

ACTIVITIES IN WEATHER MODIFICATION ^{1/}

By

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In 1966 the National Academy of Sciences and the National Science Foundation issued a series of reports of vital significance to the growing science of weather modification. It was convincingly demonstrated that, with the use of existing knowledge and current technology, physical changes in clouds could be artificially produced. In contrast to previous attitudes of skepticism in some quarters, a consensus developed that weather modification is an important area for scientific inquiry and engineering application. These developments had nationwide repercussions. The Department of Water Resources, like many other government agencies and private concerns, began to explore new areas in its weather modification activity.

Actually, the history of Department of Water Resources activity in weather modification is relatively long. It began in 1951 when the Legislature passed the Weather Modification Act, a statute which the Department was designated to administer. The Weather Modification Act is primarily a regulatory measure. Administrative activities under it include the issuance of licenses to engage in weather modification activities in California, the collection of data on each operational weather modification project in the State, and the annual publication of this data in the Department's Bulletin 16 series entitled "Weather Modification Operations in California".

During the 1966-67 water year, which runs from October 1, 1966, through September 30, 1967, eight California licensees conducted nine weather modification projects. These projects were conducted mainly to increase surface storage in reservoirs for municipal and irrigation use and for use in hydroelectric installations. Additional purposes were ground water storage and applied research. Five projects were conducted in Central California, three in Southern California, and one in Northern California. A summary of active licensees and of the weather modification projects conducted in California during the 1966-67 water year are presented in the tables attached to this paper.

Recently the regulatory program was systematized. The procedures for securing a license for publishing notices of intent to engage in a weather modification project and for reporting operational data were revised. Equally important steps were taken to improve liaison with California's weather modification licensees. One of the most significant of these steps was the publication of a booklet entitled "Statutes and Procedures Pertaining to Weather Modification Projects in California", which explained the new administrative procedures. I hesitate to delve too deeply into the mass of administrative improvements which have been instituted in recent years. An example, however, will indicate their scope. I believe that anyone comparing the latest issue of Bulletin 16 to an issue dated several years earlier should appreciate the value of these thorough-going changes for the obtaining of accurate and systematic data on weather modification projects.

The Department's regulatory program, however, encompasses only half of its potential activities in the field of weather modification. Under Water Code Section 235, the Department is empowered to conduct weather modification projects and supporting investigations. For almost a decade, this mandate was not employed. Following the publication of 1966 scientific studies, however, farsighted Department planners began to explore the possibility of a state weather modification project, and during the following year the outline of a plan took form.

The potential role of a state weather modification project in California is unique due to the magnitude of the State Water Project and Central Valley Project. By 1990 all but one of the State's eleven hydrologic study areas will in some degree be dependent on state or federal projects for the inter-basin transfers of water supplies. Thus, it is very

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important to minimize shortages within the system and to increase system capabilities. It is possible that weather modification operations as an adjunct to reservoir operation -- and integrated with watershed management programs -- could be used to some degree to "smooth out" water supply fluctuations, thereby minimizing shortages. If conducted in a suitable area, weather modification could boost a marginal water year into the safe area. On a long-term basis, weather modification could be useful in increasing the yield of the system. Although estimates vary, it is likely that the coordinate operation of the State Water Project and the Central Valley Project will meet California's water requirements only until about 1990. Certain areas of the State, such as the South Coastal area, will become more dependent upon an imported water supply even before that date. An increase in water supply such as that afforded by weather modification would be extremely useful in minimizing these deficiencies.

In summary, therefore, in a large system that supplies areas heavily relying upon water imports, weather modification could fulfill important needs if developed as an adjunct to reservoir operation. The thrust of the Department's weather modification program will be toward the application of weather modification research to engineering operations, rather than the conduct of research per se. The basic overall objective of the program will be to establish weather modification as a supplemental water supply to maximize efficiency of operation of the State Water Facilities.

Many studies must be made, and many problems must be solved before attainment of the basic objective is approached. This work may be resolved into two basic steps. First, specific technical problems in maximizing efficiency of weather modification in a studied watershed must be solved. This would include determination of the precipitation climatology peculiar to the watershed, particularly in relation to wind flow and diffusion properties. Water management problems--particularly maximizing runoff or storage as snow, and minimizing losses due to evaporation or maldistribution of precipitation in a watershed--should also be studied. The second step involves the investigation of how various modes of operation of a weather modification project in an important watershed would affect the operation of a complex system of reservoirs, powerplants, pumping plants, and canals. A variety of techniques, including statistical evaluation and use of various simulation models, would be used in this investigation. Data obtained from field operation of a weather modification project would be integrated into operation studies of the State Water Project - Central Valley Project. These are our basic guidelines for a possible state weather modification program.

As we have seen, the Department has had a relatively long history of activity in the field of weather modification. It has watched the progress of this growing field through the years, keeping an eye on new developments. Recently, the field of weather modification, and with it the Department's expanding weather modification activities, has entered upon a new, vital, and significant phase.

TABLE 1

ACTIVE WEATHER MODIFICATION LICENSES DURING OCTOBER 1966 THROUGH SEPTEMBER 1967

License Number and Licensee	
1	North American Weather Consultants Santa Barbara Municipal Airport Goleta, California 93017
5	Water Resources Development Corporation 611 S. Palm Canyon Drive, Suite 216 Palm Springs, California 92262
12	Precipitation Control Company of California 105 Pierce Street Taft, California 93268
18	Los Angeles County Flood Control District P. O. Box 2418, Terminal Annex Los Angeles, California 90033
21	Atmospherics Incorporated 3435 E. Pontiac Way Fresno, California 93726
22	San Bernardino Valley Municipal Water District 355 North D Street, P. O. Box 1144 San Bernardino, California 92402
23	Pacific Gas and Electric Company 245 Market Street San Francisco, California 94106
24	International Weather Control, Inc. 40 West First Street, Suite 104 Reno, Nevada 89501
25	K. R. C. Service Corporation 2956 C Street San Diego, California 92102
26	Santa Clara Valley Water Conservation District 15420 Almaden Road San Jose, California 95118
27	Vista Irrigation District P. O. Box 1088 Vista, California 92083

TABLE 2

SUMMARY OF WEATHER MODIFICATION PROJECTS IN CALIFORNIA
OCTOBER 1, 1966 - SEPTEMBER 30, 1967

<u>Project number (a)</u>	<u>Licensee</u>	<u>Client</u>	<u>Target Area</u>	<u>Period of seeding</u>	<u>Purpose of precipitation increase</u>
1-67-1	North American Weather Consultants	Southern California Edison Co.	Upper San Joaquin River Basin	Oct. 10, 1966 Apr. 24, 1967	Storage in hydroelectric installations
12-67-1	Precipitation Control Co. of California	Kern County	Upper Kern River Watershed	Nov. 16, 1966 Mar. 31, 1967	Surface storage
18-67-1	Los Angeles County Flood Control Dist.	Los Angeles County Flood Control Dist.	Drainage areas tributary to District's reservoirs	Nov. 11, 1966 Apr. 22, 1967	Surface storage
21-67-1	Atmospherics Incorporated	Kings River Conservation District	Kings River Watershed above Pine Flat Dam	Nov. 6, 1966 Apr. 11, 1967	Surface storage
21-67-2	Atmospherics Incorporated	Fresno State College Foundation	Southern Sierra Mountains	May 17, 1967 Sep. 25, 1967	Applied research on orographic cumulus clouds
22-67-1	San Bernardino Valley Municipal Water Dists.	San Bernardino Valley Municipal Water Dists.	Upper Santa Ana River Watershed	Jan. 22, 1966 Apr. 22, 1967	Surface storage and recreation
23-67-1	Pacific Gas and Electric Company	Pacific Gas and Electric Company	Watersheds of Mt. Meadows and Butt Valley Reservoirs and Lake Almanor	Nov. 14, 1966 Apr. 28, 1967	Storage in hydroelectric installations
26-67-1	Santa Clara Valley Water Conservation District	Santa Clara Valley Water Conservation District	Santa Clara County	Nov. 6, 1966 Mar. 31, 1967	Surface and ground water storage
27-67-1	Vista Irrigation District	Vista Irrigation District	Lake Henshaw Watershed, San Diego County	Oct. 1, 1966 June. 1, 1967	Surface storage and research

(a) First number indicates license number; second - the water year; third - numerical sequence of projects undertaken by licensee.

TABLE 3

SUMMARY OF PROJECT OPERATIONS IN CALIFORNIA
OCTOBER 1, 1966 - SEPTEMBER 30, 1967

number (a)	Licensee	Number of generators	Silver iodide use (grams per hour per generator)		Total silver iodide dispersed (grams)		Total generator hours	
			Ground generators	Aircraft	Ground generators	Aircraft	Ground generators	Aircraft
1-67-1	North American Weather Consultants	12	6.0	----	31,364	---	5,227.3	---
12-67-1	Precipitation Control Company of California	--	----	42.5	----	---	----	100.0
18-67-1	Los Angeles County Flood Control District	14	6.0	----	----	---	1,837.5	---
21-67-1	Atmospherics Incorporated	24	12.0	----	18,730(b)	1290	1,560.8	30.8
21-67-2	Atmospherics Incorporated	--	----	----	----	3,854(c)	----	91.0
22-67-1	San Bernardino Valley Municipal Water District	17	10.0	----	16,158(d)	---	1,615.8	---
23-67-1	Pacific Gas and Electric Company	6	25.4	----	94,017	---	3,700.5	---
26-67-1	Santa Clara Valley Water Conservation District	21	25.0	----	----	---	1,762.5	---
27-67-1(e)	Vista Irrigation District	--	----	----	----	---	----	---

(a) - First number indicates license number; second - the water year; third - numerical sequence of projects undertaken by a licensee.

(b) - In addition, the licensee dispersed 1350 grams of silver iodide from pyrotechnic devices used on the ground during December, January, and April.

(c) - In addition, the licensee dispersed 155 pounds of dry ice.

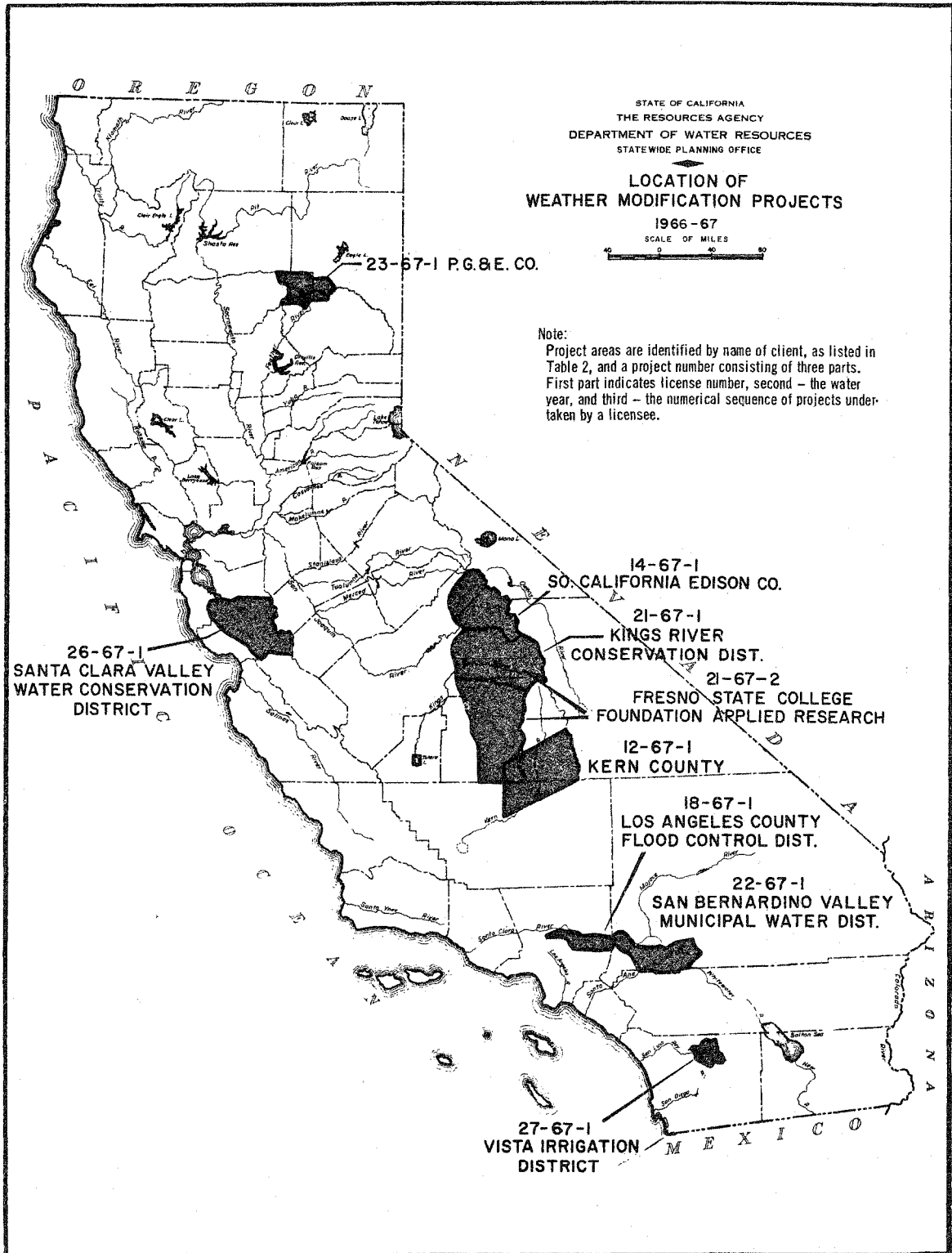
(d) - In addition, the licensee dispersed 500 grams of AgI from pyrotechnic devices used on the ground during April.

(e) - The licensee used electric discharge method.

TABLE 4

WEATHER MODIFICATION LICENSES ISSUED FOR CALENDAR YEAR 1968

License Number	Licensee
1	North American Weather Consultants Santa Barbara Municipal Airport Goleta, California 93017
5	Water Resources Development Corporation 611 S. Palm Canyon Drive, Suite 216 Palm Springs, California 92262
12	Precipitation Control Company of California 105 Pierce Street Taft, California 93268
18	Los Angeles County Flood Control District P. O. Box 2418, Terminal Annex Los Angeles, California 90033
21	Atmospherics Incorporated 3435 E. Pontiac Way Fresno, California 93726
22	San Bernardino Valley Municipal Water District 355 North D Street, P. O. Box 1144 San Bernardino, California 92402
23	Pacific Gas and Electric Company 245 Market Street San Francisco, California 94106
24	International Weather Control, Inc. 40 West First Street, Suite 104 Reno, Nevada 89501
25	K. R. C. Service Corporation 2956 C Street San Diego, California 92102
26	Santa Clara Valley Water Conservation District 15420 Almaden Road San Jose, California 95118
27	Vista Irrigation District P. O. Box 1088 Vista, California 92083
28	Weather Science, Inc. 1808 Newton Drive Norman, Oklahoma 73069
29	World Weather, Inc. 1510 Ranson Drive Houston, Texas 77055
30	Fresno State College Foundation Atmospheric Water Resources Research Fresno State College Fresno, California 93726



STATE OF CALIFORNIA
 THE RESOURCES AGENCY
 DEPARTMENT OF WATER RESOURCES
 STATEWIDE PLANNING OFFICE

LOCATION OF WEATHER MODIFICATION PROJECTS

1966 - 67

SCALE OF MILES



Note:
 Project areas are identified by name of client, as listed in Table 2, and a project number consisting of three parts. First part indicates license number, second - the water year, and third - the numerical sequence of projects undertaken by a licensee.

26-67-1
 SANTA CLARA VALLEY
 WATER CONSERVATION
 DISTRICT

23-67-1 P.G.&E. CO.

14-67-1
 SO. CALIFORNIA EDISON CO.

21-67-1
 KINGS RIVER
 CONSERVATION DIST.

21-67-2
 FRESNO STATE COLLEGE
 FOUNDATION APPLIED RESEARCH

12-67-1
 KERN COUNTY

18-67-1
 LOS ANGELES COUNTY
 FLOOD CONTROL DIST.

22-67-1
 SAN BERNARDINO VALLEY
 MUNICIPAL WATER DIST.

27-67-1
 VISTA IRRIGATION
 DISTRICT