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ABSTRACT

Among the more unusual features pertaining to the environmental sampling program at the Berkeley site of the Lawrence Radiation Laboratory are (1) the difficult climatological situation arising from meteorological factors in conjunction with the hilly terrain; (2) the very close proximity of densely populated areas; (3) the wide range of the research program carried out at LRL. Efforts to overcome these difficulties are discussed and the general scope of the Environmental Sampling Program is briefly described. An air and atmospheric deposition sampling station of unique design is shown.

The advantages of automatic data processing in handling and presenting the large amounts of data collected are discussed. IBM 650 and 1401 computers plus allied equipment are used for rapid and systematic data compilation.

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INTRODUCTION

Before considering our sampling program, let us first examine some of the features of our environment. Figure 1 is a map of the San Francisco Bay Area showing the location of the Berkeley site of the Lawrence Radiation Laboratory and Figure 2 is a view of San Francisco Bay with the Laboratory and the University of California Campus in the foreground. Approximately 3,900,000 people inhabit the Bay Area, most of them living along the western, eastern, and southern margins of the bay.

San Francisco Bay is generally ringed with hills around 1 to 2 thousand feet high, forming a natural atmospheric basin with its attendant smog problem. Winds are most often from the west or northwest.

Surface wind patterns are strongly influenced by the topography. During periods of stable atmospheric conditions and light winds, air tends to channel in through the Golden Gate and leave the Bay Area through the gap to the northeast where the Sacramento River enters, or over low spots in the hills along the eastern side. Figure 3 shows a typical summer wind circulation pattern[1] and illustrates one of our problems. The westerlies tend to split at the Berkeley-Oakland Hills, one branch going north, the other south. The point at which this split occurs is in the neighborhood of our site in Berkeley. Therefore, wind directions recorded at the Weather Bureau stations in Oakland

[1] Halbert E. Root, San Francisco, the Air Conditioned City, Weatherwise, April 1960, pp. 47-54.

and San Francisco are poor indicators of wind conditions in Berkeley.

Another meteorological condition somewhat unfavorable at our site is the high incidence of inversion conditions. On the basis of 5 years of records at the Oakland Airport, 40% of the time the lapse rate is unfavorable for atmospheric diffusion at our particular location.[2] Conditions are deemed unfavorable whenever the Laboratory is in the inversion or just below it. Under these conditions there is little turbulence, and any contaminants released to the atmosphere tend to hang together at the elevation at which released.

Figure 4 shows a cross section through the Berkeley Hills. The Laboratory is at an elevation of about 700 to 900 feet on the western slope. The city of Berkeley extends from the Bay to an elevation a little above the Laboratory to the north and to the south. Figure 5 shows the same cross section, but superimposed upon it, to the same vertical scale, are typical lapse-rate conditions. Figure 6 is an aerial view of the Laboratory, showing its relation to residential areas.

Another feature of the Laboratory important in the environmental survey program is the extremely wide scope of research carried on. Any nuclide in the entire chart may be involved--all the way from tritium to lawrencium, element 103.

There are no reactors at Berkeley. However, pile-irradiated slugs from Livermore, Vallecitos, and the MTR are a major source of isotopes. Other major sources are bombardments on the various accelerators at Berkeley and purchases from Oak Ridge.

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[2] Humphreys and Wilkins, Diffusion and Engineering Climatology for the Berkeley Radiation Laboratory (A Preliminary Report), Scientific Services Division U.S. Weather Bureau, December 1953.

ATMOSPHERIC SAMPLING

The first point at which we sample for possible release of contaminants to the atmosphere is at the exhaust stacks themselves. The various laboratory rooms are individually exhausted. Our program is designed to sample every one of these--some 350 in all--on a weekly schedule. (At present only those with the most serious potential for release of activity are being sampled, although construction of the complete sampling system is under way.) The great advantage here is that if one of these samples should show a significant amount of radioactivity, it would be possible to inquire into what work was being carried out in the corresponding room at that time--leading usually to only a few nuclides that could possibly be present. With only a few possibilities, it is generally quite easy to identify the particular one. Another advantage in sampling close to the source is that that is where the concentration is highest and detection easiest.

Stack samples are taken at 1 liter per minute with 1-inch-diameter membrane filters, which are changed weekly. In sampling stacks where radioactive gases might be released, we include activated carbon in the sampler. We have been able to purchase a product composed of activated carbon and a binder pressed into a disc about 1/8-in. thick. This serves the purpose quite well for the more reactive gases, particularly halogens. Figures 7 and 8 illustrate some typical stacks and the process of changing samples.

These stack samples are our primary source of information concerning any release of activity to the atmosphere. We do, however, take two other types of atmospheric sample--perimeter samples and what we call "local area" samples, which are samples of outdoor air on the Laboratory site. These two additional types of sample provide us with a "defense in depth," and also provide that most essential bit of information, the quality of the actual air our nearest neighbors are breathing. Calculated and derived information is nice, but there really is no substitute for direct measurement. Local-area samples are collected at nine places, as shown in Figure 9.

The design of these sampling stations has proved quite efficient. Essentially it is a sheet metal cylinder with a perforated metal bottom. Figure 10 shows a sampling station with its air sampler installed inside. Air is drawn in from below the housing through a tube and is sampled with a modified "Filter Queen" vacuum cleaner at 4 cfm through a 4 x 9-in. piece of HV-70 paper.

A solid partition about a foot below the top forms a recess which serves as the rain collector. This recess is lined with a polyethylene bag which is completely removed and replaced with a new one whenever the sample is collected. With this system there are no worries about cross-contamination.

A 2-in. pipe flange in the base of the housing serves as a universal mount. Installation of one of these stations requires only the setting of a length of pipe in a post hole and running electrical conduit to it.

Figure 11 shows the location of the perimeter stations. Locations were chosen to be downwind from the Laboratory and also to be in the direction of our nearest neighbors where possible. Atmospheric sampling equipment in these is the same as for local-area samplers, although at these locations it is installed in small buildings.

WATER SAMPLING

We are more favorably located with respect to possible contamination of drinking water systems. There are no nearby sources of drinking water. Water for most of the Bay Area is piped in from the Sierra Nevada, more than 100 miles away. The sanitary waste from the Laboratory is discharged to the local municipal sewer system and, after treatment, flows into San Francisco Bay.

The storm drains flow directly into the Bay by way of two small creeks. For the most part this water is in culverts underground as it travels through the city of Berkeley and is generally not available for any kind of public use.

There are ways, of course, for liquid waste to get into the food cycle. The sludge from the sewage treatment plant might be used in fertilizing crops, and also, some fish are caught in San Francisco Bay. The general situation, however, is much less sensitive than at AEC sites located on rivers that are used downstream for domestic water supplies.

A continuous sample is withdrawn from the waste from those Laboratory areas which constitute the most serious potential for discharging contaminants to the sewer system. Work is currently under way on a continuous sampler for the entire waste system of the Laboratory.

Eight nearby creeks, some quite small, are sampled at certain intervals. The one that flows through much of the Laboratory area and comprises the major part of the storm drain system is sampled every week. The two most remote creeks are sampled once a month. All other creeks are sampled every two weeks. Creek sampling points are shown on Figure 11.

COUNTING AND DATA PROCESSING

Air samples taken in the environmental sampling program are identical to the large number of breathing-zone samples that are taken throughout the Laboratory, and are handled in the same way. Most of these are 4 x 9-in. pieces of HV-70 filter paper. The automatic counter for these papers, developed by Health Chemistry's Instrument Group, handles the major part of the counting load in our low-level counting room. Filter papers are counted twice for both beta and alpha emitters: once after 5 hours' decay and finally after 3 days' decay. A similar piece of equipment is being built to handle the expected large increase in the number of membrane filters from the expanded stack-sampling program.

The counting load for water samples is considerably less. These samples are counted manually at present for both beta and alpha activity.

In counting samples, both air and water, we rely almost exclusively on gross counting. Because of the earlier mentioned wide scope of the Laboratory's research program, it seems futile to try to make specific isotope assays a part of our routine program of counting. In the event any sample is significantly higher than expected background, we first inquire into what isotopes might be suspected, based on the research program at the source of the sample, and hope to identify the particular isotope with gamma or alpha pulse-height analysis, half life, and perhaps beta energy studies. If these efforts fail to identify the isotope beyond reasonable doubt, Tables 3 and 4 of NBS Handbook 69, MPC's for unidentified nuclides, are used in evaluating the hazard.

All counting data from all samples are processed by an automatic data-processing system based on either the IBM 650 or 1401 computer. At the time the samples are changed, IBM cards with the sample location prepunched are filled in with time-on and time-off data. After key punching, duplicates of these cards are generated and sent to the counting room. The counting data are then entered on each card, and after this is key punched the card is sent to the computer center where the air or water concentration is computed and printed out in orderly fashion on log sheets.

Before this automatic data processing system was adopted, only the raw gross counting data were entered in the records. The present system, besides presenting the data in far more useful form, has resulted in an actual saving in manpower.

By use of an automatic data-processing system, together with automatic filter-paper counting, one capable technician is able to make something over 80,000 counting determinations per year, besides doing all the counter reliability checks, data recording and special counting analyses where necessary.

CONCLUSION

In closing, we would like to mention a couple of basic principles under which we operate and which we feel are quite important. The first thing to keep in mind is that in an environmental sampling program we are in effect auditing our own books. We are making certain measurements of air and water in the vicinity of our Laboratory, exhibiting these to the public as proof that the community is not in any way being injured by our presence. It would be perfectly natural for the public to exhibit some skepticism toward this information. The extent to which anyone is willing to accept our findings depends a great deal on the general reputation of our institution. But it also depends to a considerable degree on the professional standing of the people who make the measurements and make the interpretations. Here is an area in which all Health Physicists must live up to the very highest professional standards.

Another fact to be borne in mind is that it is impossible to absolutely <u>prove</u> that the nearby public is never subjected to any hazardous amounts of radioactivity from our institution. No matter how many samples we take, nor how closely our sampling sites are spaced, there is always the possibility of missing something. This possibility can be made extremely small--at tremendous expense--but it never vanishes. So, the practical approach is to make sure our program is honestly designed to detect radioactivity where it would most likely be found in case of a release and where the consequences would be the most serious. Mistakes and oversights can never be completely eliminated. The essential thing is to make sure they either are unbiased, or are biased toward being on the safe side.

ACKNOWLEDGMENTS

Although environmental sampling as a full-fledged program at Berkeley is relatively new, much work by many people has gone into its development. Mr.

M. D. Thaxter in particular should receive the major credit for the establishment of this program. Mr. Jensen Young has developed much of the sampling equipment. Also we would like to mention Erich Berthold, whose idea originated the design of our local-area sampling stations.

Our most important product is accurate and reliable counting data. For this, credit is due Marilyn Bailey, who so conscientiously and uncomplainingly performs all the myriad counting and recording chores.

FIGURE CAPTIONS

Figure 1. San Francisco Bay Area.

Figure 2. View of Bay Area; Lawrence Radiation Laboratory and University of California Campus in foreground.

Figure 3. Typical summer wind circulation pattern.

Figure 4. Cross section through Berkeley Hills.

Figure 5. Typical lapse rates and frequencies of occurrence.

Figure 6. Aerial view of Laboratory, looking eastward.

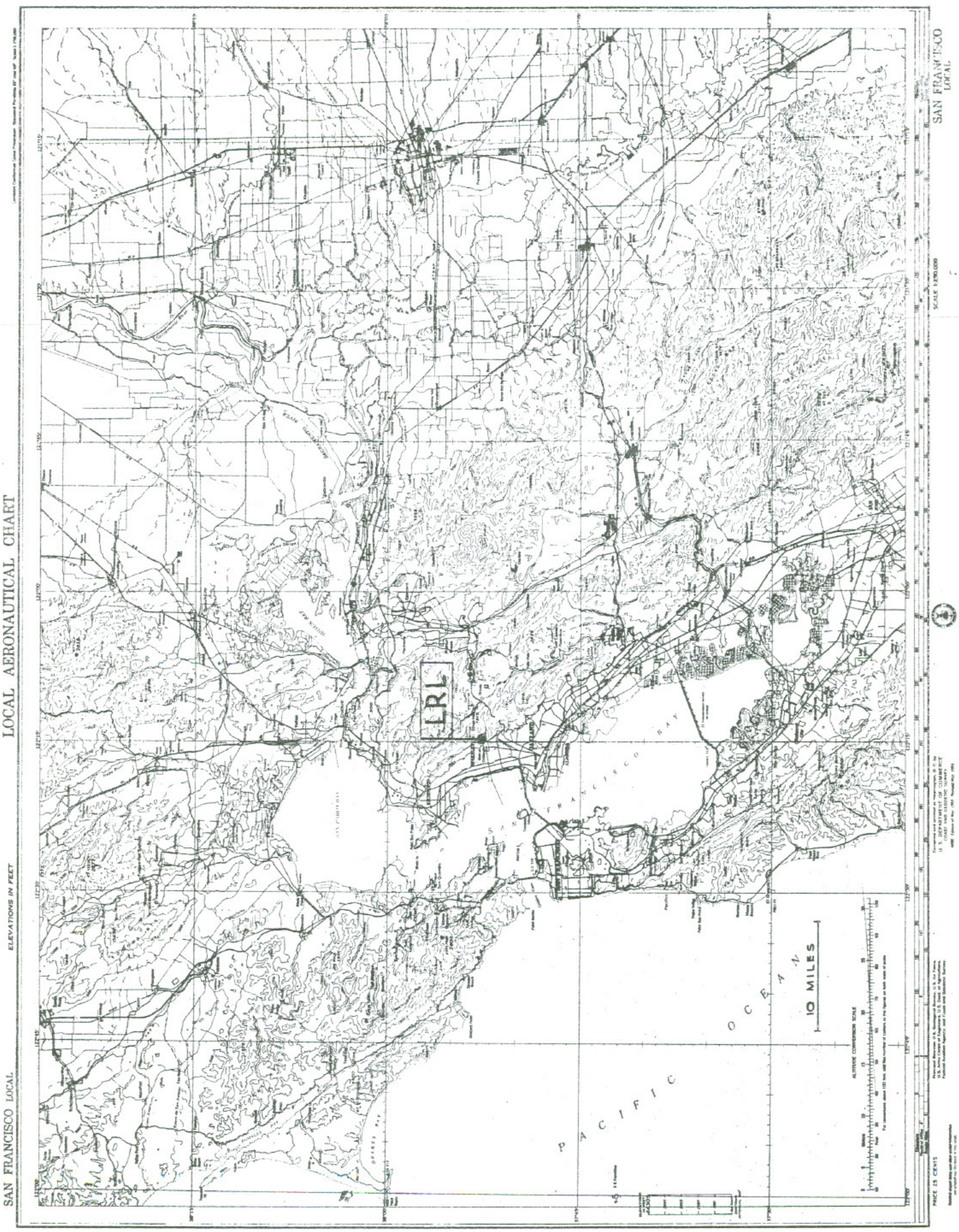
Figure 7. Berkeley box exhaust manifolds.

Figure 8. Stack sampler installed on hood exhaust duct.

Figure 9. Local area-sampling sites.

Figure 10. Local area-sampling station.

Figure 11. Perimeter air sampling sites and surface water sampling sites.


SAN FRANCISCO LOCAL
ELEVATIONS IN FEET
LOCAL AERONAUTICAL CHART
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PACIFIC OCEAN
10 MILES
SAN FRANCISCO
LOCAL
PRICE 25 CENTS

Fig. 1

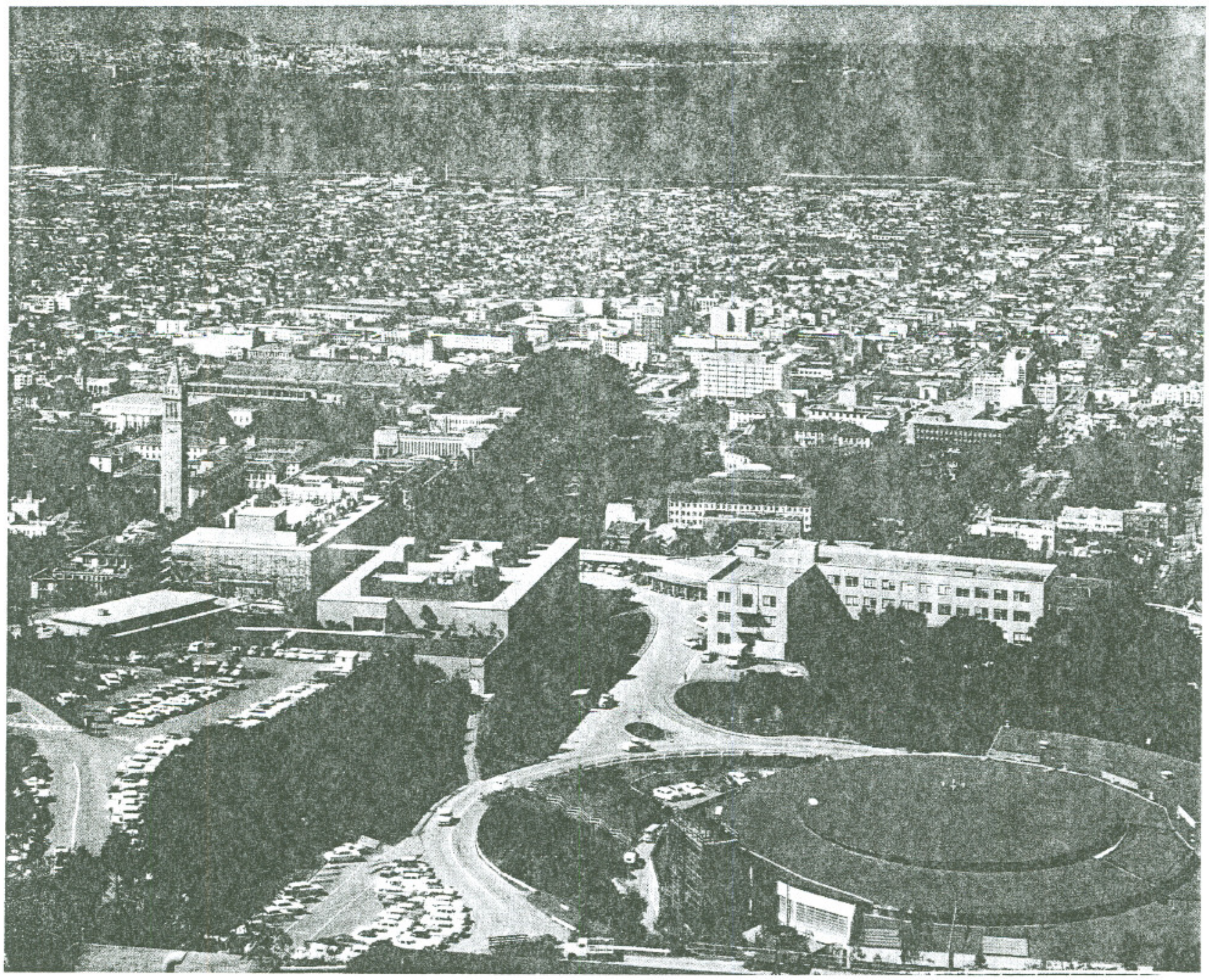

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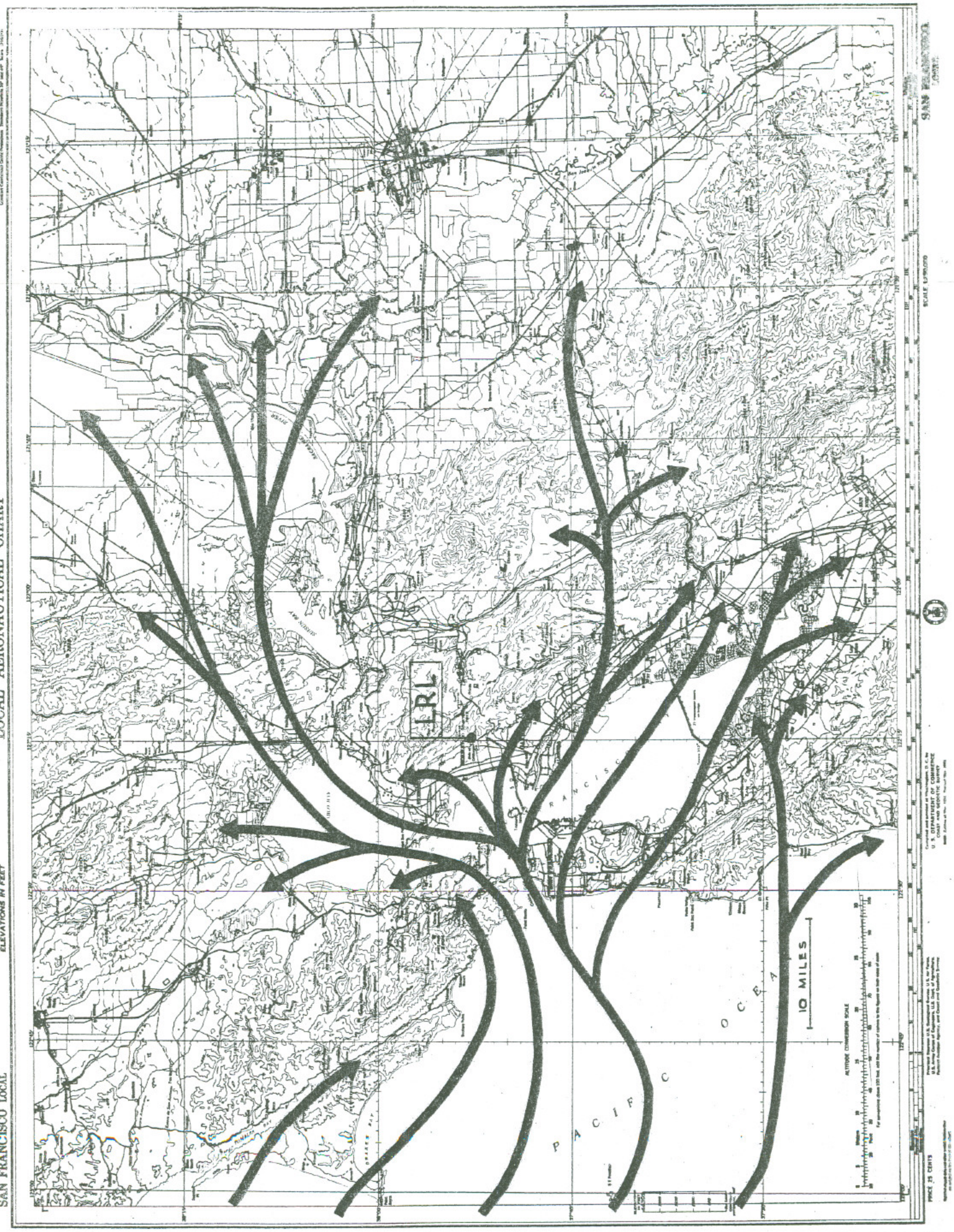
Fig. 2


SAN FRANCISCO LOCAL
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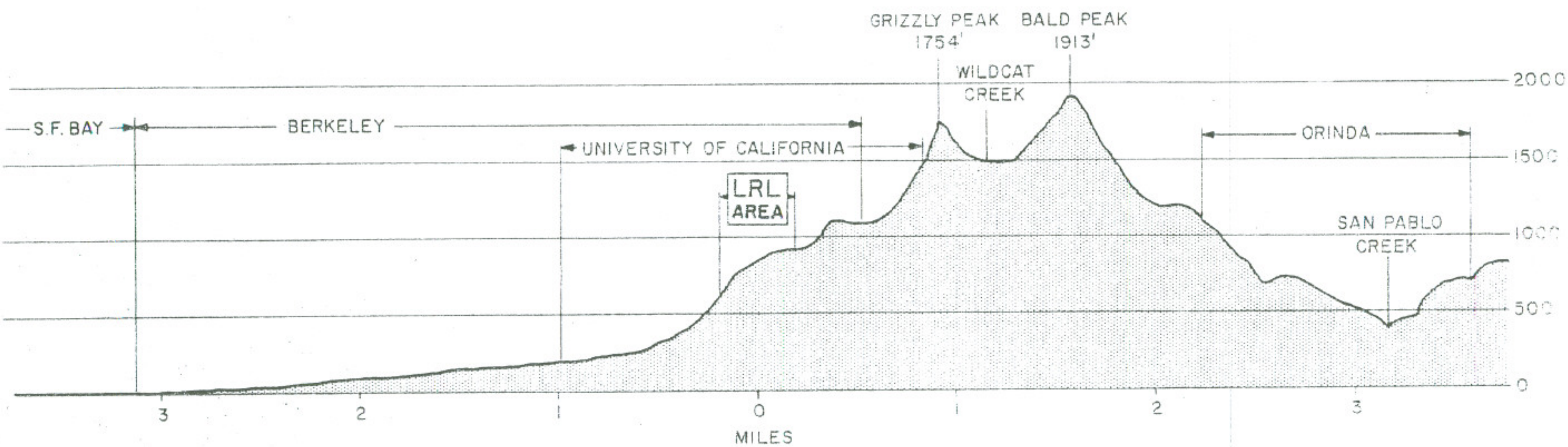
CROSS SECTION THRU LAWRENCE RADIATION LABORATORY

FROM SAN FRANCISCO BAY TO ORINDA



CROSS SECTION THRU LAWRENCE RADIATION LABORATORY
FROM SAN FRANCISCO BAY TO ORINDA

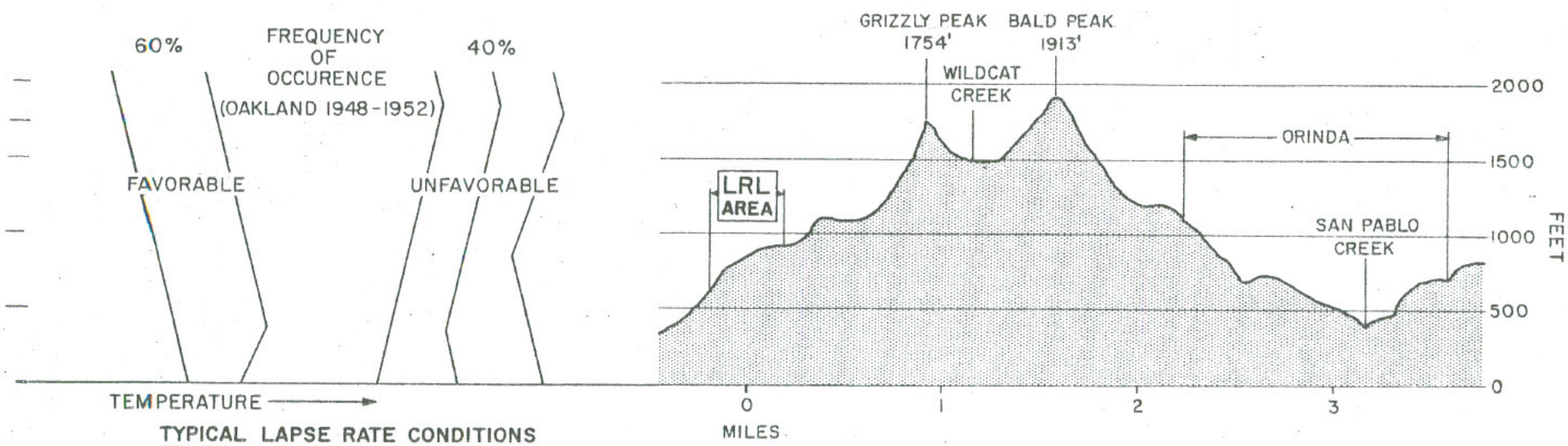


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Fig. 6

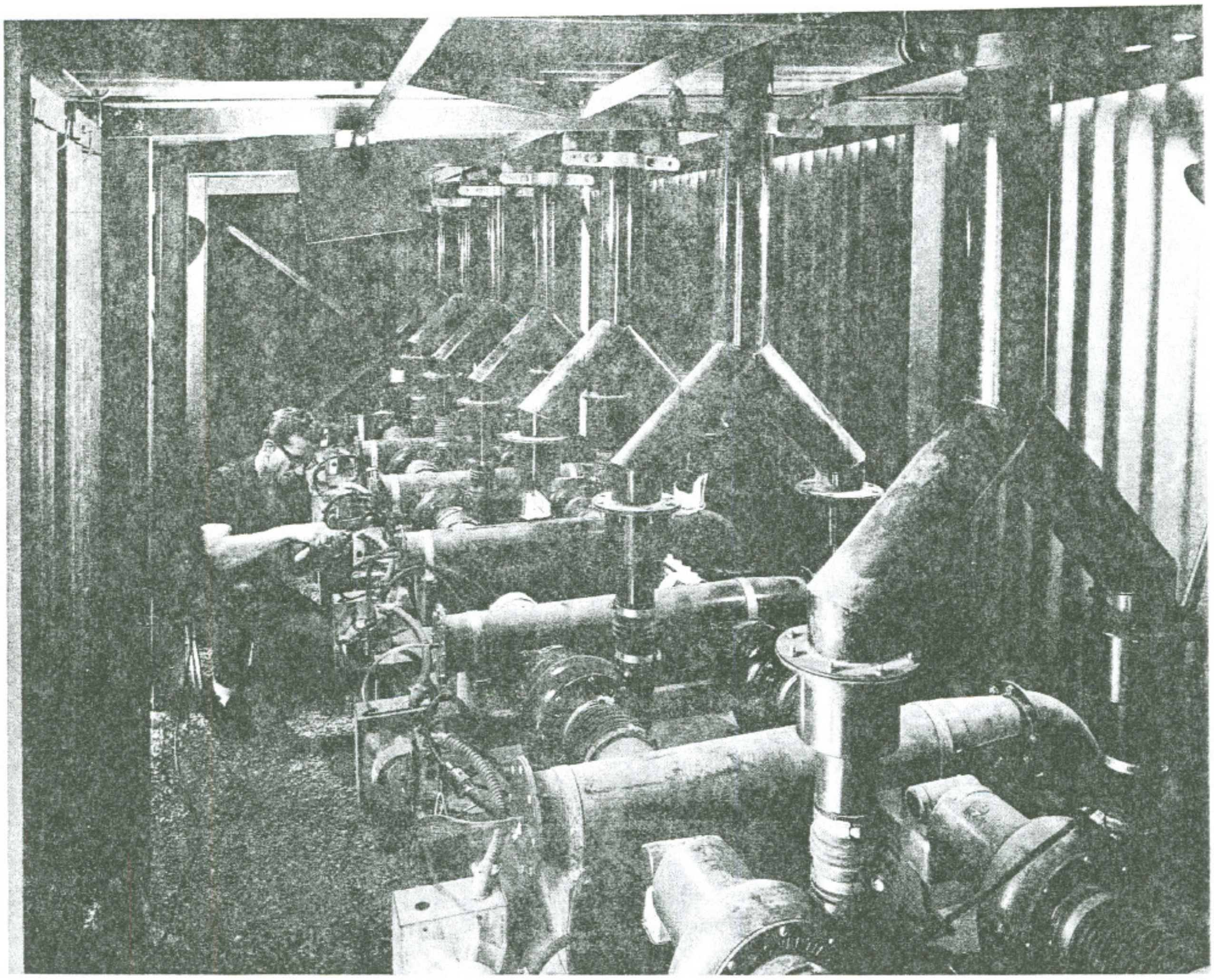

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Fig. 7

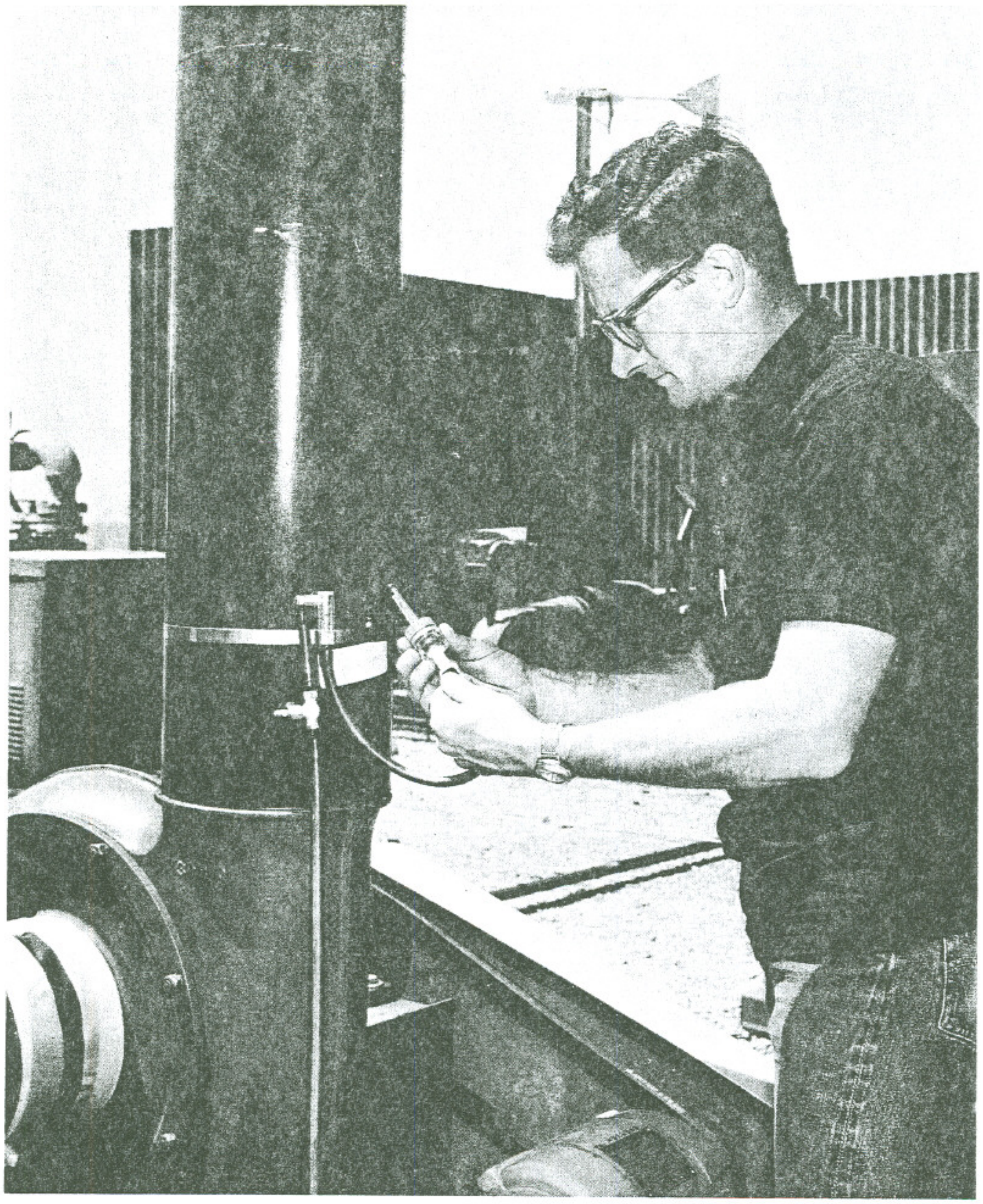

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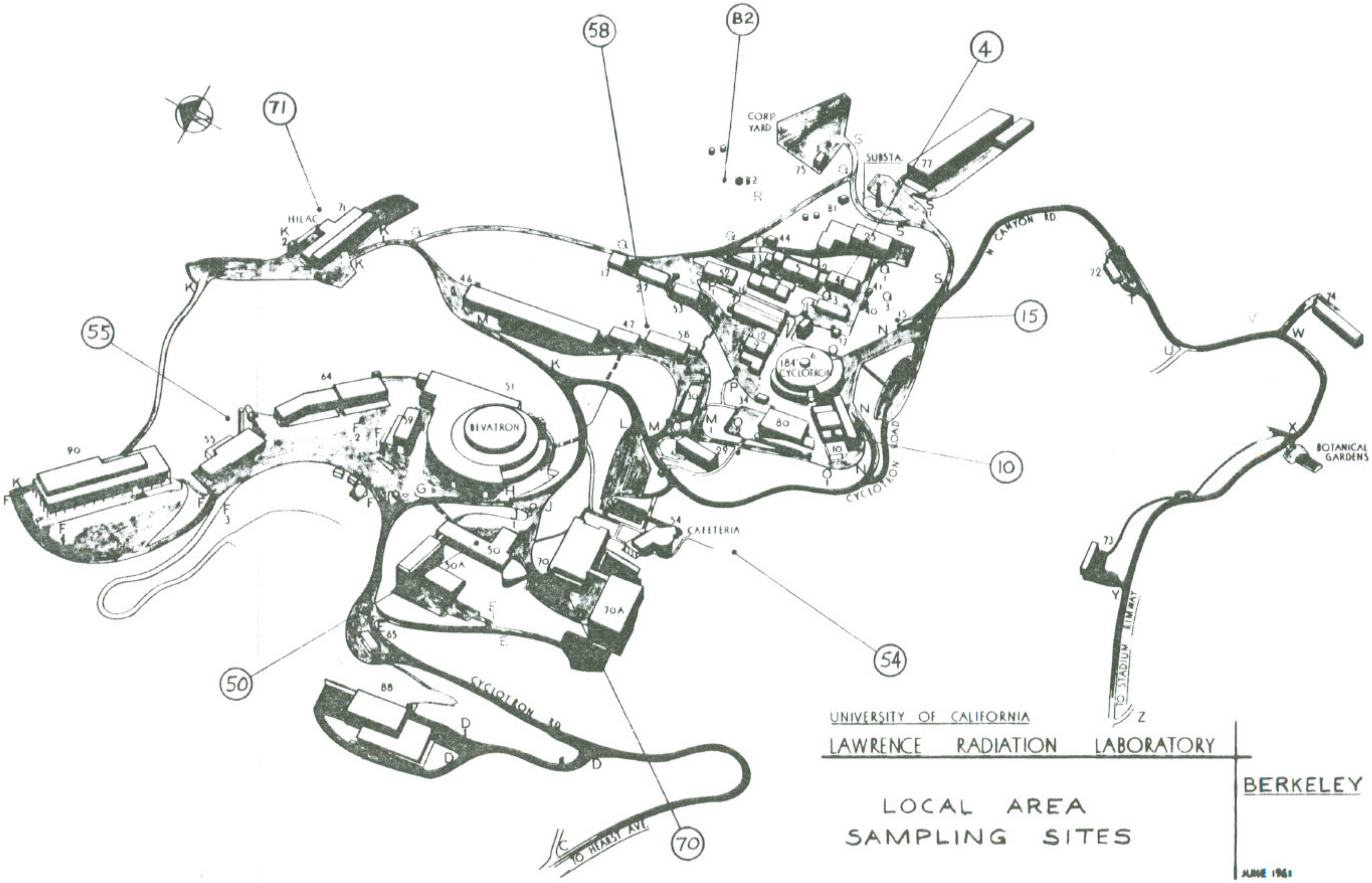
Fig. 8



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LAWRENCE RADIATION LABORATORY

BERKELEY

LOCAL AREA SAMPLING SITES

JUNE 1961

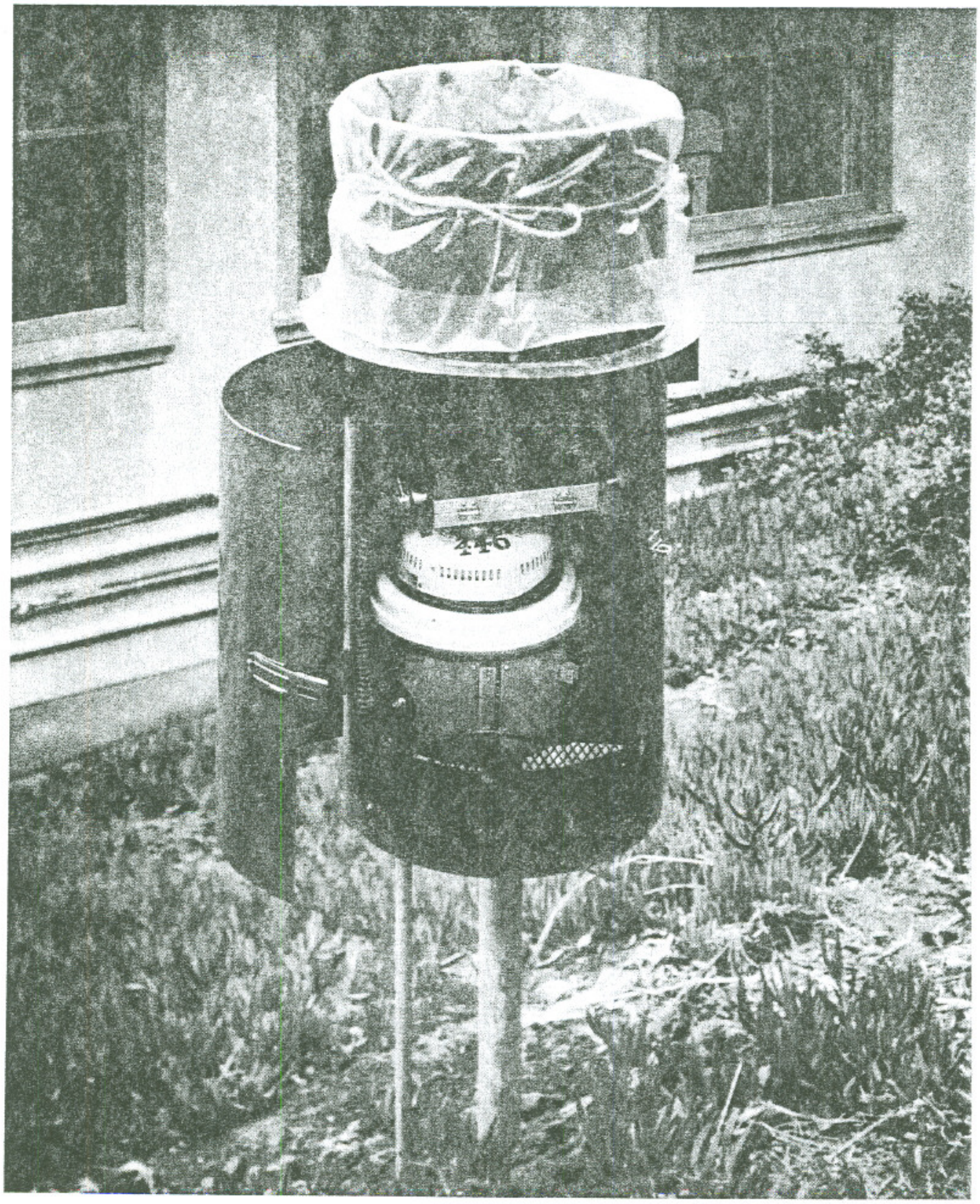

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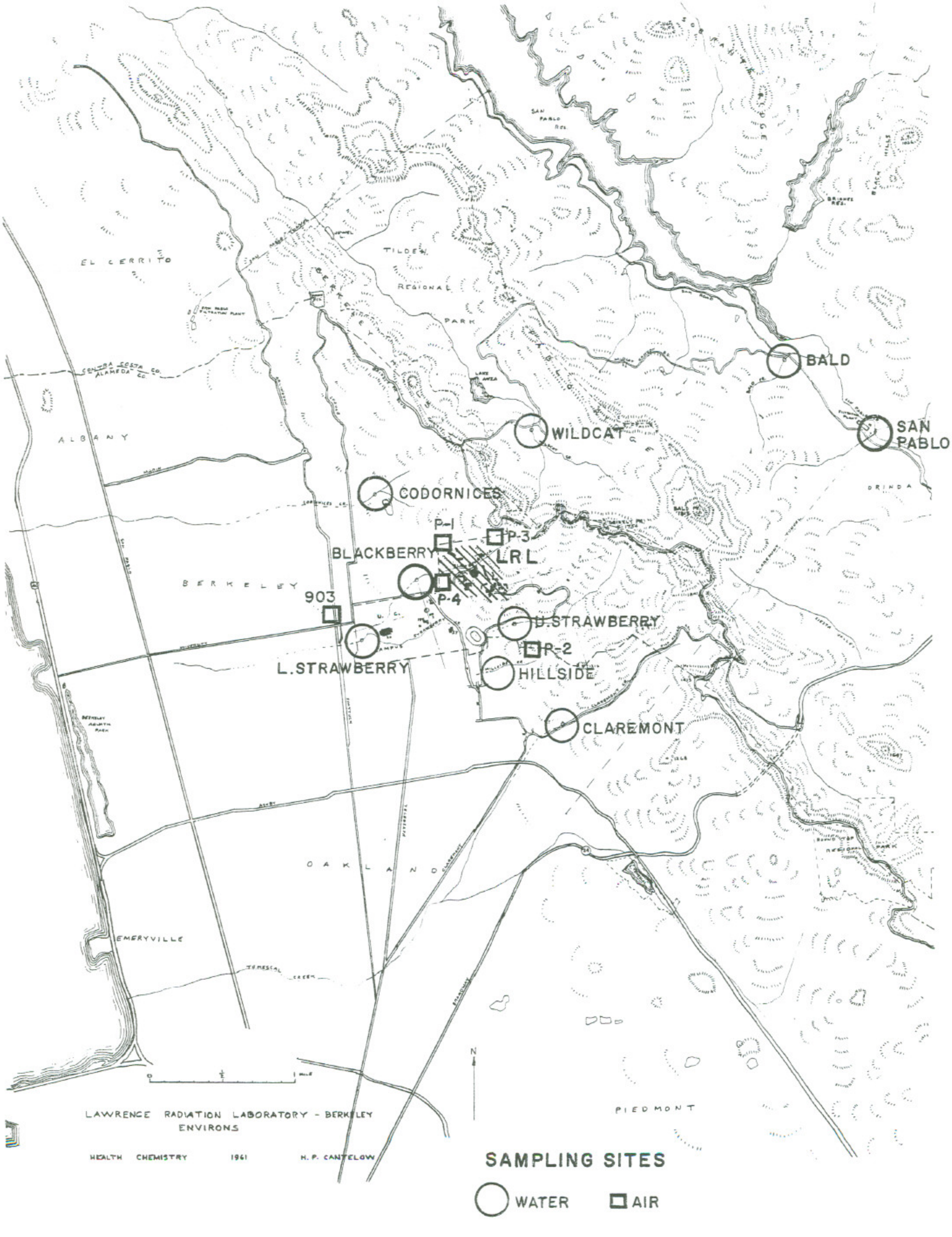
Fig. 10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