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# GENERAL REACTOR SITE SURVEY OF THE LOS ANGELES AREA

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# GENERAL REACTOR SITE SURVEY

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# LOS ANGELES AREA

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This report is based upon studies conducted for the Atomic Energy Commission under Contract AT-11-1-GEN-8.

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## III. SYNOPSIS

Maximum safety consistent with research utility is the criterion for selecting a research reactor site. This report reviews the physical characteristics of the Los Angeles area as they influence site location. The extreme hazard condition produced by an accident such as a low level eruption, which would release all of the fission particles from the reactor into the surrounding area, is considered.

The dilution rate and air transport movements are studied to determine their effect. Wind velocity and vertical temperature change affect the rate of dilution such that, in light winds and temperature inversions, dilution takes place slowly. In most of the area, throughout the summer and frequently during the winter, a temperature inversion occurs generally between the 1500 and 4000 feet elevations. It is desirable to avoid the temperature inversion areas, i.e., to locate at an elevation of 5,000 feet or above. A site situated at a high elevation may, however, be subject to night air drainage down the valley into a populated area. The nighttime land breeze and daytime sea breeze which constantly reverse the surface air flow in the region overshadow the effects of the yearly prevailing wind, which is from ocean to land during the summer and reverse during the winter months.

The presence of rainfall during the hazard period, while curtailing atmospheric particle movements, gathers the polluted material in the surrounding area into drainage channels, either above or below the ground. Surface velocity is quite rapid and the path is easily defined, but ground water paths are not easily determined and the velocity of underground flow through porous material is only a few feet per day. A heavy rainfall increases the distance the particles will be carried during a storm. Rainfall intensities are generally light in the Los Angeles area.

Disposal of radioactive particles in nearshore ocean waters would probably result in sorting out and concentrating the material according to specific gravity and size along the beaches, due to the actions of waves and nearshore circulation.

If the well defined earthquake fault areas are avoided, a reactor facility building can be designed and constructed to withstand any expected seismic disturbances.

Research utility indicates a maximum of two hours driving time from any of the participating universities or other groups, while the safety formula requires that an area of about 400 acres be fenced and guarded, with the nearest center of population at least one mile distance.

Although the physical characteristics of fourteen areas within the Los Angeles region have been studied, it is not the purpose of this report to recommend any specific site, but rather to present information which, when combined with the building and reactor design studies now being conducted, will permit a recommendation at that time.

## IV. INTRODUCTION

This report presents the material gathered in the first of three phases of study to investigate the design and location problems involved in a regional reactor facility for use by university and other research groups throughout the country. The Southern California area, and in particular the University of Southern California, the University of California at Los Angeles, and the California Institute of Technology represents a typical university group. Therefore, physical requirements of the Los Angeles area have been taken as a typical example for detail study.

The primary criterion in selecting a site and designing a research reactor facility is maximum safety consistant with research utility. Therefore, the physical characteristics of the site and the design of the reactor unit with its component buildings is related to the maximum power level of the reactor, the meteorologic, hydrologic, and seismologic characteristics of the region, as well as the proximity to a heavily populated area. This first report, while recognizing the relationship of these various considerations to the reactor and its component building, will treat only the considerations with respect to the site.

The disposal of radioactive waste during normal operation of the facility is considered a routine problem and only the extreme hazard condition with its relation to the physical characteristics of the site location has been studied in this report. It is considered that the extreme hazard condition would exist when a low level explosion releases all of the fission particles from the reactor into the surrounding area, thus resulting in a possible radioactive exposure of any nearby population.

The following characteristics are considered as pertinent to the safety of the surrounding population with respect to the location of the facility site. The safest installation would clearly be one located in an isolated region, many miles from any population. However, as the facility is intended for use by the university group, its usefulness should not be reduced by locating the site any great distance from this group. In order to permit daily access, a compromise must be made that will locate the site within a maximum of two hours driving time of the universities and, also, in an area some distance from large population concentrations.

The seismologic characteristics of the area can be classified as a controllable factor in the safety considerations, since (1) trigger mechanisms can be designed that will render the reactor inoperative and not subject to a hazard caused by the earthquake, and (2) the reactor housing can be constructed to withstand the seismic forces. In contrast are the uncontrollable factors which exist during the post-explosion period, such as meteorologic and hydrologic conditions, because the most likely source of danger would be the human exposure to the radioactive particles carried by air or water. Detail studies of all of these characteristics are therefore required, especially those which are beyond control, so that the site may be located where their effects will be least harmful. Several typical areas near Los Angeles have been selected for this detail investigation. However, it is not the purpose of this report to recommend any specific site, but rather to present information which, when combined with the building and reactor design studies, will present enough data, including relative costs, to permit consideration of the whole problem.

## V. REGIONAL CHARACTERISTICS

The Los Angeles region referred to in this report is the area within about a one-hundred mile radius of the city's civic center. The region lies along the Pacific Ocean and enjoys a semi-tropical climate. A relief map, Figure 3, indicates the general topography with other characteristics of the region shown on maps Figure 1 through 8.

### A. Driving Time and Population Density Characteristics:

Representatives of the university group believe that the utility of the research reactor would be reduced considerably if the driving time were increased above a maximum of two hours. Such a condition would eliminate return trips the same day and would require housing arrangements at the facility. A site that would reduce the driving time below the maximum would, therefore, be desirable. However, the universities of the group are all located in the midst of highly populated areas.

The area required to be completely controlled by the reactor facility has been given by the following formula: $R = 0.01 \sqrt{K}$ *,* where R equals the radius in miles of the controlled area and K equals the maximum power level of the reactor in kilowatts. Therefore, if the reactor should have a maximum power level of 1000 kilowatts, an area of approximately 400* acres would have to be fenced and guarded. In addition, the nearest population concentration should be at least one mile away. Figure 1 is a map in which the outer extremity of the unshaded area represents two hours driving time distance from the universities, while the inner contour of the unshaded area represents a distance at least two miles from a population density of 1000 persons per square mile. Thus, the unshaded portion of the map includes the parts of the region considered suitable for possible site selection with respect to the problems of locating away from population concentrations while maintaining reasonable accessibility. Care must be taken to select an area where prospects for population growth in the near future are not anticipated.

The following chart gives the actual driving time and distances from each participating university for the typical sites considered.

* Atomic Energy Commission Safeguard Committee.

* for K = 1000 kw
Area = 200 acres,
not 400

## 1. Driving Information Chart

| AREA | MILES FROM | | | | MINUTES FROM | | | |
|---|---|---|---|---|---|---|---|---|
| | USC | UCLA | CIT | AV | USC | UCLA | CIT | AV |
| **Group A** | | | | | | | | |
| Solstice Canyon ($A_1$) | 37 | 26 | 50 | 38 | 60 | 45 | 100 | 68 |
| Los Flores Canyon ($A_2$) | 31 | 20 | 44 | 32 | 55 | 40 | 95 | 62 |
| Rustic Canyon ($A_3$) | 21 | 10 | 34 | 22 | 30 | 20 | 65 | 38 |
| **Group B** | | | | | | | | |
| Santa Susana ($B_1$) | 36 | 26 | 42 | 35 | 60 | 45 | 65 | 57 |
| **Group C** | | | | | | | | |
| Oak Springs Canyon ($C_1$) | 38 | 28 | 39 | 35 | 70 | 60 | 70 | 67 |
| Alisos Canyon ($C_2$) | 45 | 46 | 37 | 43 | 75 | 75 | 60 | 70 |
| **Group D** | | | | | | | | |
| Loomis Ranch ($D_1$) | 44 | 45 | 36 | 41 | 90 | 75 | 60 | 75 |
| Grizzly Flats ($D_2$) | 27 | 28 | 19 | 25 | 50 | 50 | 35 | 45 |
| Trail Canyon ($D_3$) | 42 | 31 | 23 | 32 | 75 | 55 | 40 | 57 |
| Gold Canyon ($D_4$) | 41 | 30 | 28 | 33 | 75 | 55 | 45 | 58 |
| Kagel Canyon ($D_5$) | 39 | 28 | 27 | 31 | 65 | 50 | 45 | 53 |
| **Group E** | | | | | | | | |
| Palmdale ($E_1$) | 72 | 61 | 49 | 61 | 110 | 100 | 75 | 95 |
| **Group F** | | | | | | | | |
| Verdugo Mountains ($F_2$) | 26 | 27 | 21 | 25 | 45 | 45 | 30 | 40 |
| Elysian Park ($F_1$) | 8 | 13 | 10 | 10 | 20 | 25 | 20 | 22 |

## B. Meteorologic Characteristics

(Prepared in cooperation with Dr. N. Neiburger, Assoc. Prof. of Meteorology at U.C.L.A.)

The meteorologic characteristics of the area are important in determining the consequences of releasing radioactive particles into the atmosphere. Since particles with an average diameter of 1 to 10 microns and specific gravity of about 5 will remain suspended over long periods, the rate of dilution and of transport by air movements should be evaluated to insure that they will not reach populated areas before becoming sufficiently diluted. The influences which affect rate of dilution are strength of wind and vertical temperature gradient. In light winds and temperature inversions, dilution will be very slow. The influences on transport include prevailing wind flow, land and sea breezes, and mountain valley air drainage effects.

### 1. Temperature Inversion

Temperature inversion occurs when, at one or more levels, the temperature of the air increases with increase of height, instead of decreasing. Such a temperature inversion normally occurs at the surface of the earth on still clear nights because this surface, which is a good radiator, cools faster on such occasions than does the free atmosphere, and by contact correspondingly chills the adjacent air. Another common cause of temperature inversions is turbulence induced by friction. The mass of air forced to higher levels cools by expansion and those brought to a lower level are warmed by compression, until an adiabatic gradient is established from top to bottom of the agitated layer. In this way, the upper portion of the layer becomes cooler than it otherwise would have been, and therefore colder than the air next above. Thus a temperature inversion is established between the turbulent air beneath and undisturbed air above. Temperature inversions also characteristically occur over the eastern portions of oceans and adjacent west coasts of continents. Such inversions are caused by the general sinking of air on the eastern side of the semi-permanent anticyclone which is present over subtropical oceans, particularly in summer.

In the most of the Los Angeles region throughout the summer and during most days in winter the temperature decrease which occurs near the ground is capped by a temperature inversion varying in height, with the elevation of the base of the inversion averaging about 1500 feet, and its top averaging about

4000 feet. This produces a dispersion limit since the temperature inversion prevents vertical diffusion. At times when the temperature inversion is present, the horizontal air movement (wind) is sluggish and lateral dispersion is correspondingly reduced.

Of importance then is the frequency at which a temperature inversion condition exists over this region. In parts of the Los Angeles area during July and August there is, on the average, only one day in each month in which there is no inversion below 3000 feet, and on that day the inversion is present at a higher level. It is present along the coast up to the mountain ranges both day and night. In the afternoons the heating at the higher elevations along the slopes of the mountains may wipe out the inversion, only to be restored there by midnight or early morning. In September, the height of inversions will be lower; they will be wiped out more frequently but the effects are more pronounced when present. In March most days free from temperature inversions occur and from then inversion frequency increases. May and June have more inversion periods, but many are at high levels where their effect is considerably weaker.

Meteorologists recommend that a site location should be away from a temperature inversion area or at an elevation of 5000 feet or above. Normally, a site at this altitude would be above the inversion.

2. Mountain Drainage

During clear nights when there is little or no general wind, there is usually a flow of the surface air, commonly most pronounced in ravines, down the sides and along the basin of the valley. Usually this movement is gentle to very slow, but if the area is free from forrests or in the winter covered with snow the downflowing current may attain greater velocities. Thus a site located at a high elevation, while being free from a temperature inversion handicap, may be subject to this winter night drainage down the valley into a populated area. It is important, therefore, that a location in this area be away from the natural drainage into the populated regions of the Los Angeles basin.

3. Prevailing Wind

The Los Angeles region lies along the coast and, therefore, the surface wind is governed by the typical land and sea breeze effects. Whenever a strongly heated region adjoins one that is less heated, a local circulation from one to the other usually prevails. Thus, along the coast a sea breeze starts during the morning after the land surface has become sufficiently warmed. By night, when the water surface is relatively warm and the soil cool, because of its rapid radiation, the direction of the surface wind is reversed or offshore. Besides being reversed in direction and occuring at night instead of by day, the land breeze differs from the ocean breeze in usually being weaker. Hence, when the landward breeze carries air 10 to 25 miles inland, the seaward breeze seldom extends more than 5 to 6 miles to sea. In Los Angeles area during the spring, summer, and fall months, the surface wind blows from the ocean toward the land about two-thirds of the twenty-four hour day, reversing during the rest of the day. During the winter months, the time and directions are reversed. Consequently, the overall prevailing wind is from the ocean to land from a yearly standpoint, but is from land to sea in winter. Figure 2 shows the prevailing air current flow in the region from a yearly standpoint.

In the free air (away from the surface) the prevailing wind is generally from a southwesterly direction during the summer due to the heating of the continent, which sucks the air inland. In the winter the winds are mostly northerly at these levels. In both cases the resultant air movement is usually light.

4. Dilution

The tolerance values recommended by the Atomic Energy Commission for $\beta$ and $\gamma$ radiation are $10^{-7}$ $\mu$c/cc for air and $5 \times 10^{-4}$ $\mu$c/cc for water ( $\mu$c/cc = microcuries per cubic centimeter). These values are based upon continuous exposure and could probably be increased by several orders of magnitude for short, single exposures.

If the assumption is made that in the event of reactor catastrophe, the fission products expand into the volume of the reactor building, a further dilution of roughly $10^8$ in air and $10^4$ in water is required to reduce the activity to the conservative tolerance values given above, when the reactor operates at an equilibrium power of 100 kw. These dilutions, therefore, indicate the magnitude of the problem that should be met by the meteorologic and hydrologic conditions of the site.

## C. Hydrologic Characteristics

(Prepared with the cooperation of Mr. A. L. Sonderegger, an Engineering Consultant in Hydrology.)

The hydrologic characteristics of the area are of importance in developing methods to render harmless the larger radioactive particles deposited on the surrounding ground after an extreme hazard condition, especially if it is raining at the time. The effects of rainfall frequency, maximum rainfall during any storm, type, and path of runoff, and the location of surface and subsurface water supply basins are factors influencing the harmless disposition and dilution of the radioactive particles.

### 1. Rainfall Frequency

The frequency of rainfall is important since the presence of rain at the critical time will prevent some of the harmful particles from being dispersed into the atmosphere and tend to deposit the particles in a smaller area. After reaching the ground, the presence of running water over the area will move these particles into common drainage channels either above or below the ground. This process of collecting the material will occur whenever it rains. If satisfactory dispersions were obtained by the forces of the explosion and atmospheric transport, a location where it never rained might therefore be desirable. However, if this dilution is not satisfactory, the frequent rainfall might be utilized to gather the dispersed harmful particles into a catch basin for further treatment. In the Los Angeles area about twenty storms producing rainfall of 0.01 inch or more can be expected to occur during the season, with rain occuring during 35 to 40 days, dependent upon the location. While the yearly frequency may remain near normal, the occurrence varies greatly with some months receiving rainfall six times more often than normal.

### 2. Rainfall Intensity

The rainfall intensity influences the rapidity and distance the particles will be carried during the storm. A heavy rainfall saturates the ground, resulting in a more rapid surface runoff. The accumulation of large amounts of water in regular drainage channels would cause the particles to be carried further during a heavy rainfall. Maximum storm precipitation will determine the size of the catch basin to be constructed to arrest all of the harmful particles if such a structure is needed. Rainfall intensities are generally light in the Los Angeles area, with a few scattered locations receiving more than one inch per hour. In one area rainfall of more than an inch in five minutes, 26 inches in a twenty-four hour period, has been recorded.

Figure. 5 is an isohyetal map showing the amount of rainfall that could be expected to fall during a twenty-four hour period with a probable frequency of once in fifty years. This map therefore indicates the maximum amount of rainfall that might be expected during any storm in the areas under consideration. An isohyetal map is shown on Figure 4, from which it can be seen that the yearly average rainfall in this area varies from 4 to 40 inches.

3. Runoff

The runoff of an area consists of the direct runoff and the ground water runoff. The factors that control the runoff are numerous and largely interrelated. Of these, the rainfall is most influential. The topography of the drainage area surface, its smoothness or roughness and gentle or steep slopes, will affect the speed of concentration. Slower concentrations allow more ground percolation and greater evaporation. The geology of the area, including the perviousness or imperviousness of the subterranean formations, is a factor. The general shape of the area also influences the nature of the runoff. The path of surface water can be readily determined by observation, but the ground water paths need further study. Of the water that percolates into the soil some is taken up by plants to be transpired by them through their leaves. A portion is evaporated directly, and some, the hygroscopic water, resists evaporation and is held in the soil. The remaining water passes downward under the influence of gravity until it reaches an impervious stratum. It then begins to move in a lateral direction toward some outlet. This water, flowing through underground porous materials, such as sand and gravel, or porous rocks such as sandstone, or in fissured rocks, furnishes almost all underground water supply. Large, free-flowing underground rivers are rarely found. The velocity of flow of underground water through porous material is seldom greater than a few feet per day. It has been recommended that one of the better ways of controlling this water pollution problem would be to locate on a top mesa with a closed basin where the subterranean composition is sandstone, which could act as a semi-permanent reservoir to hold and slowly release by further percolation a harmless concentration of radioactive particles.

It is important to control both the surface and ground water runoff in the area selected.

4. Water Supplies

The map on Figure 6 shows the principal local sources of water in this Los Angeles area. The key wells are indicated and although wells are found in almost all parts of the region, the places where large number of wells are concentrated indicate the magnitude of the water pollution problem that could be expected in these areas. The principal ground water basins are shown which would present a very serious problem if contaminated. The spreading basins shown are important since they indicate the areas which are used to direct surface runoff into the underground water storage basins. The site should be located so that the surface runoff will not reach these spreading grounds.

5. Oceanography

(Prepared with the cooperation of Mr. D. L. Inman of the Scripps Institution of Oceanography.)

Some of the areas under investigation are located near the ocean where drainage directly into the sea could be provided. A study was therefore deemed advisable to determine if adequate dilution of the harmful particles would result if deposited in the ocean.

The Scripps Institution of Oceanography was contacted to see if some of their investigations might indicate the nature of distribution of radioactive disposal material placed in nearshore ocean waters. It is estimated that the material under consideration would be a solid with a specific gravity of approximately 5.0 and ranging in diameter from 10 to 1000 microns.

The distribution of material in the ocean is both a problem in advection and diffusion. Advection is the movement of particles in the direction of the wave, commonly called current, while dispersion is the lateral separation of particles due to the turbulence of the wave action. However, considering the size and specific gravity of the material involved, the primary influence is that of advection or currents on the distribution of particles. Thus, this study is concerned with the characteristics of waves and currents in transporting material.

Investigations at the Scripps Institution on the sorting of sediments and the nearshore circulation of water, while primarily undertaken as a study in nearshore sediment distribution, throw some light on this problem. The way in which waves and currents sort material is apparently dependent upon the size, shape and specific gravity of particles, and the velocity, degree of turbulence, viscosity, and specific gravity of the transporting agent. Studies have shown that nearshore waves and currents are particularly effective in sorting out and concentrating materials of given specific gravity and size.

In general, nearshore waves consist of high crests separated by relatively flat troughs. Particles on or near the bottom are subjected to a shoreward surge as a crest passes over them, followed by seaward movement as the trough passes the point. Measurements indicate that both the magnitude and duration of the onshore and offshore velocities are different, and further, that the velocities and durations change with changing wave period and height. This type of motion is particularly effective in sorting material, in that certain sizes and specific gravities are moved more rapidly and at different velocities than other material. It is thought that the differential between crest and trough velocities cause certain materials on the bottom to be moved shoreward while suspended material near the bottom may be moved offshore. The size and specific gravity of the material moved are dependent upon the wave period and height. Thus, the orbital motion in the waves tends to sort out and concentrate similar materials at uniform heights along the beach, and on the ocean bottom in nearshore waters.

The material is further concentrated in a lateral sense by the effect of longshore currents. Investigation indicates that, under given wave types, water moves shoreward in certain localities. The shoreward mass transport of water and the angle of wave approach give rise to longshore currents which move parallel to the beach. The cumulative effect of shoreward transport of water, longshore currents and rip currents is to give a more or less eddylike circulation in the nearshore water. While rip currents may have high velocities and thus may tend to take some material seaward, it is thought that their spasmodic tendency and changing position along the beach, depending upon the character and type of waves, would not make them a satisfactory disposal agent. Thus, the general tendency of the nearshore circulation (i.e., rips and longshore currents) is to further concentrate material brought shoreward by the waves.

In summary, it may be said that present investigations indicate that waves and currents are exceptionally good sorting agents and that for the size and specific gravity radioactive fission effluents, there may be a tendency to form concentrations similar in sizes of material at specific locations along the beach. The degree to which material of a given size and specific gravity would be concentrated, in addition to other factors, is a function of the wave types, and directions to which the material is subjected, the bottom topography near the beach, and the size and type of material naturally found on the beach. Thus, the statements made here are broad generalizations for beaches in general and may not be adaptable to all locations.

There is some information regarding the seasonal wave types and directions along the Los Angeles coastal area, however, the specific effects of these waves in relation to bottom topography and in producing rip and longshore currents have not previously been investigated.

Although the material presented has been with respect to offshore disposal of the particles, the possibility of drainage some distance to sea has been considered. The surface wave motions herein discussed are effective in this area normally to depths of 500 to 1000 feet, and below this surface action, internal wave motion and other not fully understood movements would continue material transport. Therefore, since it would be necessary to go more than twenty miles to sea before these depths would be encountered, this possibility of away from shore drainage was considered impractical. Figure 7 is a coastal chart showing the ocean topography in this area. It might be noted that the Santa Cruz basin has been designated as a chemical disposal area.

D. <u>Seismologic Characteristics:</u>

(Prepared with the cooperation of Dr. J. P. Buwalda, for twenty-one years Chairman of the Division of the Geological Sciences including the Seismological Laboratory of the California Institute of Technology.)

A map showing the active fault locations in the region is shown in Figure 8. Geologists have made extensive studies in this entire area and have accurately defined most of the actual fault lines. Thorough studies of the magnitudes, periods of frequency and other pertinent characteristics have been made concerning the earthquake wave motions.

Since the Southern California region has had a rather active history of earthquakes, engineers in cooperation with seismologists studied the forces involved and have developed building designs and methods of construction to withstand earthquake forces. It is believed the reactor structure can be designed to withstand the worst expected conditions.

While a severe earthquake always leaves in its wake many collapsed buildings and much structural damage, it also shows that a properly designed structure is capable of withstanding the strongest recorded earthquake shocks.

Earthquake consists of chaotic ground movements caused by wave motions of extremely variable wave lengths, amplitudes and accelerations. The horizontal ground displacement is usually the most destructive since the inherent design and the mass of the buildings naturally resist the increased stresses due to vertical earth movements.

When the ground underneath a structure is moved suddenly to one side, the building will tend to remain in its original position because of its inertia. The acceleration of the horizontal movement varies; its maximum value is the yardstick commonly adopted for measuring the equivalent static earthquake force. If the acceleration of the horizontal earth movement is maximum, it is assumed that the stresses in the structure caused by the earthquake are the same as those produced by horizontal static forces equal to one-tenth of the gravity forces acting on the building. While other methods of evaluating earthquake forces have been proposed and used, the one described is specified in many building codes as a practical means of safe design. Buildings designed on this basis have satisfactorily resisted earthquakes of the intensity of those which have occurred in the United States.

In a small structure of the type necessary to house the reactor, a reinforced concrete building could easily be designed, to a factor of .15 g, even 1.00 g instead of the recommended 0.10 g, thus assuring more than adequate resistance to any earth movements.

Geologists have found that the effect of the earthquake is less if a structure is built upon solid ground as contrasted with buildings located on large alluvial fill basins. Nevertheless, many important buildings in Los Angeles have been designed and constructed to withstand earthquake forces even though located on an alluvial fill. A building should not be located directly across a fault line and since the geographic positions of the active faults are well defined, these vulnerable areas can be avoided for possible site selection. The forces of an earthquake reduce materially beneath the surface of the ground, therefore, in most underground structures the effect of an earthquake is non-destructive.

If the reactor is built on solid ground a few feet away from an active fault, the structure, when properly designed, can be capable of withstanding the strongest recorded earthquake shocks. In addition, as an added safety factor, mechanisms that operate when a predetermined shock intensity level is reached are available that can be utilized to actuate triggering devices to render the reactor inoperative during the remainder of the earthquake. Since earthquake waves travel with a general velocity of about three miles per second, six instruments placed $60^{\circ}$ apart forming a three mile ring around the facility would probably provide an adequate warning pattern.

## VI. DESCRIPTION OF POSSIBLE SITE AREAS

Fourteen areas within the Los Angeles region have been investigated in this study and are designed on the maps Figures 1 through 8, with those areas having the same general description grouped together. At the present time, it is estimated that an area of about one square mile (a section) of land will be required. Some of the areas shown are privately owned, and although no attempt has been made to negotiate a purchase, the average prevailing price would probably be less than one hundred thousand dollars. Other areas investigated are within the National Forest or on Government Domain Land and could be leased on a semi-permanent basis at a very nominal cost. The areas selected for presentation are typical of the various characteristic sites available and at this stage of the investigation no actual site locations are being proposed.

### A. Coastal Mountain Areas - Average Elevation 2300 ft:

This group consists of the Solstice Canyon (A-1), Figure 9. The Los Flores Canyon (A-2) Figure 10, and the Rustic Canyon (A-3) Figure 11 locations.

#### 1. Population Density:

This group is located in the rugged Santa Monica Mountains. Many summer homes are scattered throughout the area but no large concentrations of population are nearby. The Santa Monica, Westwood Sections are the nearest populated areas, and the distance to these varies from seven to twenty miles.

#### 2. Meteorologic Characteristics:

Due to the relatively low altitude and proximity to the coast, these areas will be subject to the temperature inversion condition whenever present in the area. The normal flow of air would be up the canyons towards the San Fernando Valley during the daytime with a reversal at night. The daytime currents will probably not be dangerous since good dispersion would take place. However, at night the cold air drainage down the canyon, taking particles out to sea to be returned the next day, might prove dangerous since the daytime sea breeze might shift slightly in direction and pass over the Santa Monica region.

#### 3. Hydrologic Characteristics:

(a) Rainfall:

Most of the rainfall in this area occurs during the winter months, with almost none occuring during the months of May through September; however, in several typical years more than half of the twenty inch yearly average has been deposited during a single month.

(b) Runoff:

During the rainy seasons, these mountain areas are heavily vegetated, but this retention feature is overcome by the rather steep slopes resulting in a moderately rapid runoff of surface water. The surface runoff will quickly concentrate into the canyons below each of the areas, facilitating the possible construction of a retaining basin, provided the tributary watershed is relatively small.

(c) Subterranean Characteristics:

This area is mostly over a sandstone base which would provide good percolation into this underground retaining medium. Since the area has no ground water deposits large enough to be a source of water supply, and due to the proximity of the ocean which would be the eventual outlet, these areas provide an excellent location for disposing of the radioactive pollutants into the natural subterrain. These areas, are considered to have the best hydrologic characteristics, because control of surface runoff and underflow is feasible.

4. Seismologic Characteristics:

No active faults cross through any of these areas, the nearest one being the Inglewood fault, which is about eight miles away from the Rustic Canyon site and nineteen miles from the Solstice Canyon site.

5. Accessibility:

These areas are all located on privately owned land and none of them would need road improvements of more than a mile from an existing improved highway.

B. Simi Hills Area (B-1) Figure 12 Average Elevation 2000 ft:

1. Population Density:

This area is located on the tops of the Simi Hills. A few ranch houses are scattered in the sparsely inhabitated surroundings.

The North American Field Laboratory for propulsion and rocket research is located in the adjoining section. The small towns of Chatsworth and Simi are located about five miles away.

2. Meteorologic Characteristics:

This area, being located on the divide between the San Fernando Valley and the Santa Clara Valley, presents a rather indeterminate prevailing wind condition. During the day the wind flows toward the west in the San Fernando Valley, while in the Santa Clara Valley the air flows eastward from the ocean; thus, at this divide the two streams converge with the resultant direction indeterminate without actual observations being made. The result of this convergence could be that any contamination would be carried upward to higher levels where the flow would carry the air to the south in winter, north in summer, but with little likelihood of its being brought back to the surface. At night the tendency is for the air to flow eastward. The most serious effect would be the nighttime movement into the San Fernando Valley.

3. Hydrologic Characteristics:

(a) Rainfall:

Rainfall in this area occurs mostly during the winter months of October, through May, with none usually recorded during the remaining summer months. Of the 16 inches normal annual rainfall, almost half is recorded frequently during a single month.

(b) Runoff:

This area is located in a top mesa of rolling hills. The surface is covered with grass and brush. Several flats are available. If the runoff is retained before it reaches the very steep, narrow canyons, there would be rather slow convergence and the total runoff would be small.

(c) Subterranean Characteristics:

Most of the subsurface material in the region is perch gravel shale and sandstone. The sandstone is generally deep. Ground water in the perch gravel would flow into the San Fernando Valley water basins as shown in Figure 6. Percolation in sandstone would probably prove harmless.

4. <u>Seismologic Characteristics:</u>

The Inglewood fault is the nearest active fault and is more than twenty miles distant.

5. <u>Accessibility:</u>

This area is privately owned. An improved road has been constructed into the North American test facility and this road would have to be continued for not more than a mile.

C. <u>Santa Clara Valley Areas - Elevation Average 2000 ft:</u>

These areas include one in Oak Springs Canyon (C-1) Figure 13 and another in Alisos Canyon (C-2), Figure 14, both of which drain into Santa Clara Valley by way of Soledad Canyon.

1. <u>Population Density:</u>

In this section of the upper Santa Clara Valley the population is very scattered. No areas with a population density of more than two hundred per square mile are in this region.

2. <u>Meteorologic Characteristics:</u>

The air movement is out the valley towards the desert, with quite brisk winds. On calm clear nights drainage would be westerly toward the ocean, with not much likelihood of contaminating any populated areas. For both day and night conditions, this area is the most desirable of those being presented.

3. <u>Hydrologic Characteristics:</u>

(a) Rainfall:

Rainfall in this area is more frequent throughout the year with most months receiving some precipitation. The area closest to the desert receives about half the eighteen inches normally received at Oak Springs. Here also a majority of the rain occurs during the winter season, with most of it frequently being produced during a single month.

(b) Runoff:

These areas are located in very steep and rocky terrain. Most of the characteristics of the area are such that in heavy storms very rapid runoff in surface drainage would occur.

(c) Subterranean Characteristics:

These areas are located where the top surfaces are primarily sedimentary rocks, thus water movement above the surface would rapidly drain into the Santa Clara water basin which is a good water supply source and has considerable usage. Canyons have shallow alluvial beds that drain into Soledad Canyon.

4. Seismologic Characteristics:

The Alisos Canyon area is about ten miles from the San Andreas fault and the Oak Springs Canyon area is about five miles from the San Gabriel fault.

5. Accessibility:

Both of these areas are within the National Forest Boundaries and the authorities concerned have indicated that a semi-permanent usage permit could be obtained for this project. Good roads are near the areas with the maximum estimated improvements being less than a mile of additional roadways.

D. Angeles Forest Areas - Average Elevation 3500 ft:

This group consists of areas near Loomis Ranch, (D-1) Figure 15, Grizzly Flats (D-2), Figure 16, Trail Canyon (D-3), Figure 17, Gold Canyon (D-4), Figure 17, and Kagel Canyon (D-5), Figure 18.

1. Population Density:

Since these areas are all well within the National Forest, the permanent population is very scattered and the further issuance of homesite permits has been discontinued so that future expansion around these areas is controlled.

2. Meteorologic Characteristics:

These areas, especially the Loomis Ranch region, are such that a high elevation site could be selected and, therefore, this altitude would generally be above the temperature inversion condition and good turbulent air movement toward the desert would prevail during the day. The primary concern here would be during the winter time at night when drainage down the canyons into the populated valleys could occur. If the facility were not operated at night, these areas would be particularly advantageous in dispersing the polluted air by meteorologic transport.

3. Hydrologic Characteristics:

(a) Rainfall:

The rainfall in these regions is generally the largest amounts found in the Los Angeles area, and may average thirty-six inches. Also, due to the occasional showers in the mountains, the frequency of precipitation is a maximum, with rainfall being recorded in most of the months throughout the year. These areas are also near locations where the maximum amounts of rainfall in the shortest periods of time have occurred.

(b) Runoff:

Most of the region has very steep-sloped mountains with very few flat spaces. Ground vegetation coverage is not consistent in the region. The general characteristics of the area are such that rapid runoff can usually be expected.

(c) Subterranean Characteristics:

The earth surface in these areas is composed primarily of a poor grade of granite. Due to the numerous fissures throughout the area, the ground water is trapped in these pockets and their release to the water supply is spasmodic. Both surface and ground water drain into the various canyons directly into developed water supply basins. During the winter months, precipitation in all of the areas in the higher elevation is frozen, and therefore, the speed of drainage would be dependent on the rate at which the snow melted.

4. Seismic Characteristics:

The San Gabriel fault passes within one to two miles of the Grizzly Flats, Trail Canyon, Kagel Canyon, and Gold Canyon areas. Loomis Ranch is about eight miles distant.

5. Accessibility:

Road improvements to these areas might be quite extensive due to their remote locations; however, fire truck trails to most parts of the regions are existing, and the improvements would not be too costly. It is estimated that an improved road of four miles would be the maximum necessary for access to any of the areas. Deep snow makes winter access difficult at Loomis Ranch.

E. Desert Area, (E-1, Figure 19) - Average Elevation

An area in the desert regions of Antelope Valley has been considered; however, since the driving time is close to the maximum, a detailed description of the area is not presented. The rainfall would be very slight, but due to the scarcity of water, all possible underground sources are being utilized. This condition makes the water pollution problem a prime consideration. If further investigations suggest that the other areas are not satisfactory, the desert region will be studied more completely.

F. City Area, Average Elevation, 1200 ft.

Two areas that are typical of some possible locations within the city have been studied. They are the Verdugo Mountain Area (F-1, Figure 20) and an undeveloped portion of one of the city parks (F-2, Figure 21).

1. Meteorologic Characteristics:

Since the areas are both surrounded by areas of heavy population concentrations and are of a low elevation where the temperature inversion condition would exist, the air transport of contaminated particles to populated regions would be very likely.

2. Hydrologic Characteristics:

The frequency of rainfall would be about average for the area and the likelihood of large maximum precipitation in a short period of time would be infrequent. The runoff would rapidly drain into the nearby water supplies and some would be carried in the city drainage systems. The basin area is composed of deep alluvial fill in most locations. The granite formation of the Verdugo Mountains is exceptionally solid, in contrast to that of the San Gabriel Range, making large excavation by tunneling practicable.

3. Seismic Characteristics:

Verdugo Mountain area is about three miles from the San Gabriel fault and Elysian Park is about five miles from the end of the Whittier fault.

4. Accessibility:

The areas are in privately owned regions, and due to their locations near the city, their real estate evaluation is much higher than the other areas presented. Generally good roads are in the vicinity, with the building of improved roads of more than a mile being unnecessary.

# SUMMARIZATION CHART

## AREA PREFERENCE FOR 24-HOUR OPERATION

### METEOROLOGIC CHARACTERISTICS

1. Group C - Santa Clara Valley

   Air movement during both night and day is up and down the sparsely populated Santa Clara Valley.

2. Group D - Angeles Forest Mountains

   Excellent daytime diffusion but cold winter nights could drain into populated valleys below.

3. Group E - Desert

   Excellent daytime diffusion - nighttime drainage into Palmdale and other valley cities.

4. Group A - Santa Monica Mountains

   Daytime movement rapid inland but nighttime reversal plus drainage may eventually transport over Santa Monica area.

5. Group B - Simi Hills

   Convergence of Santa Clara and San Fernando currents at this point makes daytime condition uncertain - nighttime drainage to San Fernando Valley.

6. Group F - City

   Both daytime and nighttime movement may danger nearby heavily populated regions.

### HYDROLOGIC CHARACTERISTICS

1. Group A - Santa Monica Mountains

   Absence of usable underground water-sandstone subsurface - ability to control surface runoff.

2. Group B - Simi Hills

   Top mesa with sandstone and perch gravel substructure - underground water to Santa Rosa and San Fernando.

3. Group C - Upper Santa Clara Valley

   Small alluvial fill over clay affords rapid surface and ground water runoff to developed water supply basins.

4. Group D - Angeles Forest Mountains

   Poor granite subterranean structure making indeterminate ground water runoff plus rapid surface runoff to water supply of populated regions.

5. Group E - Desert Area, Antelope Valley

   Lack of quantity of water forces usage of all underground water sources making safe disposal of pollutant very difficult.

6. Group F - City

   Natural runoff of both surface and ground water to surrounding populated regions water supply almost impossible to prevent. Solid granite formation available.

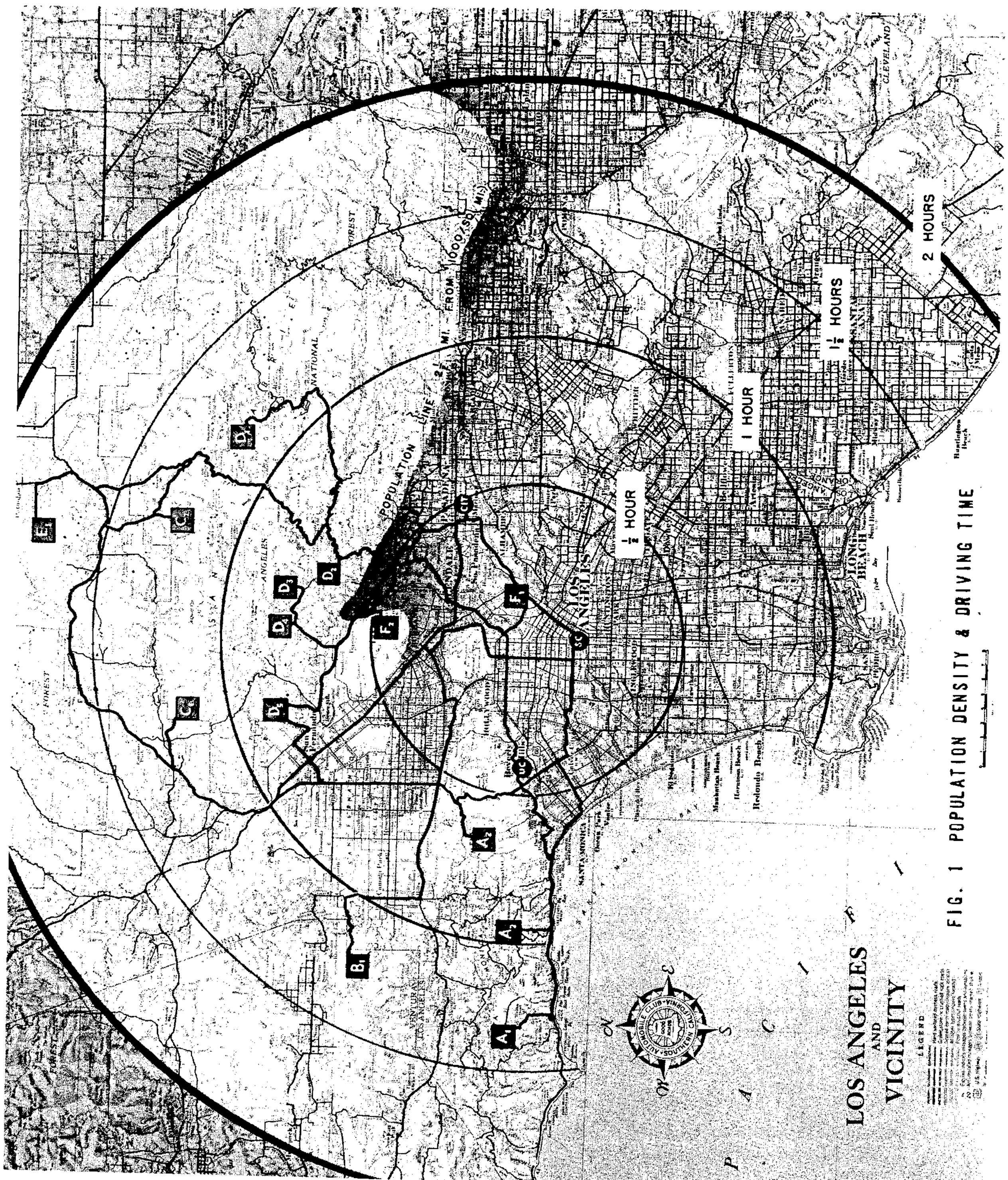


FIG. 1 POPULATION DENSITY & DRIVING TIME

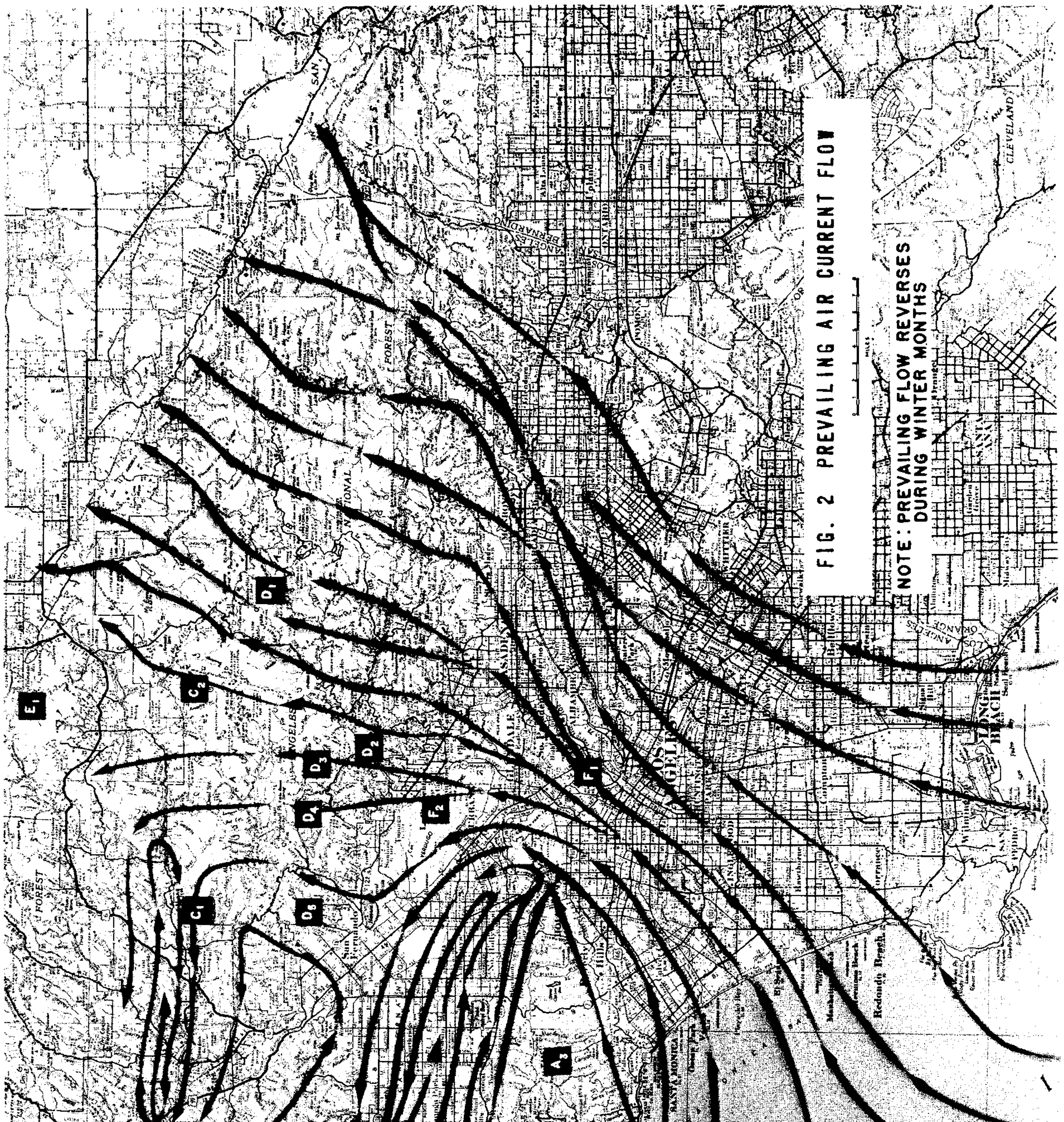


FIG. 2 PREVAILING AIR CURRENT FLOW


FIG. 3 PRINCIPAL WATER SHED AREAS

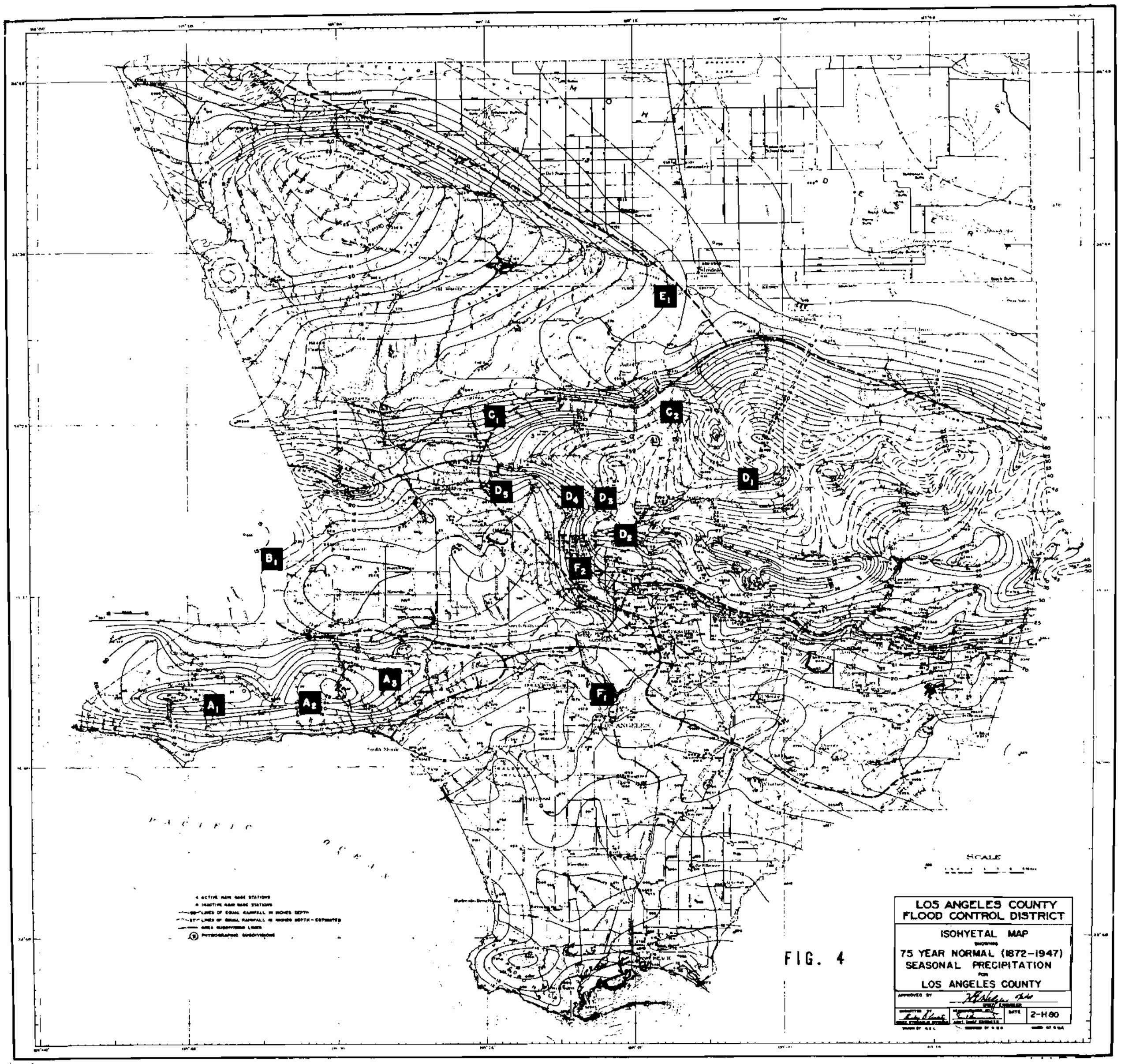
E1
C1
C2
D1
D2
D3
D4
D5
B1
F1
F2
A1
A2
A3
PACIFIC OCEAN
SCALE
LOS ANGELES COUNTY
FLOOD CONTROL DISTRICT
ISOHYETAL MAP
SHOWING
75 YEAR NORMAL (1872-1947)
SEASONAL PRECIPITATION
FOR
LOS ANGELES COUNTY
APPROVED BY
DATE
2-H60

FIG. 4

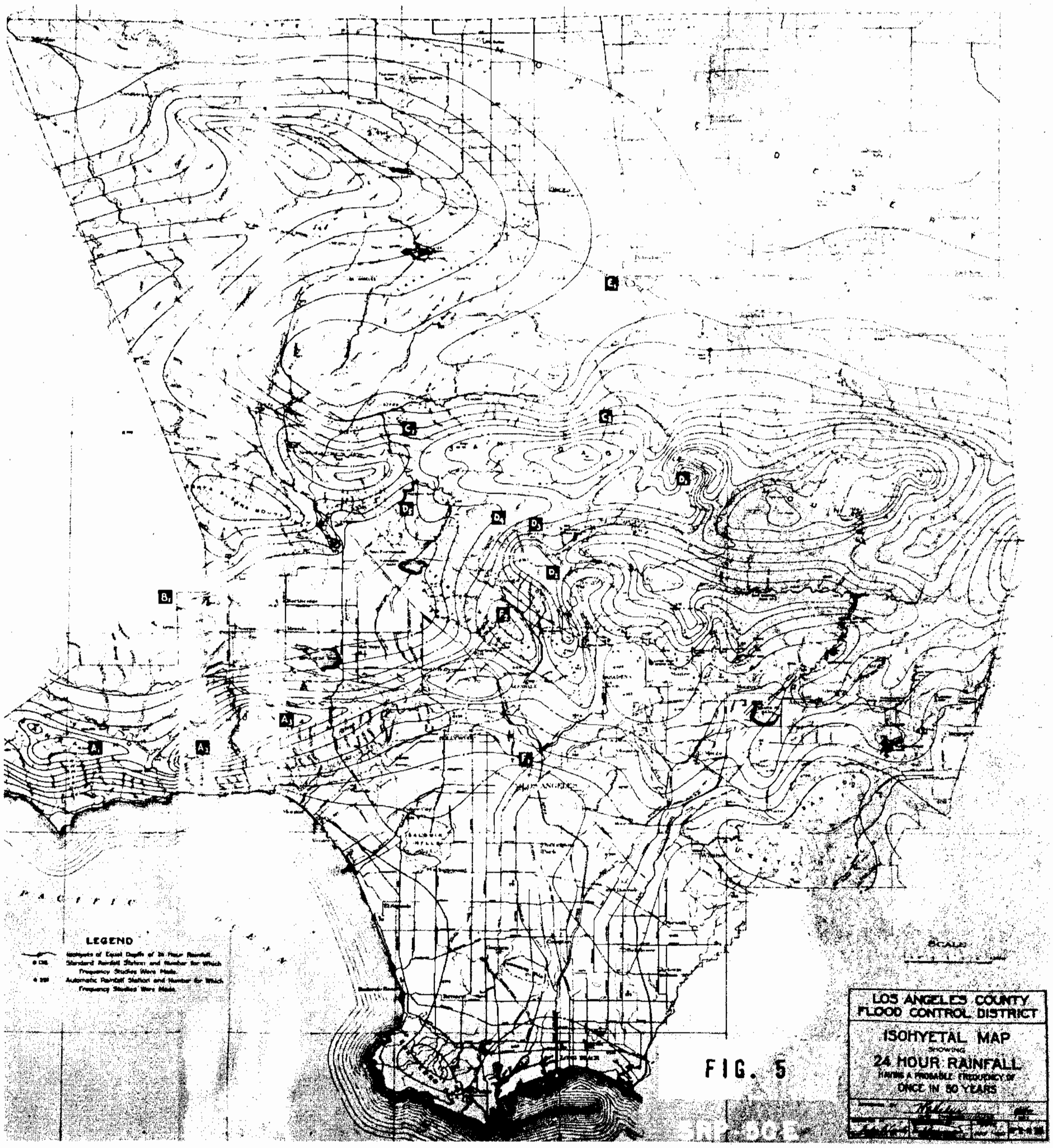
PACIFIC
LEGEND
Standard Rainfall Station and Number for Which Frequency Studies Were Made.
Automatic Rainfall Station and Number for Which Frequency Studies Were Made.
SCALE
LOS ANGELES COUNTY FLOOD CONTROL DISTRICT
ISOHYETAL MAP
SHOWING
24 HOUR RAINFALL
HAVING A PROBABLE FREQUENCY OF
ONCE IN 50 YEARS

FIG. 5

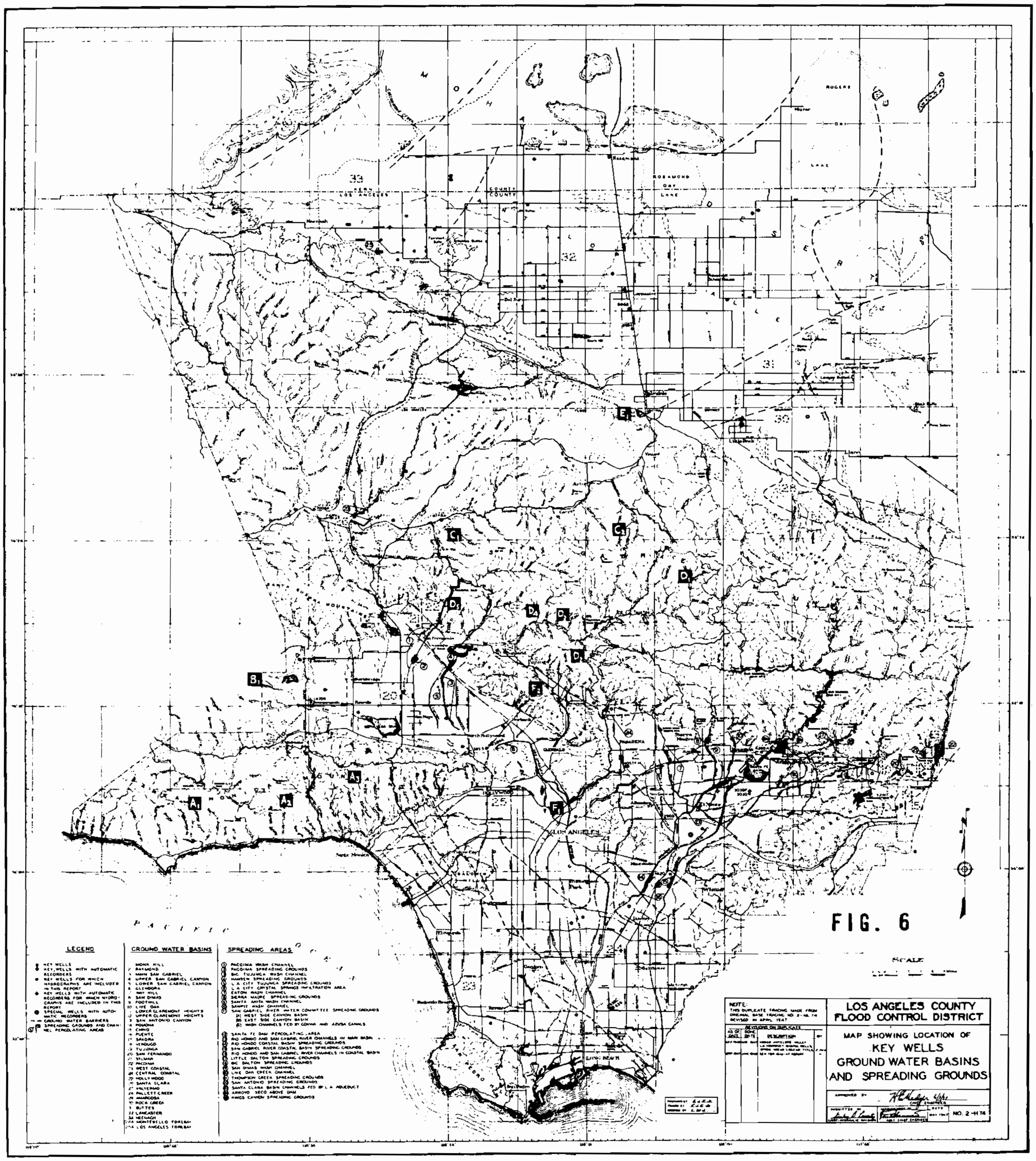
LOS ANGELES COUNTY
FLOOD CONTROL DISTRICT
MAP SHOWING LOCATION OF
KEY WELLS
GROUND WATER BASINS
AND SPREADING GROUNDS
NO. 2-H74
SCALE
LEGEND
GROUND WATER BASINS
SPREADING AREAS
PACIFIC
LOS ANGELES

FIG. 6

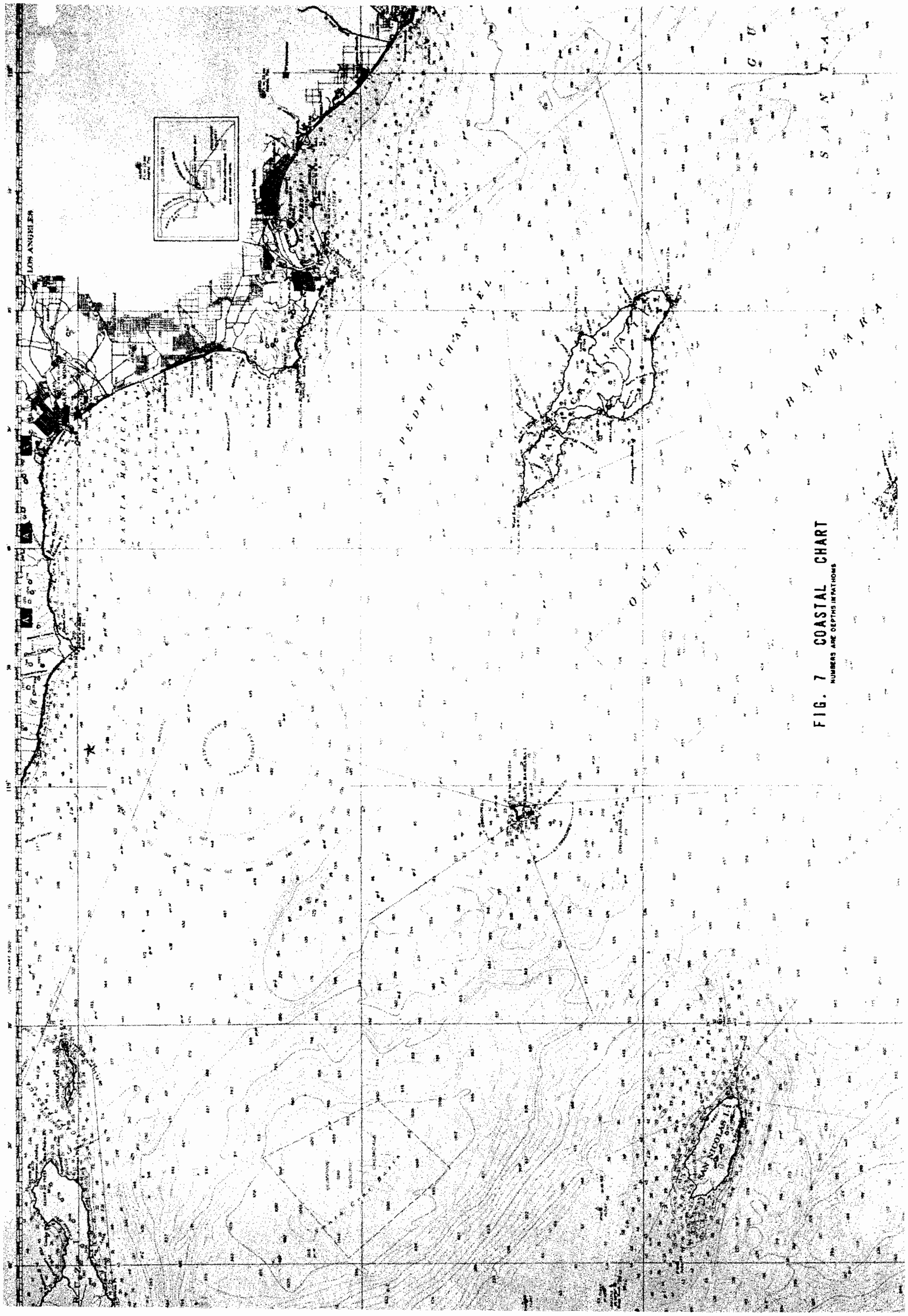


FIG. 7 COASTAL CHART
NUMBERS ARE DEPTHS IN FATHOMS

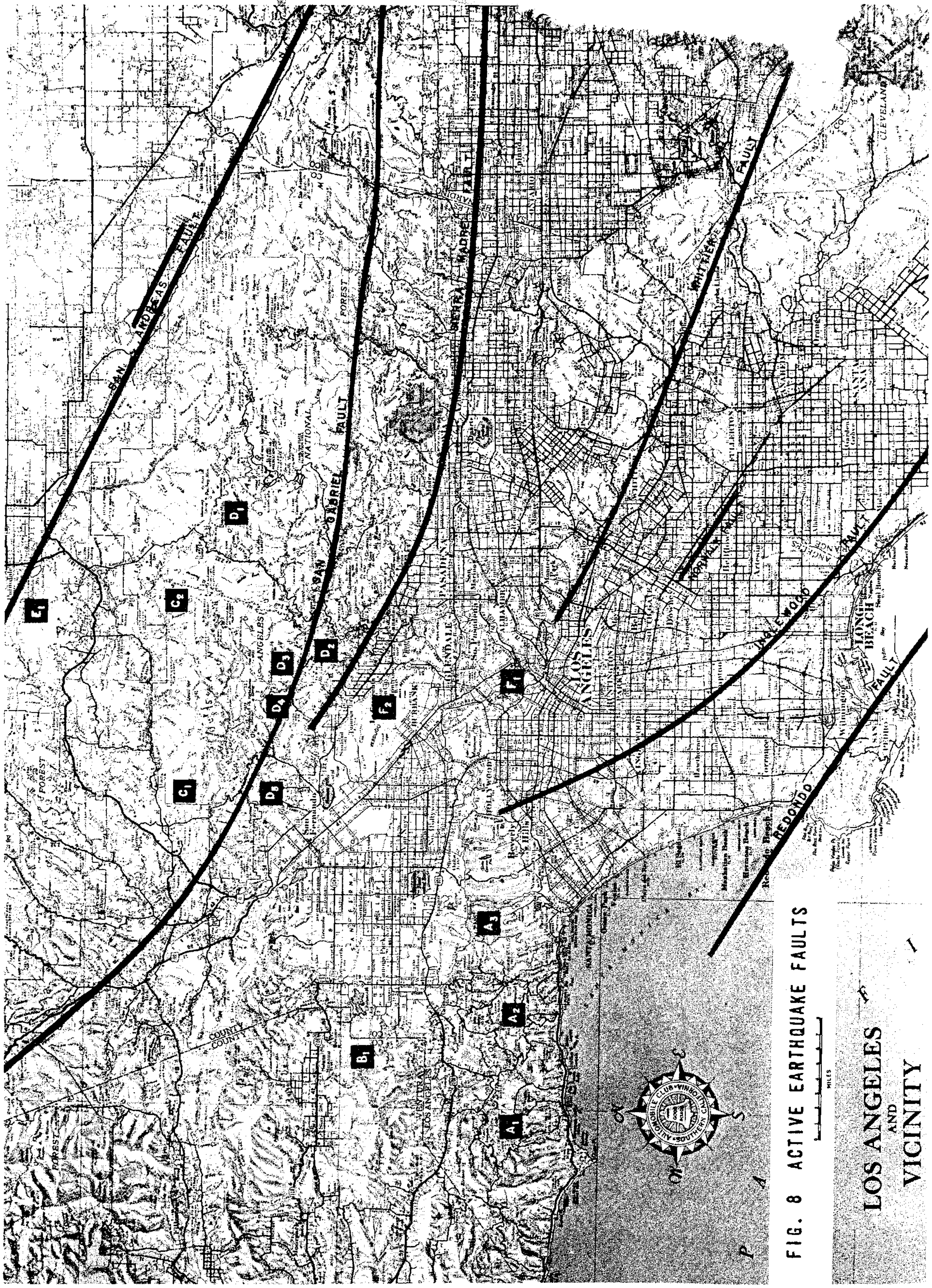


FIG. 8 ACTIVE EARTHQUAKE FAULTS

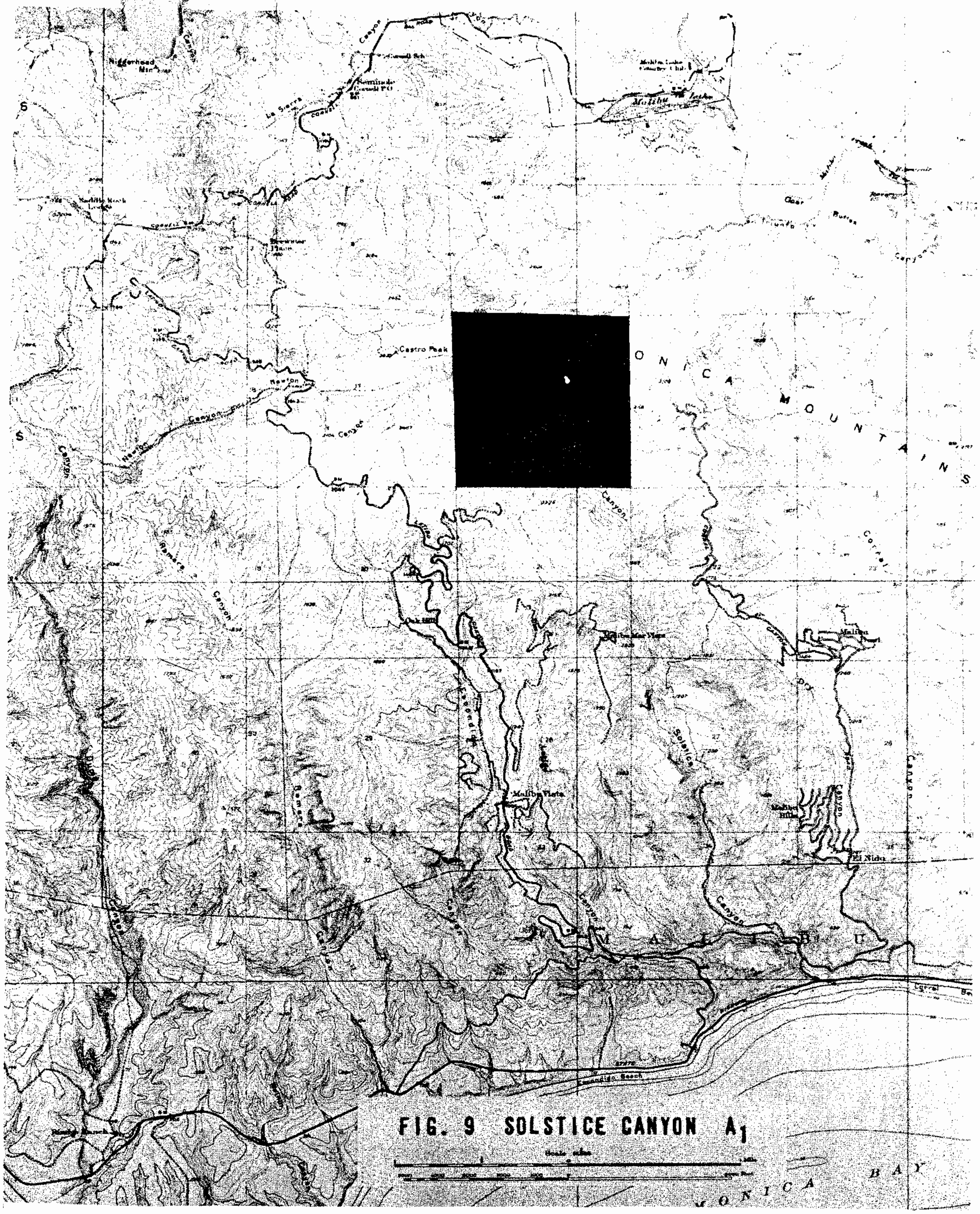


FIG. 9 SOLSTICE CANYON $A_1$

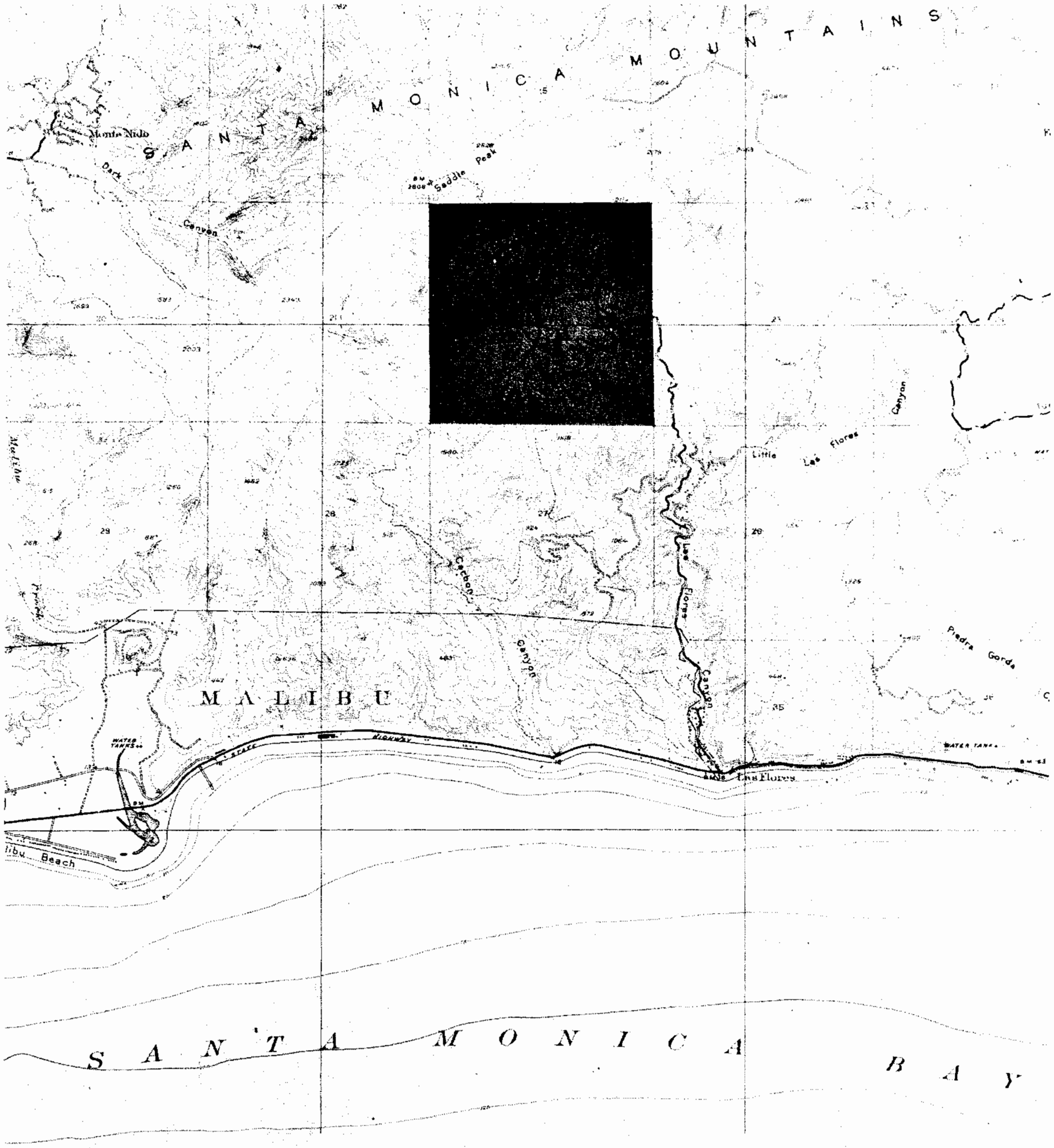


FIG. 10 LAS FLORES CANYON $A_2$

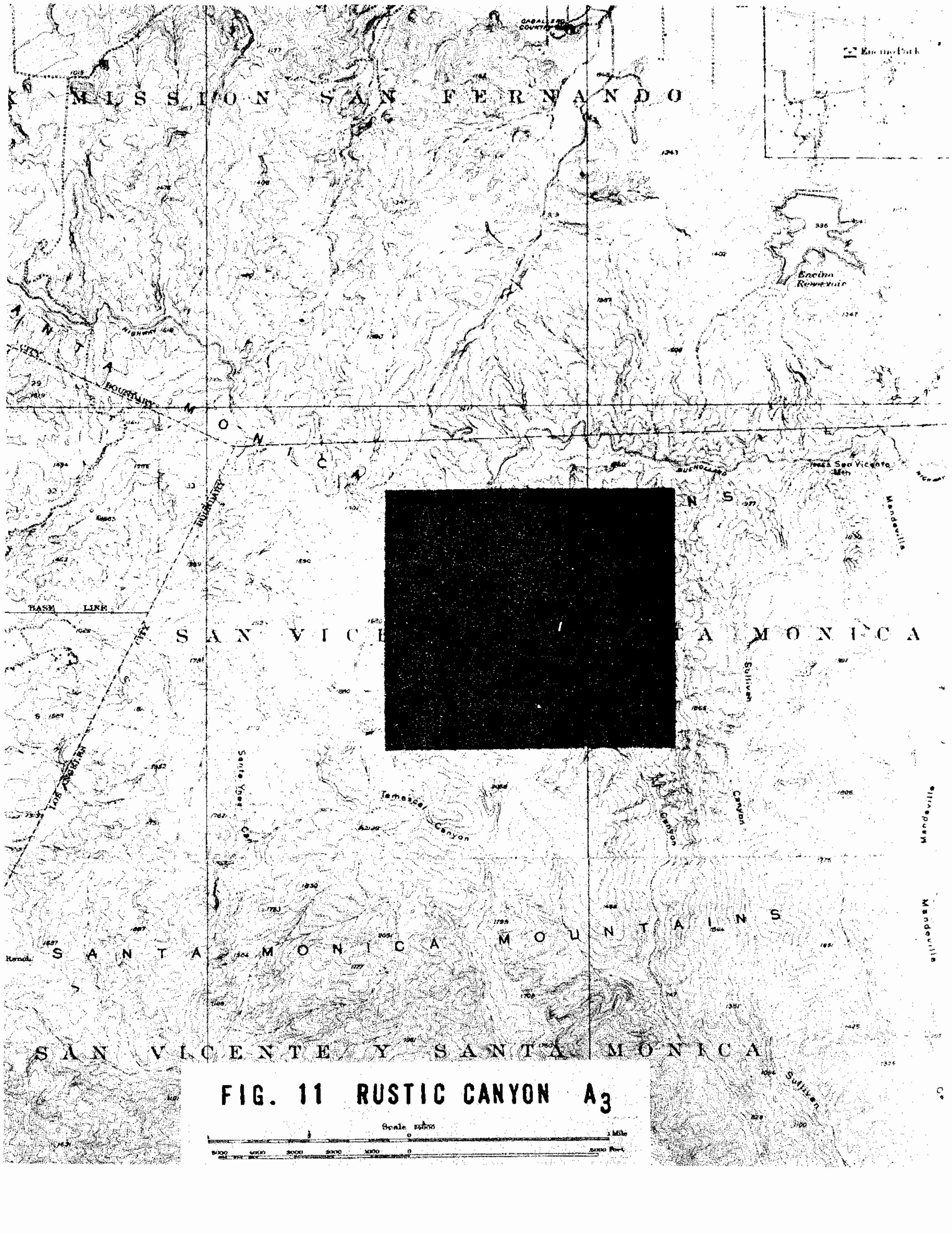


FIG. 11 RUSTIC CANYON $A_3$

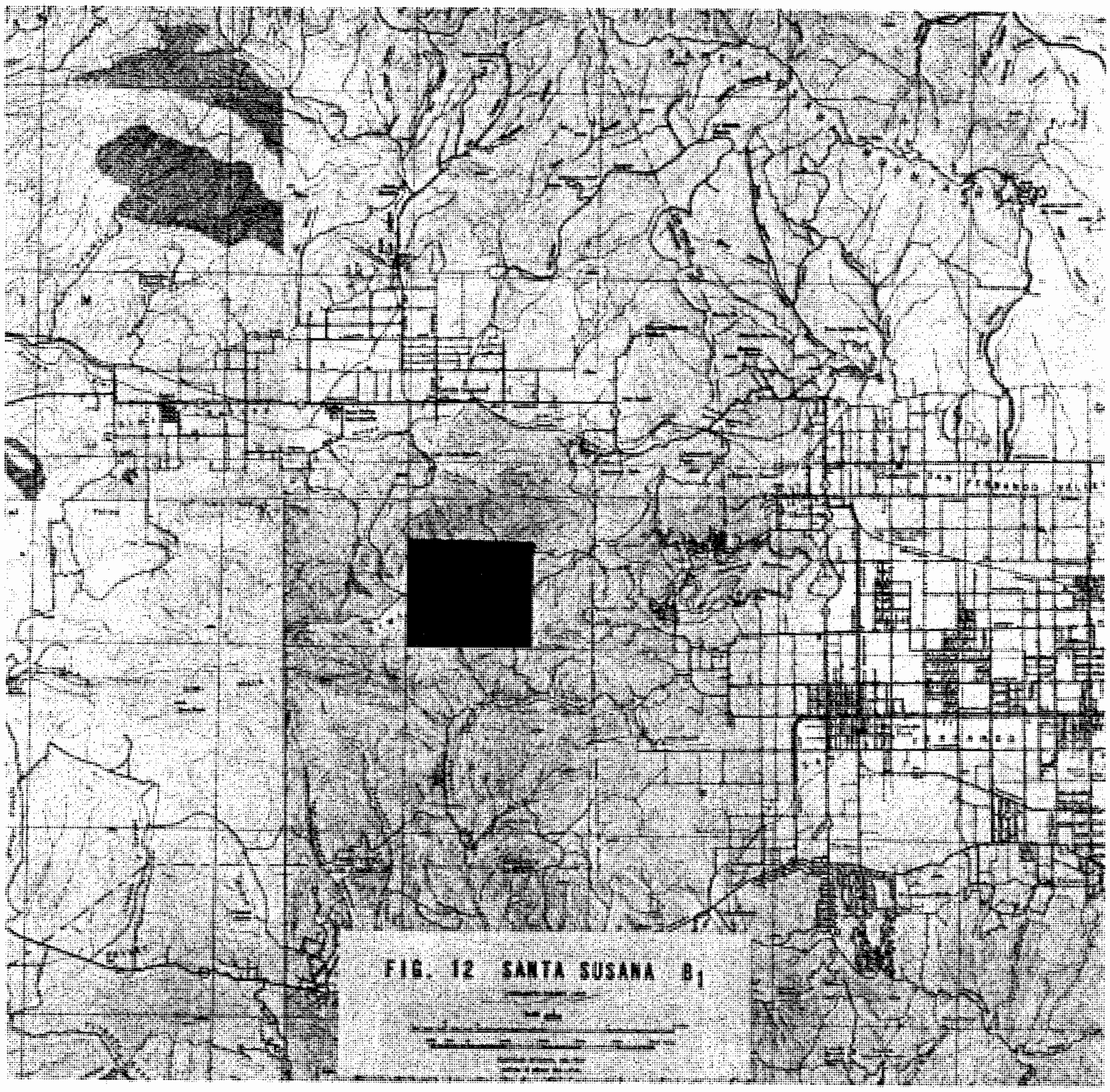

FIG. 12 SANTA SUSANA $B_1$

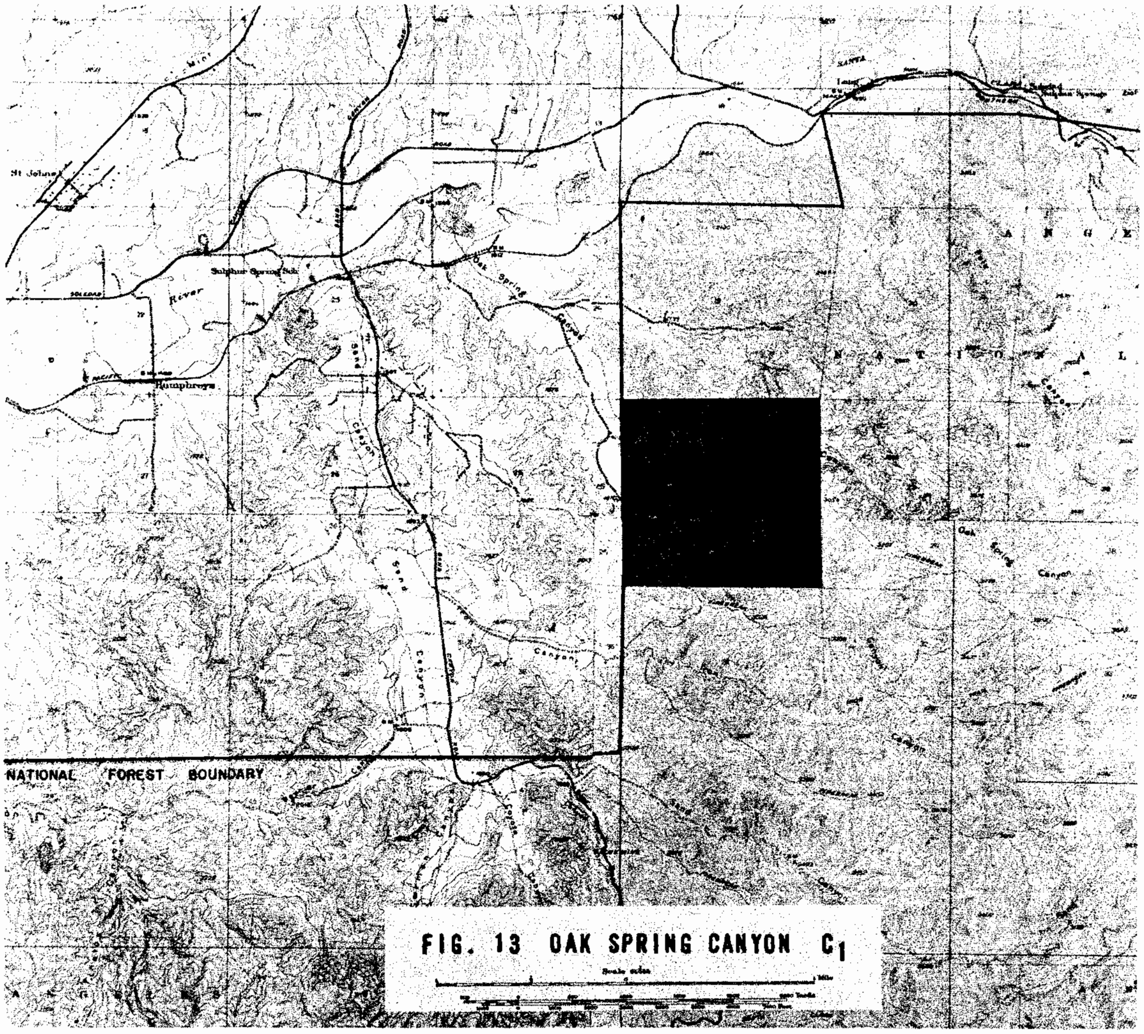


FIG. 13 OAK SPRING CANYON $C_1$

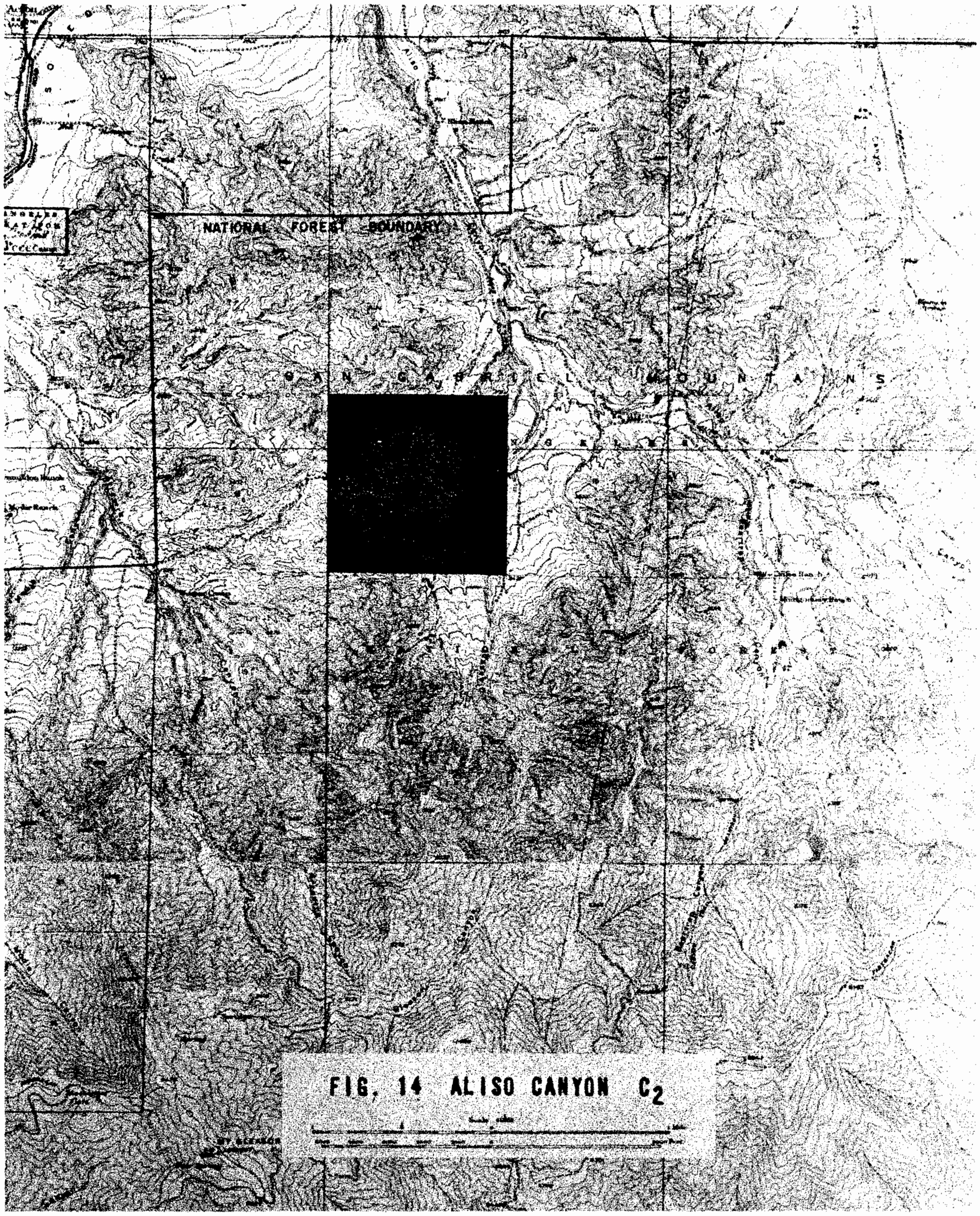


FIG. 14 ALISO CANYON $C_2$

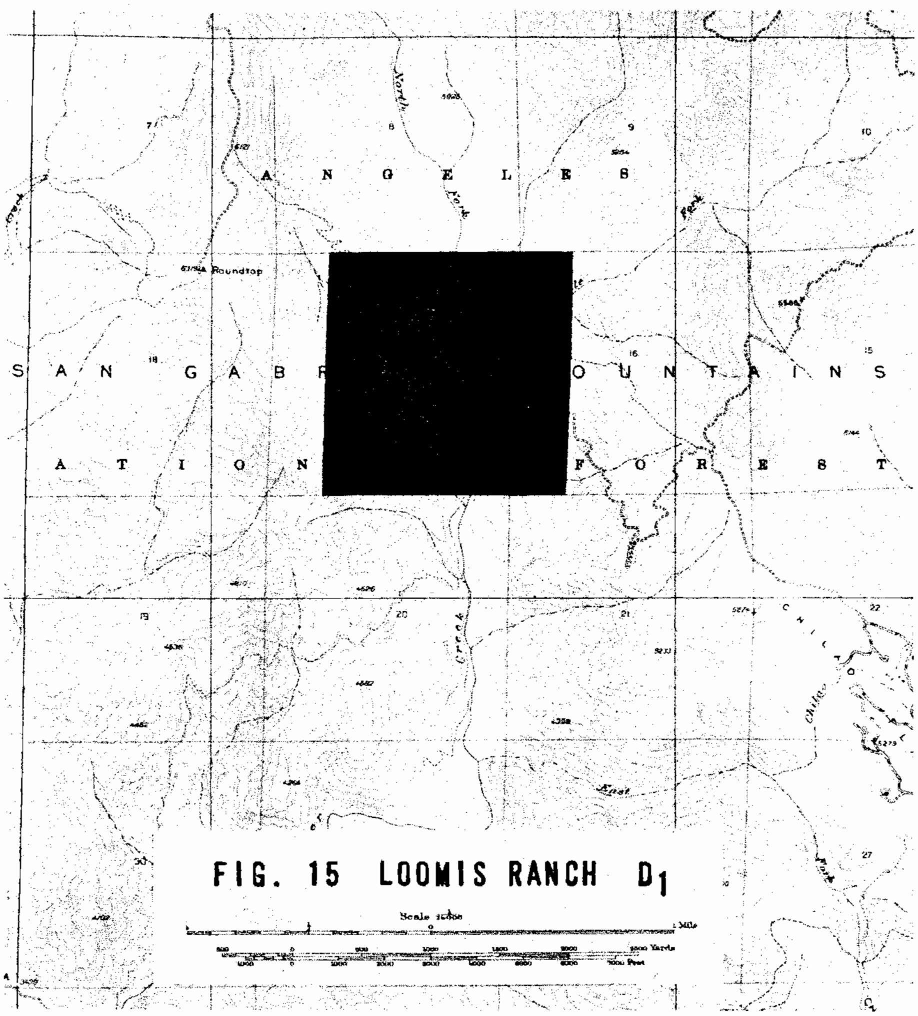


FIG. 15 LOOMIS RANCH $D_1$

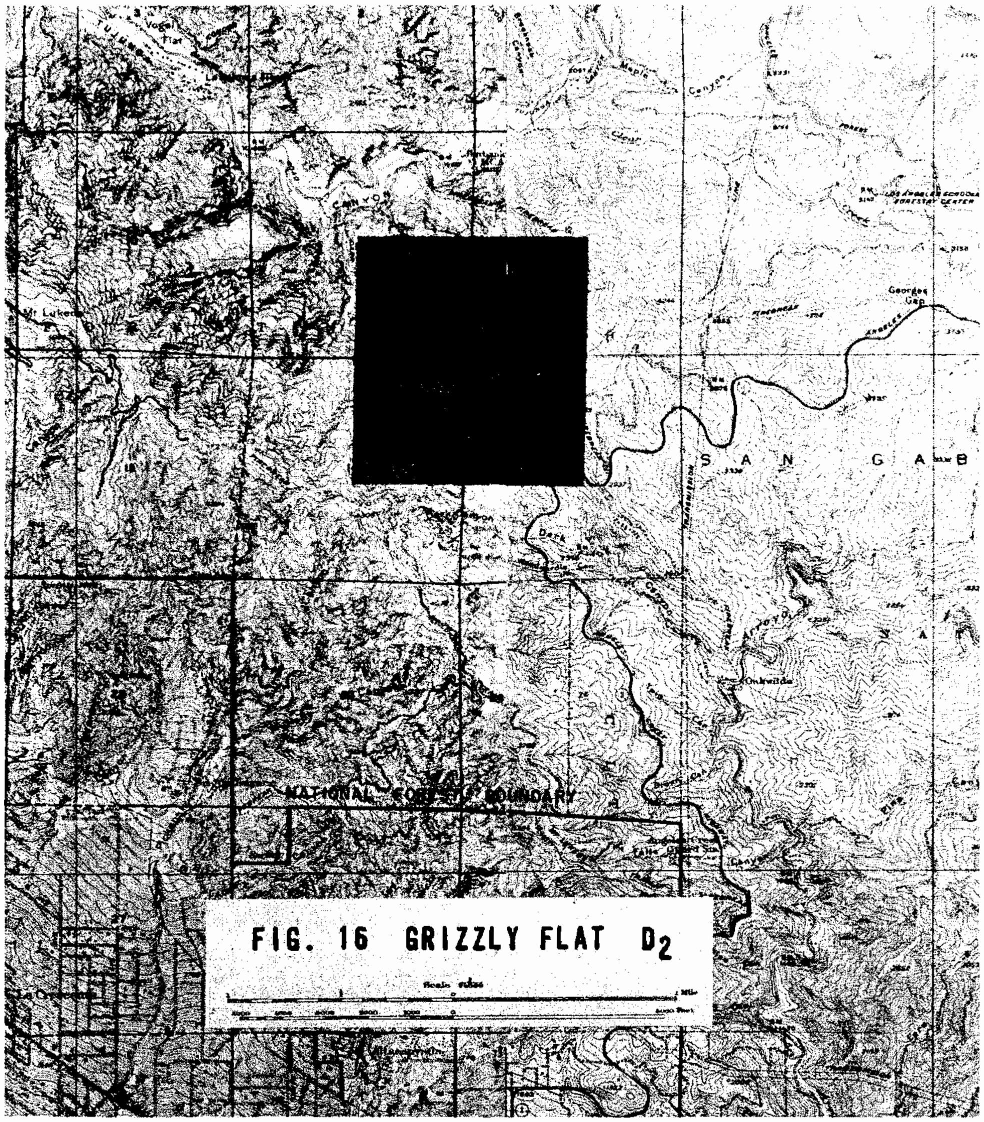


FIG. 16 GRIZZLY FLAT $D_2$

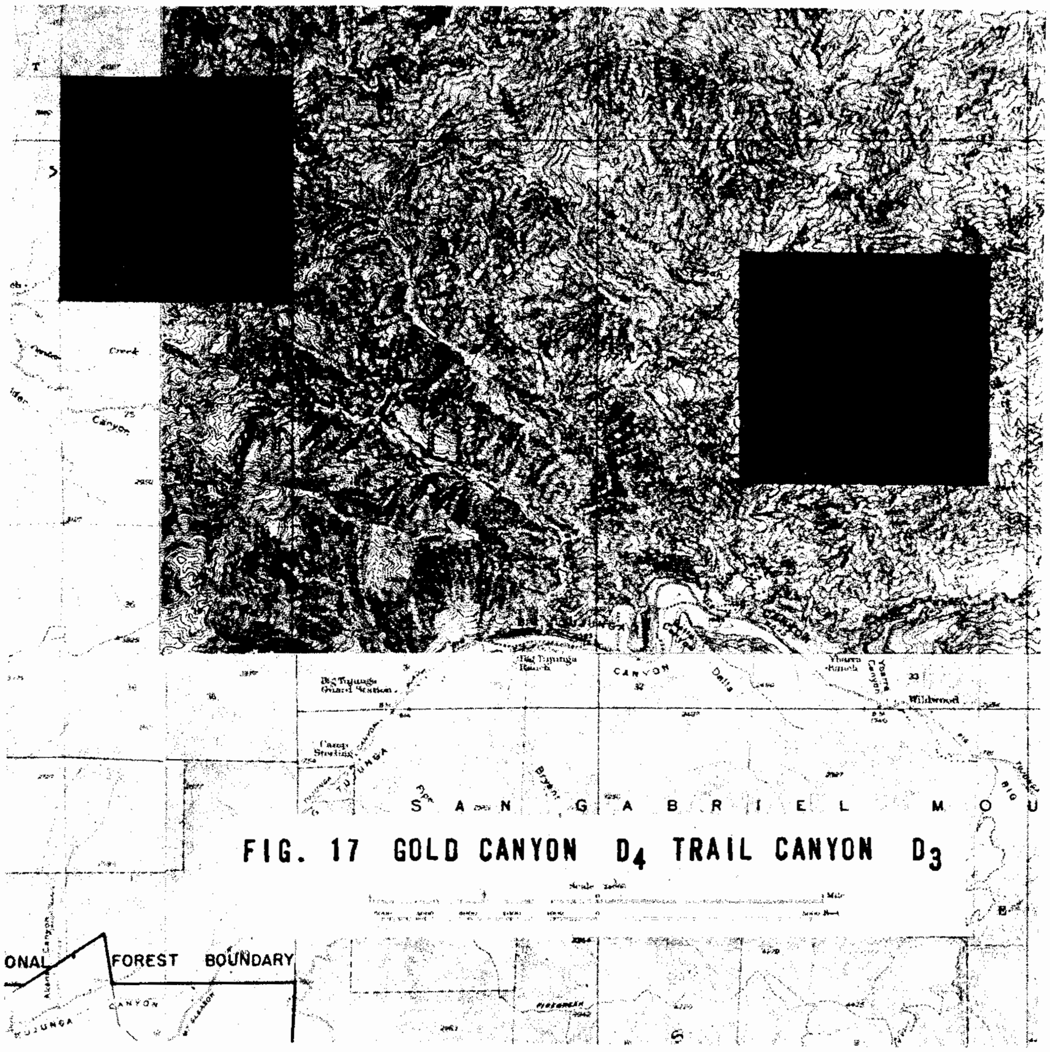


FIG. 17 GOLD CANYON $D_4$ TRAIL CANYON $D_3$

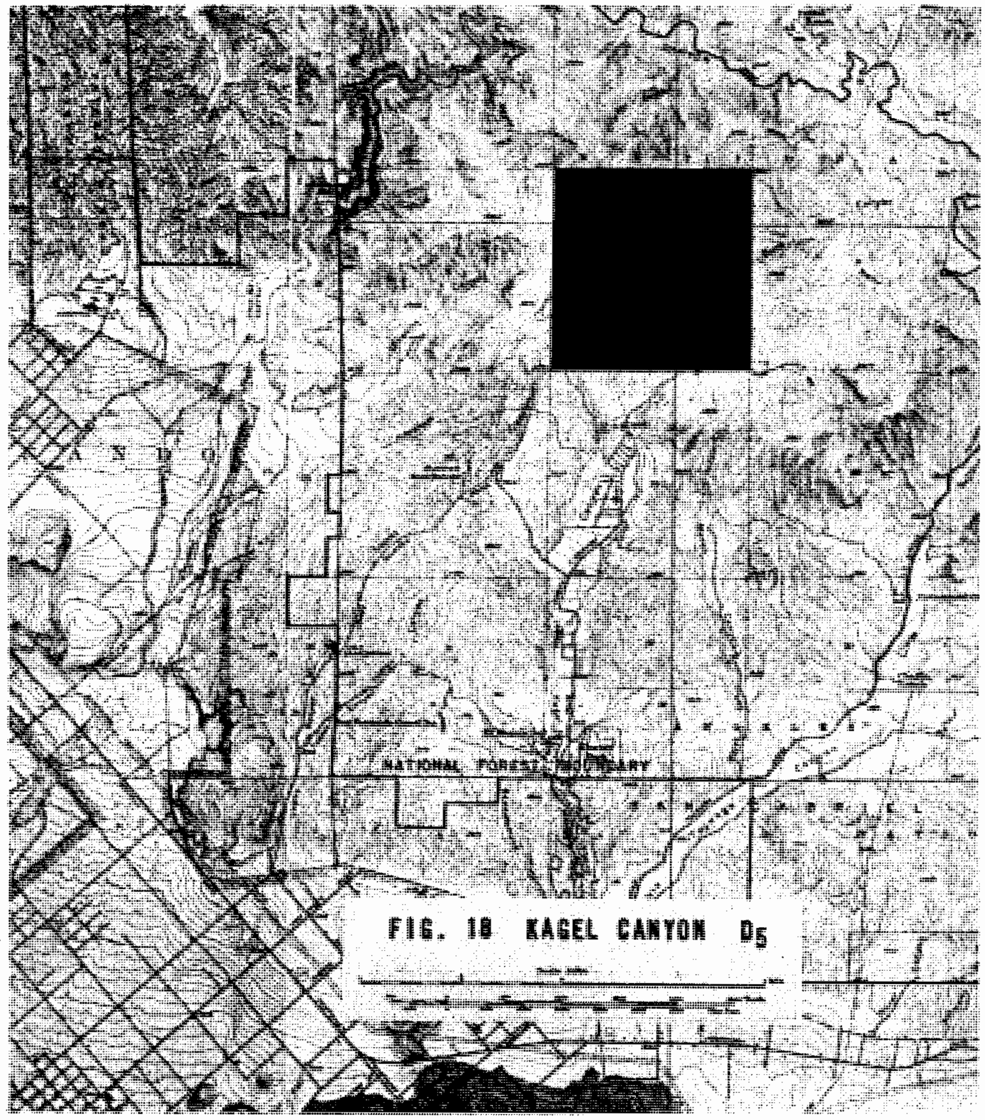


FIG. 18 KAGEL CANYON $D_5$

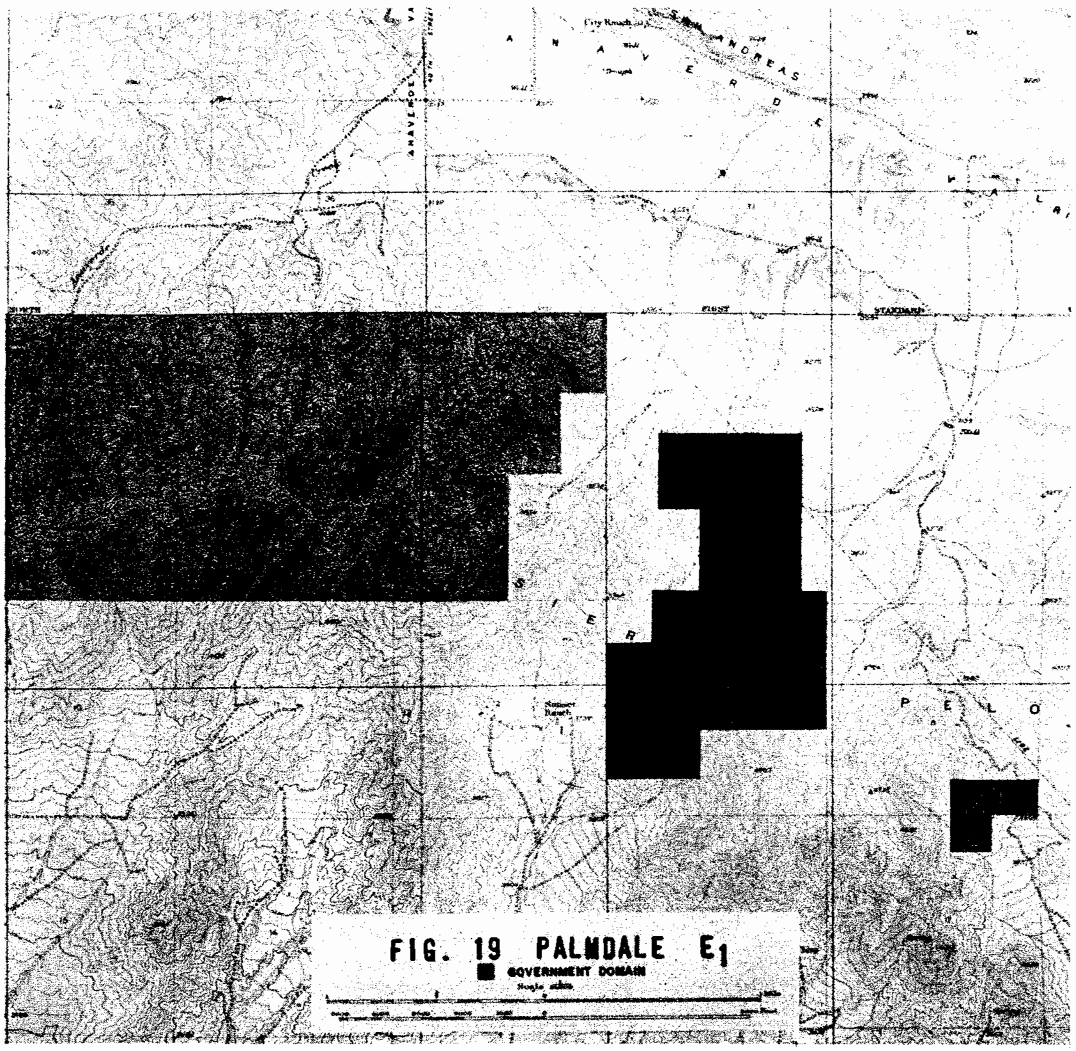


FIG. 19 PALMDALE $E_1$

FIG. 20 ELYSIAN PARK $F_1$

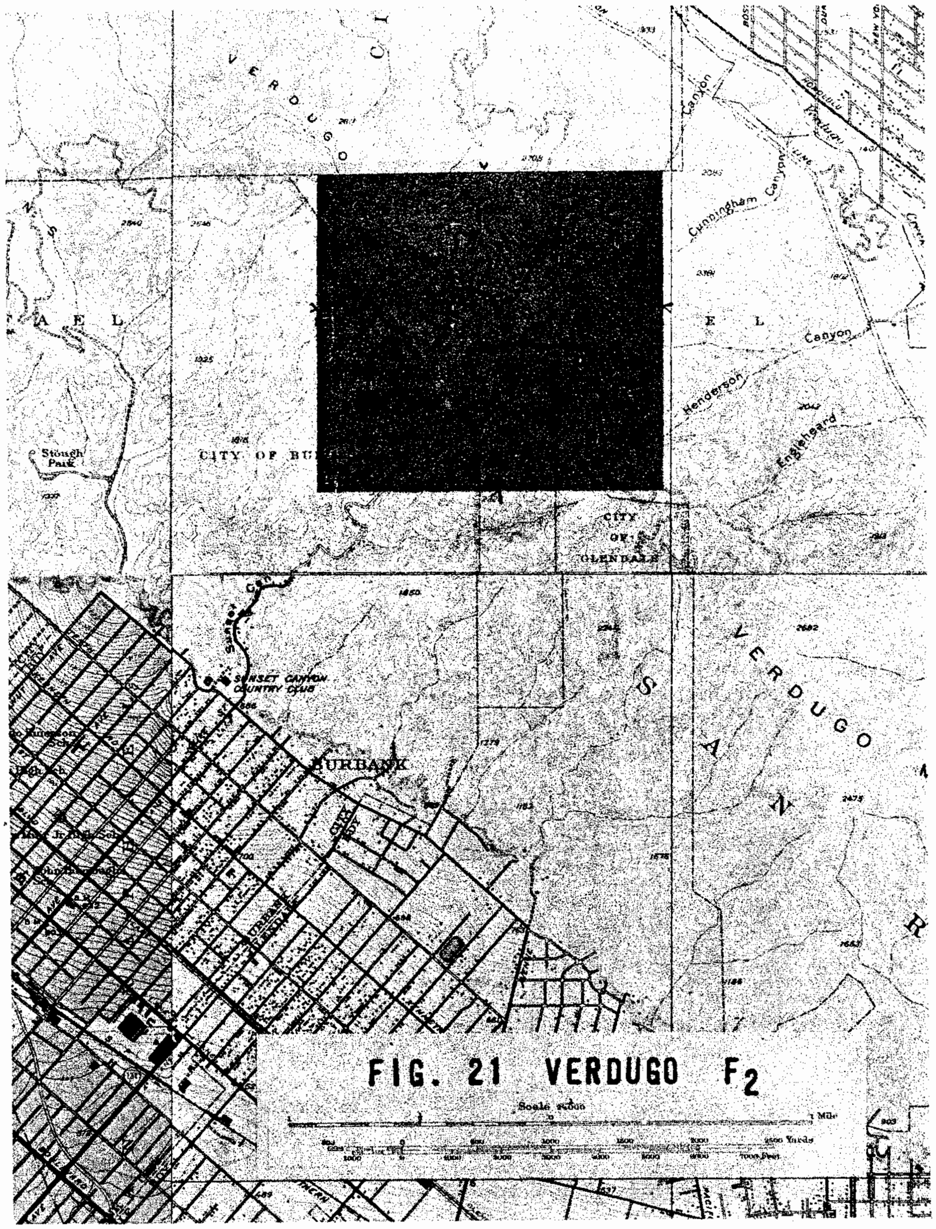


FIG. 21 VERDUGO $F_2$

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