TEXAS WATER DEVELOPMENT BOARD

REPORT 187

WEATHER MODIFICATION ACTIVITIES IN TEXAS, 1973

Prepared by
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M-33 radar dish. This 15-foot parabolic dish antenna was used in the San Angelo Cumulus project to collect cloud physics data and obtain rainfall rate measurements. The radar system was later moved to Snyder to evaluate an operational cloud seeding project.

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WEATHER MODIFICATION ACTIVITIES IN TEXAS, 1973

INTRODUCTION

During calendar year 1973, nine weather modification projects were conducted in the State of Texas. These projects included seven operational cloud seeding projects, one precipitation management research project, and one rain augmentation evaluation project. In all cases the objectives of the cloud seeding projects were to increase rainfall, to decrease hailfall, or both. In all operational cloud seeding projects silver iodide was the seeding agent used to stimulate rainfall and/or suppress hailfall. Sodium chloride (NaCl) was used in the research project.

Better Weather, Incorporated, resumed hail suppression operations for the fourth consecutive summer in the Littlefield area. The Plains Weather Improvement Association formed its own cloud seeding corporation and continued hail suppression activities in the Plainview area. Meteorology Research, Incorporated (MRI) began the final summer of precipitation management and cloud physics research in the San Angelo area and began the first summer of rainfall augmentation evaluation of the Colorado River Municipal Water District (CRMWD) cloud seeding project. Coincident with the MRI evaluation, the CRMWD resumed its efforts to increase rainfall in the Big Spring area. The four remaining weather modification activities were conducted by Irving P. Krick, Incorporated of Texas to increase rainfall in different areas in Oklahoma and Arkansas, utilizing ground-based silver iodide generators located in several Texas counties along the state border.

Two methods of cloud seeding were utilized in Texas during 1973. One method was to attempt to introduce the seeding material into clouds from ground-based generators. This method is based on the premise that the seeding material is transported from the ground to cloud base by the vertical component of the low level winds. The second cloud seeding method employed aircraft with silver iodide flares affixed to their wings to deliver the seeding material directly to the inflow region at cloud base.

All weather modification activities in Texas are conducted under the surveillance and authority of the Texas Water Development Board, the state agency charged by the Legislature with the responsbility for administering the Texas Weather Modification Act (Chapter 14, Texas Water Code).

The Act establishes guidelines for issuing licenses and permits to weather modifiers, and provides for the regulation and proper documentation of all weather modification activities taking place within the State. This is the legal framework within which weather modifiers conduct their operations and the Board exercises its assigned responsibilities.

Table 1 lists the weather modification licenses and project permits which were issued through 1973. The text of this report describes the weather modification activities which took place during 1973 under these licenses and permits. Such activities in earlier years have been described in Texas Water Development Board Report 175. No attempt is made to analyze the degree of success of these activities. Clear-cut results are difficult to obtain and usually require that a given project continue for a number of years before quantifiable effects can be detected. This is due to the great variability of natural weather phenomena in Texas.

Interested readers are encouraged to consult the scientific literature and to communicate directly with the sponsors and operators of projects reported herein concerning any evidence which may relate to the effectiveness of their projects.

TABLE 1.–WEATHER MODIFICATION LICENSES AND PERMITS ISSUED, 1970-73

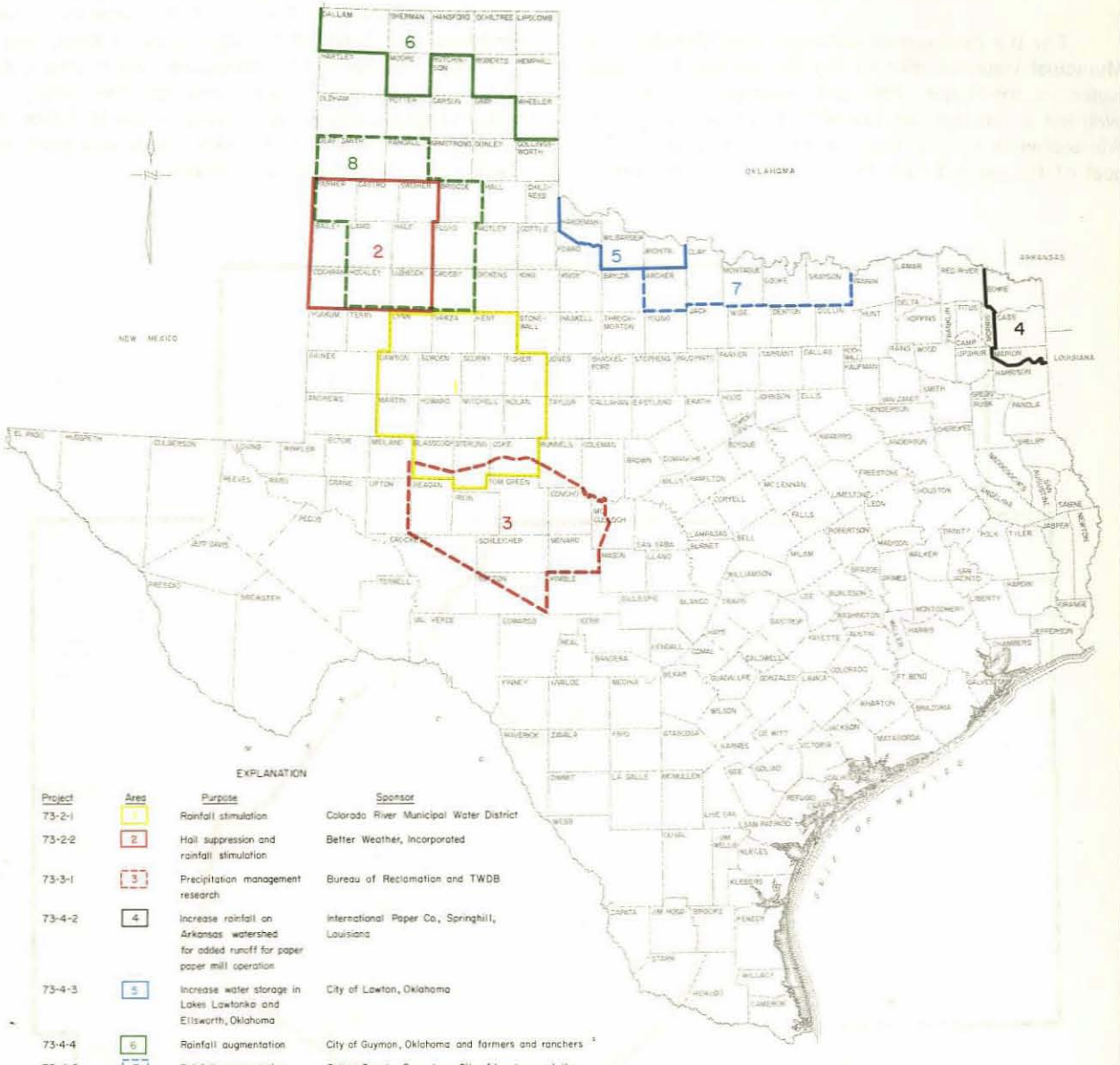
FISCAL YEAR, LICENSE, AND PERMIT IF ANY	LICENSEE OPERATOR	SPONSOR	TARGET AREA	OBJECTIVE
		CALENDAR YEAR 1970		
70-1	World Weather, Inc. 620 Commercial Tower Midland, Texas 79701	None	None	None
70-2-1	Atmospherics Incorporated 5652 East Dayton Avenue Fresno, California 93727	Plains Weather Improvement Association Post Office Box 1627 Plainview, Texas 79072	Hale, Lamb, and western one-third of Floyd Counties	Hail suppression
		CALENDAR YEAR 1971		
71-1	World Weather, Inc.	None	None	None
71-2-1	Atmospherics Incorporated	Plains Weather Improvement Association	All or portions of Crosby, Floyd, Swisher, Hale, Lubbock, Lamb, and Castro Counties	Hail suppression and rainfall enhancement
71-2-2	Atmospherics Incorporated	Colorado River Municipal Water District Post Office Box 869 Big Spring, Texas 79720	All or parts of Dawson, Borden, Scurry, Martin, Howard, Mitchell, and Nolan Counties	Rainfall stimulation
71-3	Sierra Research Corporation Post Office Box 3007 Boulder, Colorado 80303	None	None	None
71-4-1	Meteorology Research, Inc. Post Office Box 637 Altadena, California 91001	TWDB, and Division of Atmospheric Water Resources Management, Bureau of Reclamation, Denver Federal Center Building 67 Denver, Colorado 80225	All or portions of Coke, Schleicher, Crockett, Upton, Glasscock, Sterling, Tom Green, Irion, and Reagan Counties	Precipitation management research
None Required	University of Washington Seattle, Washington 98195 University of Nevada Reno, Nevada 89501 Meteorology Research, Inc., and United States Air Force HQ Air Weather Service (MAC) Scott, AFB, Illinois	Office of Emergency Preparedness Washington, D.C. 20504 Bureau of Reclamation	South and east Texas	Rainfall stimulation–emergency drought relief

TABLE 1.—WEATHER MODIFICATION LICENSES AND PERMITS ISSUED, 1970-73—Continued

FISCAL YEAR, LICENSE, AND PERMIT IF ANY	LICENSEE OPERATOR	SPONSOR	TARGET AREA	OBJECTIVE
		CALENDAR YEAR 1972		
72-1	World Weather, Inc.	None	None	None
72-2-1	Atmospherics Incorporated	Better Weather, Inc. Mr. H. C. Armstrong Star Route 2 Fieldton, Texas Plains Weather Improvement Association	All or portions of Castro, Swisher, Floyd, Hale, and Lamb Counties	Hail suppression and rainfall enhancement
72-2-2	Atmospherics Incorporated	Colorado River Municipal Water District	All or portions of Dawson, Borden, Scurry, Nolan, Coke, Sterling, Glasscock, Howard, Martin, and Mitchell Counties	Rainfall stimulation
72-3-1	Meteorology Research, Inc.	TWDB, and Bureau of Reclamation	All or portions of Sterling, Coke, Runnels, Irion, Tom Green, Schleicher, Menard, Concho, Sutton, Reagan, Crockett, and Glasscock Counties	Precipitation management research
72-4-1	Irving P. Krick, Inc. 611 S. Palm Canyon Drive Suite 216 Palm Springs, California 92262	City of Lawton, Oklahoma City Hall Lawton, Oklahoma 73501	No target area in Texas. Oklahoma target area includes Comanche County	Rainfall stimulation to increase water storage in Lakes Lawtonka and Ellsworth, Oklahoma
72-4-2	Irving P. Krick, Inc.	City of Guymon, Oklahoma, and farmers and ranchers Henry C. Hitch Ranch, Inc. Post Office Box 1308 Guymon, Oklahoma 73942	No target area in Texas. Oklahoma target area includes all or portions of Beaver, Harper, Woods, Woodward, Ellis, Major, Alfalfa, Cimarron, and Texas Counties.	Rainfall stimulation
72-4-3	Irving P. Krick, Inc.	Farmers and ranchers in Ellis County, Oklahoma Ellis County Weather, Inc. Attn: Mr. Dick Hamilton Harmon, Oklahoma 73845	No target area in Texas. Oklahoma target area includes all or portions of Ellis, Beaver, Harper, Woods, and Woodward Counties	Rainfall stimulation
72-5-1	Weather Science, Inc. Post Office Box FF Norman, Oklahoma 73069	Bureau of Reclamation	All or portions of Wheeler, Gray, and Hemphill Counties	Cloud physics research and increase runoff to Lakes Altus, Foss, and Mountainview, Oklahoma

TABLE 1.—WEATHER MODIFICATION LICENSES AND PERMITS ISSUED, 1970-73—Continued

FISCAL YEAR, LICENSE, AND PERMIT IF ANY	LICENSEE OPERATOR	SPONSOR	TARGET AREA	OBJECTIVE
		CALENDAR YEAR 1973		
73-1	World Weather, Inc.	None	None	None
73-4-1	Irving P. Krick, Inc.	City of Lawton, Oklahoma Cotton County Service, Inc. Route 1 Randlett, Oklahoma 73562	No target area in Texas. Oklahoma target area includes all or portions of Comanche and Cotton Counties.	Augment precipitation in Comanche and Cotton Counties, Oklahoma
73-4-2	Irving P. Krick, Inc.	International Paper Co. Springhill, Louisiana 71075	No target area in Texas. Target area includes all or portions of Navada, Hempstead, Columbia, and Lafayette Counties, Arkansas.	Increase rainfall in Arkansas for added runoff for paper mill operation
73-5	Weather Science, Inc.	None	None	None
73-2-1	Atmospherics Incorporated	Colorado River Municipal Water District	All or portions of Dawson, Borden, Scurry, Howard, Mitchell, Nolan, Glasscock, Sterling, and Coke Counties	Increase rainfall
73-2-2	Atmospherics Incorporated	Better Weather, Inc.	All or portions of Parmer, Castro, Bailey, and Lamb Counties	Increase rainfall and decrease hailfall
73-3-1	Meteorology Research, Inc.	Bureau of Reclamation and TWDB	All or portions of Sterling, Coke, Runnels, Irion, Tom Green, Concho, Crockett, Schleicher, Menard, and Sutton Counties	Precipitation management research
73-4-3	Irving P. Krick, Inc.	City of Lawton, Oklahoma	No target area in Texas. Oklahoma target area includes Comanche County.	Increase rainfall
73-4-4	Irving P. Krick, Inc.	City of Guymon, Oklahoma, and farmers and ranchers	No target area in Texas. Oklahoma target area includes Texas, Beaver, Harper, Woodward, Ellis, Custer, Washita, and Kiowa Counties.	Increase rainfall
73-4-6	Irving P. Krick, Inc.	Cotton County Serv., Inc., City of Lawton, and the Oklahoma Counties of Carter, Love, Murray, Johnston, and Jefferson	No target area in Texas. Oklahoma target area includes Jefferson, Carter, Murray, Johnston, Love, Cotton, Comanche, Caddo, and Kiowa Counties.	Increase rainfall
73-6-1	Plains Weather Improvement Association, Inc.	Plains Weather Improvement Association, Inc.	All or portions of Castro, Swisher, and Hale Counties.	Decrease hailfall
73-6-2	Plains Weather Improvement Association, Inc.	Plains Weather Improvement Association, Inc.	Portions of Floyd and Lubbock Counties	Decrease hailfall



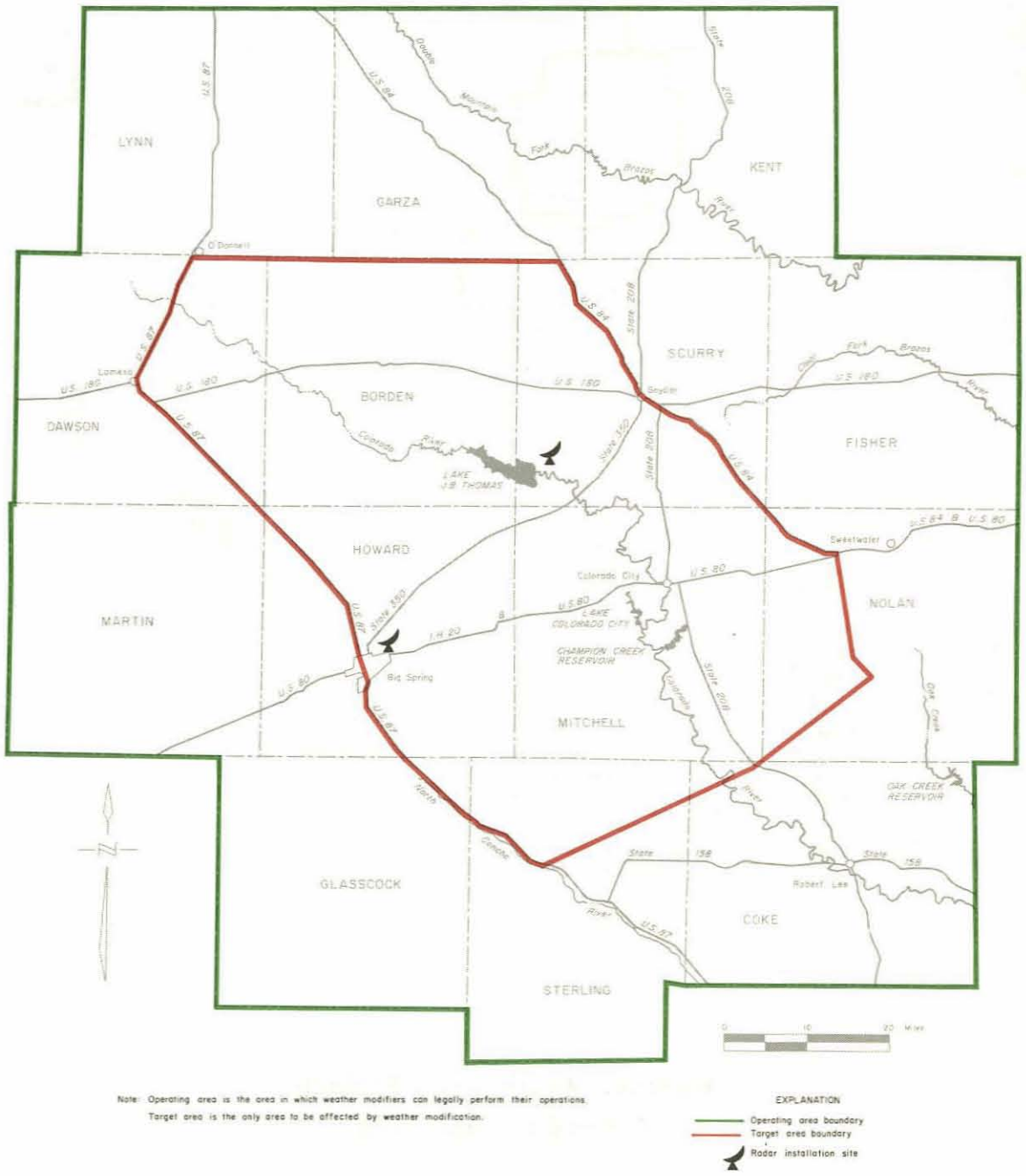
EXPLANATION

Project	Area	Purpose	Sponsor
73-2-1	1	Rainfall stimulation	Colorado River Municipal Water District
73-2-2	2	Hail suppression and rainfall stimulation	Better Weather, Incorporated
73-3-1	3	Precipitation management research	Bureau of Reclamation and TWDB
73-4-2	4	Increase rainfall on Arkansas watershed for added runoff for paper paper mill operation	International Paper Co., Springhill, Louisiana
73-4-3	5	Increase water storage in Lakes Lawtonka and Ellsworth, Oklahoma	City of Lawton, Oklahoma
73-4-4	6	Rainfall augmentation	City of Guymon, Oklahoma and farmers and ranchers
73-4-6	7	Rainfall augmentation	Cotton Country Serv., Inc., City of Lawton, and the Oklahoma Counties of Carter, Love, Murray, Johnston, and Jefferson
73-6-1 73-6-2	8	Hail supression	Plains Weather Improvement Association, Inc.

Weather Modification Projects
Calendar Year 1973

Project 73-2-1.—Colorado River Municipal Water District Rainfall Stimulation

For the third consecutive year, the Colorado River Municipal Water District of Big Spring, which supplies water to the major cities and industries in the area, awarded a contract for a rainfall stimulation project to Atmospherics Incorporated of Fresno, California. The goal of the project over the years has been to increase runoff into the storage lakes within the District, principally Lake J. B. Thomas and E. V. Spence Reservoir. Suitable clouds were seeded by means of aircraft releasing silver iodide crystals from wing-mounted flares into inflow areas at cloud bases. The base of operations for the project was located at Big Spring. By using a 3-centimeter weather radar, the meteorologist-in-charge of the project would locate and identify incipient convective rain clouds and guide the seeding aircraft to the proper clouds.



Note: Operating area is the area in which weather modifiers can legally perform their operations. Target area is the only area to be affected by weather modification.

EXPLANATION
- Operating area boundary
- Target area boundary
- Radar installation site

Project 73-2-1. Operational Summary
April 15, 1973 - October 15, 1973

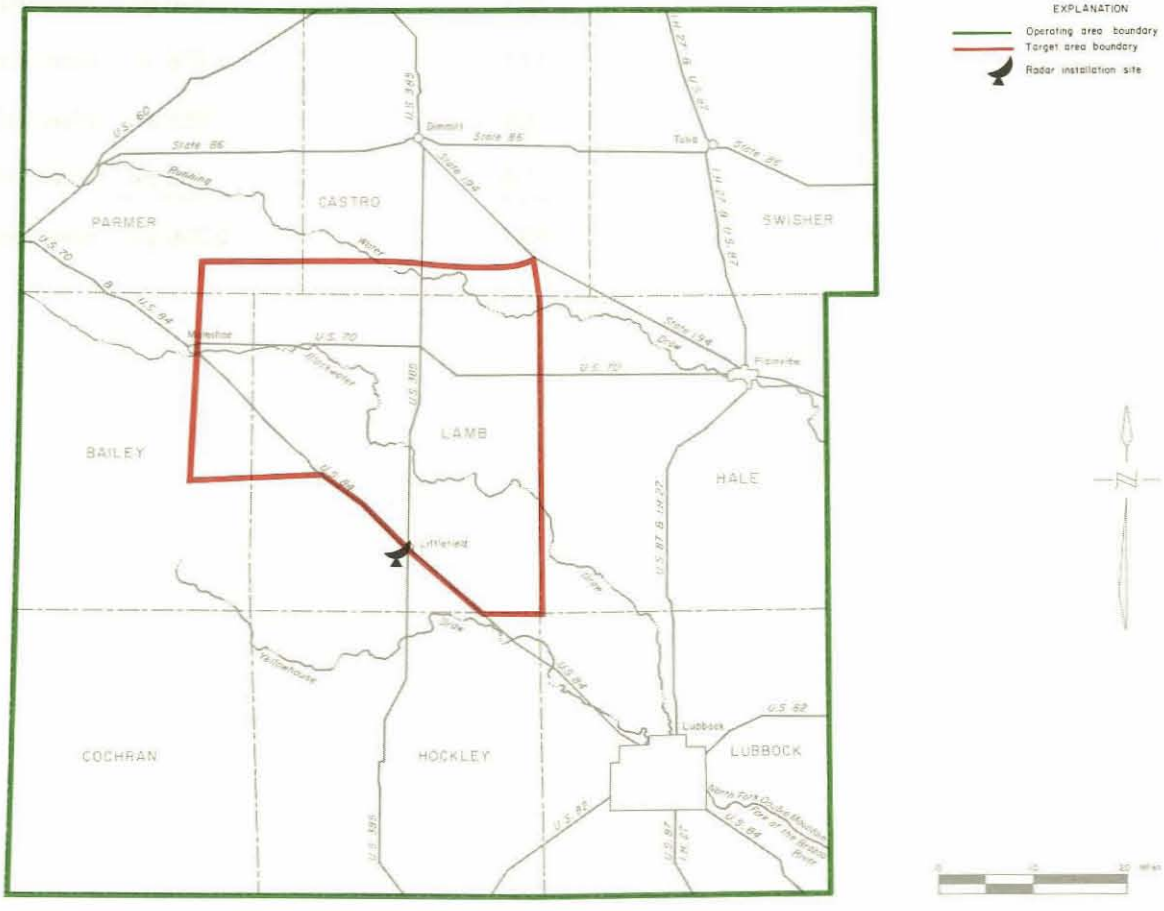
Number of Operational Days - 42
Total Number of Flights - 56
Total Seeding Material Used - 9,250 gm silver iodide

MONTHLY OPERATIONAL LOG

MONTH	NO. OF FLIGHTS	HOURS FLOWN	SEEDING MATERIAL USED
Apr.	8	9.4	1,342 gm silver iodide
May	7	9.2	1,138 gm silver iodide
June	9	13.1	1,712 gm silver iodide
July	14	20.1	2,840 gm silver iodide
Aug.	12	11.4	1,278 gm silver iodide
Sept.	5	5.5	858 gm silver iodide
Oct.	1	1.0	82 gm silver iodide
Total	56	69.7	9,250 gm silver iodide

Project 73-2-2.—Better Weather, Incorporated Hail Suppression

Under the sponsorship of Better Weather, Incorporated of Littlefield, Atmospherics Incorporated embarked on another summer season of hail suppression operations. Unlike previous seasons, no seeding was performed for the purpose of increasing rainfall although such activity was authorized by permit (Table 1). Cloud seeding was conducted only with the intent to suppress damaging hail. A new base of operations was established near Littlefield. A more sophisticated 5-centimeter radar replaced the previously used 3-centimeter radar and provided for improved aerial surveillance and aircraft guidance. Seeding was accomplished by aircraft dispensing large amounts of silver iodide into potential hail producing clouds, as determined by the radar. The silver iodide was released from pyrotechnic flares attached to the wings of the seeding aircraft.



Note: Operating area is the area in which weather modifiers can legally perform their operations. Target area is the only area to be affected by weather modification.

Project 73-2-2. Operational Summary
May 1, 1973 - October 30, 1973

Number of Operational Days - 19
Total Number of Flights - 43
Total Seeding Material Used - 43,395 gm silver iodide

MONTHLY OPERATIONAL LOG

MONTH	NO. OF FLIGHTS	HOURS FLOWN	SEEDING MATERIAL USED
May	7	8.9	6,551 gm silver iodide
June	5	5.3	5,733 gm silver iodide
July	10	14.5	9,268 gm silver iodide
Aug.	10	10.0	9,360 gm silver iodide
Sept.	9	10.8	11,512 gm silver iodide
Oct.	2	1.8	971 gm silver iodide
Total	43	51.3	43,395 gm silver iodide

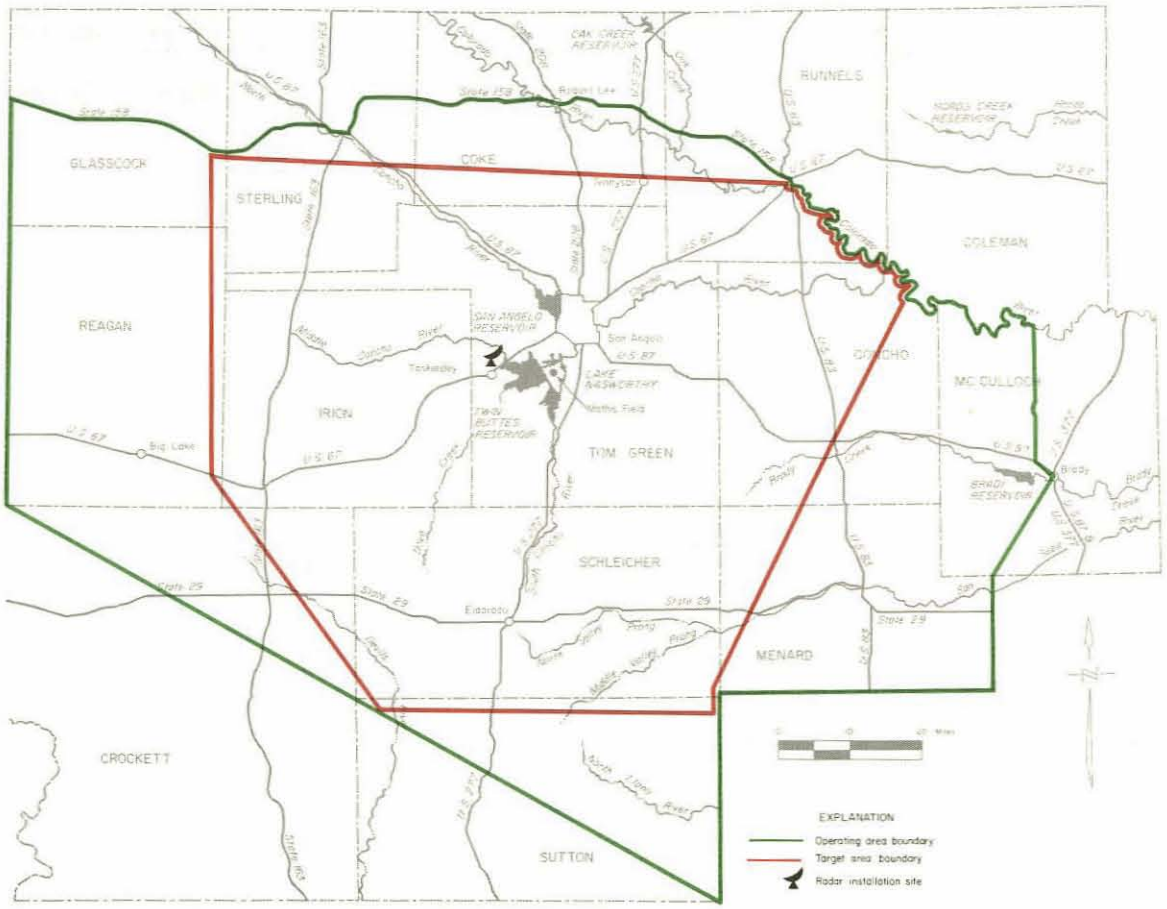
Project 73-3-1.—San Angelo Cumulus Project

Meteorology Research, Incorporated concluded the final year of field operations under a three-year subcontract with the Texas Water Development Board to perform weather modification and precipitation management research in and around San Angelo. The project was sponsored and funded by the Bureau of Reclamation, Division of Atmospheric Water Resources Management. Originally, research efforts were directed toward evaluation of cloud treatments using both silver iodide and hygroscopic seeding agents on west Texas summer cumulus clouds. It was found, however, that seeding opportunities near San Angelo were somewhat limited, and a decision was made to concentrate on only warm cloud seeding techniques (hygroscopic seeding) for the 1973 season.

Statistical control for evaluation was provided by randomized choice of seed or no-seed cloud treatment; thus, one-half of all suitable clouds were untreated. Evaluation equipment included sampling aircraft. The 3-centimeter mode of the radar provided a record of the three-dimensional time history of precipitation development, and served as the data acquisition component.

Specially prepared table salt (NaCl), milled to suitable size, was used exclusively as the seeding agent. Salt particles with mode diameters between 40 and 60 microns were released in updraft regions beneath cloud bases at rates of about 40 lb/min for durations of 4 to 6 minutes.

The base of operations for the project was Mathis Field near San Angelo. The ground-based evaluation radar system was located near Tankersley.



Note: Operating area is the area in which weather modifiers can legally perform their operations. Target area is the only area to be affected by weather modification.

Project 73-3-1. Operational Summary
May 15, 1973 - June 30, 1973

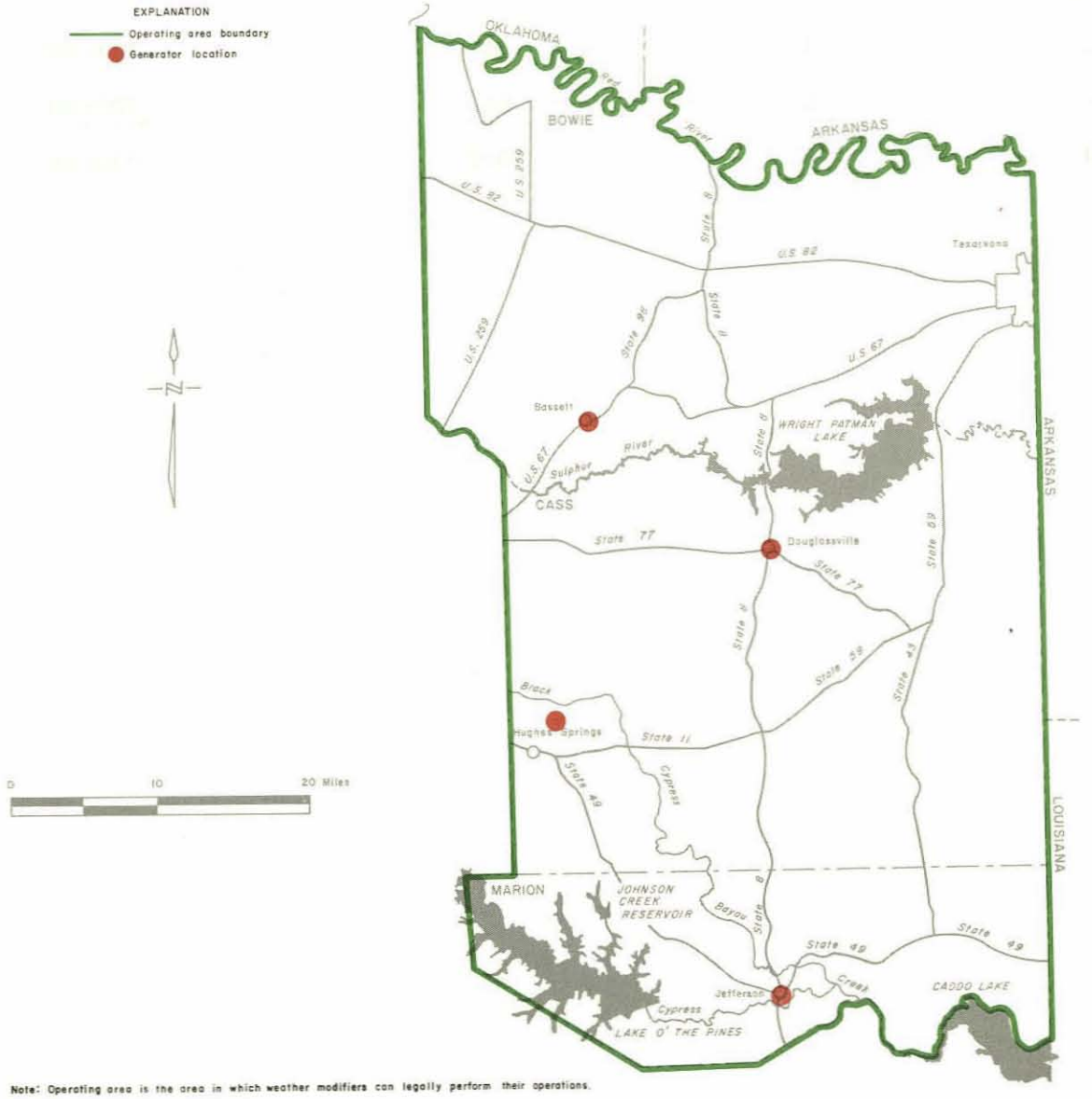
Number of Operational Days - 11
Total Number of Flights - 13
Total Number of Cloud Cases - 4
Total Seeding Material Used - 445 lb salt
(sodium chloride)

MONTHLY OPERATIONAL LOG

MONTH	NO. OF FLIGHTS	HOURS FLOWN	SEEDING MATERIAL USED
May	4	6.7	75 lb salt
June	9	20.2	370 lb salt
Total	13	26.9	445 lb salt

Project 73-4-2.—International Paper Company Rainfall Stimulation

The Texas Water Development Board approved a permit for Irving P. Krick, Incorporated, of Texas to conduct weather modification activities in Bowie, Marion, and Cass Counties, Texas. The purpose of the cloud seeding operation was to increase rainfall over tree farms in southwestern Arkansas belonging to the International Paper Company of Springhill, Louisiana. The ground-based silver iodide generators located in Texas were not operated during 1973 due to the naturally wet conditions in the target area.



Note: Operating area is the area in which weather modifiers can legally perform their operations.

Project 73-4-2. Operational Summary
January 1, 1973 - September 24, 1973

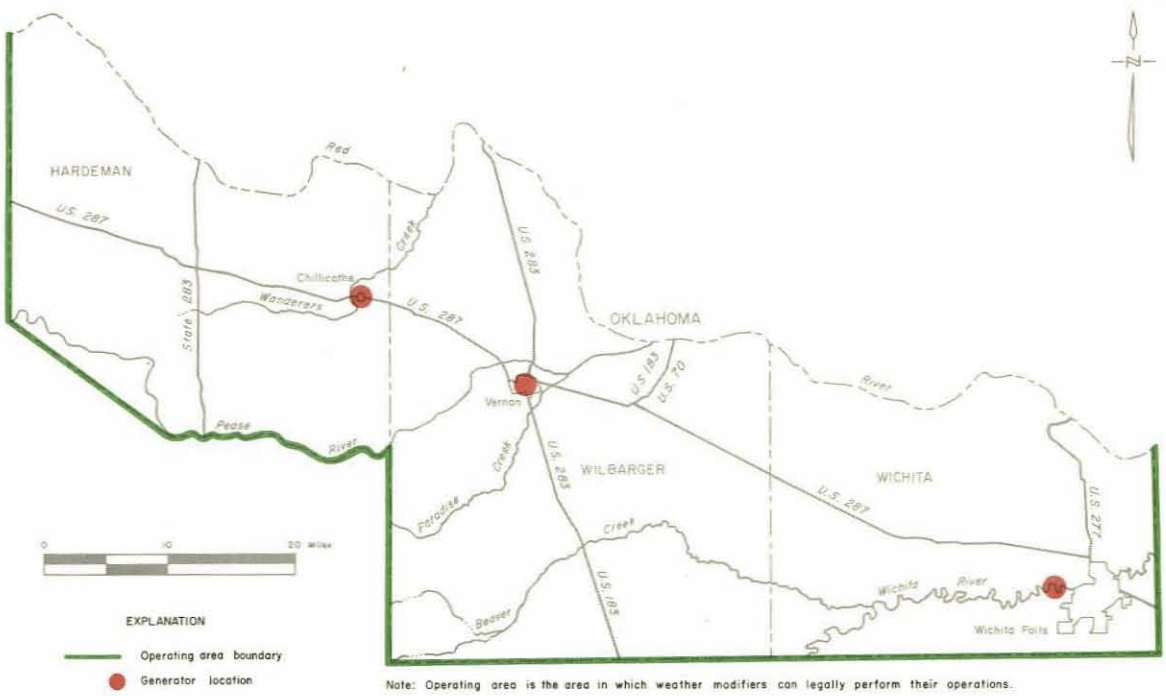
No operations in Texas during 1973.

Permit expired on September 24, 1973 and it was not renewed.

Project 73-4-3.—Oklahoma (Comanche County) Rainfall Stimulation

Irving P. Krick, Incorporated, of Texas was awarded a contract by the city of Lawton, Oklahoma to continue for the second year a program of rainfall stimulation. The intent of the program was to increase rainfall and runoff for storage in Lakes Lawtonka and Ellsworth in Comanche County, Oklahoma. Equipment included three silver iodide generators located at points in Hardeman, Wilbarger, and Wichita Counties, Texas. Additional generators were located in Oklahoma. All effects from seeding were intended for areas in Oklahoma, only.

The ground-based generators used in the operations dispensed silver iodide crystals at the rate of 0.5 gram per hour per generator. The generators were operated by local residents under the direction of Irving P. Krick, Incorporated. Radar equipment was not used.



Note: Operating area is the area in which weather modifiers can legally perform their operations.

Project 73-4-3. Operational Summary
January 1, 1973 - December 31, 1973

Number of Operational Days - 24
Total Operational Hours (all Texas generators) - 202.5
Total Seeding Material Used - 101.25 gm silver iodide

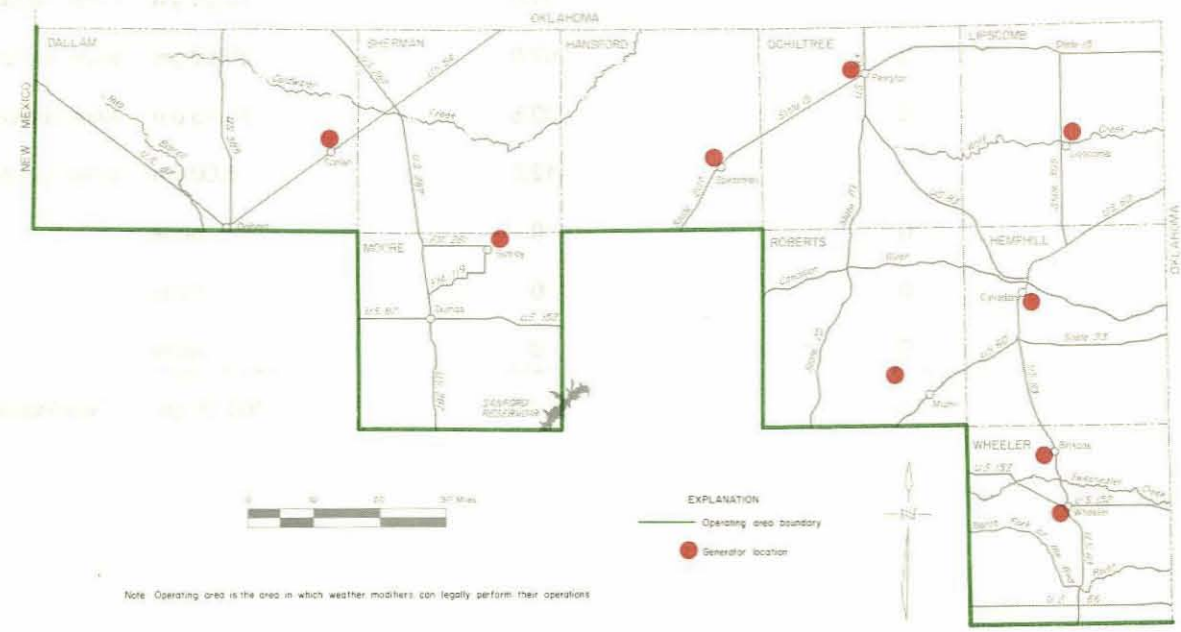
MONTHLY OPERATIONAL LOG

MONTH	NO. OF GENERATORS IN OPERATION	GENERATOR HOURS	SEEDING MATERIAL USED
Jan.	0	0	none
Feb.	2	5.0	2.50 gm silver iodide
Mar.	2	58.0	29.00 gm silver iodide
Apr.	1	6.0	3.00 gm silver iodide
May	0	0	none
June	1	21.0	10.50 gm silver iodide
July	3	67.0	33.50 gm silver iodide
Aug.	3	33.5	16.75 gm silver iodide
Sept.	1	12.0	6.00 gm silver iodide
Oct.	0	0	none
Nov.	0	0	none
Dec.	0	0	none
Total	13	202.5	101.25 gm silver iodide

Project 73-4-4.—Oklahoma (City of Guymon and Vicinity) Rainfall Stimulation

Nine ground-based silver iodide generators located in the northern counties of the Panhandle were again utilized in 1973 by Irving P. Krick, Incorporated, of Texas for the purpose of increasing rainfall on behalf of the farmers and ranchers residing in the Guymon, Oklahoma vicinity. Additional generators were located in Oklahoma. The target area included Texas, Beaver, Harper, Woodward, Ellis, Custer, Washita, and Kiowa Counties, Oklahoma. The target area does not include any portion of the State of Texas.

The generators, each with 0.5 gram per hour output of silver iodide, were operated when the synoptic wind conditions were deemed to be suitable to transport the seeding agent to cloud bases over the Oklahoma target area. The generators were operated by local residents under the guidance of Irving P. Krick, Incorporated. Radar equipment was not used.



Project 73-4-4. Operational Summary
January 1, 1973 - December 31, 1973

Number of Operational Days - 85
Total Operational Hours (all Texas generators) - 2,062.75
Total Seeding Material Used - 1,021.37 gm silver iodide

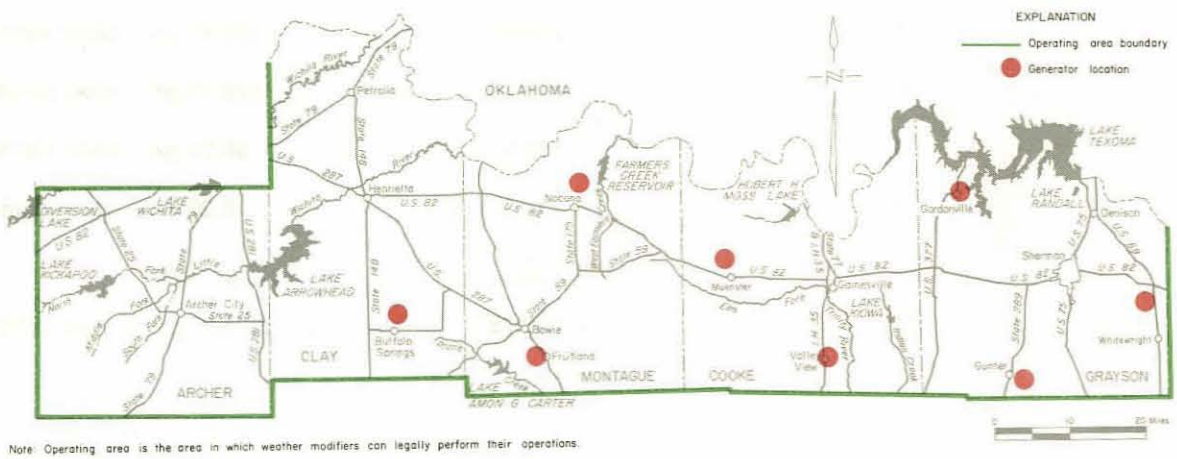
MONTHLY OPERATIONAL LOG

MONTH	NO. OF GENERATORS IN OPERATION	GENERATOR HOURS	SEEDING MATERIAL USED
Jan.	0	0	none
Feb.	0	0	none
Mar.	2	14.0	7.00 gm silver iodide
Apr.	3	54.0	27.00 gm silver iodide
May	6	172.0	86.00 gm silver iodide
June	5	154.5	77.25 gm silver iodide
July	9	488.0	244.00 gm silver iodide
Aug.	9	319.5	159.75 gm silver iodide
Sept.	9	656.25	328.12 gm silver iodide
Oct.	6	192.5	86.25 gm silver iodide
Nov.	1	12.0	6.00 gm silver iodide
Dec.	0	0	none
Total	50	2,062.75	1,021.37 gm silver iodide

Project 73-4-6.—Oklahoma (Counties of Jefferson, Carter, Murray, Johnston, Love, Cotton, Comanche, Caddo, and Kiowa) Rainfall Stimulation

Irving P. Krick, Incorporated, of Texas conducted weather modification activities with intent to increase natural precipitation on behalf of farmers and ranchers in Jefferson, Carter, Murray, Johnston, Love, Cotton, Comanche, Caddo, and Kiowa Counties, Oklahoma. Ground-based silver iodide generators were located in Archer, Clay, Montague, Cooke, and Grayson Counties, Texas. Additional generators were located in Oklahoma. The cloud seeding effects were intended only for areas in Oklahoma.

Eight ground-based silver iodide generators located in Texas, each with 0.5 gram per hour silver iodide output, were used in the operation. Local citizens under the direction of Irving P. Krick, Incorporated, operated the generators. Synoptic wind trajectories were deemed to be favorable to carry the seeding agent from Texas-located generators to the target area only during a 3-month period. No radar equipment was used.



Note: Operating area is the area in which weather modifiers can legally perform their operations.

Project 73-4-6. Operational Summary
January 1, 1973 - December 31, 1973

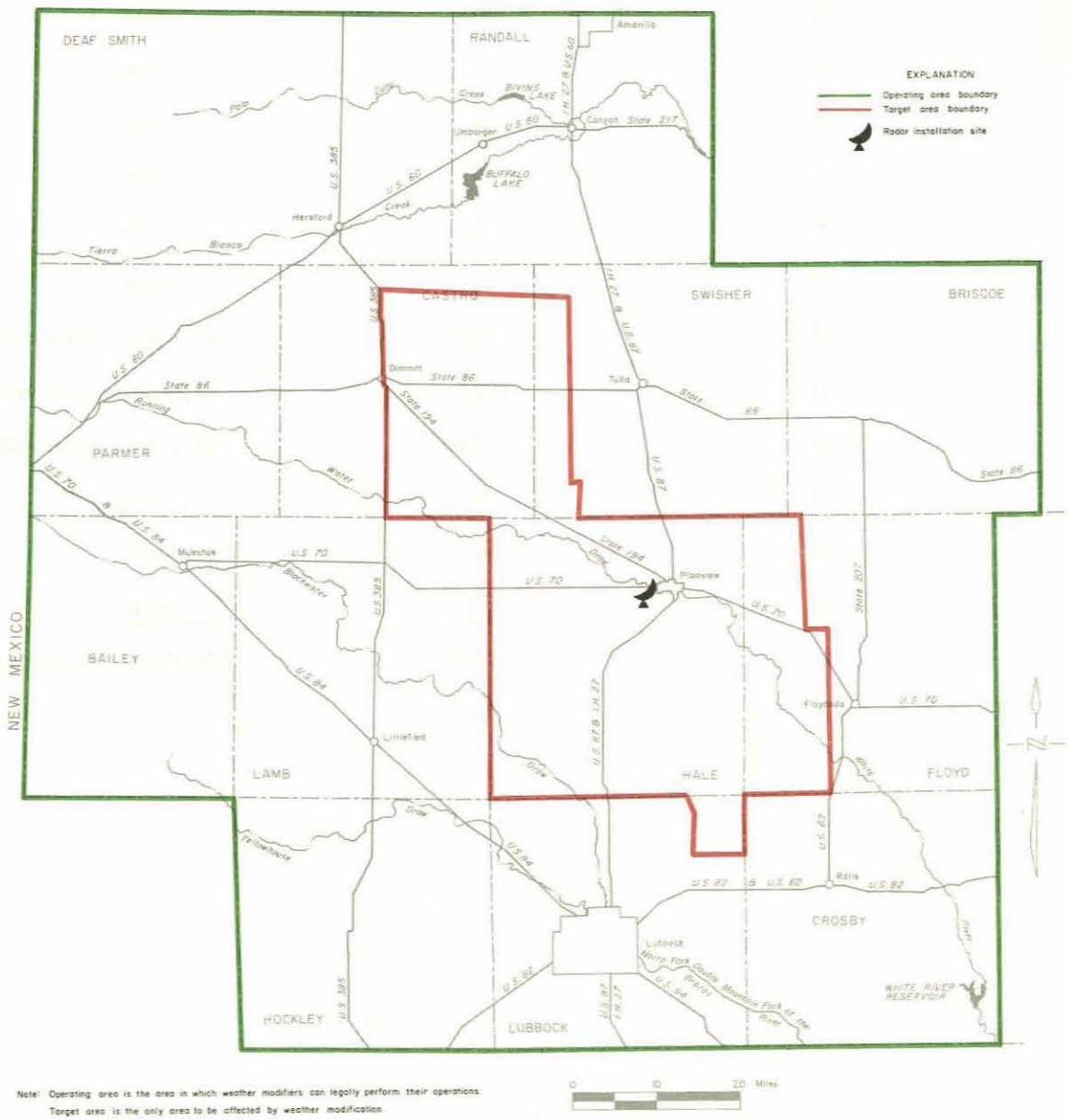
Number of Operational Days - 9
Total Operational Hours (all Texas generators) - 172.5
Total Seeding Material Used - 86.25 gm silver iodide

MONTHLY OPERATIONAL LOG

MONTH	NO. OF GENERATORS IN OPERATION	GENERATOR HOURS	SEEDING MATERIAL USED
Jan.	0	0	none
Feb.	0	0	none
Mar.	0	0	none
Apr.	0	0	none
May	0	0	none
June	0	0	none
July	2	23.0	11.5 gm silver iodide
Aug.	6	102.5	51.25 gm silver iodide
Sept.	6	47.0	23.5 gm silver iodide
Oct.	0	0	none
Nov.	0	0	none
Dec.	0	0	none
Total	14	172.5	86.25 gm silver iodide

Project 73-6-1 and 73-6-2.*—Plains Weather Improvement Association, Inc. Hail Suppression

The Plains Weather Improvement Association, Incorporated, began weather modification activities with its own personnel and equipment for the first year under sponsorship of local businessmen, farmers, and ranchers in the Plainview area. This operation was a continuation of activities performed for the Association by a commercial weather modification firm in 1970, 1971, and 1972. The operations during the 1973 summer season were directed solely toward hail suppression. The target area included all or portions of Hale, Floyd, Castro, Lubbock, and Swisher Counties. The base of operations, located at the Plainview Airport, included three seeding aircraft and a weather radar system. The radar was used to locate and identify potential hail producing storms which threatened the target area. Once the potential hail producers were identified, the radar would direct the seeding aircraft to the thunderstorm to initiate the seeding. Silver iodide released from pyrotechnic flares was used as the seeding agent.



* The second permit was issued for this project to allow for additional target area as indicated in Table 1. The composite of target areas covered by both permits is described here.

Project 73-6-1 and 73-6-2. Operational Summary
April 11, 1973 - November 30, 1973

Number of Operational Days - 25
Total Number of Flights - 67
Total Seeding Material Used - 109,160 gm silver iodide

MONTHLY OPERATIONAL LOG

MONTH	NO. OF FLIGHTS	HOURS FLOWN	SEEDING MATERIAL USED
Apr.	12	39.6	22,450 gm silver iodide
May	16	27.5	19,115 gm silver iodide
June	5	16.5	2,750 gm silver iodide
July	9	26.6	11,320 gm silver iodide
Aug.	16	29.0	35,875 gm silver iodide
Sept.	3	13.0	8,320 gm silver iodide
Oct.	6	12.7	9,330 gm silver iodide
Nov.	0	0	none
Total	67	164.9	109,160 gm silver iodide

COLORADO RIVER MUNICIPAL WATER DISTRICT EVALUATION PROJECT, 1973

Commercial weather modification activities have become common in Texas over the past few years. Since 1970 a total of 22 weather modification projects have been conducted in Texas, primarily directed toward increasing rainfall and/or decreasing hailfall. Only recently has the Texas Legislature provided funds for the purpose of evaluating one of these operational cloud seeding projects.

Weather modification activities to increase rainfall on the Colorado River Basin in Texas were initiated in 1971. The project was funded by the Colorado River Municipal Water District (CRMWD) of Big Spring, Texas, which supplies water to the major cities and industries in the area. The project employs the aerial application method of silver iodide treatment of suitable convective clouds by releasing the seeding agent into the inflow areas at cloud base. The base of operations was in Big Spring, where a 3-centimeter radar was located to provide surveillance and aircraft guidance functions for the operation.

The CRMWD project was conceived initially as an operational project which assumed a priori that cloud seeding was effective, and thus no provisions for testing this assumption were incorporated into the project design. The Texas Legislature appropriated $100,000 per year (a total of $200,000) for the fiscal biennium 1974-75 to evaluate the CRMWD cloud seeding program.

While not, strictly speaking, a weather modification activity, and thus requiring no license or permit, this program is designed to evaluate the effectiveness of the CRMWD rainfall stimulation project (Project 73-2-1). It is being conducted by the Texas Water Development Board with the cooperation of the Colorado River Municipal Water District. Meteorology Research, Incorporated of Altadena, California, is performing scientific evaluation work under contract with the Board. Under the terms of the agreement between the Board and the District, the District furnishes services such as installation of the radar and installation and maintenance of rain gages, and pays for the cloud seeding activities, while the Board pays for the scientific evaluation of the project. Conducting such a scientific evaluation on a limited budget was made possible by the loan of a surplus M-33 radar set and ancillary equipment to the Board at no cost by the Division of Atmospheric Water Resources Management, Bureau of Reclamation.

The 1973 CRMWD evaluation plan provided for randomized choice seeding of suitable clouds for treatment. One-fourth of the available seeding cases were left untreated to provide a comparison with the seeded cases. Dummy flares were used during the no-seed operations to assure that there was no bias in the selection of test clouds. Cloud seeding personnel did not know which type of flare was loaded in the aircraft flare-racks until the choice had been made and the flares were fired.

The primary evaluation tool for examining rainfall from summer cumulus clouds over the 3,750-square-mile target area was a calibrated 10-centimeter radar set located at Snyder, Texas, approximately 50 miles northeast of Big Spring. The radar beam was fixed at a 2-degree angle above the horizon and allowed to rotate one revolution per 5-minute interval. This slow rotation provided for a sampling time long enough to obtain a representative, average signal return. The radar returns are recorded on video tape for later analysis through a unique system consisting of digitizer, range sorter, and computer. The tapes can also be played back, after the fact, for visual interpretation. The 3-centimeter portion of the radar equipment was used primarily to determine cloud top heights in the operational area.

Using radar as an electronic rain gage assumes that reflectivity factors measured by radar can be used to determine rainfall rates. This assumption would be valid if the precipitation particle size distribution were a unique function of the rainfall rate. However, it has been amply demonstrated that there is no unique precipitation particle size distribution for a given rainfall rate; therefore, radar measurements of rainfall rates should be compared as often as possible with ground-truth measurements.

Twelve recording rain gages and 107 nonrecording rain gages were located within the project area. The recording gages provided measures of surface rainfall rates which were correlated with the radar-measured rainfall rates at the same location. They also provided a means of tracking treated and untreated cloud systems through the project area so that the more extensive nonrecording rain gage network could be used more effectively.

Operational Summary August 15, 1973 - October 15, 1973

During the eight flights of the 60 days of the preliminary experiment carried out in 1973, the seeding pilot treated ten separate clouds or cloud masses. Only two such operations were with dummy flares.

On one occasion an instrumented aircraft obtained rain samples below cloud base, utilizing a foil sampler to record raindrop impressions. For calibration purposes, information on drop size distributions is essential for comparison with quantitative radar measurements made simultaneously.

COLORADO RIVER MUNICIPAL WATER DISTRICT
EVALUATION PROJECT, 1973

SUMMARY OF AIRCRAFT OPERATIONS

FLIGHT	TEST CASE	DATE (1973)	TIMES (HOURS, CDT) TAKEOFF	START SEEDING	STOP SEEDING	LAND	FLARES	SILVER IODIDE (GRAMS)	REMARKS
1	1	Aug. 31	1630	1650	1715	1730	3	54	–
2	2	Aug. 31	1900	1915	2010	2015	5	–	Dummy flare
3	3	Sept. 1	2000	2010	2043	2100	4	72	–
4	4	Sept. 4	1800	1830	1915	–	5	–	Dummy flare
4	5	Sept. 4	–	1918	2013	2025	7	172	–
5	6	Sept. 12	1625	1633	1708	–	5	90	Test case 6
5	6	Sept. 12	–	1804	1821	1840	2	82	seeded twice
5	7	Sept. 12	–	1714	1751	–	5	90	–
6	8	Sept. 12	1915	1935	2020	2040	6	154	–
7	9	Sept. 21	1615	1620	1710	1740	6	108	–
8	10	Oct. 10	2020	2034	2135	2145	9	208	–
					TOTAL . . .		57	1,030	