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The Alaska Case

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The Great Alaska Earthquake of 1964 and its effects on natural processes and on the manmade environment provides the opportunity to analyze the value of experience and the relevance of research conducted by various agencies to minimize loss of life and property and to set guidelines for short-and long-range recovery from a major disaster. The study focuses on the role of scientific information, public administration, and planning efforts to mitigate the effects of earthquakes, based on the experience of the 1964 Alaska earthquake. The report discusses key obstacles to implementation of risk mitigation measures, suggests a role for seismic risk in the comprehensive planning and administrative decisionmaking processes, and offers recommendations designed to promote implementation of seismic risk mitigation.

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Summary

EARTHQUAKE HAZARD MITIGATION

Planning and Policy Implementation
The Alaska Case

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All of the materials incorporated in this work were developed with the financial support of National Science Foundation Grant CEE 8112632. However, any opinions, findings, conclusions, or recommendations expressed are those of the authors and do not necessarily reflect the views of the Foundation.

Report Objectives

The great Alaska earthquake of 1964 and its effects on natural processes and on the man-made environment provide a classic case study of nature--human and otherwise. Under the sponsorship of the National Academy of Sciences, eight volumes recorded the Alaska earthquake, its effects on the environment and people, and the participation of government: The Great Alaska Earthquake of 1964:Geology; Seismology and Geodesy; Hydrology; Biology; Oceanography and Coastal Engineering; Engineering; Human Ecology; Summary and Recommendations. Two distinct phases emerge from a review of the NAS reports and evaluation of recovery efforts after the March 27, 1964 earthquake:

- o Immediate Relief-Short-Term Restoration
- o Long-Range Recovery and Reconstruction

Immediate relief and short-term restoration were handled effectively by private citizens and local governments with assistance from military, federal, state agencies and private non-profit corporations. However, agencies, policy makers, and citizens involved in the recovery efforts were frequently unaware of the impact that one phase would have on later phases. Decisions were often made on an ad hoc basis which disregarded long-range effects.

Review of present preparedness reveals that if a major earthquake were to occur today the state would be no better prepared than on March 27, 1964. In fact, as a result of increased population and development in upper Cook Inlet, many scientists, planners, and administrators believe that another earthquake would have even greater impact on commerce and people than in 1964. Destruction of transportation systems and commerce in Anchorage, the State's major city and distribution center, would effect the entire state economy. Measures which might have been taken to reduce the dangers from earthquakes and tsunamis have not been taken or have only been partially or imperfectly instituted. Furthermore, lands designated high risk have been developed for all uses.

This Summary discusses key obstacles to implementation of risk mitigation measures, suggests a role for seismic risk in the comprehensive planning and administrative decision making processes, and offers recommendations designed to promote implementation of seismic risk mitigation.

Obstacles to Implementation of Seismic Risk Mitigation

The study focused on the role of scientific information, public administration, and planning efforts to mitigate the effects of earthquakes based on the experience of the 1964 Alaska earthquake. Many people interviewed for this study were pessimistic about

the prospects of improved risk mitigation efforts, and they often cited specific impediments, including technical issues of geology, land use allocation, government organization, and specific planning and management problems. Also, there was a broader concern related to the obvious lack of implementation of well known public safety measures.

The critical obstacles to implementation of risk mitigation in Alaska are organizational and political. Organizational obstacles include imperfect scientific information and defective theoretical approaches; ambiguous policy directives; dominance of the "rational actor" model of decision making; and the difficulty of sustaining interest in the issue over time. Political obstacles to mitigation are broader and more difficult to specify and yet probably are more important. They include leaders lacking knowledge, sympathy, or commitment to implementation, aspects of the political culture--pluralistic and elite politics-- and inadequate of definition of the government level responsible for mitigation.

Comprehensive Planning Model for Risk Mitigation

Effective risk mitigation planning must take place before disaster strikes. A planning model, that includes a "risk" component as an integral part of the comprehensive planning process is presented as a means to resolve some of the basic problems encountered in assuring that risk mitigation is integrated into future urban and regional development.

The present concept of planning as a proces for setting goal statements without the development of specific guidelines for implementation has resulted in sparadic and inconsistent application of technology directed to risk mitigation and of other technologies directed to land use allocation, transportation, and utilities development. If a planning process is to be successful, it must include: 1) development of comprehensive goals and objectives based on the understanding of the physical, social, and economic makeup of the regional/urban system, and 2) development of a master plan for implementation through team building.

In order to achieve effective implementation any plan for seismic risk mitigation should reflect the shared responsibility among all levels of government. To implement risk mitigation measures, better communication must be established among these partners and between government decision makers and the public.

The Federal Government would play a key catalytic and regulatory role by intro-

ducing incentive programs that would help reduce earthquake hazards or spread the risk. This could include the use of grant, loan, and revenue-sharing programs to ensure consideration of seismic and geologic hazards and see that adequate steps are taken to minimize them. The Federal Government could also institute insurance programs to protect lives and property by requiring future building to be constructed in safe locations and built according to earthquake-resistant standards.

State government must work with local governments to develop and encourage seismic safety regulatory efforts and enforcement procedures. In addition to aiding and encouraging local governments, the state can and should take other more direct actions. These measures could include development and implementation of statewide regulations and actions to reduce risk involving state funded construction, development of state lands, and protection of designated higher risk areas. To accomplish this the state will have to establish the administrative mechanisms necessary to direct and implement its policies.

Local agencies must be involved actively in preventive measures as well as in the immediate on-the-scene response to disaster. This fact, coupled with Alaska's strong local home-rule tradition, suggests that local governments will continue to be the primary agent for direct action in implementing seismic hazard mitigation measures. Thus, local government is recognized as responsible for enforcing building codes and land use regulations as well as providing water, sanitation, and other utilities and services. However, local enforcement of seismic safety measures has not always been effective, suggesting the need for a federal-state-local partnership in th development of planning, administrative, and political mechanisms to implement and apply seismic safety measures.

Recommendations

Many recommendations related to seismic risk have been offered over the 20 years following the Great Alaska Earthquake. As reflected in Part II of this report, "Present Planning for and Management of Seismic Risk Mitigation", they cover all disciplines from geology and engineering to planning and political science. In fact, the recommendations in this report are new only in the sense that they are made within the context of a comprehensive planning and administrative model which provides an implementable framework within which the public and private sectors can mitigate seismic risk.

Recommendation 1

Develop and institute programs of public

education, information, and disclosure to obtain a social commitment to seismic risk mitigation.

To date government has defined its public education role primarily within an emergency preparedness context. This rule should be expanded to include a significant effort related to risk mitigation information dissemination, development of distribution mechanisms of scientific information to local governments, developers, builders, and other interested parties, and public education related to building codes, siting, and risk avoidance.

Seismic risk information should be integrated into the curricula of both primary/secondary and postsecondary institutions. The state has a major public education responsibility and should stress improvements to seismic awareness curricula.

Technical proficiencies of practitioners should be improved. Most engineers designing structures for high-hazard risk areas in Alaska do not have adequate training in seismic safety.

Recommendation 2

Renewed commitment at all levels of government to evaluate risk and its effects by supporting the continued development of socioeconomic and physical-biological data bases.

Increased support for basic research and identification of other natural hazards is necessary. Though state and local governments have capacity and authority in this area and should be encouraged to invest in short- and long-range research, a strong federal presence in necessary. Joint local, state, and federal agreements in data collection may be an important model for future efforts. A successful example is the stong motion instrumentation project in Anchorage.

Recommendation 3

Government should support the development of institutional processes and strategies necessary for the synthesis of data bases into goals for risk reduction.

Agencies and commissions designated to implement policy should also help to focus public attention and to achieve consensus. Specific processes are not as important as the goal setting itself, which can give policy and planning both purpose and direction.

Recommendation 4

Government should support the integration of risk into the comprehensive planning process.

Integration of geophysical data with more general overall land use goals can be utilized as the basis for developing respon-

sive city sector urban design plans. A good example of this approach is the original urban renewal plan which was prepared for the Fourth Avenue slide area in Anchorage.

Recommendation 5

Develop guidelines for defining high seismic risk areas as standards for state and local earthquake zoning and for land use decision processes.

Currently the country is divided into broad zones of seismic risk. These are used in the application of building codes and also affect other federal and state policies.

Establishment of national or state standards based on more refined criteria within each zone would be an important step toward broad application of risk concepts to siting. Elements might include the probability of failure by unit of time and the critical nature of the structure to the public welfare. As the probability of risk increases, local and state land use policies would be expected to increase the geotechnical analysis, siting, foundation, construction, and type of use requirements. Areas which would subject populations to unacceptable risks to health and safety would not be developed or would require mitigating strategies.

This graduated approach provides a mechanism for interpreting data and applying it in state and local decision-making processes. Standardizing levels of acceptable risk would increase the possibility of implementation through the use of hazard zoning, project review, stipulations for particular projects, etc.

Recommendation 6

Establish local, state, and federal institutions to provide for an administrative mandate, intra- and inter-governmental relations, and focus public and governmental attention on seismic risk.

The federal level has begun to recognize mitigation as an important public strategy. These institutional commitments need to be expanded and strengthened. For example, the State of Alaska's Department of Emergency Services is almost exclusively an emergency preparedness organization with limited resources and little institutional commitment in acquiring a mitigation role. Its role in preparedness and accompanying organization militates against DES assuming leadership in mitigation. The State of Alaska should establish a state seismic safety commission (see recommendation 7) and a joint legislative committee on seismic safety to develop and maintain a political recognition and a mandate for resolution of seismic safety issues.

Local government should focus its seismic safety interest through a public commission similar to the Anchorage Geotechnical Advisory Commission. Alternative mechanisms for smaller communities are the appointment of specialists with a knowledge of seismic risk in relation to planning and zoning, platting, and other land use decision making bodies.

Recommendation 7

Establish seismic safety commissions in states with significant seismic risk.

The state should establish a commission on seismic safety to provide a focal point at the state level for development of required policies and implementation of needed improvements.

Additionally, the commission must have certain regulatory authority to include responsibility for a seismic safety element in local comprehensive plans, and review and approval of state construction plans for seismic safety. To carry out its mission the commission would need sufficient power, funds, and staff. The commission should be empowered to review, comment on, and approve seismic safety measures proposed for adoption by state and local agencies.

Recommendation 8

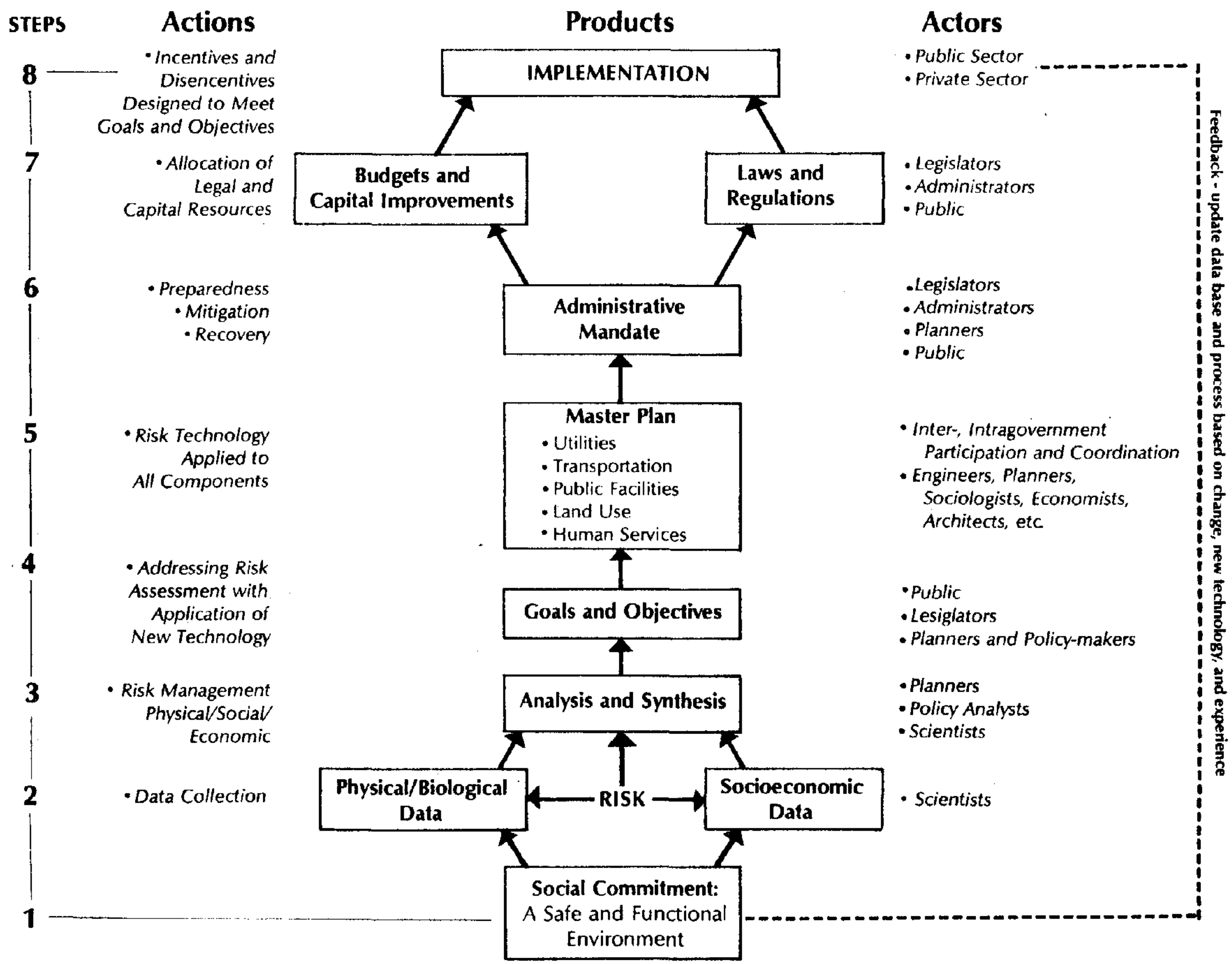
Establish federal and state incentives to ensure compliance with implementation of risk mitigation measures.

These incentives could take a variety of forms and be both positive and negative in their impact. The most comprehensive and workable one may involve federal establishment of a seismic hazard insurance pool that would provide for disaster assistance and reconstruction in the event of an earthquake and/or a broad range of natural disasters and that it be patterned after the flood insurance program.

Future federal reconstruction assistance were tied to state and local governments implementing mitigation programs to reduce exposure to risk.

Other incentives could involve the large volume of intergovernmental transfers. Local access to specific state and federal grant categories and state access to certain federal resources could be made contingent upon local and state compliance in mitigation efforts. Proactive grants and matching money for basic research, planning, and implementation would help stimulate local and state actions.

Figure 38. Comprehensive Planning Model



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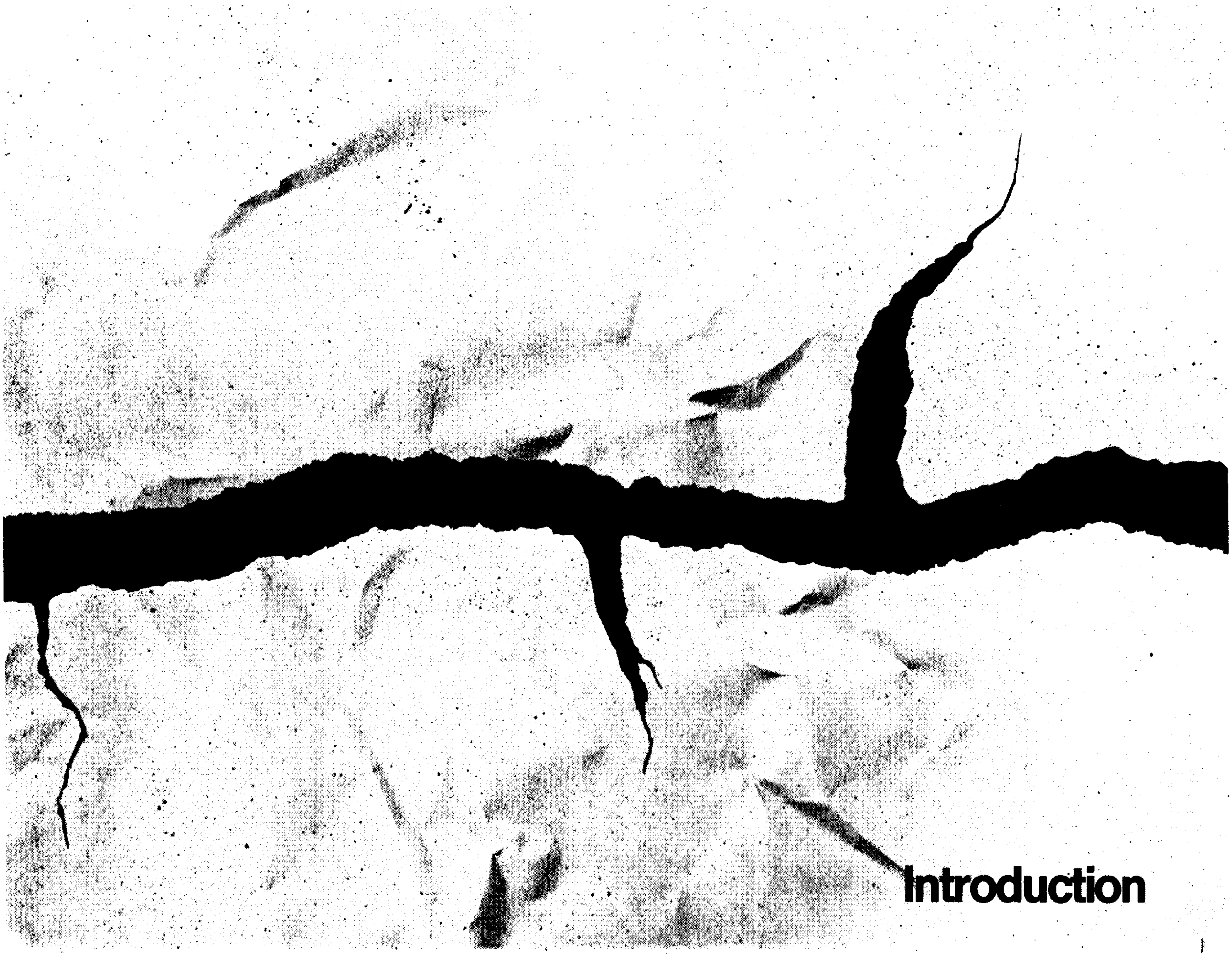
Introduction



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Introduction

The Great Alaska Earthquake of 1964 and its effects on natural processes and on the manmade environment provides a classic case for study of nature--human and otherwise. Through it we can analyze the value of experience and the relevance of research conducted by various agencies to minimize loss of life and property and to set guidelines for short- and long-range recovery from a major disaster.

Immediately after the Alaska earthquake, President Lyndon Johnson wrote to Donald F. Horning, special assistant for science and technology:

> It is important we learn as many lessons as possible from the disastrous Alaska earthquake. A scientific understanding of the events that occurred may make it possible to anticipate future earthquakes, there and thereafter, so as to cope with them more adequately. I, therefore, request that your office undertake to assemble a comprehensive scientific and technical account of the Alaska earthquake and its effects. . . . In defining the scientific and technical questions involved and the related informational requirements for collection for assessment, I hope that you will be able to enlist the aid of the National Academy of Sciences. . . . (Handler 1970)

Under sponsorship of the National Academy of Sciences, the Alaska earthquake, its effects on the environment and people, and the participation of government in the recovery were recorded in depth in eight volumes: The Great Alaska Earthquake of 1964--Geology, Seismology and Geology, Hydrology, Biology, Oceanography and Coastal Engineering, Engineering, Human Ecology, and Summary and Recommendations. The recommendations set guidelines for nationwide hazard research and establishment of policy directed to hazard mitigation; however, a review of land use and administrative practices in Alaska as well as in other earthquake- and tsunami-susceptible areas in the country has revealed that almost 20 years later, the majority of the National Academy of Sciences recommendations directed to hazards mitigation have not been followed. In fact, it is the opinion of many scientists and planners that if a major earthquake were to occur today in Alaska, the state and its major communities would be at a level of readiness no better than that of March 27, 1964. Here, as a result of increased population and development that has occurred in coastal areas, especially in upper Cook Inlet in the last 10 years, some believe that another earthquake could have an even greater impact on commerce and people than the one in 1964.

This report reviews the methodology, programs, and assistance applied to short- and long-range recovery in major communities affected by the Alaska earthquake--Anchorage, Cordova, Homer, Kodiak, Seldovia, Seward, Valdez, and Whittier.

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It also presents indepth evaluation of the recommendations made by the National Academy of Sciences and by the various task forces appointed by the President immediately after the disaster, along with a review of the present state of the art in the field of risk mitigation, prevention, planning, and management.

Mitigation of life and property losses projected to occur from future natural disasters of unknown proportions has historically eluded most public policy makers. The reasons for this are complex and variable, reflecting: fragmentation of responsibility over policy; lack of support from the general public, interest groups, and public leaders, and inadequate financial and human resources committed in relation to the magnitude of the problem; socioculturally ingrained beliefs concerning property and personal rights; uncertainty about the level of risk and potential social and economic loss; and an overall general weakness in the planning and implementing process at the local, state, and federal levels. All these factors were identified in postearthquake recovery efforts in Alaska.

The Alaska experience exemplifies the need for improving methodologies in the preparation of regional and municipal plans for seismic risk areas. Also apparent is the need to educate planners and policy makers to the importance of this issue and of developing effective interdisciplinary/interagency management systems to insure the application of recommendations made in the immediate relief and long-range recovery process.

As proved by the results of the planning process that took place in Alaska after the March 27, 1964 earthquake, decisions were made too soon and with insufficient data, and many recommendations still have not been implemented (Selkregg 1970). The Alaska experience points out that planning for earthquake-prone regions must be an ongoing process rather than a sporadic response to a disaster or to temporary concerns. A "risk component" must be treated as an integral part of the comprehensive planning process instead of a separate issue or program. Plan recommendations should include an examination of constraints and opportunities for risk mitigation and implementation plans. An estimate of costs and benefits and comparison of alternatives should be presented for public and legislative review and approval.

Methodologies for evaluating the seismic risk of urban areas are available and are being refined. Data obtained from these studies must be coupled with economic and social data in the preparation of long-range development plans. In so doing, community participation and education of policy makers about their responsibility to provide for public safety should be emphasized.

The need is for an interagency, interdisciplinary approach to data retrieval, planning, and management at federal, state, and local levels. Overspecialization and development of administrative systems responding to separate specialized fields will continue to interfere with the success of any planning process and of hazard mitigation planning in particular. Therefore, institutional changes are necessary to improve the implementation and management of hazard prevention and mitigation programs.

The scientific dialogue initiated after the 1964 earthquake has now expanded to include concern for all risks, natural and manmade, that may affect the urban enrivonment. Although this report presents a case study and lessons learned in Alaska as a result of a specific seismic occurrence, the recommendations made can be applied to the identification of all types of risk, hazards mitigation, and disaster prevention everywhere.

Part I: The Great Alaska Earthquake of 1964

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Chapter 1: Earthquakes Future Potential

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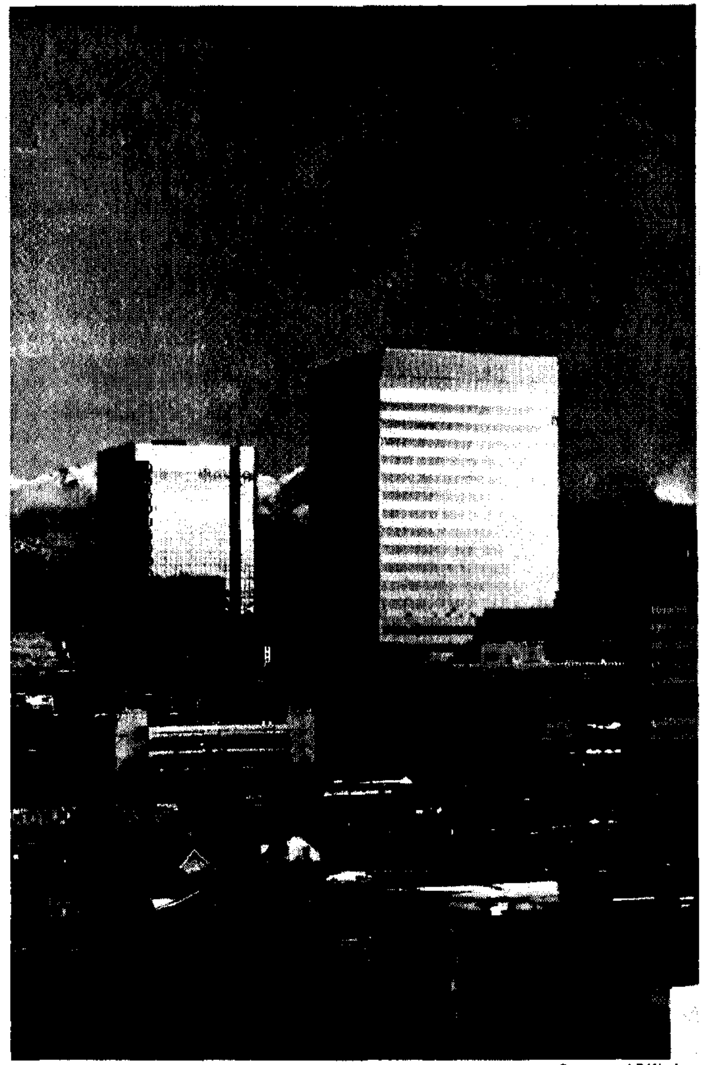
Earthquakes - Future Potential

Earthquake-prone areas encompass some of the most densely populated regions of the world, including portions of Japan, eastern China, part of the western United States, and countries bordering the Mediterranean Sea. Based on the present knowledge of risk occurrence and mitigation, it has been estimated that more than 500 million people could suffer damages to their property or lose their lives in severe earthquakes. In parts of the world where communities with high population densities were built centuries ago without building controls or regulations, death tolls have often reached staggering numbers (Table 1 and Figure 1).

Thousands of small earthquakes shake the United States each year, but moderate to severe earthquakes are infrequent. Earthquakes may occur at any time, without warning, any day of the year. They pose a significant threat for which special hazard reduction, disaster prevention, and preparedness can mitigate potential harm. Table 2 and Figure 2 shows property losses and deaths resulting from major earthquakes that have occurred in the United States since the turn of the century. The Alaska earthquake in 1964 released energy equivalent to 100 underground 100-megaton nuclear explosions placed in line (Kates 1970). The moderate earthquake in the San Fernando Valley, California in 1971 released about 1/1000 as much energy as the Alaska earthquake, yet it caused about the same property damage, though half as many deaths. What could have happened if the earthquakes had occurred at



Source: ABKJ, Inc.

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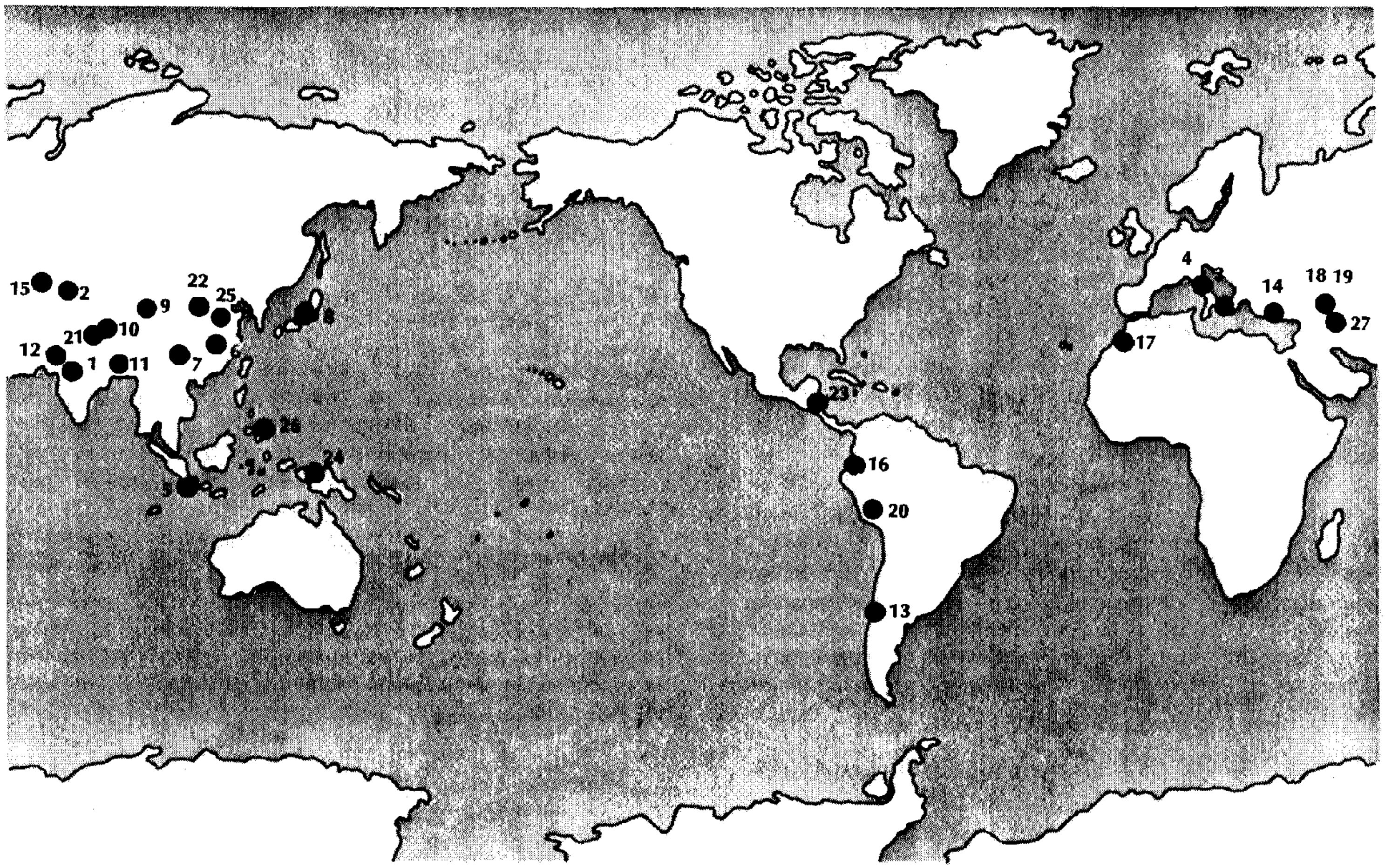
Table 1. Major World Earthquakes Since 1900 with 6,000 or More Fatalities

(See Figure 1 for location of events)

Map Key*	Year	Date	Location	Magnitude	Deaths	Remarks
1	1905	Apr. 4	India: Punjab-Kashmir	8.6	19,000	*Great length of fault. Kangra destroyed.*
2	1907	Oct. 21	U.S.S.R.; Tadzhikistan	8.1	12,000	
3	1908	Dec. 28	Italy; Straits of Messina	7.5	58,000	*Messina destroyed.*
4	1915	Jan. 13	Italy; Avezzano, Abruzzi	7.5	32,600	
5	1917	Jan. 21	Indonesia: Bali		15,000	
6	1918	Feb. 13	China; Guangdong Province	7.3	10,000	
7	1920	Dec. 16	China: Nigxia Province	8.6	200,000	*Landslides covered villages and towns.*
8	1923	Sep. 1	Japan; Tokyo	8.3	99,300	*Known as Kanto earthquake. Damage to Toyko and Yokohama. Tsunami inundated coast.*
9	1927	May 23	China: Gansu Province	8.3	41,000	
10	1933	Aug. 25	China; Sichuan Province	7.5	10,000	
11	1934	Jan. 15	India: Bihar Province	8.4	10,700	
12	1935	June 1	Pakistan: Quetta	7.6	25,000	*City destroyed.*
13	1939	Jan. 24	Chile; Chillan	8.3	28,000	*City destroyed. 100,000 people homeless.*
14	1939	Dec. 27	Turkey; Erzincan	8.0	32,700	*Many communities destroyed. 12 foot ground offset.*
15	1948	Oct. 6	U.S.S.R.; Turkmenistan	7.3	19,800	*Serious damage to Ashkhabad.*
16	1949	Aug. 5	Ecuador (central)	6.8	6,000	*Many villages destroyed.*
17	1960	Feb. 29	Morocco; Agadir	5.7	12,000	*Most of Agadir destroyed. One-third population killed.*
18	1962	Sep. 1	Iran (northwestern); Qazvin	7.3	12,200	
19	1968	Aug. 31	Iran (eastern): Khorasan Province	7.3	12,100	*About 60,000 people homeless.*
20	1970	May 31	Peru: Chimbote	7.8	67,000	*About 800,000 people homeless. Landslide buried 18,000 people in Ranrahirca and Yungay.*
21	1974	May 11	China: Yunnan Province	7.1	20,000	
22	1975	Feb. 4	China: Liaoning Province; Haicheng	7.3	10,000	*Earthquake was successfully predicted. Evacuations saved many lives. Heavy damage.*
23	1976	Feb. 4	Guatemala	7.5	23,000	*Extensive damage to buildings. Numerous landslides. One-fifth of population homeless.*
24	1976	June 26	New Guinea (west)	7.1	6,000	*Landslides destroyed villages.*
25	1976	July 28	China; Hebei	7.8	243,000	*Industrial city destroyed. Aftershocks same day of magnitudes: 6.5, 6.0, 7.1, and 6.0.*
26	1976	Aug. 17	Philippine Islands; Moro Gulf	8.0	6,500	*Many buildings damaged. Large tsunami.*
27	1978	Sep. 16	Iran (central); Tabas	7.7	15,000	*In Tabas, 9,000 out of 13,000 killed.*

Source: Gere, James M., *Earthquake Tables,* The John A. Blume Earthquake Engineering Center, Department of Civil Engineering, Stanford University, Report MP-7, August 1982.

Figure 1. Major World Earthquakes Since 1900 with 6,000 or More Fatalities



a different time of the day? What would happen if an earthquake of the magnitude of the 1964 earthquake were to occur now, when the population of Anchorage has more than doubled, and roads, utilities, and residential development has extended to marginal areas on manmade fill, wetlands, or unstable slopes?

The growing population density of cities located in areas of high seismicity increases the vulnerability to earthquakes throughout the United States. Everywhere population growth is forcing expansion to areas that are more difficult to develop--mountain regions, active fault zones, and areas of artificial fill. Major transportation routes, ports, airports, utility lines, dams, hospitals, schools, and other major public improvements follow population growth and are built in areas that may be impacted by seismic activities.

Earthquake effects at various locations will depend on local geologic conditions, magnitude, type, and duration of the seismic event, type of foundation and structures, age of the structure, characteristics of the structural and nonstructural components, use, and density of occupancy. These and other local conditions will influence the extent of the damage.

Most of the seismic activity of the world takes place along the margins of dynamic tectonic plates which form the crust of the earth. It was, in fact, the mapping of the earth's seismic

Table 2.

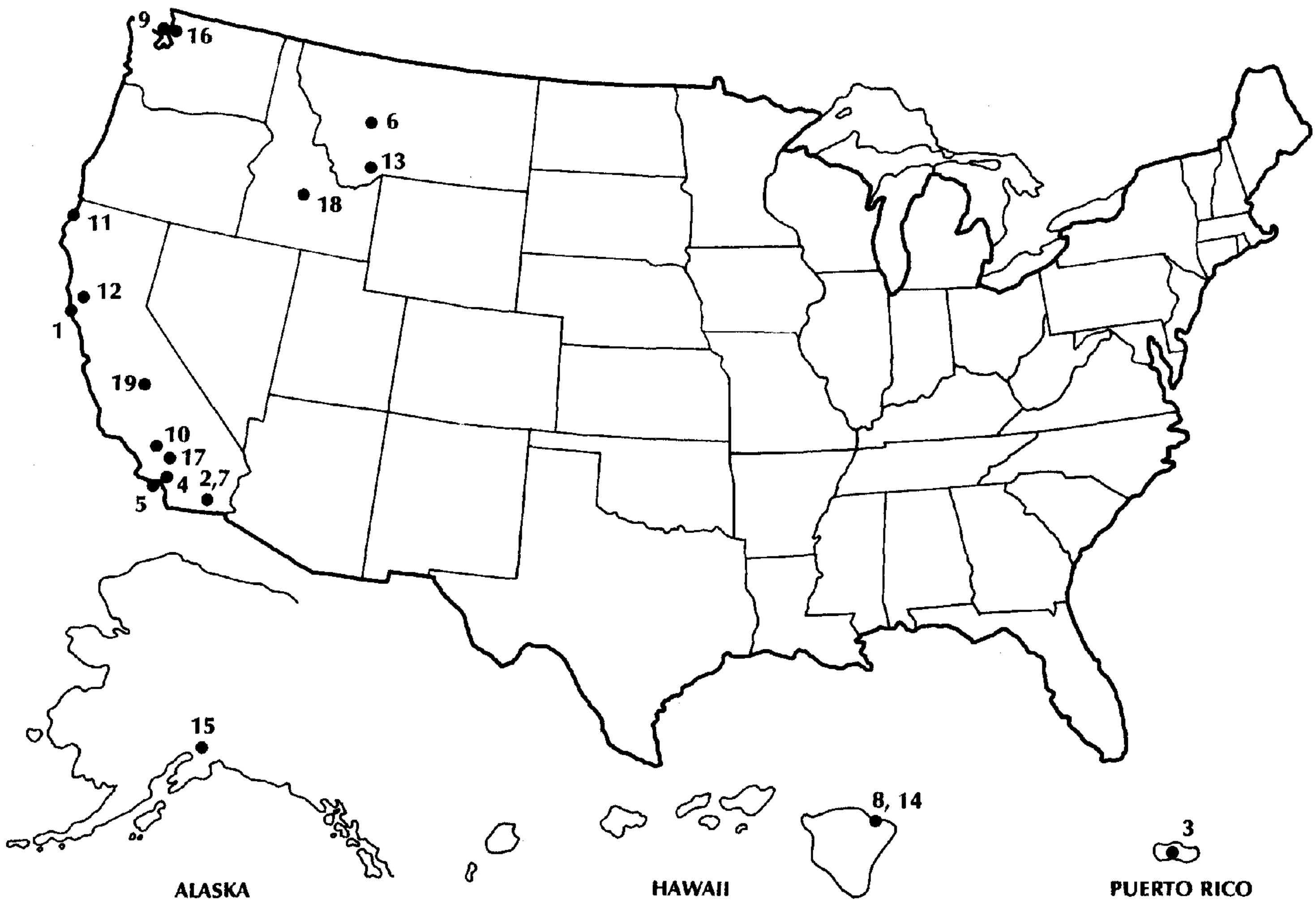
Major U.S. Earthquakes Since 1900

Map Key*	Year	Locality	Damage	Deaths
1	1906	San Francisco, California	24.0	700
		(fire loss)	500.0	
2	1915	Imperial Valley, California	.9	6
3	1918	Puerto Rico *(tsunami damage from earthquake in Mona Passage)*	4.0	116
4	1925	Santa Barbara, California	8.0	13
5	1933	Long Beach, California	40.0	115
6	1935	Helena, Montana	4.0	4
7	1940	Imperial Valley, California	6.0	9
8	1946	Hawaii *(tsunami damage from earthquake in the Aleutians)*	25.0	173
9	1949	Puget Sound, Washington	25.0	8
10	1952	Kern County, California	60.0	8
11	1954	Eureka-Arcata, California	2.1	14
12	1955	Oakland-Walnut Creek, California	1.0	1
13	1959	Hebgen Lake, Montana *(damage to timber and roads)*	11.0	28
14	1960	Hawaii and U.S. West Coast *(tsunami damage from earthquake off Chile)*	25.5	60
15	1964	Alaska and U.S. West Coast *(tsunami damage from earthquake near Anchorage, includes earthquake damage in Alaska)*	500.0	131
16	1965	Puget Sound, Washington	12.5	7
17	1971	San Fernando, California	553.0	65
18	1982	Eastern Idaho *(120 miles northeast of Boise)*	6.8	2
19	1982	Coalinga, California	31.5	1

(*See Figure 2 for location of events)

Adapted from *"Disaster Preparedness", Report to Congress, Office of Emergency Preparedness, 1972*

Figure 2. Major U.S. Earthquakes Since 1900.



activity that helped delineate the boundaries of the crustal plates and added credence to the recent theory of global plate tectonics. According to plate tectonic theory the earth's crust is composed of a moving mosaic of plates which constantly shift relative to one another. The Aleutian Island Arc and its continued continental expression (the Alaska Peninsula and the Alaska Range) represent the orogenesis related to the collision of the North American plate and the Pacific Ocean plate (Figure 3). The Alaska Range is the concave southern expression of this. These mountains merge to form an arc 3,200 miles long and 100 to 300 miles wide in which approximately 7 percent of the world's earthquakes occur. The majority of these shallow-focus earthquakes (focal depths less than 43 miles) occur between the Aleutian Trench to the south and the volcanic chain to the north. This region is one of North America's most seismically active areas, experiencing thousands of earthquake shocks each year.

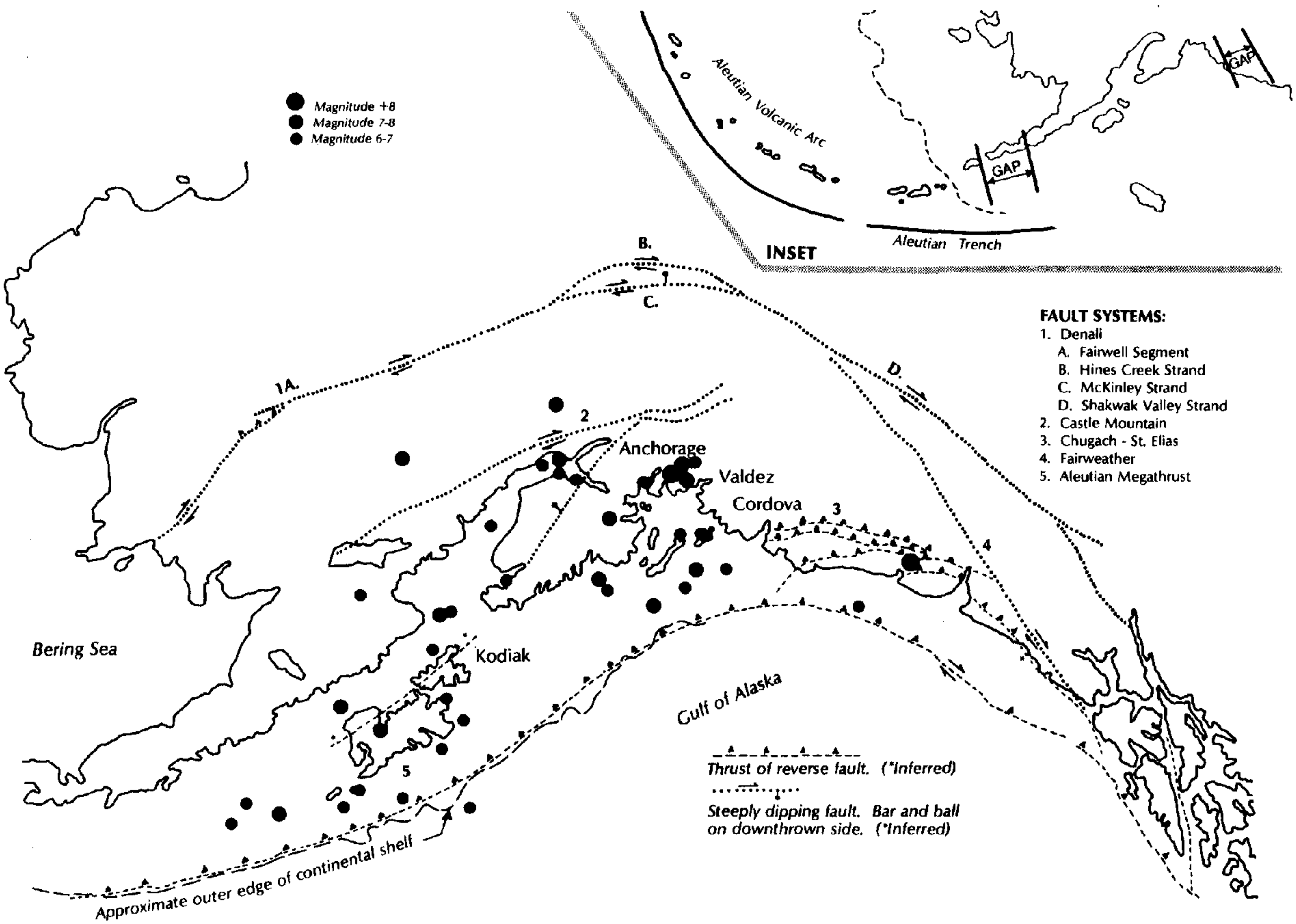
Major Fault Systems Affecting Southcentral Alaska

Major fault systems identified as affecting southcentral Alaska are shown in Figure 3. The following is a summary of the risk potential of these faults as reported by the State of Alaska, Division of Emergency Services in the Greater Anchorage Area Earthquake Response Study, prepared for the Federal Emergency Management Agency (FEMA) in 1980.

The Denali Fault System: The record of past earthquake activity indicates that this fault system has historically had only two events with magnitudes greater than 7.0--a magnitude 7.4 earthquake on the McKinley Strand in 1912 and a magnitude 8.3 event in 1904 on the Farewell segment. However, recent work (Sykes unpublished) shows that the 1904 event probably occurred north of the Denali Fault System. Eleven events of magnitude 6.0 or greater have been reported within the central and eastern segments of the system since 1900. Although historical records suggest a moderate seismic potential for the Denali System, geologic evidence forces the adoption of a magnitude 8.5 event as the "probable maximum earthquake" for design considerations.

Castle Mountain Fault System: Seismic activity along this fault is generally associated with low magnitude (3.0 to 4.5), shallow events. Only six earthquakes of greater than 6.0 have been recorded for this fault, and only two of those were greater than 7.0. The maximum historic event along this fault is the 1943 magnitude 7.3 earthquake, with an epicenter just north of the central portion of the fault. Although the two largest recorded earthquakes for this fault system were the 1933 magnitude 7.0 and the 1943 magnitude 7.3 events, a magnitude 8.0 earthquake is believed possible. This assumption is based on known and inferred geologic evidence of past fault rupture and displacement. Therefore, for design purposes a

Figure 3. Seismicity - Southcentral Alaska



magnitude 8.0 event should be assumed as the "maximum probable earthquake" associated with the Castle Mountain fault system.

The Aleutian Megathrust: Incomplete historical data and the complexity of the tectonics of this fault system make definitive statistical analysis of future seismic activity along this fault difficult. Inferred gross tectonic strains preceding the great 1964 earthquake have led to estimates of recurrence intervals of 120 to 170 years; however, historical records suggest return intervals as short as 30 years. Terrace uplifts on Montague Island associated with megathrust activity are separated by an estimated 850 years. Yet some fault rupturing on the island is thought to be as recent as 150 to 300 years, thus demonstrating the uncertainty and variability of earthquake recurrence along this fault.

Kelleher, Sykes, and others have studied spatial and temporal distribution of great earthquakes (greater than 7.7) along the Aleutian Megathrust Zone and the major plate-boundary fault systems of southcentral and southeastern Alaska. Although historic records are somewhat meager for this region, the space-time distribution of great earthquakes suggests an east-west progression of epicenters along the plate margin. Moreover, the aftershock zones (rupture surfaces) of great earthquakes tend to abut one another with little overlap. Great and large earthquakes seem not to rerupture the same area. Areas of seismic quiescence between recent rupture zones are termed seismic gaps, and are likely sites of the next major shocks in the region. Two seismic gaps exist in southern Alaska: the Shumagin Gap, near the tip of the Alaska Peninsula, and the Yakataga Gap, on the eastern side of Prince William Sound. These are two of the most likely locations for great earthquakes in the United States.

Chugach - St. Elias Fault System: Three great earthquakes associated with this system occurred approximately 80 years ago. Between September 3 and September 10, 1899, two magnitude 8.2 events and one magnitude 7.8 event occurred in this region. This area lies between the rupture zones of the great earthquakes of 1958 and 1964 and has been identified as a seismic gap (Yakataga). Because of the historical seismicity associated with the fault system and its potential rupture length, a magnitude 8.3 event should be considered probable.

Fairweather Fault System: Several major and great earthquakes have been associated with the Fairweather fault system. The maximum event attributed to the fault is the 1958 Lituya Bay earthquake which had an estimated magnitude of 7.9. A magnitude 8.1 earthquake just north of Queen Charlotte Island was recorded in 1949. Several major events with magnitudes greater than 7.0, including the 1972 Sitka earthquake (M=7.2), have also been attributed to this fault during the past 70 years. Because of the historic seismicity associated with this fault, and because of its potential rupture length, a magnitude 8.5 event should be the "probable maximum earthquake" associated with this fault.

This brief review of the future earthquake potential in Alaska, especially the southcentral area where great earthquakes have already occurred, clearly shows that seismic risk is a major issue to consider when planning for urban and regional development. This issue does not apply only to Alaska. It is a national and international issue and, as reflected in the following chapters, the guidelines for initiating local, national, and international mitigation methodologies rest with:

1. Increased knowledge of location of risk areas.

2. Development of planning/engineering/architectural standards for hazard mitigation.

3. Development of administrative systems at the federal, state, and local levels that can deal with immediate recovery and reconstruction after a disaster has occurred.

4. Incorporation and enforcement of long-range planning and hazard mitigation policies as part of the ongoing planning process.

Because the science of earthquake prediction is still in its infancy and because human response to prediction still remains unknown (Mileti et al. 1981), we must intensify the development of hazards mitigation methods. Much of the disastrous effects resulting from earthquakes can be mitigated by proper application of seismological information in determining population distribution and allocation of space. Schools, theaters, offices, high-density residential districts, and other uses that allow for a gathering of many people must be placed in safe areas with respect to seismic danger. Moreover, location and construction of utility, transportation, and communication, and other lifeline systems must follow criteria developed for seismic regions.

Knowledge obtained from past events should be transferred to planning and policy makers to insure the development of a national awareness and commitment to disaster mitigation and prevention.

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Chapter 2:
The March 1964 Earthquake
An Overview

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The March 1964 Earthquake
An Overview

On Good Friday, March 27, 1964 at 5:36 p.m., one of the greatest earthquakes in recorded history struck southcentral Alaska. The epicenter of the quake was 80 miles ESE of Anchorage at the head of Prince William Sound off the Gulf of Alaska. With a recorded magnitude of between 8.4 and 8.6 on the Richter scale and a duration of approximately five minutes, the resulting measurable vertical and horizontal dislocations of land surface were greater than any previously recorded earthquake.

The shock was felt throughout an area of half a million square miles. Seismic vibrations, vertical displacement, and water waves affected all coastal communities in the southcentral region of Alaska. Strong ground motion induced many snowslides and subaerial and submarine landslides, cutting transport and communication lines. Submarine landslides created local sea waves that, combined with a major tsunami generated by crustal deformation, destroyed ports and facilities in several coastal communities, covered sessile organisms and salmon-spawning beds with silt, and leveled forests. Tectonic elevation and depression extensively damaged the biota.

Significant damage to structures, roads, transportation links, and other manmade facilities extended over about 50,000 square miles. Ice cracked on frozen lakes and streams throughout about 100,000 square miles. Hundreds of people were homeless, and many were temporarily out of work. Several schools were damaged or destroyed and utilities were totally disrupted or completely destroyed in several communities.

The effects of the earthquake reached far beyond Alaska. Marked fluctuations of water levels in wells and bodies of water were recorded as far as Georgia, Florida, and Puerto Rico. In addition, seismic sea waves generated on the continental shelf in the Gulf of Alaska spread across the Pacific Ocean to Hawaii, Japan, and Australia. Maximum waves of 4 feet were reported in the Palmer Peninsula of South America. Heavy damage occurred in Port Alberni, British Columbia, where damage to houses and forest industries totaled several million dollars. A bridge and several tractors were destroyed in Washington State. The Oregon coast was struck by 10- to 14-foot waves. In California, damages to small craft were reported as far south as San Diego. In San Francisco Bay, a ferryboat and a houseboat were set adrift by water surging through the Golden Gate and about $1 million in damages to small boats and harbor facilities were reported at San Rafael (Tudor 1964). The brunt of the wave hit Crescent City, where 12 lives were lost despite a one-hour tsunami warning. Eight boats sank, and docks, harbor facilities, and seawalls suffered damage. Fifty-four homes were destroyed, 37 were damaged, 44 small businesses were destroyed and 147 were damaged.

Anchorage, Valdez, Seward, Kodiak, Seldovia, Homer, and Cordova were the Alaska communities most damaged by the earthquake and resultant environmental impact (Table 3, Figure 4). In Anchorage the earthquake triggered three large landslides, one in the business district and two in its most valuable residential areas. In Seward and Valdez large submarine landslides and land subsidence destroyed the cities' industrial waterfronts. Instability of soils throughout Valdez made the entire community uninhabitable. Land subsidence in Kodiak, coupled with the effects of tsunami inundation, destroyed the industrial and commercial heart of the community. Land uplift in Cordova left the small-boat harbor, city docks, and other waterfront facilities unusable. The Homer industrial district, built on a sand spit, had the dock and small-boat harbor completely destroyed by a 3-foot subsidence.

Several coastal Native villages were extensively damaged. Those receiving the major damage were Kaguyak, Old Harbor, Ouzinkie, Afognak, and Chenega. Kaguyak and Old Harbor, both fishing villages, suffered severe tidal wave damage. Villagers were temporarily relocated during disaster relief. Ultimately, the residents of Kaguyak relocated in Akhiok, and the villagers of Old Harbor rebuilt their community at the original site. A large part of Afognak was destroyed. The village was relocated and rebuilt at a new site and was renamed Port Lions to commemorate immediate relief and reconstruction assistance provided by the Lion's Club. At Chenega, a small hunting and fishing village with 76 residents, the tsunami reportedly hit within minutes after the earthquake, totally destroying the village and killing 23 people. After 19 years since the earthquake Chenega is being relocated at Crab Bay on Evans Island in Prince William Sound.

The earthquake crippled Alaska's economic base. Public and private property loss was more than $300 million (1964 value). Damage assessment began almost immediately following the earthquake, and it was soon discovered that resources within the state for long-range planning were severely limited. For example, at the time of the disaster there were only 16 firms of architects and engineers practicing in Alaska and eight urban planners, all in public employment. State government had insufficient staff to make the multitude of surveys, studies, and plans needed to guide reconstruction. Planning commissions were active in only two affected communities; comprehensive plans had been prepared only for Anchorage, Kodiak, Cordova, and Seward; and no disaster plans existed. The communities were snow covered, and many public facilities had been destroyed; however, the federal government promised quick and abundant resources for reconstruction. Federal dollars and an eager local construction industry, two important variables for rapid recovery, were in place. The major problem was to find effective and appropriate ways to channel the resources into the reconstruction effort.

At the time of the earthquake, the state of Alaska was entering a more dynamic era of economic growth. Prior to the 1960s, much of the state's economy hinged on its location as a strategic defense post. World War II had brought about a significant population increase, stimulating the construction sector of the labor market. The 1960s found Alaska in a state of economic transition. The postwar military economy was declining, and the state's strategic link in intercontinental air travel and transportation and development of natural resources (including lumber, fisheries, and petroleum) emerged as the dominant sectors.

The economy remained largely based on government and government-related activities. Only 5.8 percent of employment was based on commodity-producing industries, so little restoration of an industrial base was necessary to resume functioning. Construction, as the largest private industry, was immediately expanded, financed, or underwritten by the federal government. The emergency and reconstruction work completed between April 1964 and September 1966 pumped $321 million of new federal money into the Alaska economy. This was money which would not have been available in the absence of the disaster.

To provide urgently needed employment and to channel as much restoration work as possible to hard-hit local residents, construction contracts were let out in increments that would allow maximum participation by local bidders. This had an added advantage in allowing the architects and engineers to produce bidding documents earlier than if large segments were included in one contract. This resulted in a boost to the local economy and in an effective and fast recovery process. In addition to the disaster relief and reconstruction assistance, the state of Alaska received extra fiscal aid by the extension of the five-year federal transitional grants program provided under the 1959 Alaska Omnibus Act and by the establishment of the Federal Field Committee for Development Planning in Alaska.

As the principal and largest center of government and construction activity in the state, the Anchorage area benefited more than any other from the reconstruction activities. Employment in trade, finance, insurance, real estate, and service industries dropped slightly below 1963 levels. However, government employment increased above that of 1963 and "new jobs opened in state and federal agencies directly involved in preparing restoration contracts and providing emergency repair work." By the end of the year, however, Anchorage merchants were to enjoy "one of the greatest Christmas shopping sprees ever" (Rogers 1970).

Statistics indicate a significant increase in the movement of people in and out of Alaska despite the governor's request that only people with sure jobs should venture to the state due to lack of housing and high cost of living

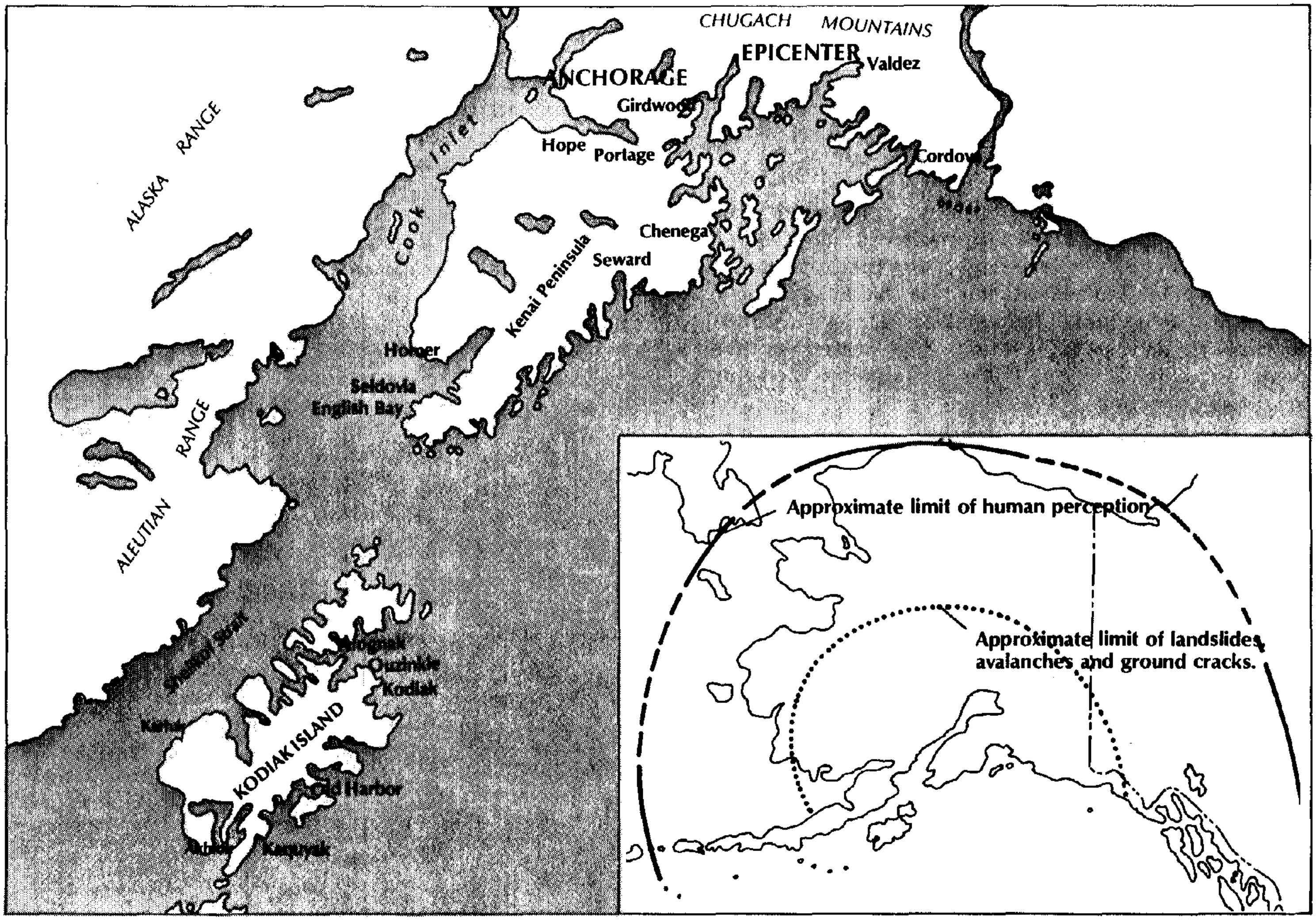
Table 3. Summary of Damages to Southcentral Alaska - 1964 Earthquake

Place*	Population	No. of Deaths	Principal Causes of Damage: Subsidence	Uplift	Landslides	Submarine Landslides	Ground Cracks	Vibrations	Waves	Fire	Types of Structures Damaged: Homes	Businesses and People	Military	Harbor	Water Supply	Other Utilities	Highways	Airports
Southcentral Alaska	107,916	115																
Afognak	190	0	●								●	●		●	●			
Anchorage & Military Bases	80,726	9			●		●	●			●	●		●	●	●	●	●
Cape St. Elias	4	1			●													
Chenega	80	23		●							●							
Chugiak	51	0						●							●			
Cordova	1,128	0		●			●				●	●		●	●			
Cordova FAA Airport	40	0					●	●			●	●			●	●	●	●
Eagle River	130	0						●							●	●		
Ellemar	1	0		●								●						
Girdwood	63	0	●				●	●			●	●						
Homer	1,247	0	●			●		●				●		●			●	
Hope	44	0	●								●				●			
Kaquyak	36	3							●		●	●						
Kadiak Fisheries	2	0						●	●					●	●	●		
Kodiak & Military Bases	4,788	15	●						●		●	●	●	●	●	●	●	●
McCord	8	0						●			●	●						
Old Harbor	193	0							●		●	●		●	●			
Ouzinkie	214	0	●						●		●	●		●				
Point Nowell	1	1							●		●							
Point Whitshed	-	1		●					●		●							
Portage	71	0	●				●				●	●					●	
Port Ashton	-	1							●									
Port Nellie Jean	3	3							●				●	●				
Seldovia	460	0	●								●	●		●				●
Seward	1,891	13	●			●	●	●	●	●	●	●	●	●				●
Tatilek	-	-		●							●			●				
Valdez	1,000	31	●			●	●	●	●	●	●	●		●	●	●	●	●
Whittier	70	13	●			●		●	●	●	●	●	●	●	●	●	●	●

(*Locations of communities indicated in Figure 4)

SOURCE: Adapted from W.R. Hansen, et. al., 1966 and R.W. Kates, 1970.

Figure 4. Southcentral Alaska: Communities Affected by the March 27, 1964 Earthquake.



(Kunreuther 1970). Following the earthquake, many wives and children left the state to join relatives in the Lower 48 while cleanup and reconstruction efforts got under way. Conversely, others traveled to the state seeking employment opportunities in the construction industry during the restoration.

Although the disaster initially presented the State with unanticipated expenditures and posed a threat of loss in revenues, in the aftermath, the earthquake seemed actually to have been economically beneficial functioning as a catalyst for future economic growth. As stated in the Alaska Review of Business and Economic Conditions, December 1965:

> Some readers may find it strange that we have not devoted a major part of this article to the effects on the Anchorage community of the March 27, 1964 earthquake. Let there be no misunderstanding, the earthquake struck Anchorage with devastating force. Damage to public and commercial facilities was extensive, and much private property was destroyed. No one living there at the time will ever forget the terrifying sequence of events. However, a city's place in the world today depends on its dynamism, and Anchorage is a dynamic, growing community. The greatest tribute to Anchorage's recovery from the earthquake is, after all, that less than two years after such a destructive experience, it has been possible to write an article about the Anchorage economic community with only passing reference to the earthquake's economic impact (Rogers 1970).

Source: City of Anchorage

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Chapter 3:
The Cities
Immediate Relief and Reconstruction

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The Cities - Immediate Relief and Reconstruction

The first disaster reconstruction team began their assessment of damages and destruction a few hours after the earthquake. It was immediately evident that local Alaska resources for reconstruction of a disaster of such a magnitude were limited. The short construction season with its annual immigration had not begun, per capita damage was extremely high, and per capita resources were very low, especially in the small scattered communities of Prince William Sound and the Kodiak region (Table 4). In contrast, external resources were abundant. Skilled personnel were numerous in the Lower 48, military aircraft were available to deliver needed emergency material, and personnel from federal agencies were ready with programs for the state's recovery.

The principal task that faced those in charge of disaster relief and reconstruction was to quickly restore the necessary services, to house the homeless, to rebuild public facilities, and to encourage the rapid restoration of private businesses. The critical operational problem was to find rapid and effective ways to funnel the plentiful but scattered resources of the country into the reconstruction effort in the tense atmosphere of a major disaster and its aftermath. One big handicap was the short construction season, which restricted the activity of most industry in Alaska. Beyond this initial goal, top government officials, local planners, and outside consultants recognized an opportunity to restore and rebuild to make Alaska 'a safer, more economically sound, and more attractive place in which to live and work (Selkregg et al. 1970).

Source: U.S. Army

Table 4. Private Real Property Damage.

(1964 Dollars)

Locality	Number of Properties with Damage Over $1,000	Dollar Damage (in thousands)	Population (1960 Census)
Greater Anchorage Borough			
Downtown area Anchorage City	242	$ 11,716	
Turnagain area Anchorage City	670	12,905	
Rest of City	320	9,678	
City Total	**1,232**	**$ 34,299**	44,237
School district, outside City	146	1,103	
Portage	20	262	
Girdwood	7	122	
Eagle River, Chugiak	13	555	
Basher	3	35	
Private Utilities	3	3,656	
Subtotal	**192**	**5,233**	**53,311**
Total	**1,424**	**39,532**	**97,548(±)**
Kodiak Island Borough:			
City, downtown	110	2,286	
City, remainder and vicinity	13	2,286	
City total (population)			2,628
Rest of Borough	132	5,686	
Private Utilities	1	482	
Total	**256**	**8,670**	7,174

Locality	Number of Properties with Damage Over $1,000	Dollar Damage (in thousands)	Population (1960 Census)
Kenai Peninsula Borough			
City of Seward	110	4,543	1,891
Homer	52	1,113	1,247
Hope	23	233	44
Kenai	7	62	778
Seldovia	93	1,040	460
Soldotna	5	18	32
Other	10	385	--
Total	**300**	**7,394**	**6,097**
Prince William Sound area:			
City of Valdez	237	2,911	555
Cordova and vicinity	85	683	1,128
Whittier	4	2,398	809
Canneries (all of sound area)	17	1,019	
Total	**343**	**7,009**	**2,844** [1] **1,759** [2]
Glenn and Richardson Highway areas	8	86	
Matanuska-Susitna Borough	27	117	5,188 [3]
GRAND TOTAL	**2,358**	**62,808**	* * * * *

Source: Adopted from the Property Damage Survey, Alaska Housing Authority, April 1964, as reprinted in the U.S. Senate, 1964, p.33 and Census Alaska: Number of Inhabitants, 1972-197-, compiled by Alden M. Rollins, University of Alaska, Anchorage, Alaska, 1978.

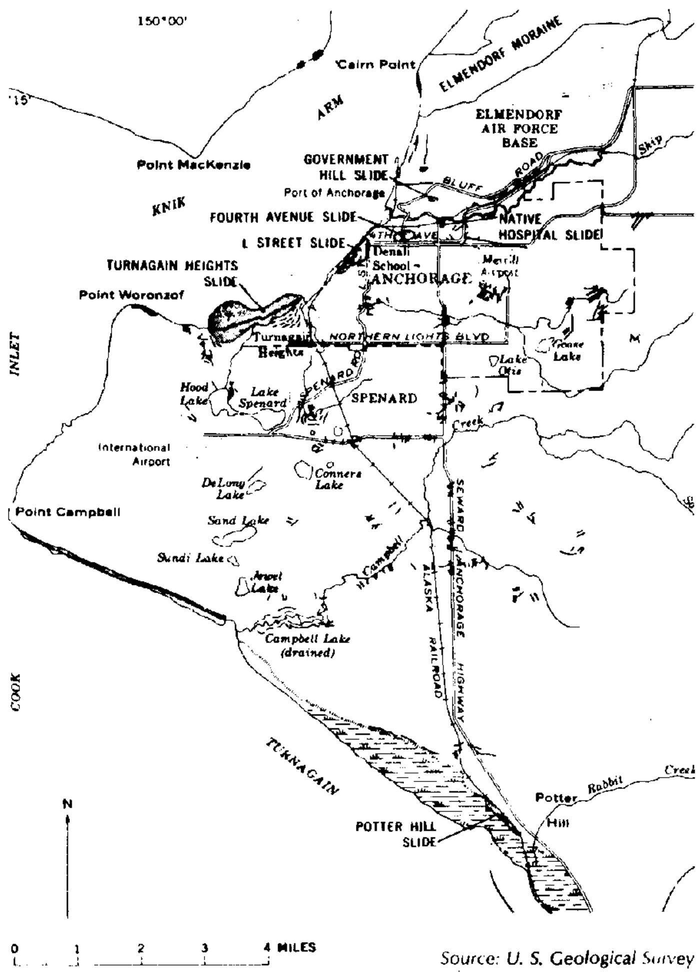
1 Census area includes Valdez/Chitina/Whittier
2 Census area includes Cordova/McCarthy
3 Census area includes Palmer/Wasilla/Talkeetna

Anchorage

In Anchorage, the major urban and distribution center of the state, the 1964 earthquake triggered five major landslides (Figure 5). The slides resulted from the failure of dynamically sensitive, saturated sand, silt, and silty clay of the Bootlegger Cove Clay formation that underlies most of the Anchorage area (Hansen 1966).

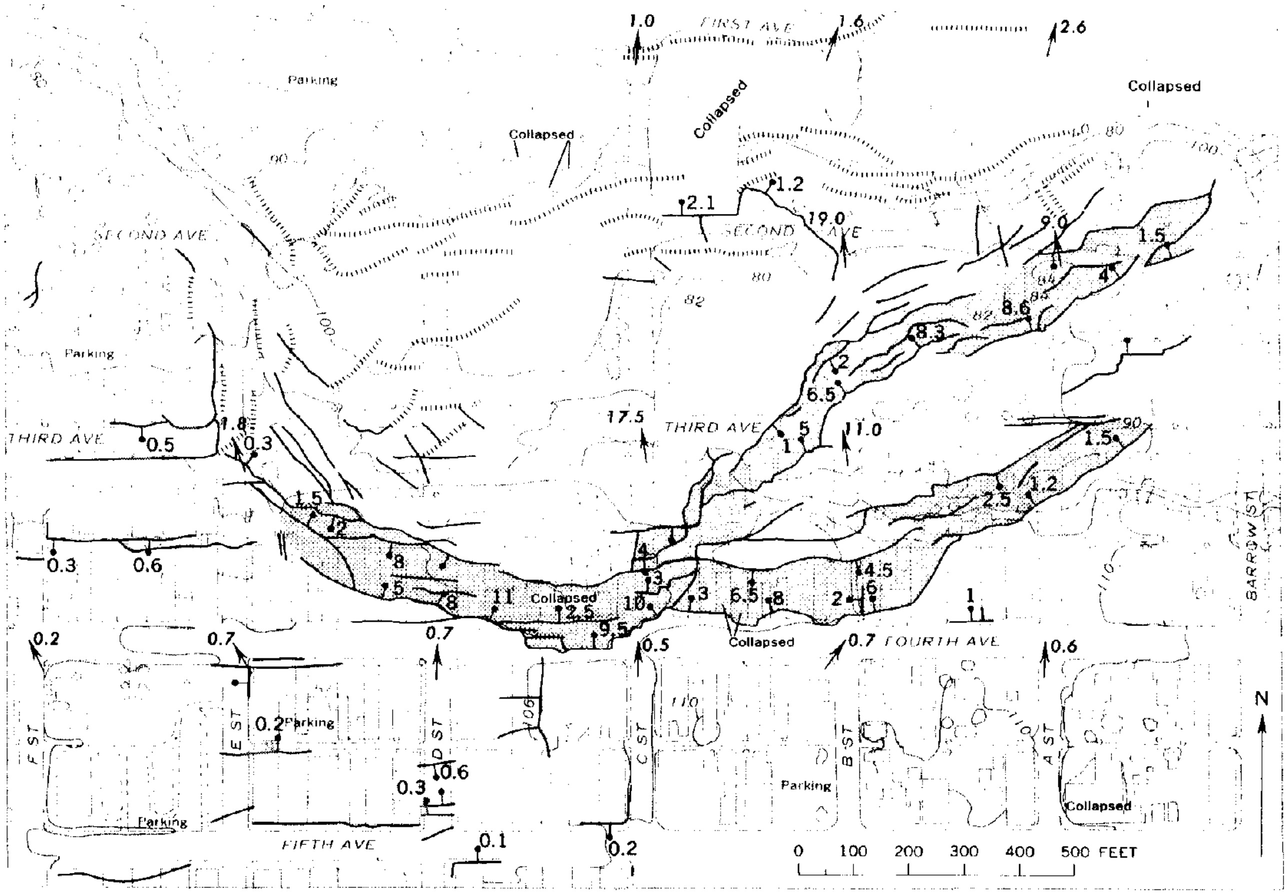
The Fourth Avenue slide (Figure 6) involved all or parts of 14 city blocks on the north side of the downtown area. The oval shaped slide area encompassed about 36 acres, containing approximately two million cubic yards of earth. Its length north to south in the direction of slippage was about 1,050 feet; east to west it was about 1,800 feet across. Strong fracturing and related ground displacements extended approximately 1-1/2 blocks south of the slide, where considerable damage was inflicted on buildings. Eyewitnesses reported that sliding began about two minutes after the earthquake started and stopped about the same time as the shaking (Grantz et al. 1964). Many small businesses, commercial buildings, apartment houses, and residences were destroyed or badly damaged.

Figure 5.
Anchorage: Major Slide Areas



Source: U. S. Geological Survey

Figure 6. Fourth Avenue Landslide Area, Anchorage.



Lateral displacement of bench mark, in feet. New position at point of arrow. No appreciable movement since earthquake. 9.0

Graben

Pressure Ridge

1.5

Fracture, showing downthrown side and displacement in feet

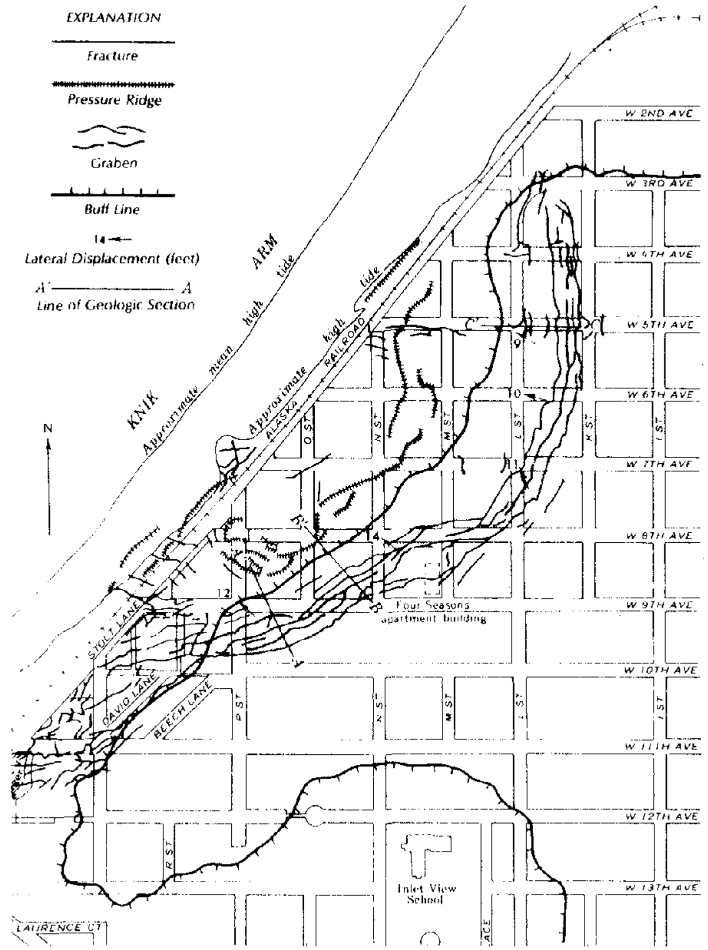
Base by U.S. Army Corps of Engineers

Compiled from aerial photographs and data taken from reports of Engineering Geology Evaluation Group (1964) and Shannon and Wilson, Inc. (1964).

The L Street slide (Figure 7) involved approximately 30 city blocks adjacent to Knik Arm in the northwest part of the city. It extended northeast about 4,800 feet along the bluff and had a maximum breadth northwest across the bluff of about 1,200 feet, parallel to the direction of slippage. It reached about 1-1/2 blocks back from the bluff into a densely settled residential and commercial area. The total volume of earth involved approached six million cubic yards. Many buildings on the slide block, including a six-story apartment building, were carried 11 feet laterally but sustained little or no damage; however, utilities to the slide area were interrupted.

Source: *Alaska Pictorial Service*

Figure 7. L Street Slide Area, Anchorage.



Source: Based on data produced by Engineering Geology Evaluation Group, 1964.

The Turnagain slide--the most devastating landslide--destroyed part of a residential neighborhood. Extending about 8,600 feet west to east along the bluffline (Figure 8), its maximum headward retrogression from the bluff was about 1,200 feet, with an average of about 500 feet into densely populated residential areas. One hundred and thirty acres of land and 75 homes were completely destroyed by displacement. The volume of earth within the slide was approximately 12.5 million cubic yards. The ground area within the slide itself dropped an average of 35 feet.

Three hundred and sixty thousand cubic yards of material were estimated to be involved in the Native Hospital slide, which at 650 feet across and 350 feet long was relatively small.

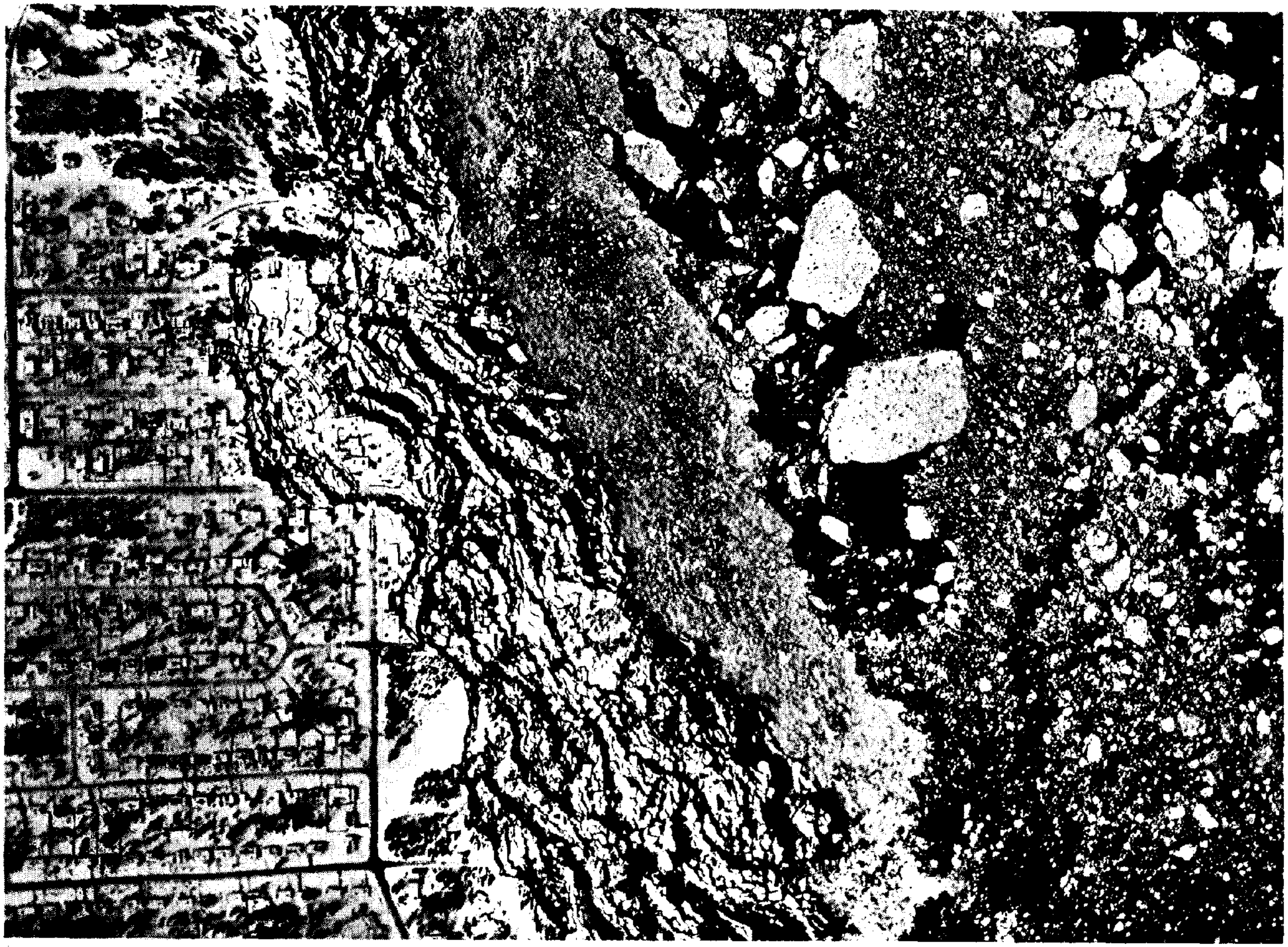
Source: City of Anchorage

The Government Hill slide involved approximately 11 acres of land. An estimated 900,000 cubic yards of earth was involved with an approximate width of 1,180 feet and an estimated length of 600 feet. The slide severely damaged an elementary school, two residences, and an Alaska Railroad building. The south wing of the school dropped 20 feet. Fortunately, the school was not in session.

Throughout the city, damages occurred in man-made fill areas, utility trenches, and roads. Shaking did not damage well-built, low structures or one-story wood framed residences. However, twin fourteen-story apartment buildings, the L Street Tower and the McKay Building on Fourth Avenue, though a mile apart, sustained nearly identical, massive damage. The airport control tower and the six-story Four Season's apartment building, under construction, collapsed. The five-story J. C. Penney store was so badly damaged it had to be demolished. One major column of the six-story Cordova Building failed. The eight-story Hill Building on Sixth Avenue was badly damaged. The latter four buildings had been designed to meet requirements of Seismic Zone 3 of the Uniform Building Code. All of these buildings had natural periods of vibration in the half- to one-second range, the same as the dominant period of the ground shaking.

According to the Anchorage Daily News of Monday, March 30, 1964, 215 residences and 157 commer-

Figure 8. Turnagain Slide Area, April 1964



Source: Air Photo Tech

cial buildings were destroyed or damaged beyond repair, and the school system was hard hit. Early estimates of school damages were approximately $3.86 million. West Anchorage High School and Government Hill Elementary School were rendered unusable. In downtown Anchorage, about 30 blocks of dwellings and commerical buildings were reportedly either destroyed or severely damaged.

All modes of transportation were severely impacted. Roads in the downtown area were completely blocked by debris or damaged by landslides. Debris and vibrations damaged or destroyed Alaska Railroad maintenance sheds and cars, blocked tracks, and rendered much equipment unusable. Bridges failed and tracks were buckled or bent along the rights-of-way from Anchorage to Portage, Whittier, Seward, and Palmer, totaling over $10 million in damage.

The Anchorage International Airport control tower collapsed due to severe ground shaking, with one person killed and another injured. The terminal itself was only moderately damaged except where it adjoined the tower. Almost 20,000 barrels of aviation fuel were lost from ruptured storage tanks. Runways and taxiways were slightly damaged but still functional. Air traffic control was temporarily resumed from a parked aircraft and later was shifted to a tower at Lake Hood, adjacent to the airport. Facilities at the Port of Anchorage were also damaged. Four cranes and two steel storage tanks were destroyed, and nearby oil-storage tanks were slightly damaged, though no major spillage occurred.

The two military bases located in Anchorage received severe damage. Elmendorf Air Force Base suffered a total of $1,021,800 in damage to buildings, structures, utilities, streets, coastal installations, and to the airfield itself. Damage to similar facilities at Fort Richardson totaled $15,667,590. Fortunately, the military bases remained fully operational. Their assistance in the disaster response and recovery was indispensable.

Disaster Response and Reconstruction

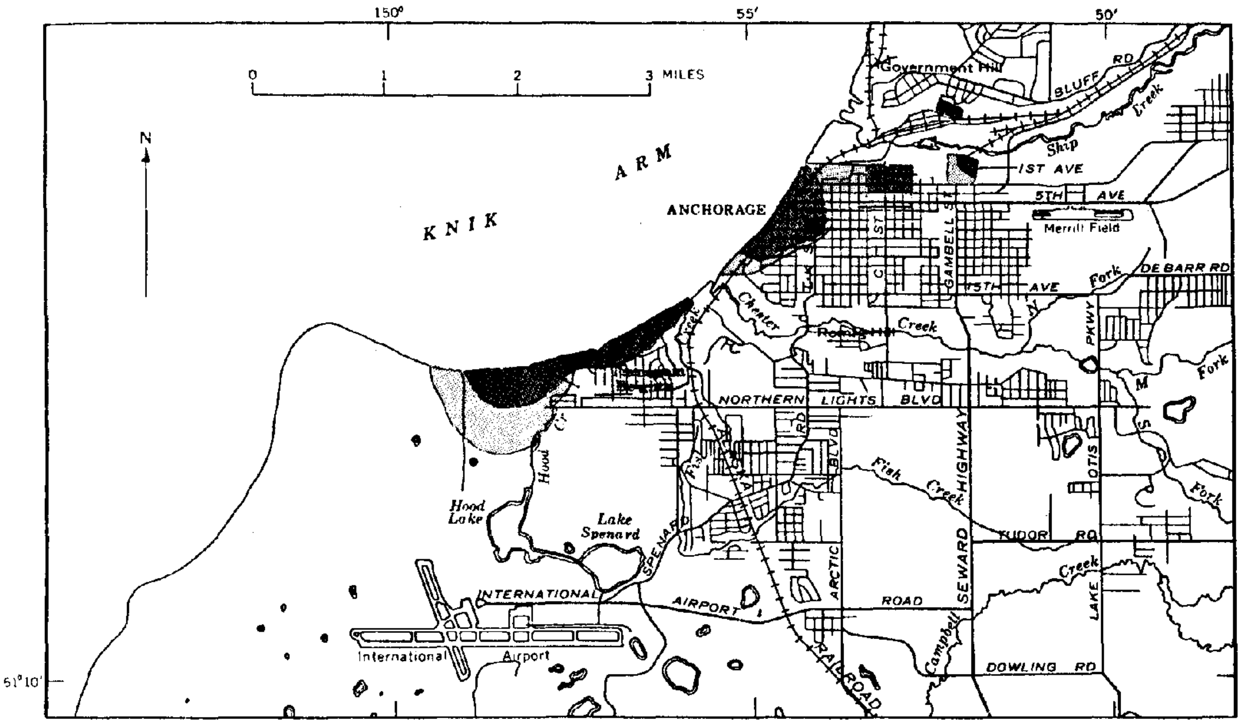
Before state and federal institutions were fully mobilized to provide assistance, local authorities mobilized operations to provide medical care, to initiate evacuation, and to reestablish communications and transportation systems. In the first hours after the earthquake, personnel from city departments and private citizens responded independently according to their training and special roles. Individuals immediately began search and rescue activities and aid to the injured, with military assistance. Later, by executive order of the President under the mandate of Public Law 875, the Alaska contingent of the U.S. Army Corps of Engineers was given the lead responsibility in repair and restoration work, including removal of hazards, clearing of roads, and restoration of utilities.

Emergency work began immediately to insure the health, safety, and welfare of the citizens. Utilities, transportation facilities, schools, and hospitals were a priority. In some instances, temporary emergency repairs were made until more definite information, upon which to base the final remedial work, could be gathered. Emergency repairs were made immediately to the municipal docks and other damaged port facilities, including a temporary petroleum offloading facility, as the Port of Anchorage was the only port left operational in southcentral Alaska after the destruction of Valdez, Whittier, and Seward.

The Alaska State Housing Authority (ASHA), which had been selected as a primary redevelopment agency, realized that long-range restoration required geological and soil data to determine where facilities could be permanently reconstructed. Lack of scientific personnel within the agency made an appeal for technical help to earth scientists in Anchorage a first priority. Over fifty professionals responded. The quickly assembled group--the Engineering Geology Evaluation Group--immediately began a program of mapping and data gathering, contracted for aerial photography, and started a drilling program in the major slide areas in cooperation with the Department of Highways. By April 12 the group had completed a preliminary report that summarized the cause of land failure and outlined the studies necessary to establish proper land uses for the area recognized as high risk (Hansen 1966; Selkregg 1970).

Delineation of the risk areas was based on the group's knowledge of the underlying geology drawn from earlier studies by Miller and Dobrovolney (1959), along with post disaster observations (Figure 9). The report prepared by this group of volunteers was necessary to initiate mechanisms for long-range reconstruction of public facilities by the U.S. Army Corps of Engineers and to assist the private sector in identifying areas safe for reconstruction where federal insured loans could be granted and where feasibility applications for reconstruction or other treatment under the Urban Renewal Disaster

Figure 9. Risk Classifications, Anchorage



Nominal-risk Area ☐

Little likelihood of landslide except for small slumps, largely in artificial fill. In all other respects risks are no greater than is normally expected in the construction industry where structures are built on a thick sequence of unconsolidated sediments. Current Uniform Building Code for Seismic Zone 3 applies both to new buildings and to plans for rehabilitation of earthquake-damaged structures. Special engineering consideration should be given to construction near the top, at the base, and on steep slopes, especially where the Bootlegger Cove Clay is present. No filling, cutting or construction should be permitted that will steepen or increase the load on or above these slopes.

Source: This map and press notice released September 8, 1964 represent the final recommendations in risk classification of Anchorage by the Scientific and Engineering Task Force.

Provisional-nominal-risk area

Reclassification to "nominal-risk" in these areas is contingent on stabilization of adjacent slide areas or stabilization within the areas themselves. If stabilization is not effected, land will be "high-risk" classification.

Unstable area ■

Land considered unstable in the event of future earthquakes unless stabilization is attained. No new construction and only limited rehabilitation is recommended unless stabilization is attained. It is recommended that after stabilization, new buildings on Fourth Avenue, L - K Streets, and Government Hill slides be limited to light structures not over two stories high. No buildings are recommended on the Turnagain Heights slide between the bluff and tidewater, nor on the First Avenue slides, even after stabilization. If stabilization is not effected, land will be "high-risk" classification.

program could be initiated (Selkregg et al. 1970). Other similar ad hoc groups were formed to assist in the evaluation of damages.

On April 3 the city council passed a resolution authorizing the preparation of an urban renewal feasibility study for the downtown area covering the L Street and Fourth Avenue slides. On April 7 a similar resolution initiated an urban renewal project for the Turnagain slide area. These first decisions were based on the findings of the Engineering Geology Evaluation Group. The firm of Candeub, Fleissig, and Associates was retained to prepare the redevelopment plan for the downtown area with the assistance of architects Robert A. Alexander and Edwin B. Crittenden (Figure 10). The plan recommended the relocation of the primary business core away from the bluff, where more favorable soil conditions existed, and designated the risk areas to be used for parks, parking, and other open-space activities. In these open spaces, only pavillions oriented towards the tourist trade were to be allowed. Detailed suggestions for pedestrian malls to revitalize the city core were also made an integral part of the plan.

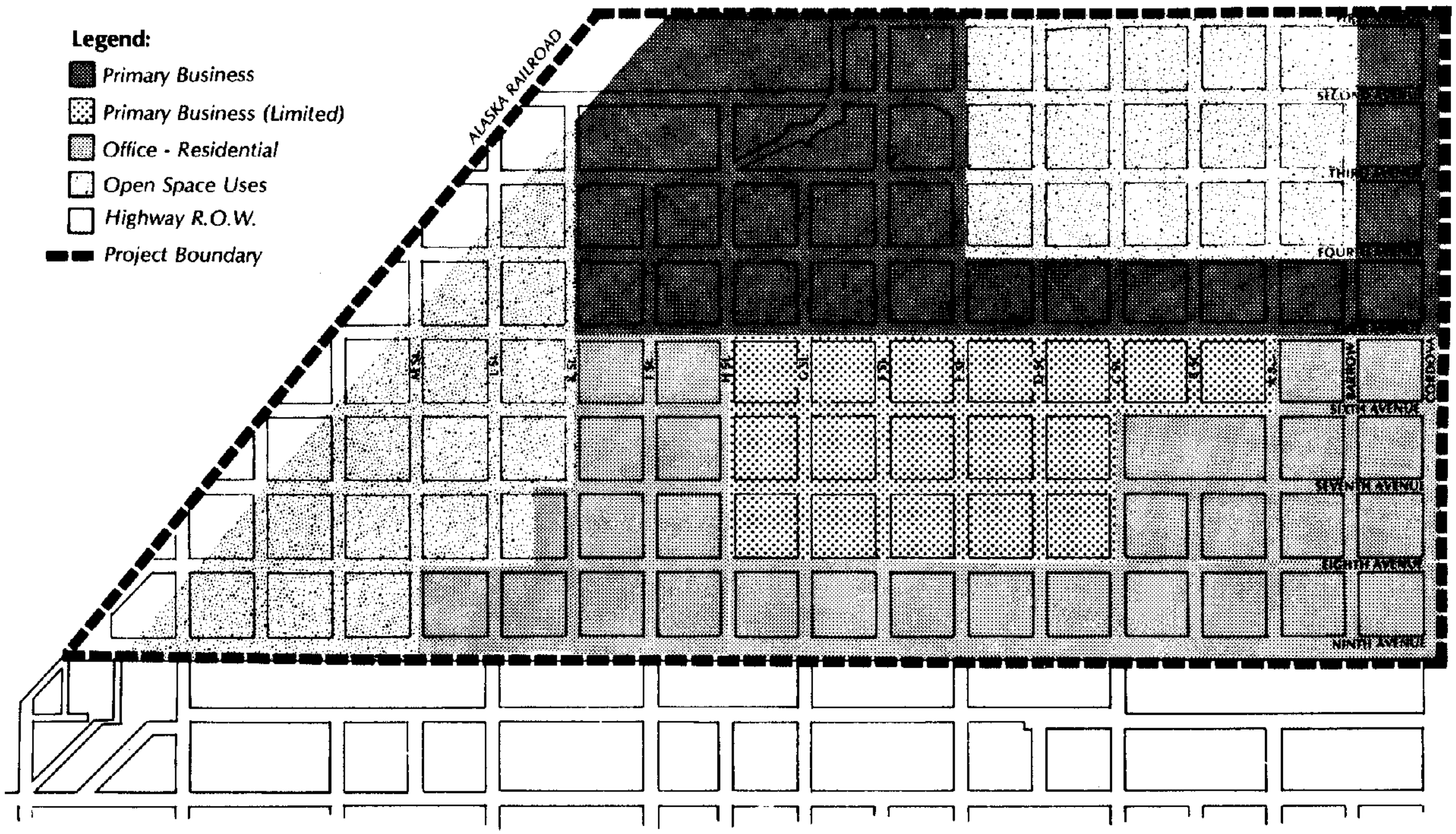
A feasibility survey for an urban renewal project in the Turnagain slide area was submitted on April 8, 1964. Because early evaluation of soil conditions in the area had classified the land along the waterfront as unstable, the Urban Renewal Administration authorized funds for land-stabilization studies prior to the development of a final redevelopment plan.

This early commitment by government and people did not last. Although some people saw the plan as a means to improve the central business district by implementing ideas considered by planners and architects prior to the earthquake as well as protecting the city from future disasters, the plan did not gain the support of the business community. With large portions of the central business district destroyed, many businessmen saw further demolition as too destructive to the city's economy. Pressures were applied by individuals on politicians to reevaluate, to further study, and to reduce areas designated as hazardous.

Shortly after the Federal Reconstruction and Development Commission for Alaska was established by executive order of the President, the commission appointed eight special task forces to deal with specific issues: community facilities, economic stabilization, financial institutions, housing, industrial development, natural resources, ports, fishing, and transportation. It became evident that to be able to advise the commission on the aspects of soil stability, geology, and engineering, an additional task force was needed to respond to local concerns and advise Congress.

On April 25 the Scientific and Engineering Task Force (Task Force 9) was established. Recommendations of this task force guided the final reconstruction decisions in Anchorage, Valdez, Seward, Homer, and Kodiak. By the time Task

Figure 10. First Development Plan for Downtown Anchorage



Source: Candeub, Flessing and Associates with Alexander and Crittenden.

Force 9 was organized, the U.S. Army-Alaska District Corps of Engineers had already been designated by the Office of Emergency Planning as the responsible agency for development of the basic information needed for final design and reconstruction. Field representatives of these two groups worked closely assisted by the engineering firm of Shannon and Wilson, Inc. and staff from the U.S. Geological Survey to develop final recommendations and risk maps (Eckel and Schaem 1966).

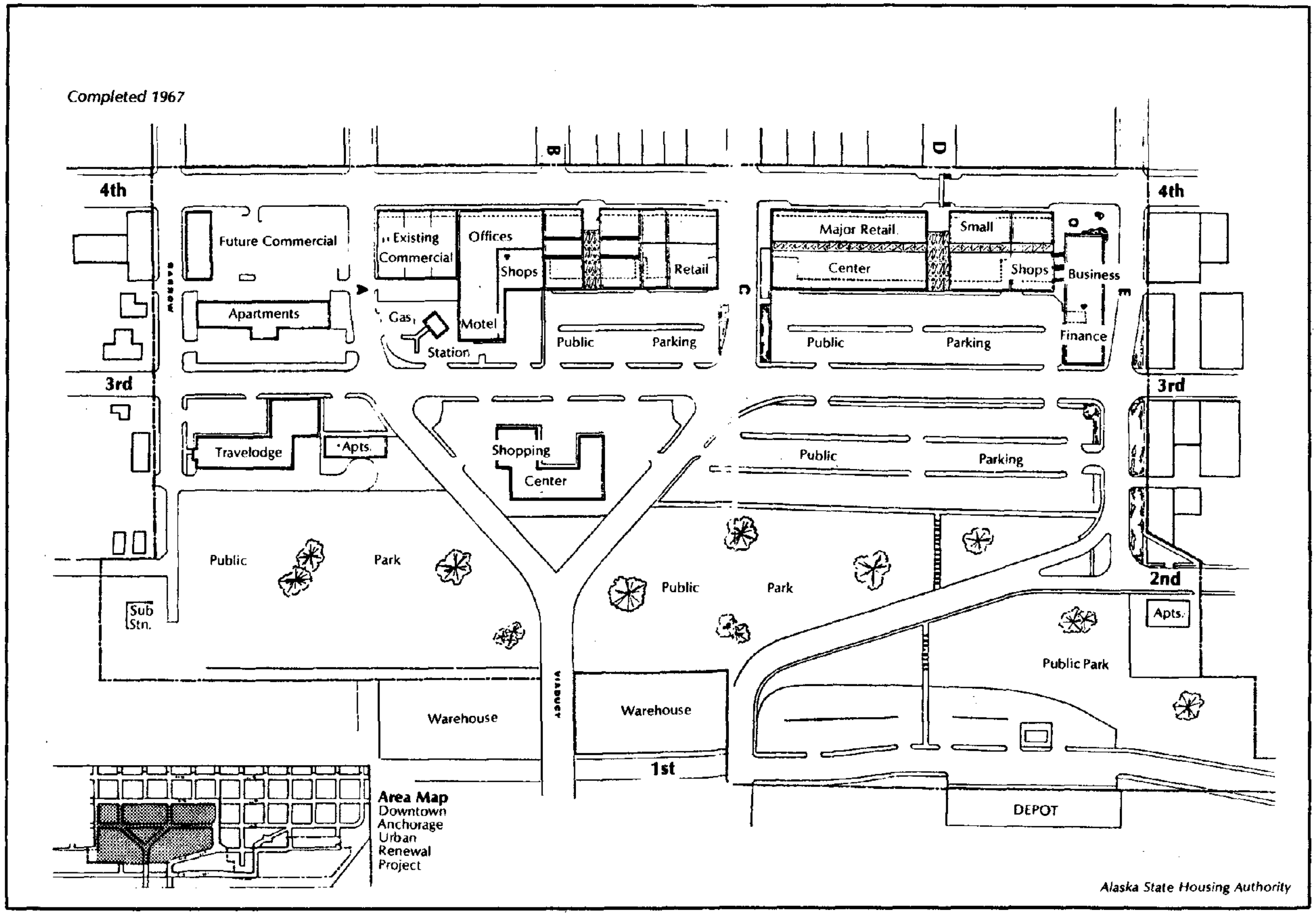
After a series of recommendations were issued by Task Force 9--May 19, June 26, July 8, 14, 17, and September 8, 1964--the final report was issued in the form of a map reflecting the classification of earthquake risk areas with recommendations of intensity of use and stabilization (Figure 11). The recommendations of possible stabilization introduced a new dimension on the development of high-risk areas. The business community saw this as an opportunity to reconsider previously approved recommendations related to land use on the three major slide areas. As a result of a public meeting and pressure of private interests, the boundaries of the downtown project were reduced to include only the area needed for the construction of a buttress on Fourth Avenue to prevent the adjacent land from sliding during another earthquake. A land use redevelopment plan was prepared by the Alaska State Housing Authority and the city planning department to expedite the approval of funds for the construction of the buttress. Work conducted by earlier planning teams was ignored. The final plan contained controls on weight of structures, depth of foundations, and excavation and building heights as required by the final buttress design.

A study to stabilize the L Street slide area was never conducted. The urban renewal project was abandoned, and in the last 10 years extensive reconstruction has occurred in the areas considered high-risk by the Engineering and Geology Evaluation Group as well as Task Force 9. This area, which prior to the earthquake had a low land use composed mostly of single-family residences, today has an assessed value of more than $100 million that reflects the value of offices and apartments.

Several methods of stabilization were tested in the Turnagain slide area (Shannon and Wilson 1965, 1966). All methods proved unsuccessful and in April 1966 the Corps of Engineers released the following statement:

> On the basis of the field and laboratory work that has been done, we have reached the following conclusions: In the interval since the Good Friday quake, the strength of the zone of failure in the Turnagain area has been increasing and has reached or in the fairly near future will reach its original value. The natural slope of slide material that now exists forms a natural buttress that will with-

Figure 11. Final Redevelopment Plan, for the 4th Avenue Slide Area, Anchorage.



stand a quake of similar intensity and duration to the one of Good Friday. The buttress area will remain in a stable condition and the zone behind the escarpment can be removed from the high-risk area provided the buttress is protected against beach erosion. The buttress itself, however, will be subject to substantial differential movements for some time to come, and may experience locally large distortions in future earthquakes. Therefore, construction upon it should not be permitted. Landward of the scarp, within the zone presently classified as high risk, local differential settlements on the order of several inches are likely to occur, particularly along the boundaries of earthquake-induced cracks. Furthermore, ground motions may be more severe during an earthquake than at locations further removed from the crest. The design of buildings to be constructed in this zone should take these circumstances into consideration.

To ease land acquisition the legislature authorized the Alaska State Housing Authority to prepare an urban renewal redevelopment plan proposing that the boundaries of the project be limited to the natural buttress, that the property be acquired and classified for park and recreation use only, and that an erosion control system be built. The state legislature authorized disposal of land in a newly developed, stable area in exchange for lots on the unstable, high-risk area. Many people obtained new lots in the Zodiak Manor subdivision, but neither the state nor the city demanded title to land in exchange. The Corps of Engineers could not initiate an erosion control project until the waterfront was in public ownership. This never occurred. Until 1975 the area remained dormant. In the last eight years, however, there have been moves to resubdivide and develop the land, and several homes have been rebuilt on the unstable bluffs.

In evaluating the long- and short-range efforts of reconstruction after the March 27, 1964 earthquake, most reports seem to concentrate their efforts on the evaluation of damages and reconstruction of only the slide areas without looking at the whole city infrastructure--utilities, transportation, public services, and general land use. Tables 5 and 6 represent a brief summary of the reconstruction efforts directed to utilities and transportation systems, two major components of municipal structure. The entire city infrastructure collapsed as a result of a physical event, and the whole socioeconomic structure was affected.

The fact that the Municipality of Anchorage owned and managed the water, sewer, telephone, and light and power utilities made reconstruction efforts, directed by the Corps of Engineers, easier and allowed for federal assistance. Also, coordination was better maintained during the reconstruction of underground and overhead utilities and in obtaining easements and right-of-way access.

The earthquake emphasized the importance of transportation in disaster relief operation efforts. Air transport appears to have been less vulnerable compared to highway, rail, and port systems. Air transportation not only provides Alaskans with a vital link between communities in Alaska and the outside, but for many communities air transport is the only direct means of travel. Also, the reliance on air transportation in Alaska is amplified significantly over the other states by lack of interconnecting highways and railroads.

Although southcentral Alaska and Anchorage are served by all modes of transportation, many of the communities within the areas affected by the earthquake were isolated due to damaged rails, highways, and ports. Immediate relief to the stricken communities and assessment of damages was conducted by aircraft. The importance of all transportation modes in Anchorage became evident during the early stages of recovery and in the long-range reconstruction phase when the function of Anchorage as the center of commerce and health and social services for southcentral Alaska was emphasized. In the last few years the function of Anchorage as the port of entry and distribution system to the state has expanded, therefore the importance of Anchorage transport systems are today even more crucial than at the time of the March 1964 earthquake.

At the time of the earthquake schools were not in session. This was fortunate since several schools were heavily damaged. The Government Hill Elementary School was completely destroyed, and West High School had severe damage. Other facilities experienced minor problems but retained structural integrity. There were a total of 24 facilities in the Anchorage school system. Twenty-one of the schools had reopened by April 8.

Three hospitals in the Anchorage area provided health services to the community--Providence Hospital, Anchorage Community Hospital, and the Alaska Native Hospital of the U.S. Public Health Service. Patients at the Anchorage Community Hospital were evacuated due to disruptions in utilities and leaking gas lines, but the hospital reopened two days after the earthquake for emergency cases. Both Providence Hospital and the Alaska Native Hospital sustained minor damage but remained operational.

The public safety building housed fire and police operations in the city. The building was not seriously damaged and early on became the headquarters for much of the disaster response operations in the city. This facility was chosen over city hall due to its accessibility and communications equipment.

Table 5. Impacts on Utilities, Anchorage

Telephone

The Anchorage Telephone Utility (ATU) system served 25,863 customers. Most damage to the system was due to slides. With electric power gone, ATU had to run on emergency batteries. Fortunately, ATU had enough cable, repair material, splicers and wiremen already on hand to install a new high-speed relay telephone system to rapidly repair the switching equipment. Seven hours after the earthquake the Broadway Exchange, largest of the four exchanges, resumed operation, and by Monday, March 30, long distance toll service in and outside Alaska had been restored.

Water

The City of Anchorage Water Utility supplied all of Anchorage, part of Spenard, and several subdivisions outside city limits from a combination of ground water and surface water from Ship Creek. Electrical failure immediately shut down the treatment plant and deep well pumps, as well as individual well pumps. Emergency water stations were established at strategic locations to provide for household use, a service which continued for up to two weeks in some areas. Also, temporary waterline pipe and fittings were laid immediately to service major slide areas where underground lines were seriously damaged. More than 14 miles of temporary surface lines were installed. Still, consumers were warned to boil water before drinking it. Restoration work began on the areas that did not slide but had been damaged by the Turnagain L Street, and Fourth Avenue slides and in other damaged parts of town. The Corps of Engineers, consultants, and city staff provided for design and acquisition of new utility easements, and material necessary for replacement and repairs. Restoration of the water utility was sped by ordering new pipes and fittings in advance of contract award so that the material was immediately available for installation before freeze-up. Along with repair of the distribution system, new lines were installed and new wells drilled to replace those destroyed during the disaster, and the wastewater treatment plant was put back into operation.

Sewer

The City of Anchorage Sewer Utility and the Spenard Utility District consisted of laterals emptying into collectors and outfalls similar to other cities of comparable size. Sewer lines in and near slide areas sustained greatest damage. The Knik interceptor sewer line in the tide flat was broken and crushed by pressure ridges. The Hood Creek outfall in Turnagain was carried away in the slide. Fourth Avenue slide graben interrupted lines between Fourth and First avenues. The L Sreet slide graben cut off collector lines between Third and Fifth avenues and blocked sewage flow from all the area to the east.

The Anchorage and Spenard systems were considered jointly in planning restoration. Until spring breakup, sewage was kept flowing in any possible manner. After emergency work restored the system to a workable condition, lines with known or suspected damage were photographed. This insured that all breaks were identified and repaired. Major repairs were finished before the fall of 1964, and minor parts were completed in 1965.

Gas

Gas is supplied from wells on the Kenai Peninsula. The 84-mile line withstood the shocks and held pressure, but in the Anchorage area the earthquake caused hundreds of pipeline failures. Leaks in the gas lines were minimized due to the foresight of the Anchorage Natural Gas Company. Rigid regulations had been developed to govern the installation of gas-fired appliances and service connections. During the earthquake, gas pressure regulation valves installed at most service connections closed when street mains or other interior lines broke.

Good maps of the system, with accurate valve locations, assisted in emergency recovery efforts. Damage was severe. A major break in the line servicing Anchorage Municipal Light and Power (MLP) left it operating sporadically on standby diesel fuel. Some outlets (e.g., Turnagain Heights) had simply disappeared. Field crews soon isolated heavily damaged downtown areas by closing a central valve in the northeast part of the system. Closure of a block valve in the immediate pressure line permitted service to about a thousand customers in southeast Anchorage, including Alaska Methodist University, Providence Hospital, and the Alaska Psychiatric Institute. This phase of recovery was completed by 7:00 p.m. Friday. By early Sunday morning, service was restored to MLP turbines through an emergency pipeline and within a week gas was restored to four of the five thousand customers. Resumption of service in the slide areas in Turnagain and Downtown had to wait for final reconstruction.

Light and Power

Municipal Light and Power operated the city-owned electrical generating station and transmission and distribution system. The earthquake caused moderate to major damage to power plants and distribution systems. Power outages affected all buildings, pointing out the importance of emergency power and lighting systems in disasters. Both overhead and underground systems were damaged. The overhead lines were about 75 percent operational immediately after the earthquake. Underground systems were about 80 percent operational except where destroyed by landslides. Light emergency repairs quickly made this system about 90 percent operational. The surveys of telephone and electrical duct system damage were inseparable and were carried out jointly; a TV camera was used to identify damage, preventing unnecessary expenditures. All essential restoration work was completed before fall 1964.

(<u>Great Alaska Earthquake, 1964, Engineering Volume</u>).

Table 6. Impacts on the Transportation System, Anchorage

Roads

The earthquake caused severe damage to most roads in south-central Alaska, the worst on the Seward-Anchorage Highway over a 17-mile section along Turnagain Arm. This paved road is the only road between Anchorage and the Kenai Peninsula, Seward, Kenai, and Homer. Cracks, fissures, snow slides, destruction of bridges, and general subsidence over the entire area made the road system south of Anchorage unusable. North of Anchorage the damage was not as great; however, transverse and longitudinal fissures on the roadbed and numerous side-hill failures and slumps occurred at various locations between Anchorage and Glennallen. Damage to bridges was slight compared to the south, although displacement was found on partially completed piers and abutments of a bridge complex over the Knik and Matanuska Rivers. On local roads, settlement and fissures occurred on many of the high "fills" in the Hillside and Sandlake districts. Alternate cuts and fills along streets, highways, and railbeds demonstrated a predictable pattern of fractures. Extensive road damage occurred in the three major slide areas. Many streets were destroyed by cracks extending a block or more beyond the Fourth Avenue slide.

Railroad

The main terminal and maintenance facilities of the Alaska Railroad at Anchorage sustained major damage. About 2 miles of marshalling-yard tracks were damaged by settlement that bent rails and sheared bolts.

Distribution of freight covered by the railroad changed as a result of the earthquake. Ships began to deliver freight directly to Anchorage on a year-round basis, decreasing the quantity of freight from Seward and Whittier. Because of reduced docking facilities at Valdez, more freight was diverted to Anchorage, increasing the flow of freight through Anchorage to Fairbanks.

Ports and Harbors

The earthquake devastated ports and harbors. Waterfront facilities at Cordova, Seward, Kodiak, Homer, Whittier, and Seldovia were completely destroyed. All goods shipped to the state had to land in Anchorage, where the dock could accommodate only two ships at one time. Most of the damage to the port of Anchorage was caused by ground displacement along fractures. Buildings, cranes, storage tanks, and piers all suffered damage. The Ocean Dock was almost completely destroyed as all pilings, buildings and light poles slumped seaward. The freight and the asphalt docks were relatively untouched; however, two cement storage tanks toppled, causing damage to the Alaska Aggregate Corporation facilities.

With the destruction of the Ocean Dock the tremendous oil requirements of Anchorage and Elmendorf Air Force Base fell on the City Dock which provided only one access to shore. The federal government assisted in repairing the access to the City Dock and in building a temporary petroleum, oils, and lubricant (POC) dock. The military installed pipelines on the City Dock by the middle of April for off-loading petroleum products. The City Dock was restored by the city, assisted by Tippetts-Abbott-McCarthy-Shatton consultants. By 1966 the city had completed a new permanent POC dock. The remains of the Ocean Dock, controlled by the U.S. Army, were dismantled in 1966 to allow access to the new POC dock. Private facilities were repaired by the owners and were soon back in operation.

Air

The Anchorage International Airport control tower was the only civilian air-traffic facility that sustained severe structural damage. The tower collapsed, killing one employee and injuring a second. As a result, all controlled use of the airport was lost. Temporary service was immediately provided by the Federal Aviation Administration (FAA) via radio equipment in an FAA flight-deck aircraft parked on a ramp at the airport. By midnight one of the Anchorage International Airport traffic-control tower frequencies was operating at the Lake Hood seaplane base contol tower, about 3,500 feet from the destroyed control tower. Later, additional air-to-ground frequencies were installed, and although the tower operators were unable to observe aircraft movement or ramp activities in some parts of the airport, the Lake Hood tower continued to control traffic until a new tower was built in 1965.

Loss of communication circuits greatly impaired the Anchorage International and Domestic Flight Service Station at Merrill Field. Immediately after the earthquake two long-distance circuits and ground-to-air circuits were found to be operational; however, local telephone, interphone, and teletype services within the facilities were inoperable. Portable radio communication units of the Gonset type were most useful in reestablishing a semblance of communication between the control facilities. Without minimal conversation between facilities, air traffic control services within the Anchorage area would have collapsed.

Bryant Army Airfield on Fort Richardson was the only major airfield in the Anchorage area that was fully operational immediately after the earthquake.

The Elmendorf Air Force Base air terminal was unstable and the control tower sustained considerable damage. Operations resumed with the assistance of a mobile unit which arrived from Tinker Air Force Base two days after the earthquake. Because Elmendorf Air Force Base was the only fully operational facility in Anchorage capable of accommodating jet aircraft, both private and military craft used that field until Anchorage International Airport was able to resume service (Great Alaska Earthquake, 1964, Engineering Volume).

Cordova

The epicenter of the 1964 earthquake occurred approximately 70 miles from Cordova. At the time of the earthquake Cordova had a population of roughly 2,000 people and was one of the main fishing and distribution centers on Prince William Sound. The city, accessible only by air and water, was striving for increased economic development through construction of a highway connection to the Alaska highway system and improved waterfront facilities. As a result of the earthquake the 39 miles of the Copper River Highway, which was to connect Cordova to the Richardson Highway, were severely damaged. All bridges were destroyed (Kachadoorian 1971). Also, a tectonic uplift of 6.5 feet rendered the commercial waterfront facilities unusable. This was far more disastrous to the city than the ground vibration or the seismic sea wave that reached the coast later. The uplift reduced the depth of the small-boat harbor basin from 12 to 5.5 feet at mean level low water (MLLW), resulting in water too shallow for any but the smallest vessels at low tide.

All dock facilities were raised so high they could be reached only at highest tide, and canneries had to extend their docks more than 100 feet to permit access. The uplift also rendered useless the natural inlets which provided shelter for boats. The entire fishing industry was severely impacted.

Because most of the community was built on argillite and graywacke, a stable foundation for the small structures existing at that time, very little damage occurred to homes and businesses. Some older dwellings built on glaciofluvial deposits in the slough south of town were damaged or destroyed. These structures, however, had been considered substandard and had already been recommended for replacement through urban renewal during the preparation of a comprehensive plan for the city in 1962 (ASHA 1962). Although earth shocks caused little damage to structures, differential movement of the ground damaged the sanitary sewerage outfall by causing joint separation. In addition, tectonic uplift left the outfall discharging into the tidelands above the MLLW line, creating serious sanitation hazards, especially in the old residential district along the slough (Arno and McKinney 1973).

The first evidence of tsunami activity was reported a half hour after the earthquake and was described as a strong surge in the area. Many other surges were reported throughout the evening as seismic waves passed by Cordova; however, no damage was reported. The largest wave hit Cordova at 12:30 a.m., March 28. The wave crested at 20 feet and flooded the shore to a height of about 34 feet above the post earthquake MLLW. The water surface rose above the deck of both city and ferry docks, pulling the pile caps loose from the drift pins. When the water level receded, many pile caps were dislocated. In addition to dock damage, some homes along the waterfront were destroyed. Total damage estimates for Cordova were placed at $1.5 million (1964 dollars).

Cordova residents faced no serious problems with regard to disaster relief. Utilities were functioning, and food, clothing, and shelter were not a problem; however, the city was faced with serious long-range economic problems. The earthquake had accelerated a situation of decay. The Cordova waterfront was in great need of redevelopment even before the disaster. A 1963 fire had destroyed an entire city block, including businesses and dwellings for 27 families. Reconstruction of the downtown business district had just been completed when the earthquake occurred.

Cordova had prepared a comprehensive long-range development plan in the early 1960s and had approved zoning ordinances and subdivision regulations. The plan pointed out the need for development of a more functional waterfront district but lack of buildable land along the waterfront had prevented implementation of the recommendations made by planners.

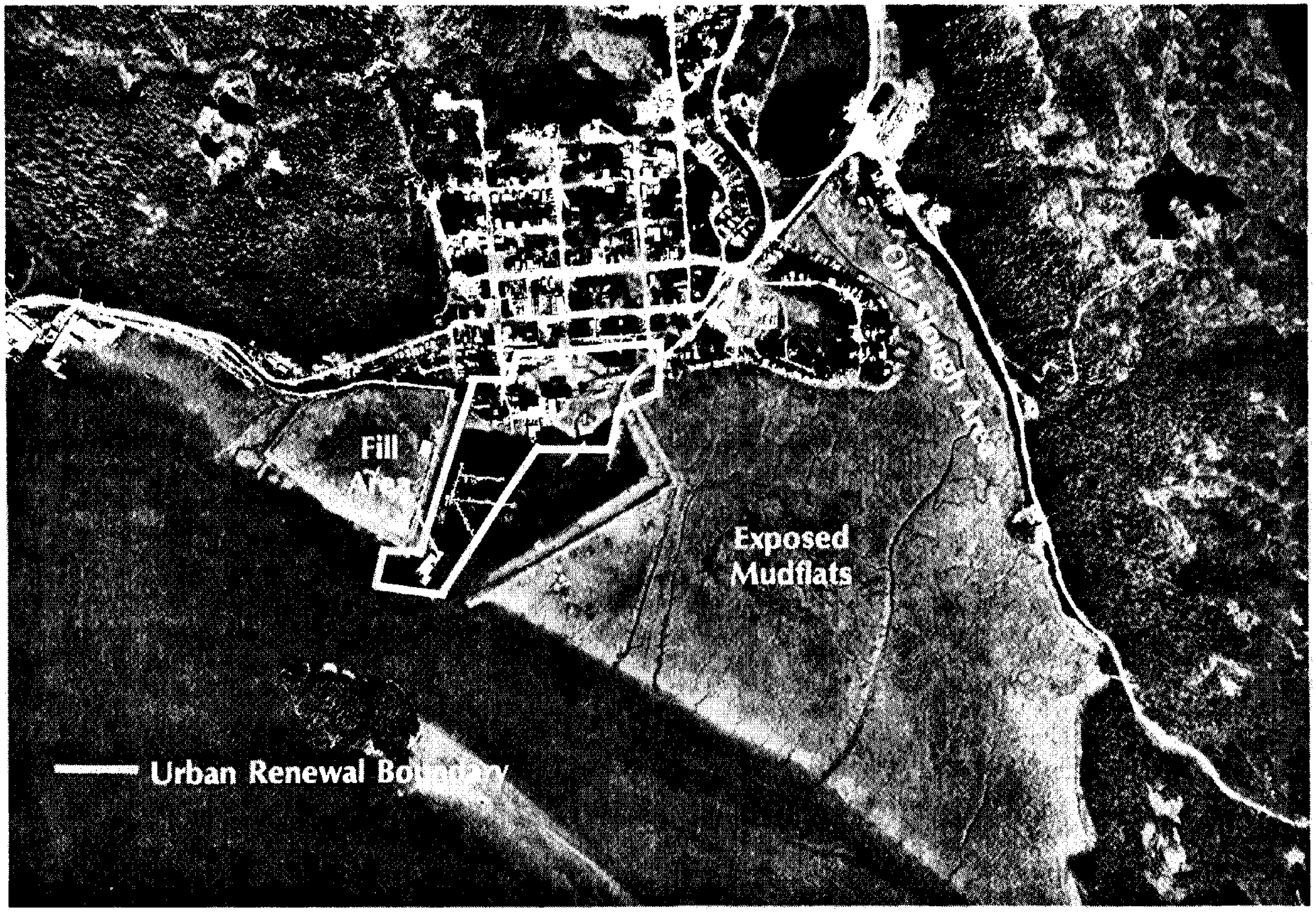
The key to reconstruction was quick rehabilitation of the city dock and small-boat harbor. Although funds were not available to immediately initiate an urban renewal project, the Corps of Engineers began dredging the harbor and demolishing damaged facilities at once. To minimize economic loss, restoration of the harbor had to be accomplished quickly. To protect the industry, protected moorage for the fleet was provided and maintained throughout restoration (Arno and McKinney 1973). The Office of Emergency Preparedness (OEP) and the Corps of Engineers funded reconstruction. The State contributed by modifying an existing contract for the construction of a ferryslip to supplement and coincide with the development of schedules for harbor reconstruction.

Final restoration required reconstruction of the dock, dock approach, and ferry terminal and for repairs to the breakwater. In the course of this work the boat basin was much enlarged, and 20 acres of new land for future development was generated by dredging the boat basin and placing fill on adjacent lowlands (Figure 12). In a sense the earthquake uplift had generated some of the land necessary to expand and enhance waterfront activities. Relocation of businesses on the fill area adjacent to the breakwater occurred during the fill operation, and structures were allowed to be erected on driven pile foundations.

Because uplift had made the waters too shallow to allow travel between town and the fishing grounds of the Copper River delta, the U.S. Army Corps of Engineers dredged a channel in Orca Inlet.

Although, due to lack of funds, ASHA had not initiated a disaster urban renewal project, an early land acquisition plan was processed to acquire structures that were to be demolished by

Figure 12. Damaged Cordova Waterfront



Source: National Academy of Sciences, Great Alaska Earthquake, Human Ecology Volume

the Corps of Engineers as part of the waterfront reconstruction program. An urban renewal project was approved and completed by February 1966. The project covered the waterfront adjacent to the newly rebuilt harbor. The goals of the redevelopment plan reflected recommendations of the long-range comprehensive plan prepared in 1962--upgrading the waterfront, constructing a ferry terminal, and developing road access by connecting the waterfront to the Copper River Highway, then under construction. By the fall of 1966 the new dock, small-boat harbor, and ferryslip facilities were completed, and land for redevelopment in the urban renewal project was available by 1968 (Selkregg et al. 1972). The Copper River Highway was repaired, but its extension beyond the portion that was constructed before the earthquake still remains in the planning stage.

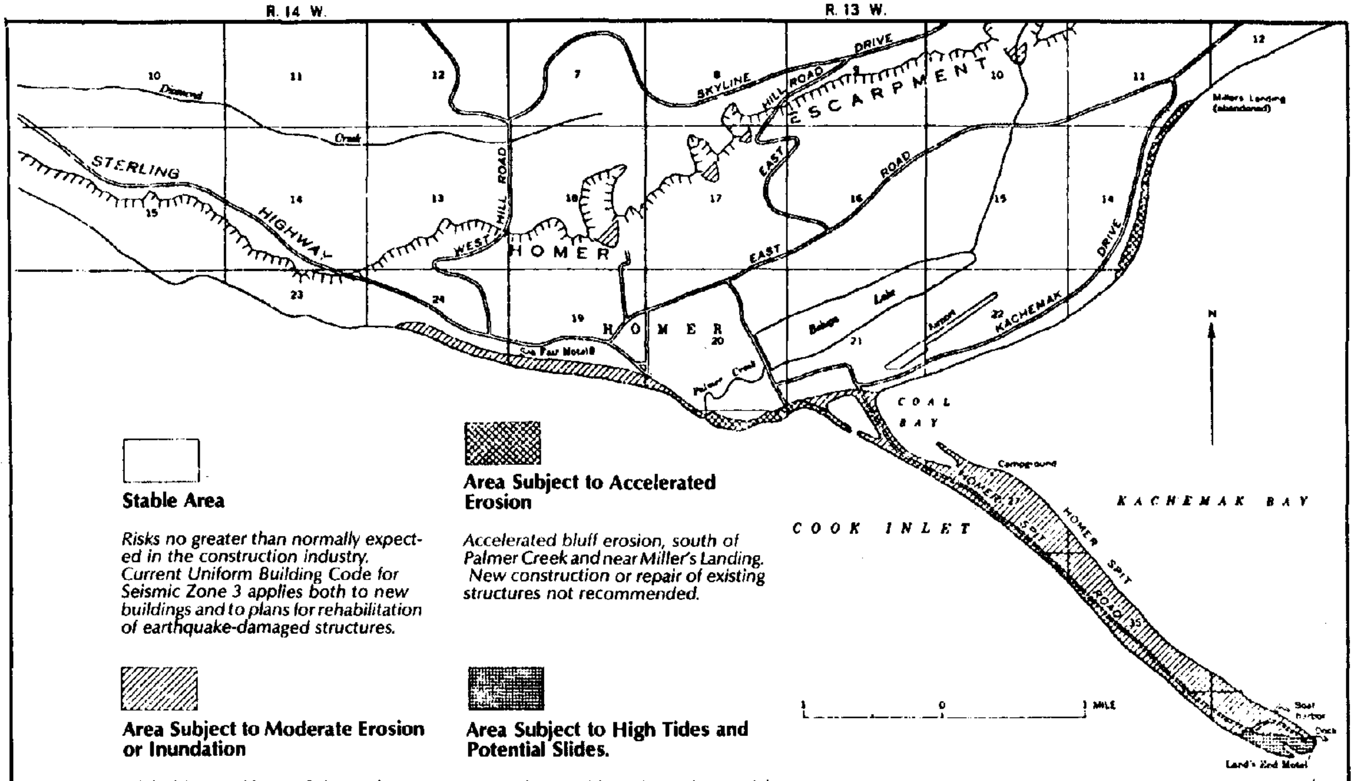
Homer

Homer, located at the southern tip of the lowland part of the Kenai Peninsula, shook for about three minutes during the 1964 quake. Land effects consisted of a two- to six-foot subsidence. The Homer Spit, a four-mile narrow tongue of land separating Cook Inlet from Kachemak Bay, subsided about six feet. Subsidence of the spit resulted from lowering of the landmass and compression of unconsolidated material that extends to a depth of about 485 feet. Extensive surface movement had localized effects on the outer end of the spit, where a submarine landslide created large fissures, destroyed portions of the breakwater, and rendered the small-boat harbor unusable. Several landslides also occurred along the escarpment and the sea bluffs.

Compared to other communities, the value of property was severely affected by loss of all the facilities on which its economy was based. The spit housed a variety of businesses and was the commercial and industrial center of the community. The small-boat harbor, a hotel, fish-processing plants, restaurants, bars, and the Standard Oil Company tank farm were concentrated at the end of the spit.

After the earthquake much of the spit was below high-tide levels, and consequently it was periodically flooded. The entire beach face had retreated, and much of the eroded material was redeposited on the access road and around the buildings. A feasibility survey for the redevelopment of the spit indicated that the utilization of an urban renewal program was not feasible because of the nature of the development and existing ownership. Rehabilitation of the spit with federal funds required that Task Force 9 evaluate the risk involved in reconstruction of the spit. Here Task Force 9 adopted risk classifications different than those applied in other cities (Figure 13). Instead of using such terms as "nominal," "provisional nominal," and "high risk," it classified areas as "stable," "subject to moderate

Figure 13. Risk Classifications, Homer.



Stable Area

Risks no greater than normally expected in the construction industry. Current Uniform Building Code for Seismic Zone 3 applies both to new buildings and to plans for rehabilitation of earthquake-damaged structures.

Area Subject to Accelerated Erosion

Accelerated bluff erosion, south of Palmer Creek and near Miller's Landing. New construction or repair of existing structures not recommended.

Area Subject to Moderate Erosion or Inundation

High tides, on Homer Spit; moderate wave erosion, bluffs along sections 24, 19, and 20; potential earthflow, sections 10, 17 and 18. Considered safe for new construction or repairs only if adequate provision is made for indicated hazards. Current Uniform Building Code for Seismic Zone 3 applies to both new buildings and to plans for rehabilitation of earthquake damaged structures.

Area Subject to High Tides and Potential Slides.

Area subject to high tides and potential slides, pending artificial filling and clarification of submarine slope stability. New construction or repair of existing structures, other than highway, not recommended.

NOTE: Classification of areas on Homer Spit should be considered as temporary, pending observation of results of natural or artificial changes in shape and height of Homer Spit.

Source: Released to Homer officials on September 9, 1964 by the Scientific and Engineering Task Force.

erosion or inundation," "subject to accelerated erosion," and "subject to high tides and potential slides." It recommended against new construction or repair only for the last two categories (Eckel and Schaem 1970). Only the end of the spit was classified as "subject to high tides and potential slides." This allowed the U.S. Army Corps of Engineers and Alaska Highway Department to initiate projects to fill the lowlands, raise the road along the spit to a level two feet above the new high tide, and to place rip-rap along the west side of the spit, projecting it from erosion. A comprehensive redevelopment plan was never prepared. The small-boat harbor was restored with funds available to the Corps of Engineers from OEP under Public Law 875. The basin was extended and the boat-launching ramp constructed using funds allocated under a 1964 amendment to the Alaska Omnibus Act.

Kodiak Island

The 1964 earthquake damaged every community on Kodiak and nearby islands except Akhiok and Karluk. The cause of damage was inundation by several seismic sea waves that followed the earthquake, coupled with tectonic subsidence (Figure 14). The city of Kodiak and the Kodiak naval station were worst stricken and accounted for about 80 percent of the financial loss of the entire archipelago (Table 7). Two people died in Kodiak, three in Kaguyak, and thirteen people lost their lives on roads or boats in isolated areas.

The earthquake substantially damaged Kodiak. Due to the excellent rock foundation of the city, only minor structural damage occurred, but 80 percent of the downtown area was demolished by the tsunami that followed the earthquake and by a landmass subsidence of 6.5 feet (Selkregg et al. 1970; Kachadoorian and Plafker 1967).

At the time of the earthquake the city of Kodiak had a well-organized planning and zoning commission and a city council fully aware of the importance of long-range planning. The community was in the process of implementing the recommendations of a long-range comprehensive plan that had been prepared with the technical assistance of ASHA, financial assistance of the Housing and Home Finance Agency (HHFA, now Housing and Urban Development), and municipal assistance programs through the Urban Renewal Administration. Two days before the earthquake ASHA had completed a survey and planning study for a possible urban renewal project covering the whole downtown area to assist in the implementation of the long-range plan.

Immediately following the earthquake, planning consultants recommended rebuilding and stabilizing the waterfront, developing the waterfront with open-space uses, and relocating all commercial and residential uses to higher ground adjacent to the designated open spaces. These recommendations were made to provide mitigation

Table 7. Earthquake Damage to Public and Private Facilities at Kodiak

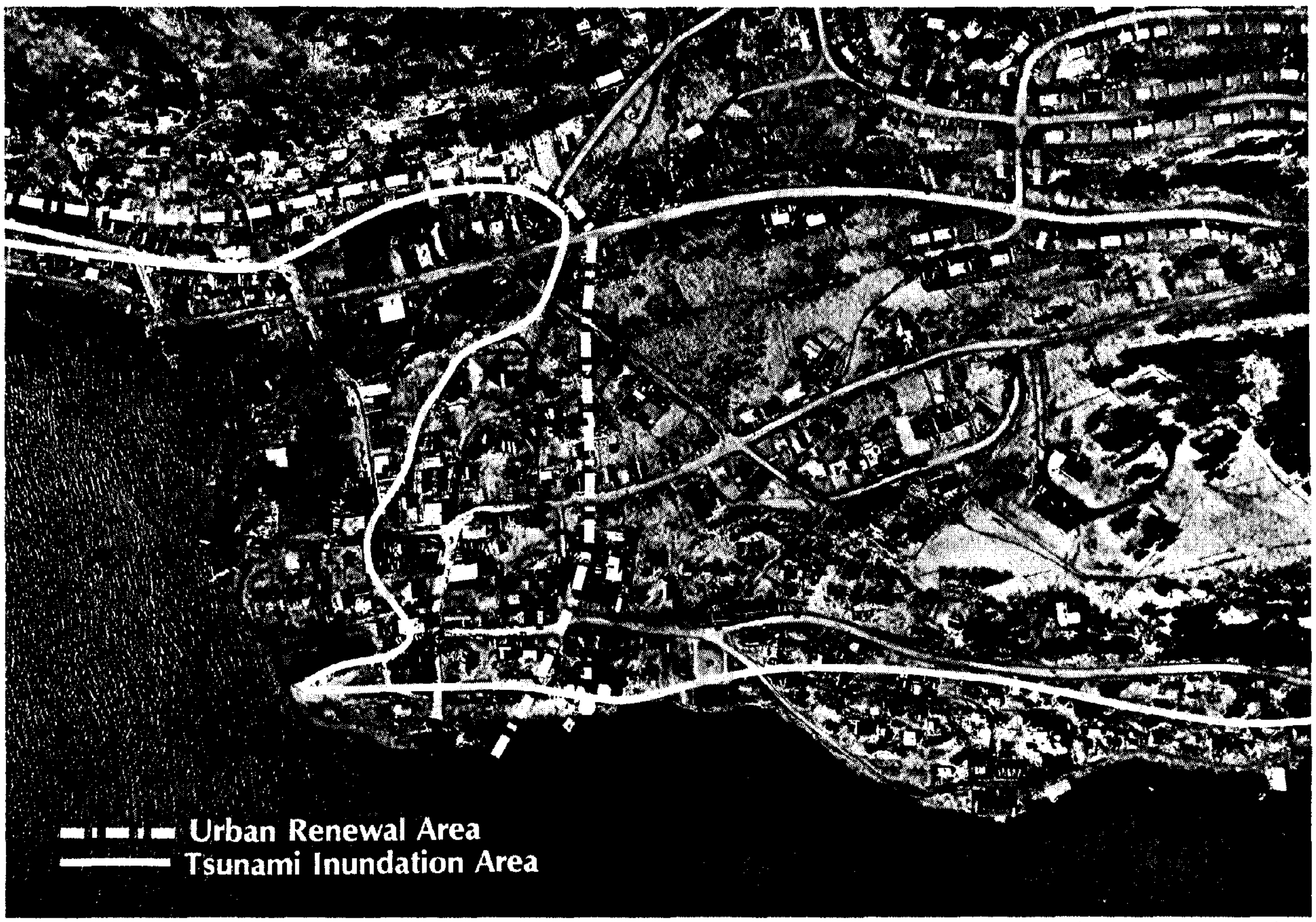
Public Facilities		Estimated Cost	
Roads:			
Alaska Street and Mills Bay Road	$ 90,000		
Marine Way and Parking Lot	160,000		
Mission Road at Shahafka Cove	75,000		
Tagura	120,000		
		$ 445,000	
Harbor:			
Boat Harbor (inner facilities)	250,000		
Dredging Boat Harbor	150,000		
Breakwater	500,000		
City Dock and Warehouse	1,200,000		
City Dock Equipment	55,000		
		2,155,000	
Sewer and Storm:			
10 Sewer Outlets	60,000		
Storm Sewers	125,000		
Sewer Ejection Station and Line	120,000		
Water and Sewer Lines	200,000		
		505,000	
Water Systems (Kraft Springs)		185,000	
Latent Damage (loss of revenue)		2,100,000	
			5,390,000
Private and Commercial Structures		11,346,000	
Private and Commercial Stock (clothing, food & other)		6,000,000	
Equipment		2,000,000	
			$19,346,000
Total, All Losses			**$24,736,000**

Losses of Property and Income in Communities on the Kodiak Archipelago

Location	Nature of Damage	Estimated Replacement Cost
Kodiak	Losses of public, private, and commercial property	$ 24,736,000
Afognak	Losses of public and private property	816,000
Old Harbor	Losses of public and private property	707,000
Ouzinkie	Losses of public and private property	349,000
Kaguyak	Losses of public and private property	321,000
Larsen Bay	Losses of public and private property	80,000
Akhiok	Losses of public and private property	0
All communities	Vessels damaged	2,466,500
All communities	Losses of income to fishing industry	5,087,000
Kodiak Naval Stn.	Damage to structures and equipment	10,916,800
TOTAL		**$45,480,100**

Source: Arctic Environmental Information and Data Center, University of Alaska, Anchorage, Alaska, Kadyak: A Background for Living, *1975.*

Figure 14. Kodiak Waterfront Damage



Source: National Academy of Sciences, Great Alaska Earthquake, Human Ecology Volume

of future tsunami hazards and to provide open space adjacent to the waterfront. This latter need had been recognized before the earthquake. The fishing industry was growing rapidly. Industrial storage adjacent to the harbor was a necessity. The planning consultants' proposal never gained the support of the business community. It was abandoned, and the Corps of Engineers, working with ASHA planners, prepared a redevelopment plan to allow for filling the lowland area to pre-earthquake elevation and to construct seawalls to protect the new harbor and waterfront from tidal inundation and erosion. A revised plan was completed by April 1964. As a disaster mitigation measure, the plan required that all buildings be constructed of reinforced concrete or reinforced masonry because this type of building had withstood the tsunami. However, the community needed to reestablish some businesses immediately, so temporary wood structures were allowed in areas scheduled for eventual redevelopment. As a result much of the reconstruction of the boat harbor, repairs to the utilities, and construction of new facilities were scheduled concurrently with final land use redevelopment.

The urban renewal plan was subject to several changes during its implementation because of the urgency for commercial redevelopment combined with local pressure. Regulations were modified to ease reconstruction, and ASHA marketed land as rapidly as it could be acquired and filled. The requirement that all buildings in the high-hazard areas be constructed of reinforced masonry was deleted at the request of the city council. In this community only, ASHA delegated final approval authority for redevelopment proposals to the city council, and local politics played a larger role here in approval of redevelopment plans.

A final land use plan was submitted to HHFA in February 1966. The plan preserved some of the original recommendations by including a central plaza surrounded by commercial facilities, continuity of architectural features, covered walkways connecting buildings, and pedestrian open spaces. By 1968 all public improvements and most private reconstruction had been completed, implementing this final redevelopment plan.

Seldovia

Seldovia lies in a protected inlet on the south shore of Kachemak Bay 16 miles southwest of Homer. The community is accessible only by sea and air, and at the time of the earthquake had about 450 people and an economy based on fishing and seafood processing.

The community did not suffer major structural damage from the earthquake, and all utilities continued to function. Virtually all of the damage was caused by a tectonic subsidence of 3.5 feet, which subjected lowlands to innundation at high tide. This included the majority of businesses and canneries and the main street (a boardwalk).

Soon after the ground shaking ceased, radio reports warning of tidal waves spurred the civil defense director to sound the fire station siren. People were advised to evacuate to the school, on higher ground away from the waterfront. The largest wave arrived between 10:00 and 11:00 p.m., cresting at about 18 feet. No major structural damage or damage to boats resulted from the tidal waves, and no one was hurt.

Seldovia's problems were not immediately apparent. Within a week, however, it was evident that the waterfront needed remedial action. Representatives from the OEP and the Corps of Engineers arrived to assess the damage. An analysis of the situation revealed that the boardwalk, breakwaters, float system, and all commercial and residential structures needed to be raised to avoid inundation at high tide. The Corps of Engineers was assigned by OEP to temporarily repair structures up to the boardwalk. No funds under this program could be used to raise or repair private buildings on the other side of the boardwalk. Some of the structures were so old and rickity that raising them was impossible. Urban renewal, therefore, was considered to plan the community and rebuild private property. A feasibility survey submitted to HUD on May 7, 1964 led to development of an urban renewal disaster project. The project covered all the area subject to inundation and some of the adjacent tideland required to expand the very limited waterfront industrial district.

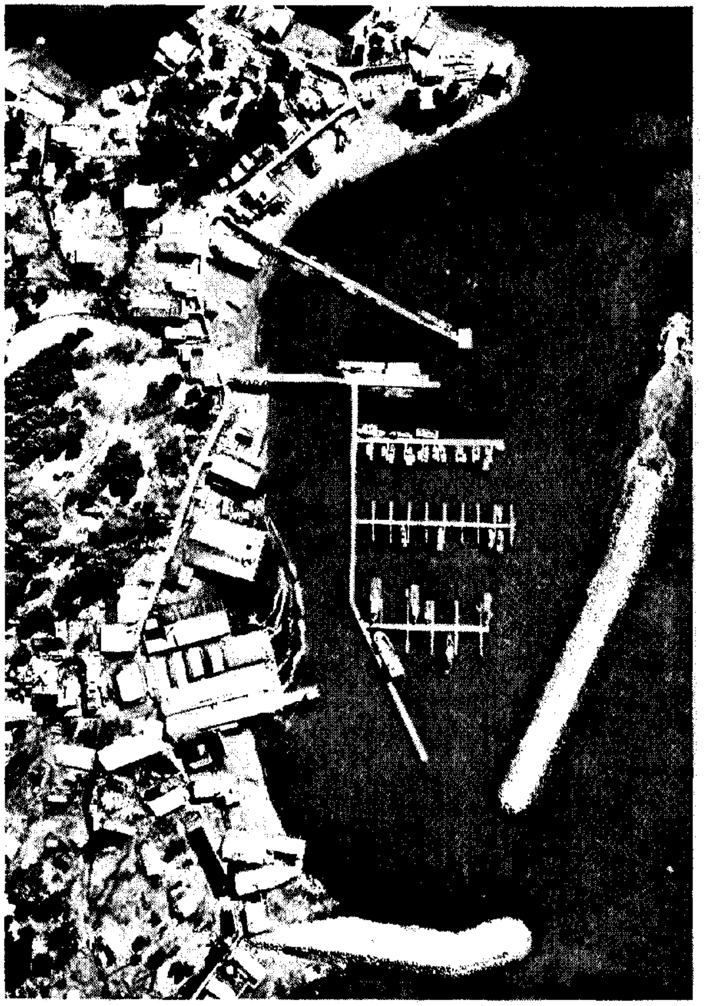
The consultant firm of Lutes and Amundson of Springfield, Oregon strongly recommended preservation of the picturesque character of the community (Figure 15), but during development more emphasis was placed on engineering rehabilitation rather than aesthetic and historical use of the land. 'The steep slopes, the piling foundations, the quaint boardwalk, and the Russian cemetery gave way to landfill, and old landmarks were leveled' (Selkregg 1970). (Figure 16)

The city government was nominal and loosely organized. The only employee was a part-time clerk, and there were no zoning or building regulations. Seldovia was the only place where the urban renewal plan was put to a vote of the citizens. Though it was approved by a vote of 155 to 135, the community at first seemed reluctant to accept planning and regulation as a way to successful redevelopment. Doubt finally gave way, and improvements to the waterfront and reclamation of 14 acres of tidelands began. Canneries were relocated on stable, permanent sites, a new deep-water city dock was built, and this improved waterfront area stimulated development of more modern fishing and processing operations.

Seward

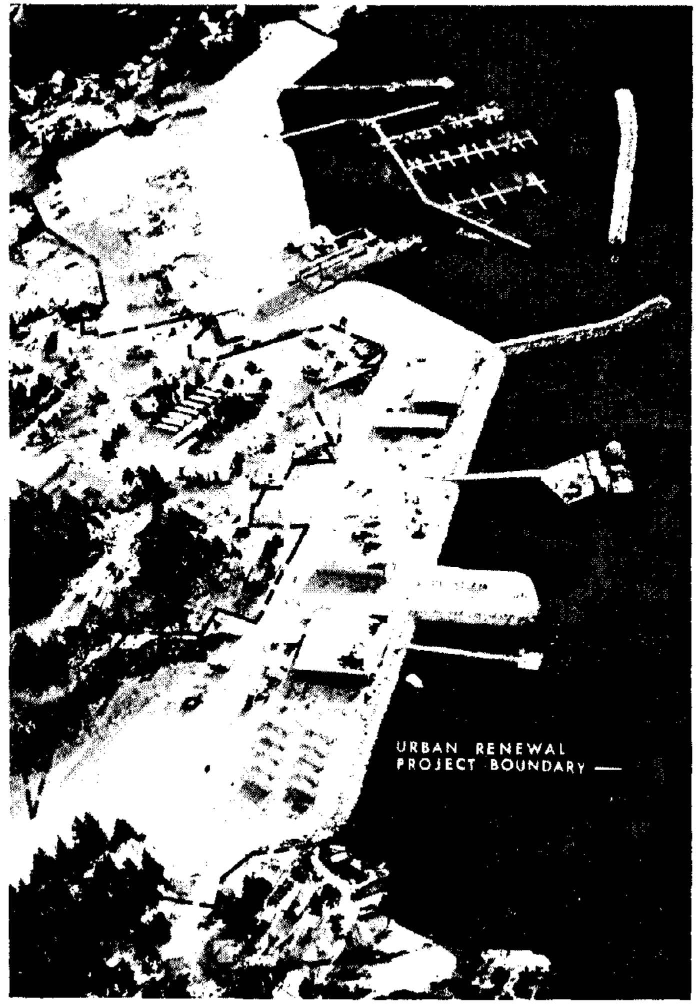
Seward, a vital railport at the head of Resurrection Bay on the Kenai Peninsula, was devastated by the earthquake and its aftermath. Most of Seward is built on an alluvial fan delta.

Figure 15. Seldovia 1964 Prior to Earthquake



Source: Air Photo Tech

Figure 16. Seldovia November 1966 with Urban Renewal Boundary

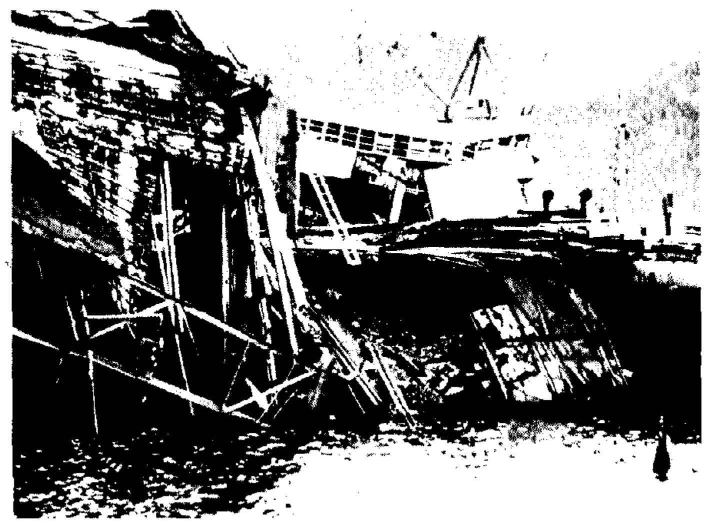


National Academy of Sciences, Great Alaska Earthquake, Human Ecology Volume

Strong ground motion lasting three to four minutes generated a submarine landslide that affected a strip of land 50 to 400 feet wide along the waterfront. Docks and other harbor facilities located on the waterfront area were destroyed, and large fractures opened several hundred feet back from the landslide scarps. In addition, the ground was fractured in the Resurrection River valley. The earthquake reactivated old slides and triggered new ones in the mountains. Rock and snow avalanches, debris flows, and creep of talus deposits occurred on steep slopes (Lemke 1967).

The section of the waterfront that failed had been extended before the earthquake by artificial fill consisting of loose gravel, and part of the lagoon area had been filled with refuse. The situation couldn't have been worse as the first sea waves hit town only minutes after the earthquake. People literally ran for their lives. Slide-generated waves and seismic sea waves crashed into shore and caused tremendous damage. The major tsunamis followed within 20 minutes of the earthquake, cresting at between 30 and 40 feet. The devastation was enormous. The docks, including one which was linked to the Alaska Railroad, were destroyed. Also gone were the small-boat harbor, fishing fleet, halibut cannery, warehouse, and other vital facilities basic to Seward's economy. An estimated 261, or 15 percent, of Seward's homes were damaged or destroyed, utilities were out, and fire destroyed the community's generating plant. Oil spills from the local storage installations resulted in fires which burned along the waterfront for several days. Roads were blocked, long-distance communications were down, and all local planes were destroyed. Twelve people lost their lives.

Local officials mobilized quickly. The downtown and waterfront areas were roped off. Initally the elementary school provided emergency housing, and a few people stayed at one of the two hospitals in the town. By Saturday the high school was designated as the emergency housing center. The Air Force recreation center functioned as a second feeding and housing station. The National Guard, Civil Air Patrol, Red Cross, and Salvation Army responded to the immediate survival needs of the community. A state representative from the Alaska Department of Health



and Welfare, assisted by members of the community, took on the task of census taking in an attempt to locate the missing and dead. Within two weeks long-distance communications, electricity, and water and sewer systems were again operating. Monetary contributions and supplies poured in from all over the country in an effort to aid Seward during its crisis.

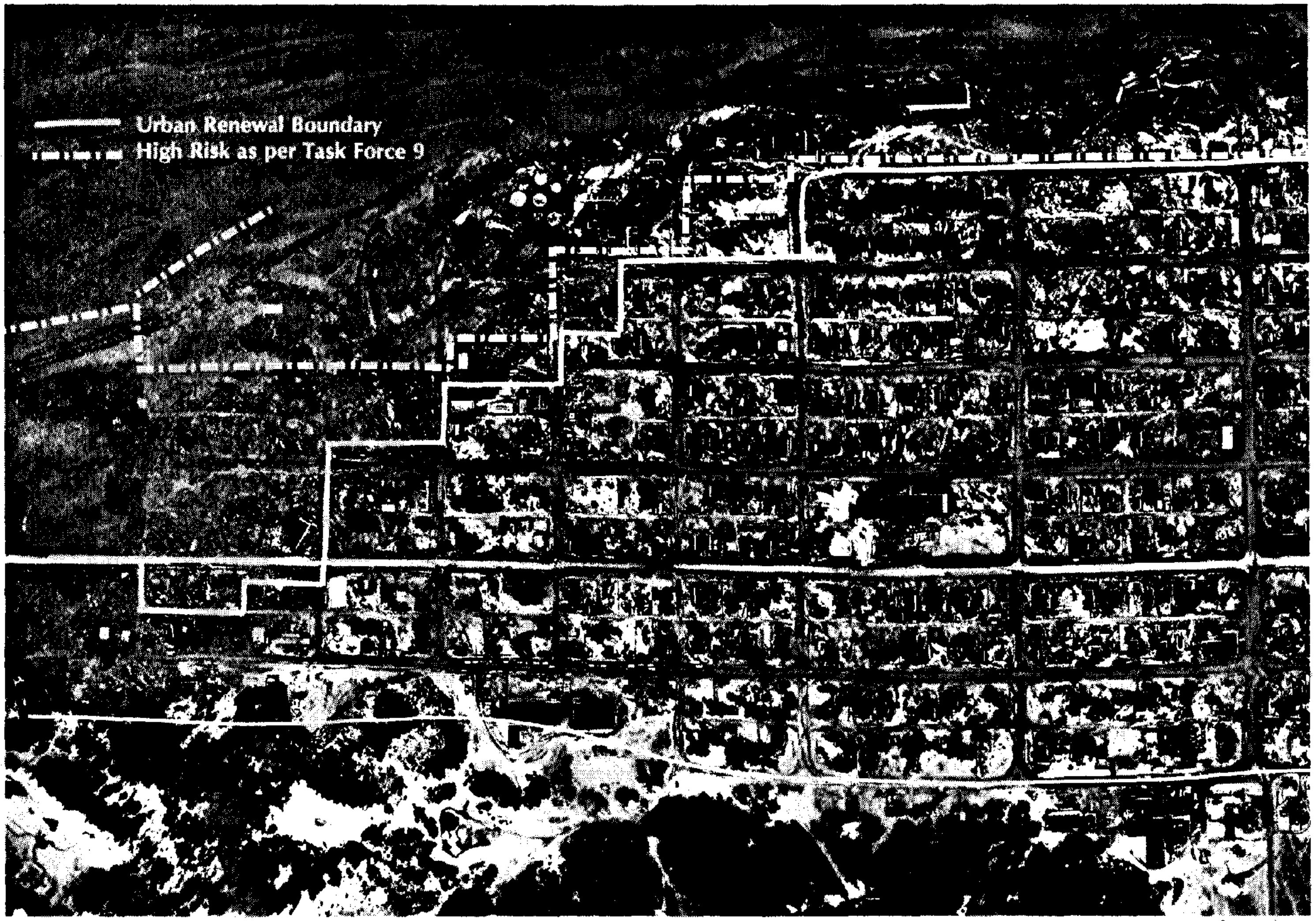
Ten days after the earthquake a preliminary report on the geology of the area was completed by an ASHA staff geologist in cooperation with the U.S. Geological Survey staff. By April 4, 1964 the city planning office had completed a feasibility survey for a possible urban renewal disaster project. The plan was hand carried to Washington for immediate approval.

At the time of the earthquake Seward had a planning and zoning commission and an approved comprehensive plan, prepared in 1959 but never implemented. Because of the declining economy, the city was not anticipating any major changes in land-use developments and city growth. The first goal of the consultant and the city was to rehabilitate the whole town through urban renewal. The plan was intended to stimulate the city's economy by relocating the city dock in a stable site across the bay, concentrating businesses in the central core, developing land adjacent to the waterfront for tourism and marine-oriented uses, and retaining the identified unstable area for park and open-space use only. Later, however, the boundaries of the project were reduced to a narrow strip along the waterfront to coincide with the area classified "high risk" by Task Force 9 (Figure 17), and the only goal set was to rebuild or restore the waterfront facilities and the terminus of the railroad.

As a result of the earthquake the entire economic base of the community was virtually destroyed. The first aim of city officials was to insure reconstruction of the railroad terminal and waterfront facilities. The federal government agreed to fund reconstruction of the small-boat harbor, city dock, harbor facilities, and a new deep-water railroad dock with adjacent yard and maintenance support buildings. OEP and the Alaska Railroad provided funds totalling $15,321,945 (Arno 1971). A representative from the Small Business Administration arrived in mid-April to arrange for loans to community members.

The location of the railroad terminal at the head of Resurrection Bay was selected by the Corps of Engineers, even though a study by their consultants (Shannon and Wilson 1964), considered the site merely "adequate." Planners and geologists were not consulted on the location of this major improvement, which from the standpoint of long-range planning, soil stability, and access, was not the best available site. "The new railroad dock and associate facilities . . . are constructed in an area swept by earthquake induced waves in 1964, and, therefore, are susceptible to damage from future waves of equal magnitude" (Lemke 1967).

Figure 17. Damaged Seward Waterfront



Source: National Academy of Sciences, Great Alaska Earthquake, Human Ecology Volume

The area along the waterfront that had failed was placed in a high-risk classification by Task Force 9, and was recommended for park or other uses that would not involve large congregations of people. No federal reconstruction funds were used for the redevelopment of this high-risk area. Urban renewal disaster funds were used by ASHA to acquire the land through condemnation and turn it over to the city for park/open-space use.

Seward is the only community that has not challenged or requested changes in the use designation (open-space only) of land classified as high risk by Task Force 9. Unwisely, the original planners were not retained by ASHA throughout implementation of the plan and communication with the city administration was weakened, along with the concept of a citywide rehabilitation program.

Valdez

Reconstruction of Valdez was truly a special case. Loss of life and damage were so great that the entire community was relocated to a more stable and safe location. Never before in the United States had a community been completely rebuilt at a new site after a disaster. Congress amended the urban renewal disaster codes and regulations to create a new classification of urban renewal 'open space' to allow for funding of a project at a new site.

The city of Valdez was originally located on the seaward edge of a large outwash delta composed of thick deposits of saturated silt, sand, and gravel, at the head of the Valdez Arm of Prince William Sound (Figure 18). Levees and dikes had been built to protect the town, which was subject to flooding from glacial streams originating from the Valdez Glacier. The high seismicity of the area was also known (Coulter and Migliaccio 1971). The community had a population of approximately 1,200 people and an economy based on shipping, fishing, canning, and tourism. Additional employment was provided by a state mental hospital.

Figure 18. Damaged Old Valdez

Source: Air Photo tech

Although not yet fully developed, the port of Valdez was gaining in importance to the state economy. As the northernmost ice-free port in the United States and the southern terminus of the Richardson Highway, it was a major port of entry to interior Alaska. City government and services consisted of a seven-member council with a mayor elected from its ranks, a volunteer fire department, and one police officer (supplemented by a state trooper).

At 5:36 p.m., as 28 adults and children on the dock watched the unloading of the Chena, a coastal supply freighter, the land began to roll, fissures opened and closed repeatedly, and pressure sent sand, water, and sewage into the air.

> As the quake reached full force, 98 million yd^3 of earth slid from the face of the delta. The harbor became a maelstrom and the big dock began to break up; mounds of water hit the Chena. When Captain Stewart reached the bridge, the ship was lying over to port 50° to 70°. The noise was tremendous, and witnesses saw incoming waves raise the freighter 30 feet higher than the dock's warehouse. Captain Stewart looked down to see people running on the dock, but as they ran, the dock disappeared. The warehouses, the packing plant, the cannery, the bar, the people plunged into the boiling water (Norton and Haas 1970).

All 28 people on the dock were killed.

Waves generated by the slide and subsequent seiches greatly damaged the town. Stress generated by the seismic shock and the submarine slide developed an extensive system of fissures throughout the unconsolidated deposits at the head of the fjord. These caused structural damage to many buildings and destroyed all utilities. An extensive fire resulting from ruptured tanks of the Union Oil Company occurred later in the evening. The portion of the waterfront that had survived, including a small hotel and the Standard Oil pumping control station, burned furiously.

> The stunned survivors of the catastrophe reacted with confused uncertainty; they left town, trickled back, and left again. Valuables, including cash, were left behind unlocked doors --the best evidence indicates that nothing was taken. Many persons set out by car for the Richardson Highway after the second wave, and a traffic jam developed where fissures across the road made progress impossible.
>
> * * * *
>
> Many of the people who had driven out the highway turned back soon after

10:00 p.m., thinking the worst was over, but a report came in of another possible tsunami. By 11:00 p.m. vehicles with loud speakers were warning residents to evacuate (Norton and Haas 1970).

The extensive damage to the community graphically demonstrated the need to relocate Valdez at a more favorable site. The site selected was on the Mineral Creek alluvial fan approximately 3-1/2 miles northeast of Valdez (Figure 19). Preliminary evaluation by a state highway department geologist, with the assistance of geologists from the U.S. Geological Survey, established that the new site had a good foundation and was protected from potential tsumani inundation by a series of bedrock ridges and small islands (Coulter and Migliaccio 1966).

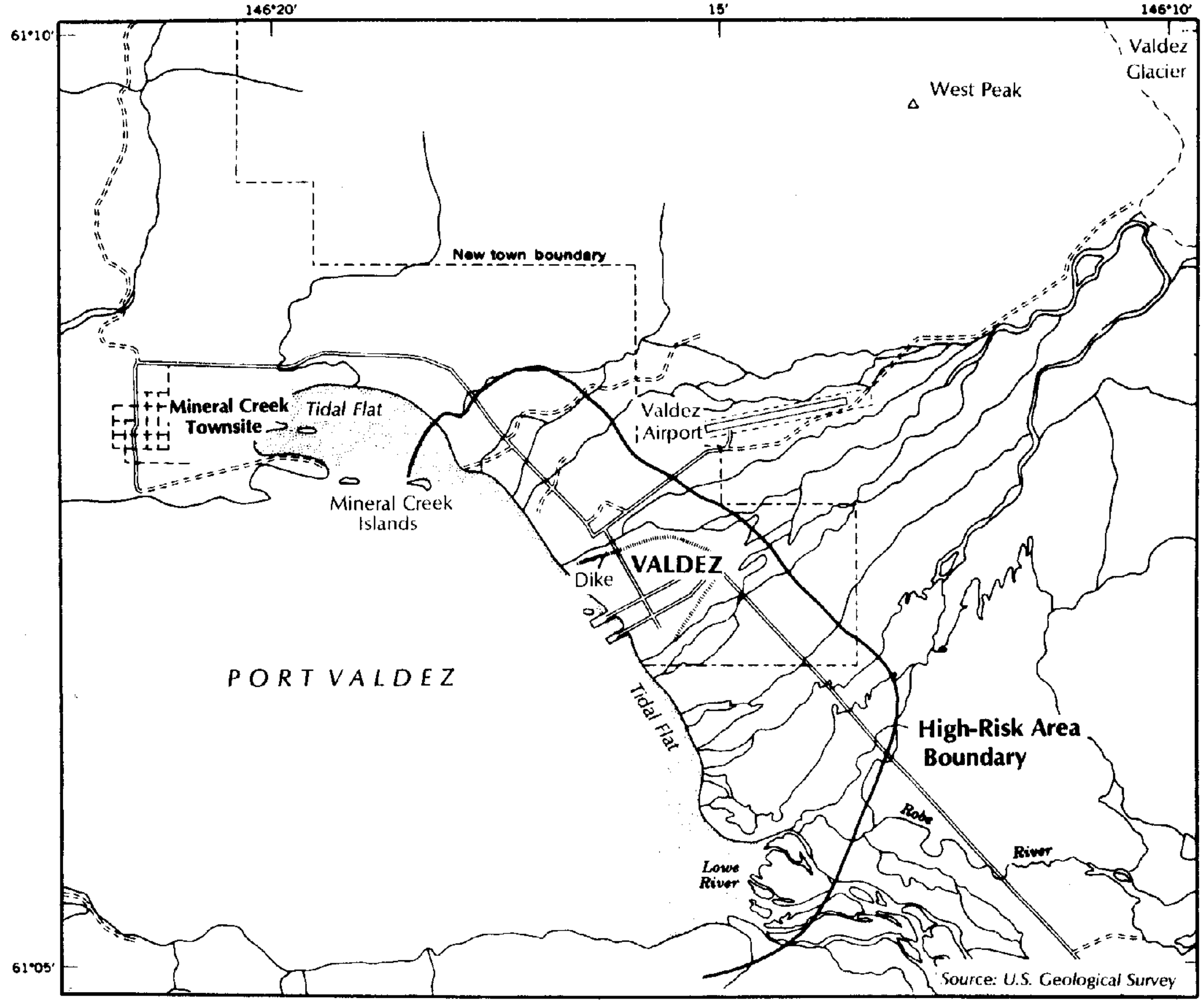
Federal reconstruction officials were concerned about relocation of such a small community. Most of the people had abandoned the town and moved to Fairbanks, Copper Center, Glennallen, or Anchorage. The strategic position of the port and its potential as an outlet for the resources of the Arctic and Interior were quickly recognized by both civil and military authorities.

Senator Anderson, chairman of the Federal Reconstruction Commission, approved the relocation on June 4, 1964. Task Force 9 endorsed the relocation after exhaustive soil studies initiated by the U.S. Geological Survey and the Alaska Department of Highways under sponsorship of the Alaska State Housing Authority and the Corps of Engineers. Shannon and Wilson, Inc. of Seattle, Washington, was hired by the Corps of Engineers to prepare the site specifics and make final recommendations.

Two urban renewal disaster projects were initiated--the Old Valdez Urban Renewal Disaster Project, pertaining to acquisition of all improvements within the old city boundaries and the New Valdez, Mineral Creek, Open Space Project, authorized by Congress to cope with the unusual circumstances requiring relocation of a whole town. The old city limits were expanded to incorporate the new site because the urban renewal programs could be applied only within municipal boundaries and required municipal approval of a redevelopment plan prior to funds allocation. Land for the new site was obtained through a gift by local businessman Owen Meals; some land was acquired from a miner; and the remainder was dedicated by the State Division of Lands.

The entire Old Valdez townsite was classified as "public open space for park and recreation use only." Task Force 9 did not reclassify the area as high risk because state, federal, and local officials had already agreed to abandon the townsite and had classified the Old Valdez townsite a high risk zone by the time Task Force 9 was appointed on April 27. This created serious problems later when a request was made for a federal loan to finance new business on the

Figure 19. Valdez and Mineral Creek with Boundary of High-Risk Area
(Drawn by the Office of Emergency Planning, October 19, 1965)



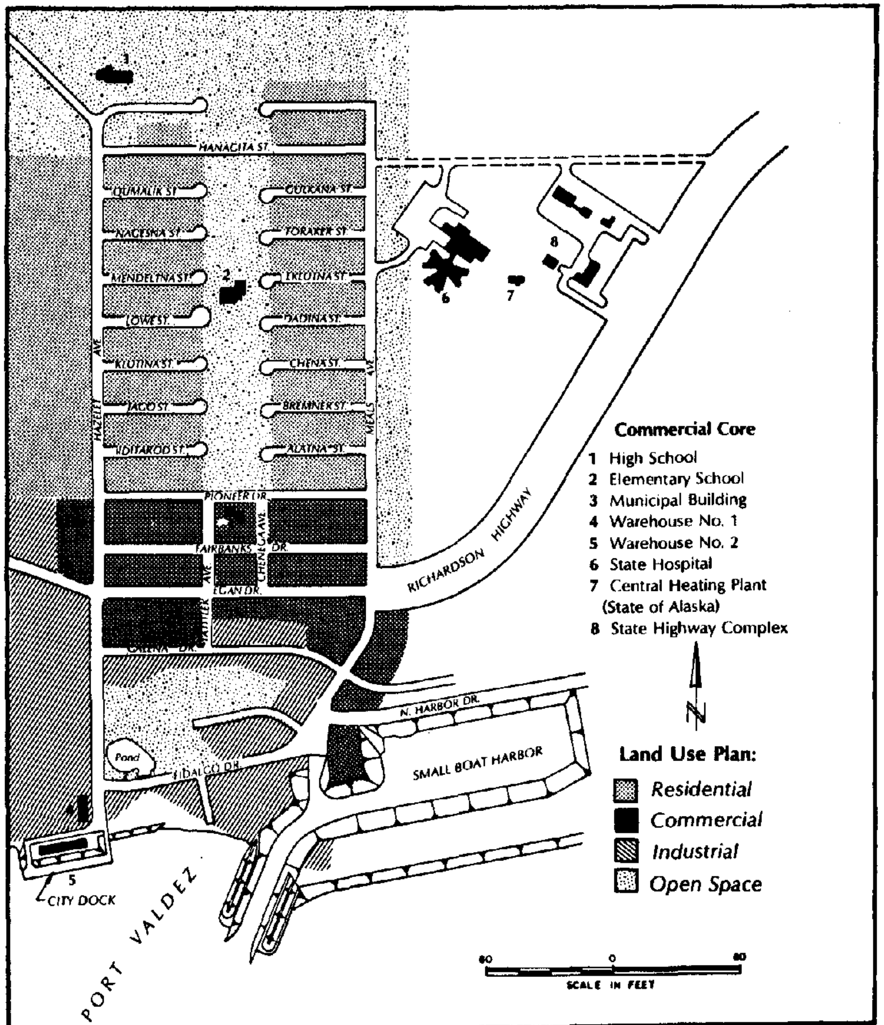
tidelands adjacent to the old city boundaries in an area that geologists considered subject to sliding and settlement in the event of another great earthquake. On October 19, 1965, after extensive consultation with former members of Task Force 9 and after evaluating the recommendations made by the U.S. Geological Survey (Coulter and Migliaccio 1966), the Office of Emergency Planning established a high risk line that encompassed the entire face of the Valdez delta (Figure 19). This action was questioned and the issue of how much information was necessary and which level of government--federal, state, or local--had the authority to apply and enforce a risk classification became a major administrative issue (Eckel and Schaem 1970).

City Planning Associates of Mishawaka, Indiana, prepared the redevelopment proposal for the new townsite (Figure 20). The new city docks, small-boat harbor, and most of the publicly owned utilities and facilities necessary for the new community were rebuilt by the Corps of Engineers, funded by OEP under Public Law 875. The private sector was reconstructed with urban renewal assistance. Reconstruction closely followed the land use plan, which incorporated concepts based on population growth, weather conditions, convenient shopping, developing residential areas close to schools and recreation facilities, expanding waterfront activity, and enhancing the tourism potential of the area. The intent was to develop a new setting that could enhance the future economy of the city and provide a more modern and permanent environment (Selkregg 1970).

The relocation of 135 families, 26 individuals, and 44 businesses, and construction of all utilities, school, roads, hospital, city dock, and small-boat harbor required coordination among all involved government agencies and the residents. Considering the chaos (both actual and potential) and the lack of guidelines, the process went well. Changes were made in the city government structure. More responsibility was assumed by the city council and mayor. Several times conflicts and misunderstandings between representatives of the Alaska State Housing Authority, their consultants, and local government caused delay, and many times the community was almost prepared to abandon urban renewal as a means of reconstruction. A major cause of this was that the original planners were not retained to explain and assist throughout implementation of the project. Residents opposed to relocation saw temporary repairs to some utilities in the old townsite as a means to delay relocation to the new site.

To encourage a rapid move and to provide jobs, agencies scheduled the city dock, small-boat harbor, city hall, elementary and high schools, a new highway department complex, and the mental hospital for immediate reconstruction. These facilities were completed by the fall of 1966 and became the catalyst for relocation of residences and businesses to the new site. ASHA allowed relocation of some residences from the

Figure 20. Mineral Creek Townsite



Source: City Planning Associates of Mishawaka, Indiana for Alaska State Housing Authority and the U.S. Army Corps of Engineers old to the new townsite. By fall 1967 the move was complete.

Whittier

Whittier, at the head of Passage Canal in the northeastern portion of Prince William Sound, originated as an army port during World War II, and at the time of the earthquake was an ocean terminal of the Alaska Railroad. The community was unincorporated and housed a year-round population of about 70 people, occupied mainly with the maintenance of government facilities. The community could be reached by rail or water. It did not have an airstrip.

Seismic ground motion is reported to have lasted 2-1/2 to 3 minutes. Locally generated sea waves occurred during and after the quake. Three major sea waves hit the community, killing thirteen people and severely injuring one. The second and third waves crested at 40 and 30 feet respectively, causing major damage to the port and rail facilities and completely destroying the electrical generating plant, phone system, sewer system, and lumber company. The waves toppled Union Oil and U.S. Army storage tanks, causing an oil spill which caught fire and burned over three square miles.

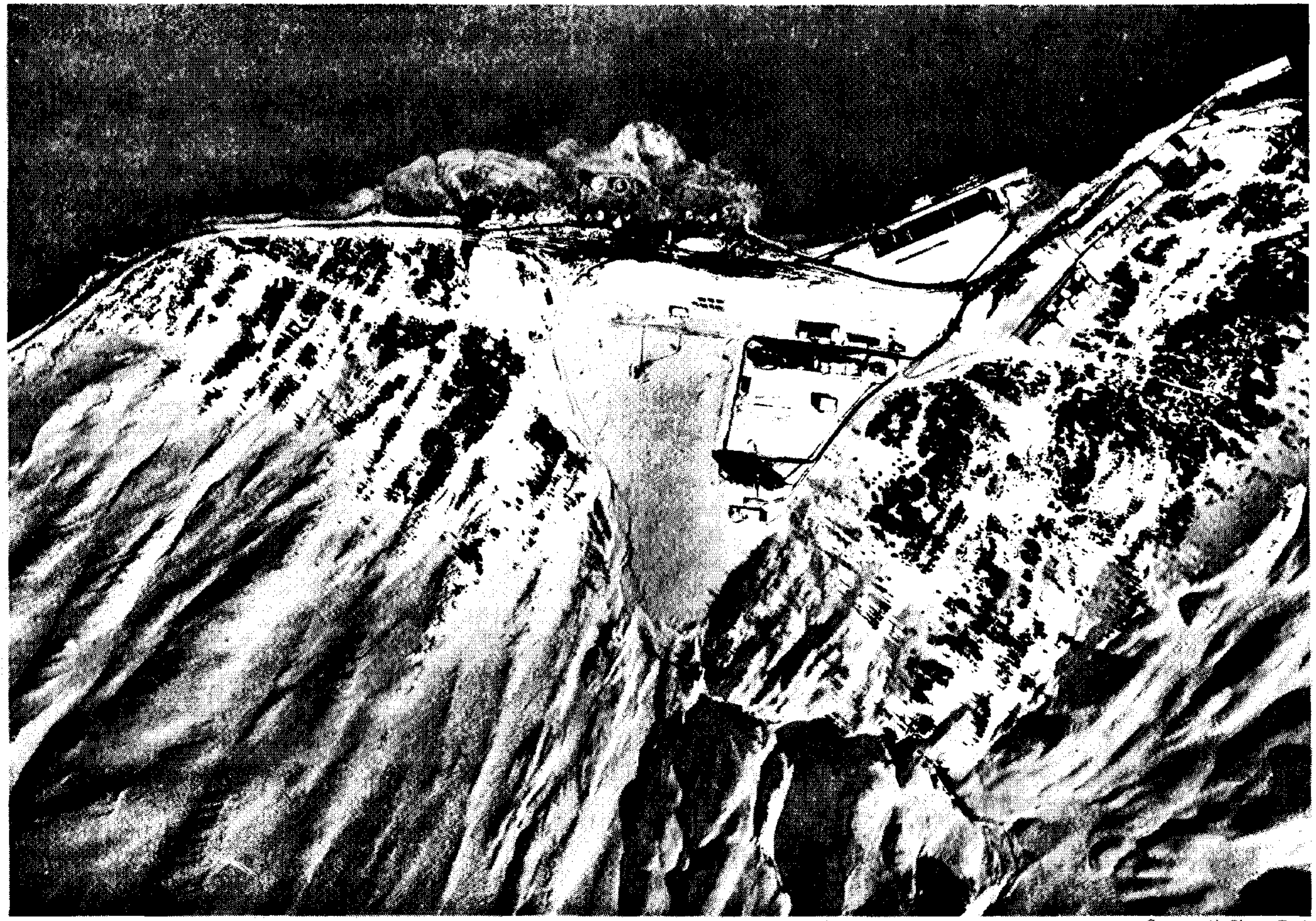
People immediately evacuated to higher ground, gravitating toward the school beyond the water's reach. After the waves had subsided, people salvaged emergency supplies and set up a temporary shelter in the school's multipurpose room. Stoves were brought in from the rail cars to provide heat.

The waterfront was in shambles and the port facilities destroyed (Figure 21). Damages resulted from a 5.3-foot subsidence of the landmass and by submarine landslides which generated waves that destroyed part of the railroad bed. Many buildings were destroyed or damaged. Facilities built on the slate and graywacke bedrock were slightly damaged, but those built on unconsolidated sediments or fill at the head of the fjord were severely damaged or destroyed. The Columbia Lumber Company's building was a pile of debris, and fires raged over the area. Smoke from the burning waterfront covered the community.

> Transport planes from Seattle that flew over the area Friday night on the way to Anchorage reported that Whittier was gone, completely wiped out; only smoke and flames, no buildings or lights, could be seen from aloft (Kachadoorian 1965).

Communication with the outside was not possible until Saturday morning, when radio contact was made with a small airplane flying overhead. Within several hours military medical personnel arrived.

Figure 21: Whittier, April 15, 1964.



Source: Air Photo Tech

Fortunately, Whittier had plenty of emergency food and medical supplies on hand from army storage. By Monday the power plant was repaired, and the school had lights and heat. Within five days a field telephone system was set up, and Whittier resumed communications with the outside world. Crews flew in the following Saturday to begin repair on the railroad tracks. The U.S. Army Corps of Engineers inspected the remaining buildings for safety within 10 days, and people moved out of the school and resumed some semblance of normal living.

Because the only other railroad port in Alaska (at Seward) was totally destroyed by the earthquake, restoration of Whittier began immediately with military assistance. Army and air force helicopters arrived with materials for reconstruction of the tracks and wharf. When repairs to the port and railroad were complete, longshoremen arrived from Anchorage and Seward, and Whittier resumed its vital position as a railport link to southcentral Alaska.

Summary

The Alaska earthquake was one of the greatest earthquakes in recorded history. The event had enormous importance for scientists throughout the world--it provided viable and measurable examples of a variety of geologic features or processes in a variety of geologic settings. The earthquake affected populated areas in different ways in response to different environmental conditions. Property damage had resulted from:

- I. Seismic vibration
  - A. Shaking of structures
  - B. Foundation failures resulting from:
    - 1. Ground fissuring
    - 2. Sliding
    - 3. Differential settlement
- II. Tectonic displacement
  - A. Regional uplift and subsidence relative to sea level

III. Water waves
   A. Local waves generated during or immediately after the event by:
      1. Submarine slides
      2. Horizontal tectonic displacement
      3. Other unknown causes
   B. Tsunami--a train of long period sea waves generated by tectonic uplift of the seafloor.

The reconstruction of the communities affected was based on studies conducted immediately after the disaster by teams of scientists gathered under the auspices of emergency planning directives. These task forces were composed mainly of physical scientists. They remained functional until their recommendations were submitted to various agencies, departments, or city administrators. There was no time to review or discuss findings and recommendations with the public and local elected officials. Press releases were used to inform the public of major issues, such as establishment of "high risk" in residential and commercial districts, without explanation of how and why these decisions had been reached. There were no clear plans for enforcement, no procedures for adjusting or relaxing restrictions after ground stabilization had occurred and for when more sophisticated mitigation measures could be developed in zoning and building codes. There was no time to evaluate the long-range economic impact of their recommendations on the cities or to relate their recommendations to a regional growth development plan.

Source: City of Anchorage

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Source: City of Anchorage

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Chapter 4: Organizational Structure of Recovery Efforts

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Organizational Structure of the Recovery Efforts

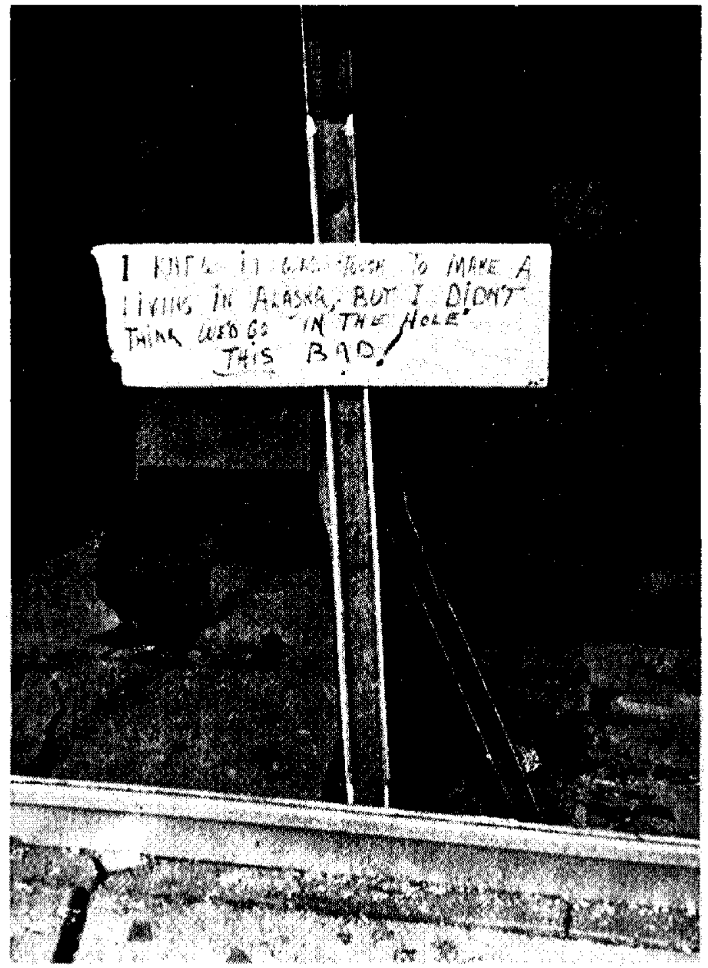
Two distinct phases emerge from an evaluation of the recovery efforts after the March 27, 1964 earthquake:

1. Immediate Relief--Short-term Restoration
2. Long-range Recovery and Reconstruction

Agencies, policy makers, and citizens involved in the recovery efforts were frequently unaware of the impact that one phase would have on the other. Decisions were often made on an ad hoc basis, disregarding long-range effects.

Disaster relief and short-term restoration of the infrastructure was handled effectively by private citizens and local governments, with assistance from military, federal, and state agencies. Tables 8, 9 and 10 display the federal and state agencies involved in the immediate relief and long-range recovery. Each organization's response varied with its particular mission and in the timing of its most important contributions. Police, fire, medical, and military organizations were critical in the dramatic hours immediately following the event. Scientific, planning, and redevelopment agencies on the state and federal levels along with engineering and financial institutions, had a major role later in the recovery and reconstruction period.

Involved throughout the recovery period were policy makers at every level, from the President and Congress down to village mayors and councils.



Source: City of Anchorage

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Table 8. Federal Relief Efforts

Organizational

Office of Emergency Planning

Directed disaster response activities among federal agencies, including recovery and reconsuction efforts of such agencies as teh Army Corps of Engineers, the Navy's Bureau of Yards and Docks, and the Housing and Home Finance Agency.

General Services Administration

Directed all administrative aspects of the federal involvement.

Search and Rescue

U.S. Coast Guard/Deptartment of Defense

Performed cooperative search and rescue operations.

Communications/Warnings

Alaska Military Command

Set up communications link with Washington, D.C. and functioned as message center among communities.

Federal Communications Commission

Fairbanks office remained functional. FCC set up initial non-military communications link with Washington, D.C.

General Services Administration

Set up major communications link between Alaska and Washington, D.C. using NASA circuit operating out of Fairbanks.

Coast and Geodetic Survey

Warned of hazardous harbors and performed tsunami watch.

Office of Civil Defense

Broadcasted warnings regarding contaminated water sources.

Federal Aviation Administration

Performed tsunami watch.

Emergency Housing, Food and Supplies

Military

The army and air force provided barracks, food, and supplies. The Navy Bureau of Yards and Docks provided temporary trailers in Kodiak.

Bureau of Indian Affairs

Surveyed Native villages and procured disaster assistance supplies, relocated those villages which were destroyed.

Health and Welfare

Public Health Service

Arranged for the delivery of typhoid innoculations and disposable syringes. Provided some medical manpower relief.

Food and Drug Administration

Assisted local officials inspection for food contamination.

Child Welfare Service

Worked with state child welfare personnel checking all children's institutions and foster homes to assess problems. Also initiated the Alaska Public Welfare Disaster project, giving needy families and dependent children grants.

Social Security Administration

Sent an official to Alaska to locate survivors of those who had been killed and to arrange for immediate aid.

Air Lift

U.S. Air Force

Airlifted personnel and supplies within and outside the state.

Bureau of Land Management

Under the Department of the Interior, airlifted supplies and personnel within the state.

Temporary Restoration of Public Facilities and Debris Clearance

U.S. Army Corps of Engineers

Performed debris clearance operations and emergency restoration of public roads, public utilities, docks, schools, and hospitals in Anchorage, Cordova, Homer, Girdwood, Seldovia, Seward, and Valdez.

Navy Bureau of Yards and Docks

Performed debris clearance and emergency restoration of roads, sidewalks, gutters, and bridges in Kodiak.

Army

Defense engineering detachments performed debris clearance and repaired highways.

Security

Military

Assisted local and state agencies in guarding damaged areas to prevent looting. Aided the evacuation of damaged Native villages.

Source: Office of Emergency Planning "The Alaska Earthquake: A Progress Report 279 Days of Federal Reconstruction Effort", Washington D.C., December 29, 1964.

Table 9. State of Alaska Immediate Relief and Long-Range Recovery

Department of Administration

Responsible for managing the complicated financial problems of the crisis and formulating a revised budget for the State Legislature. Also developed a disaster manual devoted to fiscal and audit policies; established a "personnel exchange" to expedite reassignment of state personnel; and assisted other state and local agencies in project applications for the recovery.

Department of Commerce

Under the Department of Commerce, the Alaska State Housing Authority became the focal point for urban planning and implementation for reconstruction. ASHA was organized to work with both federal and local funds and to carry out comprehensive planning, public housing, urban renewal programs, and supervise airlifting of emergency rations. A 30-day moratorium was declared on all outstanding loans.

Department of Highways

Provided emergency communications during the early hours; performed damage assessment, debris clearance operations, emergency evacuation, and tsunami watch; located emergency food and medical supplies; restored roadways; planned and coordinated long-range restoration with appropriate federal agencies.

Department of Fish and Game

Provided emergency communications during the early hours with state vessels; assisted in salvage operations in the coastal communities, performed damage assessment of fish and game resources and installations.

Department of Economic Development and Planning

Established priorities of transport, commodities, and materials; maintained constant contact with major contract agencies, shippers, the military, and carriers to facilitate activities; conducted a national tourism promotion to stimulate the Alaskan economy; assessed socioeconomic impact of the earthquake to assist decision makers at the state level.

Department of Education

Performed damage assessment and coordinated efforts to provide continuity in the school systems.

Department of Health and Welfare

Functioned to prevent outbreak of disease due to ruptured sewer systems and contaminated water supplies; conducted a massive innoculation campaign; supervised mass feedings, thus protecting the food supplies; assessed food contamination; and coordinated welfare services for qualified recipients.

Department of Labor

Developed programs to bolster the southcentral economy; expedited delivery of unemployment insurance checks; maintained staffs 24 hours per day to facilitate claims and other emergency business; established a multi-occupation training course with federal agencies under the Manpower Development Training Act.

Department of Law

Researched and drafted emergency legislation to facilitate the recovery and provided legal advice on problems connected with the recovery.

Department of Military Affairs

Assisted in many phases of the disaster. The National Guard - provided transport services, security services, and search and rescue operations; housed and fed evacuees.

Civil Defense - Functioned as the focal point for emergency operations. Efforts were directed toward reestablishing communications, assessing damage levels, organizing survival and recovery actions, and issuing tsunami warnings.

Department of Natural Resources

Prepared maps and plates delineating fault zones; initiated programs of land selection, planning, and land disposal to meet individual relocation needs; made gravel available from state-owned sites for reconstruction; instigated programs for increased timber sales; advised on shoreline erosion control in coastal communities; performed damage assessment in the agricultural areas impacted; performed food supply assessments for agricultural and human needs.

Department of Public Safety

Alaska State Police radio network provided emergency communications; performed search and rescue and evacuation operations, and were involved in fire danger assessments and tsunami warnings.

Department of Public Works

Performed damage assessment of state-owned facilities; performed search and rescue operations; assisted in emergency communications; initiated emergency contracts for debris clearance; coordinated efforts with federal agencies to facilitate reconstruction and temporary restoration.

Department of Revenue

Expedited processing of claims for tax refunds; granted a 90-day extension to those residing in the disaster-stricken area; revised revenue estimates for state budgetary purposes.

Source: William A. Egan, Office of the Governor, Report on State Government, Juneau, Alaska, May 25, 1964.

Table 10. Federal Reconstruction Efforts

Administrative

Office of Emergency Planning (OEP)

Estimated damages, advised on funding of projects and assigned specific missions to agencies consistent with their responsibilities (i.e., Corps of Engineers, Navy Bureau of Yards and Docks, Federal Aviation Agency, Housing and Home Finance Agency). After the Anderson Commission was disbanded this agency was in charge of all reconstruction activities.

Urban Renewal and Financial Housing Aid

Housing and Home Finance Agency (HHFA, now Housing and Urban Development)

Urban Renewal Administration - Using $25 million provided by the Alaska Omnibus Act, the Urban Renewal Administration authorized aquisition of property in communities for complete urban renewal programs.

Federal National Mortgage Association - Developed program to forgive mortgage indebtedness for homeowners who had lost their residences.

Public Housing Administration - Worked with Alaska State Housing Authority to expedite the the construction of low rent projects in the southcentral region.

Community Facilities Administration - Agreed to a rent moratorium on a 340 unit housing project in Kodiak due to the community housing crisis.

Federal Housing Administration - Evaluated housing situation and designed programs for those who had lost their homes as well as for homes which experienced damage.

Small Business Administration

Granted disaster loans for homes and businesses during the reconstruction phase.

Veterans' Administration

Provided loan advances for repairs and reconstruction and relaxed loan requirements to expedite assistance.

Farmers Home Administration (FHA)

Under the Department of Agriculture, the FHA concentrated on financial needs in rural areas.

Bureau of Federal Credit Unions

Under the Department of Health, Education, and Welfare, assisted credit unions in increasing their loan capabilities.

Treasury Department

Agreed to coordinate the work of various financial agencies. Coordinated activities of the Federal Home Loan Bank Board, the Federal Reserve System, the Federal Deposit Insurance Corporation, as well as other related agencies. Primary objective was to ensure the availability of credit and funds for recovery.

Bureau of Indian Affairs

Under the Department of the

Interior, the Bureau of Indian Affairs coordinated reconstruction of homes in the Native villages in the state.

Economic Reconstruction and Employment

Department of Labor

Checked inflation and redeployed unbalanced manpower into the labor force.

Bureau of Employment Security - set up training centers and 24-hour unemployment services to help place unemployed workers.

Wage, Hour, and Public Contracts Division - Monitored wage and salary scales to keep wages down. Bureau of Labor Statistics - Kept tabs on inflation and monitored for price gouging.

Department of Commerce

Area Redevelopment Administration - Created employment opportunities and provided loans for industrial expansion and resources development.

Bureau of Commercial Fisheries - Provided emergency loans to fishermen in order to salvage the 1964 season.

Business and Defense Services Administration - Studied Alaska's economy and analyzed the long-range economic development of the state.

Office of Business Economics - Matched the Business and Defense Services Administration study with a report on the state's solvency, located untapped sources of income.

Internal Revenue Service

Stepped up the processing of tax returns to provide refunds as quickly as possible. Authorized a 90-day extension on the claiming of casualty losses so taxpayers could include their losses in 1963 tax returns. The IRS also waived penalties for those who could not file by April 15, 1964.

Office of Vocational Rehabilitation

Under the Department of Health, Education, and Welfare, this agency assessed vocational and educational needs of the handicapped who had lost their jobs.

Civil Service Commission

Gave federal agencies extended hiring authority to facilitate the hiring of necessary skilled personnel.

Restoration of Public Facilities

U.S. Army Corps of Engineers

Restored small boat harbors, streets, bridges, sidewalks, and gutters. Let contracts for scientific and engineering studies in Anchorage, Seward, and Valdez which became the basis for permanent construction.

Navy Bureau of Yards and Docks

Performed the same function as the Army Corps of Engineers; however responsibility was limited to Kodiak.

Department of the Interior

Bureau of Reclamation - In charge of the restoration of the Eklutna Hydroelectric project.

Bureau of Indian Affairs - Provided water and sewer systems in Native villages.

Alaska Railroad - Repaired damage to the federally-owned Alaska Railroad.

Department of Commerce

Bureau of Public Roads - Handled most of the highway and road projects under its authority.

Maritime Administration

Compiled damage estimates on harbors and advised on reconstruction and repairs.

Rural Electrification Administration

Under the Department of Agriculture, REA worked to find financial assistance for private cooperatives.

Federal Power Commission

Surveyed Alaska's damaged power plants, counseled on reconstruction and new developments.

Office of Education

Under the Department of Health, Education, and Welfare, the agency found ways to help finance school repairs.

Community Facilities Administration

Performed extensive damage surveys to public works; assisted OEP in evaluating eligibility for financial assistance.

[a] Does not include research activities of federal agencies

Source: Office of Emergency Planning, "The Alaska Earthquake: A Progress Report 279 Days of Federal Reconstruction Effort", Washington D.C., December 29, 1964.

Immediate Relief - Short Term Restoration

During the first hours of the crisis Alaska was cut off from federal agencies in Washington, D.C. Because of this communications breakdown, and because federally owned railroads and facilities within the state were severely damaged, assistance from the federal government was initially only through military personnel, aircraft, and equipment based in Alaska.

The state government was in the process of dismantling its civil defense office at the time of the earthquake, so the most appropriate and necessary agency in the state found itself without staff when disaster struck. This was also true in Anchorage, where the civil defense director had resigned the week before the earthquake. Still in town, he reported for duty and was immediately rehired.

The smaller communities had few resources of their own available to respond to the emergency and, while in greater need of outside assistance, were more isolated from it. The communities of the Kenai Peninsula and Prince William Sound were cut off by road damage and bridge failure from Anchorage and the outside world, as well as from each other. Largely isolated from outside help, the brunt of the urgent need for response fell upon the shoulders of local government and private and volunteer organizations.

Source: U.S. Army

This early period was marked by a combination of chaos, disorganization, courage, and resourcefulness. Initial efforts included these simultaneous actions:

1. Reestablishment of communications between personnel whose decision-making roles were required for immediate response action.
2. Resolution of threatening situations.
3. Provision of critical care.
4. Agency coordination, emerging from and enhancing efforts in the first three categories.

Communications: Normal channels of communications were inoperative. With phone lines down, intracity communications were a critical issue. Police, fire, and public works car radios frequently were the only mode of communication.

The larger the city, the greater the communication problem. Anchorage was hardest hit as the only metropolitan area in the state. Local officials appeared briefly over an Anchorage radio station, operating on auxillary power, to calm the people and request state government employees to report to the state civil defense headquarters.

In smaller communities intracity communications were not as critical as communications with the outside. In Whittier, the surrounding mountains posed tremendous telemetry problems and initial contact was not accomplished until the morning following the earthquake. In Kodiak, communications were provided by taxicabs operating on citizenband radios and contact with Anchorage was made after midnight by ham relay through the Chiniak satellite tracking station.

Radio stations operating on emergency power were on the air soon after the impact, but there was no coordination of broadcasting. Two commercial radio stations, KFQD and KENI, became mass channels of public communication. State civil defense, Radio Amateur Civil and Emergency Services (RACES), state police cars, and ham radio operators all provided channels for emergency communications while manual telephone and teletype facilities were being repaired. The State Department of Fish and Game provided important communications with their statewide radio network. They concentrated their efforts on the impacted coastal communities and villages. Their vessels also assisted in recovery and salvage operations.

RACES was the only organization whose members had specific training for an earthquake. A 1962 exercise had tested RACES capabilities by simulating a devastating earthquake in southcentral Alaska.

Once some level of communications was established in the impacted cities an assessment of the extent and nature of damage began. Mayors, policemen, city managers, and other public officials communicated by radio and made visual inspections on foot and in cars. Individual citizens also reported information to authorities. In Anchorage the public safety building, close to the heavily impacted areas but sustaining no serious damage, was ideally located to receive intelligence reports on the disaster and to coordinate responses to it. In the various communities the police station or public safety building usually became the focal point for these damage assessment and response mobilization efforts.

Resolution of Threatening Situations: The danger to life did not end when the ground stopped shaking. Floods, fires, and unstable buildings were among the life-threatening situations that required immediate attention. Traditional agency response at the local level was quick. Fire departments extinguished fires and performed search and rescue operations. Police secured damaged areas and guarded against possible looting.

Response included groups of citizens forming loosely knit organizations to function over a very short time to meet critical manpower shortages. In Anchorage, for example, it was necessary early-on to cordon off large portions of the downtown sector. Volunteers from a crowd of citizens who had assembled at the public safety building were informally deputized, given hand-lettered "police" arm bands, and put on the street to assist the police primarily in keeping people out of damaged buildings. Local engineers and architects organized the assess damage to buildings. The volunteers used the city building department as headquarters and worked under the general authority of the chief inspector. They classified buildings as to safety and repairability (Norton & Haas 1970). The day after the earthquake geologists and engineers from various governmental agencies, oil companies, and other private firms organized to establish and map areas of danger in the event of strong aftershocks (Selkregg 1970).

After learning that permission to use the National Guard must come from the Governor, the mayor of Anchorage used a volunteer's ham radio to contact him. Guard troops were thus able to be placed on duty within two hours of the disaster. The Department of Military Affairs was the umbrella organization for the Alaska National Guard. Its army units were quickly mobilized to assist in search and rescue and guard duties.

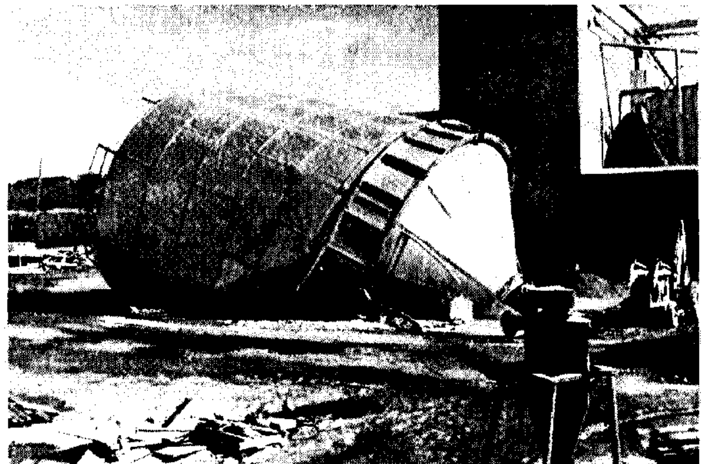
Initial search and rescue work was performed by many public and private agencies, but was sometimes hampered by lack of interagency coordination. In Anchorage search and rescue efforts focused on the Turnagain slide area. The searchers included members of the River Valley Ski Patrol, the Mountaineering Club of Alaska, and military organizations. The chief of the Spenard fire department attempted to coordinate rescue work there, but was hampered by poor communications. By evening these efforts improved somewhat, but still suffered from lack of a systematic plan of operations, difficulties in accounting for people who has left the area, and lack of cooperation between the volunteer groups and fire and police departments. As a result, some areas were searched several times while others had yet to be searched at all.

Critical Care: In providing critical care to the homeless and injured in the initial hours following the disaster, once again it was the local governments, the military, and volunteer groups that made the swiftest response. Many people needed temporary housing through the night. Some needed refuge from incoming tsunamis, others had lost their homes and had no place to go. Schools, public buildings, and hospitals became shelters.

Organizations began preparing food and coffee within an hour following the earthquake, working by candlelight with Coleman stoves. The Salvation Army implemented a disaster response plan with trained personnel. In Anchorage they set up a shelter and aid station in the Federal Building, and provided food, clothing, rescue equipment, and temporary housing in communities and remote villages. The Red Cross sent representatives immediately to all communities. They established their national disaster headquarters in the Anchorage YMCA building on March 28. Alaska Methodist University, in another part of the city, opened its dormitories to refugees within five hours of the earthquake.

In the first hours and days following the disaster, the Regional Emergency Health Services, a segment of the civil defense structure, took great care in confirming reports of fatalities. Early reports listed 119 dead. Later this figure was revised to 115. Nearly all casualties in the Anchorage area were taken to Providence Hospital. About 200 patients were treated for major and minor injuries in the first 24 hours. The hospital also became a central gathering point for people seeking refuge from darkness and destroyed homes, and for others who just wanted to volunteer their services. The Alaska Native Hospital in Anchorage treated eight people, but was prepared to receive hundreds in the anxious hours following the earthquake.

Military personnel played a large role in immediate critical care assistance. In Anchorage, troops from Fort Richardson were available virtually without limitations. Troops from Fort Wainwright, near Fairbanks, were dispatched to Valdez, where they distributed water and food, made emergency repairs, and performed guard duties. The navy assisted in Kodiak. Army



Source: City of Anchorage

helicopters and other aircraft evacuated the injured from stricken towns, and army personnel assisted in police work and other duties.

In spite of the generally spontaneous response of city personnel, officials, and volunteers, the first eight or nine hours of emergency medical care and shelter were not well coordinated. This, explained Mayor Sharrock of Anchorage, resulted from a ". . . lack of communications, lack of a functioning civil defense organization, and lack of planning. . . . We had no plan developed for this sort of thing . . ." (Haas 1970). None of the other towns had a disaster plan. In almost every case the response was of necessity and determined on the spot. Previous planning for a wartime disaster was found to be largely irrelevant to the earthquake and tidal waves that hit Alaska.

Agency Coordination - Civil Defense: Although civil defense agencies were weak and unprepared for this type of disaster, major interagency coordination efforts took shape to relieve duplication of services and to streamline the operational response. Interagency coordination in Anchorage began with a meeting at 3:00 a.m. on Saturday, called by the mayor by means of a police car radio. The meeting was attended by municipal department heads, public health personnel, public utility executives, civil defense personnel, military officials, representatives of state and federal agencies, the Red Cross, and the Salvation Army. The mayor announced that two issues would take priority: 1) accounting for missing persons, and 2) dealing with health and sanitation problems. Responsibility for restoration of telephones, electricity, and water and sewer lines was given to the public utilities; the military was to provide water purifiers, water tankers, and field kitchens; and emergency medical treatment organizations were to arrange for typhoid innoculation and other disease control, as well as provide emergency treatment. Beyond these concerns, the focus was on reestablishing air and land transportation facilities to enable the state to obtain further assistance from federal and private sources that had not yet entered the picture.

In Anchorage several umbrella organizations emerged specifically out of need. These organizations were shortlived due to their ad hoc nature, and their composition was markedly diverse. One organization, known as "Disaster Control," was formed by the building construction supervisor in the city of Anchorage and was composed of labor union members, contractors, and local businessmen. The organization had its roots among deputized volunteers doing guard duty on the streets. Headquarters were set up in the public safety building and the group performed such functions as search and rescue, demolition, and salvage operations. The group set up a manpower pool, procured medical supplies for the hospitals, sent out "light duty" search and rescue groups, cleaned up debris, and arranged for downtown shelters, cots, and bedding. The group was given formal recognition and could secure supplies directly from the military. The Alaska General Contractors Association and the labor union managed labor and equipment and responded to jobs delegated by Disaster Control. The organization functioned for six days and was then disbanded in order to restore normal agency operations.

A psychologist who chaired the Alaska Rescue Group accepted responsibility from the local civil defense director to coordinate search and rescue operations in Anchorage. He organized work from all levels of government and private volunteer groups.

Formal agency channels continued efforts to mobilize resources and manpower. The ad hoc organzations tended to disband either following completion of tasks or when normal agency functions were sufficiently mobilized to assume full responsibility.

The formal procurement of resources from outside Alaska began with Governor Egan's request to the President for the declaration of a disaster area and for federal assistance. The day after the quake the state legislature granted the Governor broad powers to deal with the emergency. With this supplement to the already considerable consitutional powers of the Alaskan governor, the various state agencies were available to respond to the crisis without further legislation (Table 9).

> The Governor, in accordance with the state civil defense plan, designated the state civil defense director as his coordinator of all emergency actions. The state civil defense office was the focal point of emergency operations and the executive portion of the state government was effectively transplanted from Juneau to Anchorage (Office of Civil Defense May 1964).

Tasks included reestablishing and augmenting communications, establishing priorities for emergency action, damage assessment by experts, and preparation of recovery plans.

The staff was composed of only five professionals and two secretaries, who activated the offices in Anchorage within thirty minutes of the earthquake. This force was expanded to approximately 150 people within 24 hours. The additional people were volunteers, including RACES operators, personnel from state departments, and a few military communications specialists. Space problems at the state civil defense headquarters quickly developed, and four mobile homes were eventually moved next to the building to accommodate the overflow.

The state civil defense personnel were usually veterans or retired military personnel and in the normal course of their duties had developed close ties with active military in Alaska. In the emergency they were very effective in coordinating military support for the state civil authorities.

From accounts of the civil defense operations several observations can be made. The agency benefited from dedicated personnel and a large number of skilled volunteers, but had several critical weaknesses. A major drawback to effective operation was the lack of an emergency communication capability. Their orientation, a result of federal emphasis, was on dealing with nuclear attack. Very little of the preparations for a nuclear war scenario were useful in the earthquake disaster. Finally, there was no disaster plan to guide them, a fact which no doubt explains some of the confusion which prevailed during the early hours of the emergency.

During the crisis the function of elected officials was to insure that the governor and the local leaders had the power to apply state and local laws and funds for the protection of life and property. Once this had been accomplished state legislators and local officials became involved personally, responding according to their capabilities and knowledge.

The most important factor in any disaster is the human reaction, yet this can be as unpredictable as the earthquake itself. In the case of the Alaska earthquake the behavior of the people was generally not unusual for a disaster of such magnitude; it was astonishingly courageous and in large part the reason for the state's swift recovery.

Many people quickly sought out familiar organizations and volunteered their services. Such unlikely groups as the Boy Scouts, the Girls Service Organization, the Lions Club, a 15-member crew from Northwest Airlines, and the League of Women Voters were among the hundreds that quickly mobilized to provide disaster relief. Where no existing group was available for a specific task, organizations were spontaneously formed. Wherever a need arose, wherever a gap appeared, people rushed to fill it.

In a presentation to Congress on September 30, 1964, Senator Bartlett recognized these efforts:

Those events, which bred devastation beyond imagination, also bred imagination to conquer that devastation. It is time, Mr. President, to pay tribute to the great spirit which on that terrible night moved Alaskans to unite and begin the awesome task of reconstruction before the earth stopped moving under their feet.

* * * * *

The work of countless individuals, both in and out of government, has been invaluable. Perhaps some day the assistance in dollars can be added up; but how does one total the intangibles of human spirit and giving? (Bartlett 1964)

Long-Range Recovery and Reconstruction

In phasing the response from emergency action to reconstruction and long-range recovery, there was a transition of control from volunteers with considerable independence and initiative to more complex organizations. Federal assistance became the major element.

On March 28, the day after the earthquake, Governor William Egan requested that Alaska be declared a disaster area, which President Johnson immediately did. On April 2 the President signed Executive Order 11150, establishing the Federal Reconstruction Development Planning Commission for Alaska--the Anderson Commission. The heads of all federal departments and independent federal agencies with any direct financial or technical part to play in the reconstruction were asked to join. It included the Secretaries of Defense, Interior, Agriculture, Commerce, Labor, and Health and Welfare; the directors of the Office of Emergency Planning and Federal Aviation Administration, the chairman of the Federal Power Commission; and the administrators of the Housing and Home Finance Agency and the Small Business Administration (Table 11a). This was an unprecedented and powerful arrangement, in which a commission of executive agencies was chaired by a member of the legislative branch.

On April 3 the Governor issued Executive Order 27, establishing the State of Alaska Reconstruction Development Planning Commission, to coordinate with the federal commission. By April 7 the two commissions had agreed to establish eight federal task forces to appraise the damages and consult on reconstruction. Communications between these groups and local, state, and federal officials opened the way for swift recovery.

The quick appointment of the Anderson Commission was possible as a result of preearthquake efforts to develop a joint federal/state planning agency that would assist the state in

Table 11a. Original Eight Federal Commission Task Forces - (Established April 7, 1964)

Community Facilities

Deputy Commissioner, Bureau of Indian Affairs, Interior
Office of Field Administrator, Health, Education and Welfare
Director, Government Readiness, Office of Emergency Planning
Deputy Assistant Commissioner for Buildings Management, General Service Administration
Commissioner, Community Facilities Administration, Housing and Home Finance Agency (Chairman)

Economic Stabilization

Administrator, Wage and Hour Public Contract Division, Labor
Chief, Economic Stabilization Division, Office of Emergency Planning (Chairman)

Natural Resource Development

Director, Office of Research, Office of Emergency Planning
Civil Works, Office of Chief of Engineers, Department of Army Defense
Senior Economist, Office of the Secretary, Interior (Chairman)
Deputy Chief, Bureau of Power, Federal Power Commission
Deputy Assistant to the Secretary, Agriculture

Ports and Fishing

Civil Works, Office of Chief of Engineers, Department of Army, Defense
Chief, Food, Welfare and Fuels Resources, Resources Readiness Division, Office of Emergency Planning
Director, Bureau of Commerical Fisheries, Interior (Chairman)
Assistant to Director, Office of Financial Services, Small Business Administration

Financial Institutions

Fiscal Assistant Secretary, Treasury (Chairman)
Small Business Administration
Director, Division of Examinations, Federal Reserve System
Assistant to Board of Directors, Federal Deposit Insurance Corp.
Deputy Director, Division of Supervision and Examinations, Federal Home Loan Bank Board

Housing

Chief Benefits Director, Veterans Administration
Director, Office of Financial Services, Small Business Administration
Director, Rural Housing Loan Division, Farmers Home Administration, Agriculture
Assistant Administrator, Program Policy, Housing and Home Finance Agency (Chair)

Industrial Development

Assistant Administrator, Industrial Mobilization, Commerce
Deputy Undersecretary, Labor
Administrator, Business and Defense Services, Commerce (Chairman)
Office of Emergency Planning
Assistant to Director, Office of Financial Services, Small Business Adminstration
Deputy Director, Office of Policy Development, Federal Aviation Agency

Transportation

Special Assistant to Undersecretary for Transportation, Commerce (Chairman)
Director, Transportation and Warehousing Policy, Installation and Logistics, Defense
The Alaska Railroad, Interior
Managing Director, Federal Maritime Commission
Office of Emergency Planning
Deputy Director, Office of Policy Development
Federal Aviation Agency

**The Scientific and Engineering Task Force was appointed on April 25, 1965.*

evaluating its resources and economic potential. To pursue this, in 1962 Senator E. L. (Bob) Bartlett had introduced a bill for the establishment of the Joint Federal/State Economic Resource Development Planning Commission for Alaska. The bill was never enacted and efforts were directed toward the establishment of this commission by executive order of the President when President Kennedy was killed (Schnoor 1970). The groundwork for establishing an Alaska federal/state commission had been laid, however, and was put to effective use in creating the Anderson Commission.

Of further assistance in the long-range recovery efforts was the concept of transitional grants. This novel idea was part of the Alaska Omnibus Act, creating the State (PL 86-70). The Act authorized a five-year program of special federal grants totalling $28.5 million to enable the state to take over its highway, airport, public health, and law enforcement programs.

When the earthquake occurred the federal transition grants had been depleted. The last grant, $3 million for fiscal 1964, had been made. Early estimates placed the cost of earthquake damage at $373 to $486 million (exclusive of federal property). This was at least ten times the state's annual revenues. Taxes and other revenues were expected to be reduced as a result of the disaster. Costs of social and health services would be greatly increased. Clearly, Alaska was incapable of bearing the cost of reconstruction by itself.

On April 6 administrative legislation was introduced for the appropriation of $50 million to supplement the depleted budget of the Office of Emergency Planning (OEP) to assist in clearing debris and the restoration of public facilities under Public Law 81-875. The most urgent work was already underway with the Corps of Engineers, the Navy, and the General Service Administration (GSA) assisting the various communities at the request of OEP. Funding was approved in a few days.

On April 28 the President announced approval of $50 million to rebuild the tracks and the Seward terminal of the Alaska Railroad. The railroad was recognized as a vital component of the Alaska transportation network, and its immediate

reconstruction was intended to restore public confidence in Alaska as a permanent home.

Bills were introduced by Senator Jackson of Washington and Representative Rivers of Alaska to create a federal office of Alaska reconstruction that would develop and administer a retroactive earthquake insurance program. These bills were never approved, primarily because of fears that they would set a precedent for handling future natural disasters.

After reviewing the extent of the disaster and evaluating the reconstruction needs, the Anderson Commission and the Bureau of the Budget proposed that the Alaska Omnibus Act be amended to provide assistance in funding highways, harbors, urban renewal projects, debt adjustments, and disaster loans. The commission saw this as an efficient way to provide a quick response, to the disaster, directed specifically to Alaska, without acting on the budgets of individual agencies. The amended legislation could help Alaska without changing or creating new disaster legislation. Under (Public Law 88-311) the transitional grant provision of the amended act, Congress authorized an additional $23.5 million in May.

It was Senator Anderson's strong conviction that Alaska could not wait for elaborate new legislation, nor afford bureaucratic delays. Rebuilding had to begin immediately and be completed by winter. At the same time, he was convinced that ill-conceived or crash plans could be extremely wasteful and fuel the already inflated cost of living in Alaska.

Red tape had to be cut. The presence of the cabinet secretaries and heads of agencies as members of the Reconstruction Commission was invaluable in accelerating the reconstruction planning process. The commission acted quickly, avoiding bureaucratic entanglements and creating none of its own. Existing laws were made to fit and waivers were granted to adjust to special conditions. The reconstruction was to be used to enhance Alaska's economic future through good city planning and sound engineering (Anderson and Bray 1970).

The commission, working with its state counterpart (made up of the governor's cabinet), was well designed for success in carrying out its mission as general coordinator of the federal response to the disaster. Without diminishing the roles of the OEP, the Corps of Engineers, and other agencies, the Anderson Commission provided the cohesiveness needed to tie the diversified programs together. "To meet these goals federal, state, and local resources and programs were joined in an early illustration of 'creative federalism' at work" (Ink 1970).

The Army Corps of Engineers and the Navy Bureau of Yard and Docks were designated by OEP to act as agents for restoration and reconstruction of public facilities. The Corps of Engineers handled projects in Anchorage, Seward, Homer, Valdez, Seldovia, Cordova, Girdwood, and

Whittier; the Navy Bureau in Kodiak. The Federal Bureau of Public Roads assumed responsibility for highways and road projects. The Federal Aviation Agency was entrusted with repairs to airports.

The transportation system needed immediate attention. The Alaska Omnibus Act was amended, increasing the federal government's share of the cost of federal-aid highway construction from 50 to 94.9 percent. In a race against time both the highway system and the Alaska Railroad were repaired by the winter of 1964-65. This included bringing the road and rail beds to higher elevations to protect them from high tides. Reconstruction and repairs to the Port of Whittier, Anchorage, and Seward became a priority.

To insure that damaged or destroyed public facilities would be reconstructed on sound building sites, OEP directed that scientific studies of soil foundations be made at selected locations where land alteration had occurred. These studies were conducted by private consultants, the U.S. Geological Survey, and the State Department of Highways. Permanent reconstruction depended to a large degree on the results of this preliminary exploratory work. Where work could proceed without this information, OEP authorized immediate repair and reconstruction.

To assist individuals, the Small Business Administration streamlined procedures to make disaster loans available to hard-hit homeowners and businessmen. Loans to homeowners were made at a low interest rate (3 percent), and bank participation in business loans was reduced from 20 to 10 percent. The loan for business was raised from $100,000 to $250,000.

A moratorium on interest for one year and on the payment of the principal for five years was granted in many instances. By September the SBA had approved 455 home disaster loans for a total of $9,014,594, and 490 business disaster loans for a total of $41,555,765. Other loan assistance at 3 percent interest came from the Bureau of Commercial Fishing. The Home Farmer Administration, the Rural Electrification Administration, and HHFA were authorized to adjust the indebtedness of some borrowers. Under the ammended Omnibus Act the federal government was authorized to purchase up to $25 million worth of state of Alaska bonds in order to complete proposed capital improvement programs. As a supplement to the 1949 Housing Act, HHFA received $25 million to assist in the reconstruction of urban areas through urban renewal, including the Valdez open space project. Also, the proportion of the project costs born by this federal assistance program was increased from 75 to 90 percent. Because local governments could not provide the 10 percent matching funds, the state legislature passed a bill authorizing that 10 percent be paid by the state. It was the first time state money was used for urban renewal projects. Prior to the earthquake municipalities provided 25 percent of the funding.

Later state participation influenced some decisions on land use and disposal by the Alaska State Housing Authority as administrator of this program in Alaska.

Even with federal assistance well organized, reconstruction presented problems. The President had declared the state a disaster area under provisions of the Federal Disaster Act of 1950. This allowed virtually unlimited direct aid for the restoration of publicly owned facilities, but did not provide any loans or assistance for the repair of private property, nor for improving government facilities beyond their capabilities at the time of a disaster. The Act also did not address how aid provided under the law should be used to mitigate the effects of future disasters. In the aftermath of the earthquake it was these issues which became the most difficult to deal with. For example, in the reconstruction of the Seldovia and Cordova waterfronts the Corps of Engineers could not begin work until lands were acquired under an urban renewal project. Acquisition of land was the only reason for initiating urban renewal in those areas.

The first requests for approval of urban renewal disaster projects for the areas affected by major landslides, tsunami, or tectonic changes were forwarded to HHFA immediately. Feasibility surveys and application for projects in Anchorage, Valdez, Seward, and Kodiak were forwarded to Washington by mid-April. These applications reflected boundaries of risk areas as recommended by early findings of geologists with the U.S. Geological Survey and the State Department of Highways working with the Engineering Geology Evaluation Group. This group of volunteer soil scientists had been officially recognized by the Governor after the local press had challenged their competency. Their recommendation for the need for further soil studies prior to redevelopment and for classification of open-space use for portions of the damaged areas had not been well received by some of the businessmen and policy makers of the communities affected. The Anderson Commission realized that further evaluation of soil and geological conditions was required before planning and reconstruction decisions could be made. To respond to this need the Scientific and Engineering Task Force (Task Force 9), constituted of structural engineers, engineering geologists, and seismologists, was appointed by Senator Anderson on April 25, 1964 (Table 11b).

The task force had a clear mandate. It was to use scientific information to make firm recommendations on where federal funds could be used for stabilization, reconstruction, and repair to private property, and to define those parts of the earthquake-damaged cities where reconstruction was inadvisable because of land stability problems. Public response to the task force was favorable. The task force presented its recommendations through press releases, including maps and explanations. Press notices were issued jointly by the task force and the Corps of Engineers and allowed opportunity for discussion and questions by the public and the press. Time was of the essence. In spite of this the Task Force 9 field team, made up of experts in the fields of structural engineering, geotechnical engineering, and seismology, proceeded with considerable care in insuring that information obtained from soil exploration programs conducted by the Corps of Engineers with the assistance of Shannon and Wilson, Inc. be incorporated in the final recommendations. The task force was concerned chiefly with land stability and reconstruction in Anchorage, Seward, Valdez, and Homer. In other communities, where damage resulted only from tsunamis or from changes in elevation, the task force merely stressed the need for compliance with the latest edition of the building code for Seismic Zone 3. Seismic Zone 4 classification was established later as a result of the San Fernando earthquake and was incorporated into the 1976 edition of the Uniform Building Code.

The task force did not guide reconstruction of airports, railroads, and highways. Only in Seward and Anchorage, where the Alaska Railroad reconstruction was related to urban renewal projects, did the task force act as advisor.

As stated in the final Recommendations and Risk Classification of the Anchorage Area on September 8, 1964,

> The Task Force 9 Field Team was formed to rate areas of Anchorage and

Table 11b.
Scientific and Engineering Task Force
(Task Force 9)

Data Analysis and Research Branch, Coast and Geodetic Survey, Commerce
Engineering Geology Branch, Geological Survey, Interior
Alaskan Geology Branch, Geological Survey, Interior
U.S. Geological Survey, Interior
Civil Works, Office of Chief of Engineers Department of Army, Defense
Military Construction, Office of Chief of Engineers, Department of Army, Defense (Chairman)
Office of Physical Sciences, Coast and Geodetic Survey Commerce

Scientific and Engineering Field Team

North Pacific Division, Corps of Engineers, Department of Army, Defense
Seismological Field Survey, Coast and Geodetic Survey, Commerce
Engineer, Geology Branch, Geological Survey, Interior
Special Projects Branch, Geological Survey, Interior (Chairman)
North Pacific Division, Corps of Engineers, Department of Army, Defense

> other quake-damaged cities for the Alaska Reconstruction Commission as guide in developing insurance and loan policies of federal lending agencies. Its findings are to be considered as advisory but by no means mandatory to city officials [emphasis added] (Eckel and Schaem 1970).

Land use recommendations made by the task force were only enforceable within the boundaries of urban renewal projects approved by local governments. In Anchorage the only urban renewal disaster project approved--the Fourth Avenue slide area--was subject to follow land use and redevelopment regulations as recommended by the task force and ASHA planners. In the L Street and Turnagain slide areas the "high risk" classification by Task Force 9 affected only the financing of homes and businesses through FHA, SBA, or other federal grants applied for by the city or by private citizens, but did not affect land use changes. As an example, in 1966 a proposal to expand the Community Hospital on L Street with Hill Burton funds was turned down because Task Force 9 had given the area a "high risk" classification. Private financing, however, could be used unless local zoning and platting regulations or other local policies would prevent it. This fact was not clear to the general public. In fact, for years after the earthquake, because planning maps showed park and open space classification for the Turnagain slide area, people believed that this was a fact, not realizing that the land had not been assembled by the Municipality or dedicated for that purpose. Park classification was only an allowable use in a residential district, not a dedicated use.

This applied to the L Street slide area where the task force had recommended open space and single family residences of limited dimension. At the time of the disaster this area was zoned Multiple Family Residential and Central Business District (R-3, CBC). However, because it was mostly developed with single family residences, it would have been feasible to change the land use classification to park use, open space, and single family residential. Instead, in 1965 the city rezoned part of this area as Residential/ Office (R-O). This classification increased the density and use of the area, and is the only classification in Anchorage having no height restrictions.

Because the Anderson Commission never considered the possibility of purchasing land in damaged areas at preearthquake prices, as proposed by Governor Egan, assemblage of land in high risk areas was prevented. Land had a very low market value after the earthquake; naturally property owners were reluctant to sell and opposed application of urban renewal disaster projects.

Many reviews written about the reconstruction period give the misconception that Task Force 9 was a planning body. It was not--nor did the federal government have the power to require local compliance with federal recommendations unless they affected federally owned property.

The task force had no planning staff, and difficulties occurred when geologists tried to present scientific data to planners having no scientific background. The intent was to use the data to effect land use controls and to initiate development that considered risk mitigation. But since the task force remained functional only until recommendations were submitted to various agencies, departments, or city administrators, there was no opportunity to review and discuss findings and recommendations with the public and local elected officials. Procedures to insure that hazard areas be recognized and that mitigation techniques be applied in the development of ordinances and zoning regulations were not established. The public was never convinced of the need for establishment of permanent "high risk" zones.

When work on the amendments to the Alaska Omnibus Act was completed in August 1964, Senator Anderson believed it was time to conclude this special post-disaster effort. The Scientific and Engineering Task Force was eliminated--just six months after the earthquake. This left a number of recommendations dangling. There were no clear plans for enforcement, or procedures for adjusting or relaxing restrictions after ground stabilization had occurred and more sophisticated mitigation measures could be developed in zoning and building codes. The task force had no time to evaluate the long-range economic impact of the recommendations or to relate their recommendations to a regional growth development plan. To obtain federal assistance, local governments had agreed--without conviction--to accept risk designations and limit development accordingly. Many of these commitments were later either forgotten or ignored. Today extensive new construction has occurred on or adjacent to slide areas in Anchorage, and the recommendations of the task force have been challenged in Kodiak, Seward, and Valdez.

A month after the dissolution of Task Force 9 Senator Anderson recommended to the President that OEP coordinate the remainder of the disaster relief work and that the Anderson Commission be replaced by one, as proposed by Bartlett in 1962, which could direct its effort to long-range economic development planning efforts for Alaska (Schnoor 1970).

> On September 18 I was able to report to President Johnson that water service had been restored to the battered communities; highways were fully operational; and rebuilding of wrecked ports was underway to provide protection for fishing boats against approaching winter storms. Although we had spent millions of dollars in a short span of time, we had avoided

inflation by pacing less-critical construction, by avoiding special premium builders, and by holding down the importation of labor from outside Alaska (Anderson 1970).

On October 6, 1964 the Federal Field Committee for Development Planning in Alaska was established by Executive Order No. 11182. The intent of this commission, however, was not to monitor or advise in the planning and reconstruction--a job given to OEP--but was to coordinate federal/state government activities related to economic development and social needs, a job that the commission performed well until it was eliminated by the President in 1971.

The redevelopment of the urban area was left to the Alaska State Housing Authority (ASHA), a public corporation under the State Department of Commerce (Table 9). ASHA's staff was made up of planners, geologists, sociologists, and appraisers. The staff doubled in size in the first months after the earthquake. For the next five years ASHA worked with Anchorage, Cordova, Kodiak, Seldovia, Seward, and Valdez in coordinating the efforts of the OEP, the Corps of Engineers, HHFA, the State Department of Highways, Health and Welfare, State Department of Natural Resources, and State Department of Public Works. It was this agency and its consultants that prepared the final redevelopment plans and monitored the completion of the urban renewal projects. The state government tried to assist by granting stable land parcels in exchange for land rendered unusable as a result of the disaster (Law 116). Under this law, used to relocate people in scattered small settlements of Girdwood, Hope, and in Valdez, land was made available to relocate some homeowners of the Turnagain slide area in Anchorage. Although several citizens obtained relocation lots in the Zodiak subdivision, they never turned in the deeds of the devastated land to the city as had been established in the law. The reason was found to be that the words 'may require a quit-claim deed' rather than 'shall require' were used in the writing of the final version of the bill (Chapter 116, Temporary and Special Acts of the Legislature for the State of Alaska, 1964; amended Chapter 52, Temporary and Special Acts of the Legislature for the State of Alaska, 1965).

State and local governments and the citizens played a major role during the long-range recovery and reconstruction of urban areas. The urban renewal projects application and proposed plans had to be approved through public hearings. In small communities great friction developed among advocates of urban renewal and foes of same. City councils were changed, new mayors elected, staff fired, consultant contracts cancelled. At times it looked like some of the urban renewal projects were lost (Valdez, Seldovia). Some were never initiated (L Street and Turnagain). Because the reconstruction of the utilities and transportation systems did not need citizens' approval, those projects moved rapidly.

Summary

In evaluating the long-range recovery and reconstruction phase, three major components seem to emerge:

1. Repair and reconstruction of utilities and transportation infrastructure, and federal and military installations

2. Assistance to private citizens--reestablish economic base through direct loans and indebtedness forgiveness

3. Reconstruction of devastated areas within municipalities

The first two phases were handled well and the economic stability of Alaska today is based on the effective reconstruction after the earthquake and the generous federal assistance in reestablishing a strong economic base.

The reconstruction of devastated areas within municipalities is a case of success and failure. Where the federal government recommendations had local approval through ordinances as part of the urban renewal programs, mitigation measures were applied and remain in force today (Valdez, Fourth Avenue buttress area in Anchorage, Seward waterfront). In areas where the recommendations were not implemented through urban renewal or other federal programs, mitigation measures were never applied. However, all the cities have recovered well and from an economic view the goals set by the Anderson Commission were met.

The Alaska experience was unique from the standpoint of political and administrative setting--a new state with the federal delegation, the governor, and a majority of state legislators of the same party as the President, still dependent on federal assistance and programs, with a population of less than 200,000, and with untapped resources of great value. The desire of the federal government was to assist in the recovery. They did it in a quick and effective way. The congress was knowledgeable about Alaska issues and resources due to the recent decision to grant statehood. There was no need to study and to justify the assistance; the facts were known.

The emotional impact of this first major earthquake of modern times also played a great part in developing friends in congress. The use of federal/state coordination through the appointment of a commission was the result of the preearthquake actions of the governor and the Alaska delegation. Success of the rapid reconstruction efforts is owed to the decision of the President and the Congress in appointing the Federal Reconstruction Development Planning Commission for Alaska with a powerful chairman.

> My service in President Truman's Cabinet gave me some element of rank. So often in Washington, progress is impeded by interdepartmental committees and councils that dwindle into forums wherein one department devotes most of its energy to protecting its own self-interest from incursions by another. That was not to be the fate of the Alaska Reconstruction Commission. We were faced with a crisis that would become catastrophic if agencies squabbled to defend their own prerogatives. No member of the Commission, particularly myself, had any ambition to make the rebuilding of the 49th state a lifetime career. I was determined that the Commission would not endure after the completion of its mission (Anderson and Bray 1970).

Chapter 5:
Post Earthquake Investigation Committee on the Alaska Earthquake

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Post-Earthquake Investigations - Committee on the Alaska Earthquake

By June 1964 the National Academy of Sciences (NAS) had established the Committee on the Alaska Earthquake (CAE). Its specific charge was to insure that as much technical and scientific information as possible would be derived from the earthquake experience and that the results would be assembled into a comprehensive report representing the major disciplines involved in data gathering. The CAE was to utilize and synthesize reports generated in conjunction with reconstruction efforts and compile them into an overview of the 1964 earthquake. To accomplish this, the committee outlined three main tasks:

- Survey work already in progress
- Identify and help fill the gaps in knowledge
- Compile and publish a comprehensive report including investigative analysis and recommendations

By the end of 1964 the CAE had structured itself into seven panels. Each was chaired by a member of the CAE and was to publish its findings in a separate volume. An eighth volume, entitled Summary and Recommendations, was to be produced by the committee itself. This was the first attempt ever to publish a comprehensive, multidisciplinary account of a major earthquake. The analytic framework of the committee's report forms the basis for contemporary postearthquake investigations, and their recommendations have had a significant effect on the direction of earthquake related research.

At the time that CAE was organized, much of the necessary research was already underway, since government agencies began data collection soon after the event. Seismologic and geodetic evidence was collected by the United States Coast and Geodetic Survey; geologic studies were undertaken by the U.S. Geologic Survey (USGS); the U.S. Corps of Engineers performed engineering studies; and the Bureau of Commercial Fisheries gathered biological data that pertained to commercial fishing. These agencies were able to divert funds to begin work immediately. Other studies that did not fall in the purview of an established agency had more trouble with funding and organization. Included in the latter category were studies dealing with socioeconomic and planning issues and biological studies that did not pertain to commercial fisheries. By the first anniversary of the earthquake, however, the committee had initiated all studies deemed essential.

The committee decided to include as much information as possible, even some that had been published elsewhere (e.g., selected Geological Summary reports published as professional papers between 1965 and 1967). Following are the resulting eight volumes and their publication dates.

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Hydrology 1968
Human Ecology 1970
Geology 1971
Biology 1971
Seismology and Geodesy 1972
Oceanography and Coastal Engineering 1972
Engineering 1973
Summary and Recommendations 1973

Generalized recommendations were based on experience gained during reconstruction. To address the many dimensions of the earthquake's impact, research by various disciplines had to be interrelated, and the recommendations of seven disciplines were brought together in the last volume.

The recommendations were framed in general terms. Most pertained to the need for additional research. Implementation, however, would require organizational, administrative, and legislative changes to translate recommendations into legislative action. The CAE expected that actual implementation would require appointment of a new task force with the specific mandate of translating the recommendation into a form that could be used for legislative action and for evaluation of cost and economic impact. This was never done.

The CAE published a set of interim recommendations, partly to influence some disaster-related legislation being considered by Congress. TROLFE (Toward Reduction of Losses from Earthquakes) was published in March 1969, five years after the event.

> The publication of TROLFE required the Committee to consider in detail the kind of recommendations it was qualified to make. Should there be suggestions about sums of money needed for research and instrumentation? The Committee decided that such specific matters were not in its province; rather, they should be handled by a task force with the mission of translating its recommendations into action. The CAE expertise lay rather in critically evaluating what had happened in Alaska and in using these evaluations to formulate general recommendations regarding the preparations for, and handling of, future disasters in earthquake-prone regions (Krauskopt 1973).

The CAE recommendations that appear in the Summary and Recommendations volume are essentially the same as those in TROLFE. General in nature, they were expected to require further evaluation to be implemented.

A review of the recommendations indicates that they fall into two categories:

- Need for additional technical research

- Application of knowledge obtained from past experience and new research

Most of the recommendations of the first seven volumes appear in the summary volume; however, many recommendations are presented outside the context of supporting arguments and lack the original discussion of policy changes or impacts.

The following discussion summarizes the content and the major recommendations of each volume.

Hydrology 1968

Hydrologic hazards refer only to conditions landward of the shoreline. They include the study of such hydrological phenomena as flash floods triggered by dam ruptures, ice-dammed lakes, snowslides, ice avalanches, landslides of rock or debris, groundwater ejection in low areas underlain by deep loose sediments, river sediment changes, lake tilting, damage to wells, and seiches. The Alaska earthquake showed for the first time that thousands of water wells around the country react to a major shock. The earthquake generated a destructive chain of seiches as far away as the Gulf of Mexico.

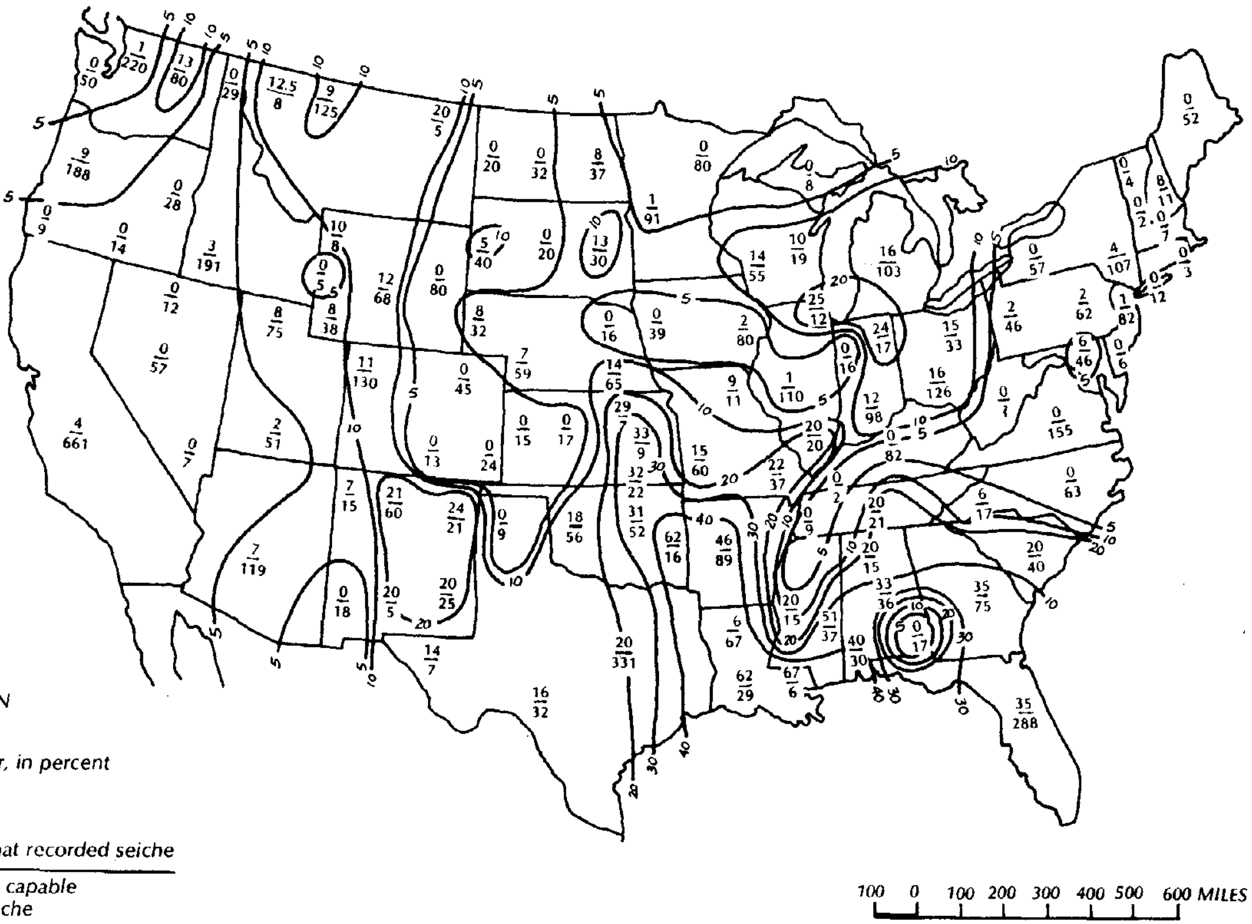
The hydrology discussion is presented in two parts. Part A contains 23 papers, organized into 5 sections, covering the effects of the earthquake on the hydrologic regimen. Part B consists of seven maps supporting Part A.

Groundwater and Surface Water - Effects in Alaska: Immediate seismic effects ranged from ice breakage, lake and stream oscillations, and groundwater ejections to spring and well-water fluctuations. The earthquake caused lasting changes in groundwater and surface water regimens. Differential uplift and subsidence of the land changed stream gradients and tilted lake surfaces. Erosion was accelerated in the uplifted areas. Compaction of unconsolidated material reduced the volume of storage of underground water and perhaps reduced its rate of flow.

Groundwater and Surface Water - Effects Outside Alaska: The seismic surface waves were so powerful they drove long period seismographs off scale throughout the world. The earthquake affected more than 700 wells in Africa, Asia, Australia, Europe, and North America. In addition, seismic seiches were recorded at more than 850 surface water gauging stations in Australia and North America. Nearly half of these recordings were at gauges relatively close to the Gulf of Mexico (Figure 22).

Effects on Glaciers: The earthquake most strongly affected the Chugach and Kenai mountain areas, where there are many glaciers. Numerous snow and rock avalanches were reported in the upper glacier basins but probably did not alter

Figure 22. Coterminous U.S., Showing Seiche Density Caused by the Earthquake



EXPLANATION

—10—
Seiche density contour, in percent

$\frac{18}{56}$

Percentage of gages that recorded seiche
Number of gages capable of recording a seiche

glacier regimen. Much larger debris avalanches occurred on the lower parts of some glaciers.

Avalanches on Glaciers and the Effects of Snowslides: Scientists concluded that most of the snow that slid would probably have avalanched under normal conditions later in the spring. The rockslides differed from conventional events because they either slid over snow or incorporated large amounts of it, and many were deposited on glaciers. These large ones probably influenced the regimen of glaciers underneath them.

Recommendations: Studies conducted in conjunction with post earthquake investigations resulted in a number of new hydrological concepts that can be applied to the prediction and the nature of future earthquakes. The major conclusions of the volume pertain to assessment of damage both in terms of describing direct or primary impacts and in assessing the geographic extent of impacts.

The recommendations can be summarized as follows:

- Instrumentation--Install new instrumentation to monitor wells and surface water.

- Monitoring and Hazard Mapping--Produce maps indicating hazard areas such as slopes prone to snowslides.

- Building Siting and Design--Restrict development in areas susceptible to tsunamis or flooding.

- Operation--Issue standing orders to fly military reconnaisance missions within hours after a disaster.

- Develop a warning system.

- Research--Conduct further research to evaluate earthquake-generated problems.

Human Ecology 1970

The human ecology of an earthquake involves the study of how people individually and collectively interact with the effects of a sudden, extreme geophysical change in their environment. Such study includes, but is not limited to, the disciplines of sociology, economics, political science, health care, public administration, and urban planning. The Human Ecology volume contains 20 papers divided into four sections.

Implications of the Earthquake Experience: The broad human adjustments to earthquake hazards are explored and three possible responses identified: alter the earthquake mechanism, modify the hazard, or bear the losses when they occur. An evaluation of the economic impact of the disaster on the economy of Alaska suggests that the earthquake impact had neither a positive nor negative effect in the long run. From the standpoint of social impact the major considerations for coping with a disaster are communication, coordination, planning, and efficient use of available resources.

Selected Studies of Impacts and Behaviors: The second section of the volume contains papers on impacts and behaviors which are more specific in their focus.

Impacts of the earthquake on Anchorage were examined in terms of seven functional processes.

- preservation of life
- restoration and maintenance of essential services
- social control
- maintenance of public morale
- economic activity
- leisure and recreation
- emergency welfare activity

After the event the first three processes assumed the highest priority, and economic and recreation activities were suspended. The "frontier spirit" made no apparent contribution to the response. Political pronouncements notwithstanding, Alaskans acted in ways similar to others affected by earthquakes. If the disaster did not alter the agency's relationship to the natural environment, the extent to which the agencies changed their organizational structure in response to the earthquake was minimal.

Reactions to the tsunami warnings in Crescent City, California, and Hilo, Hawaii, were also studied. Hilo was accustomed to tsunami warnings and, because of a devastating tsunami in 1960, knew how to respond. Crescent City's loss of life may be attributable to lack of experience.

Public Administration Aspects: This section examines the public administration aspects of the earthquake, especially the work of the Federal Reconstruction and Development Planning Commission (the Anderson Commission). The main purpose of the commission was to funnel federal aid into the state expeditiously while guarding against unrealistic demands by working within existing laws, slashing red tape, and streamlining procedures. The commission was disbanded six months after it was created.

The Scientific and Engineering Task Force was charged with identifying areas of risk relative to reconstruction in urban areas. Their recommendations became binding on all federal agencies involved in reconstruction and funding.

Their task was difficult because on the one hand there was tremendous pressure to rebuild quickly, but on the other hand determination of stability took time.

One of the primary roles of urban planning is to make a preliminary appraisal of the suitability of existing townsites after an earthquake. The evaluation should include the extent and permanence of damage, future safety and probability of recurrence, costs, and inertia to change. If existing townsites are still suitable, planning should be used to improve conditions.

The Scientific and Engineering Task Force influenced planning efforts by classifying areas of "high risk" and by recommending areas suitable for reconstruction. Effective recovery depends on:

- coordination
- communication
- funding
- preparation of defensible plans
- long-range plans available for use at the time of the disaster
- local participation through adoption of regulations to establish legal recognition of risk areas

The Human Response in Selected Communities: The fourth section of the volume documented human response in cities, town, and Native villages throughout Alaska.

Recommendations: This volume emphasized the need for new policies to prevent, mitigate, and recover from a disaster. The volume precisely defines the roles that each level of government should play in earthquake prevention, mitigation, and recovery.

Integration of earthquake mitigation measures with other hazard management programs at all levels of government and planning are important themes which run through all of the recommendations.

Major recommendations were:

- Establish a national policy, including framework for response to major earthquakes, that addresses economic, social, and land use impacts.
- Provide earthquake insurance, mortgage indemnification, special loans for businesses, and compensation for lost tax revenues.
- Restrict federal financing of reconstruction in hazardous areas.
- Relocate structures away from high-risk areas.

- Develop contingency plans at the state level for use in future disasters.
- Develop detailed contingency plans at the local level.
- Develop hazard zone regulations.
- Educate public in disaster response and mitigation.
- Adopt federal recommendations for land use, safety controls, and building codes.
- Develop and improve a systematic warning and communications network.
- Conduct additional research into human response.
- Evaluate government's liability.
- Conduct research on economic effects of disasters.
- Mapping of risk areas by federal, state, and local governments.

Geology 1971

From geological and seismological standpoints the Alaska earthquake was one of the greatest seismological events in recorded history. It shook the earth longer than most recorded earthquakes; natural and manmade structures were subjected to prolonged stresses which at least in part could be monitored; and the event took place in an area that was accessible for study and provided easily visible or measurable examples of different geologic features or processes in a variety of geologic settings.

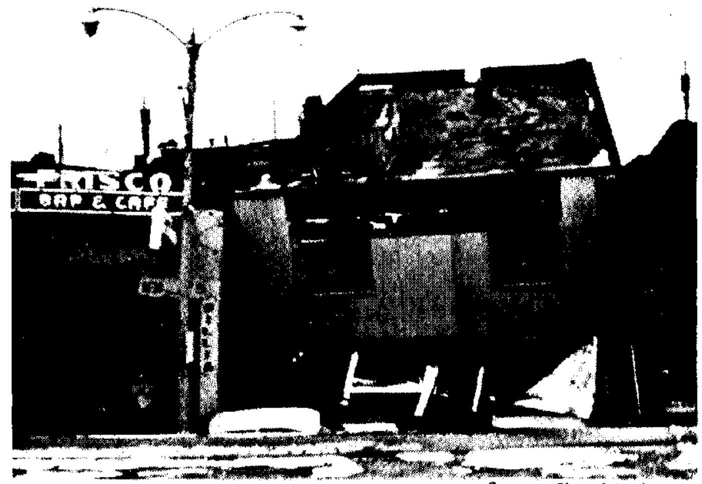
Shortly after the earthquake the USGS began an intensive program of geologic studies throughout the affected region. These studies were an integral component of reconstruction efforts.

The Geology volume consists of two parts. Part A is a collection of 29 professional papers organized into four sections which report on reconstruction activities in which the USGS participated. Part B contains plates and maps which support selected papers in Part A.

Regional and Areawide Effects: Deep-seated movements in the earth's crust caused both lateral and horizontal shifts of land and sea at the surface, which in turn caused the earthquake related damage. Tectonic movements were also direct causes of uplift, subsidence, shaking, tsunamis, sea withdrawals, encroachments, avalanches, and erosion. These tectonic effects, together with shaking, were also responsible for the changing hydrologic regimen in Alaska and elsewhere. The study established that the motion in this earthquake occurred along a low-angle thrust fault, representing an underthrust of the continental margin by an oceanic plate.

Effects on Communities: The precise cause of damage differed from community to community depending on the physiographic and geologic setting. Most damage in Anchorage was caused by seismic vibrations and by large translatory landslides caused by the shaking, which resulted in loss of strength in Bootlegger Cove clay and liquefaction of sand lenses. Other towns sustained their greatest losses when slices of steep-fronted deltas slid off into deep water.

Massive damage at Valdez was the result of submarine landsliding. Waves were caused by sliding, fissures, shock, and subsidence. Seward, which is built on an alluvial fan delta, sustained extensive damage because of submarine landsliding and waves caused by landslides and tsunamis. Fracturing, subsidence, and fire also contributed to the destruction. The city of Kodiak and many of the smaller villages on the island were flooded or even destroyed by tsumanis. In Kodiak the land dropped 5 to 6 feet and several tidal waves inundated the shoreline. Most of the damage in the other island villages was caused by sea waves and subsidence or uplift. Damage at Whittier was caused by subsidence, shock, fracturing, compaction of fill and unconsolidated deposits, waves (caused by landslides), and fire. Most of the damage to Homer and Seldovia were caused by subsidence and subsequent flooding at high tides. Other damage was caused by earthflows, landslides, submarine landslides, and seiche waves.



Source: City of Anchorage

Effects on Transportation and Utilities: The greatest damages to ports and harbors resulted from tectonic uplift and subsidence, submarine landslides, and tsunamis.

Highways, roadbeds, and bridges were affected by the presence of unstable soils and ground shaking. Damage resulted from compaction of fill and underlying sediment, lateral displacement, fractures, landslides, and avalanches.

Local geology and physiography determined the distribution, type, and severity of damages to railroads, as follows:

- Bedrock and glacial fill on bedrock: No foundation displacements, minor cracks.
- Glacial outwash terraces: Landspreading and damage in areas with high water table.
- Inactive flood plains: Landspreading, cracks, water-ejection, and flooding. Damage high in flood plains and river channels.
- Active flood plains: Landspreading, extensive cracking, and flooding.
- Fan deltas: Landspreading, cracking, and landslides.

Recommendations: The reconstruction efforts underscored the need for physical scientists, public officials, and planners to work together to ensure safer and more economical development of the land. Final recommendations emphasize that geologic maps and interpretations for special needs should be prepared for all populated seismically active areas to serve as a basis for long-range development plans.

The specific implementing authority is not identified for any of the recommendations. However, based on traditional jurisdictional distribution of activities, all recommendations would either be undertaken at the federal level or with federal funds. For example, mapping requires the expertise of soils engineers, geologists, and oceanographers. This type of work is traditionally undertaken at the federal level, the state with federal funds (USGS, NOAA, Corps of Engineers), or by the private sector for an individual piece of property. Maps are ineffective unless civic authorities, planners, engineers, builders, and the general public understand the implications of the mapped hazards and utilize them as an integral component of the land development process.

Although maps and reports had warned of landslide hazards in Anchorage before the 1964 earthquake, planners were inexperienced in translating the interpreted information into terms usable in community planning. The reconstruction efforts underscored the need for physical scientists, public officials, and planners to work together to provide safer and more economical development of the land.

Key recommendations are:

- Prepare geological and interpretive maps for special needs (such as slope, soil, construction) for all seismically active populated areas.

- Conduct further research on earthquakes, crustal structure, tsunamis, and earthquake forecasting.

- Develop and improve instrumentation for measuring and studying earthquake phenomena.

- Establish a framework for collecting data from future events.

In every case, damage should be related to mapped environmental conditions including but not limited to: active faults, landslide areas, bedrock, unconsolidated materials, soils type, hydrology, topography, submarine characteristics, and areas of potential tsunami inundations.

Biology 1971

This volume contains 13 papers which discuss the biological effects of the earthquake. Because most of the funding for biological studies came from state and federal agencies concerned with the destruction of economically important salmon and clam environments, 11 papers pertain to the effects on Prince William Sound. One paper investigates salt water intrusion into lakes of Kodiak Island, and one assesses the overall damage to fish and shellfish resources of Alaska.

The papers document the immediate death of many plants and animals, caused primarily by elevation or depression of intertidal zones. Further damage was caused by tsunami wave action and submarine landslides. Long-term effects of the earthquake on plants and animals resulted from meandering and scouring of streambeds in elevated areas, changes in habitat caused by uplift and subsidence, and periodic tidal flooding of depressed lowland areas.

Recommendations: Two short-term recommendations were made to help salvage the fishing industry--creeks should be stabilized and restocked and restrictions should be placed on the salmon harvest until the damage could be completely assessed.

- Establish advance plans and funding for biological research in future events.

- Collect baseline data for the area and conduct further research.

- Conduct research on the long-term effects of the earthquake.

- Establish a central agency, such as the University of Alaska or the Fish and Wildlife Service, for registering information on biological research relating to Alaska earthquakes.

Seismology and Geodesy 1972

The efforts of the Panel on Seismology to stimulate the making of a reversed seismic refraction profile from Anchorage to the Gulf of Alaska to provide information on the seismic structure of the earth's crust in aftershock regions did not materialize due to lack of funds for this type of research. The recommendation that a program of seismic calibration be introduced, prior to the dismantling of a temporary network of seismographs being operated by the U.S. Coast and Geodetic Survey in southcentral Alaska also failed to gain financial support (Tochen 1972). The volume therefore contains a selection of earliest seismological studies of the earthquake that had been published by the U.S. Coast and Geodetic Survey prior to the establishment of the committee. Some topics generally treated in seismological literature are covered in the Oceanography and Geology volumes.

The volume includes four major chapters related to: parameters of the main shock, foreshocks and aftershocks, geodesy and photogrammetry, and related geophysical effects.

Parameters of the Main Shock: The objective of this section is to gain a better understanding of the source and characteristics of the main shock. Focal coordinates, orientation of the plane of faulting, direction of motion, source dimensions, velocity of rupture propagation, residual strains, intensity, magnitude moment and energy, and release were investigated.

Seismologists collected initial data about the source, including epicenter coordinates, origin time, local depth, spatial and temporal distribution of aftershocks, and the character of radiation patterns. The data were subsequently analyzed, which led to new discoveries of seismic source phenomena.

Analysis of primary data led to conclusions about the initiation and propagation of the fracture, the nature and orientation of the fault motion, and permanent strain fields at large distances from the source. While multiple-source mechanisms had been suspected in previous earthquakes, the exceptional documentation of the 1964 data made a major contribution toward understanding earthquake origins. a second concern was the focal mechanism. It was established beyond a reasonable doubt that the motion in this earthquake occurred along a low-angle thrust fault, representing an underthrust of the continental margin by an oceanic plate.

The Summary and Recommendations volume, published in 1973 (a year after the Seismology and Geodesy volume), reports that the theory of plate tectonics was not formulated until after the 1964 earthquake. Plate tectonics concepts were being reported at scientific meetings and in the seismologic literature. Many of the papers in the Seismology and Geodesy volume undoubtedly had a strong influence on development and evolution of the theory of plate tectonics.

Foreshocks and Aftershocks: Only two seismograph stations, College and Sitka, reported seismic observations in Alaska on a routine basis prior to the 1964 earthquake, although a few other stations operated for short periods of time in various parts of the state. As a direct result of the earthquake, these two stations were upgraded, and many new seismograph stations were added in Alaska.

Aftershocks may alter the seismic pattern of an area for years. These changes must be considered in the overall view of the earthquake's impact.

Geodesy and Photogrammetry: The magnitude of the earthquake, the high number of aftershocks, and the evidence of crustal disturbance indicated that the earth's crust was fractured in many different ways throughout the entire region. To determine the broad regional pattern of changes it was necessary to collect basic geodetic survey data. Studies in the Anchorage area, including a detailed geodetic and photogrammetric study of downtown Anchorage, were made to determine the nature and extent of movement and to establish a basis for monitoring the shifts of manmade structures (buildings, homes, streets, etc.), through aerial photographs.

Related Geophysical Effects: A catastrophic natural event is often accompanied by other unusual phenomena that appear to be related but for which no immediate physical explanation is available. In many instances these occurrences may be only coincidental; however, until more is known they should be documented.

Recommendations: The broad conclusion reached by the panel is that basic research in all aspects of seismology and geodesy and the general application of modern technological development to seismic instrumentation and geodetic surveying can and will contribute to the overall goal of reducing earthquake hazards. The key areas recommended for immediate study and action were:

- Develop and improve instrumentation to record strong ground motion.
- Strengthen and expand the worldwide network of standard seismographs.
- Extend the existing incomplete network of strong-motion recording instruments to areas of potential earthquake occurrence.
- Improve tsunami detection and warning systems.
- Produce precise first-order translation and level surveys in seismically active areas, in order to provide a comparative base for the study of surface deformation.

- Conduct further research on the buildup, storage, and release of elastic-strain energy in the earth.

Oceanography and Coastal Engineering 1972

Although the epicenter of the earthquake was on land, the majority of the damage in Alaska outside of Anchorage was caused by marine manifestations rather than ground shaking. The damage included loss of docks, breakwaters, buildings, tanks, and railroad yards because of slumping into fjords and the crushing or sweeping away by enormous waves of other structures, railroad rolling stock, automobiles, and boats. Most deaths were by drowning after the victims fell into the water as a result of slumping or were swept away by the waves. The Oceanography and Coastal Engineering volume addresses these effects in four sections.

Seismic Effects: Some of the oceanographic phenomena associated with earthquakes are closely related to seismic vibrations. Others are the result of geologic or tectonic attributes of the earthquake. This section discusses seismic manifestations related to the earthquake vibrations.

Tsunamis: Tsumanis have been defined as "a train of progressive long waves generated in the ocean or a small connected body of water by an impulsive disturbance" (Cox 1972) and as "the gravity wave system formed in the sea following any large-scale short duration disturbance of the free surface" (Van Dorn 1972). According to both definitions, all marine waves associated with the Alaska earthquake except the seiches were tsunamis generated by abrupt bottom displacements and submarine or shoreline landslides.

The major tsunami, which swept across the Pacific, was generated by the uplift of an area of about 30,000 miles off the continental shelf in the Gulf of Alaska. In some places the uplift reached as much as 40 feet, although it averaged about 6 feet from the area of generation. The tsunami propagated across the Pacific at the long-wave velocity of $C = \sqrt{gd}$, where depth is the critical variable. Average speeds ranged from 159 knots for propagation to Yakatat, Alaska, over a path largely across the continental shelf, to 473 knots to Kauai, Hawaii, over a path mainly at oceanic depths.

Impacts of the major tsunami were extremely widespread. Traces of the waves were felt as far away as the Palmer Peninsula, Antarctica, 8,500 miles from the epicenter. The major tsunami claimed the lives of 21 people in Alaska, 19 of whom were on Kodiak Island. In Crescent City, California, 1,400 miles from the epicenter, and in British Columbia there was extensive damage. There were 4 deaths in Oregon and

12 in California. There were several independently generated tsunamis in fjords and straits which inflicted heavy damage and killed 82 people in Alaska (Figure 23).

Studies of the tsunami warning system indicate that its effectiveness was mixed. Tsunami warnings that were spread through more or less unofficial channels may have saved lives in communities where high waves arrived in the first few hours following the earthquake. In some Alaska communities people were already aware that tsunami hazard could accompany a large earthquake. The official warning was issued three hours after the earthquake. Response varied with the public's familiarity with the hazard.

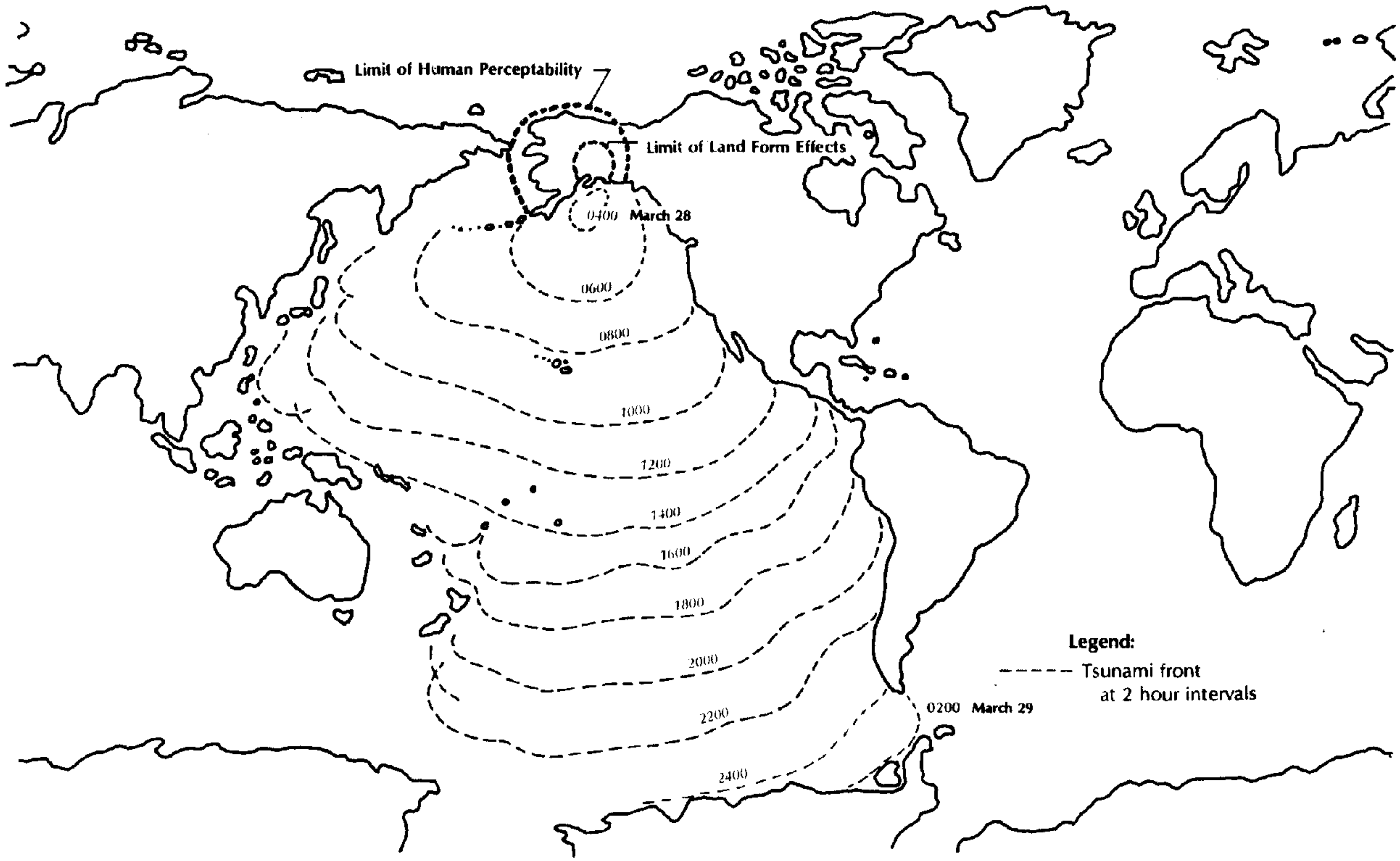
Marine and Shoreline Geological Effects: The marine and shoreline geologic effects pertain to submarine slumping and bathymetric changes. The investigations represented the most comprehensive data ever gathered on sea-floor deformation during a major earthquake. They also revealed geologic structures important to an understanding of the deformation mechanism and past geologic history.

Other Marine Aspects: Other marine effects briefly addressed by this volume included marine biological effects, physical oceanographic changes, and effects on boats and navigation. Within a month the U.S. Coast and Geodetic Survey had completed preliminary surveys and issued charts showing the extensive shoreline retreats due to sliding at the ports of Valdez, Seward, Whittier, and Kodiak. In the next eight months the major bathymetric changes in the areas of crustal depression and uplift were charted.

Coastal Engineering: Because of the devastating nature of tsunamis, the Panel on Engineering of the Committee on the Alaska Earthquake and the U.S. Army Corps of Engineers funded a special study to develop as detailed an understanding of this phenomenon as possible. One of the two papers in this section describes tsunamis. The other summarizes a special study on tsunamis commissioned by the CAE. It describes the waves that affected waterfront communities--their number, heights, velocities, and resulting damage. It presents a range of practical conclusions and recommendations which were to be incorporated into engineering practice to substantially reduce the destructiveness of the tsunami hazard.

Recommendations: The committee recognized that the physical processes of the ocean are better measured in centuries than years. This poses a great difficulty, for research must span 100 years or more in order to make an accurate evaluation of the impact of such an event as the 1964 earthquake. Accurate and complete historical data are essential in providing a picture from which insights can be made. However, recommendations were made to address immediate needs:

Figure 23. Geographic Extent of Tsunami Impact - 1964 Alaska Earthquake



- Improve the evaluation of tsunami risk

- Conduct research on the mechanisms and origination of tsunamis

- Educate the public on response to tsunami warnings

- Improve the tsunami warning system by

  - reducing lag between detecting tsunami and reporting it

  - targeting the warning to specifically endangered areas

  - cancelling the warning once danger has abated

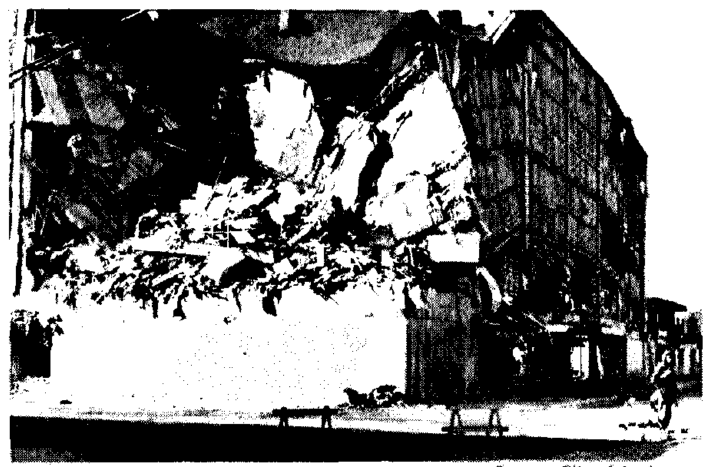
- Restrict development in tsunami risk areas through zoning

Engineering 1973

Building damage was caused by slides or large ground displacements and by vibrations. The volume contains 30 papers organized into three sections.

Ground Motion and Behavior of Soils: As there were no strong motion seismographs in the area, little is known about the magnitude of ground motion induced by the earthquake. One paper constitutes an accelerogram of the motion by comparing the effects with other known earthquakes.

Seven of the papers in this section are studies of the dynamics of soils under earthquake conditions. Major landslides are described and analyzed, with emphasis on liquefaction in landslides and on the properties of Bootlegger's Cove clay. Field evidence is supplemented by a paper on the experimentally determined properties of sand during the liquefaction process. A dominant theme in the papers was the initiating role played by liquefaction of sandy deposits.



Source: City of Anchorage

The landslides at Valdez, Seward, and Kenai Lake were attributed to liquefaction of gravelly sands; the Fourth Avenue, L Street, and Government Hill slides were attributed to liquefaction of sand layers; and the Turnagain Heights slide was attributed primarily to liquefaction of sand lenses. Damage to the railroad, to highway bridges, and to embankments was also caused by liquefaction of silty and sandy material.

The Alaska earthquake clearly demonstrates that soil investigation must be conducted prior to design of structures, and characteristics of soil under dynamic loading must be taken into account in the engineering design.

Structural Engineering: The papers relating to structural engineering again point to the lack of recording instruments. They discuss the nature of the shaking and the resultant damage. One paper analyzed nonstructural damage, including damage to electrical and power distribution systems, facades, ceiling patterns, elevators, plumbing, ventilation, fire protection, and telephone lines.

Cost of damage was a common element in all papers and a recurring conclusion is that proper engineering and construction could have prevented much destruction. Military structures sustained less damage than their civilian counterparts, and the cost of architectural damage was greater than the cost of structural damage.

The nature of damage to the seven buildings over five stories high in Anchorage indicated deficiencies in the existing building code. Analysis of why the damage occurred and estimates of the approximate magnitude of the forces that produced the failures were an important basis for building code revisions. Several changes have been made to the Uniform Building Code since 1964 to correct deficiencies that were exposed by the Alaska and other earthquakes.

Damage and Repair: This section was previously prepared by staff of the Corps of Engineers. It emphasizes the role of the military in the reconstruction and gives detailed descriptions of damage and the subsequent repair. Papers discuss: typical Alaska structures, structures on military bases, harbors and waterfronts, the railroad and the Alaska highway system.

Recommendations: The recommendations of the Engineering volume are extensive and pertain not only to design but include research, insurance regulation, land-use planning, construction, and operational recommendations as well. Jurisdictional responsibility for the recommendations covers all levels of government as well as the private sector, and all have policy implications.

- Recognize the specific hazards of avalanches, earthslides, submarine slides, soil liquefaction, and subsidence and guide future planning and development accordingly.

- Consider the dynamic behavior of soils in the design of structures.
- Identify existing structures that pose a threat and restrict their use.
- Design critical facilities (hospitals, for example) to be functional after a major earthquake.
- Restrict development of high-risk areas through zoning.
- Provide instrumentation in taller structures.
- Consider potential earthquake impact on nonstructural elements such as utilities, and on structures other than buildings, such as dams, bridges, and fluid storage tanks.
- Produce maps indicating seismic risk areas.

Summary

The analysis presented in the National Academy of Sciences volumes remains the most comprehensive postearthquake investigation conducted to date. It includes descriptions of:

- Source, mechanisms, causes, and tectonic implications of the event
- Nature of investigation and reporting
- Summaries of events and effects, including land subsidence and uplift, landslides, and tsunamis
- Damage and repair to structures and transportation and utility systems
- Extent of impacts including hydrological and biological effects
- Evaluation of human response and of the effectiveness of administrative systems directed to disaster relief and reconstruction
- Recommendations for research and studies in all fields of applied seismology, geology, and geophysics.
- Geographic impacts throughout North America, Europe and Asia.

The fact that separate panels examined the various aspects of such a complex phenomenon resulted in both duplication and better interrelation of various disciplines. Because of funding priorities the research was heavily weighted toward the geophysical sciences and did not define implementation responsibilities or strategies. The reports, however, point strongly to the need for:

- Improved monitoring and warning capabilities
- Environmental evaluation and regulation directed to land use and location of structures
- Building construction standards
- Organizational preparedness
- Systematic research of human response to disaster

As stated, the purpose of the National Academy of Sciences report was to define the lessons to be learned from the Alaska experience. The recommendations were designed to reduce the loss of life and property in subsequent major earthquakes. Despite the CAE's attempt to make the report broadly comprehensive, there are gaps in the record, mainly in those subject matter fields not included in the work of government agencies. One of the greatest deficiencies is the lack of reports from state and local agencies. Their reporting and recommendations in the fields of applied sciences, planning, and implementation would have strengthened the efforts of the committee in presenting to the President and the Congress the need for funding of earthquake mitigation programs.

> Many of the recommendations are, in effect, calls for action by governmental bodies whose responsibilities pertain to earthquakes and other disasters. The effort here, however, has been to frame the recommendations in general terms. To put them into effect will require the organization of one or more task forces with the mission of expressing the recommendations in a form suitable for legislative action and for estimates of costs (Konrad B. Krauskopf 1969).

Source: City of Anchorage

Translating technical knowledge into public policy designed to minimize risk to life and property requires formulation of recommendations for specific types of regulations to be applied to land use allocation and construction. It is necessary to identify the level to which recommendations related to seismic effects on urban areas have been implemented. Also, they must be answered from the standpoint of economics and the regulatory powers available at the local level. Some of the questions to ask are:

- To what extent have the recommendations been implemented?
- Who was supposed to implement them?
- What are the obstacles to implementation?
- Are the recommendations still valid?
- What needs to be done to implement them?

Part II: Seismic Risk Mitigation Today

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Chapter 6: Present Planning and Management of Seismic Risk Mitigation

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Present Planning and Management of Seismic Risk Mitigation

In 1964, when the Great Alaska Earthquake occurred, there was limited knowledge of seismic hazards. In addition, concern over the risk of earthquakes was not reflected in U.S. public policy. The extensive work conducted by the National Academy of Science to document this major event set the stage for the development of comprehensive analytical seismology and risk mitigation studies. The following discussion summarizes the major legislative actions that led to current national commitment to risk prevention and mitigation.

On December 31, 1970, the President (Nixon) signed Public Law 91-606, the Disaster Act of 1970. Section 203(h) of the act requested that a full investigation be made to prevent or minimize loss of life and property due to major disasters. In 1972 the President, in his State of the Union message to Congress on January 20, stated that the administration would consider new and accelerated activities aimed at reducing the loss of life and property from earthquakes, hurricanes, and other natural disasters. Prompted in part by the property losses resulting from the 1971 San Fernando earthquake, Congress enacted the Disaster Relief Act of 1974 (Public Law 93-288) to assist local and state governments in carrying out their responsibility of disaster mitigation and prevention. The act required that every state designate a lead agency and prepare a state emergency plan outlining the process for delivering federal aid and the framework necessary to coordinate state and local government action.

Seismic risk reduction was also the focus of the Earthquake Hazards Reduction Act of 1977 (U.S. Public Law 95-124). The purpose of this act was to reduce the risks to life and property resulting from future earthquakes through the establishment of an effective earthquake hazards reduction program. For the first time national concern for risk mitigation as a method to minimize death and loss of property was addressed. The act brought national attention to the development of earthquake resistant design and construction, earthquake prediction, model codes, research, planning, and education programs.

As a result of the Hazards Reduction Act of 1977, on July 20, 1979, President (Carter) signed an executive order that created the Federal Emergency Management Agency (FEMA) with the responsibility of coordinating disaster assistance programs. The intent of the act was to streamline emergency management programs and increase management efficiency in disaster preparedness, mitigation, relief, and recovery. The act also stressed the need for increased research in the area of disaster mitigation and prevention along with technical assistance to local and state governments.

Under the authority of the act the principal agencies entrusted with the responsibility for performing research on prediction, mitigation, and prevention of seismic disasters are the National Science Foundation (NSF), the U.S. Geological Survey (USGS), and the National

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Oceanic and Atmospheric Administration (NOAA). In summary, since the March 27, 1964, earthquake substantive research programs on earthquake hazards mitigation have been developed in earthquake engineering and geophysics by NSF, in seismology and geology by the USGS, in building standards by the National Bureau of Standards, in seismic analysis of nuclear power plants by the Nuclear Regulatory Commission, and in disaster relief by the FEMA. The total federal output for these programs was approximately $60 million in fiscal year 1981 (Earthquake Engineering Research 1982).

The following brief review of the major research efforts funded by NSF, USGS, NOAA, and some private agencies is made to illustrate the direction of this relatively new scientific concern. Through the preparation of this report the research team uncovered a multitude of data developed by all levels of government, academic institutions, and the private sector. The consistent and recurring problem seems to be that most of the material is specialized and has not been integrated or presented in a manner conducive to application by local governments. Each discipline seems to remain mutually exclusive in its research efforts, and only in recent years have some attempts been made to relate the scientific findings to actual application in planning design and construction in seismic risk regions.

Research Applied to Earthquake Hazard Mitigation – An Overview

The number of deaths resulting from earthquakes is to a large extent a function of the relationship between urban development patterns and the knowledge and application of hazard prevention and mitigation measures. The impact of a major seismic event on human life and property is expressed in a complex interplay of geophysical and manmade systems, including but not limited to:

- Size and depth of earthquake.
- Location of the epicenter, fault rupture, in relation to population centers.
- Concentration of development in high risk areas.
- Generation of fires or tsunamis.
- Type and age of buildings.
- Occupancy level of buildings affected.
- Time of day the disaster occurs.
- Efficiency of warning operations.
- Efficiency of rescue operations.

Because of the complexity of the effects of earthquakes, decisions related to planning and development in seismic regions require interdisciplinary collaboration between research and applied technology. The major disciplines involved in the evaluation of seismic risk and hazards mitigation are shown in Table 12.

The Geosciences: Most of the earthquake research in the geosciences is conducted under the auspices of the Earthquake Hazards Reduction Act of 1977, which established the National Earthquake Hazards Reduction Program, responsible for research, operational activities, and overall program coordination.

The United States Geological Survey (USGS) has the lead responsibility for earthquake prediction research. The USGS participation in the Hazards Reduction Program includes support of research through grants and contracts, as well as in-house studies. In addition to prediction, the program includes studies directed toward earthquake hazard analysis through evaluation of the geologic setting of earthquakes--faulting and related tectonics, earthquake-induced geological hazards, and prediction of effects of ground motion on specific geological conditions.

The National Science Foundation (NSF) also supports basic scientific research on earthquake processes, earthquake engineering, planning, and architecture.

The programs of both agencies are complementary and represent a balance of the following elements:

- Fundamental earthquake studies
- Earthquake prediction
- Induced seismicity
- Earthquake hazards assessment
- Engineering
- Research for utilization

Slightly over a third of the USGS earthquake hazard mitigation budget is used for hazard assessment. Approximately one-half of these funds are spent in the state of California, with the remainder distributed throughout the rest of the country.

The U.S. Geological Survey assessment research includes

- National Studies: Broad scale investigations of geographic studies to determine the history and likelihood of earthquake occurrence, degree of ground shaking, severity of geologic effects, and earthquake losses for the entire nation (Map Scale 1:5,000,000).

- Regional Studies: Investigations of the temporal and spatial characteristics of earthquake hazards (e.g., seismicity, faulting, unstable ground, etc.), and assessment of high risk regions at regional scale (Map Scale 1:250,000 or larger). The majority of this research is utilized in conjunction with regional

Table 12. Major Disciplines Involved in Seismic Risk and Hazard Mitigation.

DISCIPLINE	PRIMARY CONCERNS
GEOSCIENCES **Geology**	Geologic mapping
Seismology	Predict ground motion; define source mechanisms Identify areas subject to ground failure/ liquification
Hydrology and Oceanography	Evaluate water content/behavior - tsunami prediction
Soil Mechanics	Evaluate soil/structure interaction
ENGINEERING **Civil** **Structural** **Mechanical** **Electrical**	Design structures and life-lines to resist earthquakes; predict structural performance for specified ground motion levels
ARCHITECTURE	Predict the performance of architectural non-structural elements for specified ground motion levels Define building and site plan concept/ configuration and building function/ occupancy characteristics
PLANNING **Physcial** **Socio-economic**	Provide framework for new development and redevelopment; land use allocation; open space; utility; transportation networks and other site planning guidelines at Regional and Urban scales Develop implementation plans and ordinances Develop guidelines for minimizing impacts of the earthquake hazards on society Develop emergency preparedness procedures Evaluate human response to predicction of the hazard Adoption of policies to prevent or minimize seismic damage Adoption of disaster relief policies including reconstruction, financing, and taxation policies Allocation of funding to implement policy objectives
LEGAL	Liability of federal, state and local governments

Adapted from Scholl, 1981.

and state planning efforts such as the Southern California Earthquake Preparedness Program (SCEPP).

- Topical Studies: Investigations into the cause and nature of geologic earthquake hazards and into improved methods for quantitatively assessing earthquake hazards and risk.

- Earthquake data services: Collection and dissemination of data on earthquake occurrences and effects.

Table 13 shows the percentage of funding for various programs under the U.S. Geological Survey hazards assessment program.

Funding for operational or ongoing research activities is not limited to the two primary agencies responsible for earthquake research. The FEMA is responsible for coordination and management of programs under the Federal Earthquake Hazards Reduction Act. Other agencies, such as NOAA, through the Pacific Tsunami Warning Center, have an integral role in mitigation of earthquake-inflicted damage.

To a significant degree research and activities directed toward the application of geotechnical studies is funded by FEMA or NOAA, or through joint programs with user states such as California and Alaska.

Table 13.
Summary of Funding for Hazards Assessment
(in percent)

	Present Subtotal	Estimate Total
National Studies		7
Regional Studies		59
California	26	
Western	16	
Eastern	17	
Topical Studies		32
Earthquake potential	7	
Ground motion	13	
Ground failure	7	
Risk	3	
Postearthquake investigations	2	
Program management		2

SOURCE: USGS Office of Earthquakes, Volcanos, and Engineering

Research pertaining to tsunamis is funded primarily by NSF. The U.S. Army Corps of Engineers Coastal Engineering Research Center, however, has developed the numerical model used by the

U.S. Flood Insurance Program to project inundation levels. This program is administered by FEMA.

The operation of over 130 seismograph stations in Alaska represents a complex administrative network, including participation of the USGS, NOAA, Lamont-Doherty Laboratory of Columbia University with NSF, University of Colorado, a division of the University of Alaska, and the State of Alaska Geological and Geophysical Survey.

The orientation of the various funding agencies reflects different missions and the various seismic networks set up around the state of Alaska have differing purposes. For example, the Lamont-Doherty network is monitoring the gap area around the Shumagin Islands, with primary focus on earthquake prediction and plate tectonics. The USGS is concerned with the area around Prince William Sound and the Cook Inlet. NOAA is interested in collecting information on coastal earthquakes which could generate tsunamis. The USGS programs are directed at gaining greater knowledge of volcanoes, fault locations and movement. In addition, NOAA, in conjunction with the Agency for International Development, is presently conducting research to improve the ability to detect tsunamis and shortening the time between detection and issue of warnings. The research--Tsunami Hazard Reduction Utilizing Satellite Technology (THRUST)--is being conducted jointly with the government of Chili.

The Alaska Division of Geological and Geophysical Survey (DGGS) has statutory responsibility for seismic hazards mitigation in the state of Alaska. The division has identified a need for geologic studies to understand the tectonic framework of Alaska, and to identify and evaluate active faults. In 1983 they have assumed the responsibility for maintaining building instrumentation.

Engineering: Engineers are concerned with relationships between ground motion and earthquake resistant design. Research correlates the projected motion with building strength and necessary ductility. The primary concerns are to achieve a seismic resistant structure designed in accordance with conditions defined by the geosciences.

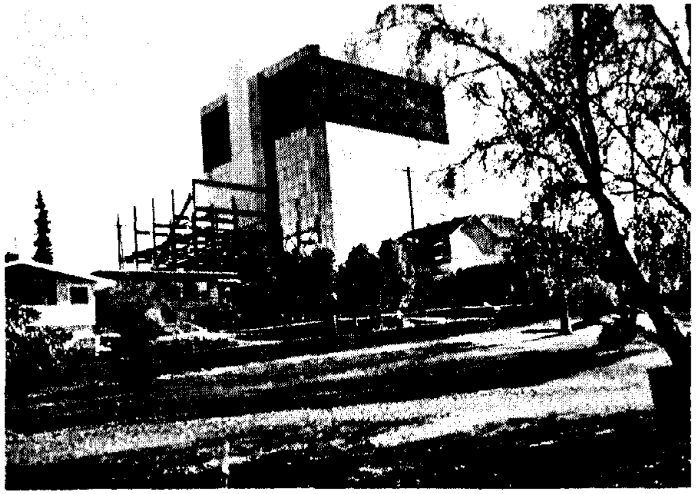
Earthquake engineering research is specialized and highly technical. The application of engineering research forms the basis for the development of safe cities through design of structures including emergency and critical facilities, commercial, financial and industrial institutions, high density residential structures, and governmental systems. Engineering design affects the stability and restoration criteria of lifeline systems--water, sewer, gas, electricity, fuel, and communication. Major consideration must be given to the design of critical facilities such as dams, nuclear power plants, pipelines, offshore platforms, liquified gas storage tanks, and other chemical facilities. It is essential that seismic engineering research, a relatively new field, be ongoing and that engineering organizations and government agencies be knowledgeable and be prepared to use the skills gained to develop better methods of seismic engineering and earthquake resistant construction.

Research conducted in the engineering fields is primarily funded by the National Science Foundation Earthquake Hazard Mitigation Program.

The specific objectives of the NSF program are as follows (Krimgold 1981):

- To gain understanding of the nature and distribution of destructive earthquake ground motion.
- To develop and install instrumentation to measure strong earthquake ground motion and its effect on constructed facilities.
- To develop through experimental and analytical research an understanding of the behavior of geotechnical materials subjected to destructive earthquake loadings.
- To develop analytical, numerical, and computer methods to study and predict dynamic response of structural systems.
- To experimentally determine the structural properties of materials, elements, and systems subjected to intense cyclic dynamic loads.
- To develop methods to evaluate the hazard potential of existing buildings and structural systems.
- To develop methods of analysis and design to reduce damage to nonstructural and architectural components.
- To develop methods to predict seismic effects on distributed lifeline facilities.
- To develop improved methods to assess and predict the safety of dam-reservoir systems.

The actual research is undertaken by universities, private contractors, and such non-profit organizations as the Earthquake Engineering Research Institute (EERI) and the Applied Technology Council (ATC). The latter organization has been particularly active in the field and was established in 1971 under the direction of the Structural Engineers Association of California (SEAOC). The general purpose of ATC is to provide an organization to address the increasingly multi-disciplinary nature of developing seismic codes and to translate and



summarize technological research information into forms useful to practicing engineers.

The majority of ATC projects are funded by the National Science Foundation. Other funding sources include the National Bureau of Standards, the Department of Housing and Urban Development, and the Federal Highway Administration.

ATC has been active in drafting model codes, taking into consideration the most current seismic design criteria in all of the engineering disciplines.

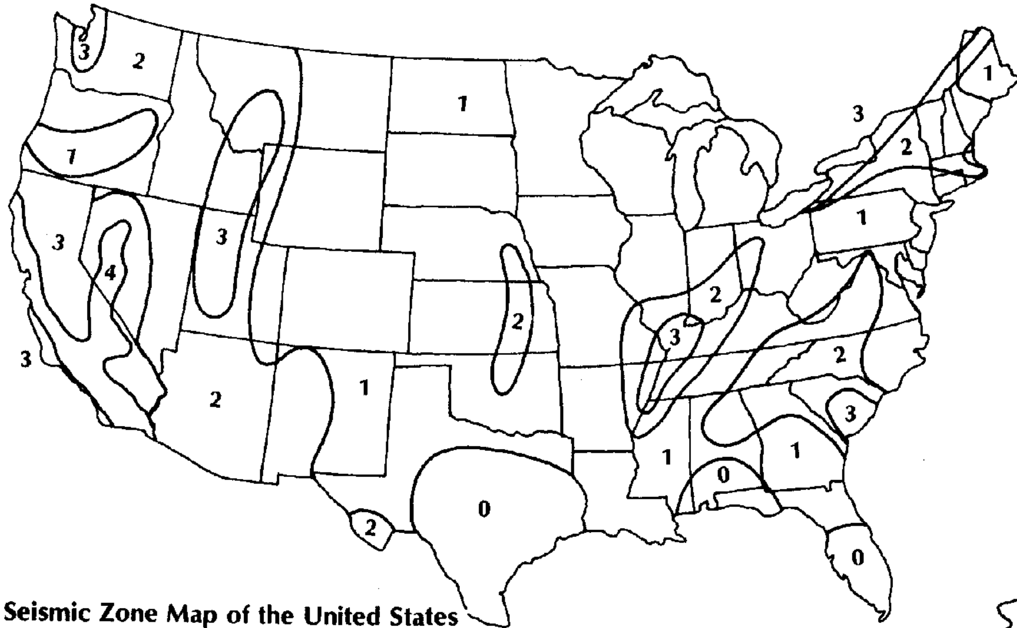
In the United States earthquake-resistant design provisions have been included in the main body of the building codes since 1933, the year of the Long Beach earthquake, when Los Angeles adopted a requirement that structures be designed for 0.08g. Seismic resistant design criteria of most buildings in the United States must comply with building codes adopted at the local level. Seismic standards in these codes are generally based on the Uniform Building Code (UBC).

The UBC is a model code which includes enforcement procedures, requirements pertaining to various occupancies, fire safety, structural safety, appliances, housing, mechanical, plumbing, material evaluations, etc.

The UBC was first published in 1927 by the Pacific Coast Building Officials Conference. It is revised and published every third year by the International Conference of Building Officials. Adoption of these changes typically takes several years. For example, by 1981 the State of California was just holding hearings to incorporate portions of the 1976 UBC into the California Administrative Code for public schools. Some municipalities still adhered to the 1973 UBC. Anchorage has recently adopted the 1982 version, changing from the adopted 1979.

The seismic design criteria included in the UBC are based on four projected levels of seismicity or zones. These zones are based on the best available geological-seismological data related to ground-shaking and proximity to active fault areas (Figure 24).

Figure 24. Seismic Zone Map of the U.S. - Uniform Building Code



Seismic Zone Map of the United States

Legend:

Zone 0 *No damage*

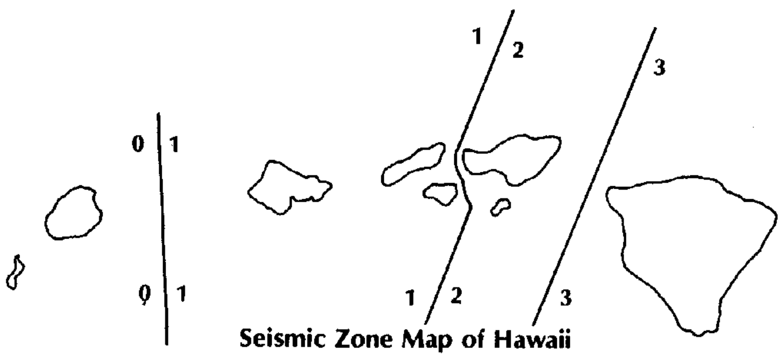
Zone 1 *Minor damage; distant earthquakes may use damage to structures with fundamental periods greater than 1.0 seconds; corresponds to intensities V and VI of the M.M. Scale.*

Zone 2 *Moderate damage; corresponds to intensity VII of the M.M. Scale.*

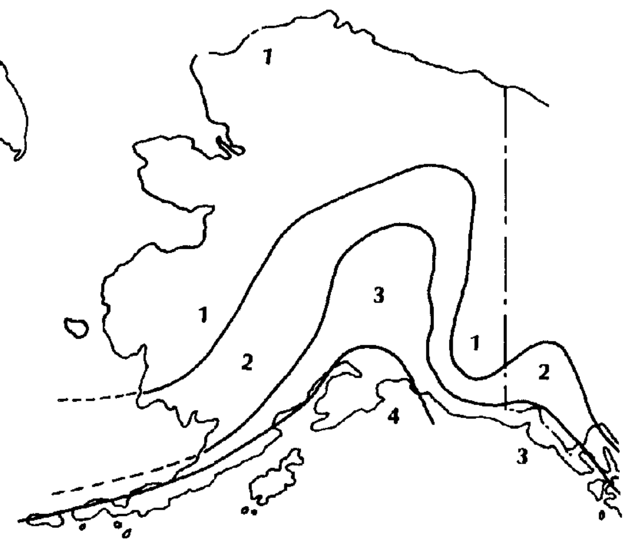
Zone 3 *Major damage; corresponds to intensity VIII and higher of the M.M. Scale.*

Zone 4 *Those areas within Zone No. 3 determined by the proximity to certain major fault systems.*

*Modified Mercalli Intensity Scale of 1931.



Seismic Zone Map of Hawaii



Seismic Zone Map of Alaska

Improved techniques that incorporate the frequency-dependent effects of fault rupture and of regional and local geology and seismic waves are being developed by ATC. The ATC has produced a model code, the basic purpose of which is to present the current state of knowledge in the fields of engineering seismology and engineering practice as it pertains to seismic design and construction of buildings. This document has seven major objectives:

1. To evaluate the knowledge acquired in recent research and experience gained during on-site observations of the effects of earthquakes and to assemble it in a concise and comprehensive document for general use by building design professionals and others.

2. To write the tentative design provisions so as to permit, insofar as possible, ingenuity of solution, but with definitive criteria to evaluate the resulting design.

3. To provide seismic criteria which will be applicable to all probable earthquake areas of the United States.

4. To recognize that acceptable seismic risk is a matter of public policy determined by a specific government body and should be based upon:

   (a) An evaluation of available technical knowledge, including the areas of seismicity.
   (b) Reasonable means available for protection.
   (c) The magnitude of the earthquake risk compared with acceptable risks for other hazards.
   (d) The economical and social impact of a major catastrophe.

5. To provide tentative design provisions applicable to all buildings, including existing buildings, and appropriate structural and nonstructural components. To include requirements for structural analysis, design, and detailing which will provide adequate earthquake resistance for typical buildings and to make recommendations with respect to the design of atypical buildings.

6. To recognize that for critical facilities there should be consideration in the design of buildings --structural and nonstructural systems of limiting damage--in order

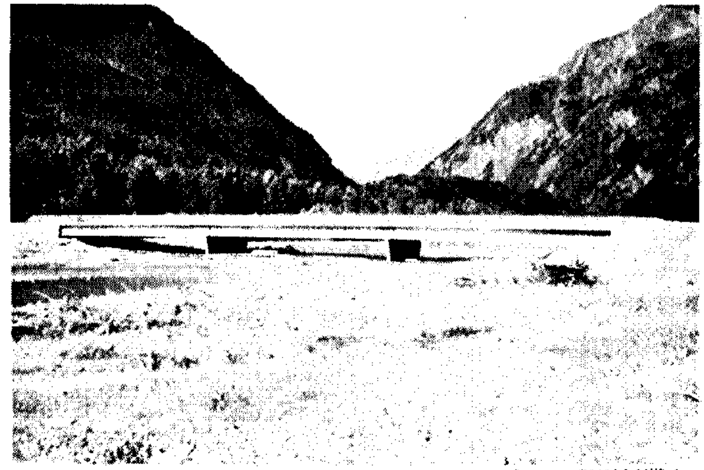
to maintain the level of function determined to be necessary.

7. To provide a commentary to assist the user in understanding the intent and background of the provisions and to assess the implications of any alterations made to the provisions in the future

Building codes have begun to address non-structural elements only in the last decade. The safety of emergency services--hospitals, fire, police, and communications--is a necessity. Equipment used must remain operational after an earthquake. Examples are smoke and fire alarm systems, elevators, air handling systems and emergency power supplies.

The National Science Foundation and private testing laboratories are undertaking seismic testing programs of mechanical and electrical equipment. Once these tests have been concluded it is anticipated that additional model mechanical and electrical codes will be developed.

Earthquake design should anticipate and achieve desired levels of performance of non-structural systems. Recent earthquakes have shown that vibration and displacement effects of building response have caused unanticipated effects on utility and other systems, resulting in costly and extensive damage. Economic impact resulting



Source: CH2M Hill, Inc.

from loss of use of buildings due to "damage to secondary systems can be extreme, since about 60 to 70 percent of construction costs for finishing buildings is for secondary systems" (McCue 1981).

In 1970 the American Society of Civil Engineers (ASCE) established the Technical Council on Lifeline Earthquake Engineering (TCLEE). Recently studied earthquakes in Japan, Algeria, Italy, and China have provided many examples of lifeline failure. During the 1979 earthquake in Imperial Valley, California, valuable information was obtained from instruments installed on overpass bridges. In 1969 the Federal Highway Administration (FHWA) initiated studies on the effects of earthquakes on highway bridges. The ATC has completed a study entitled "Seismic Design Guidelines for Highways and Bridges."

Adoption of recommendations included in this study is being considered by the American Association of State Highway Officials.

Architecture: Architecture encompasses decisions related to structure, design, and siting at the inception of project development. Building characteristics, including materials, configuration, connection details, and overall design affect potential structural response during an earthquake. The study of structures damaged during earthquakes has shown that building size, shape, and disposition of major structural and nonstructural building elements has a major affect on seismic performance (Arnold 1981).

To achieve optimum building response for performance, the selection of the site and design of the building should be considered together. To date the architect relies on the structural engineer to satisfy code authorities and on geologists, engineers, and planners to evaluate and select the site location.

In the last decade some architectural research has begun to define the role of the architect in risk mitigation and in the hazard reduction field. In 1975 a workshop directed to evaluate the responsibility of the architectural profession on earthquake hazard mitigation and to develop guidelines for future research in the field was financed by NSF. In 1976 NSF awarded the first contract on architectural topics and in 1977 the AIA Research Corporation developed a series of seminars for faculties of universities to introduce seismic design into architectural curricula (Earthquake Engineering Research 1982). To date, however, research pertaining to architectural response to seismicity is minimal.

Specific aspects of architecturally generated hazards are addressed by individual jurisdictions through their building and zoning codes. For example, based on observations of suspended ceiling failures in the 1964 Alaska earthquake and in the 1971 San Fernando earthquake, the California Office of the State Architect (OSA) changed the design requirements for suspended ceilings. As a direct result of these requirements during the Santa Barbara earthquake of 1978 no failures of suspended ceilings were reported in newly constructed schools.

Elsewhere in the country, however, nonstructural elements as a rule are not addressed by building codes, but are left to the individual responsibility of architects, engineers, interior designers, and (most important) building users.

Architectural design variables such as building envelope, including shape, height, and setbacks, are often determined by the preference of the architect, owner, and zoning ordinances that control type, use, and density of development. The increased awareness of the interdisciplinary research necessary to deal with seismic risk mitigation, prevention, prediction, and planning has expanded the scope of support by the NSF by adding architects, sociologists, and planners to the traditional research teams of geologists and engineers. Architects and planners are contributing a new dimension in seismic mitigation as reflected by the work conducted by the Disaster Research Center at Ohio State University, the Natural Hazards Research and Application Information Center at the University of Colorado at Boulder, at Tokyo and Kyoto Universities, and at the Department of Architecture, Oxford Polytechnic and AIA Research Corporation. Interdisciplinary seminars, workshops, and conferences are principally financed by the NSF and USGS.

Planning and Public Administration: Land use planning and decisions based on sound information about earthquake hazards and implemented over an extended period of time can be among the most effective measures for saving lives and minimizing disruption in case of an earthquake.

Urban planners are among the primary users of data generated by other disciplines, most notably the geosciences. A successful planning process consists of three primary components which together constitute a framework for guiding the development of urban or regional systems.

- Collection and analysis of physical, social and economic background data.

- Utilization of data in the preparation of comprehensive plans of various scales of analysis (county/borough, city, neighborhood); special purpose plans--coastal zone management, wetlands, transportation, health, utilities, emergency response, preservation, site analysis, etc.

- Development of regulations, ordinances, budgets, and administrative systems for implementation of the plans.

Only recently has the need of relating physical, social, and economic issues in the development of alternative methods of risk mitigation disaster and recovery prevention been considered. However, research related to pre-earthquake planning and postearthquake recovery is still in its infancy. Research efforts seem to have focused mostly on the application of geological information in the allocation and development of special zones--microzonation (Borcherdt 1975; Brabb 1979; Blair and Spangle 1979, Earley and Kockelman, 1981).

Major seismic events have provided information on postearthquake losses and impacts of specific regions and communities. Excellent examples are the Managua earthquake (Kates et al. 1973); the Romania earthquake (Jones and Avgar 1977); and the Campania-Basilicata earthquake (Lagorio and Mader 1981).

Recently the NSF has supported preparation, by the American Institute of Planners, of a manual for planning in seismic risk regions (Jaffe et al. 1981) and a specific study leading to the development of methodology for land use planning after an earthquake (Mader et al. 1980).

For the last 15 years individual cities and states have produced hazard maps that can be used to catagorize various seismic risks--faults, landslides, soil liquefaction, potential for strong ground motion, funded mostly by the USGS. Also new methodologies in seismic risk analysis and hazard mitigation have provided planners and decision makers with better tools for land use planning, and siting and designing of critical facilities. Updating of building codes has provided guidelines for safer building construction technology.

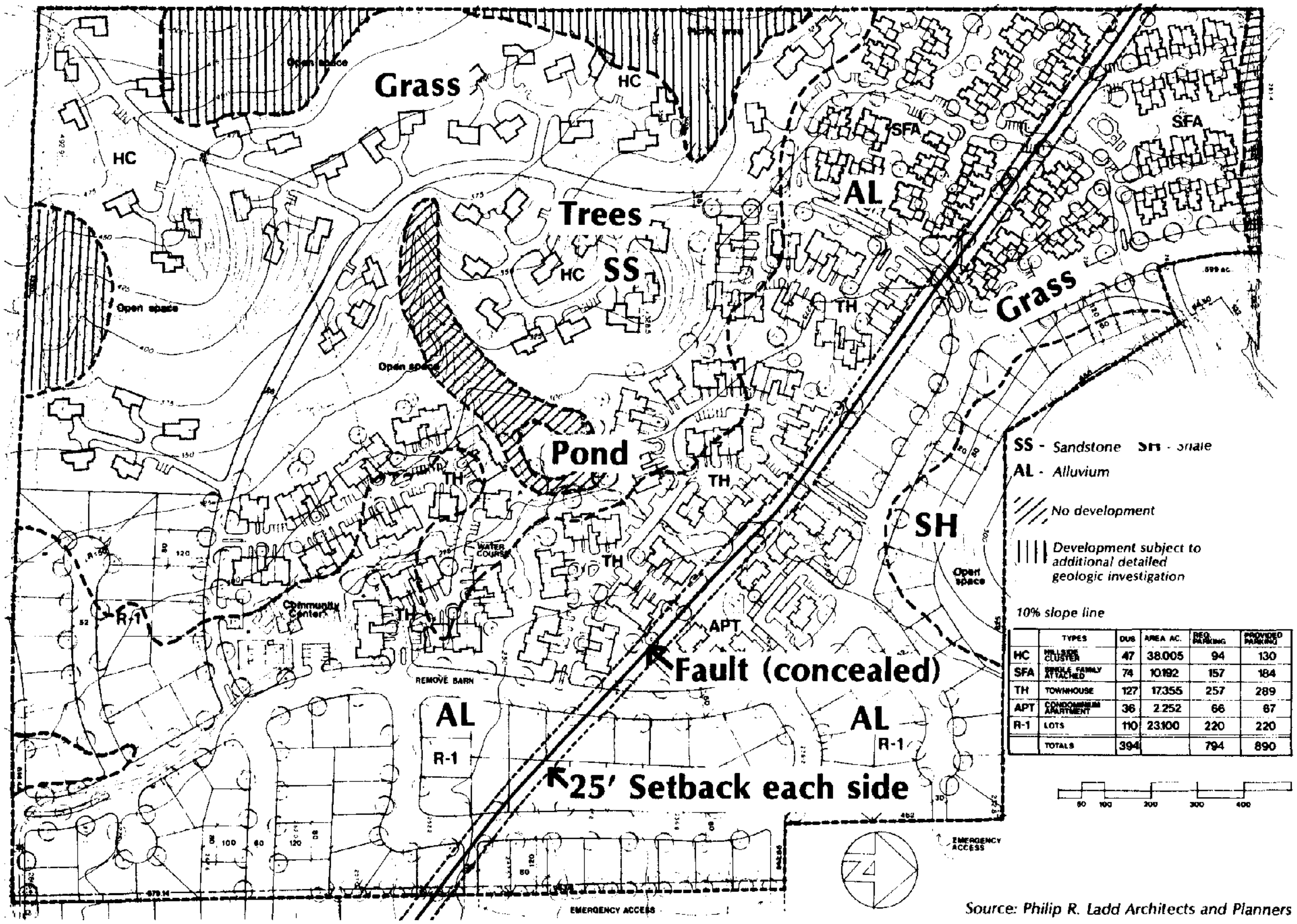
California has pioneered land use planning for the purpose of seismic safety. All local governments are required to prepare a general plan and since the San Fernando earthquake of 1971 all plans must contain a Seismic Safety Element (SSE). Also, a recent state law, the Alquist-Priolo Special Studies Zone Act, requires that the state geologist designate an area of about 1/8 mile on either side of known active faults as special studies zones. In these zones geologic reports must be made prior to development of multifamily dwellings (Figure 25). Sellers of homes in these zones must disclose to prospective buyers that the property is in a special studies zone.

In 1981 the City of Los Angeles adopted the Earthquake Hazard Reduction to Existing Buildings Ordinance to deal with rehabilitation and strengthening of old buildings.

Despite the great amount of attention and money which has recently been expended in the field of earthquake-related research, there is no consistent federal, state, and local framework that can provide for the application of scientific research to the development of policies and regulations directed to mitigation of seismic risk. Recently the NSF has listed the following priorities for directing funds for research in the socioeconomic field (Krimgold 1981):

- To continue to improve procedures for rapid response to optimize learning from post-disaster earthquake studies;
- To develop international cooperative research programs which take advantage of unique research opportunities;
- To improve existing and develop new information transfer programs to

Figure 25. Site Plan for Special Studies Zone



	TYPES	DUS	AREA AC.	REQ. PARKING	PROVIDED PARKING
HC	HILLSIDE CLUSTER	47	38.005	94	130
SFA	SINGLE FAMILY ATTACHED	74	10.192	157	184
TH	TOWNHOUSE	127	17.355	257	289
APT	CONDOMINIUM APARTMENT	36	2.252	66	67
R-1	LOTS	110	23.100	220	220
	TOTALS	394		794	890

Source: Philip R. Ladd Architects and Planners speed the flow of information developed through research to operational government agencies and to design professionals;

- To study the interaction between design considerations for other hazards and seismic resistance of constructed facilities;

- To develop knowledge on the socio-economic aspects of hazard mitigation;

- To improve the understanding of disaster impacts and response;

- To provide a basis for improving the dissemination of information on earthquake hazards and its utilization by decision makers and the public.

In the last five years the NSF, USGS and FEMA's interest in expanding the number of professionals and scientists involved in earthquake-related sciences and technology in this country and abroad has increased. This has led to sponsoring several workshops and conferences directed toward evaluating the process involved in risk assessment, hazard mitigation, disaster prevention, and disaster recovery--both short- and long-range.

A new dimension in risk mitigation awareness has emerged as reflected by the involvement of planners, public administrators, sociologists, and architects along with engineers and seismologists. The title of some of the conferences conducted recently reflect the new awareness. As an example, "The Social and Economic Aspects of Earthquakes, and Planning to Mitigate Their Impact," Bled, Yugoslovia, 1981; "Urban Scale Vulnerability: U.S.-Italy Colloquium on Earthquake Hazard Mitigation," Rome, Italy 1981; "Workshop on Earthquake Disaster Mitigation Through Architecture, Urban Planning, and Engineering," Beijing, China, 1981.

> The purpose of making structures safe has assumed a broader meaning. Preventing injuries and deaths is still of paramount importance, but the human suffering involved in the overall disruption of social and economic systems must be considered also (Jones 1982).

Public Administration/Current Management Concepts of Risk Mitigation

Research related to the organizational and institutional contexts of decision making as it applies to earthquake mitigation is still limited. The following discussion is an evaluation of the present public administrative structure and its response to the application of innovative methodologies directed to risk mitigation, prevention, and recovery.

In setting the framework for the following analysis, 'mitigation' is defined as a management strategy to balance current actions and expenditures with potential losses from the future hazard occurrences (Petak 1982). A community subjected to any type of disaster follows identifiable stages:

- **Mitigation:** Activities that could prevent or alleviate the impact of a catastrophic event before the event occurs. These include building codes, land use regulations, flood insurance, siting and design of critical facilities, and public education.

- **Preparedness:** Measures aimed at insuring or improving response capabilities, especially during the emergency period, including installing warning systems, stockpiling supplies, maintaining resource inventories, devising special hazard plans, making structural adjustment (dams and levees), developing location plans, and drills and test exercises.

- **Response:** Search and rescue operations, debris removal, fire fighting, and provision of such emergency resources as food, shelter, clothing, and medical care.

- **Recovery:** Restoration and reconstruction of the community to at least predisaster conditions. Emergency repairs, restoration of repairable and restorable structures, replacement of capital stock to return to predisaster levels or greater, and major construction are examples of recovery activities.

The implementation of risk mitigation systems depends on the effectiveness of the administration charged with its management. Mitigating life and property losses which may result from some future natural disasters has historically been a difficult task largely eluding public policy makers. The reasons for this phenomena include fragmentation of policy responsibility; lack of public and interest group support for political action; inadequate financial and human resources committed relative to the magnitude of the problem; ingrained sociocultural beliefs about property and personal rights; government subsidy of risk taking; uncertainty about the level of risk and potential for economic loss from any one disaster scenario; general weaknesses in the implementation process; and the power of local economic elites to prevent measures preceived to be counter to their financial interests.

Whether induced by nature or manmade, risk is a fact of life. Society cannot eliminate it, but can attempt to minimize and prepare for it. In terms of natural disaster mitigation, society has addressed risk primarily through two interdependent approaches--land use and building regulation. Land use regulation involves controlling settlement patterns relative to risk. This means taking protective or abatement steps to mitigate loss in areas already settled or deemed too economically valuable not to settle though they are recognized to carry a level of risk. Building regulation is theoretically tied to the land. Based on the government's power to establish minimum standards for design and materials used, building codes are widely used to minimize a variety of risks, including earthquakes. The effectiveness of these measures are limited without parallel efforts to regulate land use in regard to risks from earthquakes.

Development and adoption of earthquake hazard mitigation measures and policies related to land use planning, site selection, design of foundations and structures, abatement of hazardous structures, and location and construction of critical facilities is one thing, but actual implementation is another.

Until a few years ago the subject of policy implementation received little scholarly attention. Though regarded as important, most scholars and researchers simply chose to focus on other research. Without effective implementation, decisions of policy makers cannot be executed successfully. If policy is inappropriate, it cannot alleviate the problem for which it was designed and will fail no matter how well it is implemented, but even a brilliant policy may fail to achieve its goals without proper implementation.

Factors critical to establishing conditions for and identifying primary obstacles to successful policy implementation are: public education and communication, resources, dispositions or attitudes of leaders, and bureaucratic structure (Edwards 1980). Other variables may include leadership, political environment, and intergovernmental relations.

Organizational structures should be designed to facilitate the attainment of goals and objectives. The structure of organizations has a significant influence on implementation. One important feature of bureaucratic structure that significantly influences policy implementation is organizational fragmentation. Responsibility for a policy area is frequently dispersed among several organizations, often radically decentralizing the power to accomplish policy goals. These are buttressed by state constitutions and city charters which mandate a fragmented administrative structure, and by federal grant programs which encourage state and local governments to mirror fragmented national efforts. Such diffusion complicates policy coordination because it inhibits changes in policy, wastes resources, generates undesired actions, confuses officials at lower level jurisdictions, and results in conflicting policies and responsibilities that fall into the cracks of organizational boundaries. The more actors and agencies involved and the more interdependent their decisions, the less the probability of successful implementation (Edwards 1980).

Lack of interagency coordination has perhaps the most debilitating effects on policy implementation. Priorities of agencies differ, and bureaucrats tend to avoid communication with their counterparts in other agencies, even when their responsibilities clearly overlap or interface. Federal agencies operate independently and often pursue or encourage policies different from those of other agencies (Petak 1982). In general, the more coordination required to implement a policy, the less its chances of success (Edwards 1980).

Charges of inadequate coordination have often been leveled at past hazard management attempts. A recent California study, 'Earthquake Prediction and the Governmental Process' (Lambright 1982), discusses the organizational structure problem in implementing earthquake predictions.

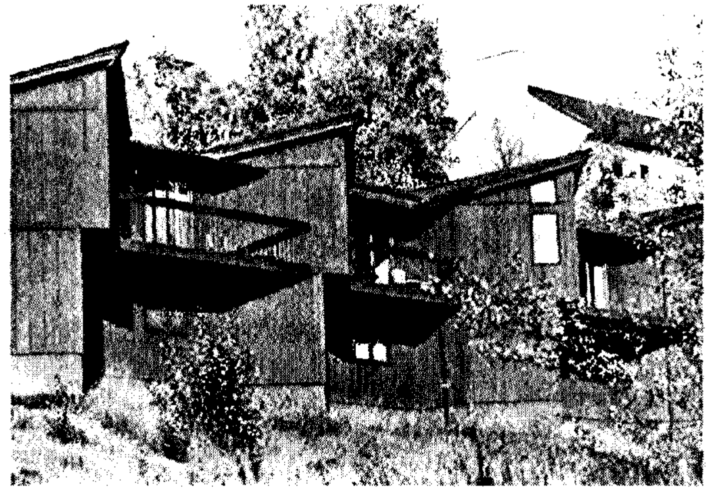
> Implementation varies not only by earthquake predictions; it also varies by who is doing the implementing. It matters whether a city like Los Angeles or a county like San Bernadino, is the affected party. One has more resources than the other; one is less in need of technical assistance than the other. The real problem in implementation is that too much decentralization in response to prediction may lead to non-preparedness, as well as preparedness. Also, there may be some programs that require cooperation across jurisdictions that would prefer to operate autonomously. . . . There has been more fragmentation than cohesion around this interest. The coalition for change is growing, but the process is very, very slow. The governor and legislature have competed, rather than allied in developing a statewide earthquake program. The agencies have tended to go their own way. Each local jurisdiction looks after itself.

Due to fragmentation the narrow responsibility of many agencies sometimes means that certain functions simply get overlooked and fall between the cracks of organizational structure.

All levels of government are becoming aware that their decisions have land use impacts of more than local concern. The federal government's interest in land use has increased because of problems such as energy shortages, air and water pollution, and natural hazards that transcend state boundaries. State governments often believe that federal involvement is undesirable and that land use problems are more appropriately solved at the state level. At the same time, local governments guard their traditional powers of land use control and maintain that the vast majority of land use decisions concern only local affairs and are best handled at that level.

Land use planning and plan implementation have traditionally been carried out at the local level using zoning, subdivision, and grading ordinances, urban renewal, land acquisition programs, and taxation policies to tackle all hazards, including landslides, floods, earthquakes, hurricanes, and fires. A study of the problems in San Francisco's 1974 seismic safety plan implementation (Jacobs 1982) found that under San Francisco's governmental structure and process the plan is an advisory document which does not necessarily mandate actions. Thus, it does not appear that the plan itself has had a major impact on either the nature of construction in the city or how it goes about its business. This plan, like all plans, merely represents a policy. Without proper implementation, the plan accomplishes nothing except, perhaps, a false sense that something has been accomplished.

Despite their availability to local government, land use regulations have seldom been used to encourage the adoption and enforcement of measures to reduce earthquake hazards. Notable



exceptions may be found in California, where cities ranging in size from Portola Valley (population 4,500) to Los Angeles (population 2,902,000) have introduced zoning regulations along active faults. A larger number of communities throughout the country, however, control construction in landslide-prone areas, where earthquakes might trigger renewed movement, either through stipulations pertaining to grading in the UBC (e.g. requiring additional information on soil and geological conditions) and or through individually adopted drainage and grading ordinances ((Jacobs 1982).

A major land use problem is that critical facilities, such as lifelines, high-occupancy buildings, emergency facilities, unique and large structures where failure might be catastrophic, unreinforced masonry structures, and other nonresistive developments exist and continue to be constructed in earthquake-hazard areas. Additionally, reconstruction commonly takes place in hazardous areas after earthquake damage and after existing structures are found to be in hazardous areas as new information becomes available.

Four categories of reasons for many such land use problems were provided by The Policy Group on Earthquake Hazards Reduction (1978):

1. Existing earthquake hazard information is generally not adequate, sufficiently detailed, or in a useful form for preparing and implementing land use plans to avoid earthquake hazards and mitigate damage.

2. Federal, state, and local governmental units and the private sector generally have inadequate understanding of earthquake hazards and how to avoid them and mitigate the damage.

3. Coordination of federal land use planning and development programs to avoid earthquake hazards and mitigate damage is virtually nonexistent. Similar problems exist at and between other governmental levels.

4. Professional land use planners generally have little, if any, training or experience to help them to understand and apply earthquake hazards information.

One reason not mentioned involves local political factors. Economic interests adversely affected by mitigation may act as 'veto groups' preventing adoption of measures seen by them as counter to their interests.

As previously stated, in April 1979 the Federal Emergency Management Agency (FEMA) was established to formally reorganize and consolidate the planning, mitigation, and assistance functions and responsibilities that were previously under several separate federal agencies, including the Federal Disaster Assistance Administration (FDAA) and the Federal Insurand and Hazard Mitigation Agency (FIHMA). It was hoped that through the central agency public decisions regarding natural hazard mitigation and emergency assistance could be made more efficient and effective. The FEMA is an attempt to centralize and institutionalize federal decision making in high-risk events, primarily when efforts at other levels of government fail.

Implementation of Support Systems: If implementors lack the resources necessary to carry out policies, implementation likely will be ineffective. Important resources include finances, and adequate staff, and the information, authority, and facilities necessary to translate proposals into functioning public services.

A study of seismic safety policies in 13 California communities indicated that allocation of monetary resources reflects the priorities of their land use objectives. Dollars can be translated into additional staff to carry out the objectives or to release existing staff for this work by hiring new employees to take over old responsibilities (Wyner 1982). The study found that no community had added new staff specifically to implement land use goals. Virtually all had adopted Seismic Safety Elements (SSE) that recommend gathering more data about geologic conditions in areas that might be susceptible to earthquake damage. Money is clearly necessary to implement these data collection activities, yet with a few exceptions involving construction of public facilities, no jurisdiction had allocated funds for this kind of research. New data relevant to land use planning came only from reports submitted by private developers as part of the permit approval process for new buildings.

A crucial weak point in local seismic safety policy is enforcement of seismic design regulations. Comparatively low salaries and inadequate inspection and design review staff are important obstacles to good performance. State governments should do what they can to make available specialized personnel who are competent in seismic design problems and familiar with sophisticated forms of earthquake-resistant construction (Scott 1979).

A 1980 Los Angeles city ordinance was aimed toward abating the threat of existing hazardous structures. Although a good first step, three features caution against optimism:

1. The program is to be carried out over 15 years, and with appeals and other likely delays it could take much longer.

2. No explicit funding plans were presented, at least in public, and interviews indicate that unless significant outside funds were forthcoming, sufficient "political will" would be lacking to enforce the program at much beyond the symbolic level (the cost of rehabilitation is approximately $750 million).

3. This ordinance only applies to the city of Los Angeles, not the county of Los Angeles, and does not affect other cities (excluding Long Beach and Santa Ana) and

counties of the Los Angeles basin (Nilson et al. 1981).

The FEMA (1980) found that the availability of adequate staffing and resources at all levels of government determines the efficiency of an agency's programs and initiatives. In many agencies, earthquake preparedness has been accorded low priority. The FEMA recommended that additional resources be provided to accelerate earthquake hazard mitigation and preparedness activities under the National Earthquake Hazards Reduction Program (An Assessment of the Consequences and Preparations for a Catastrophic California Earthquake: Findings and Actions Taken, 1980).

Leadership: Where the implementors' attitudes or perspectives differ from the decision makers', the process of implementing a policy becomes infinitely more complicated. Because implementors generally have discretion, their attitudes toward policies may be obstacles to effective policy implementation. Communications from superiors are often unclear or inconsistent, and most implementors enjoy substantial independence. Some policies fall within the "zone of indifference" of administrators; others elicit strong feelings. These policies may conflict with implementors' substantive policy views or their personal or organizational interests.

Here is where dispositions pose obstacles to implementation. The attitudes of staff and elected officials toward seismic safety's role in land use planning have an important bearing on how it and other seismic safety policies will be implemented. Planners tend to believe that engineers and building officials can "solve" any seismic-related problems posed by a development proposal. At the same time, building department personnel do not see land use-related seismic safety matters as very important to them. For example, the planning department head in a large city recently said that he had not looked at the Seismic Safety Element (SSE) in the four years since it had been adopted, and the planners in other cities indicated that their city's SSE was not at all helpful in land use planning and, furthermore, they were dubious about the "expert" opinion on the relationship between seismic safety and land use planning (Wyner 1982). These attitudes suggest that planners give low priority to the SSE and seismic safety in land use planning. The study concludes that with very few exceptions, the dominant attitude of professional planners was a combination of indifference and resignation to the status quo.

Given the virtual absence of resources allocated to implementing land use recommendations in SSE, personal dispositions of key individuals take on added importance. Without money or official incentives, only the strong personal commitment of individual leaders will make seismic safety an important factor in land use planning. With very few exceptions such attitudes were absent, and seismic safety has become just another item on a long list of factors involved in land development. The SSE requirement, which was a call to seismic safety awareness for local planners, has merely been added to an already crowded agenda.

These findings are consistent with other studies. Most urban planners deal with a myriad of urban development considerations, and seismic safety is but one very small part. Also, planners operate in the political world. Seismic safety is not a popular political issue, and most local elected officials do not want to hear about it. It is much easier for a politician to deal with the problem of a street that is too narrow to accommodate traffic or an undersized culvert than it is to define an acceptable level of seismic risk (Mader 1982).

A comparative study of six local experiences in long-term recovery from natural disasters found that perceptual or attitudinal characteristics affect a locality's inclination to mitigate hazards (Rubin 1982). What mitigation involves, particularly the specific techniques and processes, is not clear to all decision makers. A local official may fully support the concept and process of recovery but be unable to push for mitigation measures because of perceived cost/benefit ratios for different mitigation options. The study found that the availability of experienced, professional leadership at the local level such as a city manager, county executive, mayor, or other elected official, made a very positive contribution to recovery. The effective use of local governmental power was, in fact, more important than the form of local government. In the final analysis, however, when economic and development pressures outweigh the perceived benefits of mitigation, the former win over the latter (Rubin 1982).

The Florida State Legislature requires no assessment of hurricane hazards and makes no requirements governing new construction in flood prone areas, whereas the State of California mandates structural and nonstructural risk avoidance policies (Svenson and Corbett 1981). A study, 'Development of Earthquake Hazard Reduction Policies in the Cities of Long Beach, Los Angeles, and Santa Ana,' counted the active role of the city council, staff members, and professional experts in adopting and implementing the seismic ordinances of three cities. Petak (1982) concluded that as a result of enforcement of seismic ordinances enacted in Long Beach, Los Angeles, and Santa Ana, some potential losses have been minimized (Petak 1982).

These studies suggest that effective leadership at all governmental levels in developing, adopting, and implementing the earthquake hazard mitigation measures is the single most important factor. However, only a few jurisdictions have fully implemented even some of the proposed risk reduction measures, and many jurisdictions have accomplished next to nothing because the dominant attitude of the leaders is a combination of indifference and resignation to a relatively low priority for seismic safety issues. Leaders often perceive that economic and development pressures outweigh the mitigation benefits.

Political Environment: The political environment in which earthquake hazard mitigation implementation takes place has an important bearing on the likelihood of success. Three aspects of the political environment of seismic safety policy seem particularly relevant in a discussion of land use, building structure site planning, and critical facilities--interest group support, mass public support, and the political benefits or incentives for office holders.

Earthquake hazard mitigation is not an issue that has stimulated the creation of new interest groups nor for the most part, has it attracted the support of already established local interest groups. A recent study found that virtually no interest groups appeared to support the concepts or the specific land use policies embodied in the Seismic Safety Elements of 13 counties and cities of California studied with the exception of a regional structural engineers association. Local interest groups have not initiated requests for new and stricter land use policies. Most interest group involvement in implementation of seismic safety-related land use policy has been opposed by affected parties.

The same study also observed occasional group-based conflict over land use policies involving seismic safety. Often a political fight, private development interests argued for reduction in seismic safety standards in already adopted policies, or homeowner groups argued that seismic safety should be one of many reasons used to reject or modify a development proposal. Usually earthquake-risk reduction did not carry the day. Wyner (1982) concluded that seismic safety was in no case the primary or sole justification for political behavior. What is noteworthy is that the infrequent incidence of major seismic events and seismic safety's low visibility keeps the conflict at a relatively low level.

A recent survey of the attitudes held by policy makers and political influentials revealed that the most serious problems perceived at state and local levels in California, Massachusetts, and Utah were inflation, unemployment, the costs of welfare, and similar issues. Other problem categories making a strong showing in one or more of the survey sites included pollution, crime, low economic growth, drugs, education, housing, and pornography (Wright et al. 1980). This survey also revealed that the seriousness attributed by policy-making or policy-influencing elites to natural hazards problems was uniformly low. No hazard problems finished among the top five problems in any site. Fire finished among the top 10 in California and Massachusetts, and earthquakes were rated as the tenth most serious problem on the list in Los Angeles, the same

rating given in Salt Lake City. The majority of respondents surveyed in Salt Lake City and Boston perceived earthquakes as a non-problem, despite an objective and scientifically confirmed seismic hazard in both cities. Surveys in Anchorage during the past decade have never shown earthquakes as a problem requiring governmental attention by even a small minority. With few exceptions, natural hazards issues were concentrated toward the bottom of the list. Another study explains why most seismic safety proposals are pushed to a low rung on a jurisdiction's agenda of community problems.

> Exacerbating the tendency to assign a low political priority to seismic safety is the perception that preparedness and hazard mitigation programs demand investments in time, money, and energy--but then only yield indefinite and politically invisible results (Nilson et al. 1981).

Though mass public support for seismic safety policy and its implementation remains latent and has not been translated into overt political behavior, recent research strongly suggests that the public believes that local government should actively pursue seismic safety goals (Turner et al. 1978). Those attitudes, however, have not been sufficient to generate any significant political response (Nigg 1980); but reactivation of this latent support has begun to surface--even in "the absence of earthquake-oriented political constituencies" (Atkisson and Petak 1981).

Most local officials do not perceive earthquake hazard mitigation and implementation of land use policy as providing any political benefits to them. They seem to believe that the public does not know much about seismic safety, ranks it very low on any priority list of community problems, and does not engage in any sustained activity regarding "the absence of earthquake-oriented political constituency." Furthermore, no elected or appointed officeholder could recall seismic safety as an issue in recent local political campaigns. Political incentives in the form of punishments or rewards are almost entirely lacking, at least as perceived by those who must adopt and implement seismic hazards mitigation policy at the local level. In short, earthquake hazard mitigation appears to elected officials to have no constituency. Politicians will not risk their future political lives without one. This cardinal rule of American politics must be honored in the field of seismic safety.

This perception is critical because it represents the primary guide for decision makers. In the absence of overt political behavior by citizens or interest groups calling for active implementation of earthquake hazards mitigation, leaders see no political advantage from strong support of seismic safety issues.

A considerable absence of 'inside' advocates has also been found in recent studies of seismic hazards mitigation (Atkisson and Petak 1981; Wright et al. 1980). Public problems, political issues, and policy proposals tend to be 'owned' by specific legislators, committees, or institutional entities. Like stray dogs, 'unowned' problems, issues, and policy proposals swiftly become undernourished and have a way of disappearing into the night. The sustained interests by a few policy makers can make a difference.

The legislatures in California and Utah have made some progress in dealing with seismic safety issues. The formation of state level seismic safety councils in a few states has led to similar outcomes. When problems are 'institutionalized' the interests and energies of individual policy influentials are linked to the fate of such problems and issues, and the probability that these matters will be heard and acted upon by the policy system is considerably increased. In other words, things are changing mainly due to the following:

- Officials are showing real alarm at the damage and loss estimates of a major earthquake in an urban area.
- Geoscience and engineering specialists are both willing and able to communicate effectively with officials and the lay public.
- Earthquake prediction and prediction-response technologies are obviously, if slowly, improving.
- Potential seismic safety advocates are developing 'institutionalized' bases of support (governors' task forces, California Seismic Safety Commission, the Southern California Earthquake Preparedness Project, etc.).
- Improved seismic safety is being linked with goals which have broader political support (national security, community revitalization, and grassroots organizations, for example).

Public Education and Communication: Before a population can respond effectively to the threat of an earthquake it needs certain kinds of information. People must know the nature of the threat and what can be done to minimize it. Information and its dissemination through the communication process, therefore, play a key role in reducing the impact of earthquakes and other hazards.

Earthquake hazards have been receiving more attention. As noted earlier, major research programs have been carried out at universities throughout the country by research firms and by federal agencies. In addition, increasing involvement of social scientists in the study of earthquakes and other natural hazards has provided a valuable link to public understanding. There is an expanding body of knowledge based on the geological, engineering, and socioeconomic aspects of earthquake hazards, but there is always a gap between what is being learned through research and what is being applied. The challenge is to improve and increase the use and application of existing knowledge on earthquakes, despite its inadequacy and incompleteness, and to expedite the use of new data.

Scientists and planners need to build communication skills to inform the public and the policy makers of their findings. Consideration of seismic risk in land use planning, building structures, site planning, critical facilities, and other areas will gain greater prominence only if scientists and researchers promote understanding of their work, learn how to communicate and evaluate their needs and the needs of planners and policy makers, and design their products and recommendations to be of optimum use. This broadening of scientific responsibility would enhance public understanding and support of research needed to assist policy makers in setting guidelines for public safety. Elected officials, planners, professionals, and scientists need to assume the role of public education.

> Unless the public increases its awareness and understanding of risk, and the mitigation management alternatives available, success at implementing hazard reduction programs is unlikely (Selkregg 1983).

This relationship between public awareness, support, and implementation is an important one. It suggests that the political and technical leaders are less likely to achieve policy goals related to risk reduction in the absence of public support.

While the public presently appears to lack knowledge about earthquake safety measures, several studies found that people would like to know more about earthquake prediction, preparedness, and hazard mitigation. Turner et al. (1980) concluded:

- There is an awareness among the public that large groups of people are currently living 'at-risk' from a wide variety of conditions, especially hazardous structures. Eighty-one percent of greater Los Angeles supported strict enforcement of building codes.

- There is a widespread sentiment that something can be done to mitigate those hazards.

- Government has the primary responsibility for taking, or at least for initiating, these actions.

- The public wants more information to clarify situations made ambiguous by various predictions.

- There is a general misconception about what government can do. Better communication should be developed to improve public understanding and confidence in governmental response.

- A well educated and informed public can accept prediction and respond in a reasonable and rational way.

- No local government jurisdiction can respond adequately to an earthquake by itself.

- There needs to be a state-level program of assistance to help get information to the people. There is a tendency for state and federal levels of government to forget what local governmental responsibilities are.

- Public education, not just information, is the major way to address the problem of achieving responsible and rational responses to a prediction.

Based on the major conclusions of a number of studies (Meltsner 1978; Wright and Rossi et al. 1980; and others) the following general synthesis was offered:

> While the public recognized the dangers posed by earthquakes in California and believes that specific actions can and should be taken to lessen these dangers, they are not organized and mobilized to provide concrete and politically relevant support for policy innovations. The public wants to know more about both the earthquake threat and the current status of preparedness, and such recep-

tivity obviously provides opportunities for Southern California Earthquake Preparedness Project (SCEPP) to "cultivate" public opinion. If the media are willing to cooperate on a sustained basis, the impacts of a public education campaign can be significant. It must be remembered, though, that the "public" is differentiated and that special measures will have to be taken to reach Blacks, Mexican-Americans, the elderly, and certain other groups.

These findings are consistent with Wright and Rossi (1980) data. When they compared their findings on elite and public favorability toward land use and building regulations, they found marked discrepancies. Approximately 85 percent of the public sample supported such measures, but the elite support figures never exceeded 50 percent, indicating that "public thinking on these matters may be somewhat more progressive than the thinking of the political leadership" (Wright et al. 1980).

Earthquake awareness should not be promoted with scare tactics. Since large earthquakes happen infrequently, scare tactics would soon become counter productive (Wiggins 1974). For the public to be aware of seismic concerns and support planning actions that reduce seismic hazards, education is needed at the elementary school level through higher education (Mader 1981). This is taking place to a considerable extent in some areas. The California Seismic Safety Commission successfully sponsored legislation that requires the initiation of a model earthquake education curriculum (SB 843, 1981). The curriculum is now being developed by the Lawrence Hall of Science at the University of California at Berkeley. The SCEPP, jointly sponsored by FEMA and the California Seismic Safety Commission, is undertaking a massive earthquake education program in Southern California (SCEPP Executive Summary 1981).

Education of policy makers and community participation need to be stressed so that each group can substantially contribute to promoting and enhancing public safety. Communication seems to play a key role in disseminating the knowledge and information on earthquake hazards and mitigation measures between researchers (producers), policy makers (users), and planners (users). Since researchers and users tend to have divergent motivations, it may be necessary to use intermediaries to interpret research results and to create products that clearly will be helpful to the users. Information must be kept flowing by efforts from both the producers and the users of earthquake information and technology. Until a common base is established with each group sharing pertinent information, public apathy and lack of understanding of the problem will impede support of scientific research and policy implementation.

A comprehensive public awareness program is needed in tandem with a balanced risk concept which considers land use planning, as well as economic, social, and cultural impacts to the community (Marsh 1982). The most serious social impacts of disasters and the effects of regulations need to be identified to raise public awareness and encourage appropriate preventive and response actions.

Effective communication must be implemented between planners, professional communities (geotechnical, policy makers), and the public. Communication can be improved and enhanced through the proper use of follow-up, regulating information flow, effective utilization of feedback, repetition, empathy, mutual trust, effective timing, simplifying language, effective listening, and using the grapevine (Gibson et al. 1982).

Intergovernmental Relations: Earthquake hazards reduction is obviously the responsibility of a great many agencies at all levels of government. Each level of government (federal, state, and local) has a crucial role to play in the quest for public safety in seismic regions. A number of studies (Petak and Atkisson 1981; Wyner 1982; May 1982; Lambright 1982; Svenson and Corbett 1981; Olson and Nilson 1981; Working Group on Earthquake Hazards Reduction 1978; Scott 1979; Sutphen 1982) encourage significant improvement in the federal, state, and local capabilities and in partnerships for the implementation of seismic safety plans.

The major land use problem is that critical facilities, unreinforced masonry, and nonresistive developments exist, in and continue to be constructed in, earthquake hazard areas even after an earthquake occurs. The Working Group on Earthquake Hazards Reduction offers the following specific reasons:

1. Federal, state, and local governmental units and the private sector generally have inadequate understanding of earthquake hazard and how to avoid the hazard or mitigate the damage;

2. Coordination of federal land use planning and development programs to avoid earthquake hazards mitigate damage is virtually nonexistent. Similar problems exist at other governmental levels and between governmental levels.

While each level of agreement needs the others' contributions in an intergovernmental partnership, it is agreed among researchers that the state governments are clearly in a pivotal position. Wyner, Petak and Atkisson, Scott, and others have stated that, in an area of known seismic activity, the state government has major responsibilities and should play several pivotal roles in the quest for seismic safety: evaluating hazards and determining levels of protection and life safety standards for all kinds of structures, taking ultimate, direct responsibility for important types of facilities, identifying and evaluating major fault zones and areas of earthquake hazard, and preparing guidelines for land use regulations and construction in these zones.

In recognition of the political realities of land use planning for seismic safety of 13 local communities in California, Wyner (1982) suggested that initiatives to utilize land use planning as an approach to earthquake risk mitigation probably must come from some place other than the local government. Though mandates given to local planners from state, regional, or federal governments frequently create hostility, lead to evasive action, and result in less than complete implementation, they nevertheless represent the most likely opportunity for some action. Another study points out that it seems incongruous that local jurisdictions find themselves in the lead in the hazardous structure abatement program. The cost and the technical complexity of a hazardous structure abatement program simply dwarfs the resources of most local jurisdictions. Olson and Nilson (1981) suggested the following resolution:

> A carefully coordinated and large scale intergovernmental effort involving the federal, state, and local governments is necessary. Moreover, this intergovernmental effort should also seek to involve important private sector interests. Only by combining political and economic resources through such a partnership will California be able to effectively reduce the life safety threat by all types of hazard-structures, and before the next major earthquake.

Potential Legal Implications for Local Government

Recently the issue of municipal liability for proceeding with development in high risk areas in the face of known seismic instability has been raised.

> It is only in modern times that our population has become concentrated in major cities along our coastal regions, and major construction has occurred on landfill and other unstable soils. Thus, it is only very recently that the potential for great earthquake destruction in this country has existed (Cranston 1977).

Evaluation of the legal implications has largely been funded thus far through the NSF's Earthquake Hazard Reduction Program.

The increase in potential loss from earthquakes, combined with the additional responsibilities imposed on local governments to reduce the risk of loss from earthquakes, has increased the risk that local governments will be held liable for allowing development to proceed in areas of known seismic instability. This increased risk of liability is particularly acute in light of an explosion in natural disaster lawsuits in which private parties have targeted local governments with requests for damage compensation resulting from natural disasters, such as fires or floods.

As an example, Hurricane Frederic, which struck the gulf coast in 1979, left in its wake 200 lawsuits brought by homeowners against the City of Mobile, Alabama, with asserted damages totaling more that $100 million. The homeowners alleged that the city was responsible for their losses on a variety of grounds including improper zoning and failure to keep streams and drainage ditches open (Anchorage Daily News, 31 October 1982).

The Los Angeles County Flood Control District and Los Angeles County face 110 suits arising from floods occurring in 1978 and 1980 with total potential damages in the range of $200 million. In one typical suit from this group, it is alleged that the county had knowledge of a flood hazard created by a brush fire which destroyed the watershed of a small creek. It is further alleged that in spite of this knowledge, the county failed to repair the watershed and prevent the flood (Los Angeles Times, 22 October 1982).

In the absence of specific statutory imposition of strict liability upon local governments, there are two routes by which private parties can seek recovery for damages caused by natural disasters:

- General tort--recovery for a wrong, error, or omission.
- Inverse condemnation--taking private property for public use without formal condemnation proceedings.

General Tort Liability: For several reasons, tort liability does not appear to be an effective route to hold a municipality liable by private parties for allowing development in areas of known high risk. A state legislature can severely restrict this type of liability. California, for example, has protected local governments from liability for actions or omissions in connection with the administration of hazardous area building reconstruction standards. Section 19167 of the California Health and Safety Code provides:

> Immunity from liability for damages or injuries caused by earthquake. No city, city and county, or county, nor any empoyee of any such entity, shall be liable for damages for injury to persons or property, resulting from an earthquake or otherwise, on the basis of any assessment or evaluation per-

formed, any ordinance adopted, or any other action taken pursuant to this article, irrespective of whether such action complies with the terms of this article, or on the basis of failure to take any action authorized by this article. The immunity from liability provided herein is in addition to all other immunities of the city, city and county, or county provided by law.

The California legislature has also protected local governments from liability for injury arising out of acts or omissions in connection with the administration of required soil reports and investigations [California Health & Safety Code §17956 (Deering 1982 Supp.)].

Other states, such as Alaska, prefer to protect local governments through one generalized immunity statute. Specifically, AS 09.65.070 subsection (d) states:

(d) No action for damages may be brought against a municipality or any of its agents, officers or employees if the claim

(1) is based on a failure of the municipality, or its agents, officers, or employees, when the municipality is neither owner nor lessee of the property involved,

(A) to inspect property for a violation of any statute, regulation or ordinance, or a hazard to health or safety;

(B) to discover a violation of any statute, regulation or ordinance, or a hazard to health or safety if an inspection of property is made; or

(C) to abate a violation of any statute, regulation or ordinance or a hazard to health or safety discovered on property inspected;

Under general tort principles, a municipality would not necessarily be liable even if there was no protection by an immunity statute. The courts of some states have found municipalities immune from suit on the basis of a governmental-proprietary distinction. According to this theory, a city plays a dual role--one governmental, one corporate. Governmental functions are those which are performed as an agent of the state for the direct or indirect benefit of all of the state's citizens. Functions performed by a municipality in its corporate capacity, however, benefit only municipal citizens, and are therefore proprietary (Olson 1979). Courts working with the governmental proprietary distinctions conclude that a city should enjoy no immunity from liability for tortious conduct in the performance of proprietary functions. Though the governmental-proprietary distinction has been developed by numerous jurisdictions, no consistent or rational applications have been developed. Consequently, many states have searched for other means by which to immunize municipal governments from certain types of tort suits.

Both California and Alaska follow what appears to be the modern trend in governmental tort immunity law. While both states permit actions to be filed against a municipality in its corporate capacity, the enabling statutes have many exceptions to the general waiver of tort immunity. The tort claims statutes of both states are modeled after the Federal Tort Claims Act, 28 U.S.C. §2671 et seq. (1976) and contain a discretionary function or duty exception to the general waiver of tort immunity. The laws of California and Alaska conclude that "discretionary" acts, i.e., those at the planning level, will not result in legal liability, while decisions at the operational or ministerial level are actionable [State vs. I'Anson (Alaska 1974)]; [Johnson vs. State (California 1968)]. The key distinction is between basic policy formulation, which is immune, and the execution or implementation of that basic policy, which is not immune [State vs. Abbott (Alaska 1972)].

The Supreme Court of Alaska has made the discretionary function exception (immunity) a narrow legal doctrine. Examples of state activities considered to be "operational" (actionable) include adoption of a plan for a road construction project, [Moloso v. State (Alaska 1982)]; design of an airport taxiway [Japan Air Lines Co., Ltd. v. State (Alaska 1981)]; negligent performance of an inspection for fire hazards [Adams v. State (Alaska 1976)]; failure to post a road warning sign and failure to place a no-passing highway stripe [State v. I'Anson, I'Anson, (Alaska 1972)]. The only recent example of a "planning level decision" provided by the court was a decision to install flashing red and yellow lights in lieu of a sequential traffic signal [Wainscott v. State (Alaska 1982)].

Although local government decisions concerning development or zoning have been traditionally considered a governmental function immune from liability [Young v. Jewish Welfare Federation of Dallas (Texas, Civ. App. 1963)], the discretionary function exception has been construed so narrowly that it is not possible to say with certainty that a municipality will not be held liable for its decisions concerning development in high risk areas. The general decline of governmental tort immunity has been best summed up by the Alaska Supreme Court as an evolution from early common law that "The King can do no wrong" through a stage where "[t]he King can do only little wrongs" to its present posture, where liability is the rule, immunity the exception (Adams v. State).

Inverse Condemnation: Inverse condemnation is a type of eminent domain proceeding which is initiated by the property owner and is available where private property has been taken for public use without formal condemnation proceedings. Inverse condemnation is also available when a person's property suffers physical damage proximately caused by a public improvement or public use maintained, planned or designed by a local government (Marin v. City of San Rafael, Cal. Ct. App. 1980).

Recent cases from California suggest that greater use is being made of the inverse condemnation action to recover damages against local governments. In the context of government liability, an inverse condemnation theory has several advantages over tort liability. First, the tort immunity statutes have no application against inverse condemnation actions. Inverse condemnation is based on the "just compensation" provisions found in most state constitutions. Thus a state legislature cannot constitutionally immunize, by statute, a local government from inverse condemnation actions. Second, the municipality's wrong, e.g. "fault" or "negligence," is irrelevant in an inverse condemnation action. Third, as long as the damage was proximately caused by a public improvement or public use, it makes no difference if a concurring cause was present. Finally, it is not necessary to show that the work of construction was performed by the local government entity. It is enough that the work somehow was approved or accepted by the public agency. This approval need not be formal: official acts of dominion or control over the property may imply approval or acceptance. Even use of the land for a public purpose over a reasonable period of time may constitute an acceptance (Marin v. City of San Rafael).

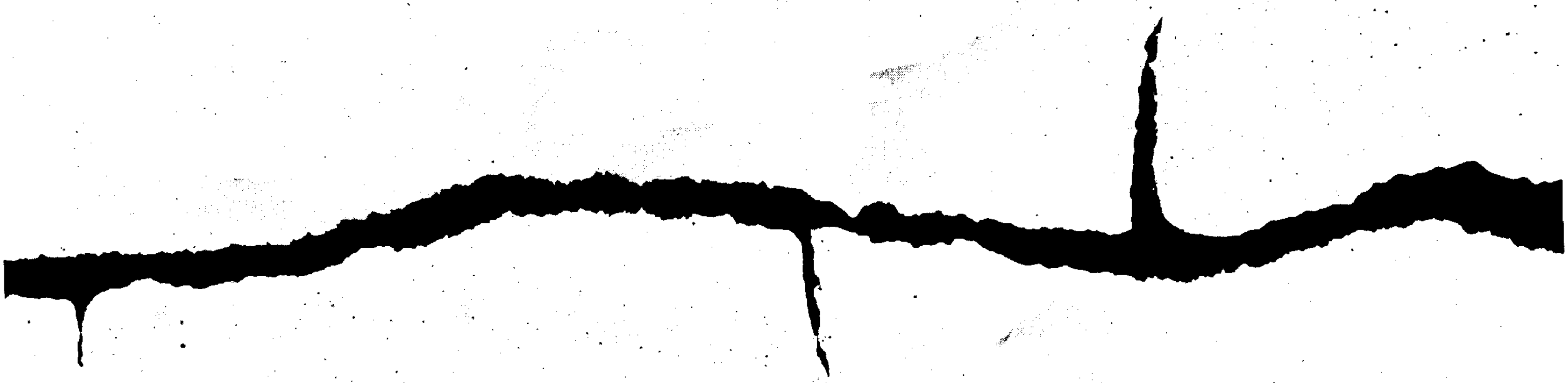
Not even the broadest of the new inverse condemnation cases, however, have held a municipality liable in inverse condemnation merely for having made a zoning or development decision in an area which was somehow subject to natural destructive forces. Nevertheless, municipal participation in development projects above and beyond the mere zoning decision is increasing nationwide, and the likelihood of a claim by inverse condemnation is all the more likely.

This potential area for liability could easily be found where, for example, a city accepts the dedication of streets in a subdivision and thereby takes responsibility for the maintenance and design of the streets. Another likely situation for inverse condemnation claims applies to areas serviced by municipally-owned utilities or other capital improvement projects.

Municipal participation in accepting dedications of property or servicing areas with public conveniences may present the greatest liability exposure. A decision to participate generally will not include any inquiry other than into the economics of participation and future needs of the participation. The concept of liability via inverse condemnation would be several times removed from the current issues that would arise from current municipal participation, since the liability aspects are the most likely ones to be overlooked and the ones which harbor the greatest potential for claims under this theory of law.

Summary: Decisions concerning zoning or development have been considered to be in the range of basic policy formulation and therefore immune from tort claims by private parties. Absent overriding zoning/development restrictions, local governments are generally not liable under present tort law for proceeding with unrestricted and unregulated development in known seismically hazardous areas. State immunity statutes and case law have restricted municipal tort liability under similar circumstances to nondiscretionary acts or omissions.

With regard to inverse condemnation law, local governments are probably not liable for damage caused by known natural destructive forces on the basis of a zoning or development decision. In light of the recent trend of California inverse condemnation cases, this conclusion may shortly be subject to change. Ongoing monitoring of pending litigation by local government is a necessity.



Part III: Alaska Today

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Chapter 7: Current Seismic Risk Mitigation and Preparedness in Alaska

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Current Seismic Risk Mitigation and Preparedness in Alaska

Evaluation of current disaster mitigation and preparedness practices in Alaska is the next step in reviewing the two-decade period following the 1964 earthquake. A comparison of the historical overview with the current situation will assist in offering alternative approaches to deal with the planning and administrative problems of earthquake disasters in the future.

This review focuses on

1. disaster preparedness providing immediate, short-term response to an emergency;

2. the intermediate process of reconstruction and restoration of the physical, economic, and social infrastructure;

3. long-term mitigation of earthquake related hazards to life and property.

Each of these components were part of the recovery following the 1964 earthquake. However, in the effort to rebuild the commercial, residential, and governmental infrastructures, the restoration and mitigation phases were not defined adequately and were perceived as competition rather than complementary goals. Mitigation efforts were seen as roadblocks to rapid restoration. In some cases, decision makers failed to take into account planning and mitigation needs. This resulted in short-term benefits but long-term vulnerabilities to future loss.

A critical problem since 1964 has been the incomplete integration of these three components into a single process designed to reduce future loss. While preparedness, restoration, and mitigation are recognized conceptually as interactive elements in a policy process, they rarely are treated that way in policy implementation. As a result, responsibility and administration of each goal has been compartmentalized, leading to a failure in understanding of the interactive policy effects such that an action in one area reduces the demand for effort in another.

Within this chapter, the issues found in relief, reconstruction, and mitigation will be viewed in terms of structure and leadership of the response, resource allocation, political environment, agency coordination, communication, and the role played by education. In addition, issues will be evaluated in terms of effort, output, and cost effectiveness, performance impact, and the process developed to address them.

The information in this chapter is based on a mix of primary and secondary data. In chronolo-

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gical terms, relevant organizations at the local, state, federal, and private levels were reviewed to identify responsibilities, key personnel, studies, documents, and reports related to the study objectives. Upon a review of secondary resources, separate qualitative interview guides were developed for civil defense directors, planning officials, utility officials, superintendent of schools, public safety and public works officials, and others, related to their responsibilities in the process.

Team professionals visited the communities of Valdez, Kodiak, Cordova, Homer, Kenai, Seward, Seldovia, Whittier, Palmer, Juneau, and Anchorage to conduct interviews with key players in the preparedness system. Telephone interviews complemented on-site efforts and a total of 157 interviews were completed. These included 112 interviews with public sector officials and 45 interviews with people in the private sector. Of the government employees, 119 were local officials, 23 were from the state, and 15 represented the federal government. Fifteen interviews were with public works officials, 10 with planners and community development directors, and 18 were completed with public safety officials. In addition, 12 mayors and city/borough managers, 10 elected council/assembly representatives, 5 harbormasters, and 8 health care delivery personnel were interviewed. At the state and federal level, 10 geologists, seismologists, and natural resource scientists, and 12 emergency preparedness/disaster response agency representatives were interviewed. Seven members of planning and other boards and commissions, 7 utility personnel, 5 school district officials, and 6 volunteer agency representatives (such as Red Cross, The Salvation Army, etc.) responded to questions. Finally, members of private organizations with designated preparedness roles, consultants conducting planning design and construction work, and a selection of larger private businesses were contacted. Often interview material was crosschecked with secondary sources or additional interviews to verify critical material.

Supporting this effort, an additional 34 incorporated communities along the southeast, southcentral, and southwest coasts and the Aleutian chain were asked to respond to a short inquiry regarding their community's efforts in disaster preparedness and mitigation efforts. Of the 34 communities surveyed, 53 percent returned the questionnaires for analysis. Most of the responding communities were from the southeastern and southcentral areas of the state. Each of these interviews was qualitatively analyzed.

To gain an understanding of national and regional efforts, team members attended the Western States Seismic Policy Council meetings in Phoenix, Arizona in May 1982; the Microzonation conference, Seattle, Washington, June 1982; Earthquake Engineering Research Institute Seminar, Anchorage, Alaska, October 1982; the

International Earthquake Conference, Los Angeles, California, February 1983; the American Planning Association annual meeting, preconference seminar on Planning and Earthquake Risk Mitigation, Seattle, Washington, March 1983; ASPA National Conference, Administrative Response to Natural Hazard Mitigation Policy Implementation, New York, New York, April 1983; and the University of Colorado, Natural Hazard Research and Applications Information Center Workshop, Boulder, Colorado, July 1983.

Anchorage

Today Anchorage is a large metropolitan city with a mid-1983 population of 238,000. Development is extensive throughout the bowl area and very little prime building land remains. Since 1964, the economy of Anchorage has become significantly more diversified. The largest employer is still government at all levels, with private sector employment showing the largest gains in the past two decades. The greatest growth in the private sector has been in the service industries. In recent years the city has strengthened its position as a distribution center for the state. Several oil companies have their headquarters in the city (Figure 26).

A number of critical seismic hazard issues face Anchorage. Local government has permitted extensive commercial redevelopment in the L Street slide area. Multi-storied commercial structures and multi-family residential structures now cover L Street despite documented levels of risk. In addition, during the past few years the Turnagain slide area below the bluff has been subdivided. Despite the immense destruction from the earthquake, this area was never officially rezoned to an open space category and private developers have ignored the risk aspects and pushed ahead with development.

The Fourth Avenue slide area was buttressed following the earthquake and development complies with the recommendations of the urban renewal plan developed for reconstruction. This zone has height and loading limits. Zoning ordinance changes, however, are needed to insure the continuation of these restrictions. This 'special zone' must be shown on zoning maps to ensure that in the future only development complying with engineering restrictions will be allowed. The Fourth Avenue slide is the only area given this special designation in Anchorage.

Extensive new residential construction has occurred in the surrounding hills and in large bogs and swamps. This development in the lower and middle elevations of the Chugach mountains has been popular during the last decade due to the excellent views. Development has displaced the natural vegetation and some homes have been built on pilings on steep slopes. No water or sewer systems are available, therefore wells and on-site disposal systems are used. It is feared that removal of vegetation coupled with the changes in the water content of the shallow,

Figure 26. Anchorage Today

Source: Air Photo Tech

unconsolidated material may result in localized sliding in the event of another earthquake. Local instablility may occur in the lowland, where construction has taken place in marginal areas with high water table and thick peat deposits. Construction on pilings and on manmade fill had not occurred at the time of the 1964 earthquake, therefore these conditions have never been tested.

The city of Anchorage has adopted a comprehensive development plan and a zoning ordinance; however, to date special zoning regulations recognizing areas of seismic hazards have not been adopted. A coastal zone management plan adopted by the Municipal Assembly, the State Legislature, and the Federal Coastal Zone Management Agency delineates seismically hazardous areas; however, mitigation and disaster prevention methods have not been developed.

The Municipality has adopted and enforces the 1982 Uniform Building Code Seismic Zone 4 requirements; however, many local officials believe that these national standards are not stringent enough to mitigate or prevent damages from a major earthquake.

Since the mid-1970s, Anchorage has benefited from the expertise and experience of a Geotechnical Advisory Commission made up of professionals with training on seismic issues. The group started slow, but was heavily utilized in 1982 and 1983, advising the Anchorage Municipal Assembly on siting and seismic safety of a proposed state office building to be built near the Fourth Avenue slide area, and in reviewing a new downtown comprehensive plan. The commission is only advisory in nature and has no regulatory or enforcing powers; however, their increased participation displays an awakening of greater public awareness of seismic risks in Anchorage.

Building instrumentation has been a dynamic issue facing local officials in recent years. In the late 1970s local government removed the building instrumentation requirement of the Uniform Building Code because of cost maintenance and pressure from private developers. In 1983, due to the diligent efforts of elected officials and the Geotechnical Advisory Commission, the code has been amended and the provision was reintroduced with funding appropriated for the maintenance and monitoring of the instruments. Other areas where increased mitigation efforts are evident include the computerization of slope and soils information by the municipal planning department. The data will be of assistance in assessing specific sites and providing a resource base for geotechnical hazard studies needed for the design of high rise structures.

The disaster response process is far more organized and dynamic than what existed at the local level in 1964. A well organized emergency response plan exists for the Municipality, although its orientation has been toward nuclear attack rather than natural disaster. In August 1983 the Municipal Assembly passed an ordinance changing the name of the Department of Civil Defense to Office of Emergency Management, and establishing that risk preparedness must include all risks, not only the risk of war. A director with broad knowledge of risk mitigation and hazard prevention was appointed. The city has an excellent emergency medical staff organized under the fire department. Local private hospitals also are well prepared for a seismic event, but their preparation is not coordinated well with the local government. For the first time, in 1982 a successful disaster simulation exercise was completed utilizing private hospitals, local government, and military personnel as players.

It is encouraging that in the past two years local government has displayed increased awareness and greater willingness to direct attention to seismic risk mitigation and disaster prevention. However, the city still lacks the means of integrating seismic risk into the comprehensive planning process and implementing such mitigation efforts.

Cordova

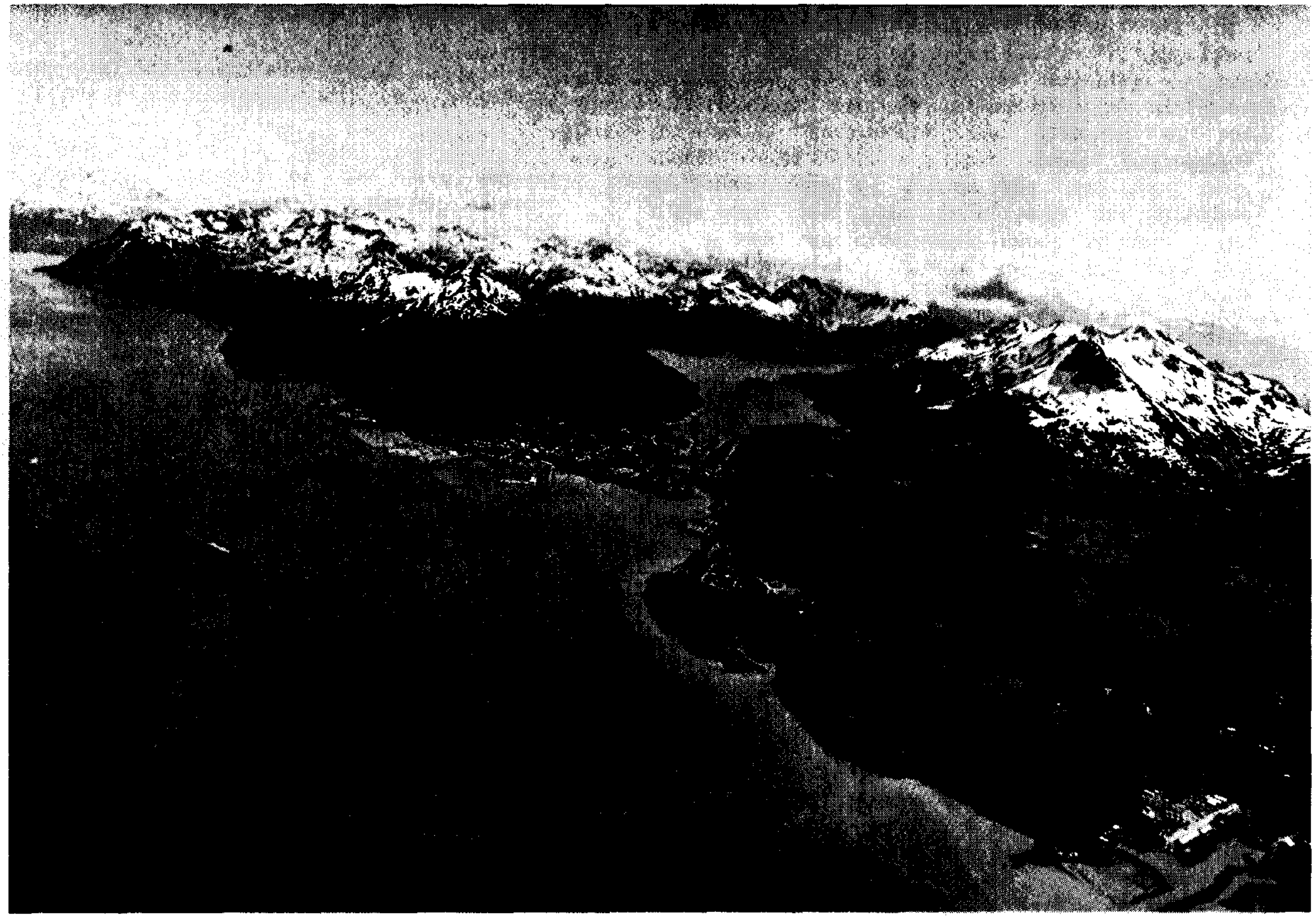
In 1980 Cordova had a permanent population of 2,780 within city limits, and an estimated 3,000 to 3,500 people residing in the entire service area. The population fluctuates with seasonal employment, almost doubling during the fishing season with an influx of transient fishermen, tourists, cannery workers, and their families. The economy is still largely dependent on the fishing industry.

Access to Cordova remains limited to air and water. The city maintains two docks and two airports and is a stopping point on the Alaska Marine Highway System. The extension of the Copper River Highway beyond the portion under construction prior to the earthquake remains in the planning stages.

As noted earlier, one incidental but positive impact from the uplift which occurred in the area was the expansion of the waterfront. Once a slough, this area was uplifted and portions of it filled, creating a new 20-acre industrial/ commercial zone. It should be noted, however, that uplift and subsidence may effect this area in the future (Figure 27).

Planning resources in a city the size of Cordova are very limited. Cordova has prepared a Coastal Zone Management Plan which contains passing reference to tsunami hazards and seismic activity. No other ongoing planning with respect to earthquake hazard mitigation appears in local government documents. In fact, the only new building in which seismicity was a consideration

Figure 27. Cordova Today



Source: Air Photo Tech

is a power plant, still in the planning stage. Cordova seems typical with regard to mitigation and public policy. Lack of public education, a general lack of interest as well as adequate funds puts mitigation low on the list of local government priorities.

Homer

Since March 1964 the city of Homer has grown to a population of over 2,000 people. In the summer the spit is a favorite location for tourists. A hotel has expanded its quarters at the end of the spit. Tourism, fishing, and fish processing provide the basic economy for the community.

Residents remain vulnerable to earthquakes. The potential for tsunamis resulting from volcanic eruptions of Mount St. Augustine is another threat to the city. This active volcano is less than 80 miles from Homer. Landslides generated by an earthquake remain a potential hazard. 'Thus, extensive building on the outer end of the spit seems very unwise' (Waller 1971).

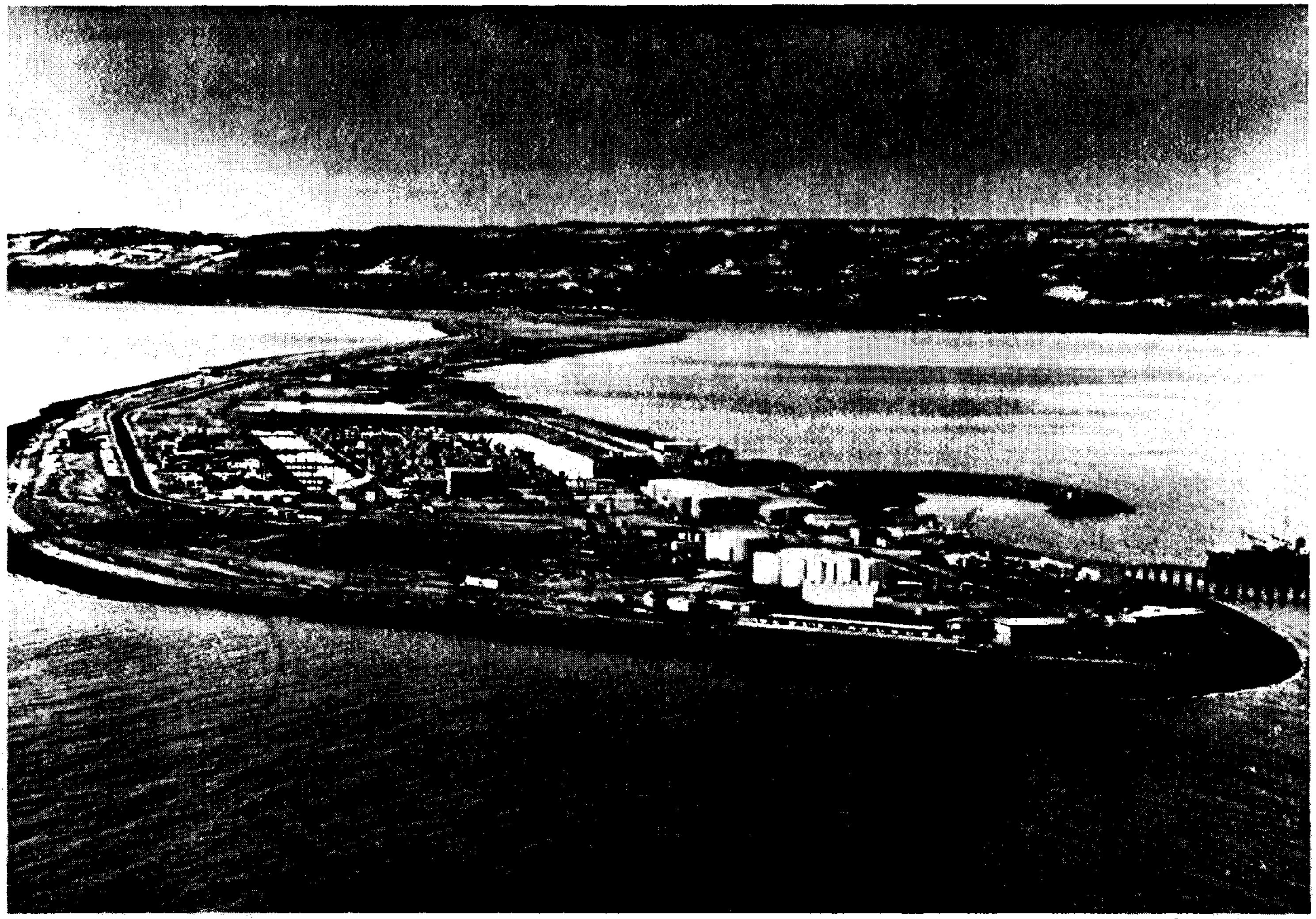
The city has an emergency response plan which was prepared over the last several years and contains sections on natural disaster response. Local radio stations broadcast tsunami warning simulations four times per month. However, the local government does not seem well prepared to evacuate the spit or surrounding low-lying, vulnerable areas. The spit has a siren system, but local officials consider it inadequate. It has been estimated that evacuating the low-lying areas would take 2-1/2 to 3 hours and evacuating the spit would require 45 minutes. The harbormaster's vehicles are equipped with a public address system to be used for warning, but the actual evacuation and traffic control procedures have never been tested.

No building codes have been adopted in the city. Homer has a comprehensive plan which has recently been updated. The Kenai Peninsula Borough has developed a Coastal Zone Management Plan but, as of this date, it has not been adopted. Current local policy prohibits permanent residences on the spit. The development of further overnight hotel accommodations and industry are allowed in designated areas (Figure 28).

Another area of concern is the development taking place on the bluffs. In 1964, this area was undeveloped and experienced minor damage. The stupendous view from these lands has attracted the construction of summer and year-round residences. Vegetation has been removed and erosion is rapidly undermining the stability of the bluffs. Some local government officials are concerned that they are becoming vulnerable to land slides, but elected officials have been reluctant to finance formal studies to determine the true level of hazard.

It appears that local government places a low priority on emergency preparedness and earthquake hazard mitigation policies. With marine-related

Figure 28. Homer Today



Source: Focus Foto

activities being the heart of the economy, the government is naturally reluctant to instigate plans and programs which would limit this industry to any degree.

Kodiak

The Kodiak Island Borough has a population of 9,939 with large seasonal fluctuations due to the active commercial fishing industry. The city of Kodiak is the largest community in the borough, presently housing a population of 4,756, and is the central hub for the commercial fishing and the fish processing industries in the area. The Kodiak area also benefits from a thriving tourist and recreational fishing industry.

As in 1964, the Kodiak area remains susceptible to tsunami inundation. The Borough of Kodiak developed an Emergency Preparedness Plan in 1973 and the document contains elements addressing natural disaster response. Kodiak has a U.S. Coast Guard station in the immediate vicinity. The station is geared toward disaster response activities and regularly participates in tsunami training exercises. Due to its location, however, the facility itself is vulnerable to tsunami inundation. However, facilities constructed since 1964 have been located above the mean flood line, reducing the risk. In addition to the Coast Guard, Kodiak has available approximately 50 or 60 National Guard personnel to assist in disaster response operations. Members of the city government have participated in annual simulated exercises through the State Division of Emergency Services, testing the statewide notification system.

According to local government personnel, the City of Kodiak has placed a low priority on emergency preparedness. Local government suffers from the common philosophy that response to earthquakes and tsunamis is beyond their control. In addition, there is a general feeling that the Coast Guard will provide the necessary disaster response operations. Kodiak has experienced a lack of continuity in local government leadership. According to one official, the city has had 15 city managers in the last 16 years. This level of turnover tends to negate the effectiveness of ongoing programs, including those responding to natural hazards.

On the positive side, lifeline facilities now are less susceptible to tsunami inundation than in 1964. Police and fire facilities, schools, hospitals, and city and borough administration offices are located on higher and much safer ground. The area that was inundated in 1964 now mostly is developed with commercial establishments. No single family homes remain in the high hazard area; however, there are some multi-family dwellings (Figure 29).

The Kodiak Island Borough has a comprehensive plan which is out of date and has adopted a Coastal Zone Management Plan. Major studies

Figure 29. Kodiak Today

Source: North Pacific Aerial Surveys, Inc.

have been conducted to evaluate an area with high potential for landslides on the southeast slope of Pillar Mountain (Kachadoorian and Slater 1978). Increased movement of the slope and rock fall began in 1971 after the removal of a large quantity of material from the base of the slope for construction of an extension to the city dock. It is projected that severe sliding could result in a locally generated seawave, which would inundate the city in a similar manner as occurred in 1964.

The Kodiak Island Borough and Near Island Master Plan, completed in 1982 and funded by a grant from the State of Alaska to the City of Kodiak, recommended a variety of measures to mitigate local tsunami damage including stabilization of Pillar Mountain, creation of a breakwater, and the recommendation to permit industrial uses in the tsunami experience zone with residential uses located outside the hazard zone.

As a result of extensive testing and evaluation by a technical committee appointed by the state, the Kodiak Borough, and the city, it was found that the potential for major sliding does exist. Remedial work recommended includes removal of material at the head of the potential slide area, terracing, and buttressing of the base of the slide. To date no money has been appropriated for engineering and construction of the project.

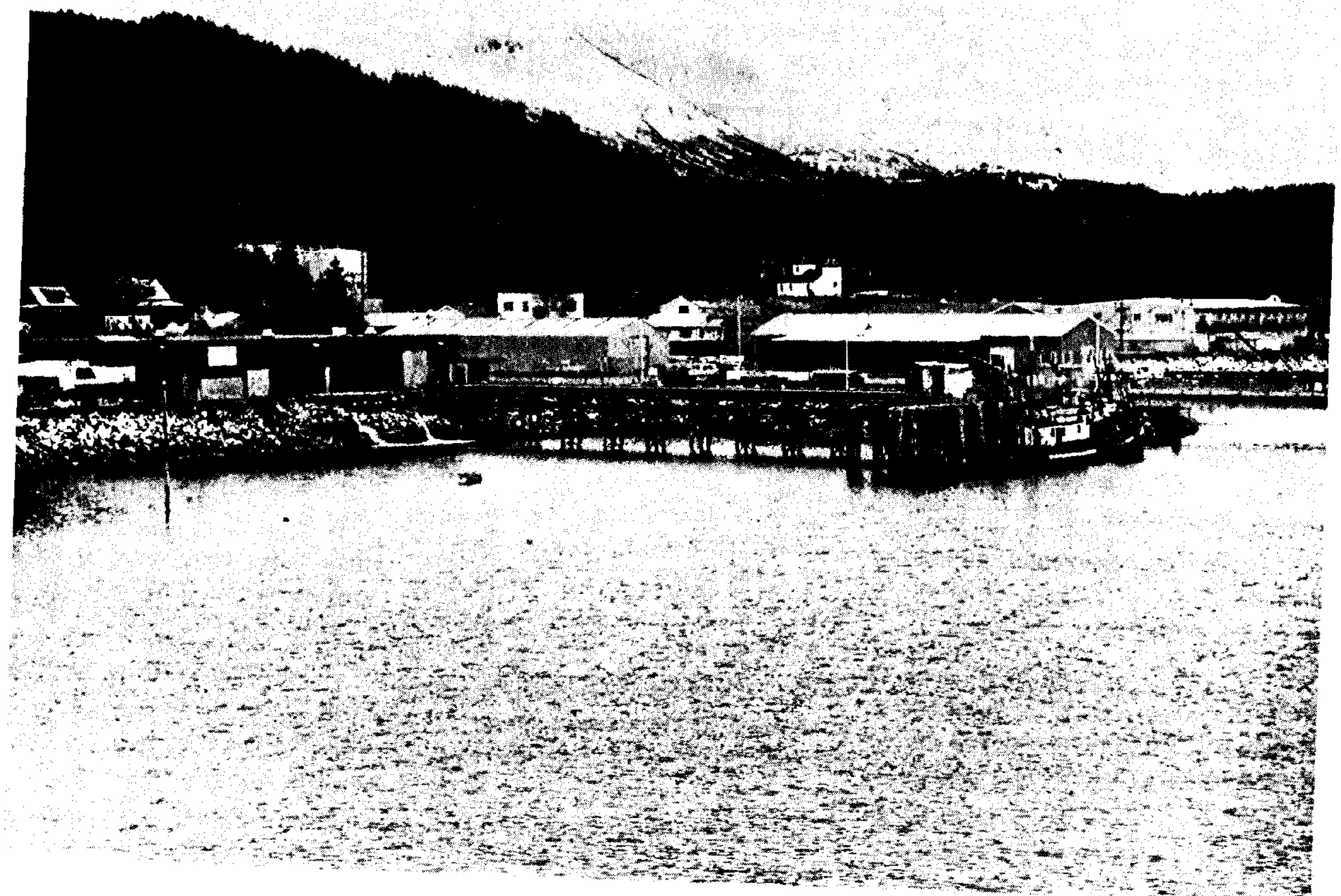
Commitment to disaster mitigation measures in the city and borough governments appears weak. Coastal Zone Management has provided an avenue for control that did not exist before, and the Uniform Building Code is being utilized. However, according to local officials, special earthquake concerns have not been taken into account. Part of the problem is simply not knowing which questions to ask--typical in smaller communities.

Seldovia

Seldovia has a population of 479. The community's economy is tied to the fishing and the fish processing industries, as well as tourism from the Homer area (Figure 30).

According to public safety officials disaster response has received good public input and the city has an emergency preparedness plan. Seldovia maintains a siren system for emergencies which can be tapped for tsunami warnings. Local government personnel are concerned, however, about the lead time needed for locally generated tsunami warnings to insure evacuation of the waterfront area to higher ground. Here, as in Homer, volcanic activity at Mount St. Augustine could result in a seismic sea wave which might impact the area with little warning. There also is concern that even though people know what to do in the event of a tsunami warning, they are unaware of how rapidly they must move in order to insure their safety. Earthquake preparedness and tsunami information have been included with utility bills in an effort to increase public awareness.

Figure 30. Seldovia Today



Source: *Real Life Images*

As with the other southcentral communities, Seldovia does not have an on-going program of earthquake hazard mitigation. However, the community has a comprehensive plan, has adopted the Uniform Building Code, and has a designated building inspector. Earthquake risk was considered several years ago in the construction of a medical clinic. Public officials seem aware of the risk, and reasonably prepared, given their limited resources.

Seward

Seward has a population of 1,843 within city limits (1980 U.S. Census). The city is accessible by highway, is the southern terminus of the Alaska Railroad, and is a stopping point for the Alaska Marine Highway System. The boundaries of the city contain 22 square miles, of which only four or five square miles are developed or suitable for development (Alaska Consultants 1979).

The economic slump which followed the 1964 earthquake lasted until the mid-1970s. Since 1976 Seward has been a base for oil exploration activities in the Northern Gulf of Alaska. The harbor is deep and ice-free, and is in close proximity to the outer continental shelf activities of major oil companies. Other industries contributing significantly to the economy of Seward include commercial fishing and fish processing, the federally-owned Alaska Railroad dock and shipping facilities, and a lumber mill producing green lumber and wood chips used in paper production. Seward also has a significant tourist industry due to ideal boating and recreational fishing conditions (Figure 31).

Due to Seward's location on Resurrection Bay, railroad facilities, dock facilities, and fuel tanks always will remain vulnerable to geophysical hazards and resultant tsunami activity. Local government has recognized this hazard and has prepared an effective tsunami evacuation warning system which is unique among the communities impacted in 1964.

Although a land use plan has not been adopted, the city has adopted and enforces the Uniform Building Code. The city engineers stated that the recent construction of a large industrial project was preceded by an extensive study on the level of seismic risk. City officials maintain that land use classifications established to supplement the recommendations of Task Force 9 generally have been followed. Local government has acknowledged the waterfront area as high risk and certain portions have been designated for park and recreational use by city ordinance. This compliance largely is the result of federal regulations governing urban renewal funds in 1964 that allowed for condemnation and acquisition of waterfront land. However, public awareness of seismic and tsunami hazards is poor.

Mitigation practices appear to be in effect with the location of the proposed extension of the

Figure 31. Seward Today

Source: Air Photo Tech

harbor facilities. The site selected for the new facility is one recommended in 1964 by geologists and supported by planners from the Alaska State Housing Authority (Lemke 1971).

Seward has not rebuilt in high risk areas; however, lack of local resources, poor public education, and lack of an adequate means of implementing mitigation practices makes it difficult for Seward to focus on the importance of this issue.

Valdez

The Port of Valdez was chosen in the early 1970s as the terminus of the Trans-Alaska Pipeline. The city has a population of 3,079. Valdez is accessible by air, by road via the Richardson Highway, and is a scheduled stop on the Alaska Marine Highway System (Figure 32).

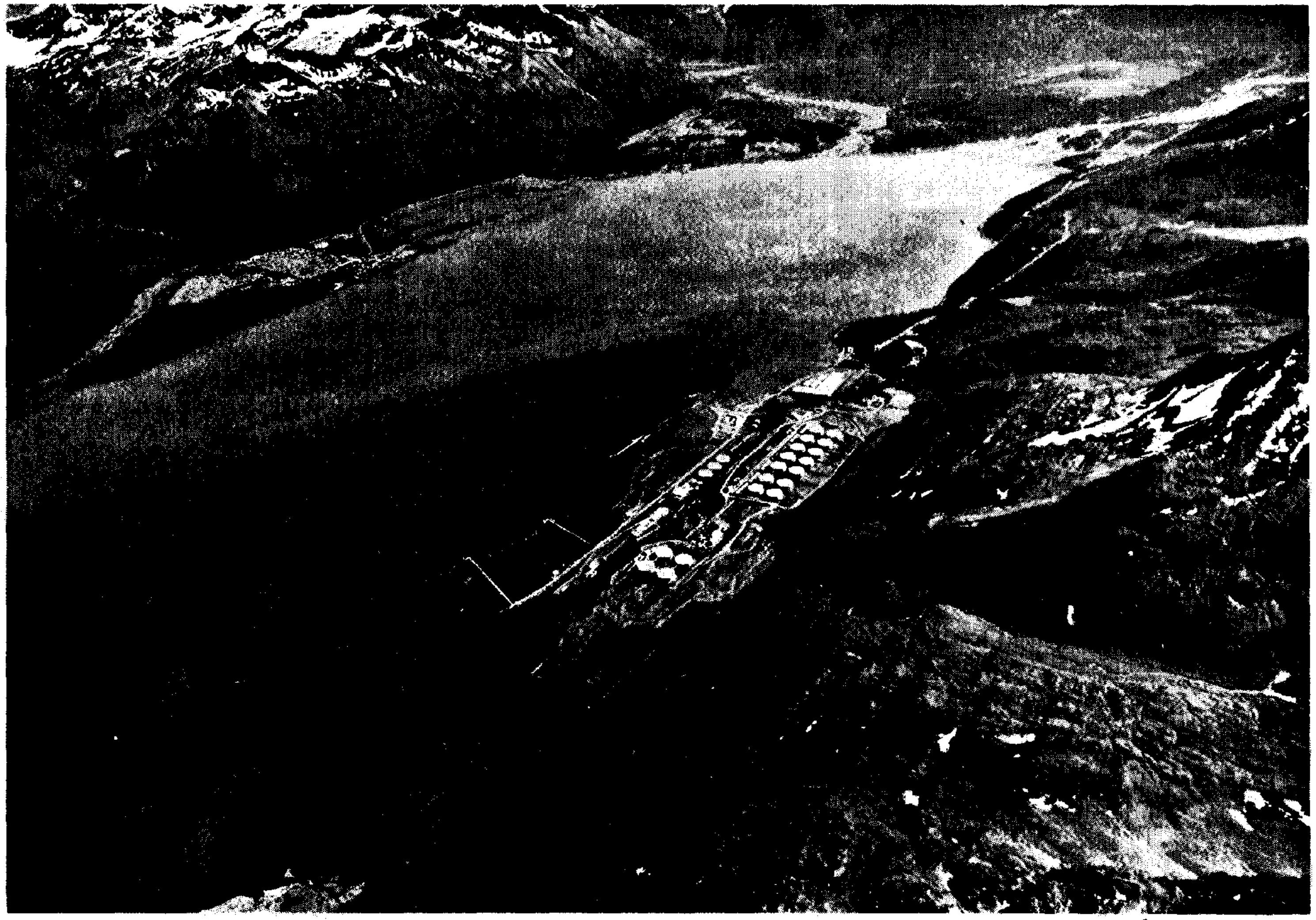
The city has prospered in recent years due to revenues generated from the Alyeska Pipeline Company's marine terminal facilities. Valdez, an ice-free port, benefits from both commercial and recreational fishing and has a thriving tourist industry.

Disaster preparedness is on a par with other coastal communities in Alaska. The city has an emergency preparedness plan and schools practice annual earthquake drills, with teachers receiving special training. Hospital personnel have had only minimum emergency preparedness training and the facility maintains a very limited stockpile of supplies. Lack of adequate numbers of medical personnel to meet disaster-caused injuries could pose a problem. Public officials generally believe that public awareness is low.

Alyeska Pipeline Company maintains a self-contained enclave, however, medical needs are generally met at the Valdez Community Hospital. Local community health officials indicated that no ongoing working relationship exists between local emergency preparedness personnel and the marine-pipeline facility personnel with respect to disaster response preparations. In addition, it is very likely that road access to the pipeline terminal would be cut off as a result of damage from a large earthquake or locally generated tsunami, although the facility usually could be accessed by air or water. With potential fire hazards and other disaster-related problems associated with the industry, this lack of coordination could pose a problem in emergency response.

The city is situated as well as a port community in this region could be with respect to seismic risk. City officials stated that the city adheres strictly to the Uniform Building Code Seismic Zone requirements and performs site-specific evaluation for proposed public buildings. The City Hall building specifically was designed and structured to handle earthquakes, and schools and the community hospital were surveyed to assess geophysical risk. In 1982 the city

Figure 32. Valdez Today



Source: Air Photo Tech

installed a new dock. Floats were used in the design to withstand the effects of severe ground shaking and tsunami hazards. If dislodged from their moorage, the floats can be retrieved and restored.

There has been a great deal of pressure to rebuild at the old townsite. Local business interests are pressing the city to sell industrial development bonds for development of the area at the head of the bay. To date these attempts have been unsuccessful.

Other than the recommendations made immediately after the earthquake the city has not adopted additional regulations directed to risk mitigation. However, Valdez has commissioned the mapping of natural risks as part of the preparation of a Coastal Zone Management Plan. In addition, Valdez's prosperity has given the community more public facilities and more human and material resources to draw on in the event of a disaster.

Whittier

The city of Whittier became an incorporated municipality in 1969. In 1973 the city bought, for $200,000, all the U.S. military installations except the petroleum facilities. Today the city is a prime recreational center for pleasure boating and is an important fishing center due to its excellent access to Prince William Sound. The year-round population is about 200 with a higher influx during the summer months. The community continues to function as a vital rail-port link with southcentral Alaska having the only roll-on-roll-off barge/rail facilities in Alaska. Access continues to be limited to water and rail.

Whittier does not have an emergency preparedness director or plan. It is generally assumed that the police and fire chiefs would be in charge in the event of an emergency. No medical supplies have been stockpiled in the area and no doctors or nurses reside in the community. Seventeen people have been identified who are classified as Emergency Medical Technicians Level 1. Due to its isolation, evacuation of the community in the event of an emergency could be extremely difficult. Communications with areas outside Whittier are limited to telephone and a marine sideband belonging to the railroad, as well as the radios on board vessels in the area. There is no tsunami warning system. There is a siren at the firehall but it is not set up for use in such an emergency. People residing on their boats during the summer particularly would be vulnerable to locally generated tsunamis.

The community has a planning and zoning commission but no building codes have been adopted. Earthquake hazard mitigation practices are virtually nonexistent. The old military buildings were designed to withstand earthquakes and held up relatively well in 1964, with the exception of some nonbearing walls in one building. The fuel tanks, which caught fire and burned in 1964, have been reconstructed on the same site at the head of the bay and remain vulnerable to inundation and subsidence in the event of another earthquake.

Present Organizational Structure

The number of organizations which directly or indirectly address the attendant problems of natural disasters is almost limitless. This section highlights big organizational components. By dividing the section into two parts, there is a recognition that two sets of private and governmental institutions exist with only limited interaction despite the effect that actions in the preparedness field have on mitigation efforts and conversely mitigation effects on preparedness.

Organzations Addressing Earthquake Preparedness and Response: The chain of command in the declaration of a disaster has not changed significantly since the Great Alaska Earthquake. Most communities under study have designated an emergency preparedness director who is briefed on the procedures of handling local emergencies. Of the Pacific Rim communities surveyed, 50 percent had developed civil defense-type plans and 44 percent had a designated civil defense/emergency preparedness director.

When the resources at the local level are exhausted local directors can notify the appropriate state department. In Alaska responsibility rests with the Department of Military Affairs, Division of Emergency Services (DES). This agency, working closely with the local designer, analyzes the situation at the local or regional level and deploys needed resources to assist in disaster response. DES is responsible for coordinating all relief efforts at the state level, including tapping resources from all other state departments. The agency is an arm of the governor and acts on the authority of the chief executive. If it is found that the scope of the disaster is beyond state and local resources, the Governor may request a disaster declaration by the President, thereby qualifying the area for federal aid.

The Disaster Relief Act of 1974 (Public Law 93-288) defines a major disaster as any

> hurricane, tornado, storm, flood, high water, wind-driven water, tidal wave, tsunami, earthquake, volcanic eruption, landslide, mudslide, snowstorm, drought, fire, explosion, or other catastrophe in any part of the United States which, in the determination of the President, causes damage of sufficient severity and magnitude to warrant major disaster assistance above and beyond emergency services by the federal government to supplement the efforts and available resources of states, local governments, and private relief organizations in alle-

viating the damage, loss, hardship, or suffering caused by a disaster.

The President has delegated the primary authority of disaster assistance coordination to the Federal Emergency Management Agency (FEMA Executive Order 12148). An appointed Federal Coordinating Officer makes the initial appraisal of the disaster and coordinates all disaster response efforts. State and federal declarations allow emergency spending measures to go into effect. Assistance may be made directly to an individual or to state and local governments. Theoretically, FEMA works through the states, but operationally it can work directly with municipalities.

An earthquake of the magnitude of the 1964 event would require federal resources for disaster response and restoration; smaller disasters could be handled by the state. Under either scenario DES would identify and deploy resources in accordance with the State of Alaska Natural Disaster Plan, prepared pursuant to provision of Alaska Statute 26.23.040, April 3, 1978. This plan, required under Public Law 93-288 and approved by FEMA, makes the state responsible for disaster recovery. The federal government only supplements state efforts. This will insure that the state has greater control over the long-range recovery and mitigation than it did in 1964.

The 1978 Alaska Disaster Act broadened the responsibilities and powers of the DES by eliminating the old State Disaster Office and placing all state emergency programs under one organization. However, the division has never been adequately funded. DES has a small headquarters in Wasilla, north of Anchorage, and a few field offices scattered throughout the state. The intent is to expand the division in the event of a disaster. This approach has limited the division's mandatory mitigation activities, which require ongoing institutional support in order to be addressed successfully.

The state's emergency response plan, adopted in 1978, involves a detailed description of departmental responsibilities and emergency response procedures in the event of floods, forest fires, earthquakes, tsunamis, utilities emergencies, and volcanic hazards, as well as civil defense procedures in the event of a national emergency. Officials from departments which would be affected by DES actions are aware of the existence of the plan and generally are knowledgeable of their designated role. However, all deferred the function of coordination to DES as the agency in charge of handling the operation.

At the local level there are now 22 communities with emergency response plans on paper. DES has reviewed these plans and made recommendations on their development, but has provided little financial support. Annually DES conducts on-site practice sessions in each of the communities. Emergency planning, however, is not a primary mission of DES as indicated by a memorandum from the Commissioner of Natural Resources (December 24, 1982). The commissioner declined to assist the community of Hyder in preparing a disaster plan because DES's primary focus is on "responding to disasters rather than preparing for them" (Combellick, no date).

The Anchorage emergency preparedness plan deserves special notation. It is considered a prototype plan within Alaska. The federal government, which pays half of the civil defense costs at the local level, provided information and guidance toward the plan. The plan is detailed in emergency operations procedures and has been commended by those in the emergency preparedness field. The plan, however, reflects the federal government's orientation in the area of emergency preparedness in that much of the plan is devoted to nuclear war protection.

Other areas which the plan devotes attention to are air disasters, hazardous materials, and earthquakes. The earthquake section of the report is comprised of only six pages out of a total of 267. This is noteworthy in that Anchorage has the highest population density in Alaska, yet displays little planning effort at the local level regarding specific disaster response in the event of a major earthquake. In general, however, the plan is detailed in emergency operations that can be adapted to a natural disaster situation.

Other communities' plans are neither as current nor as well developed. Outside designated civil defense directors, few local officials were aware of the contents of the plans. Several local directors expressed a need to update the plans but felt that limited resources would not allow meaningful improvements. In the smaller communities, official recognition of planning for disaster is mixed. Some local administrators expressed little interest in pre-planning and suggested that local ad hoc efforts supplemented by external assistance are of more value than any planning exercises.

While federal, state, and local resources have contributed towards the development of response planning, it is not clear whether proper implementation of this planning effort has occurred in Anchorage or in other communities in southcentral Alaska. While civil defense directors have been designated for all of the incorporated areas in southcentral Alaska there is little evidence that these directors have taken on more than a narrow role for themselves in emergency preparedness. Interviews with the directors suggest that they see their function as active only in the event of a disaster and not on a regular ongoing basis.

Only Anchorage has a full-time civil defense director who does not share responsibilities with other municipal functions--police chief, city manager, etc. However, even in Anchorage the civil defense office has always been a nominal operation. While the office has been aggressive in planning for a future disaster it has had limited success in its ability to organize and coordinate other agencies.

It also appears that the civil defense directors only occasionally attempt regular communications or public education. Communications are infrequent with DES and with other local government officials in the same community. Interviews with elected local officials suggest that they rarely are involved in the process nor have they been informed about civil defense drills.

The result is a relatively weak commitment to emergency preparedness, both politically and in terms of resource allocation. Budgets are small, staffing, especially in the smaller communities, almost is nonexistent, and the political environment tends to ignore the whole issue. For example, the preparedness officer for one of the Anchorage hospitals stated that although he had held his job for three years, he had not met the Anchorage civil defense director until a few weeks prior to our interview in May 1982. In most communities many officials responsible for various aspects of emergency preparedness and response were not aware who their civil defense director was, or, if they knew, had never been contacted by that person for anything related to preparedness. Thus it appears that while planning exists on paper and the basic infrastructure and designees for emergency preparedness are in place, they have failed to expand beyond very limited roles.

Compared to community efforts, DES is better staffed and better trained. However, because of the large number of communities that DES serves, as well as the extent of mandated responsibilities, attention to individual communities is limited. Many local officials complained that though state officials were well meaning, their visits to speak to local media, local assemblies, and to the public provided only minimal support or knowledge for the real preparedness needs of the community.

Many times directors would open their desk drawers and show the tsunami warning stickers or earthquake preparedness instructions that are supposed to be hung on public phones or distributed in public places. Of the Pacific Rim communities surveyed, only 22 percent carried out any public education on what to do in case of an earthquake. This reflects the difficulty with state efforts at public education. Without the support and interest of local personnel, state efforts in public education and mobilization are limited.

If a community does not have its own emergency plan, DES will prepare one for it. However, these local emergency plans are not incorporated into state regulations; therefore local responsibilities are not mandated, and state authority merely is advisory.

Organizations Addressing Earthquake Mitigation: One of the key weaknesses of mitigation efforts has been the difficulty in identifying agencies to be held responsible for policy development. Twenty years after the 1964 earthquake this problem appears to be slowly resolving itself. At the federal level the Federal Emergency Management Agency (FEMA) which consolidated much of the government's efforts in risk management, has established a new hazards mitigation program. While FEMA has had a statutory mitigation role, its actual work and effort has historically focused on relief and reconstruction. The new mitigation activity is a departure from the past and reflects a heightened interest on the part of the federal government in hazards mitigation.

The state of Alaska has faced a similar problem in that the Division of Emergency Services created under state statute also had the legal mandate for natural hazards mitigation. However, due to funding, staffing, and general emphasis on emergency preparedness the division has done very little in regard to hazards mitigation. DES also interfaces as the state agency with local civil defense and emergency preparedness offices. These offices, while having the legal authority to pursue mitigation measures, have undertaken very limited efforts in this area.

One unsuccessful attempt to implement a hazard mitigation program was the proposal for an Alaska Hazards Advisory Council. The division developed such a proposal in 1981 to insure a comprehensive approach to hazard mitigation with the use of experts from various technical fields, i.e., engineering, architecture, planning, geology, and seismology. Although never formally rejected, the proposal was tabled at the department level and never entered the legislative review process. This suggests a form of political power which prevents ideas from ever coming up. Controlling the public agenda reduces the need to publicly oppose proposals.

Other proposals have been more successful in implementing mitigation-oriented programs. In 1983 the state approved a reorganization of the Department of Geological and Geophysical Survey (DGGS) and added an engineering geology section. This section now has a state seismologist for the first time in Alaska. House Bill 379, passed in 1983, is a pioneering effort on the part of the state to fund activities related to hazards. For example, this bill, along with a $500,000 appropriation, will help develop an Alaska seismological data center in conjunction with University of Alaska Geophysical Institute. This will eventually become an archive for all existing seismic data to be used by planners, politicians and private industry. In addition, the monies will be used to fund a number of seismic stations in various regions in Alaska and for instrumentation of buildings. This is the first time that state resources have been directly appropriated for these uses. In addition, money has been appropriated for engineering geological studies which will be part of an attempt to establish a seismic risk map for southcentral Alaska to be used in site specific evaluation. These recently funded proposals provide for wide ranging cooperation involving local, state, federal and academic agencies, including the United States Geological Survey, University of Alaska Geophysical Institute, Municipality of Anchorage, Division of Geological and Geophysical Survey. It is still unknown whether or not the state will be able to develop a long-term commitment to earthquake mitigation but initial efforts are promising.

There is no similar organizational development at the local level. Local planning departments and building or public works departments are the primary actors. Planning and zoning commissions, city councils, and municipal assemblies also play key roles. Public works departments have performed their functions as the primary technical group as regulation enforcers rather than as policy makers. Planning departments have straddled roles of land use law enforcement and recommended changes in mitigation efforts. Generally, however, local planners in southcentral Alaska remain cynical about local political and civic support or interest in mitigation efforts. In addition, many of these planning officials felt that their other duties, connected with limited resources, gave them little time to adequately concern themselves with seismic risk.

One local body that provides input to mitigation decisions is the Anchorage Geotechnical Advisory Commission established in the mid-1970s. Objectives of the commission include the provision of professional advice on geotechnical matters to local government, perform and review special studies as designated by the mayor or assembly, advise other land use planning and regulatory boards, recommend changes in policies where such changes would reduce seismic risk--this would include a review and recommendation of current construction practices. The commission has also been encouraged to sponsor education programs and has been a prime instigator of the strong motion instrumentation program in Anchorage. However, this body is exclusively advisory and in most of its history has been relatively ineffectual in obtaining political or community support for changes in hazards risk policy. In a 1982 review the Municipal Assembly asked the commission to come up with proposals in a number of areas, including balanced risk and the relationship between siting and construction techniques. While the commission has yet to complete its work on these topics, it is significant that a political body actually has requested these types of policy recommendations. In the past the assembly has permitted the commission's recommendations to go unheeded as in the development in both the Turnagain and L Street slide areas.

Immediate Relief - Short Term Response

When planning for disaster relief, planners are generally guided by a worst case scenario. It is reasonable to assume that southcentral Alaska will experience a future seismic event of the magnitude of the 1964 earthquake. As in the past, this will result in significant amounts of damage and all levels of government will be involved in relief operations. Adequacy of response can be discussed in terms of general organizational and planning preparedness and specific components of the relief and restoration process.

Communications: Communications technology has vastly improved since 1964. The physical isolation of Alaska's communities from the Lower 48, as well as from each other, has encouraged the use of satellite telephone and television communications and sophisticated radio technology. In addition, other communications networks utilizing HF, VHF, and microwave transmission exist, although most networks generally operate independently of each other. Modern switching equipment has been designed to withstand seismic vibrations, and microwave facilities established to access the satellite earth stations are inherently earthquake resistive and/or easily restored to service (Greater Anchorage Area Earthquake Response Study 1980).

Intracity telephone communications are vulnerable to landslides. Underground cables tend to fail in slide areas or where there are poor soil conditions. Overhead cables are susceptible to breakage from falling trees, poles, and other structures. Aside from distribution failure, it is likely that local telephone systems would

experience problems from heavy use following a large seismic event. A backlog of calls conceivably could render the system useless for several days (Greater Anchorage Area Earthquake Response Study 1980).

Sophisticated radio backup is available throughout the state. Aircraft, marine vessels, state and local agency vehicles, as well as private operators, cab drivers, and service vehicles are equipped with mobile radios which could provide communications in the event of an emergency.

Local ad hoc communications networks are expected to develop in the smaller communities.

Anchorage's police, fire, and public works departments, ambulance services, and public and private utilities have mobile radio equipment which is accessible through the Anchorage Emergency Operations Center.

Mass media communications generally are dependent on the availability of power to provide continuity in broadcasting. Certain radio stations have emergency generators and are tied into the Emergency Broadcast Network with the Division of Emergency Services. It is anticipated that these stations will be functional shortly after a large earthquake, disseminating information to the public as it becomes available.

Continuity of information dissemination, warning coordination efforts, and official intra- and interstate communications are of critical importance following a large earthquake. The DES has the responsibility of insuring the operation of communications in this area by several methods. The first is through the National Warning System communications network, whose primary function is to communicate a warning of attack on the United States, although it also is used in the event of other national emergencies.

The state maintains a separate Alaska circuit with this network for use in state and regional emergencies. The system consists of an amplified telephone circuit, generally set up at the local police or fire department, and it is monitored 24 hours per day. The network presently ties together Kodiak, Seward, Soldotna, Cordova, Valdez, Juneau, Sitka, Ketchikan, Anchorage, Wasilla (headquarters for the Division of Emergency Services), Palmer (Tsunami Warning Center), Fairbanks, Nome, and Bethel.

The United States Department of Commerce, Alaska Tsunami Warning Center is responsible for analyzing seismic episodes and determining if a tsunami warning is necessary. Once the determination has been made the agency, using the National Warning System, contacts DES. The broadcast is heard simultaneously in all of the communities listed above. Each community, along with DES, implements emergency procedures and contacts other communities in their area.

The major drawback to the National Warning System is its dependence on landlines. It is very possible that, in the event of a major earthquake, telephone networks will not be operational. To bypass this system DES maintains three radio stations with emergency generators. The first station is a single sideband tied into the frequencies for the regional headquarters of the Federal Emergency Management Agency in Washington and California. This system is tested weekly to insure voice communication and radio teletype capability. The second station is a sideband tied into specific state agency frequencies such as the Alaska State Troopers and the Department of Transportation and Public Facilities. The third station is referred to as the ALERT (Alaska Emergency Radio Transceiver) radio and will operate on any and all high frequencies. There are three additional stations which are awaiting antennas and are not yet operational. The first will provide statewide two way communications with the National Guard network, the second will be tied into the Radio Amateur Civil Emergency Services (RACES), and the third will be the state's official interface with the Military Affiliate Radio System (MARS). When the other three stations become operational, the state will have simultaneous two way communications capability on six high-frequency sideband radios.

Although DES equipment reflects state of the art technology, there is no mandate insuring that these communities purchase and be licensed to use a single sideband high-frequency radio. If a tsunami warning is issued and the telephone lines are down, there is no way to determine whether a community has officially received notification.

Public warnings can also be accomplished through the use of the Federal Communication Commission (FCC) regulated Emergency Broadcast System (EBS). In southcentral Alaska, KFQD-AM radio is the designated control station responsible for transmitting emergency information generated from official government agencies to the southcentral region of Alaska. All other radio stations which remain operational monitor KFQD. Information is transmitted over special EBS equipment to KFQD. Other radio stations with EBS equipment can simulcast with KFQD or record information to be disseminated at a later time, depending on station policy.

A change is presently underway in the use policies of the EBS. The Division of Emergency Services intends to utilize the system, not only in an emergency, but also as an information source following a major earthquake. This change is the result of a seismic event which occurred in September 1983, with a recorded magnitude of 6.3 on the Richter scale. Although the earthquake did not cause major damage or injuries, DES activated the EBS in the form of a test in order to disseminate critical information. FCC rules are explicit with regard to activation of the EBS. It is to be used only as a test or in the event of an emergency. However, DES has now received written approval to create an information dissemination mode and is presently rewriting procedures with KFQD. This will greatly expedite the information dissemination process and should enhance public awareness as to the purpose of the system.

There are numerous small networks in the private sector capable of providing inter- and intracity communications. Two voluntary groups in Anchorage are noteworthy. The Anchorage Amateur Radio Club, affiliated with the American Radio Relay League, has members participating in the Amateur Radio Emergency Services (ARES), and the Radio Amateur Civil Emergency Services (RACES). These organizations are on the DES contact list and the members are trained to provide emergency communications in any situation.

Resolution of Life-Threatening Situations: There is a wide range of agencies whose duties include search and rescue operations and the maintenance of public order. All of these agencies were interviewed and are well aware of their roles when called upon for assistance. This is an area which lends itself to "quasi-military protocol" where implementation would not be a problem.

Elmendorf Air Force Base and Fort Richardson Army Base, located in Anchorage, have disaster response plans which address the need for civilian assistance in a number of areas including search and rescue operations. Elmendorf Air Force Base particularly is geared to this component as it frequently is involved in search and rescue operations for downed aircraft and remote location rescue. The army will respond to requests from civil authorities for assistance upon approval by or at the request of the commander of the Alaskan Air Command located at Elmendorf AFB. Close coordination exists between the two bases when responding to civilian requests.

Kodiak houses a Coast Guard search and rescue unit which could be dispatched in civilian emergencies to assist the smaller coastal communities likely to be impacted by earthquake and tsunami activity. The Kodiak Coast Guard unit especially is aggressive in its practice drills because of the high potential of tsunami damage to its own facilities. Since damage suffered in 1964, the Coast Guard has located all new buildings above the high water mark to reduce risk.

The State of Alaska Army and Air National Guard, under the administration of the State Department of Military Affairs, are at the governor's disposal. Between the two military organizations there are about 2,500 people available to assist in domestic emergencies. The Guard would help maintain public order by providing security to areas of the community closed off due to hazardous conditions, and could provide search and rescue and other ad hoc support as might be required at the local level. The Army and Air National Guard participate in simulated exercises which test the viability of disaster preparedness plans.

The Civil Air Patrol (CAP) is also a part of the Department of Military Affairs. CAP is an auxilliary branch of the U.S. Air Force with squadrons located around the state. CAP has searching functions only and is not authorized to land and rescue but may fly supplies to areas in need. CAP has regular training classes in survival, searching grids, observer classes, etc. At present, they do not have a disaster preparedness plan with the state; however, they are in the process of developing one with the Division of Emergency Services.

Rescue operations, crowd control, and patrol of dangerous areas are functions of the Department of Public Safety and of the Alaska State Troopers. In those areas of the state which are unincorporated, the Alaska State Troopers will provide all these services. In areas with municipal police departments, the troopers will serve as an adjunct to local law enforcement personnel. Formal memoranda exist between the state troopers, the military, and the Coast Guard regarding agency authority and responsibility in disaster situations. The Anchorage Rescue Council was formed by the Anchorage office of the Alaska State Troopers in 1975 in recognition of a need for coordination between public and private organizations in search and rescue attempts. The organization is composed of people trained in search and rescue techniques. All are members of the National Ski Patrol and skilled in the use of skis, snowshoes, and snow machines. The state troopers maintain communications with volunteer organizations through the use of an on-call list and these volunteer services are tapped once or twice per month.

In Anchorage, rescue and extrication efforts largely would involve the Anchorage Municipal Fire Department. Within the department the largest division is Fire and Rescue Operations, with 200 people manning 11 fire stations and 15 fire companies. The department is geared toward the management of emergencies on a daily basis, giving them an added advantage of preparedness in the event of a major earthquake.

The Anchorage Police Department maintains a staff of 285 officers and a reserve force of 50. Maintenance of public order would fall under their jurisdiction in the event that major portions of the city needed to be secured. Both departments have specific responsibilities in an emergency. They have reviewed the Anchorage Emergency Preparedness Plan, and have participated in simulated exercises.

Staffing in smaller communities is commensurate with their populations. All but Whittier have a trained public safety staff. In several communities the police chief is the designated emergency preparedness director, and the fire or police department is considered the operations center for any relief efforts. Small staffs and limited resources will hinder smaller communities in a large scale disaster. Public safety officials operate under the assumption that the military would back up any shortfall in local effort.

Severely damaged and collapsed structures create serious hazards and hinder transportation and access. Avalanches and tsunamis can scatter debris across communities, block major transportation routes, and damage or destroy businesses and residences. Debris inhibits the restoration of utilities, the movement of goods and services, and search and rescue operations. After life-threatening dangers such as fires or toxic substances are under control, debris clearance becomes the next major priority.

Implementation and control of debris clearance operations would be concentrated at the Alaska Division of Emergency Services, delegated to the Department of Transportation and Public Facilities, and augmented by the Army National Guard and appropriate federal agencies. In Anchorage, the emergency preparedness office would officially maintain control with delegation of authority to the Department of Public Works for coordination between the public and private sectors. The interviews revealed no ongoing agency coordination other than traditional channels.

On the federal level, the Corps of Engineers, after receiving a formal disaster declaration from the President, has contracting powers and can function as the prime contracting agent, hiring manpower and equipment from within the private sector to perform debris clearance operations. The military can also assist. On the state level, the Department of Transportation and Public Facilities has heavy equipment and is capable of debris clearance. The Army National Guard has heavy equipment and can provide operators and manual labor to perform this function. Under federal guidelines, however, manual labor can be provided only under a disaster declaration; otherwise, only the equipment and operators can be provided.

In April 1980 a disaster was declared in Anchorage following a large windstorm that severely damaged the east part of town. The National Guard offered equipment and manpower for debris clearance, but according to Guard personnel there was a general reluctance on the part of local officials to utilize their resources.

In Anchorage, the Department of Public Works also has equipment and manpower capable of performing debris clearance and the staff is knowledgeable about who has the capacity to assist in the private sector. Duties for the department are specified in the emergency preparedness plan and the staff is aware of the plan and has participated in the emergency exercises held by the Civil Defense Office (now the Emergency Preparedness Office). In addition, the department has an in-house response plan. Within the department, the Street Maintenance Division is charged with the responsibility of opening up the streets with the assistance of private contractors, if needed.

Overall, there appears to be adequate capacity within the public and private sector to handle debris clearance operations. A weak link may be interagency and public and private sector coordination.

Debris clearance in smaller communities has not changed since 1964 and is ad hoc, utilizing public and private resources. While large scale damage would have to await external assistance, local capacities are considered good, due to the increased availability of equipment and skilled operators.

Critical Care: Direct service would occur primarily at the local level, with more serious cases being treated in Anchorage or airlifted to the Lower 48. The state's involvement would be mainly disease control, as a result of food and water contamination, and in identification and coordination of resources. State public health nurses may supplement local medical care if service falls short of demand. Divisions within the State Department of Health and Social Services were interviewed and all were aware of their roles as designated in the State Natural Disaster Plan and most have participated in simulated exercises. The State of Alaska, Department of Environmental Conservation is charged with the responsibility of testing and supervising water quality, insuring proper sewage and solid waste disposal procedures, and air quality monitoring in affected communities. The department employs sanitarians to handle field work.

Casualties resulting from an earthquake occurring in southcentral Alaska would impact all four health care facilities in Anchorage. With 186 primary care physicians, 1,248 licensed nurses, and 5 highly trained Emergency Medical Services (EMS) units, Anchorage has emerged as a regional health care provider. The hospitals generally are well equipped to handle emergencies.

Providence Hospital in Anchorage maintains a backup generator, which can provide limited service during major power disruptions, and has a well which provides a backup water supply. Food and supplies can be maintained independent of outside resources for up to 30 days. Depending on the nature of the casualties, Providence could handle anywhere from 60 to 120 patients over their normal occupancy of 250.

Humana Hospital of Alaska, also in Anchorage, maintains a backup generator system, which could be operated without outside resources for up to three weeks, but does not have a substantial backup water supply system. Humana has 199 beds but would be hard pressed to staff for that many acute care cases. Humana stocks supplies for an average of 45 days; however, the more expensive supplies are generally not stocked very far in advance.

Other primary care facilities located in Anchorage are the military hospital at Elmendorf Air Force Base and the Public Health Service (PHS) hospital for Alaska Natives. All of the hospitals, with the exception of the PHS facility, are located in areas which are anticipated to experience low impact in the event of a major earthquake. The Alaska Native Hospital is located near one of the slide areas of the 1964 event. Relocation of this facility has been under consideration since the earthquake.

Both Humana Hospital and Providence Hospital maintain disaster response plans and conduct drills. Until recently there has been little cooperation between the public and private sectors in such planning activities. The Anchorage Health Systems Plan, 1982-1984, published by the Municipality of Anchorage Human Resources Planning Division, Department of Community Planning, and the Municipal Health Commission, contains only precursors for disaster response planning for the medical community. Both hospitals adopt the attitude that regardless of what shape the public sector is in following a disaster, their facilities will be ready.

Disasters which result in casualties exceeding the local care capacity would be airlifted to the Lower 48. This is especially true with burn victims. Providence Hospital is the only facility that houses a burn center, but it is limited to the treatment of five or six patients.

Emergency communications procedures to coordinate and organize local response activity have been developed in the event of a major disaster. The PBX operators have call lists to contact in case of emergencies. In the event that telephone service is disrupted, the lists would be dispatched by messenger to the local radio stations.

The hospitals are required to participate in an accreditation process. In 1983 the hospitals sponsored the first area-wide disaster drill through the efforts of the Joint Medical Disaster Preparedness Committee. The Joint Medical Disaster Committee, which is composed of members from the hospitals, military, paramedics, and blood bank, functions as a planning body, meeting once per month to assess medically oriented disaster preparedness. Organizational efforts in the past to do simulated emergency drills have had limited area participation and limited success.

In July of 1982, as part of the Joint Medical Disaster Committee's assessment of disaster preparedness, the Greater Anchorage Area Disaster Preparedness Exercise Scenario was held. Although the exercise was targeted to assess response for a major airline crash, the general emergency process outlined in the Emergency Operations Manual for the Municipality was put into effect. The exercise stipulated an estimated 250 to 300 casualties, 20 percent of which were considered deceased. A wide variety of agencies participated, including the Mayor and major department heads.

Such wide-ranging support has helped to test the adequacy of the disaster response operations. Municipal participation in Anchorage is a new phenomenon resulting from recent changes in the municipal administration, and the hospitals are experiencing public support in their efforts for the first time. Several years ago an area-wide disaster simulation exercise was proposed but was canceled by the city's central administration as a result of private businesses' concern and political pressure over negative airline publicity and possible impacts on the tourist industry.

Medical facilities in smaller Alaskan communities are more limited in their capacity to handle major emergencies. All the coastal communities, except Whittier, have adequate medical resources for normal operations. Kodiak's hospital was pronounced unsafe in the event of an earthquake by state officials, but engineers who subsequently studied the structure disagreed.

In any event, supplies and manpower are the most critical problems facing smaller communities. Medical evacuation is considered in all small community planning efforts. In addition, active medical personnel are quite confident that assistance calls to the general public would produce sufficient support personnel. In fact, there are many people with medical training who could be called upon in an emergency.

Under a 1904 congressional act, the American Red Cross is the delegated agency to provide mass care service delivery. The Red Cross is a public non-profit corporation which functions solely by volunteer donations. Other than tapping resources provided by the military or the National Guard, the agency receives no federal dollars to provide this service.

The Southcentral Alaska Chapter of the Red Cross maintains a staff of four and a cadre of trained volunteers in all communities. During a natural disaster, if the local resources of the Red Cross are insufficient, the national organization will provide additional staff and volunteers to compliment the local personnel. The Red Cross does not warehouse supplies. After performing a needs assessment, supplies, and food are generally purchased or donated from the local community, as it is the belief of the agency that restoration at the community level begins with stimulating the local economy. If the local community is not capable of providing needed food, clothing, and other basic items, then the local chapters look to the national organization to supply the necessary commodities. Overall funding is through the national organization. The focus of the service delivery for this agency is on the individual's needs, and the agency will continue service delivery at the disaster response level until all individual needs have been met.

Emergency food and shelter form another component under the direction of the Red Cross. The southcentral office has been active in locating churches and training members to run emergency shelters. Churches, although limited in the number they can house, often have kitchen facilities, recreation areas, and various small rooms for accommodating different activities, making them excellent emergency shelters.

Schools make ideal shelters and focal points for information dissemination. In Anchorage there are 50 elementary schools with a total of 1.8 million square feet, and 10 secondary schools with a total of 1.9 million square feet of space.

The School District maintains communications with the State Division of Emergency Services concerning disaster response operations. An emergency communications system has been established with one-way emergency radios installed in some facilities and others housing two-way systems. Eventually, this communication system will be tied into the Anchorage Municipal Emergency Operations Center. The system is tested weekly and has been utilized during local power outages.

Some of the schools have been specifically designated as evacuation centers. Facilities at the University of Alaska and Alaska Pacific University in Anchorage also carry this designation and are rated to house large numbers of people on a temporary basis. The secondary schools all maintain emergency auxillary generators. This is critical if a major disaster occurs during the winter months due to the typically harsh climate.

There appears to be some jurisdictional question about the operation of shelters for the Anchorage area. Although the Red Cross is federally mandated to perform this task, a formal agreement with the city is still required to define who has jurisdiction over the shelter. The Red Cross was asked to help alleviate a housing crisis in Anchorage during the winter of 1982, but refused to do so until given complete jurisdictional control over the operation of the shelter. A formal written agreement now is being reviewed. If accepted, it will be the first agreement that has been sanctioned by both the Municipality and the Red Cross--an action the agency has been attempting to obtain for approximately five years. It is the agency's hope that such an agreement can be reached before a natural disaster forces an agreement under pressure.

The Red Cross works closely with the DES. If necessary, the agency would look to DES to function as the communications liaison between the Red Cross and the smaller communities. In the smaller southcentral communities, school facilities are the designated mass care centers. It is assumed that residents requiring care would bring many of their own necessities. While actual planning of how to handle mass care has not been done, school administrators and emergency preparedness directors are aware of their general responsibilities.

Valdez had to put into practice mass care techniques when a luxury cruise liner, the

Princendom, sank. Red Cross officials organized an effective mass care program for the survivors with the assistance of volunteers and donations from local merchants.

A partial analysis of individual household preparedness has been done by the DES. DOWL Engineers sampled 313 Anchorage households in order to determine the level of self sufficiency (shelter, food, energy, etc.) in the community. Results of the survey revealed that most people believed they had food supplies for two weeks; however, only 10 percent had stored sufficient water supplies to last the same amount of time. In addition, only 23 percent had made personal emergency plans in case of a disaster. Twenty-eight percent owned a pick-up truck, camper, motor home, or other type of accommodation which could function as alternative housing in case of displacement. General household preparedness levels can thus be considered modest at best.

Though quantitative data is not available for the smaller communities, interviews with local officials suggest that small community populations have a higher proportion of preparedness and self sufficiency. This pattern is similar when comparing urban populations to more rural populations throughout the United States. As a greater proportion of Alaska's population becomes more urbanized, it is anticipated that household preparedness levels will decrease.

Restoration of Lifeline Facilities: Present technology has vastly improved the status of lifeline facilities; however, the magnitude of an event similar to 1964 certainly will impact much of the lifeline infrastructure. If such an event occurred during the winter months, the resulting problems would be compounded by the severity of Alaska's climate. Power outages, natural gas disruptions and breakdowns in the water and sewer systems are anticipated. This section focuses on the susceptibility of infrastructures to damage in the event of an earthquake. Later in this chapter the mitigation efforts in lifeline facilities will be addressed.

Electrical Generation: Public utilities have grown in size and complexity commensurate with the rise in population. Electricity is provided by a group of cooperatives and local public utilities. The largest, Chugach Electric Association, maintains 35 miles of subtransmission lines, 307 miles of transmission lines, and 1,134 miles of distribution lines, and operates five generating plants. Municipal Light and Power (MLP) is Anchorage's municipally run utility. MLP operates two power plants with a capacity of 200 megawatt hours serving a third of Anchorage. Other companies include Matanuska Electric Association (MEA), Homer Electric, and local plants in Valdez, Kodiak, and Cordova. The federally run Alaska Power Administration has a hydroelectric plant at Eklutna.

Now, as in 1964, an earthquake of similar magnitude would be expected to cause a power black-

out. Under the Division of Emergency Services State Natural Disaster Plan, all public, semi-public, and private utilities still operating are to shut off power at the main generating plants immediately following such an earthquake. This action should minimize the risk of fire.

Lightly damaged plants will be capable of going back on line within 30 minutes. Most of the generation plants located in Anchorage would probably be back on line in the first hour. Most of the remaining plants should be operating within three to four days.

Chugach Electric's power plants, located outside the immediate Anchorage area, should fair well in a major earthquake. The main problems with the outlying generating plants are some susceptibility to tsunami inundation and the vulnerability of overland and submarine transmission lines. Many of these lines run through areas prone to slides and avalanches, may swing into other lines and cause short-circuiting, and are susceptible to tension breaks from severe ground motion. Such damage is identified fairly easily and can be rectified in a short period.

The majority of the customer service distribution system should be restored within twenty-four hours with total restoration within a week (Greater Anchorage Area Earthquake Response Study 1980).

Damage to fuel storage tanks and natural gas feeder lines is likely and substantial loss would result in a need for alternative sources of fuel. The utilities in Anchorage are experienced in coping with service interruptions caused by high winds. Damage posed by earthquakes would be similar in nature; therefore the quality of restoration is not anticipated to vary (Ibid).

Natural Gas: Inexpensive sources of natural gas have lead to its widespread use for electrical generation, heating, and water heating in the Anchorage area. Major service disruptions could have tremendous impact on the continuity of electrical generation, as well as on home and water heating and prevention of water line freeze-ups.

As described in Part I, the system survived the 1964 earthquake remarkably well. Today, Enstar Natural Gas Company (formerly Alaska Gas and Service) operates a significantly larger system in Anchorage and is expanding rapidly into areas north of the city. Survivability in the event of another major earthquake is considered good. In 1964 there was only one line running up from the Kenai peninsula to Anchorage. Today there are several lines running from three different sources. Two lines cross Cook Inlet to Potters Flats. At that point, the system expands to three lines and continues into Anchorage.

The most vulnerable point might be the lines which cross from the Kenai Peninsula under Cook Inlet. Enstar Natural Gas estimates that even in a worst case scenario with both of these lines going out due to a major earthquake in the middle of winter, restoration could be accomplished in one week barring major weather problems.

The distribution system is anticipated to withstand the effects of a major earthquake quite well. Fires due to natural gas leaks would be a rarity because of safety valves utilized throughout the system. The areas most likely to experience service disruptions are those located in the major slide areas of Anchorage. It is estimated that with a disruption of service to 12,000 people, restoration at the 50 percent level would be achieved in 48 hours and 80 percent within 96 hours. The remainder would be restored within two weeks (Greater Anchorage Area Earthquake Response Study 1980).

Water and Sewer Utilities: Anchorage has two primary service providers of water: the municipality operates Anchorage Water and Sewer Utility and the privately owned Central Alaska Utilities (presently being purchased by the Municipality of Anchorage). There are other small, privately run water utilities and an estimated 4,000 to 5,000 private wells. The Anchorage Water and Wastewater Utility provides the only sewage collection and treatment available in Anchorage.

Both ground and surface water sources are tapped for distribution throughout the Anchorage area. As noted in the Greater Anchorage Area Earthquake Response Study, the measure of reliability of the system can be assessed through the impact which the system received in 1964. Areas impacted by ground failure or major ground displacement experienced major to total service disruptions and are expected to be impacted in a future event. These areas include the downtown sector of Anchorage and all property bordering Knik Arm. The system components are pressure-regulated and damage is assessed by noting pressure reductions. The use of technical maps are used to locate the damage.

It is estimated that a moderate earthquake (5 on the Richter Scale) could cause complete separation of pipeline in the older sections of town and downtown. Restoration of the system under such a scenario could occur in less than 24 hours. A more serious earthquake, with intensity of 6.5 and above on the Richter Scale, could cause severe structural and pipeline damage in the older areas of town and in areas where construction on marginal soils has occurred. Water service can be restored partially by rerouting. The utility noted that restoration is an ongoing process since they are still locating damage that may have been related to the 1964 earthquake. Of interest is the fact that on September 7, 1983 Southcentral Alaska experienced an earthquake registering 6.4 on the Richter Scale, centered 40 miles southwest of Valdez, which caused only minimal damage.

Contamination of the water system by ruptures in sewer lines can be expected in the event of a major earthquake. The sewer problems in Anchorage are anticipated due to the low elevation of the sewage treatment facility at Point Woronzof, which makes it susceptible to inundation and/or subsidence. The Anchorage Water and Wastewater Utility, however, is satisfied with its ability to restore service without the assistance of outside resources. Emergency planning has been a priority of the agency that regularly performs simulated emergencies with damage assessment, setting priorities, and restoring service.

All the smaller communities have public water and sewer utilities. Their capacity to sustain system integrity and to repair damages varies. Valdez officials feel its bedrock base will respond to seismic activity well and, with a larger work force and parts supply, their capacity to restore the system is high. Valdez and Kodiak officials felt even a 25 percent failure in the system could be dealt with locally. Homer and Seward, with their smaller resource base, were less confident.

Transportation: Anchorage is the major transportation center for southcentral Alaska and the state as a whole. The city hosts the major port for the southcentral area, major airports, and the Alaska Railroad terminus. Two of the four major highways for the state also originate in Anchorage. Obviously, any disruption in the major modes of transportation in Anchorage would have a deleterious effect on the distribution of vital goods and services to the state.

As discussed in Part I, the 1964 earthquake impacted all modes of transportation. Certain aspects of the system have changed. This will reduce the level of impact; however, the nature and location of the road, highway, and railway systems make it virtually impossible to totally mitigate damages.

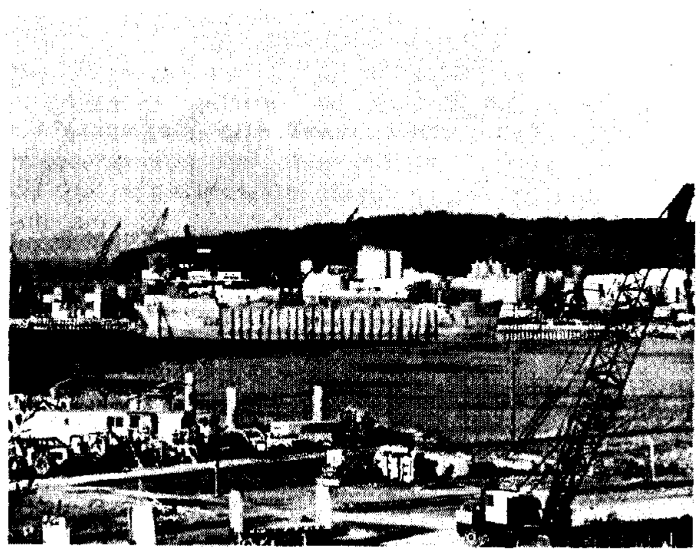
Airports: Airports provide Alaska's most vital link for assistance during disaster relief. In 1964 it was the least impacted of all the major modes of transportation. Availability of alternative road access is considered important in case of blockage. While Anchorage has several routes available to airports in the area, smaller communities are more vulnerable.

The city of Kodiak is susceptible to losing road access to its airport through tsunami and slide action. Other communities are less vulnerable, but face a limited threat of inundation. In the event of ruptured fuel tanks and lines, all facilities have close access to fire-retardant foam to reduce the risk of damage (Greater Anchorage Area Earthquake Response Study 1980).

The Federal Aviation Administration Enroute Air Traffic Control Center, located near Elmendorf Air Force Base, has emergency operations plans and emergency generators which can maintain the facility for up to 17 days. As noted earlier, the FAA simulates disasters twice yearly and considers natural disasters part of the training exercise. Should the Anchorage FAA facility become inoperable, aircraft can be controlled through facilities at Kenai. If all radar systems fail the agency can still revert to the old fashioned manual control method in which each aircraft gives a fixed position to a ground station and an estimated arrival time to the next ground station. This information is plotted on maps and is an effective means of controlling airspace and traffic (Omalia 1982).

One potential source of problems, as identified in the Greater Anchorage Area Earthquake Response Study, is the passenger arrival ramp at the Anchorage International Airport. If this bridge-like structure were to collapse it would be quite dangerous and could result in life loss.

Ports: Port facilities are the most vulnerable part of the infrastructure, subject to high losses and extended restoration times. Port facilities in southcentral Alaska are subject to locally generated wave or tsunami threat as well as subsidence uplift and submarine landslides. The economic effects of damage can be seen in the shift of water transport to Anchorage after 1964. Anchorage was the only commercial port to avoid major damage, and therefore benefited in subsequent years.



Depending on the location and size of future seismic events, some port facilities can be expected to be lost, affecting commercial freight, or fishing activities. The large populations which concentrate in port areas increase the risk and the need for adequate warning and evacuation procedures.

Roads and Railroads: The road and railroad systems in southcentral Alaska are expected to sustain significant damage. Soil stability remains the major variable determining survivability of the road and railroad beds. In 1964 liquefaction greatly increased the amount of ground failure along highways. In addition, it was found that in areas that had been filled extensively, damage from subsidence and fracturing was heavier. This type of damage again would be anticipated in the event of another large seismic event. Loss of bridges, overpasses, damaged beds, and slides can be expected to disrupt land transport. The rapid repair of the Alaska Railroad, despite heavy losses in 1964, suggests that short-term restoration of these systems is likely. Loss of key bridges and overpasses, however, could extend the time it takes to restore primary land links among communities.

Public Buildings: Restoring public buildings to use is critical to permit the efficient organization of response and relief. Loss of large public facilities could reduce the ability to communicate, coordinate, and manage the necessary response in a postearthquake period. In addition, the need for public facilities in a successful mass care effort is critical.

Depending on age, composition of materials, and location of the structure, the survivability of public facilities is variable among communities. In Kodiak the structural integrity of the hospital is disputed and the fire station is poorly located. Anchorage city government is now in the Hill Building, located off the major slide areas but within the potentially hazardous downtown core area. Public facilities in Valdez are generally considered to be seismically safe due to the entire relocation of the community after the 1964 earthquake. Seward's city hall, schools, and fire department appear to be safe. In addition, the fire facility (which currently houses their emergency operations center) has a reinforced concrete basement.

Interviews with public officials suggest confidence in the survivability of most public buildings. Evidence related to locating and techniques of construction support this conclusion.

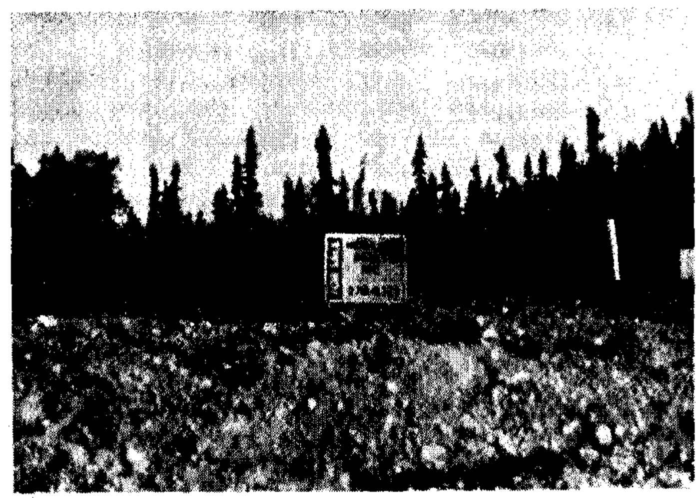
Reconstruction and Restoration

Once relief is provided in the immediate aftermath of an earthquake communities face the prospect of reconstruction of private and public facilities. The task of rebuilding damaged areas and reestablishing a viable economic infrastructure is based on elaborate and at times conflicting federal, state, and local programs. This section looks at:

1. The loan systems that exist to reconstruct earthquake damaged areas.

2. Current financing procedures and their relationship to mitigation of future property loss.

In 1964 it was envisioned by federal decision makers that recommendations from the Scientific and Engineering Task Force (Task Force 9) defining geologically hazardous areas would be binding on all federal agencies providing funding for reconstruction. With the Task Force's dissolution after only six months, there was no clear plan to enforce recommendations or to relax them for future reconstruction and development. Over the years local land use policies in communities such as Anchorage have, in fact, encouraged development in areas considered by Task Force 9 to be seismically hazardous. Except where federal urban renewal dollars were tied to local reconstruction, no government agency has been able to effectively draw the line defining areas unsuitable for construction in such a way as to prohibit the use of public or private funds for development. Federal spending by the Housing and Home Finance Agency (now Housing and Urban Development) for stabilization of the Fourth Avenue Slide area in Anchorage, the waterfront in Seward, and the relocation of the community of Valdez did ensure the implementation of federally defined earthquake hazard mitigation practices through compliance by local government in its land use policies. Part of the problem stems from conflict among scientific experts defining the amount of risk. Questions as to the degree of soil stability coupled with technical advancements in construction methods has created a state of ambiguity for local decision makers. Such ambiguity, along with land shortages in strategic areas such as Anchorage, has opened the door for pressure from the private sector to develop areas once defined in 1964 as geologically hazardous.

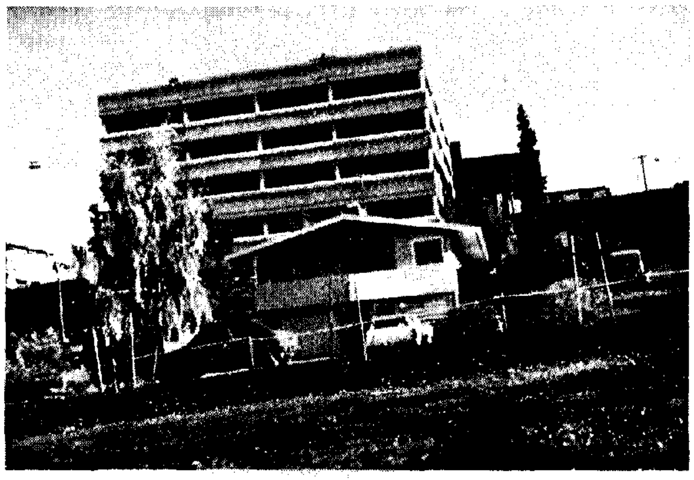


The only agency which has institutionalized some of the recommendations of Task Force 9 is the Department of Housing and Urban Development (HUD). HUD continues to follow the recommendation prohibiting the use of Federal Housing Administration (FHA) federally insured loans in the L Street slide area. However, some of the task force recommendations have been relaxed by HUD over the years, and as a result the Turnagain slide area, considered off limits in 1964, can now be developed with FHA insured loans. Veterans Administration loans are also based on HUD-FHA guidelines and prohibit development in the L Street slide area. On the other hand, the Small Business Administration has not institutionalized this policy and will finance loans in these areas.

Financing agencies are not equipped to be watchdogs performing seismic risks studied to assess investment risk. If a local government is willing to issue a building permit financing agencies are, for the most part, not concerned with natural hazards which might affect the site. In Alaska private home loans are largely acquired through the state's Alaska Housing Finance Corporation. Funds obtained through bonding comprise over three-quarters of the home loan market. The secondary mortgage market continues to purchase mortgages in the state but at a much reduced level than is the national trend. These programs do not have provisions to ensure that construction has occurred on sites which are seismically safe. Finance agencies are required to comply with external controls such as local building codes and zoning ordinances. However, with the exeption of HUD and the Veterans Administration, site specific evaluation and policy setting with respect to natural hazards is not an anticipated agency function. Land use decisions such as these are largely left to local government. However, if another external control designed to govern all financing policies regarding site specific hazards was implemented at the state or federal level, finance agencies would be expected to comply.

Earthquake insurance, a standard exclusion by insurance companies, is obtainable but not required for participation in any of the ongoing programs. The insurance is expensive ($1.50 per $1,000 of dwelling costs, with a 10 percent deductible) and purchased by only a very small segment of homeowners. Companies at times have been reluctant to underwrite homes built on bluffs or commercial structures known to be constructed on unstable soils.

The only home finance program implemented in recent years which mandated earthquake insurance was a 1979 $50 million municipal bond program in Anchorage. Anticipating concern over earthquakes, local officials and bankers went to New York to convince the bond rating services that earthquake insurance should not be a necessary requirement for a good bond



rating. Their efforts appeared successful. However, several days after their return to Anchorage, a moderate earthquake occurred in the Yakitat area, 370 miles from Anchorage. Word reached New York and the rating services refused an 'A' rating without adding the earthquake insurance provision (Bob Sullivan, Alaska Mutual Bank, 9/27/83).

Alaska Housing Finance Corporation (AHFC), the largest bearer of mortgages in the state, has financially protected itself in the event of a major disaster. The agency carries a 2 percent special hazards earthquake insurance policy and an 8 percent earthquake endorsement policy which covers defaults as a result of a natural hazard and/or a major earthquake. An AHFC administrator who was interviewed believed that the homeowner who defaults on house payments due to damage or destruction from an earthquake would receive assistance from the federal government to cover major losses in this area.

An alternative to the current exposure to risk and the attendant political pressure to reduce losses in the use of a seismic event would be a federally subsidized insurance program similar to the National Flood Insurance Program. This program could provide earthquake insurance to communities instigating federally defined mitigation practices.

The Federal Emergency Management Agency (FEMA) coordinates the majority of the federal relief and reconstruction programs, but the agency may designate another appropriate agency to coordinate a specific task. There are a variety of additional agencies which have also institutionalized programs directly related to disaster relief and reconstruction (e.g., U.S. Army Corps of Engineers, the Small Business Administration, the Farmers Home Administration, the Department of Housing and Urban Development, and the Department of Health, Education, and Welfare). In some instances, a community or an individual has several different pockets to choose from to accomplish immediate relief or long-term reconstruction. However, agency funding guidelines have been established and if another agency's programs are available for reconstruction, those funds must be used instead of FEMA's. Both private and public sector facilities damaged by a natural disaster can qualify for disaster assistance. If a facility is damaged beyond repair FEMA may authorize its replacement to predisaster design based on standards for new construction. Table 14 displays the federal programs available to states, their subdivisions, or individuals for immediate relief and long-range reconstruction. Only the specific disaster programs which might be used in Alaska are included in the presentation.

The financial implications of a major earthquake are monumental. With the belief that low-interest federal disaster loans and loan forgiveness programs would bail out stricken communities, strong incentives to prohibit construction in risky areas simply does not exist. There is no existing law that prohibits individuals from receiving federal disaster assistance for construction or reconstruction in a seismically hazardous area. Such a provision would be difficult to mandate. Instead, the government must deal with each disaster on a case-by-case basis. FEMA is granted such discretionary powers through the Federal Disaster Act of 1974. For example, the act discusses restoration of areas affected by landslides. If a damaged facility is located in a slide area the regional director of the FEMA may decline to grant assistance for restoration if the area has not been stabilized properly.

Long-Term Mitigation of Impacts

While public awareness and political interest in the last two decades has provided the stimulus for major efforts in the area of emergency preparedness, the scientific and technical community has focused on disaster prevention and mitigation. Public funds for prevention and mitigation studies and application have been limited, thus public recognition of mitigation practices is substantially lower than awareness of emergency preparedness programs. Implementation of recommendations to mitigate earthquake disaster loss have been slow to evolve and difficult to enact within the political process. Political receptivity to mitigation proposals are highest in the aftermath of a major seismic event.

Mitigation efforts can be summarized as follows:

1. Development of land use regulation related to the type and intensity of development allowed.
2. The development and use of seismic-resistant design and construction techniques, including development and enforcement of building codes.
3. Retrofitting existing structures and/or developing land stabilization programs.
4. Mitigating loss of critical facilities and lifelines.

Source: ABKJ, Inc.

Table 14. Federal Responsibilities - 1984

Federal Emergency Management Agency (FEMA)

Coordinates federal disaster relief operations and reconstruction efforts; provides temporary communications; performs the following tasks or designates appropriate federal agency: debris cleanance, mass care (food, water, and shelter), search and rescue, temporary public transportation, health, medical and sanitation services, temporary housing; provides grants to remove damaged timber; provides loans not exceeding 25 percent of the annual operating budget of a community to fund government services where there has been a substantial tax loss due to a disaster; provides analysis and assistance in resource allocation of construction materials in an impacted area; advises on hazard mitigation practices; provides grants for repair or restoration of private nonprofit facilities and public facilities.

Department of Housing and Urban Development (HUD)

Provides insured loans to persons to acquire mobile homes for principle residence following a disaster; provides guaranteed insured home loans to disaster victims; refinances any note held by the agency where refinancing is necessary because of damage resulting from a major disaster; provides community development block grants to assist in restoration of a damaged area.

U.S. Department of Agriculture

Food Nutrition Service: Provide free food stamps, after federal approval, to disaster victims.

Farmers Home Administration: Provide guaranteed preferred low interest disaster loans to replace damaged or destroyed farm property; provide annual operating expenses for up to six full crop years; refinance debts made necessary from the disaster; provide assistance in feed for stock.

Rural Electrification Administration: Provide guaranteed insured loans for supplying central station electric and telephone service on a continuing basis for rural areas; also renegotiate existing loans due to the disaster.

Bear the cost for additional construction of damaged projects where the contract to purchase timber is with the Department of Agriculture or the Department of the Interior.

Small Business Administration

Provide long-term low interest disaster loans to businesses and homeowners; pay current liabilities of businesses which could have been paid if the disaster had not occurred.

Department of Treasury

Bureau of Alcohol, Tobacco, and Firearms: advisory assistance in preparing for the refund of excise taxes paid on distilled spirits, wines, rectified products, beer, tobacco products and cigarette papers and tubes.

Internal Revenue Service: Counseling and guidance on tax matters, assistance on preparation of returns.

Department of Health and Human Services

Center for Disease Control: Prevent the spread of communicable diseases in the aftermath of a disaster.

Health Resources Administration: Formula grants may be used for repair or replacement of health facilities damaged or destroyed by natural disasters.

Office of Education: Project grants to construct and equip facilities for private schools destroyed by a disaster; maintenance and operation grants to public schools suffering continuity problems following a disaster.

Administration on Aging: Discretionery grants to provide services to the elderly in a presidentially declared disaster.

Department of Labor

Job placement and disaster unemployment assistance to individuals unemployed because of a disaster.

National Institute of Mental Health

Crisis counseling for disaster victims.

Veterans' Administration

Counseling, forbearance and indulgence on a case by case basis to owners holding veteran's loans.

National Weather Service/ National Oceanic and Atmospheric Sciences

Forecast weather related to natural disasters including dissemination of flood and tsunami warnings.

Department of Transportation

Federal Highway Administration: Provide project grants to repair or reconstruct federal-aid highways, roads, and trails.

U.S. Army Corps of Engineers

Provide emergency assistance in case of floods; emergency repair of flood control works damaged by floods; restoration of federally authorized coastal protection structures damaged by extraordinary wind, rain, or water action; promote recognition of flood hazards in land and water-use planning.

States/FEMA

Grants up to $5,000 per individual or family unit which can't be met by any other assistance (funded by FEMA after request from the governor--75% - 25% fund sharing).

Volunteer

American National Red Cross: Provide food, clothing, shelter, first aid, nursing, hospital care, blood, feeding stations. Services or funds issued to communities or individuals.

The Salvation Army: Counseling, registration and identification of victims, missing persons, medical assistance, temporary shelter, mass and mobile feeding and related services.

Mennonite Disaster Service: Cleanup and restoration of disaster locations, warning evacuation, search and rescue; temporary repairs to damaged homes; reconstruction and rehabilitation of essential community buildings.

5. The development of warning systems to provide people time to evacuate high risk areas in an impending disaster, and education programs to instruct the general public on how to react to an earthquake and make reasonable decisions concerning risk.

Disaster Mitigation Through Land Use Planning:
Land use planning is largely a local prerogative in the United States. Its role has grown historically with the advent of urbanization. As land use has intensified and multiple uses occurred, inevitable conflicts have arisen. Today, land is seen as a scarce resource, resulting in allocation problems within the political environment. Proper allocation of land usage can be a mechanism for reducing risk from seismic and other natural hazard events. An earthquake carries the potential for loss of economic investment, loss of human life, and for demands on government resources to reduce individual losses. Land use policies can address issues of seismic mitigation in a number of ways:

- Prohibit building on land vulnerable to earthquakes.
- Restrict development by distinguishing types of structures permitted.
- Require soils tests to increase knowledge on placement and design on specific properties.
- Educate landholders as to implications of risk to improve rational economic decision making.
- Remove all or some existing land uses from areas designated as highest risk in a seismic event.

To accomplish any of these policy goals a process must be developed which includes data gathering, planning and recommendations, decision making, and enforcement.

Under the Alaska state constitution local government is organized into boroughs and cities. Boroughs are regional governments with planning and zoning, taxation and education as mandated powers. A borough may contain one or more cities within its boundaries.

Currently there are 11 organized boroughs or unified city-boroughs in Alaska. Generally, the boroughs or unified city-boroughs provide planning and zoning services or delegate their authority to the first class cities within their purview. In areas of the state which are unorganized or in organized areas not providing their own planning and zoning services, the Alaska Department of Natural Resources is the planning agency obligated to provide services (The Alaska Land Act AS 38.05).

Under state law, first and second class boroughs must have a planning commission of at least five members. This commission is required to prepare a comprehensive plan. State law is very general as to what this plan should contain:

> The comprehensive plan is a compilation of policy statements, goals, standards, and maps for guiding the physical, social, and economic development, both private and public, of the borough, and may include, but is not limited to, the following: statement of policies, goals, standards, a land-use plan, a community facilities plan, a transportation plan, and recommendations for plan implementation (AS 29.33.085).

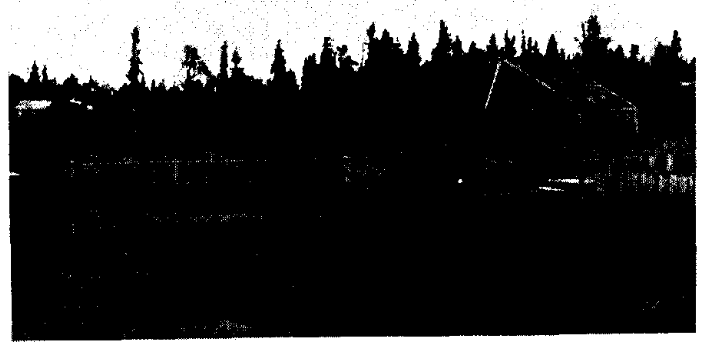
The planning commission is required to review the comprehensive plan every two years as a minimum and make recommendations to the local elected council or assembly. The Department of Community and Regional Affairs, through the Division of Community Planning, provides both financial and technical assistance for the preparation of these plans. State support comes in the form of either annual revenue-sharing funds or special purpose grants. Boroughs receive $2.00 per capita annually in revenue sharing for planning purposes.

The Division of Community Planning has not provided support systematically to address specific hazards in the planning processes of local communities. Except for requirements of the Alaska Coastal Management Program, Alaska law does not require that local comprehensive plans or ordinances consider geologic hazards. Only in the area of flooding, through participation in the National Flood Insurance Program, have local governments been effective in addressing hazards as part of planning and zoning.

Relatively little attention has been paid to geologic hazard and seismic risk in comprehensive plans throughout the communities of south-central Alaska. Three years prior to the 1964 earthquake, a metropolitan area general plan for Anchorage was published. This was a major effort to outline a general plan for the growing city to the year 1980. In 218 pages of analysis not one word was written concerning the geologic hazards which underlay major building sites in the city.

In July 1975, just prior to the unification of the Greater Anchorage Area Borough (GAAB) and the city of Anchorage, GAAB published a preliminary draft of a comprehensive development plan. This draft contained, for the first time, a policy pronouncement that local government in Alaska has a responsibility to decrease danger resulting from construction on hazardous and unstable soils and to control development which would be hazardous to the health and safety of individuals in the community. Based on extensive studies conducted by the U.S. Geological Survey before the earthquake (Miller and Dobrovolney 1959) and after the 1964 earthquake (Schmoll and Dobrovolney 1972), and by an environmental atlas of the Greater Anchorage Area Borough (Selkregg 1972), the plan pointed out that a number of conditions existed in the Anchorage bowl which were hazardous to future development, including landslide potential, fault lines, rock falls, and subsidence areas. They noted that the historical and future trends were moving toward development in hazardous locations and that already many high risk areas had been developed in the bowl. The report stated that:

> Hopefully, as developers, renters, and buyers become more aware of the variety and magnitude of the dangers which they may face, increased effort will be directed toward ensuring that development will only be allowed in such areas when it is designed to adequately mitigate such hazards. In order to accomplish this, the borough, other public agencies, and private enterprise must adopt policies and programs to insure that construction or reconstruction in areas subjected to hazardous conditions does not occur (Greater Anchorage Area Borough July 1975).



To attain these objectives the draft plan recommended that the borough adopt policies to prevent the construction on or use of property that was unsafe. Also, the borough should fobid the creation of unsafe conditions as a result of development which would subject other persons to dangers or expenses required to mitigate resulting hazardous conditions. In addition, the plan calls for the preservation of the bluffs along Cook Inlet, particularly those subject to earthquake-triggered landslides. Public acquisition of high risk land was suggested as a policy alternative to curtail unsafe development. These sweeping recommendations, however, never made it beyond the Planning and Zoning Commission. After unification of the city and borough in 1975, the Comprehensive Development Plan Ordinance was prepared. The plan, adopted July 20, 1976, contained four sentences dealing with natural and manmade hazards. The plan promised :

a. To protect the public from natural and manmade hazards and nuisances by:

- Regulating development of those lands which, if improperly developed, would be hazardous to the health, safety, or property of individuals in the community.

- Minimizing potential hazards from development on unstable soils.

b. To minimize the possibility of structural damage or failure and excessive public installation and maintenance costs resulting from building on unstable soils, the Municipality shall insure that development will avoid such areas unless adequately designed and engineered.

c. Developers shall be encouraged to utilize marginal lands by incorporating them in their development plans or as open space and less intensively used areas (Municipality of Anchorage 1976).

Implementation regulations addressing these goals were never adopted.

A new comprehensive plan adopted by the Municipality of Anchorage in September 1981 condensed the goals dealing with hazardous lands down to a single statement, "to assure, through appropriate land use regulation, that development in areas designated as hazardous land occurs in a manner consistent with State Geophysical Standards in order to protect human life and the public safety and welfare" (Municipality of Anchorage 1981). Three policies supporting this goal were recommended in the plan, including:

- Discourage development in high risk areas.

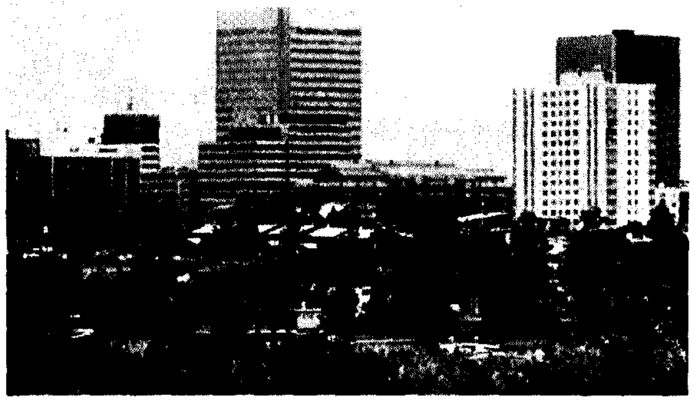
- Require the use of central sewage.

- Utilize engineering specifications sufficient to mitigate the potential loss of life and property.

In theory, discouraging development in high hazard areas and building specifications which would mitigate loss are compatible policy objectives. However, in interviews with project staff, local public works officials flatly stated that any building could be built on any site if engineered properly. This philosophy was reflected by the president of the construction firm which built Resolution Tower, a multi-story office building on the L Street slide. He stated that "buildings built properly can withstand an earthquake and if Resolution Tower ever goes into the Inlet, it'll be in one piece' (Anchorage Daily News). That optimism is not shared by geologists and seismic engineers. In a survey of 138 professionals nationwide, 73 percent considered the L Street slide area to be moderate to high risk (having a greater than 10 percent probability of failure within 100 years). More than half the respondents felt that structures within a quarter mile of the coast were in this same category (Earth Science Associates, no date).

Conflicting opinions among professionals is a major problem in reaching a political consensus on implementing actions designed to meet comprehensive planning objectives. In November 1983, Anchorage newspapers carried articles on plans to develop land below the bluff on the Turnagain slide site. Experts appeared to disagree on the level of risk and the role of government in protecting private owners from risk.

Anchorage not only permitted rebuilding in the major slide areas of L Street and Turnagain, but also went through a series of changes in which zones went from low density single family to commercial, permitting multi-storied structures in the L Street area. In addition, the Anchorage Assembly rejected a proposal that would have prohibited future residential development in the Turnagain slide area below the bluff (20 February 1978). In the former instance, the planning department actually recommended the zoning change providing 'expert' input which overcame assembly concerns over



risk. The latter was opposed by the department and action occurred despite it.

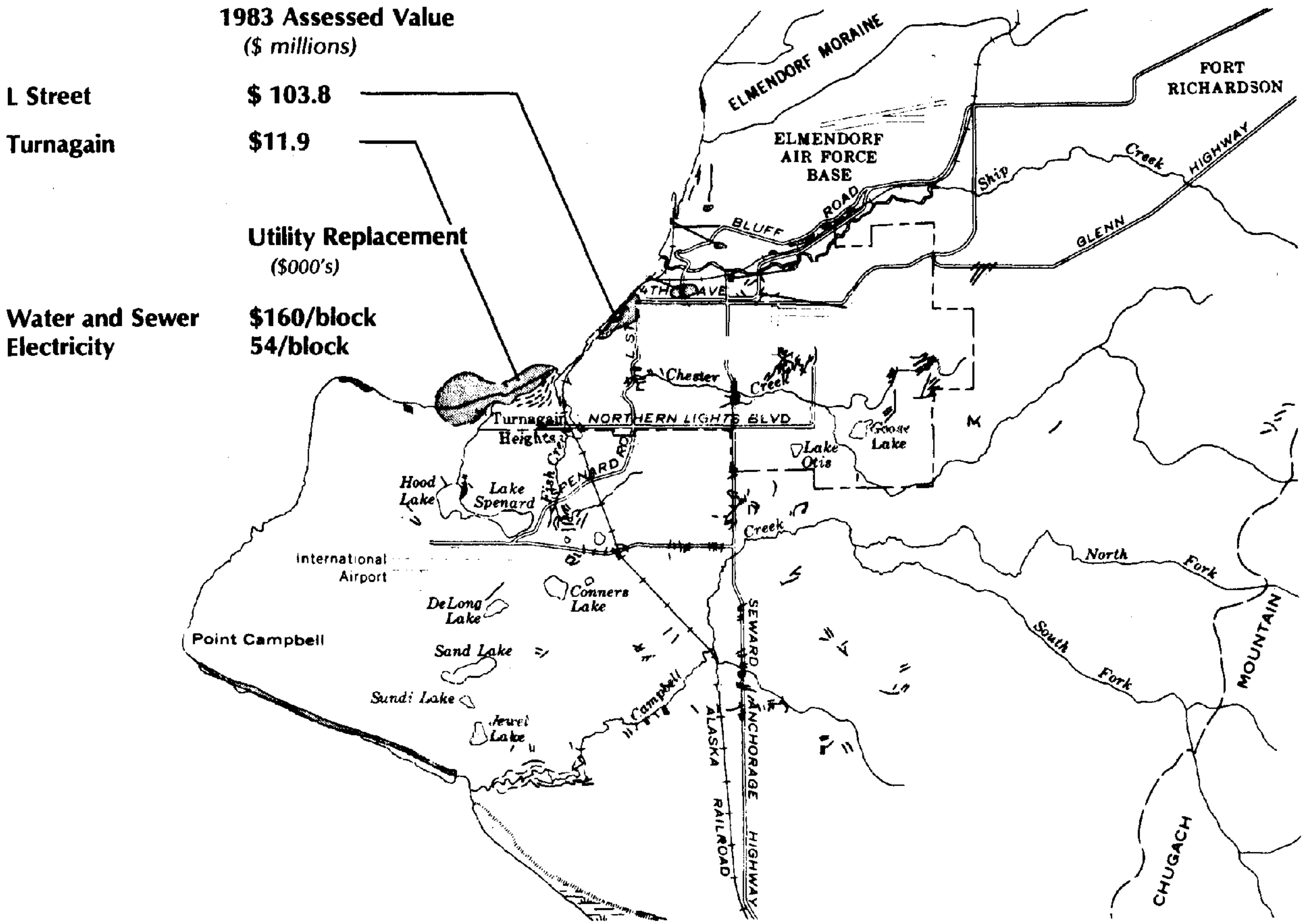
This possibility is due to a failure in state legislation. In order to facilitate reconstruction, the legislature classified the Turnagain slide area as unstable, making available exchange lots in Zodiac Manor Subdivision, located across town. The State, unsure of what to do with the unstable land, allowed for the exchange to occur without requiring title to the damaged property. In actuality, property owners were allowed to 'double dip,' retaining title to their Turnagain property as well as obtaining a new building site. All of this occurred as a result of changing 'shall' to 'may require a quit claim deed' within the original legislation. When owners began paying taxes on the unusable land, it reestablished ownership and pressure to rebuild. After the 1978 Assembly action, development plans slowed due to failure to acquire utility extentions. The State of Alaska refused a utility grant based on the coastal zone management plan. The Municipality, however, agreed to pay a portion of the utility installation because the area borders a city park. With work planned to begin in 1984, the debate on municipal legal risk and the geologic implications of the development continues. The economic risks, however, are high as noted in one case where a private party purchased a slide lot to build a residence. After investing $10,000 in geologic testing and legal fees, he was told that a foundation would cost more than the home and he had to abandon the project. The same lot is currently for sale by the original seller. As of 1982, the original slide area of the 1964 earthquake in the Turnagain area had an assessed value of $11.9 million dollars ($4.5 million in land and $7.4 million in buildings). The area encompassing the L Street slide had a 1982 assessed value of $103.8 million ($35.9 million in land and $67.9 million in buildings). In addition, the Municipal Water and Wastewater Department estimated that it would cost approximately $160,000 per block to replace water and sewer lines. Municipal Light and Power estimates power replacement at $54,400 per residential block and $420,600 per commercial downtown block (Figure 33).

Several officials interviewed also stressed the politics of risk areas. 'Once the first (house or building in the bluff area) is built politics come in. . . . First one gets in then everything goes.' Another noted that the money in this town and the attorney(s) they buy overpower those concerned with risk. The role of elites is highlighted in community power studies. In addition, the political effectiveness of development interests wanting to build in high risk areas is increased due to the fragmented nature of those concerned about risk mitigation issues.

Municipal planners in Anchorage admit that the current and past comprehensive plans do not pay a great deal of attention to seismic risk. They note that past administrations encouraged economic development and that anything that cost more money, such as efforts at mitigation, was considered a negative toward that goal.

The only instance in southcentral Alaska in which the concept of zoning has been used as a device to mitigate hazards is the recent adoption by the Municipality of Anchorage of the residential alpine/slope district into its zoning regulations. This zoning approach is used to mitigate loss of life and property by taking into account a number of environmental factors, of which geologic hazards is one. The use of the alpine zone is currently limited to a very small amount of acreage in the Eagle River area. While other zoning efforts in Alaska have been used to reduce the possibility of flooding

Figure 33. Anchorage 1983 Assessed Value of Land and Structures in L Street and Turnagain High-Risk Areas



in Fairbanks, there is no evidence beyond the Eagle River case that zoning changes have been made that would reduce the possibility of loss through a seismic event, whether by ground shaking, landslide, or tsunami.

As already noted, urban renewal following the 1964 earthquake provided for restrictions on high risk lands in exchange for federal funds. Height and design requirements were part of the Anchorage Fourth Avenue urban renewal plan. Building was prohibited on the original Valdez townsite and portions of Seward's waterfront. Kodiak added foundation requirements and restricted residential structures in the tsunami zone.

Smaller communities face planning and zoning problems similar to Anchorage. In a survey of 34 Alaska coastal communities by the study team, 33 percent had done no comprehensive planning at all. In those communities which have engaged in comprehensive planning, 58 percent of the community plans took no note of seismic risks in the area. Furthermore, 67 percent of the surveyed communities had developed zoning classifications; however, of those with zoning classifications, only 33 percent had considered seismic risks or other hazards. Reasons that risk fails to enter public investment decisions include a public that seeks to utilize its private investment as it sees fit, politicians who balance economic benefit with risk, and planners who must consider the varied interests of the community.

The Kodiak Island Borough has a comprehensive plan which was completed in 1968 and adopted in 1972. It is badly out of date. A revision was proposed, based on a consultant's recommendation, but was rejected soundly by the borough assembly. The Community Development Department is slowly reworking the plan and presenting its efforts to the assembly one section at a time. The Kodiak Borough has a planning and zoning commission, but it seems that interest in comprehensive planning is minimal.

The reconstructed city of Kodiak is very similar to what it was prior to its destruction in 1964. Only residential structures are not permitted to be rebuilt in the area subject to tsunami inundation. Kodiak has little private land available for development, therefore the value of land is going up. In recent years a few multi-family units have been constructed in the area subject to flooding. Most people interviewed felt that planning consultants simply get too specific and too restrictive for the political and economic environment of the city.

Attention to seismic risk in the preparation of comprehensive plans may be due to the degree of perceived risk in the future or damage incurred in 1964. For example, Seldovia and Cordova, which suffered primarily from subsidence and uplift, pay very little attention to other geologic hazards.

Homer's comprehensive plan is currently being updated, but officials expressed little hope or interest in incorporating risk elements into the planning process. One official noted that, in the interest of individualism and the tourist dollar, he doubted the city council would be willing to act unless the hazard could be demonstrated.

Seward's plan has a detailed section on geology which includes a map designating unstable land and high risk areas. The plan also lays out several recommendations, including one which would not permit permanent construction in the high risk area along the waterfront.

Valdez is somewhat different in that its relocation after the 1964 earthquake resulted in the development of a detailed community plan. Throughout the years this plan has been updated to reflect population and economic growth, and supplemented with a number of studies related to hazards. These include flooding, high winds, and refinement of earthquake and tsunami mitigation measures in the early planning stages of the new town. However, the City of Valdez continues to request that the federal government review the requirement that the old townsite remain an undevelopable "high risk" area when industrial and storage sites in support of the terminus of the Trans-Alaska Pipeline are needed.

This history suggests that removal of land for reasons of risk is unlikely to occur without the presence of external stipulations attached to grants and other transfers. Without federal restrictions on the use of its urban renewal money, it is unlikely that local governments could have resisted pressures to develop high risk land. Where those stipulations were not present, development has occurred since 1964.

The most recent vehicle for restricting land use is the Alaska Coastal Management Act (6AAC 80.050). While comprehensive in nature, the Coastal Management Act deals with geophysical hazards by stating:

> Districts (local government) and state agencies shall identify known geophysical hazard areas and areas of high development potential in which there is a substantial possibility that geophysical hazards may occur. Development in these areas may not be approved by the appropriate state or local authority until siting, design, and construction measure for minimizing property damage and protecting against loss of life have been provided.

The act thus provides the opportunity for state and local governments to begin the process of risk mitigation planning. The six communities studies have gone through the process of developing coastal management plans. In addition, 61 percent of the 34 Alaskan communities surveyed had also participated in coastal management planning. However, of those communities engaged in such planning efforts, 36 percent have not made an analysis of earthquake risks even though identification of geophysical hazards is mandated by law. The primary difficulty in this identification process is the lack of accurate data bases. From an implementation standpoint the Coastal Zone Management Act has yet to generate mechanisms by which the identification process actually leads to a decision-making process dealing with development in high risk areas.

Anchorage has extensive physical data contained in three volumes: Coastal Resource Atlas, Volume 1--Anchorage; Volume 2--Eagle River, Chugiak, Peter's Creek, Eklutna; Volume 3--Girdwood. Also, the Geotechnical Hazards Assessment Study (Harding-Lawson Associates 1979) was commissioned by the Municipality of Anchorage as a base for the preparation of a risk assessment map to be used in the Coastal Management Plan. The purpose of this study was to provide an inventory of all existing geotechnical data and to map areas of potential hazards (Figure 34).

The release of this report resulted in a major public outcry of concern about the economic implications of limiting development, since large portions of Anchorage were labeled high risk. The mayor, George Sullivan, was quoted as blasting the report he had commissioned because the earthquake danger was presenting much of the city as unsafe. He noted that he expected Anchorage buildings to survive the next big earthquake. Planning commission members openly worried not about the fact that large portions of the population could be at risk, but that the report would dry up the supply of mortgage money from the east coast to Anchorage (Anchorage Daily News 1 May 1979). The Anchorage Assembly, supported by a recommendation of the municipal planning staff, never adopted the Harding Lawson report, but recognized it as an information source only. The only support for the report for adoption by ordinance came from the Geotechnical Advisory Commission. Despite this, the report has had some important effects on the planning process in Anchorage. Real estate firms have started using the maps to direct new home buyers concerned about hazards to more stable areas.

A new Planning and Zoning Commission has begun relying on the Coastal Resources Atlas and the risk maps as an important planning tool. Their interest increased after the occurrence of an avalanche in Eagle River and a major wind storm which damaged structures in east Anchorage. Both of these risks had been identified in the reports. While the Harding-Lawson Associates report does not carry official weight, the information is included in the Coastal Zone Management (CZM) Plan that was adopted by the assembly and the report is adopted by reference in the current comprehensive plan.

Figure 34. Anchorage Geological Hazards

LEGEND

Hazard Zones	**Seismically Induced Ground Failure**
1	**Lowest Ground Hazard Susceptibility.** *Includes exposed bedrock, thin alluvium and colluvium over bedrock, generally coarse-grained glacial deposits, and mixed coarse and fine-grained glacial deposits overlying bedrock in upland areas. May experience minor ground cracking and acceleration of normal mass wasting processes in unconsolidated material such as rock falls and snow avalanches.*
2	**Moderately Low Ground Failure Susceptibility.** *Mixed coarse and fine-grained glacial deposits in lowland areas, thick deposits of channel, terrace, flood plain and fan alluvium. The thickness of alluvium in the upland areas is variable, and some areas are rated as 1. May have very low susceptibility; may experience minor ground cracking, localized settlement due to consolidation, and perhaps liquefaction or lurching of localized saturated zones of fine-grained material.*
3	**Moderate Ground Failure Susceptibility.** *Fine-grained surficial and subsurface deposits, including the Bootlegger Cove Clay, and other silt, clay and peat deposits. Where coarser material (alluvium or till) overlies these deposits, the seismic-related ground failure susceptibility is controlled by the fine-grained material. May experience ground cracking and horizontal ground movement due to landspreading or lurching, and subsidence due to consolidation.*
4	**High Ground Failure Susceptibility.** *Fine-grained, surficial and subsurface deposits within the vicinity of steep slopes. Includes areas above and below the slope, the width of which is approximately 10 times the height of the slope. Includes a band behind seismic-induced landslides, the width of which is approximately 10 times the slope height in the slide area. Highly susceptible to all types of seismically-induced ground failure, including liquifaction, translational sliding, lurching, landspreading, cracking and subsidence.*
5	**Very High Ground Failure Susceptibility.** *Areas of previous seismically-induced landslides. Includes the zone of tension cracks above the headward scarp, and the toe bulge or pressure ridge areas.*
•	*Although portions of these previous slides may remain relatively undisturbed from future strong shaking, these slides will be the more likely site of future seismically-induced sliding.*

Increase in Susceptibility to Ground Failure

▲ Approximate Extent of Bootlagger Cove Clay.
Arrows toward area underlain by Bootlegger Cove Clay.

Source: Harding, Lawson & Associates

The CZM plan provides legal authority on land use decisions within the district. It is also recognized at the state and federal levels as a regulatory document governing agency spending or direct delivery. Requirements of the plan include identification of natural hazards and development of policies addressing such hazards. The extent to which specific policies are developed addressing natural hazards will determine the level of potential mitigation implementation available at the local level.

Review of comprehensive and CZM plans suggests that mitigating identified natural hazards has yet to be fully implemented. However, as noted earlier in this chapter, the municipality did approach the state in 1979 for funds to install utilities in the Turnagain slide area. The state refused the application based on provisions of the Anchorage Coastal Zone Management Plan which prohibited such investments in high hazard areas. One weakness in current comprehensive and CZM planning lies in the failure to develop specific strategies and administrative processes to implement general policies and objectives. Without implementation tools it is difficult to utilize these documents.

The coastal development program studies for other areas in southcentral Alaska tend to fall into two categories. In the first are those developed by the boroughs of Kenai and Kodiak. These studies, because of the large land mass involved, tend to take a macro approach and therefore the geologic hazards review lacks sufficient specificity for actual use in decision making. These contrast with the plans developed by Cordova and Valdez, which focus on much smaller land areas related to their community boundaries. These studies have a more thorough information base concerning geologic hazards and define specific zones or areas which are high risk. All of these coastal development plans have now been officially accepted by the local governments studied in this project except for the Kenai Peninsula Borough. It now appears that the plan produced by the Kenai Borough will probably not be accepted under the present administration. The concept of coastal zone management has not been strongly supported. This attitude has removed a large number of communities, though they face high earthquake and tsunami risks.

Disaster Mitigation Through the Development and Enforcement of Building Codes: Protecting man-made structures from seismic risk is a part of building codes and regulations. The development of building codes has been a national effort, with the federal government leading the way in research and funding. The scientific community has done substantial work on design and construction techniques which would better withstand natural disasters.

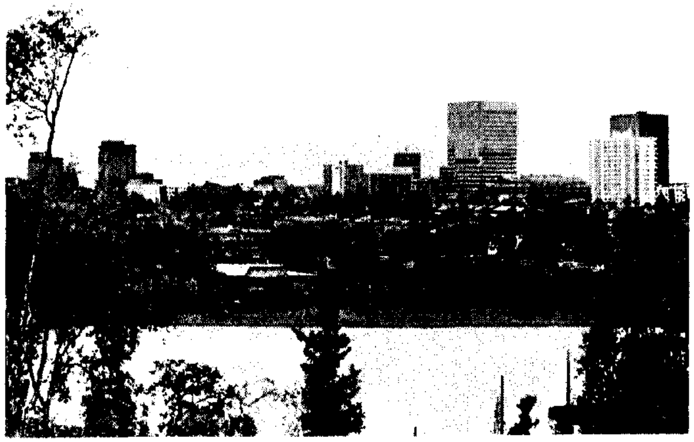
Of the Pacific Rim communities surveyed, approximately half had developed building codes for construction of residential, commercial, and public facilities, with 44 percent having adopted codes for industrial facilities. However, of those communities employing building codes, 56 percent had no special requirement for seismic risks or other hazards.

Of the communities affected by the 1964 earthquake, all but Homer and Whittier have adopted the Uniform Building Code (UBC), Zone 4. This code is the most restrictive in terms of recognition of risk and contains features which are designed to reduce loss due to earthquakes. They include foundation design, the ability to withstand shaking, load, and so forth. The major problem with the UBC is that it is a minimum standard for a large and diverse nation. Individual or local circumstances may dictate more stringent needs. However, building officials tend to perceive the UBC as a maximum in all circumstances rather than a minimum set of requirements. While there is only one instance in which the UBC has been altered to eliminate a standard related to earthquake mitigation, there is no evidence that any community has ever recommended strengthening the UBC to improve the ability of manmade structures to withstand an earthquake.

At the request of the municipal engineering staff the Anchorage Assembly voted to delete the UBC requirement for installation of accelerometers in large buildings in Anchorage. The rationale involved the inability of the staff to monitor the instruments and objections from the private sector over the cost. In 1982 the assembly allocated $50,000 for the installation of accelerometers in public buildings and in 1983 it reinstated the UBC requirement for the instrumentation of buildings.

The debate over this issue and subsequent local action has resulted in substantial interagency cooperation and an implementation plan for installing, reading, and storing this data, involving the University of Alaska Geophysical Institute, the USGS Menlo Park Office, the State Division of Geological and Geophysical Survey, and the Municipality of Anchorage.

This instance and general enforcement of the UBC suggests that the greatest need in the building code area is for better awareness among elected officials, the public, and those in enforcement. An unresolved question is who is responsible for recommending improvements to building codes and other areas of mitigation to meet the particular needs of a local area. Many times those in the enforcement area do no want to take responsibility for recommending changes to the rules and regulations which they enforce. When public works officials in Anchorage were asked if they had ever recommended amendments or improvements to the UBC based on their technical expertise, they replied that they were enforcement officers and did not feel they should be involved in policy making. These types of recommendations were better developed by the planning department. The planning director, on



the other hand, when asked why his department had never developed recommendations for improvements in the UBC, pointed out that his staff was not technically capable to do so but would respond to recommendations made by the Public Works Department.

There are also examples of uneven efforts in using updated versions of the UBC. While communities like Anchorage and Valdez respond rapidly in updating the UBC as improvements are added, the City of Kodiak is still using the 1979 UBC and is only now working on the possible adoption of the 1982 version. Cordova recently adopted the 1979 UBC. Most areas outside the old Anchorage city limits have been subject to building codes only in the last four years, though those areas of Anchorage subjected to the greatest proportion of new construction are still not regulated.

The rapidly expanding Matanuska-Susitna Borough has no building codes.

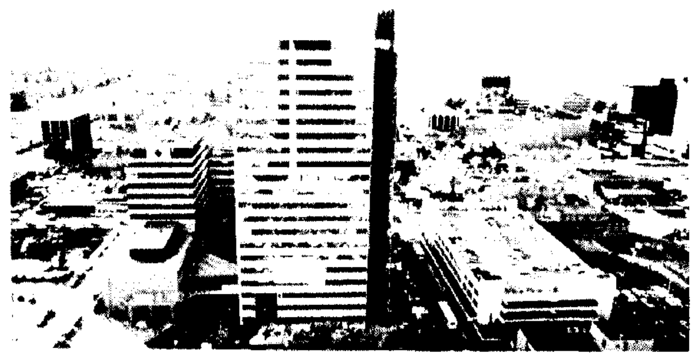
When it comes to enforcement of existing codes, most officials feel that the quality is generally good. However, there have been historical ups and downs. A number of public works directors stated that while current enforcement appears to be satisfactory and even vigorous, historical enforcement over the last 20 years has been uneven. They suggested that it is likely that a substantial number of buildings which are not sufficiently resistant to seismic risk have been added to the existing stock.

Compliance with codes means building to standard in both public and private facilities. In public facilities there has been increased attention directed toward the need to survive a seismic event.

The state has been willing, especially within the last decade, to increase its assurance that its capital construction budget is invested in projects which are seismically resistant. For example, design improvements were made to the Third Avenue jail based upon recommendations made by the Anchorage Geotechnical Advisory Commission. The Commission also asked the Anchorage Municipal Assembly to request the State of Alaska to invest $400,000 in site and geologic testing for the state office building proposed for Anchorage. This pattern is similar for local public investments. Anchorage had plans for a new sports arena reviewed by consulting experts in order to insure that the design would meet seismic safety standards for that type of structure. Significant investments in seismic evaluation of its site and design work so that it would withstand both ground shaking and tsunami were made for the Valdez Community Center. The only example of a public facility actually having lowered standards involved improvements to the power plant at Cordova. Local codes were dropped in favor of the less stringent state code UBC, Zone 3, in order to get competitive bids for carrying out the proposed improvements to the plant.

The interest of the private sector is more troublesome. The smaller communities are not faced with the high rise development by private investment seen in Anchorage. Generally, the low height and low density structures are constructed to reasonable standards. Kodiak, for example, has increased foundation requirements in its tsunami prone areas and Valdez toughened its code related to wind risk.

The larger structures in Anchorage are faced with more substantial requirements. A working guide by the Public Works Department provides architects and builders with requirements for multi-storied structures in Anchorage. These requirements include the need for additional geologic tests, core sampling, and proper site evaluation that must be considered when building design begins. Building officials readily admitted, however, that except for the largest investments, most permits are handed out based on the review of an overworked staff and the stamp of an architect who is willing to attest that the design meets requirements. The staff's background, predominantly in civil engineering, does not provide sufficient expertise to properly address seismic risk in the permit application and code enforcement process. Only on the largest and most significant investments, whether public or private, does the department deem it necessary to hire consultants for more extensive review. On public projects the municipality generally abrogates their inspection responsibility and project managers hire 'independent' inspectors. The question of abuse was raised when the new junior high school in Eagle River was forced to remain closed during 1983-84 because of numerous code violations, including the possibility of seismic failure. After this event, the mayor of Anchorage ordered municipal inspection on all public projects.



Smaller communities are even more limited in their capacity to properly evaluate plans. Some, like Seward and Homer, rely to some extent on expertise provided by the state. Others, like Valdez, generally have the resources to make evaluations with local staffs or consultants.

Most of the communities that were damaged during the Alaska earthquake presently have their own building codes. Where local building codes are not adopted, the state's adopted building code, UBC Zone 3 1982, is supposed to be utilized. However, there is little evidence that building codes are used in rural areas except for the construction of public facilities that utilize state funds. Even though many smaller communities have adopted the Uniform Building Code, most of them do so only in part. Only a few of these communities have adopted the sections that relate to seismic or hazard risk.

Local officials in smaller Pacific Rim communities in Alaska were asked if earthquake risk was considered in the design of critical facilities, including schools, harbors, fuel tanks, electric plants, satellite communications, general public facilities, etc. Of 76 facilities mentioned by respondents, public officials considered earthquake risk in only 26 when the facilities were designed. Of course, structural design by professionals may have included these items as a matter of course, without the knowledge of local building officials.

Earthquake risk is most often considered when constructing harbors and electrical generation facilities. Also schools, airports, and public safety facilities have received some attention. However, for the majority of facilities that are contracted in rural Alaska, local officials have had uneven interest in hazard mitigation.

There is an increasing awareness among public officials in Alaska that building codes do not necessarily insure adequate protection against all hazards, including earthquakes. The Anchorage Geotechnical Advisory Commission has recommended that the size and use of a particular structure determine the need for increased geologic study and building requirements. The concept of balanced risk, with more stringent requirements for larger or intensively used structures, and structures built in areas designated as having a higher probability of impact during a seismic event, is now being considered.

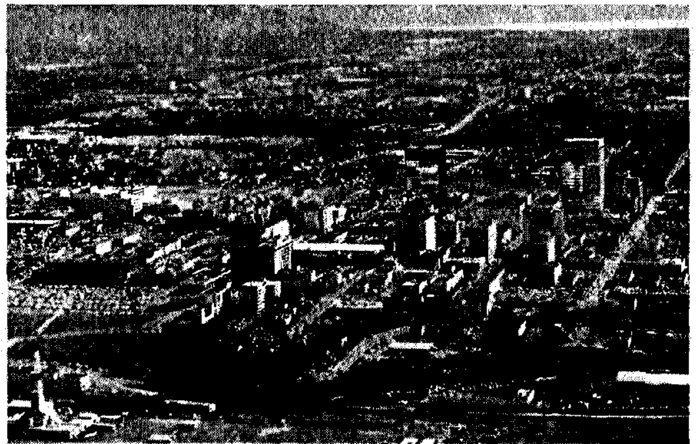
In an internal document the Anchorage Planning Department recognized that the Uniform Building Code does not go far enough in mitigating seismic risk in Anchorage. Initiated by the Geotechnical Advisory Commission, the department's memorandum notes that "lateral force coefficients need to be increased to reflect actual loading conditions during an earthquake, and foundation design considered to modify earthquake intensity." The memorandum further states that technical experts in other departments (primarily the Public Works Department) do not necessarily share this opinion and still rely on the building code in its present form for most building decisions (Municipality of Anchorage, no date). This highlights the phenomenon of shared interests between the technocrat and development interests. Common education and professional values concerning the capacity of technology to deal with risk increase the likelihood that the developer and regulator will fail to recognize the inability of technology to solve all natural hazard risks.

Disaster Mitigation Through Retrofitting and Land Protection Improvements: The building inventory in Alaska is quite new by most standards. The majority of housing and commercial stock in Anchorage, for example, was built since 1970. The entire community of Valdez was built after March 1964. This is true of most commercial, residential, and industrial structures in the region. Because of this, concern over older buildings which may not meet current codes has not been an important issue.

One unusual situation is Providence Hospital, which built its newest wing in 1976, using the building standards for medical facilities at that time. It constructed the facility in such a way that at a later time additional stories could be added. In a recent proposal to the Health Planning Commission to add additional beds to the facility, the construction of an entirely new wing was considered necessary because the newer building codes were more stringent, and major retrofitting of the existing facility would be needed in order to add additional stories.

Because of the uniqueness of the relatively new inventory, there are no plans to develop policies in Alaska which would focus on older structures and their susceptibility to damage. Rather than inherent flaws in the codes, building officials voiced more concern over poor building practices which could produce unsafe structures susceptible to damage during an earthquake.

Of greater debate is the proper siting of structures which have been built to code. Dwight Ink, federal director of the Alaska reconstruction effort, was surprised on a 1982 trip to Anchorage to see multi-story buildings on the L Street bluff, since recommendations after the earthquake had urged that no structure over two stories be built there. Geotechnical Advisory Commission member John Aho noted that the problem is not the number of new buildings on the bluff but their location. "It doesn't matter how well you engineer a building. If the soil gives way underneath it, there's going to be some problems" (Anchorage Daily News, 21 July 1982). Code enforcement is focused primarily in the areas of sanitation and fire hazard and there is no instance of existing stock being cited or reviewed because of nonconformance with any seismic risk standards.



Source: Chaplins Photography

Following the 1964 earthquake, the most notable land improvement that took place was the construction of the Fourth Avenue buttress in Anchorage. Similar efforts were not pursued in the other two major slide areas in Anchorage, L Street and Turnagain, due to the massive size of the areas involved and the high cost of stabilization. Today it is possible to drive below the L Street Bluff area and see water seeping out of the bluff between the Bootlegger's Cove clay and the composite soil above it.

A major effort designed to reduce loss through land improvements is underway at Pillar Mountain, near the city of Kodiak. Pronouncements during the 1970s by the USGS concerning the possibility of a landslide of Pillar Mountain as a result of an earthquake has had some serious economic impacts on the city of Kodiak. Federal support for harbor improvements and other economic development investments have been difficult to acquire because of concern over Pillar Mountain. The slide has a long history but reactivated itself in 1971 when large amounts of material were removed from the base of the slope. Since that time considerable study has been carried out, including two geotechnical efforts, to identify the extent of risk posed by the mountain. The latest, carried out by R & M Consultants under contract with the City of Kodiak found that, while not conclusive, there is a sufficient risk from landslide that remedial measures would be required. The report suggests that Pillar Mountain be topped and terraced. This procedure would utilize the material generated to add weight and bulk to the base of the mountain, thus reducing the possibility of major slope displacement. The overall effort is estimated to cost $25 million. The City of Kodiak is currently attempting to obtain state and/or federal funding to implement this project.

When city officials were asked why the city was concerned about Pillar Mountain, local political and administrative officials stated flatly that it was for economic reasons, not risk avoidance. Officials in the community did not seem overly concerned about the mountain but were very concerned that federal recognition of the problem would reduce economic development efforts. Since the slope stabilization effort would also provide land for industrial development and harbor expansion, Kodiak would get the economic benefit that they desire while still fulfilling the mitigation concerns of state and federal authorities.

Mitigation of Loss of Critical Facilities and Lifelines: Survival of the lifeline infrastructure is an important consideration of any mitigation effort. Intact utilities, critical facilities, communication and transportation systems permit both more rapid relief efforts and general recovery of the economic and social life of the community. While utility and facility disruption can be anticipated in a major seismic event, progress in reducing exposure to system failures is critical.

Electrical Generation: Today earthquake mitigation practices are a part of planning and construction. In Anchorage, Municipal Light and Power stresses the philosophy that a reliable system design minimizes the occurrence of long-term power failure. Officials would rather deal with intermittent shortages than with fewer long-range outages, and their technology reflects this philosophy. System components are designed to restart after shortages, and loops are built into underground lines. Municipal Light and Power maintains supplies of fuel at selected locations for emergency use. Despite improvements, outages are predicted to occur, with fuel tanks rupturing at 7 or 8 intensity with the system experiencing extensive damage. One concern is the proportion of underground lines now existing in the Anchorage area. Although aesthetically pleasing and less susceptible to wind disturbance, underground power lines are not expected to fair well in the event of traumatic ground shaking (Tom Stahr, Manager, Municipal Light and Power, Interview, June 1982).

Since 1964 there has been a trend toward utilizing a smaller number of large capacity generators as opposed to a large number of small generators. Such a move strains the system as damage to one or two large generators can affect the integrity of the entire generation system. However, much of the equipment presently in use is new and less susceptible to breakdowns.

The exposure of long distance transmission lines to earthquake damage was noted earlier in this section. However, major transmission lines are designed to withstand high winds and are to some degree inherently earthquake resistant (State of Alaska Division of Emergency Services 1980).

Chugach Electric also has plans to reduce the vulnerability of its submarine cable across the Knik Arm by upgrading this portion of the system with construction of a combination submarine cable-overhead circuit to Anchorage. An additional submarine cable crossing will be located in Knik Arm approximately seven miles from the present crossing and will provide an alternative to the present transmission system (State of Alaska Division of Emergency Services 1980).

Loss of power plants remains a problem but location of newer facilities minimizes this possibility. For example, the Municipal Light and Power Plant II is located in an area with good soil stability and is less likely to be impacted by slides than the older Plant I. Loss of Plant I would not have as great an impact now that Plant II produces the majority of bulk power (State of Alaska Division of Emergency Services 1980).

Valdez, with its relocation, built a more resistant system with fuel tanks now less vulnerable and protected from tsunamis. Kodiak, Seward, and Whittier remain as vulnerable as before with exposed fuel tanks and facilities. Kenai Peninsula communities intertie with Chugach Electric's grid, including Homer Electric, and outages should be of shorter duration as long as major transmission lines can be repaired quickly. Southcentral Alaska also faces new power options in the future with small and large scale hydroelectric projects. Kodiak has a hydroelectric project currently under construction, and the massive Susitna Dam project, which would supplement the need for new facilities for decades, now is being studied. Also, the intertie project for the railbelt from Anchorage to Fairbanks is designed to increase system integrity.

Natural Gas Distribution: Enstar Natural Gas Company has used earthquakes as part of the planning criteria since its inception in 1960. Earthquake hazard mitigation practices are in effect in the following ways:

- All component systems are separated into zones which are controlled by valves so leaks can be immediately cut off.
- Valves can always be located quickly because they are part of a map record.
- All pipelines now are constructed of ductile iron, a type of line which requires no lubrication due to its teflon lining, which is less susceptible to cracking from earth movement.
- The distribution system uses plastic pipe in place of metal.
- Each home is equipped with a regulator which shuts off automatically in the event a pipe on either side breaks.

Enstar recently began construction of a new line around the Knik Arm to the Beluga fields, providing both long-term alternative supplies and reducing a shutoff problem. This line would be more readily repairable than the submarine lines crossing Turnagain Arm.

Source: North Pacific Aerial Surveys, Inc.

Water and Sewer Utilities: In Anchorage the municipal Water and Wastewater Utility relies on soil tests, studies, and analyses, and has standardized the pipeline system with the use of ductile iron piping up to 36 inches in diameter. Location of service is a function of city government land use policies. The utility does not have a say in location of facilities or areas to be served.

To date there is no way to mitigate the effects of total ground failure. Generally, areas subjected to major ground displacement and failure also will experience total system failure. In Anchorage it is anticipated that the downtown core area, the L Street and Turnagain slide areas will experience an 80 percent system failure in the event of a major earthquake. Damage to systems from seismic vibration where displacement does not occur will be light with primary damage resulting from separation of service lines from structures.

Smaller communities should suffer problems related to their soils and susceptibility of plants to inundation. The extensive failure of the Valdez systems should not be repeated, though localized interruptions could be extensive.

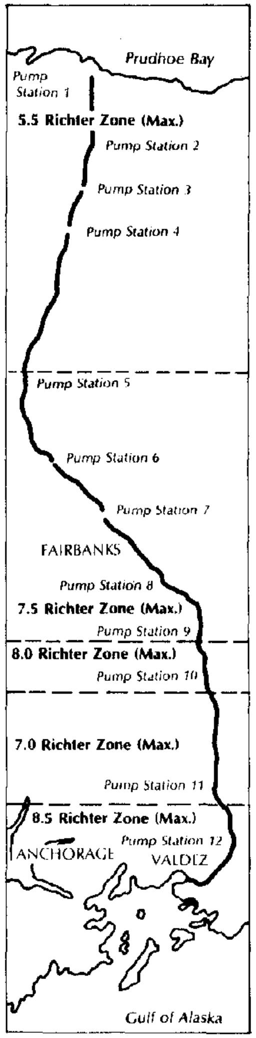
Public Facilities: Geotechnical studies assuring the stability of sites and structural integrity of public facilities are becoming more commonplace in Alaska among all levels of government. The state recently requested geotechnical hazards studies and review by the local Geotechnical Advisory Commission in Anchorage on the site selection and design of the Third Avenue Jail. The state also invested $400,000 to do site and geologic testing for the state office building proposed for Anchorage. This pattern is similar for local public investments. Plans for the new sports arena in Anchorage were reviewed by outside experts to assure that the design would be relatively safe. The new Valdez community center also included significant investments in seismic evaluation of its site and design work so it would withstand both ground shaking and tsunami. The City of Cordova lowered standards related to improvements to their power plant. Local codes were dropped in favor of less stringent state code UBC, Zone 3, in order to get competitive bids for carrying out the proposed improvements to the plant.

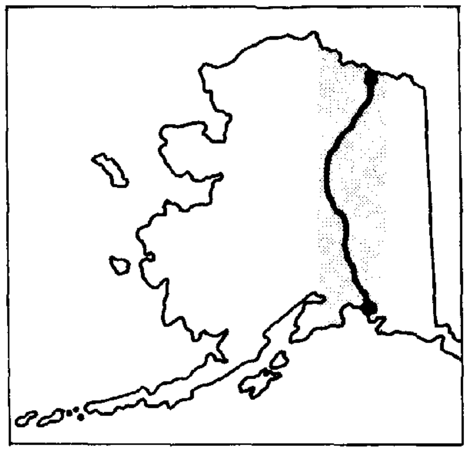
Despite the increased attention to seismic risk, public facilities critical to postearthquake response are constructed with incomplete safeguards. In September 1983, the Anchorage School District found itself not being able to open a new junior high school because of structural defects that a preliminary study by a seismic engineering firm concluded made the building vulnerable to both earthquake and wind damage. The district now faces substantial costs in strengthening the structure as well as losing its availability for an entire year. The Anchorage School Board chairman has asked the legislature to require the consideration of seismic risk in all public construction design.

Of special note is the survivability of the 798-mile Trans-Alaska Pipeline, transporting oil reserves located on the north slope of Alaska to Valdez. This is a good example of implementation of earthquake hazard mitigation techniques. Although constructed with private funds, most of the lands the pipeline traverses belong to the state and federal governments. Detailed analysis of seismicity was performed by members of both the public and private sectors and the pipeline was constructed according to state of the art seismic design procedures. An agreement was reached between federal and state officials and Alyeska Pipeline Service Company, the consortium in charge of construction, that certain construction standards were to be met. Where design was not technically feasible to compensate for a predetermined risk level, Alyeska was to install ground motion detectors to monitor ground shaking in order to facilitate shutdown of the system, thus minimizing oil spills (Figure 35).

The route chosen for the pipeline was graded according to historical seismic episodes. Analysis revealed that the northern end of the pipeline was found least susceptible to seismic disturbances and pipeline construction was designed to withstand an earthquake of the magnitude of 5.5 on the Richter Scale. The southern terminus of the pipeline at Valdez was rated at 8.5 on the Richter Scale. Over active fault zones, the pipeline can sway horizontally up to 20 feet and vertically up to 3 feet. The terminal facilities at Valdez were built on bedrock and are located well above the tsunami inundation level, and holding tanks are filled to a lower level than is their capacity in order to allow for sloshing in the event of major ground shaking. The federal agency responsible for pipeline monitoring was interviewed and confirmed that Alyeska met state of the art standards. However, they did provide a caveat that an earthquake monitoring system was to be installed throughout the length of the pipeline to facilitate decision making regarding a shutdown in operations in the event of a major earthquake. This system is partially functional but there have been vendor problems and Alyeska has been forced to cannibalize parts from the monitoring stations located in the areas of low

Figure 35. Seismic Zones, Trans-Alaska Pipeline Route





Location of Section shown

SOURCE: *Seismic Qualifications of Trans-Alaska Control System by D. J. Nyman, V. J. McDonald, R. P. Beck* seismicity in order to maintain monitors in the more active areas. The federal government would like to enforce the preexisting agreement of a full-scale monitoring system, but with the current federal cutbacks has been unable to do so. Fault slippage also is regularly monitored, but standards in this area are more relaxed with monitoring occurring at greater and greater intervals as time passes.

Transportation/Airports: The integrity of air transportation in Alaska is considered vital in order to assure rapid relief and reconstruction efforts. There are several airports available in the Anchorage area, and they are located on different types of soil conditions. In addition, runways are inherently earthquake resistant since they are designed to withstand large jet operations.

Since 1964 certain mitigation practices have been instigated which further assures the survivability of airport facilities in the event of a major earthquake. In 1978 construction was completed on the new Anchorage International Airport control tower. Seismic ground motion was taken into consideration during construction and all Instrument Flight Rules equipment and radar components are located at ground level in the new facility. If the tower should topple equipment would probably remain intact. Emergency generators also are now available at Anchorage International Airport to provide temporary power for lights on runways, taxiways, and to some extent, the terminal. The Federal Aviation Agency provides for emergency power generation to the control tower. In addition, adequate emergency communications equipment exists at all facilities. Elmendorf AFB control tower, constructed in 1969, is very similar in design to the new one at Anchorage International Airport (State of Alaska Division of Emergency Services 1980).

Impact to the smaller communities is likely to be the same as in 1964. The major problem identified is the inability to access the airports by road after a major seismic event. This might be especially critical in Kodiak and perhaps Valdez, where the new townsite is separated from the airport by the old townsite. The old townsite continues to be susceptible to local seawave inundation which could result in the destruction of roadway connections.

Ports: In varying degrees, port facilities all are vulnerable to tsunami inundation. To mitigate this the Anchorage Port uses dock pilings which are sunk 110 to 160 feet into the silt of Knik Arm, and built to survive the winter ice floes of the Cook Inlet. Expansion joints are numerous allowing for expansion and contraction during seasonal fluctuations thus improving the facilities' integrity during a seismic episode. In addition, cranes are built to withstand high winds and some have self-contained diesel power backup generators.

As with the airport, rupturing of fuel lines and storage tanks is a significant possibility in Anchorage. Firefighting foam is not stored at the port; however, large supplies are maintained in the city and adjacent military lands. Generally the Anchorage Fire Department's response time to the port is estimated at three to five minutes (State of Alaska Division of Emergency Services 1980).

Generally, smaller ports are more vulnerable, though Valdez completed a floating dock system designed to reduce loss and increase the ease of placing it back in operation after an earthquake.

Roads and Railroads: Highways and the Alaska Railroad are located, for the most part, along the same routes that existed in 1964.

In 1964 bridge damage was greatest where the ties between the substructure and superstructure were broken, allowing the deck and supporting piles to vibrate against each other. Today regulation of bridge design includes mitigation of seismic risks. The State of Alaska utilizes the American Association of State Highway and Transportation Officials (AASHTO) specifications for bridge and pedestrian overpass construction (State of Alaska Division of Emergency Services 1980).

Despite these safeguards, with the few transportation and options available, the loss of even a

Source: Air Photo Tech

few bridges or road/rail beds would cut off all land routes between communities in southcentral Alaska. This can be expected in a future large seismic event though the overall integrity of the transportation systems has been enhanced.

Evacuation Warning and Public Education in Hazard Areas: Advances in the technology of predicting major seismic events has been supported by federal government programs. Warning a population of an impending disaster has been a long-term goal of the scientific community. About half of the USGS Earthquake Hazards Reduction Program is devoted to development of prediction capabilities. The work in the United States compliments very aggressive prediction programs in other high seismic risk countries including Japan and China.

Though extensive monitoring and warning seismograph networks exist, very few prediction techniques are used in Alaska. The USGS has funded a single small earthquake prediction study in the vicinity of Adak Island. The high cost of data gathering and studies in Alaska in combination with its low density of population does not make Alaska a prime candidate for prediction efforts. In addition, while prediction has scientific credibility, its interest at the political level must be suspect. Other mitigation measures available to government are either not within the jurisdiction of federal authorities or are politically difficult to address. Increasing the cost of investment because of greater or more stringent building codes or removing large tracts of high risk land from development would be a difficult task. While earthquake prediction is still in its infancy, there has been encouraging progress in related areas such as the volcanic hazards program. In addition, the National Landslide Hazards Reduction Program encompasses a major increase in USGS research in this area.

The most successful and effective warning system that currently exists is the tsunami warning system. The major difficulty with the warning system is inadequate communications to small and remote communities which are still vulnerable to inundation.

The Alaska Tsunami Warning Center is operated by the National Weather Service, located in Palmer, Alaska. The Center issues warnings for the entire northern Pacific Ocean and interfaces its activities with the Division of Emergency Services (DES). DES assists by helping to improve communications capabilities and by working with coastal communities to create education programs.

Communications are tested on a regular basis and there is an annual full dress scenario where the center contacts each community which in turn activates a telephone network designed to contact all key personnel. These would include city managers, harbormasters, public safety officers, etc. Recent tests have generally been successful, however, the 1982 test failed to successfully contact the city of Homer, which is quite vulnerable to tsunami in the spit area. This is due to the fact that Homer has failed to acquire adequate communications equipment to be tied into the network and the closest communication center is approximately 20 miles north of the community. The unincorporated community of Whittier, with its large public boating facility, also is without adequate warning systems.

The ability of the state to warn of a tsunami is based on its ability to detect earthquakes in the Alaska area. For many years, seismic equipment designed to register earthquakes and their intensity have been maintained by a variety of federal, state, and educational institutions. In recent years federal support for these stations has declined and it was only during the 1983 legislative session that the state began to assume an increased responsibility in this area.

In addition to transmitting a warning, communities have the responsibility of carrying out proper evacuation. Most of the communities likely to be affected by tsunamis seem well prepared to evacuate. However, a number of public officials did express concern because large portions of the current population never have experienced a destructive earthquake. Therefore, the urgency of the situation may be lost due to a lack of appreciation of the destructive power of a tsunami. Kodiak officials noted that a tsunami warning that came to Kodiak several years ago was greeted by residents coming down to the harbor area in order to watch the water or wave come in. Fortunately, there was no major impact on the Kodiak area. There has been no actual exercise in any of the communities where an attempt to clear the harbor or waterfront areas was actually done. However, Seward evacuated its harbor area successfully and within one hour when a boat accident released toxic chemicals. Homer, as noted earlier, appears to be more vulnerable. They are faced with a long narrow strip of land vulnerable to a tsunami with only a two lane road leading to high ground. The harbormaster noted that the current siren is insufficient to make people aware of any danger. While plans have been made to provide one way traffic out of the harbor area and spit, there have been no practice drills, educational programs, or other organization that would assure rapid evacuation of this area.

Communications and organizational support appear to be sufficient for the current warning system. One of the key drawbacks is the failure to adequately communicate with and educate the public on their role in any evacuation or warning. Neither state nor local government has aggressively pursued the public education effort. The transient nature of the population in Alaska would suggest that an ongoing public education program would be necessary in order for the average citizen to effectively respond to any disaster warning. The state does provide stickers, brochures, local speakers, etc. for a limited education effort.

Local government has done very little to support the state Division of Emergency Services (DES). Interviews suggest that public awareness of disaster planning and response to warnings and disasters is extremely limited. Most education has been relatively passive using posters and brochures with limited distribution. These require individual citizens to seek them out, pick them up, read them, etc. Though most citizens are not aware of it, the most widely disseminated information is found in the civil defense section of the Anchorage telephone directory. While DES has an education director, it has been able to mount only a few active programs that seek out the public and on a regular basis provide education on preparedness and response to earthquakes and other natural disasters. One difficulty is apathy, with the public ignoring educational opportunities until the disaster actually occurs. Earthquakes are perceived by the public as distant future events with an occurrence unlikely to directly affect them. This is much the same response as the driver who fails to fasten the seatbelt, unwilling to believe that an accident could happen to him or her. The nature of earthquake risks suggests the need for a concerted effort if one is to expect public recognition and preparedness for future events.

Alaska school systems are involved in an effort to educate a large population about what to do during strong ground motion. School disaster preparedness materials are supposed to be incorporated into the service programs to teachers, who are then asked to transmit this information to children through practices. While the preparation for and practice in the event of fire is an ongoing and required effort, response to and preparation for earthquakes has not been as aggressively followed. Generally, teachers incorporate this type of instruction as an option and many fail to do so at all. Interested school administrators seldom know details of the community's preparedness information themselves, nor do they make sure of or supervise the transmission of preparedness information to students. Some districts, for example Valdez, have actually had earthquake drills. The Anchorage School District has recently begun to incorporate a more thorough earthquake component in its curriculum, instructing students on preparedness techniques and explaining the "reasons why" the techniques are important.

Two examples demonstrate inconsistencies of school personnel when dealing with an earthquake. In a 1981 seismic event, a grade school child reacted by ducking under the desk as instructed by posters. The teacher physically removed the child and scolded him for his behavior. During the 6.3 event in 1983, however, several reports described teachers instructing children on procedures to protect themselves. This event occurred only a few days prior to a national news feature on regular earthquake drills taking place in Coalinga, California, badly damaged in recent ground motion.

The key element in earthquake drills is what to do with the children once the ground shaking and tsunami threat had passed. While plans exist on paper, there has been virtually no effort to practice what these plans might include, nor have parents been informed on how reuniting families would be carried out. In general schools are supposed to keep children at the facilities until parents come for them. Buses could be used to take children home once areas of the community were considered safe, but co-ordination of this with parents in any organized fashion is nonexistent. If it was required that each child be picked up by a parent the traffic generated could congest the transportation corridors needed by emergency vehicles.

The public's general knowledge concerning risks of natural disasters is at best limited and at worst dangerous. While there are some indications that the professional community has gained a greater awareness of local hazards and has used this in their decision making, there is much evidence that this is not true for the general public.

By and large most education in this area deals with issues of preparedness. In addition to government efforts to heighten awareness, the media in the past two years has aggressively provided information on how to prepare for an earthquake and what to do when one occurs. In 1983 alone, multi-part news stories for both radio and television were aired and dozens of newspaper articles appeared, including several full-page discussions. In recent years, more articles have appeared on local and state action in the mitigation field. For example, extensive news coverage was provided on the state's studies related to site selection for a possible state office building in Anchorage, rebuilding in the Turnagain slide area, forecasting of future earthquakes, and other issues. These stories included geologic analysis and reasonably sophisticated reporting of the issues.

Historically, however, except in straight news events, the media has reflected a variety of economic concerns that any mitigation efforts might have on a community. For example, the National Science Foundation grant upon which this study is based produced "Waste in Taxpayer Dollar" articles, including a cartoon depicting Dr. Selkregg, the principal investigator, as Chicken Little calling out 'run for your lives, the ground in falling!' Detailed information concerning risk identification due to earthquakes or even threat of that possibility has usually led to locally published cries of concern. As noted earlier, the Harding Lawson Report which identified areas of increasing seismic risk in Anchorage was attacked heavily in the papers. This attitude goes all the way back to the 1964 earthquake as reflected in an newspaper editorial entitled "It's Enough to Make Any Alaskan Angry." The editorial began "Alaskans are learning there are some things worse than the aftershocks that follow an earthquake. Among them are scientists" (Anchorage Daily Times, 27 April 1964).

This pattern for whatever reasons, has shifted since 1981. There is strong evidence that the quantity and quality of media coverage of seismic issues has improved. Locally written and wire service articles have appeared which factually discuss Alaska's high risk, potential for future events, and "what to do when the walls shudder" (Anchorage Daily News, 8 September 1983). The ultimate compliment suggesting that seismic issues were important was a tongue-in-cheek

Source: City of Anchorage

article by a local columnist entitled "Ways to survive and brag about it after the next earthquake" (Anchorage Daily News, 18 September 1983). Along with the humor were several real lessons for readers.

There has been little effort on the part of government in Alaska to provide systematic public education. The DES has done some advertising which told people that "worrying about earthquakes is good for you!" and very pointedly said that in order to reduce earthquake risk land-use controls should be imposed to prevent new building activity, revise building codes, establish a seismic safety commission, etc. While the division asked the public to get involved with their community, they have not been able to get that message across sufficiently to heighten public awareness to the extent that these various objectives could gain the necessary public and legislative support. In fact, in the survey of Pacific Rim communities only 11 percent had ever carried out any public education on the risk of earthquakes and what could be done to reduce damage.

Despite the increased media attention to hazards risk and general heightened public awareness, there still exists a major educational and attitudinal gap. Also, increasing public awareness has yet to translate into more effective mitigation measures. A humorous column in the Anchorage Daily News by Satch Carlson satirizes "Alaskan" attitudes which are just close enough to reality to suggest a great deal more effort is still needed if public education is to be successful.

> I think city officials and many of the populace are being mean to those Turnagain property owners who want to build on shaky ground. These are the people who found out in 1964 that their meager plots had a tendency to turn into squishy liquid and squoosh out into the Inlet when things started getting very weird.
>
> I says these people got guts.
>
> Back in the years immediately following the earthquake, you'd think we all turned lily-livered. Why, all

over the place there were areas of subsided swamp that we were told would never be used again. Too dangerous. Fault-lines were mapped and extrapolated; the Army Corps of Engineers worked overtime doing studies and making recommendations, and we all figured we'd be required to avoid those places most likely to slide down toward Kodiak if we wanted to build something.

I can remember visiting Guy Martin, attorney and writer and teacher and stuff, in a tiny house perched above Bootlegger's Cove; the house was more or less condemned, at that time, but I vaguely remember that Martin wanted to buy it, but it couldn't be sold because of its perilous location or something.

You know what that kind of thinking is? It's chicken, that's what it is. And that's hardly the Alaska way.

Thus it was that we changed our attitudes toward earthquakes. To begin with, who knows when we're going to have another one? Why, it might not come for years, long enough for us to build and develop and sell at a profit, a clear opportunity that would be denied us by those timid hand-wringers who worry about a few lame digits on the Richter scale.

I don't think Guy Martin's house is there anymore; there is a handsome condominium development in its place. You think those condo dwellers are worried about collodial clay? Heck, no: They're Alaskans!

I believe in the Alaska sense of individuality that says a man has a right to be as stupid as he pleases; if I own a section of swamp and I build my castle there, despite all the warnings that it'll sink in the ooze, then I'm the one who has to keep moving the furniture to the higher levels (we can always use the turrets as the foundation for the new castle).

Besides, when the inevitable happens, somebody's sure to bail me out.

Was it not thus in 1964? Did not Ernest Gruening bring home some $400,000,000 in disaster relief funds? (True, $400,000,000 doesn't go as far as it used to, but it still ought to repair the cracked plaster.) This is a state with spirit, I tell you; that spirit and low-interest loans had us back on our feet and building again in no time, turning ourselves to the true task, which is making money.

And I don't think those property owners are looking for a handout either. All they want is to build their humble abodes on their own property, tremulous as it might be, and I am sure they would be willing to waive any possibility of compensation in the event of another catastrophe. Something that runs with the land, a few paragraphs attached to the deed making these lands and fixtures ineligible for relief when the clay slides out from under'em, and I think all parties would be satisfied. As Mark Twain put it, 'Experience is a wonderful teacher. A man who carries a cat home by the tail isn't likely to employ that method again.

'But I say if he wants to let him! 'Tisn't easy being eccentric' (Satch Carlson, Anchorage Daily News, 10 December 1983).

Part IV: Toward More Effective Implementation

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Chapter 8: Toward More Effective Implementation of Seismic Risk Mitigation

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Towards More Effective Implementation of Seismic Risk Mitigation

In terms of the number of people, the amount of property, and the critical economic facilities exposed to risk, Alaska is more vulnerable today than it was two decades ago. Growth in the economy and population are not the only factors in this increased risk. Measures which might have been taken to reduce the dangers from earthquakes and tsunamis have not been taken or have only been partially or imperfectly instituted. Lands designated high risk have been developed for industrial, commercial, and residential use. This concluding section provides a discussion of the key obstacles to implementation, suggests a role for seismic risk in the comprehensive planning and administrative decision making processes, and offers specific recommendations designed to promote implementation of earthquake risk mitigation measures.

Obstacles to Implementation

This study has focused on the role of scientific information, public administration, and planning efforts to mitigate the effects of earthquakes based on the experience of the 1964 Alaska earthquake. Something would be missing, however, if the specific obstacles to implementation identified were not addressed. Many people interviewed for this study were pessimistic about the prospects of improved risk mitigation efforts, and they often cited specific impediments, including technical issues of geology, land use allocation, government organization, and specific planning and management problems. Also, there was a broader concern related to the obvious lack of implementation of well known public safety measures. No factor, or set of factors, can be singled out as the critical obstacle to implementation, but we can identify some obstacles found by the authors to be significant to implementation of geophysical hazard mitigation.

Research on general problems of policy implementation (Bardach 1977; Pressman and Wildavsky 1973) is only partially applicable to risk mitigation. Case studies have focused on failed implementation of Great Society programs involving continuously visible and defined groups of people such as the poor, the unemployed, or a minority group. Earthquake hazard mitigation presents different implementation problems than many other government programs designed to attack social and environmental ills. The threat from earthquakes is largely invisible and of low probability, though of great potential consequence. Additionally, the actual effect of implementation measures to deal with them cannot be easily evaluated in the short run and at low cost.

The critical obstacles to successful implementation of risk mitigation efforts in Alaska are organizational and political. Organizational obstacles include imperfect scientific information and defective theoretical approaches; ambiguous policy directives; dominance of the

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'rational actor' model of decision making; and the difficulty of sustaining interest in the issue over time. The political obstacles to mitigation are even broader and more difficult to specify and yet probably are more important. These include leaders lacking knowledge, sympathy, or commitment to implementation, aspects of the political culture--pluralistic and elite politics--and lack of definition of the level of government responsible for mitigation.

Organizational Obstacles to Implementation

Each obstacle cited below calls for additional research, none operates exclusively, and the relative weight of these individual factors is difficult to assess. Nevertheless, each helps to explain the weak implementation of measures to reduce the dangers from earthquakes in Alaska.

Implementation Obstacle #1 – Imperfect Scientific Information

The accuracy, reliability, and availability of scientific geotechnical information has been a major obstacle to implementation. Geology and other relevant sciences cannot accurately predict when, where, or how severe an earthquake will be, and this uncertainty makes communications between the technical expert, the planner, and the layman citizen or public official difficult. U.S. Geological Survey geologists brought to Alaska after the 1964 earthquake found this to be a major problem. One of them noted that the value systems of scientists, which include careful emphasis on areas of doubt, possible weaknesses in the data, and at times excessive modesty, can convey ambiguity and uncertainty to the layman even when general conclusions are clear (Ernie Dobrovolny 1982).

In Alaska more scientific and technical information is needed, particularly for communities outside Anchorage. First, however, inadequate use of existing technical information must be addressed. A subtle contempt for science and intellectual abstractions in U.S. and Alaskan political cultures may add to the problem of translating technical information for lay understanding. An Anchorage newspaper editorial shortly after the earthquake stated, 'Alaskans are learning there are some things worse than the aftershocks that follow an earthquake. Among them are scientists' (Anchorage Daily Times 27 April 1964). Such contempt for scientific and technical disaster research is surely one factor in the failure to effectively use the geotechnical information that is available.

In 1959 a geological study of the Anchorage area warned of the potential for earthquake-triggered landslides in areas where they actually occurred in 1964 with loss of life and property (Miller and Dobrovolny 1959). Since the 1964 earthquake a great deal more scientific information has been developed on earthquake hazards for Anchorage and other communities in Alaska. A conclusion from the work done for this study is that though ambiguities in the scientific information do exist, other organizational and political obstacles are more important. Technical knowledge needed to initiate safer development in Alaska is available, however the claim of imperfect scientific information is often used as an excuse for inaction.

Implementation Obstacle #2 – Lack of a Model for the Incorporation of Natural Disaster Risk into the Policy Making Process

Earthquake hazard mitigation in Alaska has been hampered by lack of understanding of how it relates or should relate to local, state, and national public policy decision making. Risk evaluation, prevention, and mitigation studies now too often are isolated from the planning process. Responsibility and expertise are fragmented among various agencies, levels of government, and jurisdictions. A planning model presented in this section provides one design for incorporation of risk into the comprehensive planning process. Without a theoretical understanding of the placement of risk mitigation measures within the policy making process, such as this model provides, the whole process of risk mitigation is flawed. The critical thing is not the acceptance of one model but a recognition that lack of any systematic understanding of the place of risk in policy making is a fundamental obstacle to implementation.

Implementation Obstacle #3 – Ambiguity in the Organization of the Policy Process and of its Policy Direction

Organization of the earthquake mitigation process lacks clarity. Much of this results from the absence of an overall understanding of how risks and geotechnical hazards should be placed in the policy process (obstacle 2 above), but many other deficiencies exist.

- **Ambiguous Policy Directives.** Successful policy implementation is unlikely in a situation where precise policy directives are not present. The Alaska case is a hodge-podge of local planning and zoning, state land use regulations, and federal policy statements. Of these, the Alaska Coastal Management Act (6AAC 80.050) contains the most specific directive to evaluate geophysical hazards. This act requires that local governments and state agencies identify known geophysical hazards and prohibit devel-opment in these areas'. . . until siting, design, and construction measures for minimizing property damage and protecting against loss of life have been provided.' In practice, however, local communities have found compliance difficult because of the act's generality and lack of a mandate to develop specific strategies and implementation processes. Beyond this is the fact that existing policy directives are often incomplete and imperfect. The result is that a zoning official in Alaska recently stated that zoning and earthquakes have never been associated and that he had never thought about their relationship. In short, when policy direction is this ambiguous and confused, planners and policy makers often simply cannot cope with these complexities.

o **Fragmentation of agency Responsibility and Lack of Agency Support for Mitigation.**

Responsibility for geophysical hazard mitigation is spread among agencies and governmental organizations. Planners and other governmental officials in Anchorage have mentioned that the lack of communication among departments is a stumbling block to hazard mitigation. Building permits are issued by one department, planning is done by another, zoning enforcement by yet another. As a result, according to one official, 'Things get built before we know what's going on.' Geophysical hazards are not any one department's responsibility, so they become no one's.

o **Budget Constraints and Financial Resources.**

Shortage of funds is an obvious problem for public programs. Geophysical hazard mitigation may be particularly vulnerable or face greater obstacles in this regard than other programs. Since hazard mitigation has little institutional presence and no constituency, it has difficulty making claims on resources. This fact also increases its vulnerability to funding cuts or underfunding during periods of revenue shortfall. This is particularly true in smaller communities where the cost of hazard studies and other measures may be the same as for large cities but financial resources are much more limited. It may also be that many officials see the results of such studies leading to expensive requirements for funding of politically unpopular risk mitigation measures.

o **Operational Rules of Implementating Agencies do not Support Risk Mitigation.** Successful implementation is hampered by operational rules of administrative agencies which skirt or neglect geophysical risk mitigation. For example, the process of building plan approval and inspection focuses on structural and design requirements, and virtually ignores siting considerations. Except in the more complex projects, neither a licensed engineer nor a building official are required to consider siting in relation to geophysical risk, nor does geophysical risk mitigation appear prominently in land use regulations. For example, the 1982 Anchorage Comprehensive Plan has few references to seismic risk, and the ones which do appear are incidental and indirect. In short, the existing rules of responsible agencies usually don't support seismic risk mitigation. Formal and informal standard operating procedures generally do not include any regular incorporation of geophysical risk. During interviews, officials sometimes referred to requirements in the Coastal Zone Management (CZM) Act as an avenue for risk mitigation. The failure to generally incorporate recognized risk data into building code, siting and zoning requirements means that hazard risk is rarely included in planning decisions. One of Alaska's borough planning and zoning commissioners said about CZM seismic risk provisions, 'We just don't specifically consider it. We have never denied anybody anything because they were in a high-risk area.'

- **Technical Staffs Do Not Have Sufficient Geophysical Expertise and Geophysical Risk Experts Are Not Provided with a Formal Role in the Decision Processes.** Planning and technical staff hired by federal, state, and local agencies rarely are trained to deal with seismic risk as part of the assessment process. Many consider mapping, storing and displaying of physical data to be the end product rather than the process leading to assessment and implementation of mitigation measures. When communities seek outside assistance for studies and maps or turn to state and federal data bases for information they often lack the necessary expertise to translate it into planning recommendations and administrative regulations and policies.

- Seismic data have rarely been included as part of the baseline used in preparing comprehensive or special development project plans. In fact, the research agenda for continued studies of earthquake issues in urban and regional planning, developed by the American Planning Association and submitted to the National Science Foundation, reflects the need for development of natural hazard education curriculum for planners. Along with this they suggest training on how to use seismic data, how to reinforce and develop knowledgeable constituencies, and how to evalute 'societal impacts of living with natural hazards and how social systems adjust to such impacts' (Jaffee 1983). Moreover, when planners are knowledgeable, statutes do not provide a meaningful and effective way for seismic experts to be involved in the process of approving development construction in areas of geophysical risk. Even when recognition of experts is institutional-ized, the role is generally advisory rather than regulatory.

Implementation Obstacle #4 - Dominance of Rational Action Model Regarding Geophysical Risk Mitigation

The analysis of problems of geophysical hazard risk mitigation is dominated by the view that

decision makers and governmental entities will act rationally when faced with information. This suggests that when officials receive information on risks, new measures to reduce risks, or recommended reforms to the planning and implementation process, they will proceed with certain rational steps implicit in the new information. The rational actor will 'value maximize,' or attempt to gain the most from a desired goal. In relation to earthquakes, value maximization can be seen as acting to reduce dangers to lives and property. The concepts of such rational behavior are predominate in planning, policy analysis, and many other intellectual endeavors because they explain or anticipate human and organizational behavior in logical and predictable ways. However, the work of social scientists such as Graham Allison (1971) and Herbert Simon (1947) demonstrated that human beings and human organizations are powerfully affected by non-rational factors. Those which pertain to organizations include 'bounded rationality' (human beings are limited in their ability to comprehend problems or situations in their total complexity); 'satisficing' (individuals and organizations while giving lip service to the pursuit of optimum solutions in fact frequently accept the first minimally adequate solution to a given problem); and factoring (complex problems are broken down into tasks managable by smaller units, but in the process the coherence of the overall effort is also fragmented)(March and Simon 1958). One result of the dominance of rational actor assumptions in addressing risk mitigation is that scientists may assume that geophysical facts need to be made clear only to policy makers for appropriate action to occur. Geologists may regard making available to decision makers USGS maps, environmental atlases, geobase data systems, and similar information sufficient for successful implementation of policy. Planners may believe that the presentation of well-developed and logically consistent land use plans will lead to their adoption, and policy analysts often think that authoritative and well-developed policies will be implemented. Frequently, and particularly in the case of geophysical hazard mitigation, these types of assumptions are faulty, and frustrate implementation.

Some scientists and planners interviewed for this study would discuss organizational and political obstacles to implemenation, but in the same conversation would switch to rational actor assumptions when discussing their own work. In particular it was noted that these actors tended to write in terms of the rational actor model, but off the record would refer to impediments implicit in the organizational and political concepts outlined in this study. For example, the Municipality of Anchorage has invested heavily in a computerized land information system but planners have been reluctant to proactively pursue risk mitigation policy alternatives because they perceive decision makers to be nonresponsive to such rational information.

Implementation Obstacle #5 - Leadership Lacking Skill/Commitment to Geophysical Hazard Mitigation Political Obstacles

The lack of statutory support for geotechnical hazard mitigation measures reduces the probability that leaders in government and the bureaucracy will take these dangers into account. Beyond these limitations, however, agency heads and local government leaders often lack the managerial and political skills to do what can be done within existing law. Medium-size cities in Alaska have a notoriously high turnover rate in city managers and other professional staff, making it unlikely that such officials will obtain the necessary knowledge and political support needed to promote risk mitigation measures. More important, however, is that leaders lack commitment to geophysical risk mitigation. It takes an exceptional leader who, in the face of the other obstacles and the pressure of daily responsibilities, can develop and sustain a personal commitment to protect his community against geophysical hazards. Whatever its basis, this kind of commitment by political and agency leaders in Alaska was almost totally absent.

Planners, engineers, building officials, and others asked to explain failures of geophysical risk mitigation efforts in Alaska have often used one word to respond: 'Politics.' When the Anchorage Municipal Assembly allowed reconstruction to resume in the Turnagain slide area, a building official said that construction was allowed for '. . . political reasons rather than construction safety reasons.' Another official said with respect to the same area, 'We get a lot of calls by people to report violations, but money in this town and the attorneys they buy overpower our concerned guy.' Similar comments, usually given in confidence, were common during the many interviews conducted for this study. Two authors in California have labeled this phenomenon 'earthquake politics' (Olson and Nilson, undated). 'Earthquake politics' is indeed <u>a</u> major, perhaps <u>the</u> major constraint on earthquake risk reduction in Alaska.

Specifying just what 'earthquake politics' is and how it affects risk mitigation is difficult. Elected officials blame deficiencies on technical information and the absence of directions and assistance from staff and other levels of government. Staff point to these explanations as excuses to mask 'political' resistance to mitigation measures, but also fail to pursue the 'rational' policy options for reasons which have to be judged as expedient rather than logical.

Assessing the relative impact and importance of these obstacles will require more detailed study. Additionally, significant theoretical differences of opinion exist among social scientists and other trained observers on this topic. Nonetheless, elements of each of the following obstacles were found to operate as constraints on geophysical hazard mitigation in Alaska.

Implementation Obstacle #6 - Pluralistic and Interest Group Policies

'With the diversification of interests in Anchorage, no one is politically strong enough to overcome development interests' (Anchorage Official, 1983). Pluralists explain American politics as competition among groups, each vying for policies to foster their own interests. Because the interests of groups are different and often compete, a particular group does not necessarily get its own way. According to interest group theorists, policy results will be an approximation of group power in the society, and groups will tend to balance each other, or 'countervail' against each other, preventing the domination of any one group (Truman 1971, Lowi 1967).

In Alaska interest groups operate both directly and indirectly in the political arena, but no group represents earthquake hazard mitigation. Realtors, property owners, bankers, environmentalists, land developers, neighborhood community councils, and other organizations are all heavily represented on legislative, planning, zoning, and platting bodies as well as providing public feedback to these same groups. Earthquake hazard mitigation, however, lacks a constituency, or recognizable 'interest' group. An official in the CZM Geological Hazards Section of the State Division of Geologic and Geophysical Survey told interviewers that citizens can go to the council if the [CZM] plan is not being complied with but could not remember a case where they ever had. Rarely do citizens have a personal financial stake in promoting mitigation measures. If a planning and zoning board allows construction in a high hazard zone, who complains? But if the same body attempts to enforce mitigation against local interests there is a strong and immediate response. To political scientists who consider pluralism the dominant philosophy of American government, earthquake hazard mitigation represents part of the 'general interest' which gets submerged in the face of the power of specialized interests (Lowi 1967).

The interest group process is also strongly supported by elements of the national and Alaska political cultures, particularly the emphasis on individualism and individual rights. The mayor of one of Alaska's boroughs, when asked about zoning for seismic risks, said:

> I think people ignore risk in decision making. The feeling is that people would survive it. We feel that people should make their own decisions rather than government making them for them.

Earthquake hazard mitigation is an approach that focuses on protection of the community and the needs of the community. In the inevitable weighing of the relative strengths of claims by community groups, risk mitigation is too diffuse and lacks the critical support of an active financially or otherwise motivated constituency. Thus, mitigation efforts are weakened by an inability to 'countervail' in the political process. This problem is compounded by the fading memory of the March 27, 1964 earthquake. Public recognition of these risks is transitory, tied strongly to the ongoing occurrence of seismic events. Mass media and public education have no record of placing risk mitigation on the agenda of public concern or maintaining public awareness of these risks over time.

Implementation Obstacle #7 - Elite Politics

> Once the first house or building in the bluff areas is built politics come in, landowners, long time Alaskans, the wealthy. First one gets in then everything goes (Anchorage Official).

There is a vast amount of writing about and studies of elites and their power at the community level. An ongoing debate exists over the nature and extent of elite power in local government (Mills 1956; Dahl 1961; Hunter 1953). Though studies have not addressed the issue of elite influence and power conclusively, it is apparent that local elites in Alaska have been one obstacle to successful mitigation measures. In Anchorage the high hazard areas of the city are also areas which are, or were prior to the 1964 earthquake, prime commercial property and some of the most valuable residential land in the city. Attempts to implement mitigation measures with respect to these areas come up directly against the economic interests of some of the wealthiest and most influential members of the community. Where there is no constituency which supports geophysical hazard mitigation, elite power does not face very stiff competition in getting its way. Moreover, with respect to most mitigation measures, interested elites in Alaska only need to prevent action not cause it, since so little hazard mitigation is yet part of law. In this regard a subtle but critical aspect of elite power becomes particularly important.

Power can cause things to happen or prevent things from happening. A number of authors have studied the operation of this 'other face' of power at the community level (Bachrach and Baratz 1970; Crenson 1971). The present study found abundant examples of this use of power. If they have the power to keep the issue off the agenda, they win. One Anchorage municipal official said:

> The trend is not towards more regulation; the public bodies must have a compelling reason to act. There is a Geotechnical Advisory Commission which has done good work . . . but it seems anti-development. It is a very remote possibility that these changes would ever occur. There is too much pressure for maintenance of the status quo.

Where mitigation measures do come up, other levels of decision making present access points for veto groups or opportunities to endlessly 'replay the match' until a solution emerges which reflects the realities of local political power. One unsuccessful attempt to implement a hazard mitigation program was the proposal for an Alaska Hazards Advisory Council. DGGS developed such a proposal in 1981 to insure a comprehensive approach to hazard mitigation with the use of experts from various technical fields, e.g., engineering, architecture, planning, geology, and seismology. Although never formally rejected, the proposal was tabled at the departmental level and never entered the legislative review process. The result of earthquake politics in Alaska is that geophysical hazard mitigation has not so much been defeated as denied an opportunity for a fair open hearing in the decision process.

Implementation Obstacle #8 - The Level of Government Problem

Three levels of government are involved in seismic risk mitigation--local, state, and federal. Local and state governments have some capacity to deal with the consequences of disasters of all types, but the federal role and responsibility is greater and is recognized and established in legislation. This is based on the concept that coping with large-scale disasters is beyond the capacity of local government. The federal and state governments have thus assumed a critical role in disaster mitigation. In earthquake hazard mitigation, however, the federal and state governments' roles have been minimal. This is true despite the fact that Alaska has a unique institutionalized history of coordination among federal, state, and local agencies.

Development of criteria to evaluate resources and land use began subsequent to the 1964 earthquake with the Federal Field Committee for Economic Development and Planning (1964-1971) and was followed by the Joint Federal/State Land Use Planning Commission (1972-1981) and the present Federal/State Land Use Council. Though all these bodies have presented information on seismic risks through the use of maps in their reports, seismic risks were seldom evaluated and policies for their mitigation were never recommended. These same agencies, which were responsible for resource development and habitat planning and management to guide state and federal investments in Alaska, never took the opportunity to include risk in the comprehensive planning and policy-making processes.

Local government, through its planning and zoning powers, has almost complete jurisdiction in risk mitigation. Most earthquake casualties come from failure of manmade structures. Mitigation efforts in this area would have the greatest effect in reducing casualties and property loss. A building which never collapses will have no need for federal response and reconstruction assistance. At the same time, the factors that limit local government interest in and capacity for response also weaken its incentive to take strong mitigation measures. In Anchorage, though the Municipality has the authority to zone for seismic risks, it has done little. What has been done in mitigation has involved the federal government, such as in the Fourth Avenue buttress area. In Seward the waterfront land was acquired by the federal government and when deeded back carried an open-space designation. The complete relocation of Valdez and restrictions on development in the old townsite was accomplished and maintained today because of federal intervention. Thus we see effective mitigation measures in Alaskan cities occurring almost exclusively as a result of federal involvement.

One way to approach earthquake risk mitigation would be to assess the nature of geophysical hazards in terms of the level of government which will cope with the aftermath of a severe event. From this perspective earthquakes are clearly not a local problem. For example, during the 1964 event, the entire transportation and economic infrastructure of southcentral Alaska was affected and the tsunami generated by the earthquake killed people as far south as California.

This line of reasoning partially explains why local governments have not done more to specifically reduce earthquake risk and look to state and federal governments as central to coping with disaster. In Alaska, as elsewhere, special preparations for large-scale disaster almost always involve higher levels of jurisdiction. Tsunami warning systems in Alaska coastal cities, for example, are provided through federal and state programs.

The implication of such a 'geographical' analysis of earthquake risk is that mitigation as well as response will be more effective if state and federal governments have an important role in the process. The fact that the only significant recognition of siting in terms of risk classifications in Alaska occurs as part of the coastal zone planning process indicates this. Yet local planning, zoning, and building codes, all vital to geophysical risk mitigation, also traditionally have had almost exclusive regulatory jurisdiction. Given the locally based obstacles to implementation outlined here, it seems critical that broader levels of jurisdiction become centrally involved in mitigation.

A Comprehensive Planning Model for Risk Mitigation

In the weeks following the 1964 earthquake, local planning teams were organized and when local skills were insufficient to direct redevelopment planning consultants were hired. To satisfy federal requirements, long-range comprehensive plans were prepared for communities that had not already developed them. All these activities were accomplished rapidly under the pressures of relocating the homeless and reestablishing local economies. Geologic data were quickly analyzed and provided to planners and decision makers to render decisions needed to meet the urgency of obtaining federal assistance. The rigorous requirements and schedules of the federal guidelines did not allow time to educate the public on the issues of risk nor to obtain citizen input. To obtain federal assistance, local governments agreed without conviction to high-risk classification and land use restrictions. Later, many of the commitments were either forgotten or ignored.

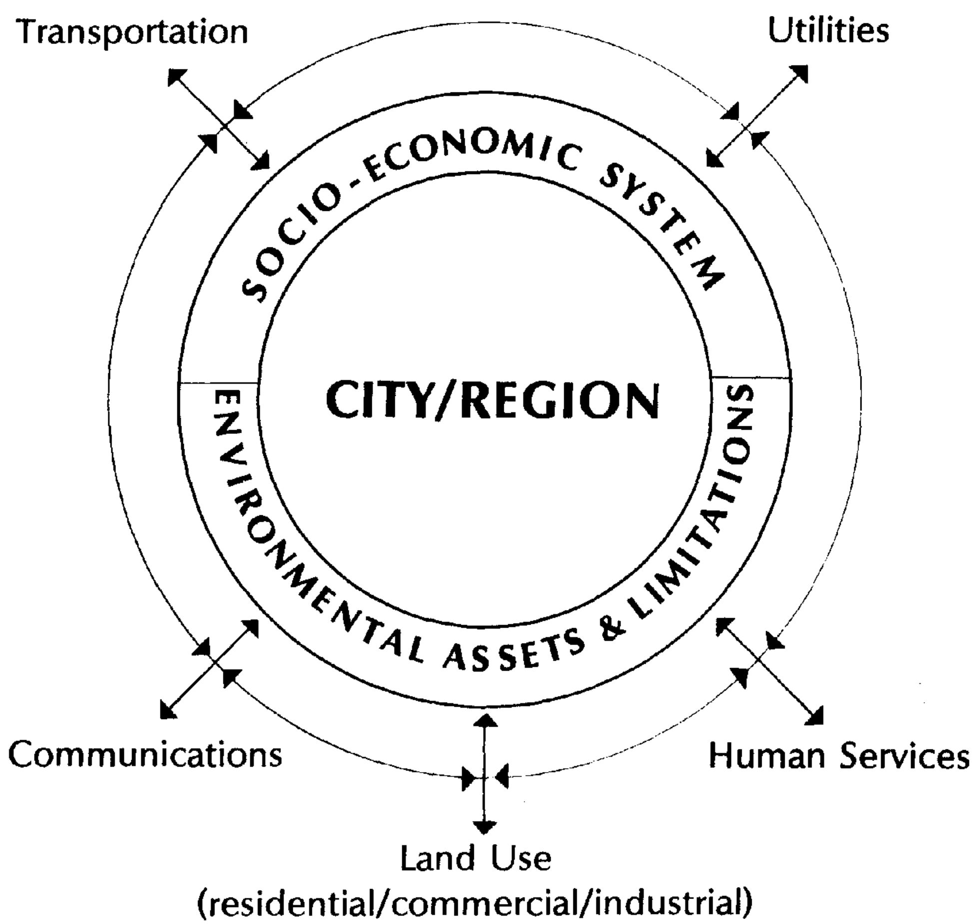
Effective risk mitigation planning must take place before disaster strikes. Only then can community participation and education of policy makers be effective. This will insure that both groups understand the multitude of topics involved in the planning process and the responsibilities that each has in promoting public safety.

To date, most of the work directed toward mitigation of seismic risk is reflected in the application of building codes directed to avoidance of structural failure of individual buildings or to development of land use restriction for areas of proven instability. Little attention is given to the disruption that may result from failure of the whole urban infrastructure. As an example, fire may destroy a great part of a city from failure of water systems. Rescue and long-range recovery can be affected by failure of transportation, communication, and utility systems.

Because the city/region functions as an integrated network, the failure of one element can affect the function of the entire system. Moreover, when disruption occurs in the major components of a city/regional infrastructure, transportation, utilities, land use and social services, the whole economy is affected. Weakening of the economic base in turn affects recovery. The planners, the public, and the policy makers in Alaska need to include evaluation of this fact when planning for the location of roads, ports, airports, major economic centers, schools, hospitals, utilities, and other basic services (Figure 36).

Not only does damage to a community's infrastructure disrupt the whole community, it also impacts the economic infrastructure of the region and state. Evaluating the social and

Figure 36. The City/Regional Infrastructure

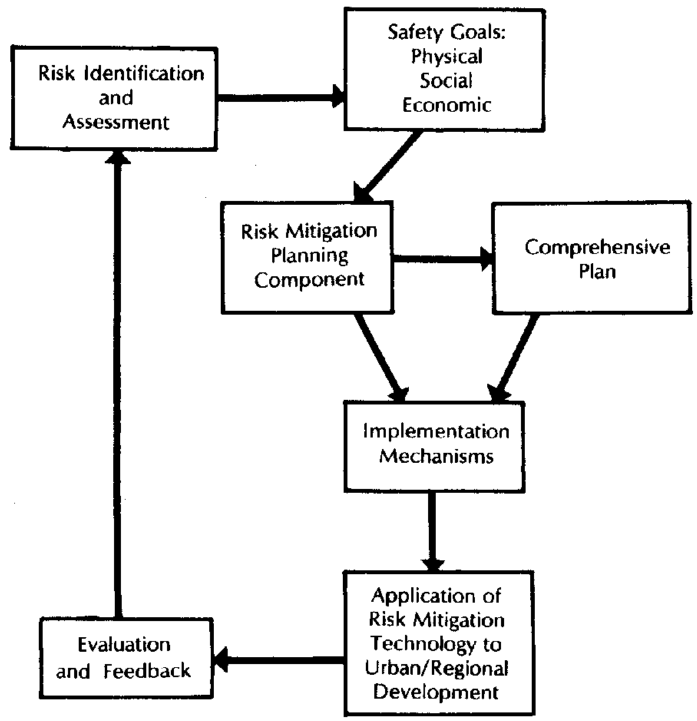


economic impact of a future seismic event would help identify potential infrastructure disruption and allow for preparation of long-range plans that would consider the effects of seismic risk. An analysis of transportation, utilities, communication, production centers, and other systems could guide the application of hazard mitigation regulations in plans for future economies and public needs.

A region or city exists as a function of its socioeconomic base and environmental assets and limitations (Figure 36). The relationships of people and their environments change after a major earthquake. New relationships may be necessary. Preplanning for post-earthquake reconstruction is needed to insure that an effective and rapid recovery occurs within the framework of the reestablishment of strong socioeconomic systems.

A comprehensive regional/city development plan tying together more specific plans which focus on various planning components is needed to assess the impact of seismic risk. To date risk evaluation and safety goals remain isolated in 'special studies' rather than being incorporated into comprehensive planning and implementation processes. After a risk analysis is made, all facets of the manmade environment should reflect awareness and application of risk mitigation components and should include an economic evaluation of cost and benefits and a comparison of alternatives when changes in established patterns are recommended (Figure 37).

Figure 37.
Risk Mitigation and Implementation Process



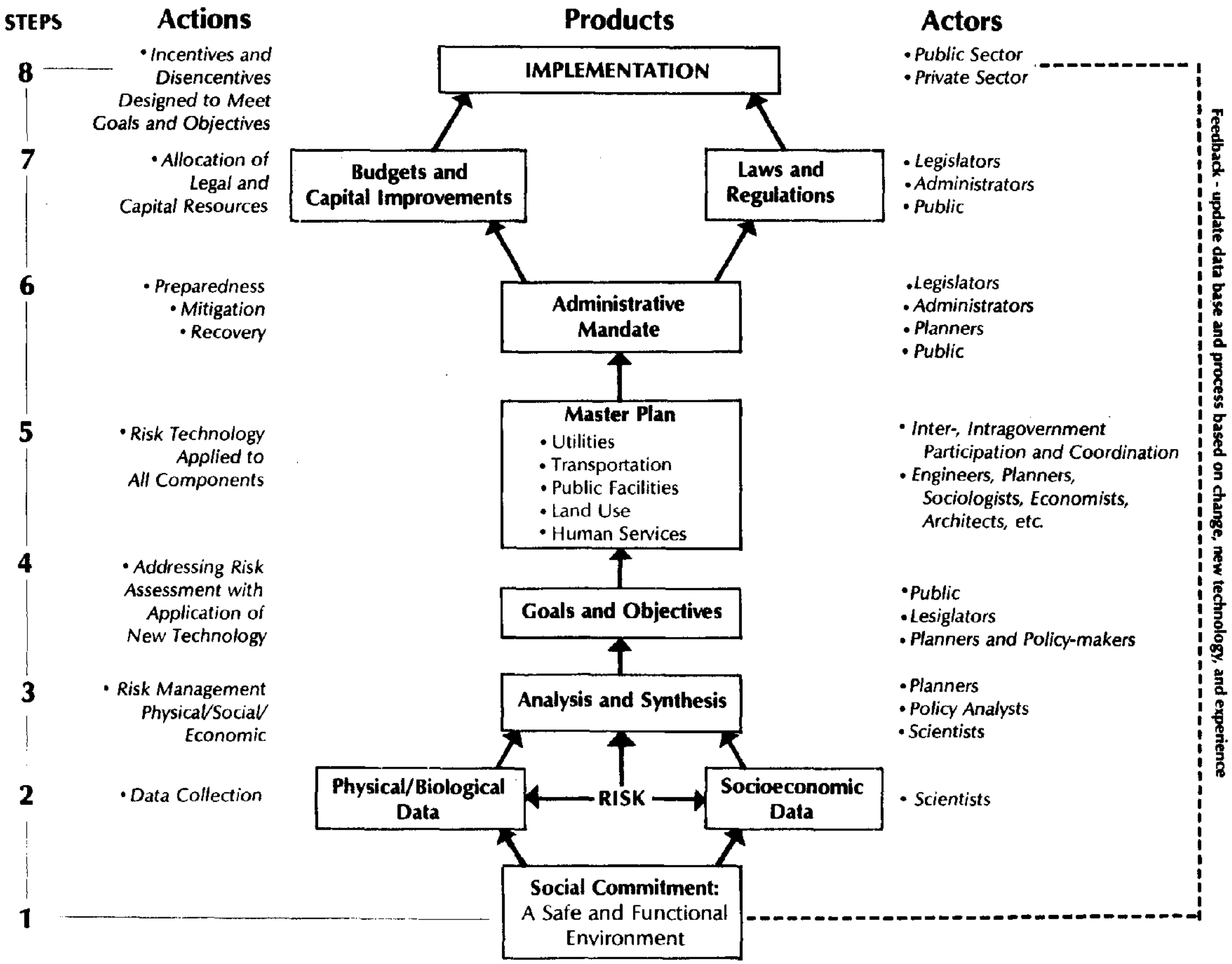
Immediately following the 1964 earthquake, areas of high risk were identified and mapped in all affected communities. Since then, local governments, assisted by the U.S. Geological Survey, have prepared detailed environmental studies for various communities (Schmoll and Dobrovolney 1971, 1972a, 1972b, 1974a, 1974b; Lemke 1967; Miller 1972). Moreover, the Municipality of Anchorage has conducted a special geotechnical hazard assessment study that, in addition to mapping seismic risk areas, has identified other hazards--wind, coastal erosion, snow- and rockslide areas, permafrost zones, and areas subject to glaciation (Harding-Lawson & Associates 1979). Many communities, in compliance with the Alaska Coastal Management Act, have prepared documents reflecting geophysical hazard zones.

Despite these efforts, designing mitigation strategies for development in high-risk areas is not much further along today than it was two decades ago. Although development is taking place on steep slopes, wetlands, and on manmade fills, comprehensive development plans or zoning of new development districts do not include geotechnical evaluation and seismic risk mitigation measures.

Identification is not the answer. Application of knowledge obtained through scientific studies is imperative. Because present planning methodologies do not seem to insure the successful application of technology directed to disaster prevention and mitigation, a new definition of comprehensive planning must be explored. The present concept of planning as a process for setting goal statements without the development of specific guidelines for implementation has resulted in sporadic and inconsistent application of technology directed to risk mitigation and of other technologies directed to land use allocation, transportation, and utilities development. If a planning process is to be successful, it must include: 1) development of comprehensive goals and objectives based on the understanding of the physical, social, and economic makeup of the regional/ urban system, and 2) development of a master plan for implementation through team building that relates all components to the urban/regional structure; that is, where people work, where they live, where they play, how they move throughout the areas, and the manner in which they are cared for and where. The result is a combination of traditional planning focusing on civic design and municipal order with emphasis on a product and the newer outlook of planning emphasizing development of general goals statements, implementation plans, and recognition of and interactions and feedback throughout the planning process (Figure 38). This planning approach is modeled after the interdisciplinary curricula that combines planning and administrative science at the University of Alaska, Anchorage.

Knowledge of risks should apply to all components of an ongoing comprehensive planning

Figure 38. Comprehensive Planning Model



process. Implementation of goals and objectives should be adjusted in response to increased technical knowledge and to changes in the socioeconomic makeup of the area. Plans should be reliable and predictable guides for public and private development decisions. At present the general setting of goals without a defined implementation mechanism does not provide the guidelines needed to express the true intent of the goals. Knowledge of risk should apply to all the components of a comprehensive development plan. To accomplish this, coordination and cooperation is indispensable. Interagency and intraagency coordination and use of common baseline data is a must when implementing plans through programs and projects.

Use of computers makes the storage, retrieval, and distribution of data easier and more accessible. The baseline data, however, must be updated on a continuing basis to insure that new information, methodologies, and concepts are used in the preparation of comprehensive plans. These plans should include regulations directed to mitigation of seismic risk and set guidelines for post-earthquake recovery. Public and private agencies must share the same reliable data to assure effectiveness in identifying risks and establishing programs responsive to specific development needs (Figure 38).

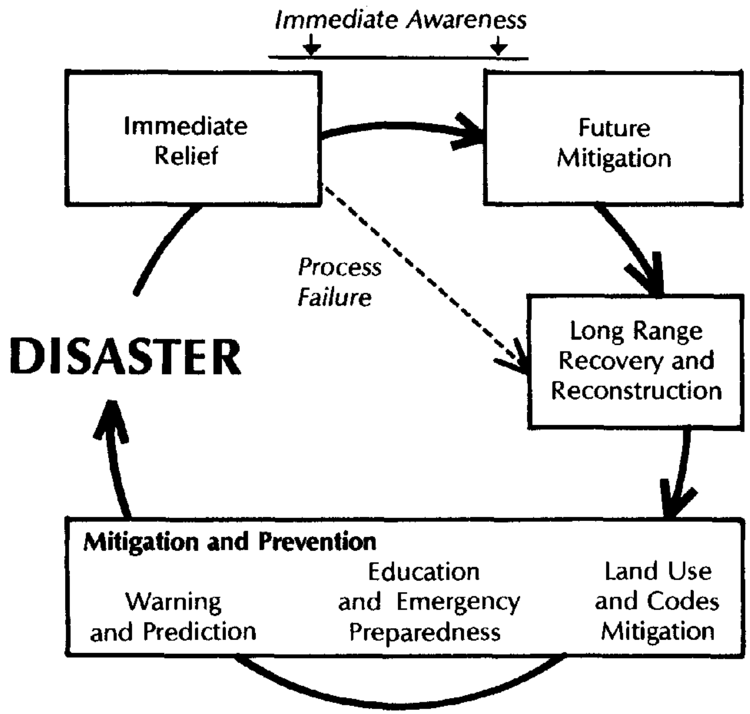
In evaluating the recovery process that took place after the March 1964 earthquake, three planning phases must interrelate, guided by common knowledge of the physical and socioeconomic makeup of the affected area: prevention, immediate relief, and long-range recovery. Preventive measures were not considered or followed in much of the reconstruction in Alaska except where federal dollars were used for urban development (Figure 39).

Overspecialization and administrative division of specialized fields affected the effectiveness of long-range recovery programs. Evident were conflicts over agency guidelines, time tables for implementation of programs, and funding of specific projects, which interfered with the continuity of the implementation process and diluted recommendations made after the disaster. Institutional changes will be necessary if interdisciplinary coordination is to be effective.

It is time to evaluate the present conditions and chart a course of action to guide future seismic mitigation efforts. Public and legislative commitment and funding efforts now should be directed to:

- o research of seismic risk causes and effects,
- o effective emergency preparedness and public education, and
- o application of risk mitigation technology to urban and regional growth and development.

Figure 39. Disaster Planning and Recovery Cycle



Administration and Politics

In order to achieve more effective implementation, greater attention must be paid to administrative and political strategies. Any plan for seismic risk mitigation should reflect the shared responsibility among several levels of government. Each must understand the others' roles in this intergovernmental partnership. To implement risk mitigation measures, better communication must be established among these partners and between government decision makers and the public. Greater knowledge about physical phenomena is necessary to understand natural hazards, but is insufficient in and of itself unless a commitment to policy implementation is developed. In a sense, the implementation of risk mitigation measures tests the commitment of scientists, educators, administrators, and politicians to ensure the long term health and safety interests of the nation.

The federal government has the ultimate responsibility to promote the nation's general welfare. It also has the greatest resource capacity to achieve this goal. After large-scale disasters, federal assistance is sought to ameliorate the effects and to maximize recovery. Such assistance usually consists of loans, grants, insurance, provision of material, and large-scale application of manpower and organizational resources.

Though the U.S. government has had a strong historic role in preparedness and recovery, until recently it lacked a national policy commitment to natural hazards risk mitigation. The Earthquake Hazard Reduction Act of 1977 represents a milestone in the quest for improved seismic safety. It provides a wide array of initiatives for an enhanced federal government role in developing effective intergovernmental and private sector programs to reduce earthquake hazards. With a variety of incentives, the act stimulates state and local governments to improve seismic safety policies and to initiate programs. FEMA, created by executive order in 1979, established an institutional presence capable of assuming broad powers. While responsibility for seismic mitigation is found in several agencies, FEMA provides the focal point for future administrative innovations necessary to coordinate the diverse tasks needed to reduce seismic risk. Other major programs where federal initiatives have been taken could provide models for future administrative innovations necessary to distribute inter- and intragovernmental responsibility. Examples include environmental protection under the Environmental Protection Agency, and coastal planning and regulation under the Office of Coastal Zone Management.

The federal government could play a key catalytic and regulatory role by introducing incentive programs that would help reduce earthquake hazards or spread the risk. This could include the use of grant, loan, and revenue-sharing programs to insure consideration of seismic and geologic hazards and see that adequate steps are taken to minimize them. The federal government could also institute insurance programs to protect lives and property by requiring future building to be constructed in safe locations and built according to earthquake-resistant standards.

State government is in a very crucial and pivotal position in the quest for seismic safety. The state has the ultimate non-federal responsibility for the public's health, welfare, and safety. These measures must include working with local governments to develop and encourage seismic safety regulatory efforts and enforcement performance. In addition to aiding and encouraging local governments, the state can and should take other more direct actions. This could include development and implementation of statewide regulations and actions to reduce risk involving state funded construction, development of state lands, and protection of designated higher risk areas. To accomplish this the state will have to establish the administrative mechanisms necessary to direct and implement its policies. The creation of a seismic safety commission would provide administrative and coordinative leadership and create the advisory and regulatory institutional presence that is necessary for the continuity of programs. Of equal importance is the strengthening of technical staff critical for successful policy development, and political leadership required for the provision of legal mandates. Legislative support could be provided through the appointment of a joint seismic safety committee which would act as a catalyst for successful political and administrative commitments.

Some state programs would be administered directly by the state, but others should be joint efforts with local governments. The state could set standards and guidelines under which local governments would carry out earthquake safety policies at borough/county and municipal levels. When relying on local government for implementation, however, experience with seismic safety and other matters argues strongly that state monitoring and back-up measures are essential to insure the consistency and reliability of local performance.

The establishment of a state revenue incentive policy seems to be an effective method not only to insure that local plans and regulations properly recognize seismic safety considerations, but also to implement earthquake hazards mitigation measures. Since local governments in Alaska depend heavily on state revenues, local agencies should be encouraged to adopt and enforce local plans and regulations conforming to and carrying out state seismic safety standards and programs. Before initiating more stringent enforcement measures, the state must provide technical and financial assistance for implementation of required policies, advise local agencies, and review and monitor their performance. In addition the state should insure that local school districts develop and teach seismic safety programs in primary and secondary schools.

Local agencies must be involved actively in preventive measures as well as in the immediate on-the-scene response to disaster. This fact, coupled with Alaska's strong local home-rule tradition, suggests that local governments will continue to be the primary agent for direct action in implementing seismic hazard mitigation measures. Thus, local government is recognized as responsible for enforcing building codes and land use regulations as well as providing water, sanitation, and other utilities and services. However, local enforcement of seismic safety measures has not always been effective, suggesting the need for a federal-state-local partnership in the development of planning, administrative, and political mechanisms to implement and apply seismic safety measures.

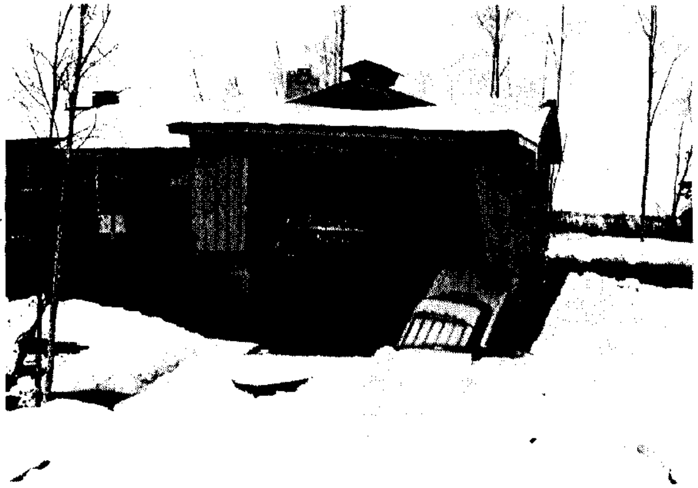
To improve implementation, attention must be paid as much to the organizational machinery necessary for the execution of a program as is paid to the creation of the organization itself. The purpose of designing an organization is to provide the conditions which facilitate the optimal attainment of organizational goals and objectives. Properly designed organizational machinery (with special attention to communications and intra- and interagency relations) would help overcome obstacles to hazard mitigation implementation.

The lessons of the post-1964 period in Alaska suggest that it is important to pay special attention to implementation directives during policy development and planning. The policy-making process should contain commitments and answer several distinct questions: What action has to be taken? Who is to take it? How should it be done? Can these people do it?

Recommendations

Implementation of measures to overcome political and administrative obstacles and develop a systematic approach to seismic risk planning requires changes in the present methods of planning and management of risk mitigation programs at local, state, and federal levels. Governments long ago accepted the public obligation to assist in disasters that are beyond the capacity of individuals and private organizations. General governmental responsibility and state and federal roles increase with the size of the disaster.

Despite this long history of public support for preparedness and reconstruction, the role of government in mitigation is more recent, less systematic, and less committed in a comprehensive way. Though this study has recognized the substantial technological advancement in disaster mitigation, there still exists systematic weaknesses in planning and implementation.



Source: *Alaska Pictorial Service*

This reduces optimal application of knowledge and prevents effective predisaster risk reduction. Responsible governmental commitment in preparedness and reconstruction and not in mitigation may ultimately increase government's legal liability. If obvious recognized risks are not mitigated and citizens are subjected to human and property losses predicted with reasonable probability, government may be held liable in the expanding interpretation of these issues by the courts.

Many recommendations related to seismic risk have been offered over the 20 years following the Great Alaska Earthquake. As reflected in Part II of this report, "Present Planning for and Management of Seismic Risk Mitigation," they cover all disciplines from geology and engineering to planning and political science. Recommendations have already been made on prediction, preparedness, mitigation, data base development, and program implementation. In fact, the recommendations made here are new only in the sense that they are made within the context of a comprehensive planning and administrative model which provides an implementable framework. Successful implementation of these recommendations requires an institutional capacity to overcome obstacles that have frustrated past efforts. Recognition of these obstacles is an important step in designing strategies that will effectively mitigate losses due to seismic events.

The following recommendations focus on all governmental levels and their optimal role in mitigating risks under the assumption that mitigating risk is a public as well as a private responsibility.

Recommendation 1

Develop and institute programs of public education, information, and disclosure to obtain a social commitment to seismic risk mitigation.
(Step 1 Figure 38) .

While local and federal agencies have played key roles in the effort to educate and inform the public about seismic risk, state government should take the lead. To date government has defined its public education role within an emergency preparedness context. This should be expanded to include a significant effort related to risk mitigation information dissemination, development of distribution mechanisms of scientific information to local governments, developers, builders, and other interested parties, and public education related to building codes, siting, and risk avoidance. One mechanism to publicly disclose risk involves making real property buyers aware of the natural hazard risks inherent in their potential purchase. This could occur by attaching to the plat a note which becomes part of the deed of trust. For example, disclosure of risk on property in the Turnagain area occurred for a few years after 1964. The platting process is an excellent mechanism to designate risk and provide for disclosure.

Another major mechanism for long-term public education is the integration of seismic risk information into the curricula of both primary/secondary and postsecondary institutions. The state has a major public education responsibility and should stress improvements to seismic awareness curricula. In Alaska, preparedness was been emphasized during 1984 as part of the twentieth anniversary of the Great Alaska Earthquake. This should be strengthened with the addition of earthquake mitigation information and institutionalized as ongoing inclusions into curricula. Mitigation concepts would be particularly relevant to science curricula at all levels. Improvements can be made in post-secondary education by stressing specialties compatible with seismic risk course material. This suggests a strengthening of graduate curricula in such areas as policy sciences, planning, architecture, political science, public administration, engineering, etc. In the short-term, faculty seminars such as those sponsored by FEMA and the National Association of Schools of Public Affairs and Administration offer opportunities for immediate improvements in disciplines with serious curricula deficiencies.

Technical proficiencies of practitioners should be improved. Most engineers designing structures for high-hazard risk areas in Alaska do not have adequate training in seismic safety. Structural engineers are not licensed in Alaska and licensed civil engineers are not tested on earthquake engineering. This problem could be addressed by licensing structural engineers and by requiring a section of questions pertinent to earthquake engineering as part of the state licensing examination requirements for civil engineers.

In Alaska, the March 1984 activities commemorating the twentieth anniversary of the Great Alaska Earthquake heightened both public awareness and public information on seismic risk in Alaska. All levels of government and the mass media participated in displays, articles, and public discussions. Three scientific conferences were organized around the theme, "Restrospect and Prospect" (Figure 40). A review of this substantial effort suggests that the coverage of the 1964 events and a reminiscence of what actually occurred dominated the information provided to the public. Much of the information disseminated involved emergency preparedness and how to ready oneself for future seismic events. The subject receiving the least public attention was risk mitigation and strategies to reduce future loss of life and property. Until mitigation is discussed as openly and as publicly as emergency readiness, public support for the recommendations in this study will be hard to rally. Scientists, researchers, architects, engineers, planners, and public administrators need to build communication skills to inform the public and the policy makers of their findings. They must assume the social responsibility to educate the public as well as policy makers.

Recommendation 2

Renewed commitment at all levels of government to evaluate risk and its effects by supporting the continued development of socioeconomic and physical-biological data bases. (Step 2 Figure 38).

Historically, the federal government has provided funding for the development of data bases related to natural disaster risk. USGS officials identified areas in Anchorage susceptible to ground failure five years before the 1964 earthquake. This increased support for basic research and identification of other natural hazards. More recently, research funds available at the federal level have begun to decline. Though state and local governments have capacity and authority in this area and should be encouraged to invest in short- and long-range research, a strong federal presence in necessary. Joint local, state, and federal agreements in data collection may be an important model for future efforts. A successful example is the strong motion instrumentation project in Anchorage. A consistent ongoing effort in basic research and data collection is essential to proper goal identification and implementation of mitigation strategies. Its costs are offset by risk avoidance measures which reduce future loss.

Recommendation 3

Government should support the development of institutional processes and strategies necessary for the synthesis of data bases into goals for risk reduction. (Step 3 and 4 Figure 38).

The overall goal of enhanced social commitment to seismic risk mitigation must be interpolated into specific long, intermediate, and short-range objectives which can act as practical guides to implementation strategies. This requires building a consensus among levels of government, private organizations, and citizens. Inter- and intragovernmental coordination and new institutional arrangements will be necessary.

Agencies and commissions designated to implement policy should also help to focus public attention and to achieve consensus. Specific processes are not as important as the goal setting itself, which can give policy and planning both purpose and direction.

Recommendation 4

Government should support the integration of risk into the comprehensive planning process. (Step 5 Figure 38).

The time to begin interpretation and utilization of basic research as part of a comprehensive planning and implementation process is now. A major problem has been underutilization of existing scientific knowledge. Scientific information is of little value unless it is implemented in planning and policy making. Resources are necessary if government is to productively use risk data bases. Federal and state government support for the preparation of natural disaster risk elements in local comprehensive plans would help overcome the problems of parochial politics and economic interests retarding mitigation measures.

Implementation incentives should be developed to insure inclusion of a risk mitigation mechanism in comprehensive plans. Tying the expenditure of federal funds to the planning process has occurred in the past. For example, a comprehensive plan is required prior to the approval of HUD housing grants. Also, a community is required to have zoning and subdivision ordinances prior to the granting of FHA loans.

Unfortunately, most public officials do not regard seismic hazards as a priority from the standpoint of implementing planning policy. To a significant degree this position is related to the erroneous perception that planning to mitigate seismic hazard is an 'either/or' proposition --either the hazard is virtually ignored from the standpoint of development standards or it becomes a dominant criteria, such as mandating open space. An underlying assumption of this project is that integration of geophysical data with more general overall land use goals can be utilized as the basis for developing responsive city sector scale/urban design plans. A good example of this approach is the original urban renewal plan which was prepared for the Fourth Avenue slide area in Anchorage. Though this plan would have permitted development in this vital portion of downtown, it would also have limited the intensity of development.

Natural hazard impact statements would be a useful tool for bringing seismic risk into the comprehensive planning process. Socioeconomic and physical impact statements regarding the potential affect of natural hazards on the community infrastructure would be useful in focusing attention on those elements in the community most vulnerable to seismic events.

Recommendation 5

Develop guidelines for defining high seismic risk areas as standards for state and local earthquake zoning and for land use decision processes. (Step 6 Figure 38).

Currently the country is divided into broad zones of seismic risk. These are used in the application of building codes and also affect other federal and state policies. This approach does not recognize the substantial differences in risk that occur within one zone. It is not difficult to recognize differential levels of hazard risk within any one zone. The Harding-Lawson report noted levels of risk within Anchorage, and the federal government recognized the increased protection afforded by moving the Valdez townsite. The Anchorage Geotechnical Advisory Commission has been investigating the possibility of strengthening geotechnical and siting requirements based on risk exposure and structure type through the preparation and passage of a seismic risk ordinance. Establishment of national or state standards based on appropriate criteria would also be an important step toward broad application of risk concepts to siting. Elements might include the probability of failure by unit of time and the critical nature of the structure to the public welfare. As the probability of risk increases by level, local and state land use policies would be expected to increase the geotechnical analysis, siting, foundation, construction, and type of use requirements. Areas which would subject populations to risk unacceptable to health and safety would not be developed or would require mitigating strategies.

This graduated approach provides a mechanism for interpreting data and applying it in state and local decision-making processes. Standardizing levels of acceptable risk would increase the possibility of implementation through the use of hazard zoning, project review, stipulations for particular projects, etc. The State of California has a prototype system in their special study zones related to active fault lines. While the thresholds of risk should be national guidelines, it primarily would be state and local responsibilities to implement the guidelines and classify lands. This could be accomplished through federal and state incentives and review.

Recommendation 6

Establish local, state, and federal institutions presences to provide for an administrative mandate, intra- and intergovernmental relations, and focus public and governmental attention on seismic risk. (Step 6 Figure 38).

FEMA at the federal level has begun to recognize mitigation as an important public strategy. These institutional commitments need to be expanded and strengthened so that FEMA can act as an effective advocate for policies and resources in risk mitigation. The State of

Alaska's counterpart, DES, is almost exclusively an emergency preparedness organization with limited resources and little institutional commitment in acquiring a mitigation role. Its role in preparedness and accompanying organization militates against DES assuming leadership in mitigation. The State of Alaska should establish a state seismic safety commission (see recommendation 7) and a joint legislative committee on seismic safety to develop and maintain a political recognition and a mandate for resolution of seismic safety issues. By holding hearings and drafting legislation, this committee would encourage public consensus and provide political leadership. It also could act as the catalyst for successful policy implementation by recommending legislation to minimize catastrophic effects upon people, property, and the economy when a major earthquake strikes again.

Local government should focus its seismic safety interest through a public commission similar to the Anchorage Geotechnical Advisory Commission. This type of local commission should have specific duties and an oversight or advisory role in certain higher-risk land use designations. The current Anchorage commission has neither. The Anchorage Geotechnical Advisory Commission should have a legal mandate to review the seismic safety aspects of all public construction projects, multistoried private construction, and construction in potential slide or other high-risk zones. The board should have the regulatory power to modify, mitigate and cancel projects if risks become unacceptable. Alternative mechanisms for smaller communities are the appointment of specialists with a knowledge of seismic risk (geologists, seismic engineers, etc.) to planning and zoning, platting, and other land use decision making bodies.

Recommendation 7

Establish seismic safety commissions in states with significant seismic risk. (Step 6 Figure 38).

The State of Alaska is the principal governing entity of a major population subject to severe earthquakes. The state should establish a commission on seismic safety to provide a focal point at the state level for development of required policies and implementation of needed improvements. Such a recommendation was made in 1981:

> A commission should be established through legislation to provide policy guidance for the governor and legislature and to help coordinate agency programs in natural hazards. Such a commission would be administered under the Office of the Governor. Specific duties would include recommending goals, priorities, and policy for hazard mitigation in the public and private sectors, developing legislation, disseminating public information, helping to coordinate hazard

mitigation activities of all levels of government, and evaluating and issuing hazard warnings. Members should be drawn from the fields of geology, seismology, planning, emergency services, local government, and state government (Combellick, no date).

Additionally, the commission must have certain regulatory authority to include responsibility for a seismic safety element in local comprehensive plans, and review and approval of state construction plans for seismic safety. To carry out its mission the commission would need sufficient power, funds, and staff. The commission should be empowered to review, comment on, and approve seismic safety measures proposed for adoption by state and local agencies.

The commission should also be responsible for the following in relation to earthquake hazards mitigation: (1) set goals and priorities, (2) develop programs, (3) devise criteria and standards, (4) provide technical assistance, (5) monitor performances, review accomplishments, and recommend program changes, (6) review reconstruction efforts after damaging earthquakes, (7) gather, analyze and disseminate information, (8) encourage research, (9) sponsor training to help improve the competence of specialized enforcement and other technical personnel, (10) help coordinate the seismic safety activities of government at all levels, and (11) insure compliance with standards. It should also take strong leadership in planning for future disasters and for disaster recovery and should represent the state's interest at the national level in pressing for federal disaster preparedness and mitigation measures and appropriate joint federal-state programs.

Recommendation 8

Establish federal and state incentives to insure compliance with implementation of risk mitigation measures. (Step 7 and 8 Figure 38).

These incentives could take a variety of forms and be both positive and negative in their impact. The most comprehensive and workable one may involve federal establishment of a seismic hazard insurance pool that would provide for disaster assistance and reconstruction in the event of an earthquake. It would actually be more advantageous if a disaster assistance insurance pool were to be established for a broad range of natural disasters and that it be patterned after the flood insurance program. The federal government already has a major financial role in large natural disasters. Federal assistance is considered critical when disasters occur that are beyond the capacity of state and local governments. Historically, however, the federal government has reimbursed reconstruction efforts which place the government at similar or greater risk in the future because those reconstruction efforts occur in extreme high risk areas. Alaska demonstrated in 1964 that federal money tied to mitigation can be successful. Efforts to protect the waterfront in Seward, reduce exposure to risk by creating a new Valdez townsite, and reduce loss in the Anchorage downtown business district by buttressing are examples of reconstruction tied to mitigation. Today, the federal government does try to employ state-of-the-art technology and will withhold funds until a project is completed properly. But these policies follow a disaster and do not precede it in a systematic and comprehensive way. If future federal reconstruction assistance were tied to state and local governments implementing mitigation programs to reduce exposure to risk, this would not only reduce the loss of life and property but decrease the financial exposure of the federal government over the long term.

It is politically and morally unthinkable that the federal government would withhold funds to disaster victims in relationship to search and rescue and other disaster response activities, but it is quite reasonable to conceive of reconstruction grants and loans, both to governments and to private individuals, being given or withheld based on the ability to develop risk mitigation strategies prior to the onset of a disaster in known risk areas. This recommendation would mean that states and local governments would have to enter into agreements with the federal government to identify risk and develop strategies to reduce losses in the future. Failure to do so would mean failure to obtain reconstruction monies in the event of future disasters. Mitigation strategies and plans could be reviewed by a responsible federal agency, such as the U.S. Geological Survey, the Army Corps of Engineers or the Federal Emergency Management Agency.

Other incentives could involve the large volume of intergovernmental transfers. Local access to specific state and federal grant categories and state access to certain federal resources could be made contingent upon local and state compliance in mitigation efforts. Proactive grants and matching money for basic research, planning, and implementation would help stimulate local and state actions.

Conclusion

Demographic shifts in the United States suggest an increasing intensity of development in high risk areas which exposes ever larger numbers of people to loss due to earthquakes. At the same time, there has been an increasing recognition of government's role in avoiding or reducing risk, tied to government's liability for failure to take prudent steps to mitigate preventable losses.

These recommendations are offered in the twentieth anniversary year of the Great Alaskan Earthquake. The increased awareness of seismic risk in Alaska by both the public and professionals has provided a medium conducive to the development of mitigation strategies prior to the occurrence of the next catastrophic event. Public awareness is also growing nationwide as political forces are beginning to hold government responsible for a broad range of natural and manmade risks. It is likely that implementation of earthquake mitigation programs is more possible today than at any time in the past two decades, making this study timely in the sense of greater receptivity in the political, administrative, and scientific arenas.

Figure 40.
Great Alaska Earthquake Retrospect and Prospect

1964 - 1984 ALASKA EARTHQUAKE CONFERENCE SERIES

The twentieth anniversary of the great Alaska earthquake of Good Friday, March 27, 1964, will be commemorated in a series of three conferences sponsored by the Alaska Academy of Engineering and Sciences, Alaska Chapter of the Earthquake Engineering Research Institute, and the Arctic Division of American Association for the Advancement of Science.

March 27 - 31, Captain Cook Hotel: What Have We Learned from '64?
"The Great Alaska Earthquake: Retrospect and Prospect"

The Alaska Academy of Engineering and Sciences invites you to an opening banquet marking the 20-year anniversary and a week of seminars for all Alaskans to reminisce, review, and recommend directions. The Good Friday earthquake offers rich lessons in past responses and future preparedness.

May 31 - June 1, Anchorage Convention Center: What Do We Know Now?
Seminar on Earthquake Engineering in Alaska

The Alaska Chapter of the Earthquake Engineering Research Institute invites engineers, scientists, architects, designers, and planners to share research and ideas regarding buildings, life lines, geotechnical engineering, architecture, urban planning, and the social sciences in earthquake-prone areas of Alaska.
A Call for Papers: EERI invites you to submit a paper on any of the above topics by February 1 to David Cole, DOWL Engineers, 4040 B Street, Anchorage, AK 99503.

October 3 - 5, Sheraton Hotel: What Shall We Do For The Future?
AAAS Conference: "Science and Public Policy"

The Arctic Division of the American Association for the Advancement of Science invites everyone, especially scientists, designers, and public officials at all levels to explore together the public policies needed to insure thorough earthquake preparedness. There will be a call for papers with deadline to be announced.

Sponsors
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Organizing Committee
Alaska Division of Emergency Services.
University of Alaska, Fairbanks: Arctic Environmental Information and Data Center; Geophysical Institute.
University of Alaska, Anchorage: School of Business and Public Affairs.
Alaska Department of Natural Resources; Division of Geological and Geophysical Surveys.
Alaska Department of Military Affairs, Division of Emergency Services; National Guard.
Alaska National Guard.
American Red Cross.
Alaska Tsunami Warning Center.
Greater Anchorage Emergency Management Council.
Municipality of Anchorage: Department of Health; Geotechnical Advisory Commission; Office of Emergency Management.
City of Palmer.
CH$_2$M Hill.
DOWL Engineers.
Battelle, Alaska Operations.

Source: City of Anchorage

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