern county has been developed in USGS Basic Contribution 20, "Flood-prone Areas of Coastal San Mateo County, California," 1972. Erosion and silting (mud damage and sediment transportation) are factors which should be considered and treated in consultants' reports for all developments in hillside areas and along drainage courses.

4. Wave and Current Erosion, Seacliff Retreat and Seashore Inundation

Seacliff erosion and seashore inundation along the San Mateo coastline are problems important to developments on and near the beach. Seacliff retreat shoreward is based on a recurrent cycle of wave induced erosion, slope failure and renewed erosion. Measured rates of 80 feet in 40 years have been recorded locally for retreat of the county coastline (Seal Cove-Moss Beach Study--1971). Seashore inundation from storm waves and tsunamis (earthquake induced "tidal waves") can result locally in substantial direct water damage, as well as accelerated erosion and seacliff retreat. Consultants should address the hazards of wave and current erosion, seacliff retreat and seashore inundation for developments within 500 feet of the shoreline. A USGS document currently in preparation will delineate the danger zone along the coastline in the event of a 20 foot tsunami, as well as the general stability of the sea cliffs [sic] .

Part of S. M. Co. "Geotechnical Guidelines" (Leighton & Assoc., 1972)

FIGURE 38

Geotechnical Review Procedure

I. Plot every project location on master set 7-1/2' = 2000 scale topographic quadrangles.

II. Utilize quad sheet location to read and transfer project location to smaller scale geologic hazard maps below. Check each project through the entire set of U.S.G.S. hazard maps listed below to determine possible incidence of geologic hazards before filling out this geohazard project check list.

	Yes	No	Hazard	U.S.G.S. Map
1.	___	___	Active Faulting	BDC 44 (If project is within 1000' of active fault, use geotechnical consultant.)
2.	___	___	Seismic Shaking	County general plan--seismic element
3.	___	___	Landslide & Slope Stability	BDC 43
4.	___	___	Flooding	BDC 20
5.	___	___	Wave and Current Erosion, Seacliff Retreat.	If project closer than 500' to shoreline, use geotechnical consultant.
6.	___	___	Seashore Foundation from 20' Tsunami	(U.S.G.S. Map in progress)
7.	___	___	Expansive Soils	(U.S.G.S. Map in progress)
8.	___	___	Subsidence & Settlement	(U.S.G.S. Map in progress.) If project is east of Bayshore Freeway, assume bay mud is present.

IV. The following projects should all include a geotechnical assessment, regardless of location.

Yes	No		
___	___	a.	Where a history of structural damage exists, possibly related to subsurface conditions (as in Seal Cove-Moss Beach Study area).
___	___	b.	Where mineral commodity exploitation has occurred or is proposed.
___	___	c.	Where the groundwater comes to the surface as in seeps, springs, etc., as determined by airphoto or on site inspection.
___	___	d.	Where land subsidence or settlement has occurred.

Part of S. M. Co. "Geotechnical Review Procedure" (Leighton-Yen & Assoc., 1972)

Subdivision, Building, and Grading Ordinances Amendment Santa Clara County

The Santa Clara County Board of Supervisors unanimously amended the County Ordinance Code (1974) so as to require site investigations and geologic reports based on official hazard maps. Four sections of the code were affected; namely, major subdivisions, minor land divisions, building sites, and grading.

The amendment provides for site investigations and geologic reports so as to discourage development on, or adjacent to, known potentially hazardous areas. The amendment also provided for the adoption of the "Seismic Safety Zones" map (fig. 29 at p. 91) as the official "County Geologic Hazards" map. This map was discussed in a preceding section of this report.

USGS Data

Eleven published SFBRS products are adopted and specifically cited (fig. 39) as part of the official county geologic hazards maps. The topics of these products were basic geology, active faults, historic marshlands, and landslides.

Method of Application

All the potential earthquake hazards, namely, ground shaking, ground failure, surface displacement, mass movement, tectonic creep, tsunami, dike failure, and seiche were composited on a map (fig. 29 at p. 91) where the relative hazards were divided into three zones. The three zones are indicated in red, yellow, and green -- the requirements for geologic investigation varying with the level of hazard.

FIGURE 39

Subdivision, Building, and Grading Ordinances Amendment

The Board of Supervisors of the County of Santa Clara, State of California, do ordain as follows:

SECTION 6: Building Permits.

Section C3-36 of the Santa Clara County Ordinance Code is added to read:

C3-36: Geologic Report.

Section 301(b)7 is amended to read:

Section 301(b) 7. Give such other information as reasonably may be required by the Building Official, such as a geologic report, which shall be necessary where the County determines that such report is needed on the basis of the County hazard maps.

SECTION 7: County Hazard Maps.

Article 3 is added to Chapter IV of the Santa Clara County Ordinance Code to read:

Article 3. County Geologic Hazard Maps.

Section C12-277. Definition. Whenever the land development regulations refer to County hazards maps, the reference is to the official Santa Clara County geologic hazards maps as herein adopted and which may be amended from time to time by resolution of the Board of Supervisors, which maps are the basis for determining whether a geologic report shall be required. The adopted maps are identified as follows:

Map Number and Name	Relative Geologic Stability Code (See Notes Below)		
	Red	Yellow	Green
1. Alquist-Priolo Geologic Hazards Zones (State of California - Special Studies Zones Official Map)	Entire Zone		
2. Relative Geologic Stability of Santa Cruz Mountains	Category W,S earthquake shear zones	P,L,H	D
7. U.S. Geological Survey Maps for San Francisco Bay Region Environment and Resource Planning Study (HUD)	Evaluate each map as applicable		

a. **Basic Data Contribution 2** - Geologic Map of Palo Alto 7.5 Minute Quadrangle San Mateo and Santa Clara Counties, California, by E.H. Pampeyan 1970

b. **Basic Data Contribution 6** - Preliminary Geologic Map of the Central Santa Cruz Mountains, California, compiled by Earl E. Brabb 1970

c. **Basic Data Contribution 7** - Faults That Are Historically Active or That Show Evidence of Geologically Young Surface Displacement, San Francisco Bay Region, A Progress Report: October 1970, by Robert D. Brown, Jr.

d. **Basic Data Contribution 9** - Preliminary Map of Historic Margins of Marshland, San Francisco Bay, California, compiled by Donald R. Nichols and Nancy A. Wright 1971

e. **Basic Data Contribution 30** - Active Faults and Preliminary Earthquake Epicenters (1969-1970) in the Southern Part of the San Francisco Bay Region (Miscellaneous Field Studies Map MF-307) by R. D. Brown, Jr. and W.H.K. Lee 1971

f. **Basic Data Contribution 13** - Geologic Map of the Sargent Fault Zone in the Vicinity of Mount Madonna, Santa Clara County, California, by Robert J. McLaughlin 1971

g. **Basic Data Contribution 39** - Preliminary Geologic Map of the Franciscan Rocks in the Central Part of the Diablo Range, Santa Clara and Alameda Counties, California, by William R. Cotton 1972

h. **Basic Data Contribution 40** - Preliminary Photointerpretation Map of Landslide and Other Surficial Deposits of the Mt. Hamilton Quadrangle and Parts of the Mt. Boardman and San Jose Quadrangles, Alameda and Santa Clara Counties, California (Miscellaneous Field Studies Map MF-339) by Tor H. Nilsen 1972

i. **Basic Data Contribution 45** - Preliminary Photointerpretation and Damage Maps of Landslide and Other Surficial Deposits in Northeastern San Jose, Santa Clara County, California (Miscellaneous Field Studies Map MF-361) by Tor H. Nilsen and Earl E. Brabb 1972

k. **Basic Data Contribution 63** - Isopleth Map of Landslide Deposits, Southern San Francisco Bay Region, California (Miscellaneous Field Studies Map MF-550) by Robert H. Wright and Tor H. Nilsen 1974

NOTES:

1. Official hazard maps are on file with Santa Clara County.
2. Color Legend for Relative Geologic Stability:
   - Red: A Geologic Report is normally required.
   - Yellow: A Geologic Report may be required.
   - Green: A Geologic Report is not normally required.
3. For statutory construction of the maps, a general provision is controlled by a specific provision, more detailed maps over general, and later maps over earlier maps.

PASSED AND ADOPTED by the Board of Supervisors of the County of Santa Clara, State of California, on November 6, 1974, by the following vote:

AYES:	Supervisors	5
NOES:	Supervisors	0
ABSENT:	Supervisors	0

Part of S. C. Co. Ordinance No. NS 1203.31 (Bd. of Supv., 1974)

The amendment requires site investigations and geologic reports based on the proposed land use and the adopted official geologic hazards map. The need for such reports is determined by a designated building official on the basis of the hazard maps.

The amendment requires that the report shall (1) be prepared by an engineering geologist registered in the State, (2) be submitted to the county for approval, and (3) specify the remedial measures that will make a safe development.

Comment

The amendment is significant for the following reasons:

1. Santa Clara County is one of the largest counties in the Bay region with the fastest growing population, is relatively undeveloped, and its most hazardous areas are relatively undeveloped.

2. Most of the geologic hazards have been identified, mapped, composited, and placed in hazard zones which require varying levels of geologic investigations.

3. A map of seismic safety zones based on USGS data has been unanimously adopted as the official county geologic hazards map in its subdivision, building, and grading ordinances.

4. The county has a State-certified engineering geologist in its Land Development Engineering Department who participated in the development of the ordinance, and who has major responsibility for its day-to-day administration.

Resource Management Zoning District, San Mateo County

The San Mateo County Board of Supervisors unanimously adopted an ordinance creating a new resource management zoning district specifically designed to carry out the objectives and policies of their open-space and conservation plans. In addition to listing the principal uses permitted in the new district, the ordinance limits the number of dwelling units by special density regulations.

USGS Data

The density regulations are partly based upon, and cite, several SFBRS published and unpublished products (fig. 40). The topics of these products include active faults, landslides, flood-prone areas, and slope zones.

The slope zone map (1:62,500) was prepared for the County Planning Department by the USGS Topographic Division. Quadrangles in the USGS 7½-minute (topographic) series are also used to compute slope percentage in the day-to-day administration of the ordinance. Some of the SFBRS products were modified and used to illustrate the application of the density regulations during presentations to the Board of Supervisors (figs. 41 and 42).

Method of Application

The density regulations are applied to each application for a zoning permit through the use of a density matrix worksheet (fig. 43). The worksheet merely provides a form for computing and accumulating the highest density permitted in the zoning district.

FIGURE 40

Resource Management Zoning District

Section 6310. PURPOSES OF RESOURCE MANAGEMENT DISTRICT. The purposes of this chapter are to carry out the objectives and policies of the Open Space and Conservation Elements as well as other elements adopted as part of the General Plan of San Mateo County, to meet the requirements of Section 65910 of the Government Code of the State of California requiring formulation of an open space zoning ordinance, and to ensure consistency between the General Plan and the zoning ordinance.

Section 6317. MAXIMUM DENSITY OF DEVELOPMENT. In the RM District, for purposes of determining the maximum total number of dwelling units permissable on any parcel, the following system shall be used:

The total parcel shall be compared against the criteria of this Section in the order listed. Any segment of a parcel to which a criterion first applies shall be allowed a maximum accumulation of that density. Once considered under a criterion, a segment of the parcel shall not be considered under subsequent criteria. When the applicable criteria have been determined for each of the areas, any portion of the parcel which has not yet been assigned a maximum density accumulation shall be assigned a density of 1 dwelling unit per 5 acres.

The sum of densities accrued under all applicable categories shall constitute the maximum density of development permissable under this section. If the fractional portion of the number of dwelling units allowed is equal to or greater than .5, the total number of dwelling units allowed shall be rounded up to the next whole dwelling unit. If the fraction is less than .5, the fractional unit shall be deleted.

(a) On lands falling within a 100 year **Flood Plain** as defined by **U.S.G.S.**, dwelling units may be accumulated at a maximum of one unit per 40 acres. Where previous actions have eliminated such flood areas, the provisions of this subsection shall not apply.

(d) For areas within any of the three **lease stable categories** (categories V, VI and L) as shown on the U.S. Geological Survey map MF 360, "Landslide susceptibility in San Mateo County," density accumulation shall be limited to one dwelling unit per 40 acres.

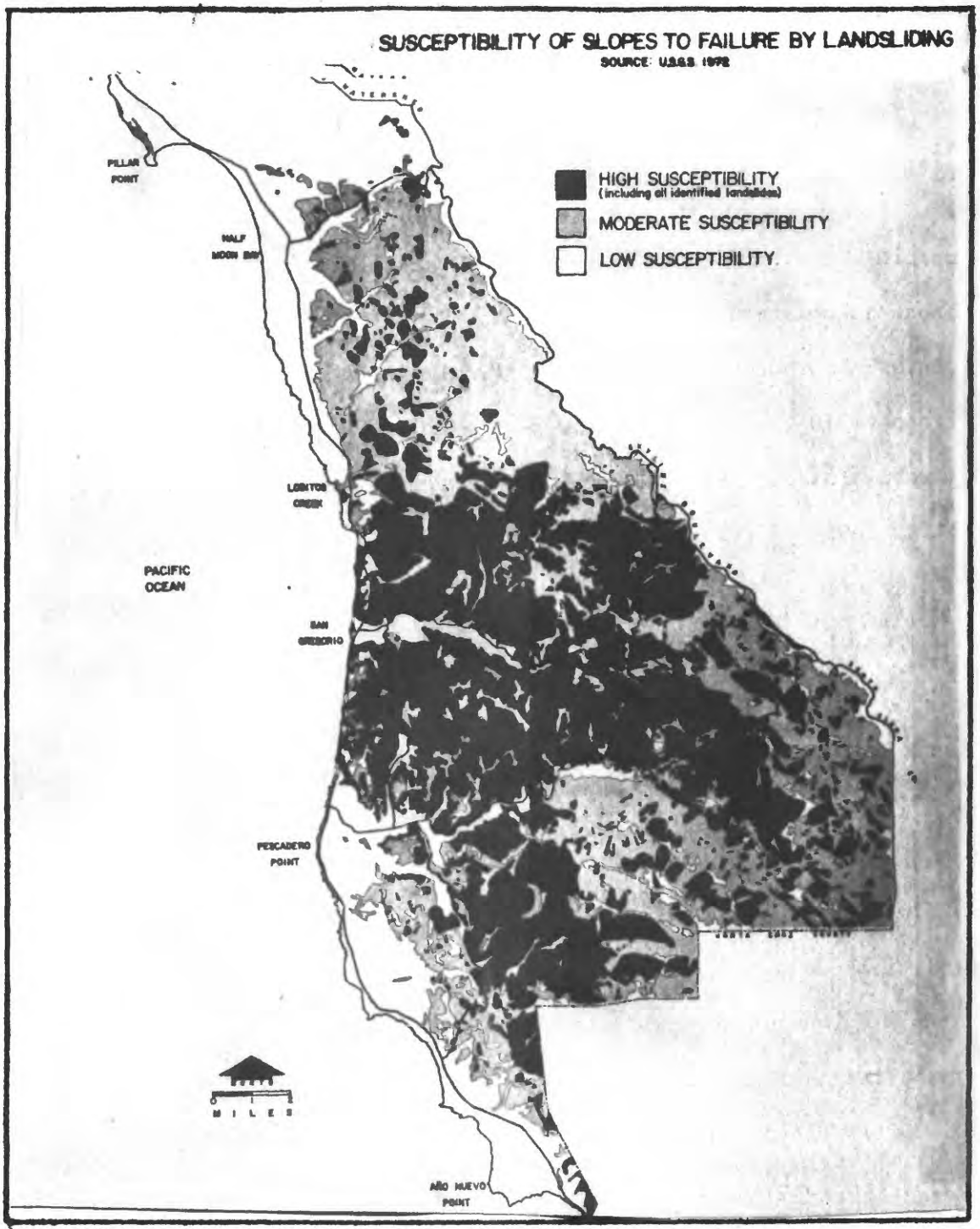
(e) All areas located within the **rift zone** or zone of fractured rock of an active fault as defined by the **U.S. Geological Survey** and mapped on **USGS map MF 355**, "Active faults, probably active faults, and associated fracture zones in San Mateo County," shall be limited to a maximum density accumulation of one dwelling unit per 40 acres.

(f) That portion of a parcel which has a **slope** in excess of 50% shall have density accumulation limited to one dwelling unit per 40 acres; that portion of a parcel having a slope in excess of 30% but not exceeding 50% shall have density accumulation limited to one dwelling unit per 20 acres; that portion of a parcel having a slope in excess of 15% but not exceeding 30% shall have density accumulation limited to one dwelling unit per 10 acres. Slope is determined by dividing the change in elevation between contours (lines of equal elevation) by the horizontal distance between the respective contours.

Part of S. M. Co. Ordinance No. 2229 (Bd. of Supv., 1973)

FIGURE 41

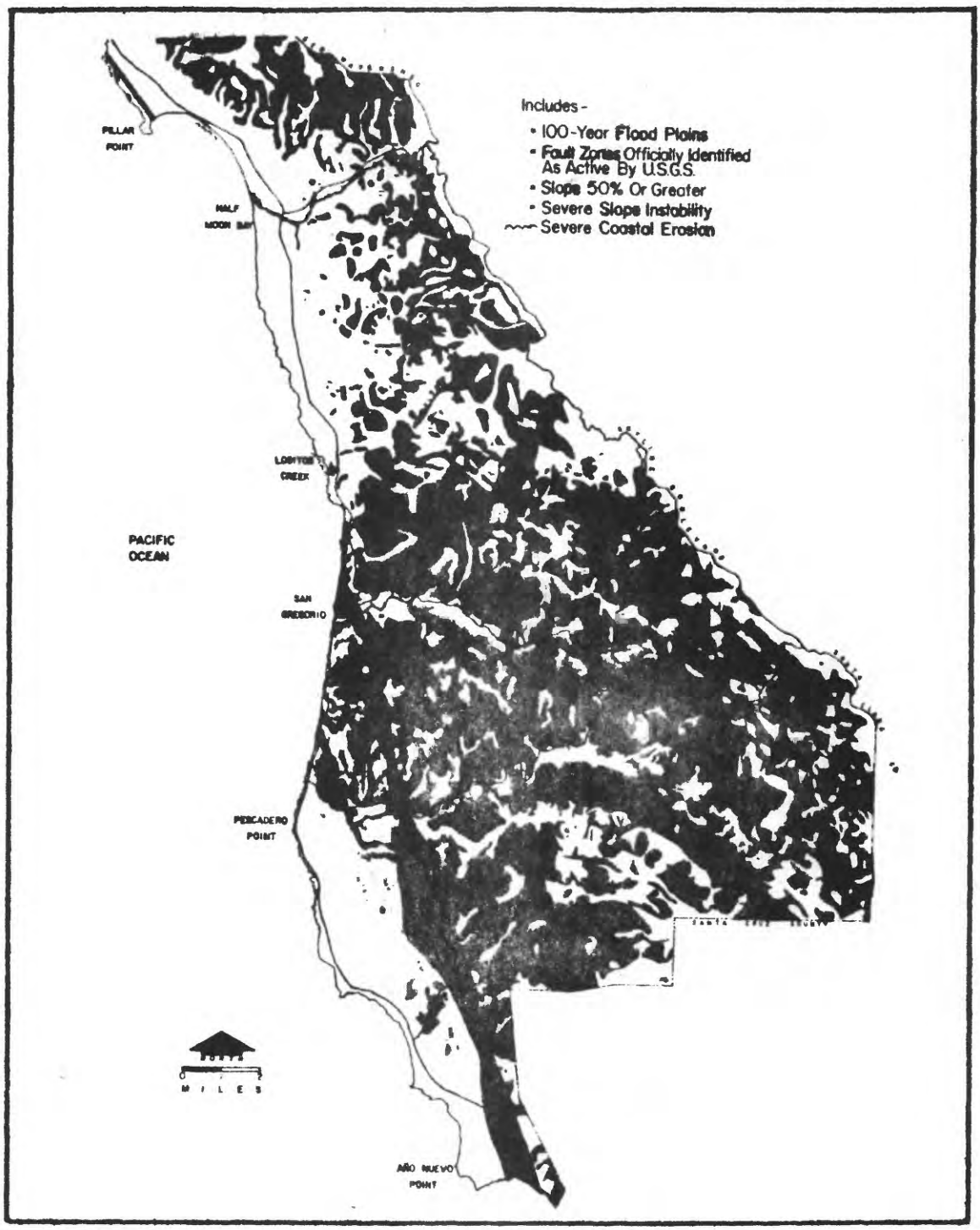
Susceptibility of Slopes to Failure



Part of S. M. Co. Correspondence (Woolfe, 1973)

FIGURE 42

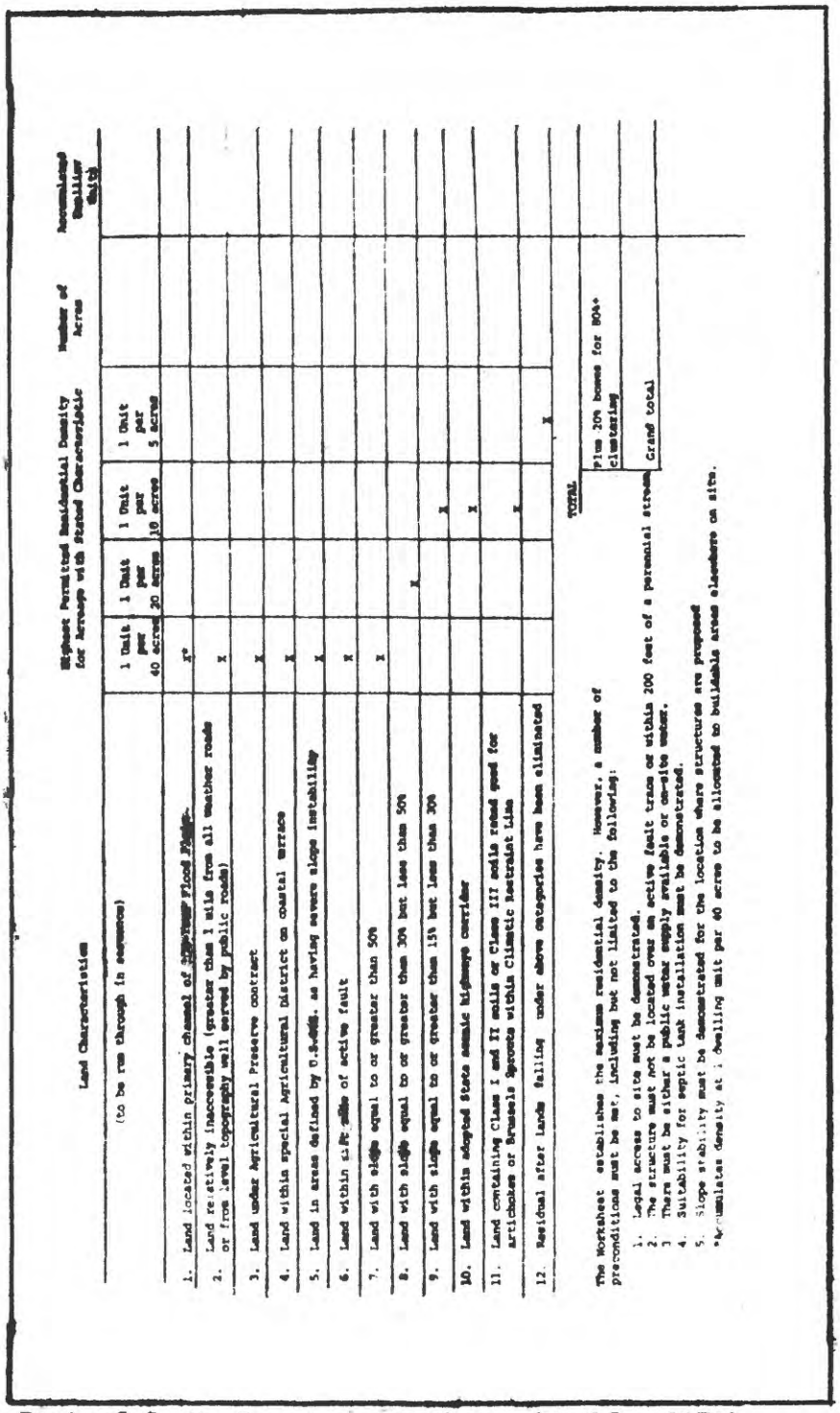
Composite Hazards



Part of S. M. Co. Correspondence (Woolfe, 1973)

FIGURE 43

Density Matrix Worksheet



Land Characteristics (to be rated through in sequence)	Highest Permitted Residential Density for Acreage with Stated Characteristic					Number of Acres	Accumulated Qualifier Units
	1 Unit per 40 acres	1 Unit per 20 acres	1 Unit per 10 acres	1 Unit per 5 acres			
1. Land located within primary channel of [illegible] Flood Plain	X*						
2. Land relatively inaccessible (greater than 1 mile from all weather roads or from level topography well served by public roads)	X						
3. Land under Agricultural Preserve contract	X						
4. Land within special Agricultural District on coastal terrace	X						
5. Land in areas defined by U.S.G.S. as having severe slope instability	X						
6. Land within 1/8 mile of active fault	X						
7. Land with slope equal to or greater than 50%	X						
8. Land with slope equal to or greater than 30% but less than 50%		X					
9. Land with slope equal to or greater than 15% but less than 30%			X				
10. Land within adopted State scenic highway corridor			X				
11. Land containing Class I and II soils or Class III soils rated good for artichokes or Brussels Sprouts within Climatic Restraint Line				X			
12. Residual after Lands failing under above categories have been eliminated					X		
					TOTAL		

The Worksheet establishes the maximum residential density. However, a number of preconditions must be met, including but not limited to the following:

1. Legal access to site must be demonstrated.
2. The structure must not be located over an active fault trace or within 200 feet of a perennial stream.
3. There must be either a public water supply available or on-site water.
4. Suitability for septic tank installation must be demonstrated.
5. Slope stability must be demonstrated for the location where structures are proposed.

*Accumulated density at 1 dwelling unit per 40 acres to be allocated to buildable areas elsewhere on site.

Plus 20% bonus for 80%+ clustering

Grand total

Part of S. M. Co. Correspondence (Woolfe, 1973)

Comment

An example of the application of the density regulations to a large parcel of land was shown on two visual displays prepared by the Survey. One was shown at the National Association of Engineering Geologists Conference held in November 1975 at Lake Tahoe, Nevada, and the other one was shown at the Joint AIP/ASPO National Planning Conference held in March 1976 at Washington, D.C.

This zoning district is particularly significant for the following reasons:

1. It affects over one-half of an urban county in a major metropolitan area of the United States.
2. It implements open-space and conservation plans.
3. Its key regulations are based upon USGS data including slope zones prepared for the county by the Topographic Division.
4. It has yet to be successfully attacked in court as a "taking without compensation."

General Reference, Alameda County

The Public Works Department of Alameda County had an engineering geology firm collect and composite geologic hazards on maps for the general reference use of various county agencies including the County Planning Department.

USGS Data

The maps are based upon, and cite, ten SFBRS published products. The topics of these products include landslides, flatland materials, and active faults. The references used to compile each of the 24 maps (1:24,000) that cover all or part of the county are cited on each map. A reduced portion of one of these maps is shown on figure 44.

Method of Application

The geologic hazards data are overlaid on USGS 7½-minute quadrangle (topographic) series, and copies are made available to other county departments. Each map also serves as an index map to record the existence of soil and geologic investigations conducted by county and city personnel, soil engineering firms, and engineering geology firms.

Comment

These general reference maps are significant for the following reasons:

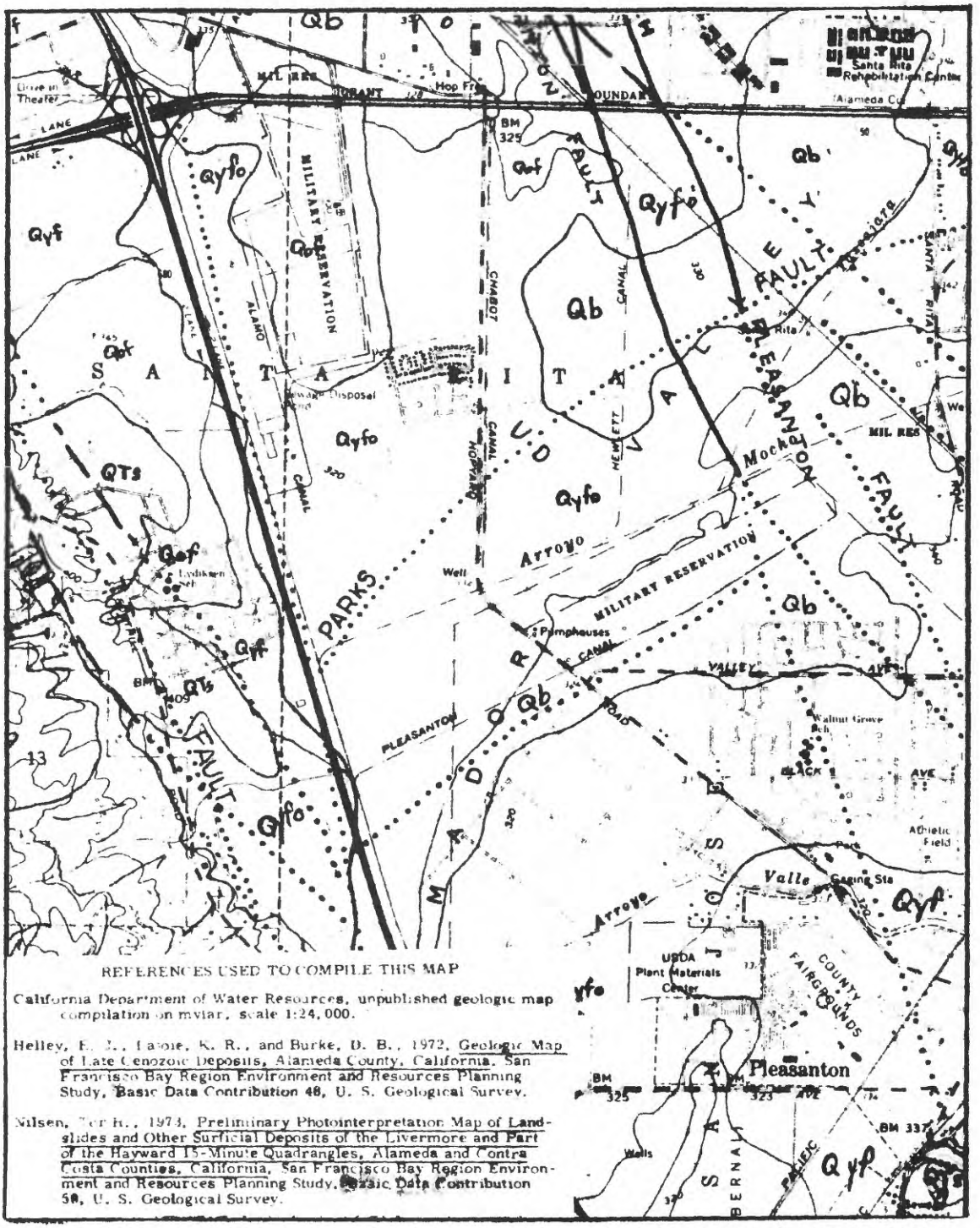
1. The geologic hazards are taken primarily from SFBRS products and placed on USGS 7½-minute base maps.

2. The county engineering geologist keeps the maps up-to-date, revises when necessary, and is available to other county and city personnel and citizens for technical assistance in the use and interpretation of the maps.

3. The maps will be used as an index to geologic hazard data and as a base for planning and development studies by the planning and public works departments.

FIGURE 44

Geologic Hazards Maps for General Reference



Part of Alameda Co. geologic hazards maps (Woodward-Lundgren & Assoc., 1975)

Environmental Impact Report, Solano and Contra Costa Counties

A draft environmental impact report (1975) for Dow Petrochemical facilities at Pittsburg and Montezuma was prepared for the counties of Solano and Contra Costa by the applicant's consultant to meet State law.

The proposed project includes the creation of new and expanded facilities to process Alaskan naptha. Figure 45 illustrates existing transportation costs to serve the western market without the new and expanded facilities. These facilities include a shallow-draft tanker dock, storage tanks, roads, railways, underwater pipelines, water supply, and waste disposal preceded by the necessary dredging, grading, and construction activities.

The environmental issues addressed in the report included water quality during construction and operation, and the possible effect of seismic activity.

USGS Data

The report is based upon, and refers to, seven SFBRS published products. The products include active faults, basic geology, hydrology, and bay circulation.

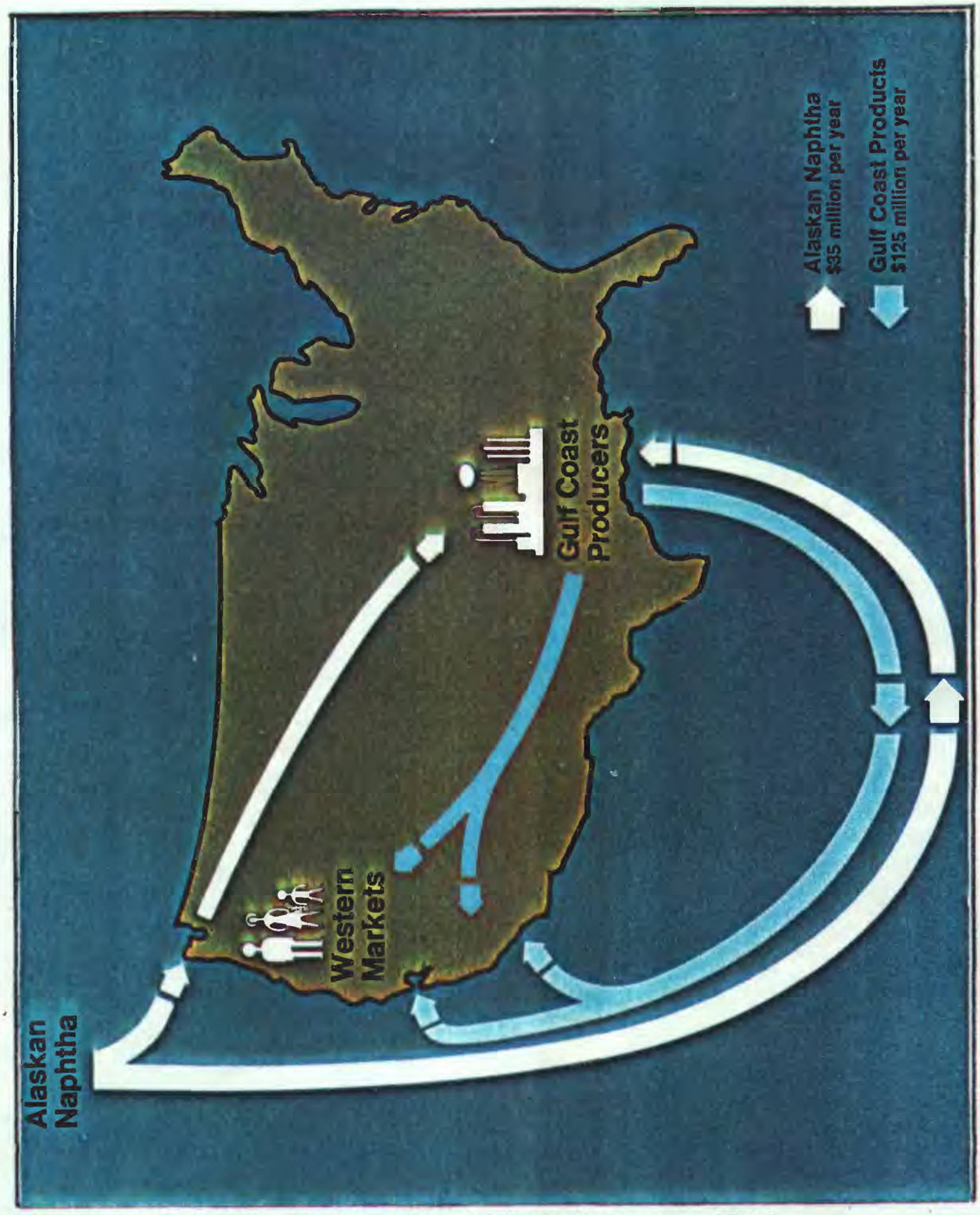
The topographic features of the project areas are presented by using part of a color reproduction of a USGS 7½-minute quadrangle (topographic) series reduced to a scale of 1:62,500.

Method of Application

The geologic history of the proposed project sites is discussed and depicted on maps together with the surficial soils and all known possible faults located nearby (figs. 46 & 47).

FIGURE 45

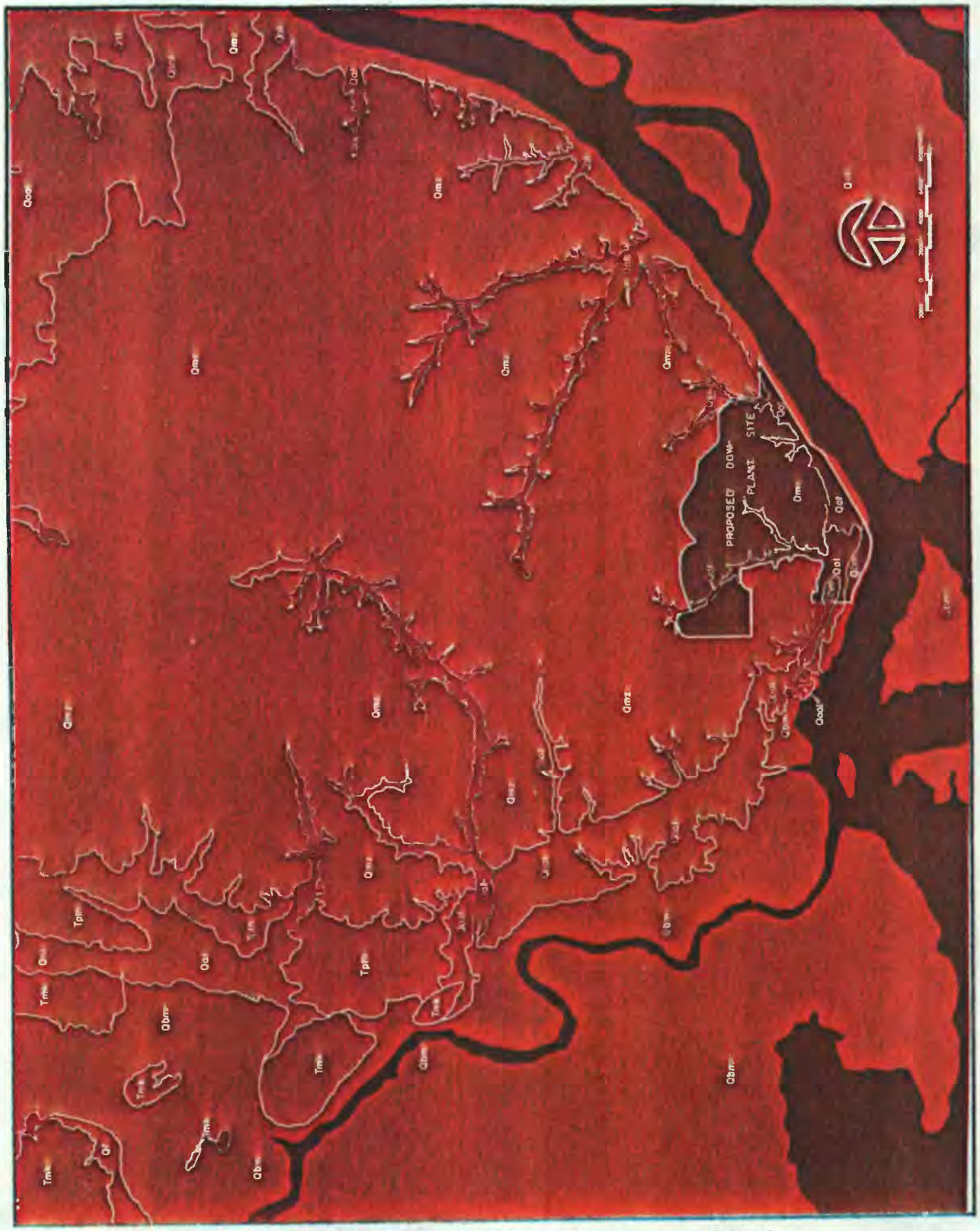
Western Market Transport Costs



Part of Solano & C. C. Co. EIR (Gilbert & Assoc., 1975)

FIGURE 46

Geology of Proposed Petrochemical Site



Part of Solano & C. C. Co. EIR (Gilbert & Assoc., 1975)

FIGURE 47

Faults near Proposed Petrochemical Sites

Part of Solano & C. C. Co. EIR (Gilbert & Assoc., 1975)

Seismicity, estuarine aquatic life, and precipitation are discussed in the report, and references are made to the SFBRS and other USGS products. Tables showing temperature variations and evaporative rates are taken from SFBRS products and reproduced in the report.

Comment

This report illustrates not only some of the types of data needed for onshore petrochemical production facilities, but that the Survey produces some of the data needed, and that both industrial and county planners and decisionmakers have received and are using such data.

Public Information, Santa Clara County

Maps showing various geologic and hydrologic hazards were prepared for public information by the Santa Clara County Planning Department.

USGS Data

These maps are based upon SFBRS products covering active faults, historic marshlands, slope zones, and flood-prone areas. The slope data shown on figure 48 are derived from a slope zone map prepared for the county at a scale of 1:125,000 by the USGS Topographic Division.

Method of Application

The geologic and hydrologic hazard data shown on figures 48 and 49 at a scale of 1:250,000 are merely collected and composited on a base map, attractively presented in color, and widely distributed as a pass-out to the general public.

Comment

The preparation and distribution of these hazard maps took place prior to the preparation and adoption of the county's seismic safety plan and ordinances' amendment discussed in preceding sections of this report.

The wide distribution to, and early familiarization of, the general public with geologic hazards is partly the reason for the unanimous adoption of the seismic safety plan and ordinances' amendment used to implement the plan.

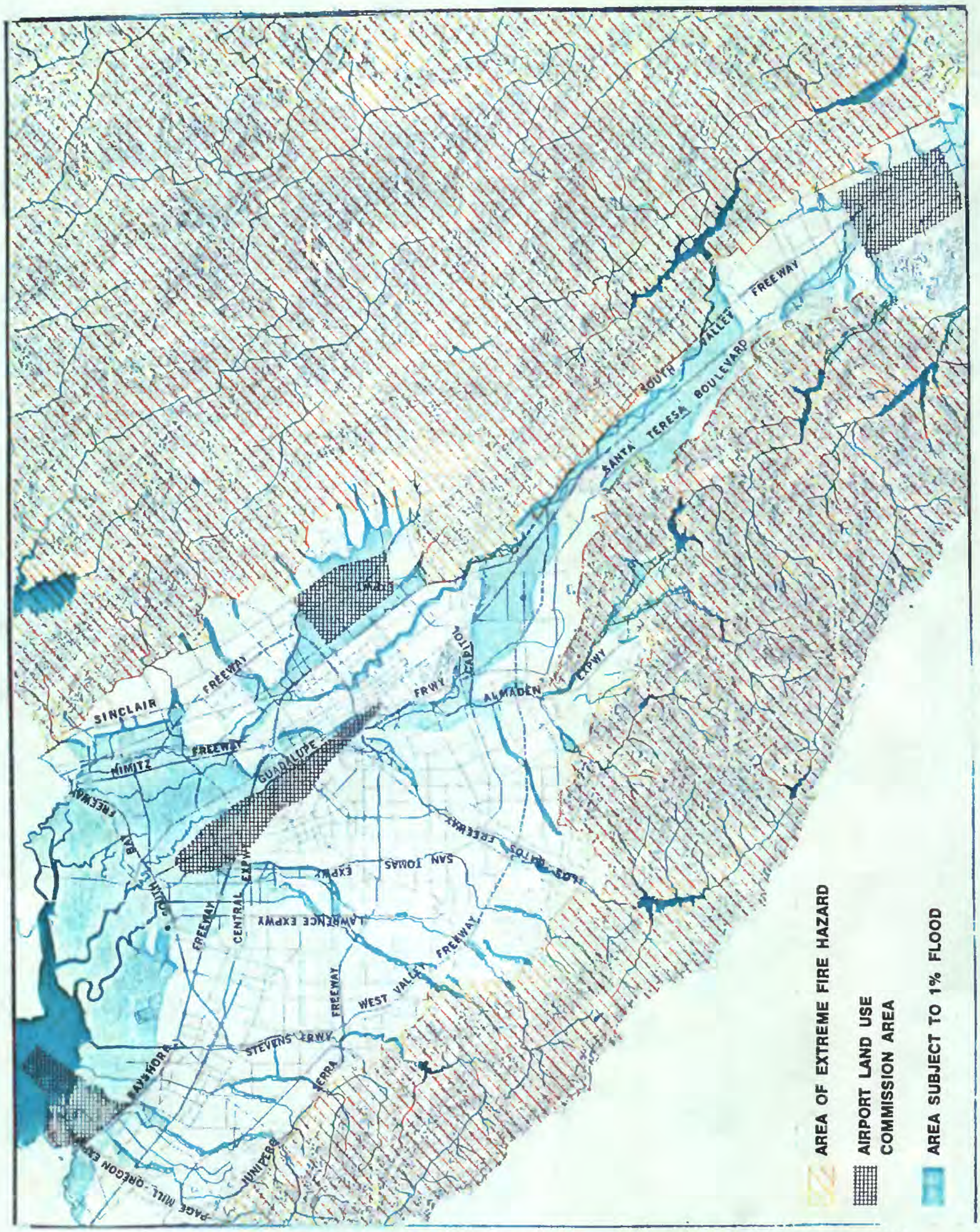
FIGURE 48

Geologic Hazard Map for Public Information

Part of S. C. Co. "Public Safety Map No. 1" (Plan. Dept., 1973)

FIGURE 49

Hydrologic Hazard Map for Public Information



Part of S. C. Co. "Public Safety Map No. 2" (Plan. Dept., 1973)

SUMMARY AND ANALYSIS

All eight counties in the San Francisco Bay region have planning staffs who are very familiar with SFBRS products and make frequent use of such products in their planning programs (see table 1). The formal adoption of plans and ordinances citing SFBRS products by county boards of supervisors is a good indication of familiarity and use by county decisionmakers. This high incidence of familiarity and use is to be expected when the population, size, recent growth, staff size, and developable areas of the eight counties are considered.

In addition, the counties are the largest general purpose unit of government in the Bay region with planning and plan implementation powers and duties, and some correlation was observed between greater use of SFBRS products by a county and its population size, staff size, growth rate, and access to a staff geologist.

Types of Planning Applications

All eight counties have prepared planning studies, plans, ordinances, or other documents which actually cite SFBRS products. All eight counties had used SFBRS products in the preparation, administration, or conduct of their planning studies, plans, ordinances, and other planning activities.

The types of planning studies, plans, or other planning activities most often indicated by counties as being based upon, making use of, or citing SFBRS products were by use and number of times indicated:

EIR/EIS preparation	8
EIR/EIS review	8
General reference	8
Geologic hazards studies	8

Ordinance administration	8
Seismic safety elements	8
Environmental analysis	7
Public safety elements	6
Solid waste management plans	6
Community assistance	5
Conservation elements	5
Potential problem areas	5

The citing of an SFBRS product in a study, plan, or other planning document does not necessarily indicate that the product played a major role in the final proposal or decision by the county. A great many other social, political, and economic factors necessarily enter into any decisionmaking process that affects the physical development of a county. However, the adoption by reference of SFBRS products in an ordinance does indicate that the product is a major development determinant.

Studies and Plans

The frequent use of SFBRS products in the preparation of the geologic hazards studies and the public safety and seismic safety elements can be attributed to State laws and the great interest in geologic hazards in California. Many SFBRS products are applicable to these studies and elements and, in some cases, are the only data available. For example, the California Legislature required each county to prepare public safety and seismic safety elements by September 1974, and the State guidelines recommend identification, delineation, and evaluation of potential seismic hazards. In addition, other geologic hazard and safety legislation exists or is being proposed.

The frequent use of SFBRS products in the preparation of the conservation and solid waste management plans indicates applicability of the products to physical resource problems or issues.

The less frequent use of SFBRS products in the preparation of the circulation and land-use elements and their studies can be partly attributed to their having been completed as required by State law prior to the release of the SFBRS products.

Ordinances

Although only two counties have adopted ordinances citing SFBRS products, seven counties make extensive use of SFBRS products in the administration of their land-use and development ordinances.

One of the ordinances creates a resource management zoning district (see fig. 40) whose maximum number of dwelling units are limited by special density regulations. These regulations are based upon, and cite, several SFBRS products such as flood-prone areas (1:125,000), landslide susceptibility (1:62,500), active fault location (1:62,500), and slope zones (1:62,500).

The other ordinance amends subdivision, building, and grading ordinances and creates an official geologic hazards map (see fig. 39). The official map is based upon, and cites, eleven SFBRS products having scales ranging from 1:10,000 to 1:250,000.

These applications are significant because the published scales were apparently not a limiting factor, both ordinances affect large relatively undeveloped areas in urbanizing counties, both ordinances were unanimously adopted by the county boards of supervisors, the use of the data has been without successful legal assault, and the applications are easily transferable to the other counties. The fact that many of the products were compiled, or supplemented by data, at scales

of 1:24,000 and were made available to the counties contributed to their use in these ordinances.

The California "Alquist-Priolo Special Studies Zones Act" (Calif. Public Resources Code, Sections 2621 through 2625 (1975)) requires the State Geologist to delineate appropriately wide special studies zones to encompass all potentially and recently active traces of four specified fault systems. The act also provides that counties shall require, prior to approval of certain projects, a geologic report defining and delineating any hazard of surface fault rupture. All approvals must be in accordance with policies and criteria established by the State Mining and Geology Board.

Of the 56 Special Studies Zones quadrangle maps prepared by the State Geologist covering the San Francisco Bay region, 38 maps contain specific references to SFBRS products. Therefore, the counties are administering a State law based upon a large number of SFBRS products. It is anticipated that many of the counties will incorporate appropriate administrative procedures into their existing land-use and development ordinances and will adopt these special studies zones by reference.

Other Planning Activities

The frequent use of SFBRS products for general reference is to be expected. Their frequent use for the preparation and review of EIR's and EIS's indicates their applicability to the analysis of environmental impacts as required by State law. Most of the EIR's are prepared by consultants for the counties or project applicants, and the use of SFBRS products depends upon the counties' criteria and guidance of the consultants.

Five of the counties use SFBRS data in evaluating potential problem areas and in assisting, or in preparing plans for, communities within the county. Each of these three activities requires large-scale data which apparently does not prevent the use of SFBRS products, at least in the initial evaluation or stage.

Extent and Intensity of Application

The extent and intensity to which earth-science data are applied varies with the type of planning activity. For example, the intensity of application increases for planning activities that range from general reference, through plans and studies, to implementation devices. Perhaps the least intensive and most extensive applications are public information or general reference where the earth-science data is presented or used merely to inform others or to familiarize oneself. A more intensive application occurs in litigation where the judicial process relies upon the expert testimony of the scientist who prepared or interpreted the earth-science data or the planner or decisionmaker who applied or made other use of the data. Expert testimony is given in a formal setting, is usually an adversary proceeding, and is subject to the critical examination of parties having strong economic, governmental, or personal interest in the outcome of the litigation.

More intensive applications usually require larger scales and greater detail in the earth-science information. For example, a zoning district map or a detailed site plan require a much larger scale or far greater detail than a land-use study or general plan.

The intensity of application is not necessarily an indication of

the importance or beneficial effect of the use of earth-science information by planners and decisionmakers. For example, earth-science data and interpretations may be used as an "early warning" of potential hazards. If public officials then require detailed on-site investigations, the result may be a most significant and effective application of the data over a large area. Although it may be a much more intensive application, a court decision based upon large-scale earth-science information may affect only that project which is the subject of litigation.

Types of Products Used

Over 90 percent of the SFBRS products were specifically identified as having been used at least once for a county planning activity. SFBRS products were used in the preparation, administration, or conduct of planning studies, plans, ordinances, or other planning activities or documents by counties a total of 1,257 times (see tables 2 and 3).

The incidence of use of an individual product could be affected by many different factors: release date, topic, type, scale, areal coverage, content, and complexity. These factors were examined to see if there was any correlation.

Generally, no significant correlation was discernible between the use of the 87 products and their release dates, type, scales, coverage, content, or complexity with the following exceptions:

1. None of the last four products released were used frequently, and the last product released (BDC 71) was identified as having been used only once.
2. Almost all of the 26 products at a scale of 1:62,500 (1" = 1 mi.) were used ten or more times.

3. All of the nine products (BDC 7, 9, 11, 37, 52, 54, 64, 67, & IR 4) used 30 or more times were small-scale (1:62,500 or smaller), large-area-coverage, hazard-type products.

4. Eight of these highly used products were interpretive. All contained data making them especially relevant and interesting, and some were supported by information at larger compilation scales.

High correlation was discerned between the number of times a product was used and its topic. The flood-prone area, topographic, landslide, fault, geologic, waste disposal, and water supply products were the ones most often used. A summary and pertinent comments for each product group follow.

Fault Products

All seven fault products were identified as having been used a total of 131 times by counties resulting in the fourth highest average use of any product group.

The fault product (BDC 7) most often identified (47 times) was a report on active faults. This very frequent use may be attributed to its large-areal coverage and hazard topic. Another fault product (BDC 1)-a map at a scale of 1:48,000 showing active breaks along the San Andreas Fault between Pt. Delgado and Bolinas Bay-had a relatively high use (20 times) considering its limited areal coverage and its being out-of-print in the SFBRS series. The infrequent use of one fault product (BDC 58) by counties may be attributed to the fact that it covers a small part of only one county in the Bay region.

The fault products were most often used by counties for general reference, seismic safety elements, ordinance administration, preparation and review of EIR's and EIS's, hazards studies, and public safety elements.

Flood-prone Area Products

All eight flood-prone area products were identified as having been used a total of 185 times by counties resulting in the highest average use of any product group.

The regional interpretive report (IR 4) and the tsunami inundation map (BDC 52) were the products most often identified (51 & 52 times, respectively). This use may be attributed to their regional coverage, hazard type, and particular interest to counties in preparing their seismic safety and public safety elements. The less frequent use of the 1:24,000 flood-prone area products (BDC 15-20) may be attributed to their limited areal coverage.

The flood-prone area products were most often used by counties for general reference, ordinance administration, seismic safety and public safety elements, and the preparation and review of EIR's and EIS's. The frequent use of flood-prone area products for seismic safety elements can be attributed to the inclusion of the Potential Inundation by Tsunamis product (BDC 52) in the flood-prone area group.

Geologic Products

Sixteen of the 17 geologic products were identified as having been used a total of 246 times by counties. Two preliminary geologic maps of one or more counties and parts of several others (BDC 46 and 64) were the geologic products most often identified (39 and 32 times, respectively). This high use may be attributed to their scale (1:62,500) and coverage. All the geologic products at a scale of 1:62,500

(BDC 6, 12, 27, 28, 39, 41, 48, 56, and 68) were frequently used, ranging between 9 and 25 times. The infrequent use or non-use of those products at a scale of 1:24,000 or larger (BDC 2, 3, and 29) may be attributed to their limited areal coverage. The infrequent use of the small scale (1:500,000) generalized geologic map (BDC 8) for the Bay region may be attributed to the availability of larger scale SFBRS products.

The geologic products were most often used by counties for general reference, seismic safety and public safety elements, preparation and review of EIR's and EIS's, and ordinance administration.

Hydrologic Products

All eight hydrologic products were identified as having been used at least once for a total of 59 times by counties. Only two products, Precipitation Depth-Duration-Frequency Relations (BDC 25) and Mean Annual Precipitation and Precipitation Depth-Duration-Frequency Data (BDC 32), were frequently used (16 and 20 times, respectively). The infrequent use of two hydrologic products (BDC 69 and IR 7) can be attributed initially to their recent release dates. The hydrologic products were most often used by counties for the preparation and review of EIR's and EIS's, general reference, and ordinance administration.

Landslide Products

All 16 landslide products were identified as having been used a total of 306 times by counties resulting in the third highest average use of any product group.

Three landslide products (BDC 11, 37, and 67) were most often identified by counties (31, 33, and 34 times, respectively). The very

frequent use of two of these products (BDC 11 and 37) may be attributed to their regional coverage and unique content. The estimated relative abundance of landslides, and the distribution and cost of structurally damaging landslides are of particular interest to counties in preparing seismic safety and public safety elements. Consequently, they more easily attract the attention of planners and decisionmakers. The very frequent use of the third product (BDC 67) may be attributed to its coverage of parts of five counties.

Seven other landslide products (BDC 31, 38, 40, 43, 46, 57, and 63) were often identified (17 to 21 times). This frequent use may be attributed to their county scale (1:62,500) and to the fact that four of them cover parts of more than one county. The identification of one product (BDC 45) at least 12 times is a very high incidence of use considering the areal coverage of the product (less than 13 square miles). This relatively high use may be attributed to its scale (1:24,000 and larger), its content (existing and proposed land uses), and the critical community problem addressed (e.g. homes abandoned).

The landslide products were most often used by counties for general reference, preparation and review of EIR's and EIS's, ordinance administration, and seismic safety elements.

Land-Use Products

All four land-use products were identified as having been used a total of 31 times by counties. The use of the product (BDC 61) most often identified by counties (15 times) may be attributed to its coverage of five counties and its being an interpretive type product. The

infrequent use (4 times) of the land-use map made by remote sensing methods (BDC 62) may be attributed to its release date, prior completion of land-use studies and elements by the counties, difficulty in orienting the product to existing landmarks, and the counties' need for land-use inventories at a larger scale with more urban and rural land-use classifications than are available in the SFBRS product. The land-use products were used most often by counties for general reference.

Miscellaneous Products

Only two of the seven miscellaneous products were identified as having been used a total of 64 times by counties. The product most often identified (54 times) was the Map of Historic Margins of Marshlands (BDC 9) which may be attributed to its regional coverage, common bayshore land development problems, the priority given to the seismic safety element by the counties, and the availability of information at larger compilation scales. This product was used most often for seismic safety elements and general reference. The nonuse of four of the other products (BDC 10, 23, 33, and TR 5) may be attributed to their lack of direct relevance to county planning activities.

Waste-Disposal, Water-Quality, and Water-Supply Products

Sixteen of the 17 SFBRS products grouped under waste-disposal, water-quality, and water-supply topics were identified as having been used a total of only 53 times by counties. The products identified most often were the probable maximum well yield (BDC 50), water-service area (BDC 4), and sewerage-service area (BDC 5) maps (26, 24, and 22 times, respectively), and this may be attributed to their regional coverage and their use for general reference and environmental evaluations.

The use of the Evaluating Pollution Potential of Land-Based Waste Disposal product (IR 6) was relatively frequent (15 times) when its coverage of only one county is considered.

The less frequent use of the other products may be attributed primarily to the fact that responsiblity for water supply, water quality, and waste disposal is assigned to single-purpose county agencies other than county planning departments or to another level of government. For example, most of the county flood control and water conservation districts have water conservation, reclamation, and distribution powers and duties. A recent inventory of the eight districts in the Bay region (Danielson, 1975) indicated that water-quality, hydrologic, and water-supply products were frequently used. The waste-disposal, water-quality, and water-supply products were most often used by counties for general reference and the preparation and review of EIR's and EIS's.

Photographic and Topographic Products

All three of the SFBRS photographic and topographic products were identified as having been used a total of 59 times by counties resulting in the second highest average use of any product group. The frequent use of the regional topographic and slope maps may be attributed to their being the only maps of those types and coverage available. The less frequent use of orthophotos may be attributed in some cases to the availability of more recent aerial photography and the fact that the land-use studies and elements requiring this product had already been completed by the counties. The nonuse of orthophotos with contours may be partially attributed to lack of knowledge of their availability.

These products were most often used by counties for general reference.

Other USGS Products

At least 85 different specific published USGS products (see appendix G) not prepared under the SFBRS were identified as having been used at least a total of 126 times by counties. Generally, the products most often identified were the 7½-minute quadrangle (topographic) series which were used for general reference and base mapping. Fault, water-resource, geologic, and ground-response products were frequently used, primarily in conjunction with the seismic safety element and geologic hazards and physical resources studies.

Undercounting

In an inventory or series of interviews of this type, there is always the possibility of receiving incomplete or inadequate responses. The result is that the interviewers do not identify all the applications made or all the products used. There are several other areas where undercounting may have occurred, for example:

1. Many SFBRS products are based upon larger-scale or more-detailed data which are sometimes available on an "official use only" basis. Usually, these products were not identified during the interview and were rarely cited in the planning documents, even though they may have been used.

2. Some counties were able to obtain access, and make use of, USGS data on an "official use only" basis prior to its publication, and often this data was not identified or cited.

3. Counties use and cite reports of other governmental agencies or of consultants which are based upon, and contain references to, SFBRS products. These products were not identified during the inventory or interview.

4. Counties often use and cite reports previously prepared by their planning staff which are based upon, and contain references to, SFBRS products. For example, plan elements are

usually based upon previous studies, and sometimes EIR's and EIS's refer to adopted county plans in which SFBRS products were used. Such uses cannot be easily identified.

5. The extensive use of the 7½-minute series (topographic) quadrangles by counties for base, reference, index, and location maps is not often acknowledged.

Comments from County Personnel

Over 100 persons in the eight counties were interviewed for this report. Those interviewed included 57 planners, 9 engineers, 5 geologists, 5 consultants, and 9 other county employees. A summary of their responses to each question and pertinent comments follow.

Map Scales

All counties responded to questions concerning the scales commonly used for their working and implementation maps. They indicated that working maps at scales of 1:62,500 or larger and implementation maps at scales of 1:24,000 or larger were used. The smaller scales of the SFBRS products did not prevent their use for most studies and plans, general reference, EIR's and EIS's, and ordinance administration. As expected, the SFBRS products were seldom used by the counties for site studies, for detailed plans, and in ordinances where larger scales are usually required.

Planning Staffs

Although all counties have professional planning staffs, most staff members lack training or experience in either earth science or engineering. Only Contra Costa County has a geologist on its planning staff; however, six other counties have access to geotechnical services which were primarily used for preparing seismic safety elements and geologic hazards studies. Several of the counties also make use of

their staff or consultant geologists for the day-to-day administration of their land-use and development ordinances. This lack of training and experience make it difficult for county planning staffs to make the most effective use of earth-science information unless it is accompanied not only by engineering interpretations and land-use capability ratings, but by educational, advisory, and review services.

Receipt, Distribution, and Custody

All eight county planning agencies are on the SFBRS mailing list, and all the planning staffs report that they are receiving SFBRS products. After receipt, the SFBRS products are usually circulated among staff members and then placed in the agencies' libraries.

Limited Use of SFBRS Products

None of the eight counties failed to use the SFBRS products. One county indicated that their limited use of some of the products was due to the completion of several studies and plans prior to the products being available. Two counties indicated they made only limited use of flood-prone area and hydrologic products because more detailed data was available from other county agencies.

Problems in Using SFBRS Products

Seven counties indicated that they experienced difficulty in using SFBRS products primarily because the scale was too small or the detail not great enough, and because of insufficient data. In the case of some of the products, the counties indicated specific problems concerning scale, detail, terminology, graphics, or accuracy.

Anticipated Use of SFBRS Products

All eight counties expect to continue to use SFBRS products in the future, and all were able to identify specific SFBRS products and their uses. They are primarily interested in the hydrologic, orthophoto with contours, water-quality, waste-disposal, and water-supply products usually for use in preparing conservation elements, administering ordinances, and studying biotic communities and flood inundation.

This interest may be attributed to their completion of the seismic and public safety elements required by State law and a reordering of their priorities.

All eight counties expressed interest in the SFBRS earth-science topical interpretive reports underway and indicated that most of these reports would be useful for their county planning activities. Interest in the coastal geologic process report was expressed by all three of the counties which have frontage on the Pacific Ocean.

Data Needed or Desired

All eight counties expressed a need or desire for additional earth-science, engineering, or other data; primarily, ground response, slope stability, flood-prone areas, ground water, faults, geology, land capability, and land use.

The expressions of a need or desire for specific data by the counties does not lend itself to weighting. However, they generally fall into the categories of larger-scale or more-detail, and more interpretive data.

Suggestions for Improving Products

All eight counties suggested specific improvements to SFBRS products, primarily larger-scale or more-detail, slope maps at 1:24,000, updating of the 7½-minute quadrangle (topographic) series, more liaison with USGS personnel, fewer technical or more interpretive products, and more engineering interpretations. The counties' suggestions concerning more liaison with USGS personnel and more interpretive products indicates a need for educational, advisory, and review services.

Services from USGS Personnel

All eight counties indicated that they had contact with, and received educational, advisory, and review services from, at least one of the 24 different USGS personnel identified. This figure does not include the providing of SFBRS products by various members of the USGS in response to verbal, telephone, and written requests.

Comparison Between City and County Use of SFBRS Products

With the completion of the inventory of county planning agencies and the interviews with county personnel, a comparison with the results of the city inventory and interviews (Kockelman, 1975) is in order. This comparison is helpful in confirming the results of both studies by identifying similarities and analyzing the reasons for any major differences.

The 91 cities and 8 counties which were the subject of the two reports lie in the same geographic location, have almost the same plan and plan implementation powers and duties, experienced parallel population growth, rely upon and affect the same natural resources, and are affected by the same natural hazards. In addition, the method of inventory and interviewing was the same for both cities and counties with the exception that two interviewers were used in each county, whereas only one interviewer was used in each of the cities.

The differences between the cities and counties is generally one of size--area and population--and those factors related thereto. For example, staff size, financial resources, and exposure to SFBRS products generally increases with the size of the unit of government.

For various reasons, some comparisons could not be made. For example, only counties are responsible for preparing solid-waste management plans; only counties have community assistance programs; civil defense plans and ordinance administration were inventoried only in counties; and two SFBRS products were released after the city study was completed.

Similarities Identified

In making the comparison between the city and county reports, the following similarities were identified:

1. Some correlation between use of SFBRS products and a city's or county's population and staff size.

2. Types of planning applications based upon SFBRS products; namely, geologic hazards studies; conservation, seismic safety and public safety plan elements; general reference; and EIR/EIS preparation and review.

3. Infrequent use of SFBRS products for site studies, detailed plans, and ordinances where larger scales are required.

4. Very frequent use of certain product groups; namely, landslides, geology, faults, and flood-prone areas; less frequent use of waste-disposal, water-quality, and water-supply products; and infrequent use of orthophotos.

5. Specific products used most often were small-scale, large area-coverage, hazard-type.

6. Use of USGS products other than SFBRS, primarily the 7½-minute series (topographic) quadrangle maps.

7. Most planning staff members lacked training and experience in either earth science or engineering.

8. Problems in using SFBRS data; primarily, scale too small or detail not great enough.

9. Need or desire for additional earth science, engineering, or other data; primarily, slope stability, faults, ground response, flood-prone areas, and geology; specifically, depth of bay muds, more detailed fault maps (1:24,000), more detailed flood boundaries, ground response, depth of ground water, stability of bayland dikes, and updated 7½-minute series (topographic) quadrangle maps.

10. Suggestions for improving products; namely, larger scale or more detail, less technical or more interpretive reports, and more liaison with USGS personnel.

11. Educational, advisory, and review services provided by USGS personnel.

Major Differences Noted

In making the comparison between the city and county reports, the following major differences were noted:

1. All of the counties were familiar with, and had made use of, SFBRS products, compared to only 3/4 of the 91 cities. This may be attributed partly to the presence of large planning staffs in all of the counties.

2. The total use of SFBRS products was greater in the counties (1,259 compared to 795), and the average use was very much greater (157 per county to 8 per city). This greater use may be attributed to the larger planning staffs, more planning activities underway at any one time, and the scale of the products being more appropriate for county-wide planning.

3. Regional topographic and slope maps received much higher use by the counties (59 times compared to 14 times). This may be attributed to their being the only maps of that type and coverage available.

4. General reference was the highest use of SFBRS products by counties, whereas seismic safety elements was the highest use by cities.

5. As expected, the scale most commonly used by counties for their working maps was smaller than the scale most commonly used by cities. However, the scales most commonly used for implementation maps differed only slightly; the counties used scales of 1:24,000 or larger, whereas the cities used scales of 1:12,000 or larger. This suggests that larger-scale, greater-detail products are needed for plan implementation regardless of the scale of the plans or the level of the unit of government.

6. All counties were on the SFBRS mailing list compared with only 37 percent of the cities. None of the counties failed to use SFBRS products compared with 21 cities. These differences may be attributed to the counties' larger planning staffs and perhaps to a greater awareness or interest in the natural processes and hazards affecting their undeveloped lands.

7. Counties anticipated using SFBRS hydrologic, water-quality, waste-disposal, and water-supply products in the future, primarily for environmental-type studies and plans; whereas the cities anticipated using hazard-type products primarily for seismic safety elements. This difference may be

attributed to completion of the seismic safety elements by the counties. All eight counties indicated that the SFBRS interpretive reports now underway would be useful for their planning activities compared with about one-third of the cities.

8. Five of the eight counties expressed a need or desire for land-use data compared with none of the cities. This difference may be attributed to the fact that cities require land-use data at a scale and level of detail that is more appropriately prepared at the local level.

9. All eight counties indicated contact with USGS personnel compared with only 20 of the 91 cities. This difference may be attributed to the size of the counties and the size of their staffs.

CONCLUSIONS AND SUGGESTIONS

All of the counties in the Bay region are very familiar with, make frequent use of, and will continue to use SFBRS products. This is not surprising since the counties are the largest general-purpose unit of government having planning and plan implementation powers and duties in a region for which the products were designed and scaled. The other conclusions reported here are grouped under specific conclusions, transfer value, and outlook for the future.

Specific Conclusions

The following specific conclusions can be drawn as a result of the inventory and interviews:

1. SFBRS geologic, hydrologic, and topographic products are being used for all county planning activities, namely studies, plans, ordinances, and other planning activities including the analysis of environmental impacts and the administration of ordinances.

2. No significant correlation was discerned between county use of SFBRS products and their release dates, type, scales, coverage, content or complexity; however, the nine products most often used were small-scale, large-area-coverage, hazard-type products. Eight of these products were interpretive and contained data making them especially relevant and interesting.

3. Certain SFBRS product groups are used more frequently because counties give priority to planning activities required by State law or needed to address critical community issues. Such activities include geologic hazards studies, seismic safety elements, and EIR/EIS preparation and review.

4. Most county planning agencies have staffs whose training and experience make it difficult for them to utilize earth-science data and to make the necessary engineering interpretations that are needed for land-use capability ratings. However, this difficulty was substantially alleviated where a geologist was on the planning staff or where the planning staff had the benefit of geotechnical services from other county or state agencies or private firms.

5. The scale and detail of the SFBRS products does not appear to limit their use by counties for most studies, plans, general reference, EIR's, EIS's, and ordinance administration; however, SFBRS products were seldom used by the counties for planning activities requiring larger scales.

6. Plans and ordinances based upon SFBRS products have been adopted and administered by some counties for over two years without any successful legal assault on the data.

Transfer Value

All uses of SFBRS products documented in this study are readily transferable to other counties in the Bay region. For example, Alameda and Marin counties transferred the method for evaluating pollution potential in Santa Clara County (IR 6) to their solid waste management planning and their environmental analyses activities, respectively.

However, transfer value outside the region is dependent upon the following factors:

1. Presence of similar geologic and hydrologic environments
2. Availability of similar data and interpretations
3. Existence of similar plan and plan implementation legislation
4. Community interest or priority in addressing earth-science related problems
5. Potential user's familiarity with the type of SFBRS products and their actual application

The first four factors are unique to each area or beyond the congressional mandate of the USGS or the Department of the Interior. The last factor is the only one that can be properly addressed in this report and will partially depend upon its readability, use of appropriate examples, and distribution to potential users.

The 17 examples of the application of SFBRS products to various planning activities illustrated in the Selected Applications section of

this report should contribute toward effecting transfer both inside and outside the Bay region.

Outlook for the Future

The time consumed between undertaking planning studies, preparing plans, and implementing such plans ranges from one to five years or more; hence our application inventory is made at a fairly early stage in the planning and decisionmaking process. Therefore, additional applications of SFBRS products to planning and decisionmaking by Bay region counties is very likely because:

1. Additional earth-science data and interpretations will be released.

2. More effective interpretations and innovative use of the data continues to be made by the counties.

3. More county staffs and consultants are becoming familiar with the products and their application by the other counties.

4. Pending studies, plans, and ordinances will be completed, and completed studies, plans, and ordinances will be revised.

5. State geologic hazard zones will be incorporated into county ordinances.

6. Recent federal rules and guidelines require counties to collect, analyze, and apply earth-science information; for example, the comprehensive planning assistance program (U.S. Dept. of Housing & Urban Development, 1975) and the guideline for the mandatory purchase of flood insurance (Federal Insurance Administration, (1974).

In addition, cities will adapt county planning studies and plans to their needs. For example, 14 cities in San Mateo County participated in the preparation of the County's seismic and public safety plans, and it is anticipated that they will adapt the plans to their needs and adopt them so as to comply with the state law.

Suggestions

Suggestions offered here are directed to future energy, resource, and environmental planning and development studies having goals similar to those of the SFBRS. These suggestions are designed to ensure more effective use of earth-science information by planners and decisionmakers. The suggestions cover the following subjects: critical issues; users advisory committee; interpretive products; impacted areas; scale and detail; information release and distribution; and educational, advisory, and review services. No attempt is made to identify the staff needed or estimate the funding required as they would vary according to the specific needs of the users, scope of the study, and capability of other agencies in the study area.

Critical Issues

The emergence of critical issues and the enactment of state and federal laws and regulations affecting counties should be monitored and analyzed so that the USGS and its scientists, engineers, and planners can better anticipate and respond to county needs.

Priority should be given to the collection, analysis, and interpretation of information relating to earth hazards, water resources, and base mapping such as flood-prone areas, topography, slope zones, orthophotos with contours, landslides, faults, waste disposal, water quality, and water supply. Products should be designed to address critical issues such as earth-hazards reduction, resource conservation, and environmental protection.[4/]

These suggestions are based upon the priority given by counties to those planning activities required by law or regulations and needed to

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4/ Information relating to "energy resources" and products addressing "energy development" could be added to these lists because of their importance as a critical national issue.

address critical community issues; the types of planning applications most often made of SFBRS products; the topic of the products most often used by counties; and their anticipated use of, or interest in, future products.

Users Advisory Committee

A committee composed of selected existing and potential local, regional, state, federal, conservation, and corporate users should be created prior to the adoption of any preliminary program design and the preparation of the detailed program design. The committee would not act as a coordinator or translator for the users but would act as users communicating directly with the producers of the information. The committee would:

1. Help USGS personnel identify critical issues and user needs
2. Collaborate in the design of the products
3. Provide an immediate and receptive user market
4. Foster continued application after program termination
5. Assist in avoiding duplication in the data collection and interpretation phases.

This suggestion is based upon the counties' problems in using SFBRS products, their anticipated use of future products, their expression of data needs, their frequent use of the products, and their suggestions for improvements.

The A. D. Little report evaluating the SFBRS also recommends the creation of a user panel (1975, p. 91) and specifies actions to be taken prior to the undertaking of a new program so as to improve the effectiveness and credibility of the program (1975, pp. 85, 86).

Interpretive Products

Greater effort should be made to provide engineering interpretations and land- and water-use capability ratings of earth-science data for

counties. This suggestion is based primarily upon the limited capabilities of county planning staffs, their interest in interpretive products, their expression of data needs, their suggestions for specific improvements, the type of products most often identified as having been used, and the types of services received from USGS personnel.

The A. D. Little report evaluating the SFBRS contains numerous recommendations concerning improvements to SFBRS interpretive reports (1975, pp. 79, 80) and the organization and presentation of engineering characteristics and suitability ratings of earth-science data (1975, pp. 87-90).

These recommendations should be given careful consideration by USGS scientific, engineering, planning, and administrative staffs, as many would contribute toward more effective use of future USGS earth-science information designed for planners and decisionmakers.

After completion and distribution of the interpretive reports and the land capability study which are part of the SFBRS, it is suggested that another interview be conducted. At that time, a sample earth-science data map accompanied by appropriate engineering interpretations and land-use capability ratings could be presented to the chairman or to a member of the county board of supervisors and to a member of the county planning staff. Inquiries at that time concerning the type of data needed or desired would most likely indicate a very great need or desire for such interpretations and ratings.

Impacted Areas

The limited scientific, engineering, and planning staffs of the

federal government should be husbanded and used to study those areas which are, or will be, impacted by development. Such impacts most often create critical national, state, and local issues relating to earth-hazards reduction, energy development, environmental protection, and resource conservation.

This suggestion is based upon the frequent use of SFBRS products by counties; their need and desire for additional earth-science, engineering, and interpretive data; and the great disparity between the earth-science information needs of planners and decisionmakers and the limited scientific, engineering, and planning capabilities to meet those needs.

Scale and Detail

An effort should be made to provide earth-science data at those scales and levels of detail commonly used by counties. In addition, the large-scale and high-resolution earth-science information needed for plan implementation, site review, and environmental analysis should be recognized.

This suggestion is based upon the documented applicability of earth-science data to county planning and the counties' responses concerning the map scales most commonly used, their limited use of certain SFBRS products, their suggestions for improving the products, their problems in using the products, their anticipated use and need of earth-science information, and their request for larger-scale and more-detailed data.

Information Release and Distribution

In addition to the standard USGS products, earth-science information needed to address critical issues should be released early through verbal briefings, seminars, map-type "interpretive inventory" reports, open-file reports, and publications in reports of cooperating agencies.

At least one copy of each product released should be provided to all county clerks with a copy of the letter of transmittal sent to the County Board Chairman, planning director, and the engineering or public works director. This letter of transmittal should:

1. Describe the product in general terms
2. Suggest uses or applications
3. Advise where explanations of the product and assistance in its use for, and adaptation to, county planning and decision-making activities can be obtained.

Care should be exercised to ensure that counties are aware of the availability of some information at larger compilation scales.

These suggestions are based upon the counties' use and interest in future SFBRS products; their familiarity with, and frequent use of, the products; and the time ordinarily consumed between receipt, understanding, and effective use of earth-science information.

Educational, Advisory, and Review Services

Educational, advisory, and review services should accompany any new earth-science data collection and analyses program designed for planners and decisionmakers. This suggestion is based primarily upon the limited capabilities of the county planning staffs, their use of geotechnical services where available, problems in using certain SFBRS products, their interest in interpretive products, their suggestions for improvements, and the type of services received from USGS personnel.

Numerous examples of such services are set forth in a recent unpublished report by the author (Kockelman, Written commun., May 1976). Some of the recommendations made by A. D. Little (1975, pp. 80-84, 91, 92) concerning new products, educational efforts, model ordinances, and informational efforts are appropriate examples of educational and advisory services.

Many of the steps recommended by Gary W. North (Written commun., Dec. 17, 1975) and the Publication Division Staff (Written commun., Oct. 1975), such as establishing technical information centers, developing a technical information assistance program, and expanding the Public Inquiry Offices' capability, are in the nature of educational services and would be supportive of any earth-science data collection and analysis program designed for planners and decisionmakers. Several of the recommendations made by Wissel and others (1976, pp. 3-5) concerning "roving geologists," seminars, reference services, information lists, and model ordinances are good examples of educational and advisory services.

Educational, advisory, and review services should be provided directly to the county planners and decisionmakers upon request. Such services could be provided by an areawide planning agency with comprehensive physical planning responsibility, or by community assistance planners employed by USGS, HUD, or State agencies. Many of these services are being provided as part of the urban area studies, but they should be formally recognized and included as a work element in any future USGS program designed for planners and decisionmakers.

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APPENDIX A

Basic Data Contributions

BDC No. 1 "Map Showing Recently Active Breaks Along the San Andreas Fault Between Point Delgada and Bolinas Bay, California," by Robert D. Brown, Jr., and Edward W. Wolfe (open-file map). Two map sheets plus text and references; scale is 1:48,000.

This map locates the most recently active surface traces of the San Andreas fault north of the Golden Gate, and documents the historic evidence and geomorphic features along its course.

2 "Geologic Map of Palo Alto 7-1/2 minute quadrangle, San Mateo and Santa Clara Counties, California," by E. H. Pampeyan, 1970 (open-file map). One map sheet plus explanation sheet; scale is 1:24,000.

The location of such geologic features as landslides, springs, and the San Andreas fault are documented, and standard geologic units are shown, including bay mud, unconsolidated sediments, and various rock types of the Tertiary and older formations. The area covered is from San Carlos south to Portola Valley and from East Palo Alto south to Los Altos Hills.

3 "Geologic Map of the Southern Part of Redwood Point 7-1/2 minute quadrangle, San Mateo County, California," by E. H. Pampeyan, 1970 (open-file map). One map sheet; scale is 1:24,000.

This map shows the location of bay mud, alluvium, and artificial fill in the marshlands near San Carlos and Redwood City. Former shorelines are indicated, and borehole information with depth of bedrock is given.

4 "Map Showing Areas Serviced by Municipal and Private Water Distributions Agencies, San Francisco Bay Region, 1970," revised and reprinted 1971, compiled by J. T. Limerinos and Karen Van Dine (Miscellaneous Field Studies Map MF-329). One map sheet, plus 5 p. table; scale is 1:500,000.

Boundaries of the various water districts in the nine-county Bay Area are shown on the map, and the table gives "water-use data" for the respective water districts.

5 "Map Showing Areas Serviced by Municipal and Private Sewerage Agencies, San Francisco Bay Region, 1970," revised and reprinted 1971, compiled by J. T. Limerinos and Karen Van Dine (Miscallenaous Field Studies Map MF-330). One map sheet; scale is 1:500,000.

The map shows the boundaries of the various sewage districts and the locations of treatment plants and sewage outfalls in the nine-county Bay Area.

6 "Preliminary Geologic Map of the Central Santa Cruz Mountains, California," compiled by Earl E. Brabb, 1970 (open-file map). Two map sheets plus explanation sheet; scale is 1:62,500 (1 in. = 1 mile).

The location of geologic units is shown for a 28 X 36-mile area from San Carlos to Santa Cruz, and the Pacific Ocean to the San Francisco Bay. The San Andreas fault zone and other faults, many landslides, and the depth to bedrock under thick unconsolidated sediments are indicated.

7 "Faults that are Historically Active or that Show Evidence of Geologically Young Surface Displacements, San Francisco Bay Region; A Progress Report: October 1970," compiled by Robert D. Brown, Jr. (Miscellaneous Field Studies Map MF-331). Two map sheets; scale is 1:250,000.

The map shows the location of known and suspected recent movements along eight major and some minor faults in the nine-county Bay Area. In addition to previously reported earthquake faults, the Healdsburg-Rogers Creek, San Gregorio, and Green Valley faults are indicated as active for the first time.

8 "Generalized Geologic Map of the San Francisco Bay Region, California," by J. Schlocker, 1971 (open-file map). One map sheet; scale is 1:500,000.

The distribution of major groups of consolidated and unconsolidated rock types is indicated for the nine-county Bay Area. A concise description of the nature, engineering behavior, and commercial uses of each group is given.

9 "Preliminary Map of Historic Margins of Marshlands, San Francisco Bay, California," compiled by Donald R. Nichols and Nancy A. Wright, 1971 (open-file map). One map sheet, plus text and references. Scale is 1:125,000.

The location of marshland, sloughs and channels adjacent to the San Francisco Bay in the mid-1800's is indicated on the map, and a summary of the geology and engineering properties of the bay mud, and its regional planning significance are given in the accompanying text.

BASIC DATA CONTRIBUTIONS (continued)

10 "Bedrock-Surface Map of Central San Francisco Bay, California," by Paul R. Carlson and David S. McCulloch, 1970 (open-file map). One map sheet; scale is 1:10,600.

The depth to the bedrock surface in the Bay is shown by contours for an area from Point Bonita to Treasure Island and from Tiburon Peninsula to Point Lobos.

11 "Estimated Relative Abundance of Landslides in the San Francisco Bay Region, California," by Dorothy H. Radbruch and Carl Wentworth, 1971 (open-file map). One map sheet; scale is 1:500,000.

This map of the greater Bay Region has six map units of progressively more average area covered by landslides. The landslide abundances are estimated primarily from characteristics of the various earth materials, and to a lesser degree from average rainfall, slope of the ground, and a limited knowledge of actual landslide distribution.

12 "Preliminary Geologic Map of Western Sonoma County and Northernmost Marin County, California," compiled by M. C. Blake, Jr., Judith Terry Smith, Carl M. Wentworth, and Robert H. Wright, 1971 (open-file map). Five map sheets, scale is 1:62,500.

The location of geologic units is shown for a 51 X 40-mile area that covers most of Sonoma County and part of Marin County. Active and inactive faults including the San Andreas fault are indicated, as well as some landslides in the area.

13 "Geologic map of the Sargent Fault Zone in the vicinity of Mount Madonna, Santa Clara County, California," by Robert J. McLaughlin, 1971 (open-file map). One map sheet plus explanation sheet. Scale is 1:12,000.

The location of geologic units and structures is shown for a 3 X 4-mile area just to the east of Mount Madonna. Complex structural relationships are shown, that were not previously realized.

14 "Distribution of Mercury in Surface Sediments in the San Francisco Bay Estuary, California," by D. S. McCulloch, T. J. Conomos, D. H. Peterson, and K. Leong (open-file map). One map sheet, scale is 1:500,000.

Sample locations and mercury concentrations in parts per million are shown for 199 samples of bottom sediments in the bay and its tributaries. The accompanying text compares mercury values for four major areas of the bay, and for various environments within the bay.

The following six Basic Data Contributions are open-file maps of flood-prone areas, showing areas that would be inundated in a very large but infrequent flood episode (a "100-year flood"). These areas are indicated on 7-1/2-minute quadrangle sheets and grouped according to drainage basins. The scale of all sheets is 1:24,000.

15 "Flood-prone areas in the Napa River Drainage Basin, Napa County, California," including St. Helena, Rutherford, Yountville, Nepa, and Cuttings Wharf 7-1/2-minute quadrangles. Five map sheets.

16 "Flood-prone areas in the Sonoma Creek Drainage Basin, Sonoma and Marin Counties, California," including Glen Ellen, Sonoma, Sears Point, and Petaluma Point 7-1/2-minute quadrangles. Three map sheets.

17 "Flood-prone areas in the Petaluma River Drainage Basin and Cotati vicinity, Sonoma and Marin Counties, California," including Cotati, Petaluma and Petaluma River 7-1/2-minute quadrangles. Three map sheets.

18 "Flood-prone areas in the Russian River Drainage Basin, Sonoma County, California," including Sebastopol, Santa Rosa and Two Rock 7-1/2-minute quadrangles. Three map sheets.

19 "Flood-prone areas between Point Reyes Station and Bolinas, Marin County, California," including Inverness and Bolinas 7-1/2-minute quadrangles. Two map sheets.

20 "Flood-prone areas of Coastal San Mateo County, California," including Half Moon Bay, San Gregorio, La Honda, Pigeon Point, and Franklin Point 7-1/2-minute quadrangles. Five map sheets.

21 "Municipal and Industrial Wastewater Loading in the San Francisco Bay, California," 1970, by W. G. Hines and R. H. Palmer, 1971 (Miscellaneous Field Studies Map MF-332). One sheet.

This report describes the approximate volumes and significant pollutional loads of wastewater discharged into the bay from municipal and industrial sources. Wastewater flow, BOD (biochemical oxygen demand), total nitrogen, total phosphate, and relative toxicity loads are indicated for 6 major subdivisions of the bay, and identified as to source, either industrial or municipal. The pollutional significance of these factors is discussed in the brief text.

BASIC DATA CONTRIBUTIONS (continued)

22 "Drift of Surface and Near-bottom Waters of the San Francisco Bay System: March 1970 through April 1971," by T. J. Conomos, D. S. McCulloch, D. H. Peterson, and P. R. Carlson, 1971 (Miscellaneous Field Studies Map MF-333). Two map sheets, with 8 figures at 1:625,000 scale.

The seasonal variation in bottom flow of bay waters is documented through the movement of bottom-drifters for two-month intervals throughout a year's time. In addition, surface-drifters are charted for the last two time intervals. The text includes a summary and discussion of the movement patterns, and tables on the speed of movement of near-bottom waters.

23 "Aeromagnetic Map of the southern San Francisco Bay Region, California," 1971 (open-file map). One map sheet, scale 1:125,000.

Local changes in the total intensity of the earth's magnetic field are shown by contours for a 28 X 35-mile area including the San Francisco Peninsula, the East Bay communities, and most of central and south San Francisco Bay. The data are from continuous flight recording at 1,000 feet above ground.

24 "Water Temperatures of California Streams, San Francisco Bay Subregion," by J. C. Blodgett, 1971 (open-file map). 53 pages.

The monthly maximum, minimum, and mean stream temperatures are given for each of 87 temperature stations. The report covers the drainage area of San Francisco Bay, plus coastal drainage from Russian River to Pescadero Creek. The data were collected over various periods from 1950 to 1969.

25 "Precipitation Depth-Duration-Frequency Relations for the San Francisco Bay Region, California," by S. E. Rantz, 1971 (open-file report), 5 pages, and "Isohyetal Map of San Francisco Bay Region, California, Showing Mean Annual Precipitation," (open-file map). One map sheet, scale is 1:500,000.

The report describes a procedure for quantitatively relating the intensity and duration of a storm and its probable frequency of recurrence to mean annual rainfall. The isohyetal map shows the variation in average precipitation across the nine-county Bay Region, using 2 and 4-inch contours. Values range from 12 inches per year near Sunnyvale to 80 inches per year in Sonoma and Napa counties.

26 "Bedrock-Surface Map of the San Francisco North quadrangle, California," by Julius Schlocker, 1961, and "Bedrock-Surface Map of the San Francisco South quadrangle, California," by M. G. Bonilla, 1964 (Miscellaneous Field Studies Map MF-334). One map sheet, both maps at 1:31,680 scale.

These maps show the elevation of the upper surface of bedrock by contour lines, and the depth to bedrock in boreholes for an area from Tiburon to San Bruno. The thickness of unconsolidated sediment at a given location can be obtained from the difference between bedrock elevation and topographic elevation at that point.

27 "Geologic Map of Late Cenozoic Deposits, Santa Clara County, California," by E. J. Helley and E. E. Brabb, 1971 (Miscellaneous Field Studies Map MF-335). Three map sheets, scale is 1:62,500.

The map shows the distribution of older bay mud, three generations of alluvial fan deposits, and some young volcanic rocks, all in Santa Clara County. The brief text gives the general characteristics, generalized physical properties, and relative ages of the units, and indicates possible uses of the map.

28 "Preliminary Geologic Map of the Mount Diablo-Byron area, Contra Costa, Alameda, and San Joaquin Counties, California," by Earl E. Brabb, Howard S. Sonneman, and John R. Switzer, Jr., 1971 (open-file map). Two sheets. Scale is 1:62,500.

The location of geologic units and structures is shown for a 27 X 17-mile area between Danville on the west and the Old and Middle Rivers on the east, and south of Antioch.

29 "Preliminary Geologic Map of the San Francisco South quadrangle and part of the Hunters Point quadrangle, California," by M. G. Bonilla, 1971 (Miscellaneous Field Studies Map MF-311). Two map sheets, scale is 1:24,000.

The distribution of geologic units and structures is shown for an area from the Sunset District and Hunters Point sections of San Francisco in the north, to Pacifica and San Bruno in the south. The San Andreas fault zone and some landslides are documented, as well as the locations of tidal flats in the 1850's, areas of artificial fill, and many minor faults.

BASIC DATA CONTRIBUTIONS (continued)

30 "Active Faults and Preliminary Earthquake Epicenters (1969-1970) in the Southern Part of the San Francisco Bay Region," by R. D. Brown, Jr., and W.H.K. Lee, 1971 (Miscellaneous Field Studies Map MF-307). One map sheet plus 7 p. text. Scale of map is 1:250,000.

In addition to the location of known and suspected active faults, the approximate magnitude and epicenter location of earthquakes greater than magnitude 0.5 is shown for an area from the Golden Gate, Oakland, and Tracy in the north, to Salinas and Hollister in the south. The relationships between active faults, epicenter distribution and fault creep are discussed in the text, as well as the implication of these relationships.

31 "Preliminary Photointerpretation Map of Landslide and Other Surficial Deposits of the Mount Diablo area, Contra Costa and Alameda Counties, California," by Tor H. Nilsen, 1971 (Miscellaneous Field Studies Map MF-310). One map sheet, scale is 1:62,500.

The distribution of landslides, alluvium, colluvium, alluvial fan and dune deposits is shown for a 24 X 17-mile area surrounding Mount Diablo. The text describes some of the characteristics of the various depoaits that are critical to land-use planning, and indicates particular uses of the map.

32 "Mean Annual Precipitation and Precipitation Depth-Duration-Frequency Data for the San Francisco Bay Region, California," by S. E. Rantz, 1971. (Open-File Report) . 23 pages, plus one map sheet at 1:500,000 scale.

This report presents rainfall data for the Bay Region in a form suitable for use in slope stability and storm-drainage studies. A table gives storm durations, and their frequencies of recurrence. These data are applicable to any site in the region where average annual rainfall is known. A map of average rainfall in the greater Bay Region, and depth-frequency curves for a particular rainfall value are also included.

33 "Map Showing Locations of Samples Dated by Radiocarbon Methods in the San Francisco Bay Region," compiled by Robert H. Wright, 1971. (Miscellaneous Field Studies Map MF-317). One map sheet, scale is 1:500,000.

Forty-six sites with a total of 76 separate radiocarbon dates are shown and briefly described. The data will be useful in studies of sea-level fluctuations, land subsidence, climate changes, sedimentation rates, archaeology, and fault movement.

34 "Preliminary Photointerpretation Map of Landslide and Other Surficial Deposits of Parts of the Altamont and Carbona 15-minute quadrangles, Alameda County, California," by Tor H. Nilsen, 1972 (Miscellaneous Field Studies Map MF-321). One map sheet, scale is 1:62,500.

The map shows the distribution of landslides, alluvium, colluvium, and alluvial fan and terrace deposits for a 17 X 11-mile area to the east and southeast of Livermore Valley. The text describes some of the characteristics of the various deposits that are critical to land-use planning, and indicates particular uses of the map.

35 "Preliminary Photointerpretation Map of Landslide and other Surficial Deposits of Parts of the Pittsburg and Rio Vista 15-minute quadrangles, Contra Costa and Solano Counties, California," by J. D. Sims and T. H. Nilsen, 1972 (Miscellaneous Field Studies Map MF-322). Two map sheets, scale is 1:62,500.

The map shows the distribution of marshland and slough deposits, landslides, alluvium, artificial fill, colluvium, and dune and terrace deposits for a 22 X 17-mile area surrounding the towns of Pittsburg and Rio Vista, and adjacent to the San Joaquin-Sacramento River Delta. The text describes some of the characteristics of the various deposits that are critical to land-use planning, and indicates particular uses of the map.

36 "Distribution of Lead and Copper in Surface Sediments in San Francisco Bay Estuary, California," by D. H. Peterson, D. S. McCulloch, T. J. Conomos, and P. R. Carlson, 1972 (Miscellaneous Field Studies Map MF-323). One map sheet, with 2 map figures at 1:800,000 scale.

Sample locations and lead and copper concentrations in parts per million are shown for more than 200 samples of bottom sediments in the bay and its tributaries. The concentrations of 30 elements in deep cores and shallow samples are compared to show the relative contamination due to man's activities. Lead, copper, and mercury are shown to have significantly higher concentrations in the shallow samples. The text also discusses the plausibility of man's activities contributing to the observed lead and copper levels.

BASIC DATA CONTRIBUTIONS (continued)

37 "Maps Showing Distribution and Cost by Counties of Structurally Damaging Landslides in the San Francisco Bay Region, California, Winter of 1968-1969", by Fred A. Taylor and Earl E. Brabb, 1972 (Miscellaneous Field Studies Map MF-327). One map sheet, with maps at 1:1,000,000 and 1:500,000 scale.

One of the maps shows the general location of landslides that damaged man-made structures during the winter of 1968-1969. The report and the second map itemize the cost by county of the landslides, and indicate the public (state highways, county costs, tax loss), private (property depreciation, damage and repair), and miscellaneous expenses. Factors contributing to landslide costs and the availability of cost information are discussed in the text. Documented costs were over $25 million in the Bay Region for the one winter season.

38 "Preliminary Photointerpretation Map of Landslide and Other Surficial Deposits of the Byron Area, Contra Costa and Alameda Counties, California," by Tor H. Nilsen, 1972 (Miscellaneous Field Studies Map MF-338). One map sheet, scale is 1:62,500.

The map shows the distribution of landslides, alluvium, colluvium, marshland, dune, and terrace deposits for a 10 x 17-mile area around Byron. The text describes some of the characteristics of the deposits that are critical to land-use planning, and indicates particular uses of the map.

39 "Preliminary Geologic Map of the Franciscan Rocks in the Central Part of the Diablo Range, Santa Clara and Alameda Counties, California," by William R. Cotton, 1972 (Miscellaneous Field Studies Map MF-343). Two map sheets, scale is 1:62,500.

This map shows the distribution of the various rock types that comprise the Franciscan assemblage, including large units of sandstone, as well as the highly sheared "melange." Numerous large landslides are also shown. The map covers the parts of Santa Clara and Alameda Counties that are south of Livermore Valley and east of the Calaveras and Madrone Springs faults.

40 "Preliminary Photointerpretation Map of Landslide and other Surficial Deposits of the Mount Hamilton quadrangle and parts of the Mount Boardman and San Jose quadrangles, Alameda and Santa Clara Counties, California," by Tor H. Nilsen, 1972. (Miscellaneous Field Studies Map MF-339). Two map sheets, scale is 1:62,500.

The map shows the distribution of landslides, alluvium, colluvium, marshland, and terrace deposits for a 28 x 17-mile area from Fremont and San Juan Bautista on the west to the county boundaries on the east. The text describes some of the characteristics of the deposits that are critical to land-use planning, and indicates particular uses of the map.

41 "Preliminary Geologic Map of San Mateo County, California," compiled by E. E. Brabb and E. H. Pampeyan and "Description of Geologic Units, San Mateo County, California," compiled by S. Ellen, C. M. Wentworth, E. E. Brabb and E. H. Pampeyan (Miscellaneous Field Studies Map MF-328), 1972. One map sheet plus 10-page text; scale is 1:62,500.

The map shows the distribution of geologic units in San Mateo County, and geologic structures, including major faults. The text provides a basic description of the rock units in technical terminology.

42 "Preliminary Map of Landslide Deposits in San Mateo County, California," by E. E. Brabb and E. H. Pampeyan, 1972 (Miscellaneous Field Studies Map MF-344). One map sheet, scale is 1:62,500.

The distribution of landslide deposits in San Mateo County is shown on the map. The text describes how the information was obtained, explains the many factors affecting the accuracy of the map, and provides some suggestions for those who use the map.

43 "Landslide Susceptibility in San Mateo County, California," by E. E. Brabb, E. H. Pampeyan and M. G. Bonilla, 1972 (Miscellaneous Field Studies Map MF-360). One map sheet, scale is 1:62,500.

The relative landslide susceptibility of all areas within San Mateo County is indicated by seven ranked units ranging from slopes less than 15 percent with very small landslides to slopes greater than 30 percent with many large and small landslides. Existing landslide areas are indicated as most susceptible to future landsliding. The text explains how the map was prepared and indicates appropriate use of the map. Percent landslide failure is calculated for the various geologic units in San Mateo County, and the data is presented in a table, with breakdown by slope interval.

ASIC DATA CONTRIBUTIONS (continued)

44 "Active Faults, Probable Active Faults, and Associated Fracture Zones, San Mateo County, California," compiled by Robert D. Brown, Jr., 1972, (Miscellaneous Field Studies Map MF-355). One map sheet, scale is 1:62,500.
The active faults and fault zones in San Mateo County are delineated on the map. The explanation includes statements on possible movement as well as general guidelines for land-use planning and construction near a fault. In addition to previously documented faults, the Serra fault is indicated as probably active.

45 "Preliminary Photointerpretation and Damage Maps of Landslides and Other Surficial Deposits in Northeastern San Jose, Santa Clara County, California," by T. H. Nilsen and E. E. Brabb, 1972 (Miscellaneous Field Studies Map MF-361). One map sheet, with map scales of 1:24,000 and 1:10,000.

This is a detailed study of landslides in a small area of the San Jose foothills, an example of what has happened and can occur in other parts of the Bay Region. A detailed map shows the distribution of landslide damage in the area. Cost figures are given for loss in valuation and remedial measures taken by the city and the utility companies, with total costs of more than $1,275,000. A second map shows the distribution of landslide deposits in the surrounding area. The text is similar to that of other photointerpretive landslide maps (e.g., #40).

46 "Preliminary Photointerpretation Map of Landslide and Other Surficial Deposits of Parts of the Los Gatos, Morgan Hill, Gilroy Hot Springs, Pacheco Pass, Quien Sabe, and Hollister 15-minute quadrangles, Santa Clara County, California," by Tor H. Nilsen, 1972 (Miscellaneous Field Studies Map MF-416). Two map sheets, scale is 1:62,500.

The map shows the distribution of landslides, alluvium, colluvium and terrace deposits for southeastern Santa Clara County. The map covers an area from Coyote and Gilroy on the west to the county boundaries on the east and southeast. The text describes some of the characteristics of the deposits that are critical to land-use planning, and indicates particular uses of the map.

47 "A Summary View of Water Supply and Demand in the San Francisco Bay Region, California," by S. E. Rantz, 1972, 41 pages (open-file report).

This report provides data on existing and potential water supply from various sources for 15 subregions of the 9-county Bay Area. It also gives statistics on the principal uses of water in each subregion. A discussion of future supplementation of the water supply deals with projects under consideration or in progress, as well as less conventional approaches such as desalinization and weather modification.

48 "Geologic Map of Late Cenozoic Deposits, Alameda County, California," by E. J. Helley, K. R. Lajoie and D. B. Burke, 1972 (Miscellaneous Field Studies Map MF-429). One map sheet, scale is 1:62,500.

The map shows the distribution of older bay mud, two generations of alluvial fan systems, and beach sand, all in Alameda County. The brief text gives the general characteristics, generalized physical properties and relative ages of the units, and indicates possible uses of the map.

49 "Solid Waste Disposal in the San Francisco Bay Region," by Joseph Goss, 1972 (Miscellaneous Field Studies Map MF-430). 10-page text plus map sheet at 1:500,000 scale.

The report describes the various methods of solid-waste disposal that are used in the United States, as well as future trends in solid-waste disposal. It delineates some basic requirements for selection and management of landfill disposal sites, and describes the possible effects of a landfill operation on water quality. The map gives the locations and descriptions of 170 existing and proposed solid-waste disposal sites in the San Francisco Bay Region.

50 "Map Showing Ranges in Probable Maximum Well Yield from Water-Bearing Rocks in the San Francisco Bay Region, California," by D. A. Webster, 1972 (Miscellaneous Field Studies Map MF-431). One map sheet, scale is 1:250,000.

This map is designed to provide general information on local supplies of ground water for purposes of water-supply management and planning. The map delineates four ranges of probable well-yield for areas within the 9-county Bay Region. The lowest category of 0.1 to 10 gpm (gallons per minute) would be "marginal to adequate for stock or single family domestic use," whereas the highest range of 100 to 3,000 gpm is "marginal to adequate for irrigation, heavy industry, and municipal uses."

BASIC DATA CONTRIBUTIONS (continued)

51 "Map Showing Areas in the San Francisco Bay Region where Nitrate, Boron and Dissolved Solids in Ground Water may Influence Local or Regional Development," by D. A. Webster, 1972 (Miscellaneous Field Studies Map MF-432). Three map sheets plus 8-page text. Scale is 1:125,000.

The maps provide a general inventory of ground-water mineral content in the 9-county Bay Region. They indicate areas where the amounts of selected critical substances in ground water have exceeded accepted standards at some time in the past. The accompanying text describes the terms used and discusses the significance of the various water-quality factors.

52 "Maps Showing Areas of Potential Inundation by Tsunamis in the San Francisco Bay Region, California," by J. R. Ritter and W. R. Dupre, 1972 (Miscellaneous Field Studies Map MF-480). Two map sheets, scale is 1:125,000.

The maps delineate areas of the San Francisco Bay and the ocean coastline that would be affected by a tsunami (seismic sea wave) that reaches an elevation of 20 feet on the coast. The text discusses the likelihood of occurrence of a tsunami of this size, and gives some tsunami precautions.

53 "Sources of Emergency Water Supplies in Napa Valley, California," by D. A. Webster, 1972 (Miscellaneous Field Studies Map MF-453). One map sheet, scale is 1:125,000.

This report demonstrates an approach to the documentation and evaluation of sources of water that could be available if normal water-supply systems are disrupted by earthquakes, nuclear explosions, floods or acts of civil disorder. The report presents general criteria for emergency water sources, and data for appropriate wells in Napa Valley. The location of emergency water-supply wells in Napa Valley is shown on the map at 1:125,000-scale (one inch = two miles).

54 "Preliminary Geologic Map of Solano County and parts of Napa, Contra Costa, Marin and Yolo Counties, California," compiled by J. D. Sims, K. F. Fox, Jr., J. A. Bartow, and E. J. Helley, 1973 (Miscellaneous Field Studies Map MF-484). Five map sheets, scale is 1:62,500.

The distribution of geologic units and structures is shown for an irregular area from Lake Berryessa, Esparto and Davis in the north and northeast, to Petaluma Point in the southwest and Rio Vista in the southeast. Known active faults are distinguished from other faults, many landslides are shown, and younger deposits are subdivided into sand dunes older fan deposits, younger alluvial fans, terrace deposits, older alluvium, and Bay mud.

55 "Map Showing Recent Tectonic Movement on the Concord fault, Contra Costa and Solano Counties, California," by Robert V. Sharp, 1973 (Miscellaneous Field Studies Map MF-505). One map sheet, scale is 1:24,000.

This map shows the location and characteristics of the Concord fault, which was recently recognized to be active. The fault extends from Ygnacio Valley in the south, through parts of Concord and Avon, and across western Suisun Bay. The text describes the fault segments and the evidence of recent activity. Progressive amounts of offset are shown for streets of varying ages. Much of the movement may be associated with a 1955 earthquake.

56 "Preliminary Geologic Map of Eastern Sonoma County and Western Napa County, California," by K. F. Fox, Jr., J. D. Sims, J. A. Bartow and E. J. Helley, 1973 (Miscellaneous Field Studies Map MF-483). Four map sheets, scale is 1:62,500.

The distribution of geologic units and structures is shown for an area in easternmost Sonoma County and westernmost Napa County and including presently urbanizing areas near Napa and near Santa Rosa; the map extends from the latitude of Napa northward to Clear Lake. Known active faults are distinguished from other faults, many landslides are shown, and younger deposits are subdivided into about 10 categories with different economic and engineering significance.

57 "Preliminary Photointerpretation Map of Landslide and Other Surficial Deposits of the Concord 15-minute Quadrangle and the Oakland West, Richmond, and Part of the San Quentin 7-1/2-minute Quadrangles, Contra Costa and Alameda Counties, California," by Tor H. Nilsen, 1973 (Miscellaneous Field Studies Map MF-493). Two map sheets, scale is 1:62,500.

The map shows the distribution of landslides, alluvium, colluvium and marshland and terrace deposits for westernmost Contra Costa County and the northeasternmost part of Alameda County. The map covers an area from Concord-Walnut Creek and San Ramon Village on the east, to San Francisco Bay on the west. The text describes some of the characteristics of the deposits that are critical to land-use planning and indicates appropriate uses of the map.

BASIC DATA CONTRIBUTIONS (continued)

58 "Faults and Earthquakes in the Monterey Bay Region, California," by H. G. Greene, W.H.K. Lee, D. S. McCulloch, and E. E. Brabb, 1973 (Miscellaneous Field Studies Map MF-518). Four map sheets, plus text; scale is 1:200,000.

The maps delineate faults and show earthquake epicenters in the Monterey Bay region. Emphasis is placed upon two seismically active fault zones present there: the Palo Colorado-San Gregorio and the Monterey Bay Fault Zones. The text describes these fault zones and discusses the seismicity in the area and the evidence for recent faulting. Estimates are made of how large an earthquake could occur on the Palo Colorado-San Gregorio Fault.

59 "Preliminary Photointerpretation Map of Landslide and Other Surficial Deposits of the Livermore and Part of the Hayward 15-minute Quadrangles, Alameda and Contra Costa Counties, California," by Tor Nilsen, 1973 (Miscellaneous Field Studies Map MF-519). Two sheets, scale is 1:62,500.

The map shows the distribution of landslides, alluvium, colluvium, marshland, and terrace deposits for the southwestern portion of Alameda County. The map covers the area from Livermore on the east to Hayward on the west and from the Oakland area on the north to Piedmont on the south. The text describes the map, states the characteristics of surficial deposits relevant to land-use planning, and gives suggestions for map use.

60 "Map Showing Evidence for Recent Fault Activity in the Vicinity of Antioch, Contra Costa County, California," by D. B. Burke and E. J. Helley, 1973. (Miscellaneous Field Studies Map MF-533). One sheet, scale is 1:24,000.

The map shows localities where evidence exists that indicate the presence of historic tectonic movement on a previously unrecognized fault in the vicinity of Antioch in northeastern Contra Costa County. A short text on the map sheet discusses this evidence and its relation to the seismicity in the area.

61 "Map Showing Areas Bordering the Southern Part of San Francisco Bay Where a High Water Table May Adversely Affect Land Use," by D. A. Webster, 1973 (Miscellaneous Field Studies Map MF-530)

The map presents information about the depth to the top of the water table, outlines problems that may develop when the water table approaches the land surface, and identifies areas where ground water may cause problems to landowners.

62 "San Francisco Bay Region Land Use Maps: Two samples," by U.S. Geological Survey, 1974 (open-file map). Two map sheets, scale is 1:62,500.

Two maps from a set of 44 that show 1970 land use and census tracts in the San Francisco Bay Region. Fourteen land-use types are subdivided under the three major groupings of livelihood, residential, and open space and agricultural.

63 "Isopleth Map of Landslide Deposits, Southern San Francisco Bay Region, California," by Robert H. Wright and Tor H. Nilsen, 1974 (Miscellaneous Field Studies Map MF-550). 1 map sheet, scale is 1:125,000.

Essentially a contour map of the distribution of landslides, the map was produced to be used with other quantified map data, and it is one of the sources of information used in the preparation of slope stability maps. A short explanation on the map sheet describes how the map was produced. The mapped area includes the area in Alameda, San Mateo and Santa Clara Counties, and the southern portions of Contra Costa and Marin Counties.

64 "Preliminary Geologic Map of Marin, and San Francisco Counties and Parts of Alameda, Contra Costa and Sonoma Counties, California," by M. C. Blake, Jr., J. A. Bartow, V. A. Frizzell, Jr., J. Schlocker, D. Sorg, C. M. Wentworth and R. H. Wright, 1974 (Miscellaneous Field Studies Map MF-574). Two map sheets, scale is 1:62,500.

The map shows the distribution of geologic units and structures within and immediately surrounding Marin County. In addition to showing bedrock units, fourteen different types of younger deposits are delineated including, among others, beach and dune sands, marine and marsh deposits, larger areas of landslide deposits, and artificial fill.

65 "Map Showing the Distribution of Potassium Feldspar and Fossils in Mesozoic Rocks of Marin and San Francisco Counties, and Parts of Alameda, Contra Costa, and Sonoma Counties, California," by Robert H. Wright, 1974 (Miscellaneous Field Studies Map MF-573). One map sheet, scale is 1:125,000.

Title is descriptive of content of map. Data from this map was used in the preparation of Basic Data Contribution 64.

BASIC DATA CONTRIBUTIONS (continued)

66 "Reconnaissance Photointerpretation Map of Landslides in Parts of the Hopland, Kelseyville, and Lower Lake 15-minute Quadrangles, Sonoma County, California," by Virgil A. Frizzell, Jr., 1974 (Miscellaneous Field Studies Map MF-594). One map sheet, scale is 1:62,500.

The map shows the distribution of landslides, alluvium, and terrace deposits for the northern most portion of Sonoma County including the Cloverdale and The Geysers areas. The text describes the map, states the characteristics of mapped deposits and gives suggestions for map use.

67 "Preliminary Photointerpretation Map of Landslide and Other Surficial Deposits of the Mare Island and Carquinez Strait 15-minute Quadrangles, Contra Costa, Marin, Napa, Solano, and Sonoma Counties, California," by Virgil A. Frizzell, Jr., John D. Sims, Tor H. Nilsen, and John A. Bartow, 1974 (Miscellaneous Field Studies Map MF-595). Two map sheets, scale is 1:62,500.

The map shows the distribution of landslides, alluvium, colluvium, marsh deposits and artificial fill for the area between Fairfield to Sears Point on the north and Point Pinole to Concord on the south. The text describes some of the characteristics of the deposits that are critical to land-use planning and indicates appropriate uses of the map.

68 "Geologic Map of Unconsolidated and Moderately Consolidated Deposits of San Mateo County, California," by K. R. Lajoie, E. J. Helley, D. R. Nichols, and D. B. Burke, 1974 (Miscellaneous Field Studies Map MF- 575). Explanation sheet plus map sheet, scale is 1:62,500.

The map shows the distribution of unconsolidated deposits in San Mateo County. Mapped deposits include, among others, colluvium, alluvium, young mud, beach and dune sands, marine terrace deposits, the Colma formation, and the Merced formation. An extensive tabular explanation provides information about these young deposits that will be useful to property owners, planners, or engineers. In addition, the explanation sheet contains a summary of the depositional history of the units.

69 "Mean Annual Runoff in the San Francisco Bay Region California, 1931-70," by S. E. Rantz, 1974 (Miscellaneous Field Studies Map MF-613). 24 page pamphlet and two maps. Scale is 1:500,000.

The runoff described on this map represents natural flow derived using data from 76 gaging stations which are on virtually undeveloped streams. The report is a byproduct from a series of reports by Rantz concerning annual precipitation, precipitation depth-duration-frequency relations, and hydrologic design of storm-drainage facilities, and it can be used by engineers and planners in preliminary planning of drainage and flood control facilities.

70 "Limnological Data from Selected Lakes in the San Francisco Bay Region, California," by Linda J. Britton, Rodger F. Ferreira, and Robert C. Averett, 1974 (open-file report). 79 pages.

This is a compilation of data from 21 selected lakes in the San Francisco Bay area. The history of each lake and of its respective regulating agency is presented. Although the type of data presented for each lake differs, physical features, chemical analysis, dissolved oxygen, temperatures, pH, and comparisons of phytoplankton concentrations are presented for many lakes.

APPENDIX B

Technical Reports

TR No. 1 "A Preliminary Study of the Effects of Water Circulation in the San Francisco Bay Estuary," (Circular 637-A,B), by D. S. McCulloch, D. H. Peterson, P. R. Carlson and T. J. Conomos, 1970, 35 p.

The report qualitatively demonstrates that high and low seasonal inflows of fresh water to the Sacramento-San Joaquin Delta correlate inversely with salinity and phosphate concentrations in the south bay. It suggests that net fresh-water flow to the bay from this source is a major quality control factor under present conditions.

2 "Land Subsidence in the Santa Clara Valley, Alameda, San Mateo, and Santa Clara Counties, California," by J. F. Poland, 1971 (Miscellaneous Field Studies Map MF-336). One sheet, map scale is 1:125,000.

This report documents the extensive subsidence affecting 250 square miles in the Santa Clara Valley since 1912, and demonstrates that it is caused mainly by clay compaction due to ground-water withdrawal. Procedures are given for determining the ultimate subsidence where the compressibility of the sediments is known, and prediction is made as to the ground-water level necessary to halt subsidence in the valley. About $13 million has been spent by public agencies for levee construction and repair of water well casings that was made necessary by subsidence.

3 "Suggested Criteria for Hydrologic Design of Storm-Drainage Faciilities in the San Francisco Bay Region, California," by S. E. Rantz, 1971, 69 p. (open-file report).

The term "hydrologic design", as used in this report, refers to the computation of design storm discharges, and not to the hydraulic design of the drainage facilities. The report presents criteria for use of the four most widely accepted methods of hydrologic design. Sample problems are worked out for each method, and results are evaluated. The report also discusses the characteristics of urban development that affect storm runoff, and suggests ways to reduce peak discharge in urban areas.

4 "Real-Estate Lakes," by David A. Rickert and Andrew M. Spieker, 1971 (Circular 601-G), 19 p.

This booklet deals with the planning and management of real-estate lakes, and discusses the various factors contributing to pollution, sedimentation, and use problems. Many suggestions are given for avoiding and/or minimizing the undesirable aspects of urban lakes.

5 "A Review of Benthic Faunal Surveys in San Francisco Bay," by Frederic Nichols, 1973 (Circular 677), 20 pages.

This report provides an overview of the various studies done on bottom-dwelling animal life in the Bay, and the general results of the studies. There is also a discussion of past and current study techniques, their general effectiveness and shortcomings. A concluding section delineates directions future research could take in assessing the relative "health" of benthic communities and the effects of man-induced pollution. The report suggests that a joint effort be undertaken by all agencies concerned, using standardized methods.

6. "Effects of Urbanization on Sedimentation and Flood-flows in Colma Creek Basin, California," by J. M. Knott, 1973 (open-file report), 54 pages.

This report deals with the effects of various land uses on stream flow, erosion, and sediment transport in the Colma Creek basin. The area includes Daly City and South San Francisco, and is bounded on the north by San Bruno Mountain. The report documents the sediment transport (and associated erosion rates) through a time of extensive urban expansion (1964-1971), and provides a comparison of erosion rates for areas in urban, agricultural, construction, and open-space land uses. The author uses the data to project future sediment yields for the area, depending on eventual land use.

APPENDIX C

Interpretive Reports

IR No. 1 "Role of Water in Urban Planning and Management," by William J. Schneider, David A. Rickert and Andrew M. Spieker, 1973 (Circular 601-H), 10 p.

The report deals with the application and use of hydrologic factors in land-use planning, and outlines a method for evaluating and ranking the types of water information that should be applied to a particular planning need. The advantages of dealing with water resources planning at a regional level are also discussed. The Washington, D.C.-Baltimore area is used as a case study, but the underlying principles and methods are equally applicable to the Bay Region.

2 "A Review of Wastewater Problems and Wastewater-Management Planning in the San Francisco Bay Region, California," by W. G. Hines, 1973 (open-file report), 45 pages plus Appendices A, B, and C.

The report describes the characteristics of the major pollutional types found in wastewater in the San Francisco Bay Region. The geographical distribution and pollutional loading of wastewater discharges into the Bay are described. The report includes a documentation of water-quality problems attributed to wastewater discharges and a discussion on the planning implications of the wastewater effects on the quality of regional surface water. Future outlook for management of wastewater in the San Francisco Bay region is also discussed.

3 "Erosional and Depositional Provinces and Sediment Transport in the South and Central Part of the San Francisco Bay Region, California," by Bill Brown and Lionel Jackson , 1973 (Miscellaneous Field Studies map MF-515). Three sheets plus a pamphlet text, scale is 1:125,000.

This report deals with the interrelated processes involved in the erosion, transportation, and deposition of sediment in the South and Central part of the San Francisco Bay region. It presents both quantitative and conceptual information on these processes and their relation to man's activities.

4 "Flood Prone Areas in the San Francisco Bay Region, California," by J. T. Limerinos, K. W. Lee, and P. E. Lugo, 1973, (Water Resources Investigation 37-73). Three map sheets; scale is 1:125,000.

The map shows the areas in the San Francisco Bay region that may be inundated by a 100-year flood. A short text discusses the concepts of the 100-year flood and explains the compilation methods involved in the production of the map.

5 "Availability of Data on Surface-Water Quantity and Quality for the San Francisco Bay Region, California," by Joseph Goss, 1973, (Miscellaneous Field Studies Map MF-526). Nine page text, tables, and map with scale of 1:250,000.

The report gives an overview of important aspects of the surface-water resources in the bay region; discusses water-quality criteria and improtant pollutants in relation to the water quality recommended for beneficial uses; outlines water-quality objectives recommended by the California Water Quality Control Board for streams, other water bodies, and drainage basins; and gives examples of the kinds of problems that require decisions by planners and government officials.

6 "Evaluating Pollution Potential of Land-Based Waste Disposal, Santa Clara County, California," by W. G. Hines, 1973, (Water Resources Investigation 31-73). Twenty-one page text and two map sheets, scale is 1:62,500.

The report is intended to aquaint planners and other decision makers with the usefulness of earth-science data when analyzing pollution and waste-disposal problems in relation to land-use planning. In the report the author emphasizes the following topics: 1) an identification and description of factors that interact to form pollution hazards; 2) a presentation of selected examples of, and possible control measures for, pollution hazards typically encountered in the bay region environment; and 3) criteria and methodology needed for the preliminary evaluation of the suitability of land areas intended for waste-disposal sites.

INTERPRETIVE REPORTS (continued)

7 "Sediment Source and Deposition Sites and Erosional and Depositional Provinces, Marin and Sonoma Counties, California," by William M. Brown III and Lionel E. Jackson, Jr., 1974 (Miscellaneous Field Studies Map MF-625). 31-page text and two map sheets; scale is 1:125,000.

The report is concerned with the erosion, transportation, and deposition of sediment as a process that alters the land surface. It explains what sediment is, where it comes from, and where it goes. The report describes how and why sediment moves from one point to another and defines erosional and depositional provinces. For areas where data are available, it describes rates and quantities of sediment movement.

APPENDIX D

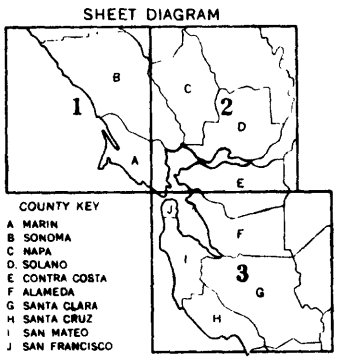
Photographic and Topographic Products

Topographic Map of the San Francisco Bay Region in 3 sheets, scale is 1:125,000 (2 miles = approx. 1 inch), contour interval is 200 feet with 40-foot intervals in flat land.

Topography, roads, and waterways form the basis of this full-color map of the greater Bay Region. The scale of this map is such that the three sheets will display the entire 10-county San Francisco Bay Region on a wall, and yet every street in the urban areas is clearly visible, allowing points to be located within a city block. Public parks, forests, and reserves, as well as airports, military bases, and cemeteries are distinguished with subtle tints, and marshes, tidal flat areas, and salt evaporators are shown by standard symbols. The sheets measure 35 to 42 inches on a side, covering the areas shown below.

Slope Map of the San Francisco Bay Region in 3 sheets, scale is 1:125,000.

The steepness of the terrain throughout the greater Bay Region is designated on the map by six color-coded slope zones: 0-5%, 5-15%, 15-30%, 30-50%, 50-70% slope, and 70% slope to vertical (a slope of 45 degrees is defined as 100% slope). The map covers the same 10-county area, in the same three-sheet format as the Topographic Map (see diagram below). The printed slope map can be obtained in the same way as the topographic map.



Slope maps for smaller areas within the Bay Region at scales of 1:62,500 or 1:24,000 can be individually made on special request to the Topographic Division in Menlo Park.

Orthophoto Quads covering areas equivalent to the 196 7-1/2 minute topographic quadrangles of the area shown above, at a scale of 1:24,000. On photographic paper $6.50 each and $8.00 with contours; on scale-stable film $20.00 each.

Orthophoto Mosaic of the San Francisco Bay Region in three sheets (see diagram above) covering approximately 3,000 sq. mi. each, at a scale of 1:125,000. On photo paper $16.00/sheet; on scale-stable film $23.00/sheet.

APPENDIX E

County Personnel Interviewed

Name	Position	Agency or Firm
ALAMEDA COUNTY		
Bill Allin	Planner	Planning
David Carpenter	Engineering Geologist	Public Works
Betty Croly	Senior Planner	Planning
Rod Egger	Planner III	Planning
William Fraley	Director	Planning
Bruce Fry	Senior Planner	Planning
Susan Hootkins	Planner II	Planning
James Sorensen	Current Planner	Planning
Jerry Wallace	Planner II	Planning
Frank Zwolinski	Coordinator	Emergency Services
CONTRA COSTA COUNTY		
Melvin Bobier	Project Planner	Planning
Gene Borcin	Senior Planner	Planning
Jim Cutler	Project Planner	Planning
Anthony Dehaesus	Director	Planning
Heinz Fenichel	Assistant Director	Planning
Dennis Mesick	Planner	Planning
Darwin Meyer	Staff Geologist	Planning
Katherine Robinson	Planner II	Planning
Dale Sander	Planning Ecologist	Planning
Chuck Zahn	Planner	Planning
MARIN COUNTY		
Ray Ahearn	Planner	Planning
Harvey Bragdon	Chief Planner	Planning
Steve Chaum	Community Planner	Planning
Richard Harris	Environmental Analyst	Planning
Marjorie Macris	Principal Planner	Planning
Salem Rice	Staff Geologist	Calif. Div. of Mines & Geol.
Dick Shaler	Mapping Supervisor	Public Works
Sol Silver	Chief Planner	Planning
Werner von Gundell	Special Proj. Officer	Planning
Herbert Wimmer	Chief Inspector	Building
NAPA COUNTY		
Lou Archeleta	Associate Planner	Planning
Bruce Baracco	Planner	Planning
Ronald Guderson	Assistant Director	Emergency Services
James Hickey	Director	Planning

APPENDIX E--continued

County Personnel Interviewed

Name	Position	Agency or Firm
NAPA COUNTY (Continued)		
Robert Jones	Civil Engineer	Flood Control
J. B. Klein	Civil Engineer	Public Works
Anthony McClimmons	Senior Planner	Planning
James O'Loughlin	Associate Planner	Planning
James Page	Sanitarian	Environmental Health
Steve Rae	Associate Planner	Planning
John Stewart	Civil Engineer	Public Works
A. R. Van Woerkom	Sanitarian III	Environmental Health
SAN MATEO COUNTY		
S. A. Armogida	Waste Mgmt. Engineer	Engineering
James Brugger	Appraiser II	Assessor's Office
Brian Brumm	Consumer Specialist	Environmental Health
Don Craig	Planner III	Planning
Robert Cunningham	Training Officer	Civil Defense
Jack Estes	County Assessor	Assessor's Office
Roman Gankin	Senior Planner	Planning
Gerald Greeve	Assist. Administrator	Civil Defense
Mark Haun	Senior Planner	Planning
Stanley Johnson	Civil Engineer	Engineering
Bill Kritikos	Planner II	Planning
Gary Lane	Planner II	Planning
George Miller	Planner III	Planning
Robert Miller	Civil Engineer	Building
Anne Parke	Planner III	Planning
Gerry Steere	Division Chief	Planning
Peter Twight	Natural Resources Coord.	Planning
Donald Woolfe	Director	Planning
SANTA CLARA COUNTY		
James Berkland	Engineering Geologist	Public Works
Steve Brooks	Environmental Specialist	Environmental Health
Roy Cameron	Director	Planning
David Culbertson	Superintendent	Parks
Arthur Devincenze	Civil Engineer	Transportation
Felice Errico	Park Planner	Parks
Marilou Ficklin	Planner	Planning
Henry Johnson	Ordinance Administrator	Planning
Ed Locke	Engineering Consultant	Metcalf & Eddy
Floyd Minata	Planner	Planning
Craig Parada	Planner	Planning
Floyd Talbot	Librarian	Planning
Warren Terriberi	Associate Planner	Planning
Eleanor Young	Planner	Planning

APPENDIX E--continued

County Personnel Interviewed

Name	Position	Agency or Firm
SOLANO COUNTY		
Louis Esperance	Building-Zoning Inspector	Planning
John Gray	Deputy Director	Public Works
Robert Grunwald	Planning Consultant	Grunwald-Crawford & Assoc.
Michael Harrold	Planner III	Planning
F. R. Henrekin	Staff Consultant	Industrial Development
Robert Johnson	Building-Zoning Tech.	Planning
Dave McCrealy	Assistant Director	Emergency Services
Charles Moore	Planner	Planning
Clayne Munk	Director	Planning
John O'Rourke	Consultant	Cooper-Clark Geotechnic Cons.
John Swenson	Engineer	Flood Control
John Wagstaff	Consultant	Sedway/Cooke Planning Cons.
SONOMA COUNTY		
George Blue	Building Inspector	Building
Dewey Butzer	Assistant Director	Public Works
Jim Casper	Chief Planner	Planning
Tom Cordill	Environ. Administrator	Planning
Paul Fenner	Environ. Resource Planner	Planning
Bob Gaskill	Administrative Assistant	Planning
John Graham	Planner II	Planning
Don Head	Engineer	Public Works
Mike Huffman	Geologist	Calif. Div. of Mines & Geol.
Jeff Hulse	Planner III	Planning
George Kovatch	Director	Planning
Steve Maki	Planner II	Planning
Ken Preston	Cartographer	Planning
Richard Retecki	Planner II	Planning
John Sudero	Planner III	Planning

APPENDIX F

County Documents Citing SFBRS Products

ALAMEDA COUNTY

County Planning Department, 1975, Preliminary draft: Solid waste management plan and draft environmental impact report: 176 p.

Goldman, Harold B., 1973, Hayward Shoreline environmental analysis: 36 p.

*Office of Emergency Services, 1973, Emergency operations plan: 359 p.

*Woodward-Lundgren and Associates, 1975, (Composite geologic hazards maps based on fault, landslide and geologic data from SFBRS products compiled on the 24 USGS 7½-minute topographic base maps covering Alameda County): scale 1:24,000.

CONTRA COSTA COUNTY

Cooper-Clark and Associates, 1975, Geotechnical services, solid waste management plans: 29 p.

County Planning Department, 1971, Land use and transportation study: 84 p.

_____1973, Environmental impact report, subdivision 4508, Bryan and Murphy: 28 p.

_____1973, Open space-conservation plan: 76 p. (SFBRS products used but not cited).

_____1974, Environmental impact report, 1887-R2-Coleman and Isakson, Incorporated: 16 p.

_____1974, Physical resources for the greater San Ramon Valley planning area: 64 p.

_____1975, Seismic safety element, 106 p.

*_____1975, Seismic safety element, technical background report: 269 p.

Tri-Cities Seismic Safety and Environmental Resources Study, 1973, Environmental analysis of western Contra Costa County: 371 p.

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* Indicates those documents discussed under the Selected Applications section of this report.

MARIN COUNTY

County Planning Department, 1973, The Marin countywide plan: 107 p.

Rice, Salem J., California Division of Mines and Geology, 1973, Geology and geologic hazards of the Novato area: 47 p.

*_____1975, Correspondence dated December 12, 1975: 2 p.

*_____1975, Geology for planning, Novato area: 56 p., 6 pls.

NAPA COUNTY

County Planning Department, 1973, Conservation and open space element: 36 p.

_____1974, Summary general plan: 6 p.

*_____1975, Land use element: 63 p.

_____1975, Seismic safety element: 58 p.

Earth Metrics, Inc., 1975, Draft environmental impact report, Souverain Vineyards subdivision, unit I: 139 p.

Environmental Impact Planning Corporation, 1975, Final environmental impact report, Monticello Ranch and Cattle Company: 122 p.

SAN MATEO COUNTY

*City-County Planning Task Force, 1975, Draft seismic and safety elements of the general plan, vols. I, II: 362 p.

*County Board of Supervisors, 1973, Ordinance No. 2229 adopted December 20, 1973, adding a Resource Management District and regulations to the county zoning ordinance: 24 p.

County Engineering and Road Department, 1975, Solid waste management plan: 361 p.

County Planning Department, 1973, Conservation and open space element: 203 p.

EDAW, Inc., 1975, Environmental impact report, San Pedro Valley County Park: 190 p.

_____1975, Master plan, San Pedro Valley County Park: 45 p.

SAN MATEO COUNTY (continued)

*Leighton, F. Beach, and Associates, 1972, Geotechnical guidelines for county review of future private construction projects: 4 p.

*Leighton, Yen, and Associates, Inc., 1972, Recommended geotechnical review procedure: 2 p.

Parke, Anne A., County Planning Dept., 1974, Staff report regarding California Department of Transportation draft environmental impact statement--route 380 Portola Freeway and alternatives: 6 p.

*Woolfe, Donald A., County Planning Department, 1973, Memorandum dated September 21, 1973: 32 p.

SANTA CLARA COUNTY

Baylands Subcommittee of the Planning Policy Committee, 1971, P.P.C. baylands findings, goals and policies for balloting: 117 p.

California Division of Mines & Geology, 1974, Environmental Geologic Atlas of the Northern Santa Cruz Mountain Range: 48 p.

*County Board of Supervisors, 1974, Ordinance No. NS 1203.31, adopted November 6, 1974, amending the subdivision, building, and grading ordinances and adding geologic hazard maps to the County Ordinance Code: 11 p.

*County Planning Department, 1973, A plan for the conservation of resources: 49 p.

*_____1973, Public safety maps nos. 1 & 2: 2 pls.

*_____1975, Seismic safety plan, An element of the general plan: 119 p.

Hillside Subcommittee of the Planning Policy Committee of Santa Clara County, 1972, A conservation/development plan for the Santa Cruz Mountains: 28 p. (SFBRS products used but not cited)

Planning Policy Committee of Santa Clara County, 1973, An urban development/open space plan for Santa Clara County: 74 p. (SFBRS products used but not cited)

SOLANO COUNTY

*Cooper-Clark and Associates, 1975, Report, preliminary geotechnical services, solid waste management plan: 15 p., 1 map.

*Gilbert, J. B., and Associates, 1975, Draft environmental impact report, Dow Petrochemical project: 298 p.

Karl Baruth Associates, 1973, City of Rio Vista-southwestern Solano County planning areas, general plan 1990: 278 p.

Sedway/Cooke, 1975, Health and safety: 73 p.

Wilsey and Ham with Cooper-Clark and Associates, Wildlife Associates, and William C. Ellis, ground-water hydrologist, 1973, Draft, Potrero Hills environmental impact report: 95 p.

SONOMA COUNTY

*Advanced Planning Division, 1974, Environmental resources management element: 46 p.

California Department of Water Resources in cooperation with county of Sonoma, 1974, Evaluation of ground water: 177 p.

California Division of Mines and Geology in cooperation with Sonoma County Planning Department, 1972, Geology for planning on the Sonoma coast between the Russian and Gualala Rivers: 38 p.

_____1973, Geology for planning of the Sonoma coast between the Russian River and Estero Americano: 42 p.

*County Planning Department, 1973, Open space element, phase II: 93 p.

Huffman, M. E., and Armstrong, C. F., 1974, Geology for planning in Sonoma county: 100 p., 11 pls.

Huffman, M. E., and Bishop, C. C., 1975, Geology work plans for Sonoma county: 85 p.

APPENDIX G

Other USGS Products Identified by Counties

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Bailey, E. H., and Harden, D. R., 1975, Mineral resources of the San Francisco Bay region, California--Present availability and planning for the future: U.S. Geol. Survey Misc. Inv. Series, Map I-909 (with pamphlet).

Barosh, P. J., 1969, Use of seismic intensity data to predict the effects of earthquakes and underground nuclear explosions in various geologic settings: U.S. Geol. Survey Bull. 1279, 93 p.

Bonilla, M. G., 1960, Landslides in the San Francisco South quadrangle, California: U.S. Geol. Survey open-file report, p. 44.

_____1967, Historic surface faulting in continental United States and adjacent parts of Mexico: U.S. Geol. Survey open-file report, 35 p.

Bonilla, M. G., and Buchanan, J. M., 1970, Interim report on worldwide historic surface faulting: U.S. Geol. Survey open-file report, 32 p.

Bonilla, M. G., and Gates, George O., 1961, Possible earthquake hazards at the site of proposed Foster City, San Mateo County, California: U.S. Geol. Survey, 33 p.

Borcherdt, R. D., and Gibbs, J. F., 1975, Prediction of maximum earthquake intensities for the San Francisco Bay region: U.S. Geol. Survey open-file report 75-180, 26 p.

Brobst, Donald A., Pratt, Walden, and McKelvey, V. E., 1973, United States mineral resources: U.S. Geol. Survey Prof. Paper 820, 722 p.

Brown, R. D., Jr., Vedder, J. G., Wallace, R. E., Roth, E. F., Yerkes, R. F., Castle, R. O., Waananen, A. O., Page, R. W., and Eaton, J. P., 1967, The Parkfield-Cholame earthquakes of June-August 1966--Surface geologic effects, water resources aspects, and preliminary seismic data: U.S. Geol. Survey Prof. Paper 579, 66 p.

Brown, W. M., III, 1971, Preliminary investigation of suspended-sand discharge of the Russian River, Sonoma County, California: U.S. Geol. Survey open-file report, 11 p.

Cardwell, G. T., 1958, Geology and ground water in the Santa Rosa and Petaluma Valley areas, Sonoma County, California: U.S. Geol. Survey Water Supply Paper 1427, 273 p.

Cardwell, G. T., 1965, Geology and ground water in Russian River Valley areas, and in Round, Laytonville, and Little Lake Valleys, Sonoma and Mendocino Counties, California: U.S. Geol. Survey Water Supply Paper 1548, 154 p.

Case, J. E., 1968, Upper Cretaceous and lower Tertiary rock, Berkeley and San Leandro Hills, California: U.S. Geol. Survey Bulletin 1251J, 29 p.

Dibblee, T. W., Jr., 1966, Geologic map and sections of the Palo Alto 15-minute quadrangle, California: prepared in cooperation U.S. Geol. Survey, Menlo Park, scale 1:48,000.

_____1972, Geology of the Calaveras Reservoir quadrangle, California: U.S. Geol. Survey open-file map, scale 1:24,000.

_____1972, Geology of the Milpitas quadrangle, California: U.S. Geol. Survey open-file map, scale 1:24,000.

_____1972, Preliminary geologic map of the Lick Observatory quadrangle, California: U.S. Geol. Survey open-file map, scale 1:24,000.

_____1972, Preliminary geologic map of the San Jose East quadrangle, California: U.S. Geol. Survey open-file map, scale 1:24,000.

_____1973, Preliminary geologic map of the Gilroy quadrangle, California: U.S. Geol. Survey open-file map, scale 1:24,000.

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Feth, J. H., 1973, Water facts and figures for planners and managers: U.S. Geol. Survey Circ. 601-I, 30 p.

Fuller, M. L., 1912, The New Madrid earthquake: U.S. Geol. Survey Bull. 494, 119 p.

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Kunkel, Fred, and Upson, J. E., 1960, Geology and ground water in Napa and Sonoma Valleys, Napa and Sonoma Counties, California: U.S. Geol. Survey Water Supply Paper 1495, 252 p.

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Leopold, L. B., 1968, Hydrology for urban land planning--A guidebook on the hydrologic effects of urbanization: U.S. Geol. Survey Circ. 554, 18 p.

Leopold, L. B., Clarke, F. E., Hanshaw, B. B., and Balsley, J. R., 1971, A procedure for evaluating environmental impact: U.S. Geol. Survey Circ. 645, 13 p.

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Limerinos, J. T., 1970, Floods on Napa River at Napa, California: U.S. Geol. Survey Hydrologic Investigations Atlas, HA-348, scale 1:24,000.

Limerinos, J. T., and Smith, W., 1975, Evaluation of the causes of levee erosion in the Sacramento-San Joaquin Delta, California: U.S. Geol. Survey Water Resources Investigation 28-74, 53 p.

Lofgren, B. E., 1968, Analysis of stress causing land subsidence: U.S. Geol. Survey Prof. Paper 600-B, pp. B219-B225.

McCulloch, D. S., 1966, The Alaska earthquake, March 27, 1964, Regional effects, slide-induced waves, seiching, and ground fracturing at Kenai Lake, Alaska: U.S. Geol. Survey Prof. Paper 543-A, 41 p.

McCulloch, D. S., and Bonilla, M. G., 1970, Effects of the earthquake of March 27, 1964, on the Alaskan Railroad: U.S. Geol. Survey Prof. Paper 545-D., pp. D1-D161.

McGill, J. T., 1959, Preliminary map of the landslides in the Pacific Palisades area, City of Los Angeles, California: U.S. Geol. Survey Misc. Geol. Invest. Map I-284, scale 1:48,000.

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_____1974, The Sargent-Berrocal fault zone and its relation to the San Andreas fault system in the southern San Francisco Bay region and Santa Clara Valley, California: Journal of Research, U.S. Geol. Survey, 11, no. 2, pp. 593-598.

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Nichols, D. R., and Campbell, C. C., eds., 1971, Environmental planning and geology: U.S. Geol. Survey and U.S. Dept. Housing and Urban Development, 204 p.

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Radbruch, D. H., 1957, Areal and engineering geology of the Oakland West quadrangle, California: U.S. Geol. Survey Misc. Geol. Invest. Map I-239, scale 1:24,000.

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_____1968, Recently active breaks along the Hayward fault zone and the southern part of the Calaveras fault zone, California: U.S. Geol. Survey open-file map, scale 1:24,000.

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Radbruch, D. H., Bonilla, M. G., and others, 1966, Tectonic creep in the Hayward fault zone, California: U.S. Geol. Survey Circ. 525, 13 p.

Radbruch, D. H., and Case, J. E., 1967, Preliminary geologic map and engineering geologic information: Oakland and vicinity, California: U.S. Geol. Survey open-file report, scale 1:24,000.

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Ritter, R. J., and Brown, W. M., III, 1971, Turbidity and suspended-sediment transport in the Russian River Basin, California: U.S. Geol. Survey open-file report, 128 p.

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Schlocker, J., and Bonilla, M. G., 1964, Engineering geology of the proposed nuclear power plant on Bodega Head, Sonoma County, California: U.S. Geol. Survey Report, 31 p.

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Thomas, T. E., and Schneider, W. J., 1970, Water as an urban resource and nuisance: U.S. Geol. Survey Circ. 601-D, 9 p.

Thomasson, H. G., Jr., Olmsted, F. H., and LeRoux, E. F., 1960, Geology, water resources and usable ground-water storage capacity of part of Solano County, California: U.S. Geol. Survey water-supply paper 1464, 693 p.

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_____1971, Index of surface water records to September 30, 1971, pt. II; Pacific slope basins in northern California: U.S. Geol. Survey Circ. 661, 53 p.

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_____1973, Water investigations 13-73, ground-water hydrology of northern Napa Valley, p. 64.

_____1974, Selected ground-water data, 1969-1974, Suisun Bay area.

_____7½-minute series (topographic), various quadrangles in the San Francisco Bay region: scale 1:24,000.

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