BC 13-072

AGREEMENT FOR SERVICES OF INDEPENDENT CONTRACTOR

THIS AGREEMENT (hereafter Agreement) is made by and between the Santa Barbara County Water Agency, a political subdivision of the State of California (hereafter COUNTY) and North American Weather Consultants, Inc. having its principal place of business at 8180 South Highland Drive, Suite B-2, Sandy, Utah 84093 (hereafter CONTRACTOR) wherein CONTRACTOR agrees to provide and COUNTY agrees to accept the services specified herein.

NOW, THEREFORE, in consideration of the mutual covenants and conditions contained herein, the parties agree as follows:

1. **DESIGNATED REPRESENTATIVE.** Dennis Gibbs at phone number (805) 739-8781 is the representative of COUNTY and will administer this Agreement for and on behalf of COUNTY. Don Griffith at phone number (801) 942-9005 is the authorized representative for CONTRACTOR. Changes in designated representatives shall be made only after advance written notice to the other party.

2. **NOTICES.** Any notice or consent required or permitted to be given under this Agreement shall be given to the respective parties in writing, by first class mail, postage prepaid, or otherwise delivered as follows:

To COUNTY: Matt Naftaly, Santa Barbara County Water Agency, 123 E. Anapamu Street, Suite 240, Santa Barbara, CA 93101

To CONTRACTOR: Don Griffith, NAWC, 8180 South Highland Dr., STE B-2, Sandy, Utah 84093

or at such other address or to such other person that the parties may from time to time designate. Notices and consents under this section, which are sent by mail, shall be deemed to be received five (5) days following their deposit in the U.S. mail.

3. **SCOPE OF SERVICES.** CONTRACTOR agrees to provide services to COUNTY in accordance with EXHIBIT A attached hereto and incorporated herein by reference.

4. **TERM.** CONTRACTOR shall commence performance on October 16, 2012 and end performance upon completion, but no later than June 30, 2013 unless otherwise directed by COUNTY or unless earlier terminated.

5. **COMPENSATION OF CONTRACTOR.** CONTRACTOR shall be paid for performance under this Agreement in accordance with the terms of EXHIBIT B attached hereto and incorporated herein by reference. Billing shall be made by invoice, which shall include the contract number assigned by COUNTY and which is delivered to the address given in Section 2 NOTICES. above following completion of the increments identified on EXHIBIT B. Unless otherwise specified on EXHIBIT B, payment shall be net thirty (30) days from presentation of invoice.

6. **INDEPENDENT CONTRACTOR.** CONTRACTOR shall perform all of its services under this Agreement as an independent contractor and not as an employee of COUNTY. CONTRACTOR understands and acknowledges that it shall not be entitled to any of the benefits of a COUNTY employee, including but not limited to vacation, sick leave, administrative leave, health insurance, disability insurance, retirement, unemployment insurance, workers' compensation and protection of tenure.

7. **STANDARD OF PERFORMANCE.** CONTRACTOR represents that it has the skills, expertise, and licenses/permits necessary to perform the services required under this Agreement. Accordingly, CONTRACTOR shall perform all such services in the manner and according to the standards observed by a competent practitioner of the same profession in which CONTRACTOR is engaged. All

products of whatsoever nature, which CONTRACTOR delivers to COUNTY pursuant to this Agreement, shall be prepared in a first class and workmanlike manner and shall conform to the standards of quality normally observed by a person practicing in CONTRACTOR's profession. CONTRACTOR shall correct or revise any errors or omissions, at COUNTY'S request without additional compensation. Permits and/or licenses shall be obtained and maintained by CONTRACTOR without additional compensation.

8. **TAXES.** COUNTY shall not be responsible for paying any taxes on CONTRACTOR's behalf, and should COUNTY be required to do so by state, federal, or local taxing agencies, CONTRACTOR agrees to promptly reimburse COUNTY for the full value of such paid taxes plus interest and penalty, if any. These taxes shall include, but not be limited to, the following: FICA (Social Security), unemployment insurance contributions, income tax, disability insurance, and workers' compensation insurance.

9. **CONFLICT OF INTEREST.** CONTRACTOR covenants that CONTRACTOR presently has no interest and shall not acquire any interest, direct or indirect, which would conflict in any manner or degree with the performance of services required to be performed under this Agreement. CONTRACTOR further covenants that in the performance of this Agreement, no person having any such interest shall be employed by CONTRACTOR.

10. **RESPONSIBILITIES OF COUNTY.** COUNTY shall provide all information reasonably necessary by CONTRACTOR in performing the services provided herein.

11. **OWNERSHIP OF DOCUMENTS.** COUNTY shall be the owner of the following items incidental to this Agreement upon production, whether or not completed: all data collected, all documents of any type whatsoever, and any material necessary for the practical use of the data and/or documents from the time of collection and/or production whether or not performance under this Agreement is completed or terminated prior to completion. CONTRACTOR shall not release any materials under this section except after prior written approval of COUNTY.

No materials produced in whole or in part under this Agreement shall be subject to copyright in the United States or in any other country except as determined at the sole discretion of COUNTY. COUNTY shall have the unrestricted authority to publish, disclose, distribute, and other use in whole or in part, any reports, data, documents or other materials prepared under this Agreement.

12. **RECORDS, AUDIT, AND REVIEW.** CONTRACTOR shall keep such business records pursuant to this Agreement as would be kept by a reasonably prudent practitioner of CONTRACTOR's profession and shall maintain such records for at least four (4) years following the termination of this Agreement. All accounting records shall be kept in accordance with generally accepted accounting practices. COUNTY shall have the right to audit and review all such documents and records at any time during CONTRACTOR's regular business hours or upon reasonable notice.

13. **INDEMNIFICATION AND INSURANCE.** CONTRACTOR shall agree to defend, indemnify and save harmless the COUNTY and to procure and maintain insurance in accordance with the provisions of EXHIBIT C attached hereto and incorporated herein by reference.

14. **NONDISCRIMINATION.** COUNTY hereby notifies CONTRACTOR that COUNTY's Unlawful Discrimination Ordinance (Article XIII of Chapter 2 of the Santa Barbara County Code) applies to this Agreement and is incorporated herein by this reference with the same force and effect as if the ordinance were specifically set out herein and CONTRACTOR agrees to comply with said ordinance.

15. **NONEXCLUSIVE AGREEMENT.** CONTRACTOR understands that this is not an exclusive Agreement and that COUNTY shall have the right to negotiate with and enter into contracts with others providing the same or similar services as those provided by CONTRACTOR as the COUNTY desires.

16. **ASSIGNMENT.** CONTRACTOR shall not assign any of its rights nor transfer any of its obligations under this Agreement without the prior written consent of COUNTY and any attempt to so assign or so transfer without such consent shall be void and without legal effect and shall constitute grounds for termination.

17. **TERMINATION.**

A. By COUNTY. COUNTY may, by written notice to CONTRACTOR, terminate this Agreement in whole or in part at any time, whether for COUNTY's convenience or because of the failure of CONTRACTOR to fulfill the obligations herein. Upon receipt of notice, CONTRACTOR shall immediately discontinue all services effected (unless the notice directs otherwise), and deliver to COUNTY all data, estimates, graphs, summaries, reports, and all other records, documents or papers as may have been accumulated or produced by CONTRACTOR in performing this Agreement, whether completed or in process.

1. For Convenience. COUNTY may terminate this Agreement upon thirty (30) days written notice. Following notice of such termination, CONTRACTOR shall promptly cease work and notify COUNTY as to the status of its performance.

Notwithstanding any other payment provision of this Agreement, COUNTY shall pay CONTRACTOR for service performed to the date of termination to include a prorated amount of compensation due hereunder less payments, if any, previously made. In no event shall CONTRACTOR be paid an amount in excess of the full price under this Agreement nor for profit on unperformed portions of service. CONTRACTOR shall furnish to COUNTY such financial information as in the judgment of COUNTY is necessary to determine the reasonable value of the services rendered by CONTRACTOR. In the event of a dispute as to the reasonable value of the services rendered by CONTRACTOR, the decision of COUNTY shall be final. The foregoing is cumulative and shall not effect any right or remedy which COUNTY may have in law or equity.

2. For Cause. Should CONTRACTOR default in the performance of this Agreement or materially breach any of its provisions, COUNTY may, at COUNTY's sole option, terminate this Agreement by written notice, which shall be effective upon receipt by CONTRACTOR.

B. By CONTRACTOR. Should COUNTY fail to pay CONTRACTOR all or any part of the payment set forth in EXHIBIT B, CONTRACTOR may, at CONTRACTOR's option terminate this agreement if such failure is not remedied by COUNTY within thirty (30) days of written notice to COUNTY of such late payment.

18. **SECTION HEADINGS.** The headings of the several sections, and any Table of Contents appended hereto, shall be solely for convenience of reference and shall not affect the meaning, construction or effect hereof.

19. **SEVERABILITY.** If any one or more of the provisions contained herein shall for any reason be held to be invalid, illegal or unenforceable in any respect, then such provision or provisions shall be deemed severable from the remaining provisions hereof, and such invalidity, illegality or unenforceability shall not affect any other provision hereof, and this Agreement shall be construed as if such invalid, illegal or unenforceable provision had never been contained herein.

20. **REMEDIES NOT EXCLUSIVE.** No remedy herein conferred upon or reserved to COUNTY is intended to be exclusive of any other remedy or remedies, and each and every such remedy, to the extent permitted by law, shall be cumulative and in addition to any other remedy given hereunder or now or hereafter existing at law or in equity or otherwise.

21. **TIME IS OF THE ESSENCE.** Time is of the essence in this Agreement and each covenant and term is a condition herein.

22. **NO WAIVER OF DEFAULT.** No delay or omission of COUNTY to exercise any right or power arising upon the occurrence of any event of default shall impair any such right or power or shall be construed to be a waiver of any such default or an acquiescence therein; and every power and remedy given by this Agreement to COUNTY shall be exercised from time to time and as often as may be deemed expedient in the sole discretion of COUNTY.

23. **ENTIRE AGREEMENT AND AMENDMENT.** In conjunction with the matters considered herein, this Agreement contains the entire understanding and agreement of the parties and there have been no promises, representations, agreements, warranties or undertakings by any of the parties, either oral or written, of any character or nature hereafter binding except as set forth herein. This Agreement may be altered, amended or modified only by an instrument in writing, executed by the parties to this Agreement and by no other means. Each party waives their future right to claim, contest or assert that this Agreement was modified, canceled, superseded, or changed by any oral agreements, course of conduct, waiver or estoppel.

24. **SUCCESSORS AND ASSIGNS.** All representations, covenants and warranties set forth in this Agreement, by or on behalf of, or for the benefit of any or all of the parties hereto, shall be binding upon and inure to the benefit of such party, its successors and assigns.

25. **COMPLIANCE WITH LAW.** CONTRACTOR shall, at his sole cost and expense, comply with all County, State and Federal ordinances and statutes now in force or which may hereafter be in force with regard to this Agreement. The judgment of any court of competent jurisdiction, or the admission of CONTRACTOR in any action or proceeding against CONTRACTOR, whether COUNTY be a party thereto or not, that CONTRACTOR has violated any such ordinance or statute, shall be conclusive of that fact as between CONTRACTOR and COUNTY.

26. **CALIFORNIA LAW.** This Agreement shall be governed by the laws of the State of California. Any litigation regarding this Agreement or its contents shall be filed in the County of Santa Barbara, if in state court, or in the federal district court nearest to Santa Barbara County, if in federal court.

27. **EXECUTION OF COUNTERPARTS.** This Agreement may be executed in any number of counterparts and each of such counterparts shall for all purposes be deemed to be an original; and all such counterparts, or as many of them as the parties shall preserve undestroyed, shall together constitute one and the same instrument.

28. **AUTHORITY.** All parties to this Agreement warrant and represent that they have the power and authority to enter into this Agreement in the names, titles and capacities herein stated and on behalf of any entities, persons, or firms represented or purported to be represented by such entity(ies), person(s), or firm(s) and that all formal requirements necessary or required by any state and/or federal law in order to enter into this Agreement have been fully complied with. Furthermore, by entering into this Agreement, CONTRACTOR hereby warrants that it shall not have breached the terms or conditions of any other contract or agreement to which CONTRACTOR is obligated, which breach would have a material effect hereon.

29. **PRECEDENCE.** In the event of conflict between the provisions contained in the numbered sections of this Agreement and the provisions contained in the Exhibits, the provisions of the Exhibits shall prevail over those in the numbered sections.

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Agreement for Services of Independent Contractor between the **Santa Barbara County Water Agency** and **North American Weather Consultants, Inc.**

IN WITNESS WHEREOF, the parties have executed this Agreement to be effective on the date executed by COUNTY.

SANTA BARBARA COUNTY WATER AGENCY

By: ______________________________
Chair, Board of Directors

Date: ________________

ATTEST:
CHANDRA L. WALLAR
CLERK OF THE BOARD

By: ______________________________
Deputy

CONTRACTOR
North American Weather Consultants, Inc.

By: ______________________________

Title: President

Sept. 10, 2012

APPROVED AS TO FORM:
DENNIS A. MARSHALL
COUNTY COUNSEL

By: ______________________________
Deputy County Counsel

APPROVED AS TO ACCOUNTING FORM:
ROBERT W. GEIS, CPA
AUDITOR-CONTROLLER

By: ______________________________
Deputy
Deputy Auditor-Controller
Gregory Eric Levin
Advanced and Specialty Accounting

Dept: 054
Fund: 3050
Acct: 7460
Program: 3009

APPROVED AS TO FORM:
RAY AROMATORIO, ARM, AIC
RISK MANAGER

By: ______________________________

EXHIBIT A

STATEMENT OF WORK

North American Weather Consultants, Inc.

TECHNICAL PROPOSAL FOR A 2012-2013 WINTER CLOUD SEEDING PROJECT IN SANTA BARBARA COUNTY AND A PORTION OF SOUTHERN SAN LUIS OBISPO COUNTY

Prepared for

Santa Barbara County Water Agency

by

North American Weather Consultants, Inc.
8180 South Highland Dr., Suite B-2
Sandy, Utah 84093

Proposal No. 12-319

September 2012

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TECHNICAL PROPOSAL FOR A 2012-2013 WINTER CLOUD SEEDING PROJECT IN SANTA BARBARA COUNTY AND A PORTION OF SOUTHERN SAN LUIS OBISPO COUNTY
Proposal No. 12-319

1.0 INTRODUCTION AND BACKGROUND

North American Weather Consultants (NAWC), the world's longest-standing private weather modification company, is pleased to submit a proposal (#12-319) for a Santa Barbara County cloud seeding, or weather modification program for the 2012-2013 rainy season. **This proposal is a revision of an earlier proposal (#11-292) submitted in response to a formal request for proposals (RFP) received from the Santa Barbara County Water Flood Control & Water Conservation District and Water Agency (Agency) dated August 5, 2011. This revision is specifically for a program to be conducted during the 2012-2013 rainy season whereas the earlier 11-292 proposal covered potential operations spanning a three year period. A ground only program was conducted for the Husana-Alamo target area during the 2011-2012 rainy season. Portions of the original proposal (#11-292) are not duplicated in this revised proposal (e.g. Sections dealing with airborne seeding, appendices, references). The reader is referred to the earlier proposal for these sections.**

NAWC has a long history of involvement in weather modification research in Santa Barbara County dating back to the 1950's. Some operational programs were conducted in the early 1950's and again in 1978 (refer to Table 1-1). There has been several research programs conducted in Santa Barbara County. Table 1-2 summarizes these programs. NAWC was involved in the conduct of a research weather modification program in the 1950's known as Santa Barbara I. NAWC was again involved in a research weather modification program from 1967-1973 known as Santa Barbara II (Thompson, et al., 1975). This second research program has served as the foundation for the design and conduct of operational seeding programs conducted within the county by NAWC, beginning in 1981.

The Santa Barbara County Water Agency (Agency) completed a number of tasks during 1981 designed to reactivate cloud seeding activities within the County. These tasks included: 1) preparation of a Negative Declaration Statement (#81-ND-87), 2) conducting a public hearing (December 10, 1981), and 3) obtaining a Weather Resource Management permit from the California Department of Water Resources. North American Weather Consultants (NAWC) was awarded an initial contract from the Agency (dated January 11, 1982) to conduct an operational cloud seeding program during the remainder of the 1982 winter season. Periodic contracts were awarded to NAWC by the Agency to continue these operational programs in a nearly continuous fashion through the 1997 Water Year. Atmospherics, Inc. was awarded a contract to conduct an operational program during the 1998 Water Year. Weather Modification, Inc., of Fargo, North Dakota, was awarded a contract by the Agency to conduct operational programs for the 1999 through 2001 Water Years. NAWC, under contract with the Agency, resumed its conduct of operations for the County during the 2001-2002 rainy season. This program utilized a revised project design based upon the highly successful results of earlier research conducted by NAWC (e.g., Santa Barbara II phase I and phase II experiments). The Agency renewed NAWC's contract to conduct the cloud seeding operations for the 2002-03 and ensuing winter seasons through the 2006-2007 winter season. The Agency again renewed NAWC's contract to conduct the cloud seeding operations for the 2008-2009 and ensuing rainy seasons through the 2010-2011 rainy season. No operations were conducted during the 2007-2008 rainy season due to extensive fire damage to portions of the upper Santa Ynez watershed from the Zaca fire. Table 1-3 provides a summary of NAWC operations for the 1981 through 2012 period. **This represents 25 rainy seasons that NAWC has conducted this program for the Agency**. NAWC and Agency personnel co-authored a technical paper that summarized the cloud seeding activities in Santa Barbara County dating back to the 1950's (Griffith, et al, 2005).

Table 1-1 Summary of Earlier Santa Barbara Operational Programs

Time Period	Target Area	Sponsor	Design	Results
1950-1953, 1955	South Coast, Santa Ynez Basin, Cuyama Valley	Santa Barbara County Water Agency	Ground Based Silver Iodide Generators	1.35 to 5.09 inch increases for 1955 program
1978	North-east portion of Santa Barbara County	Santa Barbara County	Ground based, high output silver iodide flares	Estimated increases of approximately 40%

Table 1-2 Summary of Santa Barbara Research Programs (NAWC participated in all of these programs)

Name	Time Period	Study Area	Sponsor(s)	Design	Results
Santa Barbara	1957-1960	Higher Elevations of Santa Barbara and Ventura Counties	State of California, University of California, Santa Barbara County, Ventura County, National Science Foundation, U.S. Weather Bureau, U.S. Forest Service	Randomized seeding using ground based silver iodide generators	Indications of a 45% increase, but results were not statistically significant (Neyman, et al, 1960) (Elliott, et al, 1962)
Water Balance of Orographic Clouds	1960-1963	Santa Ynez and San Gabriel Mountain Ranges	National Science Foundation	Analysis of Precipitation and Rawinsonde data during winter storms	Approximately one quarter of the orographically produced condensate fell as precipitation in the two mountain areas. More precipitation is produced in unstable versus stable air masses
Convection Band Study	1960-1963	Santa Barbara County	National Science Foundation	Analysis of Precipitation and Rawinsonde data during winter storms	The discovery that convection bands are a common feature of winter storms. Bands 20-40 miles wide centered some 30 to 60 miles apart Elliott and Hovind, 1964
Santa Barbara II Phase I	1967-71	Santa Barbara County	Naval Weapons Center, China Lake, California	Randomized seeding of winter convection bands from a single ground site using high output silver iodide flares	Increases in convection band precipitation as high as 50%, several sites statistically significant Brown et al, 1974
Santa Barbara I Phase II	1970-1974	Santa Barbara County	Naval Weapons Center, China Lake, California	Randomized seeding of winter convection bands using aircraft	Increases in convection band precipitation as high as 100%, several sites statistically significant Brown et al, 1974

Table 1-3

Historical Operational Cloud Seeding Periods in Santa Barbara County, Water Year 1982 to Present

(All NAWC programs unless indicated otherwise)

OPERATIONAL PERIOD	TARGET AREA	REMARKS
Jan 15-Apr 15, 1982	Santa Barbara County except South Coast	Airborne seeding, weather radar support provided by Vandenberg Air Force Base. Ground based pyrotechnic flare firing at Tranquillion Park.
Dec 1, 1982-Jan 26, 1983	Santa Barbara County except South Coast	Airborne and ground based pyrotechnic seeding suspended in late January due to heavy rainfall and Lake Cachuma approaching capacity.
Mar 1, 1984-Apr 30, 1984	North County	Airborne seeding and ground based pyrotechnic seeding.
Nov 1, 1984-Apr 30, 1985	Santa Barbara County except South Coast	Airborne seeding and ground based pyrotechnic seeding.
1985-1986		No program due to burn areas in San Luis Obispo and Ventura Counties
Nov 1, 1986-Mar 31, 1987	Santa Barbara County except South Coast	Airborne seeding. Ground based pyrotechnic seeding replaced with two ground based silver iodide generators (Mt. Lospe and Sudden).
Nov 1, 1987-Mar 31, 1988	Santa Barbara County except South Coast	Airborne seeding. Implementation of remotely controlled ground based silver iodide generators began (Mt. Lospe). The use of a computerized targeting model (GUIDE) began.
Nov 1, 1988-Apr 30, 1989	Santa Barbara County except South Coast	Provision of a project specific weather radar was initiated. Airborne seeding. Four manual generator sites (Gaviota, La Cumbre, Sudden, Graham Ranch) and one remote site (Mt. Lospe). Dedicated weather radar.
Nov 1, 1989-Apr 30, 1990	Santa Barbara County except South Coast	Airborne seeding. Four manual generator sites and one remote site. Special project suspension criteria developed for lower Santa Ynez River flow below Bradbury Dam. Dedicated weather radar.

Nov 1, 1990-Apr 30, 1991	Santa Barbara County except South Coast	Special targeting criteria adopted for Painted Cave burn area. Lower Santa Ynez flow suspension criteria continued. Airborne seeding. Three remotely controlled ground generators (Sudden, La Cumbre and Graham Ranch). One ground based manual site (Gaviota). Dedicated weather radar.
Nov. 1, 1991-Apr 21, 1992	Santa Barbara County except South Coast	Targeting restrictions continued for Painted Cave burn area plus Santa Ynez River flow. Airborne seeding. Four remotely controlled and one manually operated ground based silver iodide generators. Dedicated weather radar.
Dec. 1, 1992-Mar 31, 1993	Santa Barbara County except South Coast plus a portion of the Twitchell Drainage in southern San Luis Obispo County.	Cachuma Reservoir spilled for the first time since the 1982-83 winter season. Santa Ynez River flow restrictions continued. New suspension criteria for Twitchell Reservoir inflow adopted. Provision made for acquisition of weather satellite information. Dedicated weather radar.
Dec. 17, 1993-Apr 18, 1994	Santa Barbara County except South Coast plus a portion of the Twitchell Drainage in southern San Luis Obispo County.	Targeting restrictions imposed for the Marre burn area. Santa Ynez River flow and Twitchell Reservoir inflow restrictions continued. Airborne seeding. Six remote generators. Dedicated weather radar.
Nov. 15, 1994-Mar 24, 1995	Santa Barbara County except South Coast plus a portion of the Twitchell Drainage in southern San Luis Obispo County.	Targeting restrictions continued for the Marre burn area. Santa Ynez River flow and Twitchell Reservoir inflow restrictions continued. Airborne seeding. Six remote generators. Cachuma spilled. Dedicated weather radar.
Dec. 14, 1995 - Mar. 13, 1996	Santa Barbara County except South Coast plus a portion of the Twitchell Drainage in southern San Luis Obispo County.	Targeting restrictions for Marre burn area removed. Santa Ynez River flow and Twitchell Reservoir inflow restrictions continued. Continued airborne seeding. 6 remote and 2 manual generators. Dedicated weather radar.
Dec. 9, 1996 - Mar. 22, 1997	Santa Barbara County except South Coast plus a portion of the Twitchell Drainage in southern San Luis Obispo County.	Santa Ynez River flow and Twitchell Reservoir inflow restrictions continued. Airborne seeding. Six remote generators. Two manual generators. Dedicated weather radar.
Nov. 15, 1997-Apr. 30, 1998	Santa Barbara County except South Coast plus a portion of the Twitchell Drainage in southern San Luis Obispo County.	Work performed by Atmospheric, Inc. of Fresno, California. Program onset delayed, operated Jan. 1-Feb. 1, 1998. Program suspended on Feb. 2, 1998 and terminated Mar. 15, 1998 (extremely wet watersheds)
Dec. 15, 1998-Mar. 31, 1999	Santa Barbara County except South Coast plus a portion of the Twitchell Drainage in southern San Luis Obispo County.	Work performed by Weather Modification, Inc. of Fargo, North Dakota

OPERATIONAL PERIOD	TARGET AREA	REMARKS
Dec. 15, 1999-Apr. 5, 2000	Santa Barbara County except South Coast plus a portion of the Twitchell Drainage in southern San Luis Obispo County.	Work performed by Weather Modification, Inc. of Fargo, North Dakota
Dec. 8, 2000-Mar. 31, 2001	Santa Barbara County except South Coast plus a portion of the Twitchell Drainage in southern San Luis Obispo County.	Work performed by Weather Modification, Inc. of Fargo, North Dakota
Dec. 20, 2001 - Mar. 22, 2002	Portions of Santa Barbara and southern San Luis Obispo Counties, emphasizing upper and middle Santa Ynez watershed and lower Twitchell watershed	Revised project design implemented, including airborne seeding and three automated high-output ground-based flare seeding (AHOGS) sites. Custom software utilized to combine NEXRAD and aircraft track data for use in operations.
Nov. 7, 2002 - May 2, 2003	Portions of Santa Barbara and southern San Luis Obispo Counties, emphasizing upper and middle Santa Ynez watershed and lower Twitchell watershed	Airborne seeding and three automated high-output ground-based flare seeding (AHOGS) sites. Custom software utilized to combine NEXRAD and aircraft track data for use in operations.
Nov. 15, 2003 - Apr. 15, 2004	Portions of Santa Barbara and southern San Luis Obispo Counties, emphasizing upper and middle Santa Ynez watershed and lower Twitchell watershed	Airborne seeding and three automated high-output ground-based flare seeding (AHOGS) sites. Custom software utilized to combine NEXRAD and aircraft track data for use in operations.
Nov. 15, 2004 - Apr. 15, 2005	Portions of Santa Barbara and southern San Luis Obispo Counties, emphasizing upper and middle Santa Ynez watershed and lower Twitchell watershed	Airborne seeding and four automated high-output ground-based flare seeding (AHOGS) sites. Custom software utilized to combine NEXRAD and aircraft track data for use in operations. WxWorx display in aircraft cockpit of aircraft location, underlying terrain and current NEXRAD radar data.
Nov. 15, 2005 - Apr. 5, 2006	Portions of Santa Barbara and southern San Luis Obispo Counties, emphasizing upper and middle Santa Ynez watershed and lower Twitchell watershed	Airborne seeding and five automated high-output ground-based flare seeding (AHOGS) sites. Custom software utilized to combine NEXRAD and aircraft track data for use in operations. WxWorx display in aircraft cockpit of aircraft location, underlying terrain and current NEXRAD radar data.

OPERATIONAL PERIOD	TARGET AREA	REMARKS
Nov. 15, 2006 - Mar. 31, 2007	Portions of Santa Barbara and southern San Luis Obispo Counties, emphasizing upper and middle Santa Ynez watershed and lower Twitchell watershed	Airborne seeding and five automated high-output ground-based flare seeding (AHOGS) sites. WxWorx display in aircraft cockpit of aircraft location, underlying terrain and current NEXRAD radar data.

2007-2008 Winter Season	No Operations	Zaca Fire
Nov. 15, 2008 – Apr. 15, 2009	Twitchell watershed located in portions of northern Santa Barbara and southern San Luis Obispo Counties.	Revised project design partially implemented consisting of three high-output ground-based flare-seeding (AHOGS) sites. No aircraft seeding.
Nov. 15, 2009 – Apr. 15, 2010	Portions of Santa Barbara and southern San Luis Obispo Counties, emphasizing upper and middle Santa Ynez watershed and lower Twitchell watershed	Revised project design partially implemented consisting of five high-output ground-based flare-seeding (AHOGS) sites. No aircraft seeding.
Nov. 15, 2010 – Mar. 31, 2011	Portions of Santa Barbara and southern San Luis Obispo Counties, emphasizing upper and middle Santa Ynez watershed and lower Twitchell watershed	Revised project design implemented consisting of airborne seeding and six high-output ground-based flare-seeding (AHOGS) sites.
Dec. 1, 2011 – Mar. 31, 2012	Seeding only for the northern target area; Twitchell watershed.	Revised project design partially implemented consisting of three high-output ground-based flare-seeding (AHOGS) sites. No aircraft seeding

Research has demonstrated that properly conducted cloud seeding programs offer an environmentally safe and cost-effective means of augmenting precipitation from winter storms. NAWC conducted a study for the Santa Barbara County Water Agency (Thompson and Griffith, 1987), which assessed the precipitation augmentation potential from seeding wintertime cloud bands moving over Santa Barbara County. That assessment covered a sixty-one (61) year period (1920-1980). A follow-on study (Solak, et al., 1996) covered the period from 1981 through 1994, applying the same analysis methods. A key conclusion of these studies was that, under average conditions, seasonal precipitation could be optimally enhanced by 18 to 22 percent at Juncal and Gibraltar Dams through seeding of all appropriate precipitation bands from October through April. Seasonal increases of that magnitude could add as much as 4.5 to 5.0 inches of precipitation to the average seasonal total. Realizing the importance and benefit of this additional rainfall, the water purveyors of Santa Barbara County, under the administrative leadership of the County's Water Agency and/or the Flood Control District have sponsored a cloud seeding program in all water years since 1982, with the exception of 1985-1986 and 2007-2008. The 1985-1986 and 2007-2008 programs were canceled due to fires, which produced large burn areas in the project area, which, in turn, created concerns about the potential for excessive erosion and mudslides.

Availability of fresh water in adequate supplies is obviously of paramount importance. Local precipitation has been the major source of water for most areas of California. As part of Santa Barbara County's water resource development and management strategies, cloud seeding operations have been routinely utilized to augment natural precipitation, helping to stabilize annual fresh water supplies. Cloud seeding for precipitation enhancement has been shown to be an effective tool, which carries a very attractive long-term benefit/cost ratio.

The following sections provide NAWC's technical response to the request for proposals. A separate submission contains NAWC's cost estimates to perform this work.

2.0 THEORY OF CLOUD SEEDING FOR PRECIPITATION AUGMENTATION AND RESULTS OF PREVIOUS RESEARCH CONDUCTED IN SANTA BARBARA COUNTY

Two theories have evolved concerning the potential to augment precipitation. One theory postulates that a natural cloud's efficiency in producing precipitation can be increased, while the other theory postulates that seeding can enhance cloud development, leading to additional precipitation. The first theory has often been referred to as the *static* seeding hypothesis while the second relies upon *dynamic* effects of cloud growth. In many situations processes could be operative, whereby a cloud's precipitation efficiency is increased and the cloud is made to grow larger due to the seeding.

Clouds contain water vapor, water droplets and frequently ice crystals if cloud temperatures drop below freezing. Discoveries in the late 1940's established that minute particles of silver iodide, when injected into a cloud that contained supercooled water droplets, would cause those droplets to freeze (Vonnegut, 1947). Supercooled water droplets (droplets in a cloud at temperatures below freezing) frequently exist in clouds, as evidenced by icing on aircraft. These supercooled water droplets are the normal targets of most modern day cloud seeding programs designed to increase precipitation.

2.1 Precipitation Processes

There are two basic mechanisms that produce precipitation: coalescence (sometimes referred to as a "warm rain process") and ice formation (sometimes referred to as a "cold rain process). Coalescence is defined as "the growth of raindrops by the collision and coalescence of cloud drops and or small precipitation particles." This process is especially important in tropical locations in the production of rainfall but it can also be a factor in the production of rainfall in more temperate climates like those found in Santa Barbara County. Ice nucleation consists of a process in which ice crystals may be formed by freezing liquid cloud droplets within a cloud region whose temperatures are below freezing. In such cloud regions the ice crystals, once formed, will gain mass by sublimation (formation of a solid phase directly from a vapor phase, known as the Bergeron-Findeisen process) at the expense of the surrounding liquid cloud droplets that lose mass by evaporation. Upon attaining sufficient weight, the ice crystals (by this time they would be snowflakes) would fall to the ground as snow if the surface temperatures were at or below freezing, but would melt and fall as raindrops if the surface temperatures were warmer than freezing. Of interest to this discussion is the fact that cloud droplets frequently exist in portions of clouds that are colder than freezing. In fact, pure water droplets in a very clean laboratory environment can be cooled to -39C before they will freeze through a process known as homogeneous nucleation). An example of the presence of supercooled cloud droplets in clouds is aircraft icing. Supercooled cloud droplets freeze on impact with the leading edges of the aircraft. When such icing is observed or forecast, aircraft are often sprayed with an antifreeze solution prior to takeoff to avoid accumulation of excessive amounts of icing. This ice nucleation process is important in the production of snow and rain in the more temperate climates like those found in Santa Barbara County. The presence of supercooled water droplets in clouds is often the focus of attempts to artificially modify clouds.

2.2 <u>Ice Nucleation</u>

As discussed in the above, clouds often have unfrozen cloud droplets present at sub-freezing temperatures. These droplets are termed supercooled. The natural tendency is for these droplets to freeze, but to do so at temperatures warmer than -39C they need to encounter an impurity. There are natural particles present in our atmosphere that possess the ability to cause these supercooled droplets to freeze; they are known as freezing nuclei. Research has demonstrated that certain natural particles (e.g., soil particles) and certain bacteria in the atmosphere serve as freezing nuclei. The conversion of a supercooled water droplet into an ice crystal is referred to as nucleation (more correctly, heterogeneous nucleation). It is known that the efficiency of these naturally occurring freezing nuclei increases with decreasing temperatures. It has also been established that naturally occurring freezing nuclei active in the temperature range of approximately -5 to -15^0 C are relatively rare. Research has also shown that minute particles of silver iodide begin to act effectively as freezing nuclei at temperatures colder than -5^0 C (Dennis, 1980). Some more recently developed seeding formulations show nucleation at temperatures as warm as -4^0 C. Silver iodide is the agent most commonly used to "seed" clouds, a process often referred to as "cloud seeding."

There are two types of ice nucleation: condensation-freezing and contact. In condensation freezing, a nucleus first serves as a condensation nucleus in forming a cloud droplet. At temperatures of approximately -5^0 C or colder this same nucleus can serve as a freezing nuclei. In other words, under the right conditions, a nucleus can a) cause condensation, forming a cloud droplet and b) then promote freezing on the same nucleus, forming an ice crystal. Contact nucleation, as the name implies, means that a freezing nucleus must come in physical contact with a supercooled water droplet, thus causing it to freeze (as long as the temperature of the cloud droplet is cold enough for the freezing nuclei to be active). Contact nucleation can be a relatively slow process (from a few to tens of minutes) compared to condensation-freezing nucleation, which can be quite rapid (on the order of one minute).

2.3 Impacts of Silver Iodide Seeding

Since a scarcity of natural ice nuclei commonly exists in the atmosphere at temperatures in the range of -5 to -15^0 C, many clouds may be inefficient in converting water droplets into ice crystals. The addition of silver iodide nuclei to these cloud regions can produce additional ice crystals, which, under the right conditions, grow into snowflakes and fall out of the clouds as either snow or rain. Rain is produced by the melting of such snowflakes when they fall through warmer air near the ground. This increase in efficiency is usually referred to as a *static* seeding effect.

In the process of converting supercooled water droplets to ice, additional heat is added to the cloud due to the release of latent heat of fusion. This additional heat may invigorate the circulation of air within the clouds, resulting in a *dynamic* effect. This postulated *dynamic* effect was the basis for a National Oceanic and Atmospheric (NOAA) research program conducted in Florida known as the Florida Area Cumulus Experiment (FACE). Two different phases of FACE 1, 1970-76 and FACE 2, 1978-80 (Woodley, et al., 1983) indicated increases in area wide rainfall, but results fell short of strict statistical acceptance criteria. Rainfall increases from seeded convection bands in the Santa Barbara II research program (Brown, et al., 1974) were attributed to both *static* and *dynamic* effects. NAWC conducted this research program in Santa

Barbara County with funding from the Naval Weapons Center at China Lake, California. This research program is discussed in the next section.

2.4 Santa Barbara II Research Program

The Santa Barbara II research program consisted of two primary phases. Phase I consisted of the release of silver iodide from a ground location near 3,000 feet MSL located in the Santa Ynez Mountains north of Santa Barbara. These silver iodide releases were made as "convective bands" passed overhead. The releases were conducted on a random seed or no-seed decision basis in order to obtain baseline non-seeded (natural) information for comparison. A large network of recording precipitation gauges was installed for the research program (Figure 2.1). The amount of precipitation that fell from each seeded or non-seeded convective band was determined at each precipitation gauge location. Average convective band precipitation for seeded and non-seeded events was calculated for each rain gauge location. Figure 2.2 shows the results of seeding from the ground as contours of the ratios of average seeded band precipitation versus the non-seeded band precipitation.

Ratios greater than 1.0 are common in Figure 2.2. A ratio of 1.50 would indicate a 50 percent increase in precipitation from seeded convection bands. The high ratios in Southwestern Kern County are not significant in terms of amounts of additional rainfall since the convective bands (both seeded and non-seeded) rapidly lose intensity as they enter the San Joaquin Valley. In other words, a high percentage applied to a low base amount does not yield much additional precipitation. These apparent effects may be due to delayed ice nucleation which would be expected with the type of seeding flares used in this experiment that operated by contact nucleation which is a relatively slow process (see Section 2.2).

The low amounts of natural precipitation in southwest Kern County results from evaporation in "downslope" flow in the winter storms that affect this area. Such predominant "downslope flow" areas are frequently known as rain-shadow areas in the lee of mountain ranges. Figure 2.3 dramatically exhibits this feature from the coastal mountains in Central and Southern California, which are wet, to the San Joaquin and Imperial Valleys, which are dry. The 1.5 ratios along the backbone of the Santa Ynez Mountains are, however, significant in terms of rainfall amounts since this area receives higher natural precipitation during winter storms due to "upslope" flow. This upslope flow is also known as an orographic effect and accounts for many mountainous areas in the west receiving more precipitation than adjoining valleys (especially downwind valleys). It was concluded that convection band precipitation was increased over a large area using this ground seeding approach.

In a similar experiment, phase II employed an aircraft to release silver iodide (generated by silver iodide - acetone wing tip generators) into the convective bands as they approached the Santa Barbara County coastline west of Vandenberg Air Force Base. The convective bands to be seeded were also randomly selected. Figure 2.4 provides the results. Again, a larger area of higher precipitation is indicated in seeded convective bands compared to non-seeded convective bands. Notice the westward shift of the effect in this experiment versus the ground-based experiment. This feature is physically plausible since the aircraft seeding was normally conducted off the coastline in the vicinity of Vandenberg AFB (i.e., west of the ground-based release point).

A study of the contribution of "convective band" precipitation to the total winter precipitation in the Santa Barbara County and surrounding areas was conducted (in the analysis of the Santa Barbara II research program). This study indicated that convective bands contributed approximately one-half of the total winter precipitation in this area (Figure 2.5). If it is assumed that all convective bands could be seeded in a given winter season and that a 50 percent increase was produced, the result would be a 25 percent increase in winter season precipitation if we assume the convective bands would have contributed one half of the winter season's rainfall. The two reports mentioned earlier (Thompson et al., 1988 and Solak et al., 1996) provided a more precise quantification of the optimal seeding increases that might be expected at Juncal and Gibraltar Dams (i.e., 18-22%) from seeding convective bands.

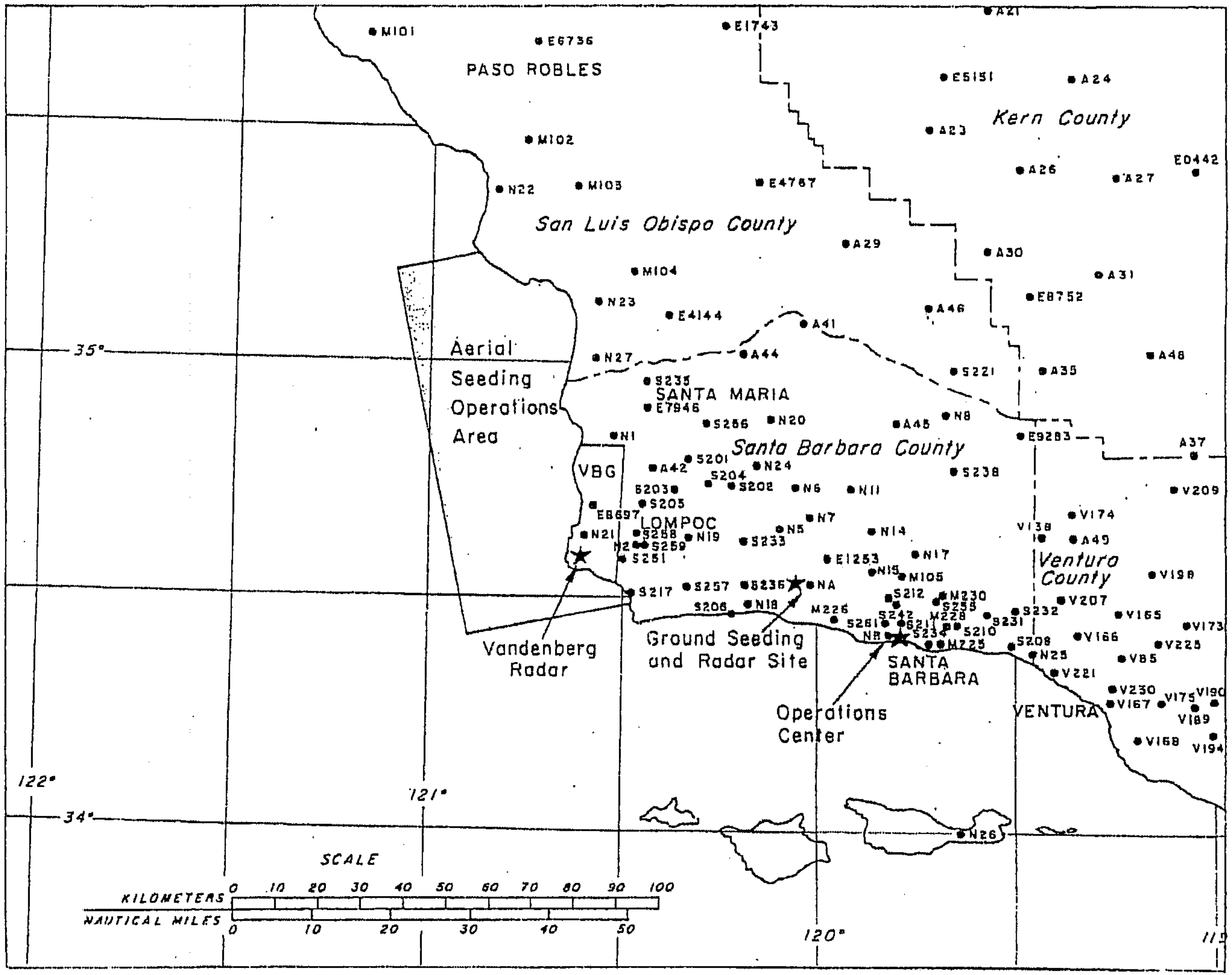

Figure 2.1 Santa Barbara II project map showing raingage locations, radar, and seeding sites.

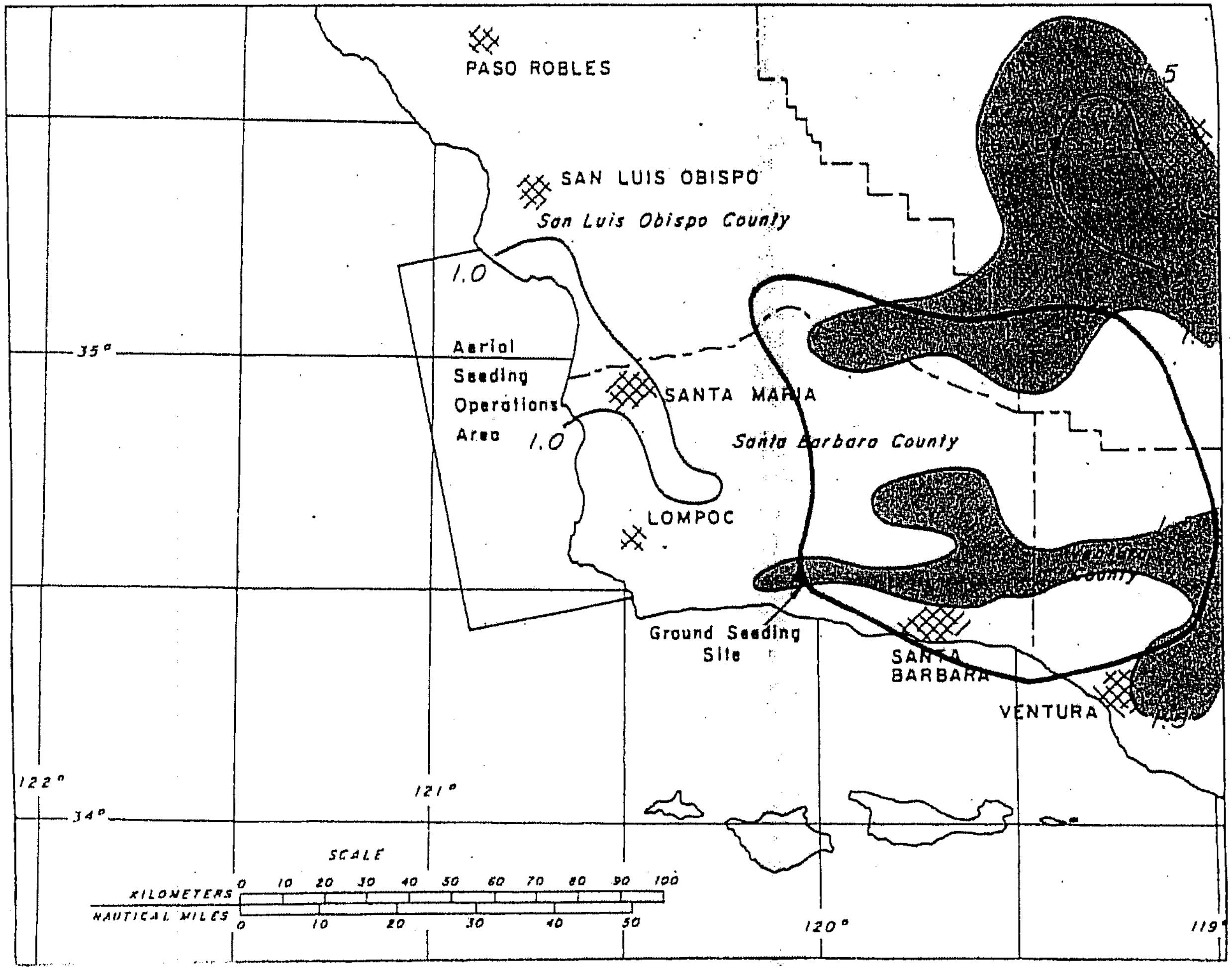

Figure 2.2 Seeded/not-seeded ratios of band precipitation for Phase I ground operations, 1967-71 seasons; 56 seeded and 51 not-seeded bands.

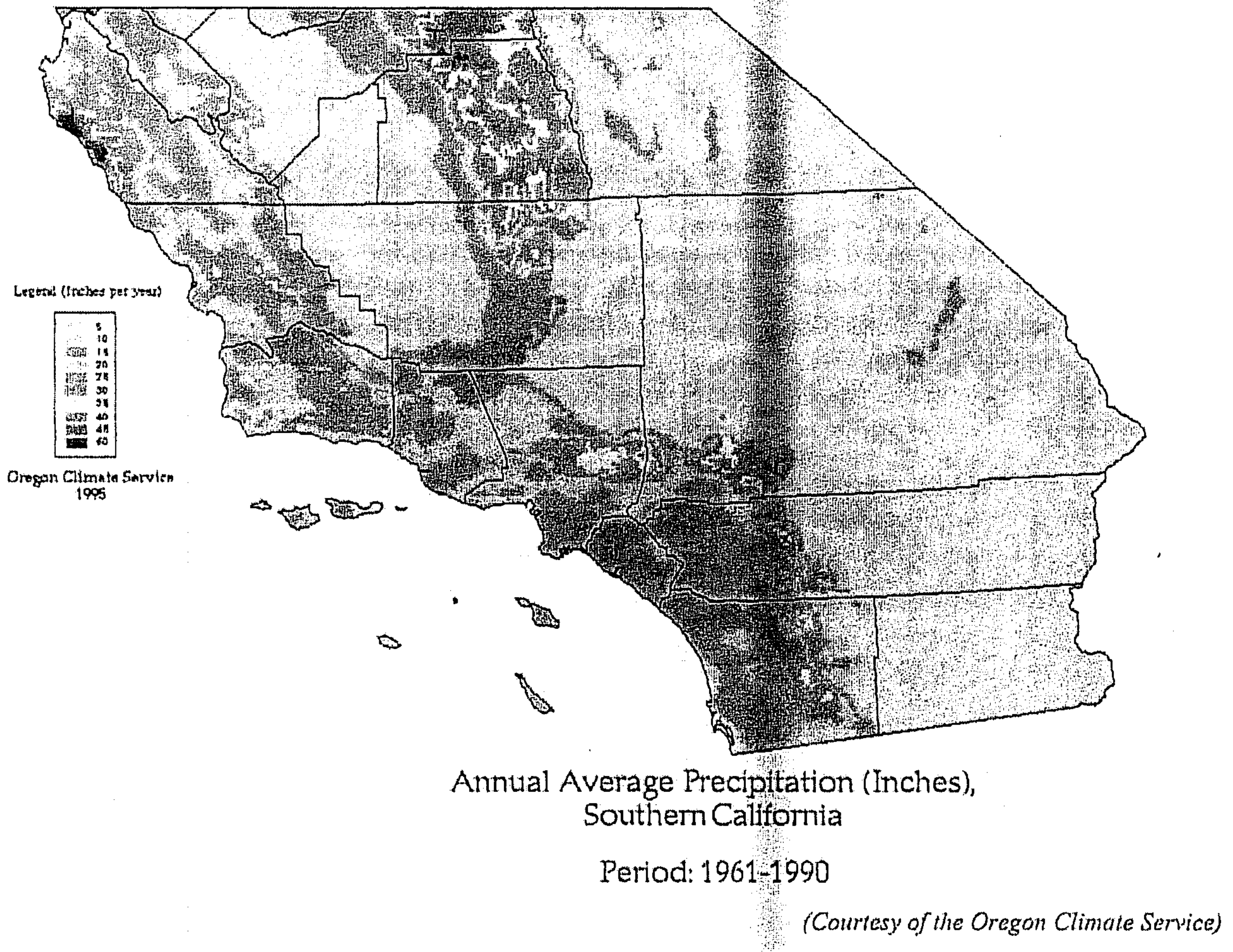

Figure 2.3 Annual Average Precipitation (inches), Southern California - Period: 1961-1990.
(Courtesy of the Oregon Climate Service)

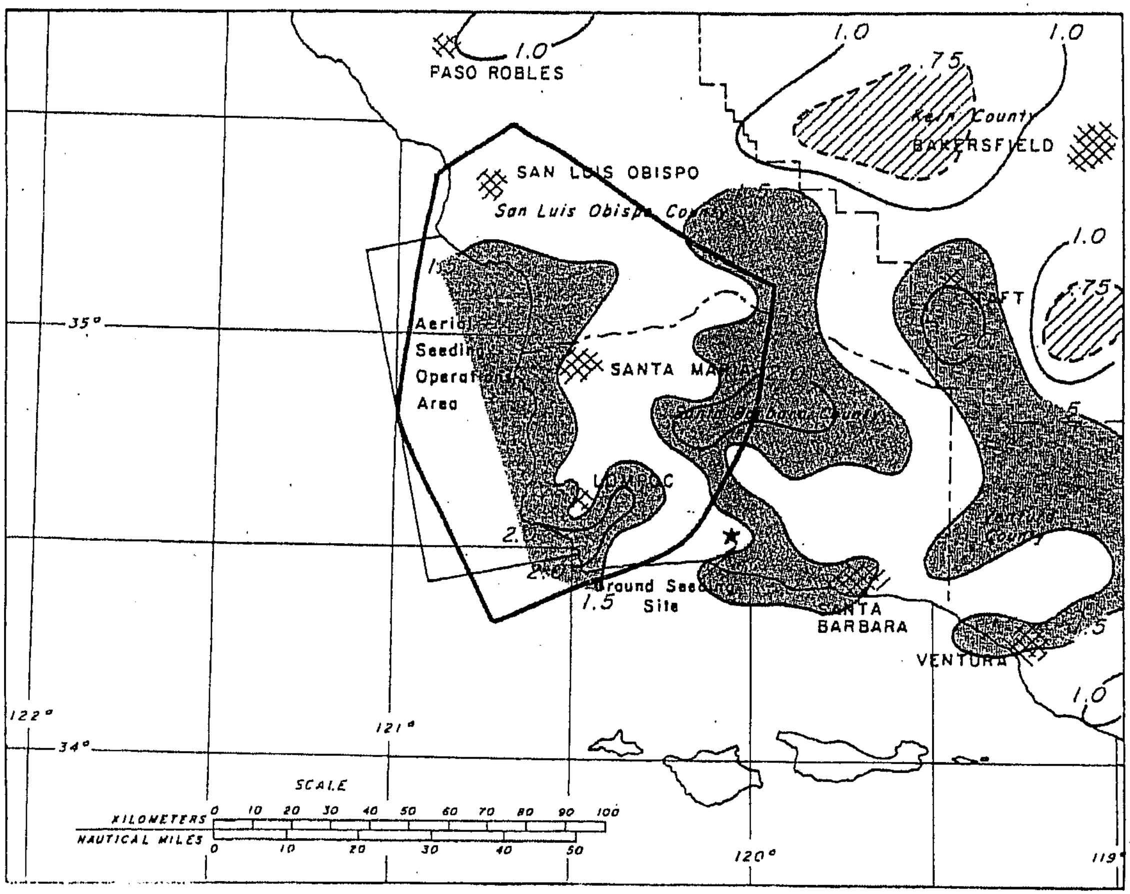

Figure 2.4 Seeded/not-seeded ratios of band precipitation for Phase II aerial operations, 1970-74 seasons; 18 seeded and 27 not-seeded bands.

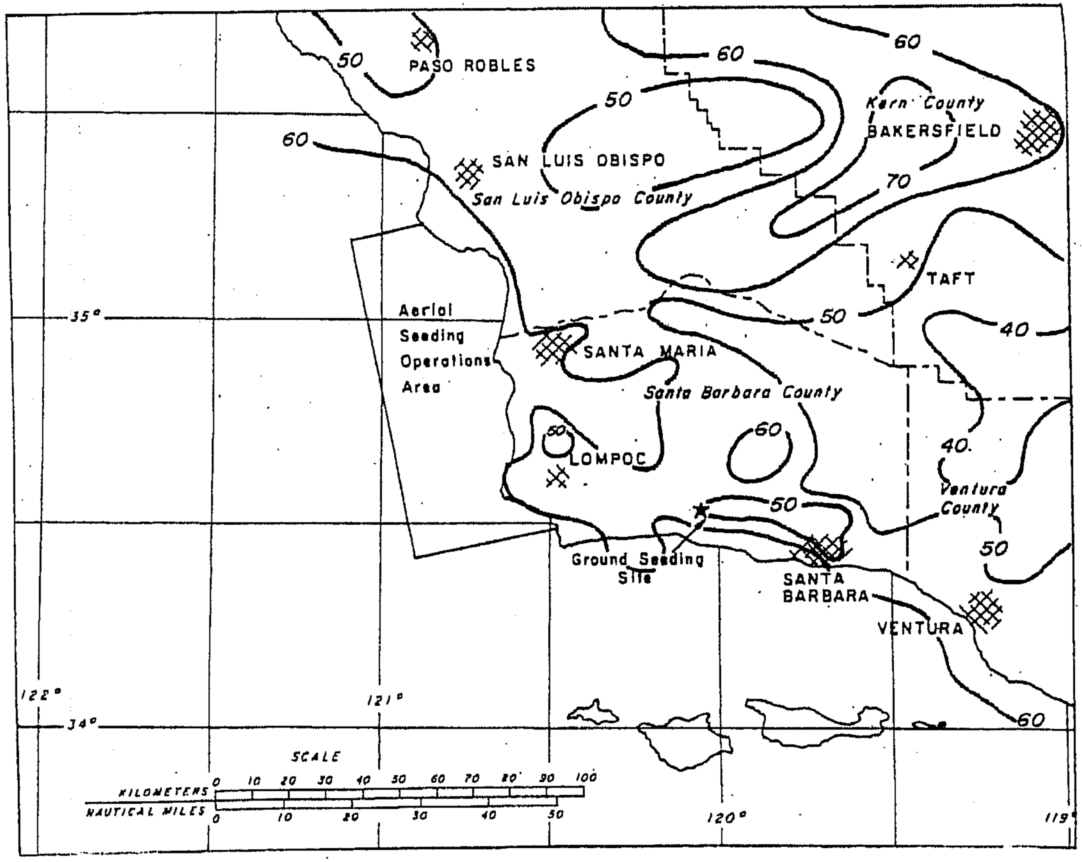

Figure 2.5 Approximate percentage of winter precipitation occurring in convection bands, 1970-74 seasons

For illustration purposes, Figure 2.6 provides a sequence of six radar images of a convection band as it moved into Santa Barbara County on April 11, 2010. The radar images are from the Vandenberg AFB NEXRAD radar site. Table 2-1 shows short duration rainfall values at Santa Maria during this event.

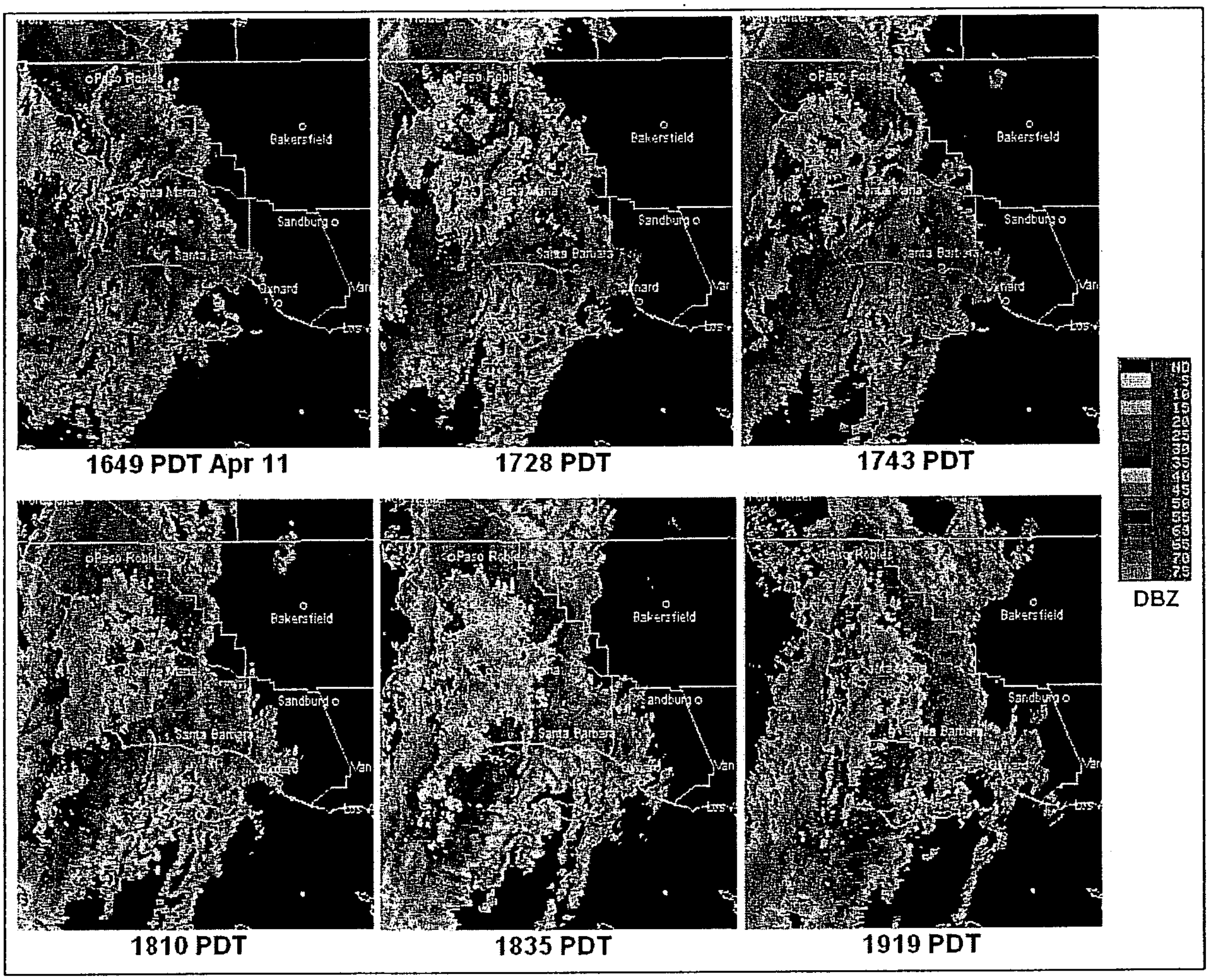

Figure 2.6 Convection Band passing over Western Santa Barbara County on April 11, 2010 as observed by the Vandenberg AFB NEXRAD Radar

Table 2-1. Short Duration Rainfall Amounts (inches) at the Santa Maria Airport During Storm Event in Figure 2.6

Period (PST)	1651-1716	1716-1730	1737-1741	1741-1750	1750-1851	1851-1914
Precipitation (in)	0.06	0.21	0.42	0.46	0.21	0.08

More recent research conducted in Texas (Rosenfeld and Woodley, 1993; Rosenfeld and Woodley, 1997) and in Thailand (Woodley and Rosenfeld, 1999) has also indicated additional rainfall being produced from silver iodide seeding of convective cloud elements. These increases appear to occur due to increased duration of the seeded entities rather than increases in precipitation intensity. These indications are in agreement with the results observed in the Santa Barbara II research program.

In summary, earlier research conducted in Santa Barbara County indicated that "convection bands" are a common feature of winter storms that impact Santa Barbara County and that those bands contribute a significant proportion of the area precipitation. In addition, research has indicated that these bands contain supercooled liquid water droplets; the target of most modern day cloud seeding activities (Elliott, 1962). Seeding these bands with silver iodide either from the ground or air increases the amount of precipitation received at the ground. These bands are typically oriented in some north to south fashion (e.g. northeast to southwest, northwest to southeast, etc.) as they move from west to east. It is common to have at least one convection band per winter storm with as many as three or four per storm being fairly common. One band is usually associated with cold fronts as they pass through the county. Frequently these frontal bands are the strongest, longest lasting bands during the passage of a storm. Other bands may occur in either pre-frontal or post-frontal situations. The duration of these bands over a fixed location on the ground can vary from less than one hour to several hours duration.

3.0 PROJECT DESIGN

NAWC's philosophy in the design of operational precipitation enhancement programs is to base the design on the results of previously conducted successful research programs that appear to be transferable to the intended target area. We keep abreast of technological changes that may be incorporated into the design of our programs but resist the temptation to employ all of the latest "gadgets" indiscriminately. We have observed that providing too many tools and duties for field personnel to perform may become counter-productive; it is easy to become lost in the details and lose sight of the key issues that need to be addressed in real-time. In other words, it is easy to get behind the power curve on a cloud seeding program when things are happening quickly. The question we ask ourselves is whether the addition of some new tool or technique will materially assist our field project personnel in doing a better job of identifying seeding opportunities and in more effectively treating these opportunities in a cost effective manner. **The bottom line is - will a given "improvement" to the program result in more water on the ground?** We believe this philosophy is in agreement with our clients' fundamental goals for their programs.

For the 2001-02 Santa Barbara winter program, NAWC proposed and the Agency accepted several modifications to the project design previously used in the conduct of this project. These changes were suggested to more closely duplicate the earlier Santa Barbara II research program, which was quite successful (refer to Section 2.4). The basic components of this revised design included: three newly designed ground-based, high output, remotely controlled flare release sites that were established at Mt. Lospe, Sudden Peak and Rancho Dos Vistas. These sites replaced a network of eight ground based liquid fueled cloud nuclei generators used previously. A specially modified twin engine Beechcraft Baron aircraft was used to treat cloud systems (using acetone-silver iodide generators) over the Pacific Ocean to the west and south of the county. The aircraft was equipped with a GPS radio modem, which provided aircraft location and altitude information to the project operations center. The project operations center was established at the Santa Barbara Airport. Another change consisted of the use of National Weather Service NEXRAD weather radar sites to provide needed radar information instead of installing project dedicated weather radar. Formerly, NAWC had installed and operated a radar sited at an exposed location on former President Reagan's ranch located on the Santa Ynez Mountain ridgeline north of Gaviota. This same revised design was used in the conduct of the 2002-2011 rainy season projects with three modifications. These modifications consisted of 1) the establishment of three additional ground based, remotely controlled high output flare sites (West Camino Cielo, Gibraltar Road, Harris Grade) 2) the use of a higher performance Cessna 340 aircraft replacing the Beechcraft Baron beginning with the 2004-2005 program, and 3) utilization of high output seeding flares on the Cessna 340 aircraft instead of the acetone-silver iodide generators used previously. **This modified design, with some minor modifications, is again proposed to be used to guide the upcoming 2012-2013 rainy season project.** Rationale for this revised design is provided in the following sub-sections. Figure 3.1 provides a map that contains the two target areas (Upper and Middle Santa Ynez Watershed Target area and the Huasna-Alamo) as specified in the RFP.

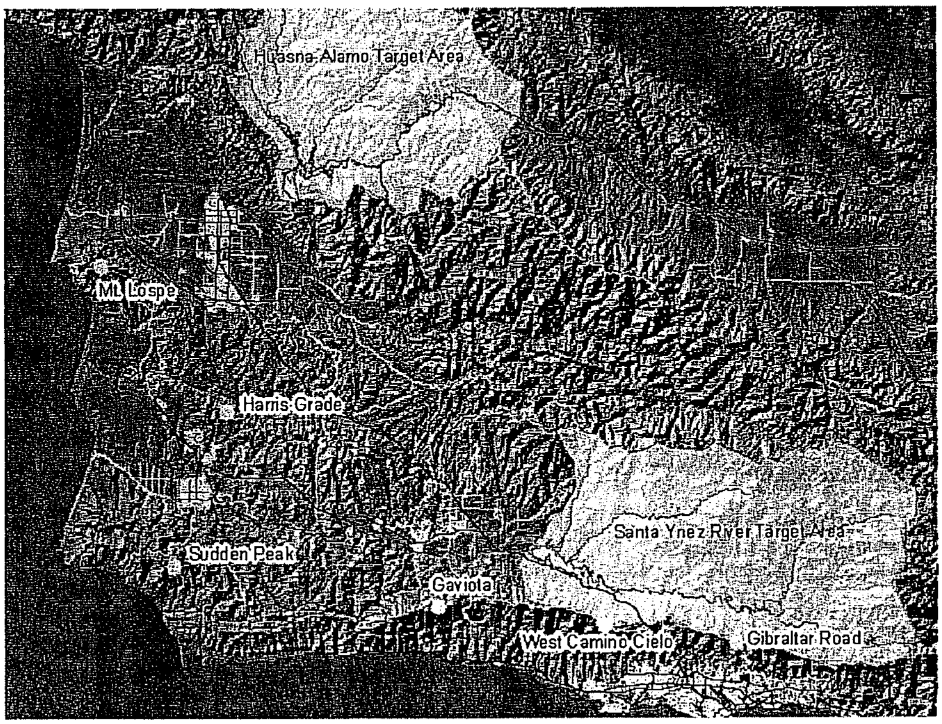

Figure 3.1 Map of the Two Target Areas

3.1 Project Design Considerations

The field of weather modification is an interesting one. Both research and operational programs have been conducted in the United States and a number of other countries dating back to the 1950's. This field has generated its fair share of controversy. The scientific community is still somewhat divided as to the efficacy of weather modification. The types of precipitation augmentation programs that find the most scientific acceptance are the winter orographic (mountainous) programs. The Santa Barbara program would be considered an orographic one based upon the coastal mountain settings of the target areas.

Several professional societies have adopted capability or position statements regarding weather modification programs. The principal societies or associations that have existing weather modification statements include:

- The Weather Modification Association (WMA)
- The American Meteorological Society (AMS)
- The American Society of Civil Engineers (ASCE)

Excerpts from these statements that pertain to winter precipitation augmentation are provided in Appendix B.

From the preceding organizational statements, the following key points regarding the current status of winter orographic seeding emerge:

X Of the primary categories of cloud seeding for precipitation increase; seeding of winter orographic storm systems seems to offer the best prospects for increasing precipitation in an economically viable manner.

X Strong (albeit largely non-randomized) statistical evidence exists for (winter) seasonal increases of the order of 5% to 15% and potentially greater in some coastal regions.

X A growing body of evidence from focused physical studies is confirming some key steps in the weather modification process, in support of the statistical evidence.

- X Additional research is recommended/encouraged. It is recognized that (needed) additional applied research can shed much valuable light on the physical processes involved, leading to improved opportunity recognition and intervention, resulting in more optimum augmentation operations, especially given technological advancements in observational systems and computer modeling.
- X Accurately quantifying the effects of cloud seeding programs remains a challenge.

3.2 Proposed 2012-2013 Program Design

As stated previously, it has always been NAWC's philosophy that the design of our operational programs should be based upon prior research programs that provided positive indications of increases in precipitation, to the extent that the research results are considered to be representative of the operational programs' conditions (i.e., transferable results). The Santa Barbara area has a unique advantage in this regard since a well-funded winter research program was conducted during the winters of 1967-1973, with funding provided by the Naval Weapons Center at China Lake, California. Section 2.4 discusses the results of this research program which were very positive. This program was known as the Santa Barbara II research program (an earlier research program, Santa Barbara I, was also conducted by NAWC). The Santa Barbara II program focused on seeding convective bands embedded in naturally occurring winter storms. Phase I involved ground seeding and Phase II involved airborne seeding.

Even though this research program was conducted approximately 40 years ago, it is our professional opinion that it offers the most relevant information for the design of precipitation enhancement programs for this area at the present time. There have not been any winter weather modification research programs conducted in representative coastal areas of the United States since Santa Barbara II. **This is a prime example of technology transfer from research to operations.** One of the reasons we feel this research program is so valuable in this area is due to the location of Santa Barbara County. Since the county faces the Pacific Ocean to the west and south and the fact that winter storms move through the county from these directions, there are no upwind land areas that provide precipitation measurements outside of areas potentially impacted by the seeding. NAWC has often used a target and control approach in an attempt to evaluate the effects of operational seeding programs. Precipitation data from upwind control areas are used to estimate natural target area precipitation. These estimates are then compared to the actual precipitation that falls in the target areas during the seeded period. Systematic differences may then be inferred to be the result of seeding. Due to the unique location of Santa Barbara County, there are no upwind control measurements that can be used to perform this type of analysis. This leaves the question most frequently asked about operational programs, "Did the seeding work and, if so, how much did it contribute?" unanswered. As a consequence of the above, **we believe the best project design for a winter cloud seeding program in Santa Barbara County to be one that duplicates, as much as possible, the design of the Santa Barbara II research Program. In fact, the combination of Phase I and II seeding modes should optimize the seeding potential for the area. Our design is based upon this approach.** More details regarding the proposed design are provided in a categorical fashion in the following sections.

The 2011 RFP initially requested three options for three possible seeding scenarios:

1. An aerial and ground program for both target areas, four months ground and three months ground and air.
2. A ground only program for both target areas, four months
3. A ground only program for the Huasna-Alamo target area only, four months.

The Agency specified that a ground only four month program covering both target areas should be conducted during the 2012-2013 rainy season (option #2 in the above). This proposed design therefore focuses on the 2012-2013 season.

3.3 Personnel

Mr. Don Griffith will serve as the project meteorologist operating from NAWC's home office in Sandy, Utah. Mr. David Yorty will provide backup to Mr. Griffith. The project meteorologist will perform the various project duties needed to conduct a safe and effective operation. A partial list of these duties is provided in Table 3-1.

Table 3-1

Partial List of Duties to be Performed by Project Meteorologist

1)	Constantly monitor weather conditions and determine, based on meteorological data and radar observation, the approach of seedable storm systems.
2)	Estimate the probable results and impacts of seeding using predictive computer models, real time rain and river flow data ("Alert System" provided by Flood Control), and other information. Such estimates shall be updated regularly as conditions change.
3)	Coordinate with Flood Control and Water Agency personnel to determine potential flows in key water courses and determine the appropriate action regarding seeding activities.
4)	Direct the actual seeding operations using appropriate storm selection and target area criteria and continuously monitor air and ground seeding operations using radar and remote interrogation systems.
5)	Maintain constant and continuous control over all air and ground seeding and keep an accurate written log of the time that seeding begins or ends.
6)	Inform Flood Control and Water Agency Personnel, through prescribed communication channels and in a timely manner, of all significant events relative to the program.
7)	Maintain, and submit copies of written operations reports to the Water Agency in a timely manner. At a minimum, such reports shall be submitted subsequent to each seeding event (see Communications for final report requirements).
8)	Provide necessary radar and precipitation data to Flood Control and Water Agency staff as requested during periods of heavy rainfall or flooding.
9)	Determine when conditions are such that program operations should be suspended for any weather related reason and adhere to suspension criteria designed by Flood Control and the Water Agency prior project initiation.

Mr. Don Griffith, President of NAWC, will also provide overall supervision of the program. Mr. Griffith has extensive experience in the design, operation and evaluation of weather modification programs. His involvement in weather modification has been continuous, beginning in the 1960's. He worked on a weather modification research program through Fresno State College in the late 1960's and early 1970's in the Sierra Nevada of California. He also worked on another major research program in the Sierra Nevada (SCPP) after joining NAWC. He was a resident of Santa Barbara from 1973-80, so he is very familiar with the meteorology of Santa Barbara County. He also was involved with a portion of the Santa Barbara II research experiment and is quite familiar with this research program, which serves as the foundation of the recommended NAWC design for the current operational program. Mr. Griffith is certified by the Weather Modification Association (WMA), as a Certified Manager and Operator and by the American Meteorology Society as a Certified Consulting Meteorologist (CCM). He is currently serving as President of the Weather Modification Association.

We also propose to have a local technician, Mr. Victor Lee, available to provide technical part-time support to NAWC on an as needed basis. Mr. Lee provided these services to NAWC for the 2011-2012 rainy season project. He will primarily be responsible for the installation, recharging, maintenance and de-commissioning of the ground based flare sites. Mr. Lee is quite familiar with the procedures needed to access the ground sites and in some cases, like Mt. Lospe, where the local landlord does not wish there to be access to this site following heavy rainfall periods. Mr. Lee lives in Orcutt, which is an excellent central location, considering the locations of the six ground sites proposed to be activated for the 2012-2013 program.

3.4 Weather Radar

In years prior to the 2001-2002 winter season, NAWC used dedicated project radar to direct operations for the Santa Barbara project to avoid reliance on Vandenberg AFB's radar to direct operations (as was done in the 1982-1988 period). Scheduling the use of the Vandenberg AFB radar was difficult at times due to other activities that utilized this facility. Another reason for dedicated project radar was the lack of usable weather radar information from the National Weather Service (NWS) in this area. This was a common shortcoming of NWS radar products in the western United States prior to the mid 1990's. This situation changed dramatically when the NWS, through a modernization effort in the 1992-1997 period, installed a network of very sophisticated 5 cm weather radars throughout the U.S. These sites are known as NEXRAD (Next Generation Radar) installations. Each installation cost on the order of $1,000,000. Figure 3.2 provides the array of these sites across the U.S. There are 159 NEXRAD sites now in service. NEXRAD radars provide information on precipitation intensities and wind speed and direction within the precipitation echoes. The radars step scan through 14 different elevation angles in a 5 minute period and a computer program integrates the stepped scans into a volume scan. Several very sophisticated algorithms then produce a large number of specialized displays and products from each volume scan. The maximum range for the detection of precipitation echoes is 143 miles from each site. The NWS provides all the necessary support for these systems; operation, calibration, spare parts and maintenance. Because the NEXRAD network is important to NWS forecasting and public safety responsibilities, to many hydro meteorological applications

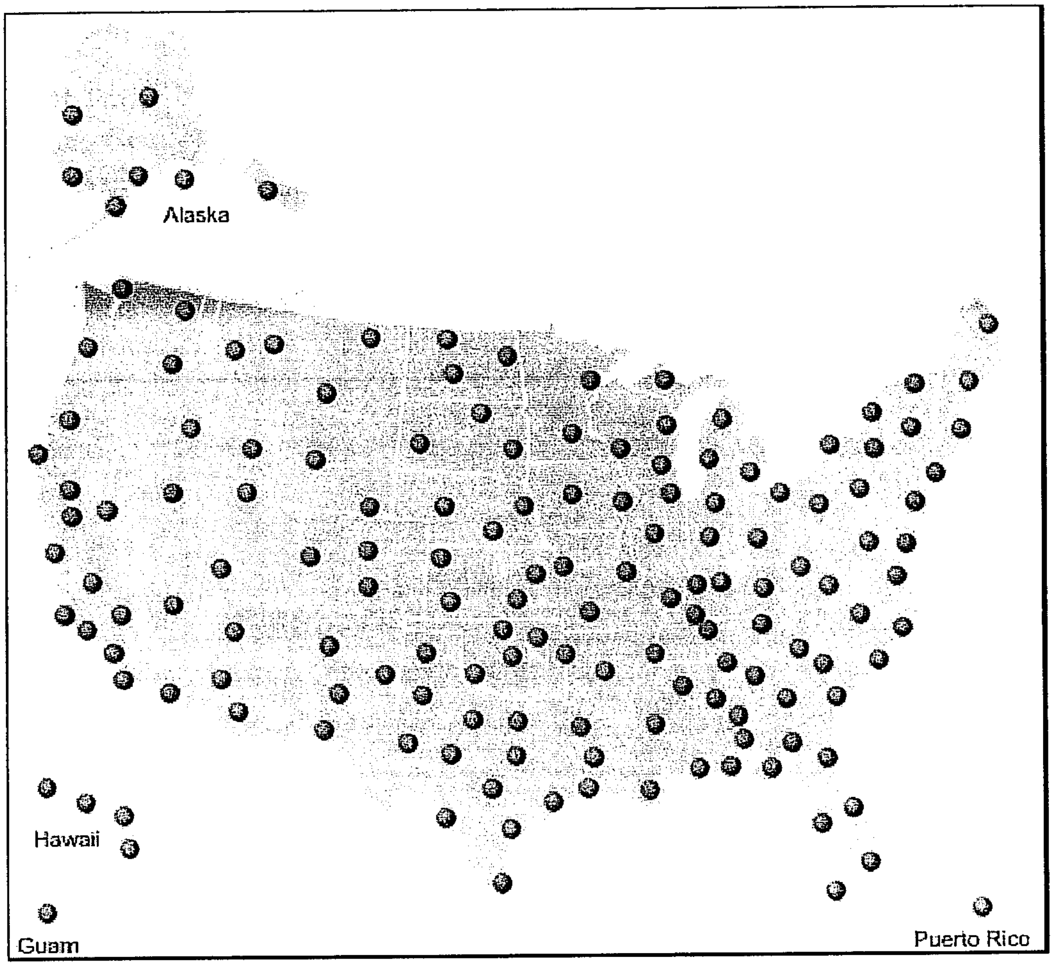

Figure 3.2 US NEXRAD Radar Locations

and to aviation safety, these radars enjoy high priority support and resultant reliability. NAWC proposes to continue its use of relevant NEXRAD radar products, which are readily available in near real-time via the internet, for the conduct of the cloud seeding program in Santa Barbara County.

The Doppler wind capability provides rapid update (every six minutes) NEXRAD vertical azimuth display (VAD) wind profiles which are invaluable in visualizing and identifying changes in the environmental wind fields that may affect seeding material and precipitation fallout trajectories. Figure 3.3 provides an example of VAD wind profiles for approximately a one hour period during a storm that impacted Santa Barbara County on March 20, 2011. This figure provides wind barbs at 1,000 foot intervals from 0340-0423 PDT. The wind direction is given by the direction the barbs are pointing. All the winds during this period were blowing from the south or southwest towards the north or north-east. This is very typical during the passage of storms through Santa Barbara County. The strength of the wind is indicated by the number of flags on each barb. Typically each barb represents a wind speed of 10 nautical miles per hour, a short barb 5 nautical miles per hour. A triangular colored barb represents a value of 50 nautical miles per hour. It is seen that the wind speeds were greater than 50 knots above the 4,000 to 6,000 foot level during this period.

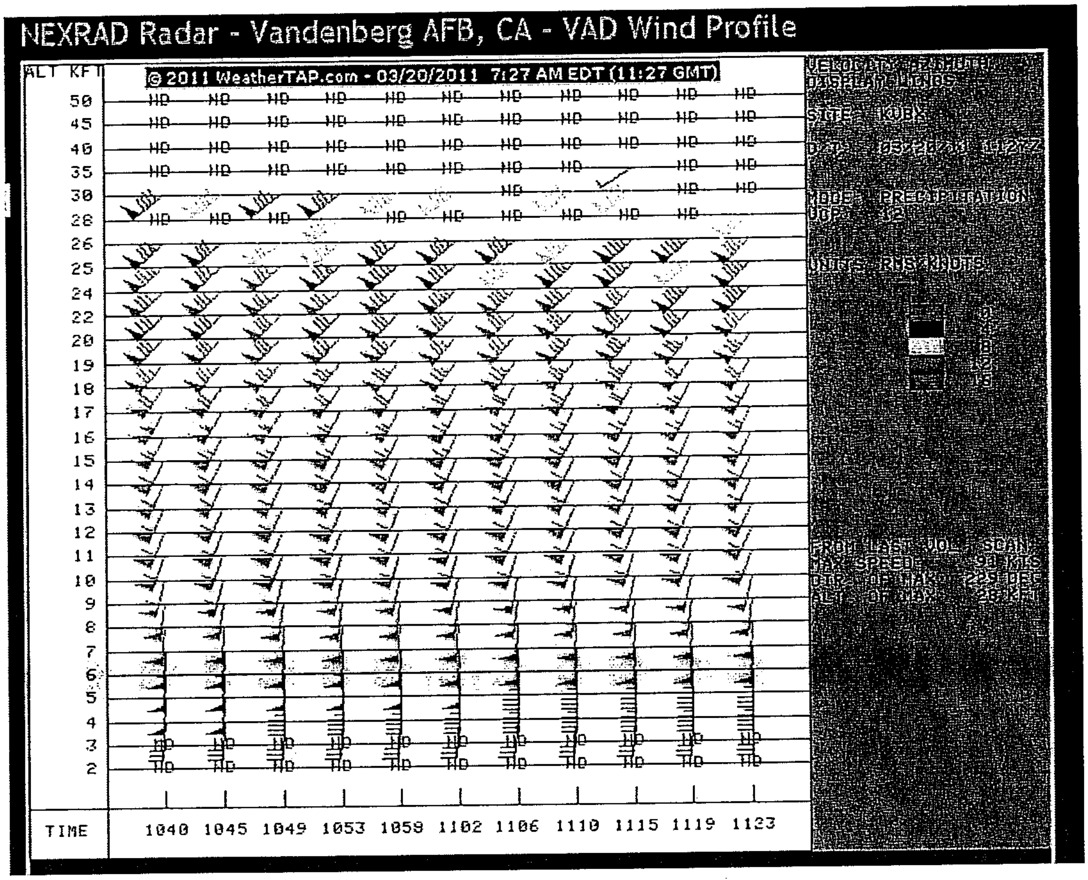

Figure 3.3 Vandenberg AFB Doppler Winds, 1040-1123 PDT, March 20, 2011

NEXRAD data are available in near real time at approximately 5-6 minute intervals through a variety of internet web sites. NAWC has utilized the WeatherTap (commercial, subscription) web site extensively over the past eight years to provide radar data to conduct wintertime cloud seeding programs. This web site provides a variety of useful products including: echo intensities (precipitation), echo tops, vertical wind speed and direction (the very useful VAD displays mentioned earlier) and composite echo displays that integrate radar returns from all of the 14 different elevation scans. There are two primary NEXRAD sites that provide coverage of Santa Barbara County: Vandenberg AFB and Los Angeles (actually located near Ojai). These locations are fortuitous and complementary, since there is the potential for some terrain blockage of the radar beam by mountain ranges. The Santa Ynez mountain range can block some radar returns from the Vandenberg radar to the south and block echoes to the north of the Ojai site. Most weather during the rainy season in this area moves in from the south through northwest. The Vandenberg AFB radar will provide data, which are not blocked by terrain from the southwest to northwest directions. The Ojai radar will provide unblocked data for storms that move in from the south. This is a powerful combination for the conduct of cloud seeding programs in Santa Barbara County.

Figure 3.4 provides a Vandenberg Air Force Base NEXRAD radar image showing a convection band approaching Santa Barbara County. The different colors in this figure represent different radar reflectivity (dBz) levels, which correspond to different rainfall rates. The only feature lacking in the utilization of NEXRAD data to conduct cloud seeding programs in the Santa Barbara area is the provision of flight track information on the cloud seeding aircraft locations. Utilization of NEXRAD data to conduct cloud seeding programs in the Santa Barbara area requires a separate provision of cloud seeding aircraft location and flight track information.

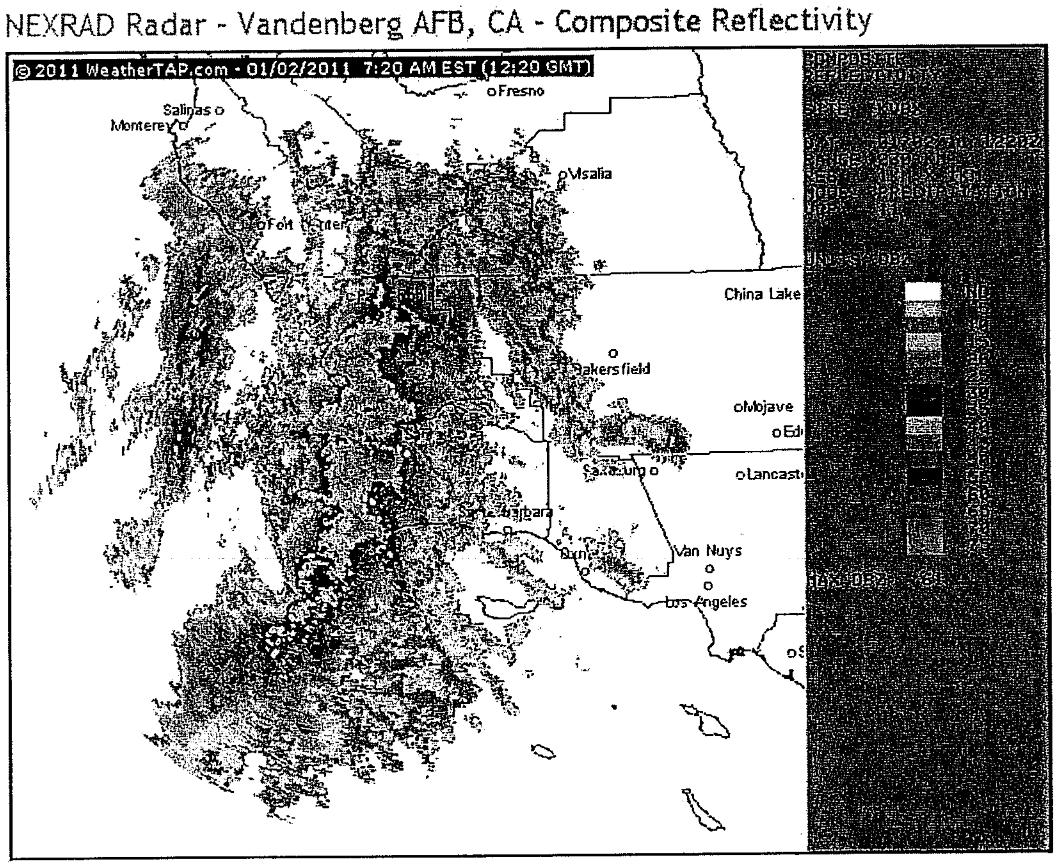

Figure 3.4 Vandenberg AFB Radar Image at 0420 PST on January 2, 2011

3.4 Ground Seeding Sites

Previously, NAWC working in conjunction with Agency personnel identified six strategically located ground sites at which NAWC installed custom designed remotely operated silver iodide pyrotechnic equipment. Site locations include Mt. Lospe, Harris Grade, Sudden Peak, Gaviota, West Camino Cielo and Gibraltar Road. Locations of the sites in relation to the project target areas were provided in Figure 3.1. Previous target areas include the Upper and Middle Santa Ynez Watershed Target area and the Huasna-Alamo Target area. NAWC will install all six remotely controlled high output pyrotechnic ground sites for the 2012-2013 rainy season.

NAWC developed a completely new design for a remotely controlled ground based flare site for the 2001-02 winter program (AHOGS - Automated High Output Ground Seeding System). This new design was used for the 2001-2010 programs. The AHOGS system allows automated, focused, high-output seeding releases from strategic ridgeline locations under program control from the project operations center with the proper computer software and password. These systems give the project meteorologist the ability to conduct intensive seeding of convection rain bands as they track into and across the project area under different wind flow regimes on a 24/7 basis. Each AHOGS consists of the following primary onsite components:

- Two flare masts, which hold a total of 32, 150-gram (fast-acting AgI) flares.
- Spark arrestors that enclose each flare.
- An environmentally sealed control box containing a cellular phone communications system, digital firing sequence relays/controller, data logger and system battery.
- A solar panel/charge regulation system to maintain site power.
- Cellular phone antenna.
- Lightning protection.

Each site is controlled via a modem-equipped PC at the operations center, running custom software to manage the flare seeding operations. The meteorologist has the option of firing flares individually in real time, or to order batch firing of any number of flares at selectable intervals at each site, e.g., three flares at 15-min intervals, beginning at any selected time. The software allows monitoring and reporting of AHOGS site status information, such as flare inventory and battery voltage.

Figure 3.11 provides a photograph of an installation of one of these units at the Gibraltar Road site. Figure 3.12 shows a close-up of flares mounted in one of the masts. The original AHOGS design was modified for the 2005-2006 project through the introduction of a NAWC custom designed spark arrestor. These spark arrestors, which fit over each of the flares, were developed to assure no large sparks or burning embers were released from the flare burns that could pose a fire concern. Normally, this would not be a concern since flares are only burned when rain is occurring eliminating any fire danger. These arrestors were developed in case of an accidental misfire or burning flares at the beginning of a storm following an extended dry spell. Figure 3.13 provides a photo of a flare burning inside a spark arrestor.

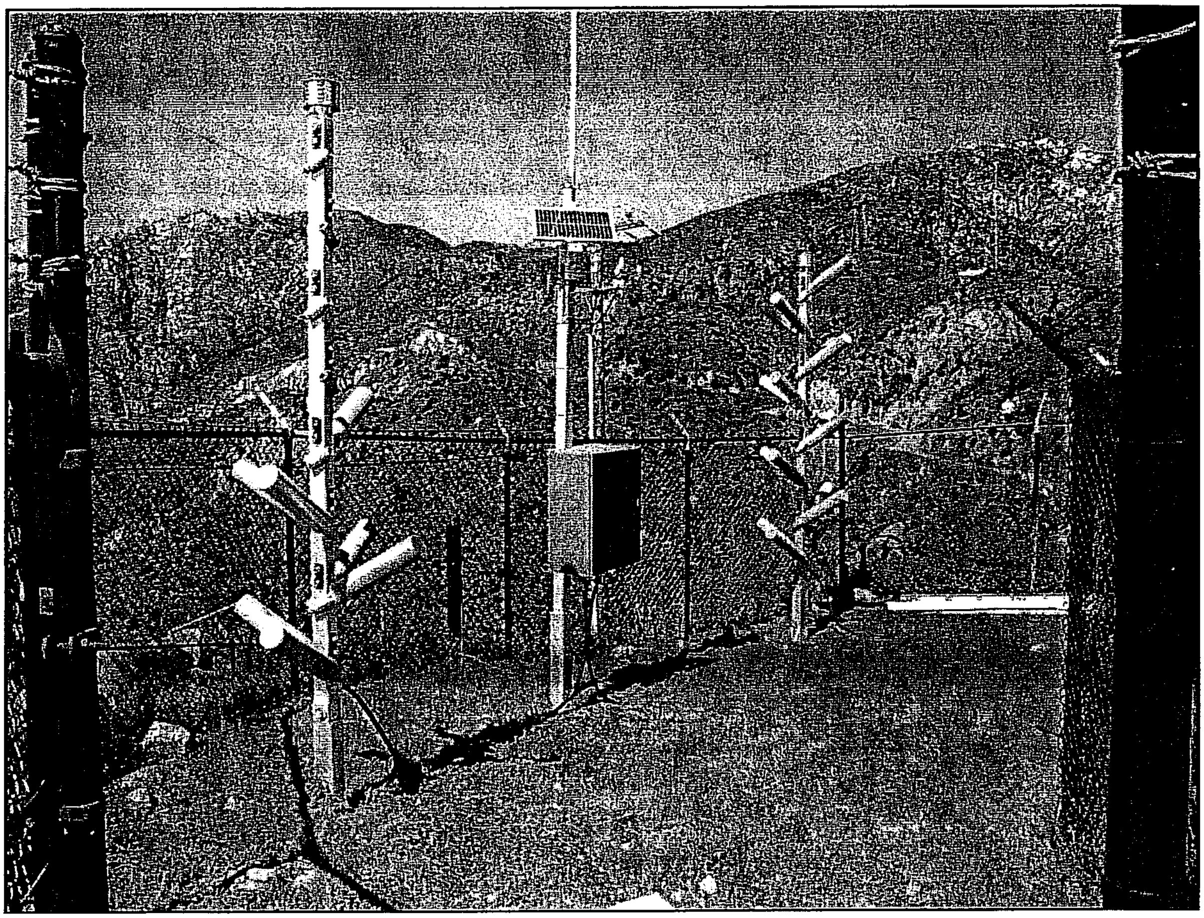

Figure 3.11 AHOGS Flare Site at Gibraltar Road

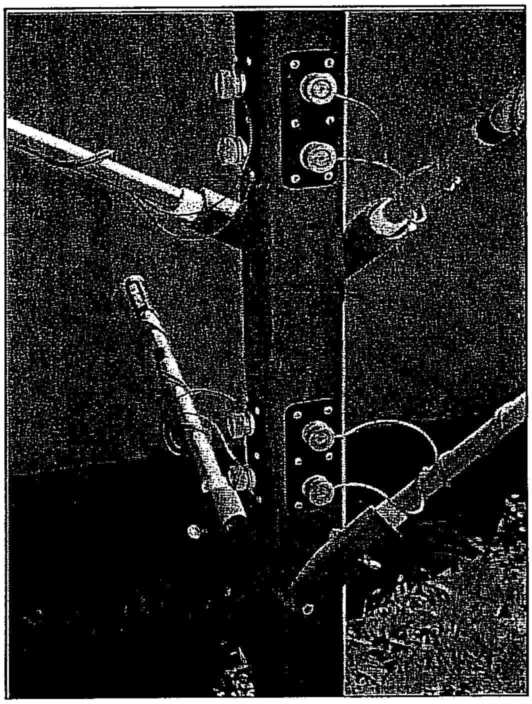

Figure 3.12 Close-Up Photo of Flares

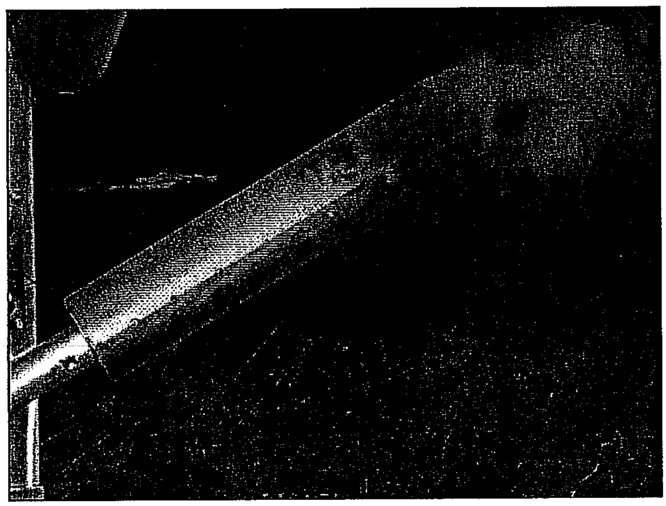

Figure 3.13 Flare Burning Inside Spark Arrestor

The AHOGS systems from the three original locations established in 2001 (Mt. Lospe, Sudden Peak and Gaviota) and the system from the Gibraltar Road site that had been damaged in the Jesusita fire in 2009, underwent substantial refurbishment during the summer of 2010 at NAWC's equipment fabricator (APCO, Inc.) located in Salt Lake City, Utah. The two masts from each of the original three sites, originally fabricated from steel, were replaced by masts made of aluminum. This was done in order for the units to better withstand the corrosion caused by continual exposure to the marine environment at these locations and also for better handling considerations due to the lighter weight of the aluminum masts. The latter three sites' masts, Gibraltar Road, Harris Grade and West Camino Cielo, had been fabricated out of aluminum.

NAWC initially used this ground-based pyrotechnic seeding approach in the operational Santa Barbara program following the completion of the research program (1982-1985), but this seeding mode was discontinued since the manufacture of high output flares (400 grams of silver iodide each) was discontinued. Table 3-3 provides information on these sites. The Agency has existing land use permits for these sites.

Table 3-2 AHOGS Site Locations

Location	Latitude (N)	Longitude (W)	Elevation (ft.)
Mt. Lospe	34 ⁰ 53.8'	120 ⁰ 35.7'	1570
Sudden Peak	34 ⁰ 34.5'	120 ⁰ 30.5'	1540
Gaviota	34 ⁰ 31.9'	120 ⁰ 05.5'	2580
West Camino Cielo	34 ⁰ 30.3'	119 ⁰ 51.1'	2790
Gibraltar Road	34 ⁰ 27.9'	119 ⁰ 40.7'	2204
Harris Grade	34 ⁰ 43.8'	120 ⁰ 24.8'	1204

The basic concept of both the aircraft and ground seeding in the Santa Barbara II research program was to place as much seeding material as possible into the warmer updraft regions of the convective bands with cloud tops colder than freezing (i.e., -4 to -10^0 or -12^0 C). High output silver iodide generators were flown on the aircraft and 400-gram output ground flares were fired every 15 minutes during the passage of convective bands over the seeding sites. The 400 gram flares (known as LW 83's) were considered very high output at the time, but have been replaced by even more effective (in terms of nuclei production) units utilized by NAWC starting with the 2001-2002 program.

The pyrotechnic flares used at the AHOGS sites are high output, each emitting 150 g of fast-acting silver iodide complexes during a burn time of approximately five minutes. Ice Crystal Engineering (ICE) of Fargo, North Dakota manufactures these flares. Some information concerning the flare manufacturer ICE is as follows: ICE was incorporated in 1999. ICE primarily manufactures three types of flares; an ejectable 20 gram silver iodide flare, a burn in place 150 gram silver iodide flare and a burn in place 1000 gram hygroscopic flare. ICE supplies flares to 20 different countries on 5 continents. Over 90% of ICE sales are to customers outside the United States.

The output of these ICE flares has been tested at the Colorado State University (CSU) Cloud Simulation Laboratory. Table 3-4 provides the results of this testing. These flares exhibited activity up to temperatures of -4^0 C, which is considered very desirable since activity at these warm temperatures can result in the creation of more artificially generated ice crystals at lower altitudes in the clouds. A couple of advantages can result:

- Ground releases of seeding material can activate more quickly since the -4^0 C level will be reached sooner than say -6 to -8^0 C which may have been the case with earlier generation flares.
- Conversion of water droplets to ice crystals at the -4^0 C level can release additional latent heat of fusion at lower altitudes within the seeded clouds, which should enhance the dynamic response of the clouds to seeding (refer to section 2.0 for a discussion).

A second important outcome of the testing of these flares at the Cloud Simulation Laboratory was that, when the seeding material was introduced into the cloud chamber, 63% of the ice crystal nucleation was produced within the first minute of introduction of the material into the chamber (see Figure 3.14). It was therefore concluded that these flares were operating by the condensation-freezing mechanism. This is also considered to be an advantage over the earlier generation flares that no doubt operated by the contact nucleation process, which is much slower. This should mean that nearly all of the seeding material that reaches temperatures of -4^0 C within target clouds should be utilized in producing ice crystals. Use of the earlier LW-83 flares, due to the slowness of the process, could mean that some of the seeding material was not activated in time to produce a seeding effect in the intended target areas. In fact, this characteristic may partially explain the extended downwind effects shown in Southwest Kern County during the conduct of Santa Barbara II, Phase I (see Figure 2.2).

Table 3-3 CSU Cloud Chamber Test Results for Ice Crystal Engineering Flare

Pyro type	Temp (EC)	LWC (g m^{-3})	Raw Yield (g^{-1} AgI)	Corr. Yield (g^{-1} AgI)	Raw Yield (g^{-1} pyro)	Corr. Yield (g^{-1} pyro)	Yield (per pyro)
ICE	-3.8	1.5	3.72×10^{11}	3.87×10^{11}	4.01×10^{10}	4.18×10^{10}	6.27×10^{12}
	-4.0	1.5	9.42×10^{11}	9.63×10^{11}	1.02×10^{11}	1.04×10^{11}	1.56×10^{13}
	-4.2	1.5	1.66×10^{12}	1.70×10^{12}	1.80×10^{11}	1.84×10^{11}	2.76×10^{13}
	-4.3	1.5	2.15×10^{12}	2.21×10^{12}	2.32×10^{11}	2.39×10^{11}	3.53×10^{13}
	-6.1	1.5	6.01×10^{13}	6.13×10^{13}	6.49×10^{12}	6.62×10^{12}	9.93×10^{14}
	-6.3	1.5	5.44×10^{13}	5.56×10^{13}	5.87×10^{12}	6.00×10^{12}	9.00×10^{14}
	-6.4	1.5	6.22×10^{13}	6.34×10^{13}	6.72×10^{12}	6.85×10^{12}	1.03×10^{15}
	-10.5	1.5	2.81×10^{14}	2.85×10^{14}	3.03×10^{13}	3.07×10^{13}	4.61×10^{15}
	-10.5	1.5	2.34×10^{14}	2.37×10^{14}	2.87×10^{13}	2.91×10^{13}	4.37×10^{15}
	-4.2	0.5	1.41×10^{12}	1.45×10^{12}	1.53×10^{11}	1.57×10^{11}	2.36×10^{13}
	-6.0	0.5	7.42×10^{13}	7.73×10^{13}	8.01×10^{12}	8.34×10^{12}	1.25×10^{15}
	-10.5	0.5	2.38×10^{14}	2.41×10^{14}	2.91×10^{13}	2.96×10^{13}	4.44×10^{15}

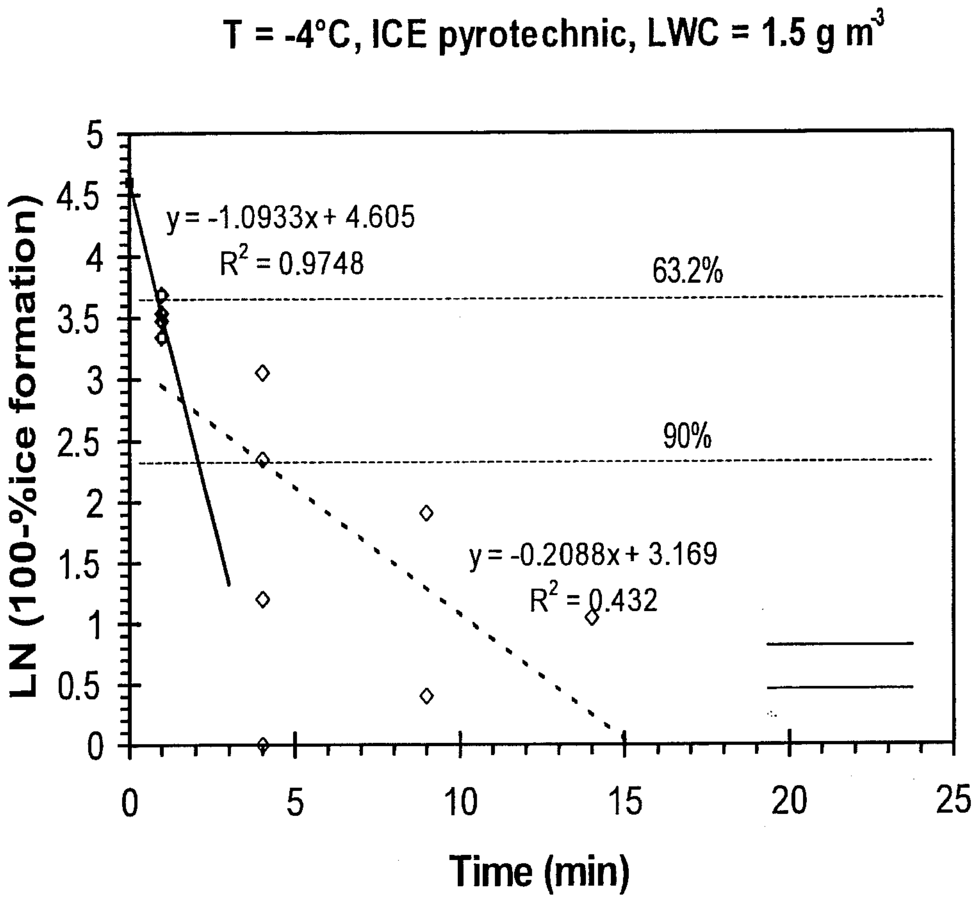

Figure 3.14 Ice Crystal Formation Kinetics for ICE Pyrotechnic Aerosol in Four Experiments Performed at the Higher LWC Condition at Approximately -4^0 C. The slope of the linear regression equations gives the rate constants for the initial fast rate and later slower rates of ice formation. The slower process was not observed at lower temperatures. The horizontal dashed lines indicate ice formation percentages.

It should be noted that the Cloud Simulation Laboratory at Colorado State University (CSU) was placed into an inactive status a few years ago. There are no other similar facilities available in the United States or in the world with the possible exception of a facility in an eastern European country. **As a consequence, there are no facilities that can test new flares (or, for that matter, acetone-silver iodide seeding formulations) that would be comparable to the results of the many years of testing performed at the CSU facility.** The newer ICE flare can be compared to the earlier LW 83 flare based upon tests conducted at the CSU Cloud Simulation Laboratory. Table 3-4 demonstrates that the ICE flare can produce more ice crystals in the critical warmer temperature regions (as much as two orders of magnitude higher at -4^0 C and -6^0 C) than the older LW 83 flare. Figure 3.15 provides a visual comparison of the nucleating characteristics of the ICE and the LW 83 flares. The figure demonstrates that the ICE flare is more effective in the warmer temperature regions of -4^0 C to -10^0 C. This temperature region is of prime importance to seeding-induced increases in precipitation in Santa Barbara County. Freezing supercooled water droplets in the upper (colder) portions of the bands may not necessarily contribute substantially to the production of increased rainfall at the ground.

Table 3-4 Nuclei Production per Gram of Seeding Material for LW-83 and ICE Flares

Temperature (^{0}C)	LW-83 (400g)	ICE (150g)
-4	2×10^{9}	1.5×10^{11}
-6	4×10^{10}	6×10^{12}
-10	3×10^{13}	3×10^{13}

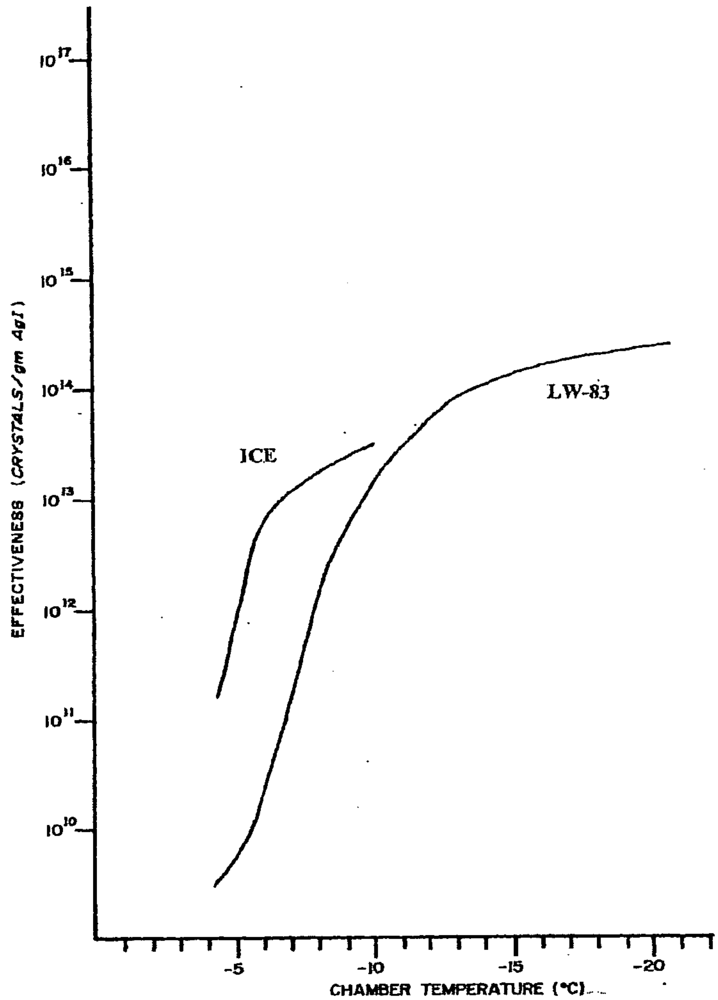

Figure 3.15 Comparison of Effectiveness of the LW-83 verses the ICE Burn-in-Place Flare, CSU Cloud Chamber results.

Figure 3.15 demonstrates that the ICE flare can produce more ice crystals (per gram of seeding material) in these critical temperature regions (as much as two orders of magnitude higher at -4^0 C) than the older LW 83 flare, although the latter flare contained more seeding material.

It should be noted that the ICE flares are more effective than the acetone/silver iodide generators (5×10^{11} versus 6×10^{12} crystals per gram) with the other benefit being that large amounts of seeding material may be dispensed over short time periods using flares versus acetone/silver iodide systems.

Based upon the above, it is estimated that the burn from six AHOGS flare sites would produce over two orders of magnitude (100 times) more ice crystals than all eight of the formerly used acetone-silver iodide generators at -6^{0} C in a one-hour period. This is an important factor in helping to achieve the higher freezing nuclei concentrations appropriate to the seeding of convective bands. Simply stated, there is no way that liquid fueled silver iodide/acetone generators can produce the high seeding rates per unit time made possible through the use of high output flares. As a consequence, remotely operated acetone-silver iodide generators cannot duplicate the ground-seeding mode tested in the Santa Barbara II, Phase I experiment.

3.7 Summary of Proposed Cloud Seeding Design

For the conduct of the 2012-2013 rainy season program, we propose that the leading edge of convective bands be seeded by firing flares from one or more of the six ground based sites. As the convective bands move onshore, flares from selected pyrotechnic ground sites (selected with consideration given to the targeting of the seeding effects within the intended target areas) would be fired at approximately 15-minute intervals as the band passes over each site. Sites to be used would be determined on a case-by-case basis and would be concerned with the likely targeting of the effects of seeding in the intended target area. This concept of targeting will be discussed in a later section. Thus, the very positive, statistically significant results of Santa Barbara II, Phase I would be replicated.

3.8 Computer Modeling

NAWC has utilized specialized computer models in the conduct of previous programs conducted for the Santa Barbara Water Agency. These models were of two basic types: 1) those that forecast a variety of weather parameters useful in the conduct of the cloud seeding program and 2) those that predict the transport and diffusion of seeding materials.

In rainy seasons prior to 2010-2011 NAWC had used the standard National Weather Service NAM (formerly ETA) and GFS atmospheric models in forecasting seedable events and associated parameters of interest (e.g. temperatures, winds, precipitation). NAWC continued to use the NAM and GFS models, especially for longer range forecasts during the 2010-2011 and 2011-2012 rainy seasons. A more sophisticated model was, however, used for shorter range forecasts. This was the Weather Research and Forecasting (WRF) model developed by NCAR and NOAA. Recently this model has shown considerable skill in predicting precipitation, pressure fields, wind fields and a variety of other parameters of interest in conducting the cloud seeding operations.

The GUIDE model (Rauber, et al, 1988) had been used for many years to predict the transport and diffusion of seeding material and fallout of seeded precipitation. There has been significant advancement in computer models that predict the transport and diffusion of particles released either from the ground or aircraft since the GUIDE model was developed. NAWC recognized that newer, more sophisticated computer models would provide more accurate predictions than those produced by GUIDE. For example, the HYSPLIT model developed by NOAA provides forecasts of the transport and diffusion of either ground or aerial releases of some material, which in our case would be silver iodide seeding particles. NAWC utilized predictions from the HYSPLIT model to assist in making seeding decisions during the 2010-2011 rainy season.

The WRF and HYSPILT models will be discussed separately in the following. **NAWC proposes to utilize these models in the performance of the 2012-2013 rainy season program.**

3.8.1 WRF Model

The Weather Research and Forecasting (WRF) Model is a next-generation mesoscale numerical weather prediction system designed to serve both operational forecasting and atmospheric research needs. It features multiple dynamical cores, a 3-dimensional variational

(3DVAR) data assimilation system, and a software architecture allowing for computational parallelism and system extensibility. WRF is suitable for a broad spectrum of applications across scales ranging from meters to thousands of kilometers.

The effort to develop WRF has been a collaborative partnership, principally among the National Center for Atmospheric Research (NCAR), the National Oceanic and Atmospheric Administration (the National Centers for Environmental Prediction (NCEP) and the Forecast Systems Laboratory (FSL), the Air Force Weather Agency (AFWA), the Naval Research Laboratory, the University of Oklahoma, and the Federal Aviation Administration (FAA). WRF allows researchers the ability to conduct simulations reflecting either real data or idealized configurations. WRF provides operational forecasting a model that is flexible and efficient computationally, while offering the advances in physics, numerics, and data assimilation contributed by the research community.

NAWC utilized NOAA's Earth Systems Research Laboratory's High Resolution Rapid Refresh (HRRR) version of the WRF model during the 2010-2011 and 2011-2012 rainy seasons. This model has a 3km grid spacing compared to the more standard grid model spacing of 13km (e.g. NAM model), plus it is re-initialized every hour using the latest radar observations. Small grid spacing is important when dealing with complex (mountainous) terrain). The NAM and GFS models are currently re-initialized every 6 hours. Hourly forecast outputs from the HRRR model are available for a variety of parameters out to 15 hours. Table 3-5 provides a summary of HRRR forecast parameters of interest in conducting the cloud seeding program.

Figure 3.18 is a three-hour forecast from the HRRR model of composite radar reflectivity over the southwest, valid at 0000 PDT, March 26, 2011. This forecast predicts a convection band to be over the western portion of Santa Barbara County. This prediction verified. Figure 3.19 provides an eight-hour forecast of one hour accumulated precipitation over the southwestern United States valid from 1300-1400 PDT March 23, 2011. The precipitation forecast to occur over Santa Barbara County during this period was associated with a convection band that did develop and that was seeded.

Table 3-5 HRRR Forecast Parameters of Interest

Parameter	Application
1km above ground level reflectivity	Forecast of convection band locations based on radar returns 1km above ground
Composite reflectivity	Forecast of convection band locations using reflectivity values from different scan elevations. This is useful when bands approach the radar site since low elevation scans may go underneath the bands.
Maximum 1km above ground level reflectivity	Forecasts that pinpoints the location of the heart of the convection bands
1 hour accumulated precipitation	Forecasts of radar derived estimates of precipitation reaching the ground in a one-hour period (QPF).
Total accumulated precipitation	Forecasts of radar derived estimates of precipitation reaching the ground for a specified time period, for example 1-6 hours in the future (QPF).
850 mb winds	Forecasts of the 850 mb (~4,000 feet) wind direction is useful in determining if and when wind directions may go out of bounds in regards to suspension criteria.(e.g., avoiding burn areas)
700mb temperature	NAWC uses this level, which is ~10,000 feet, to indicate whether silver iodide will activate. Temperatures < -5^0 C are desirable at this level
700mb vertical velocity	Forecasts the strength of the upward or downward movement at ~the 10,000 foot level. Stronger updrafts favor transport of seeding material to colder, more effective cloud regions.
Echo top height	Forecasts of cloud echo tops. Can be useful in determining whether the cloud tops are forecast to be cold enough for silver iodide to be effective (~-5^0 C).

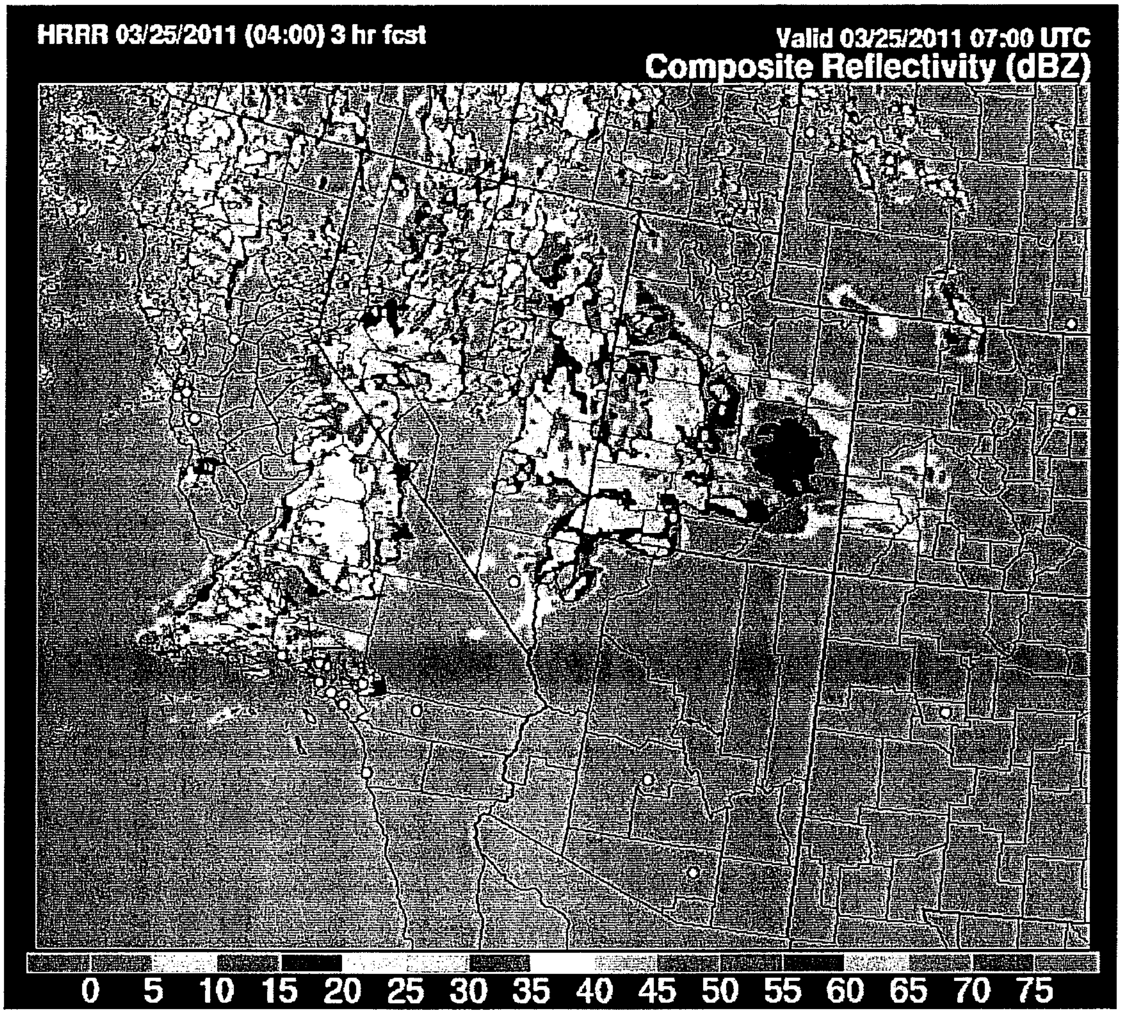

Figure 3.18 HRRR model three-hour forecast of radar reflectivity, valid at 0000 PDT on March 25, 2011

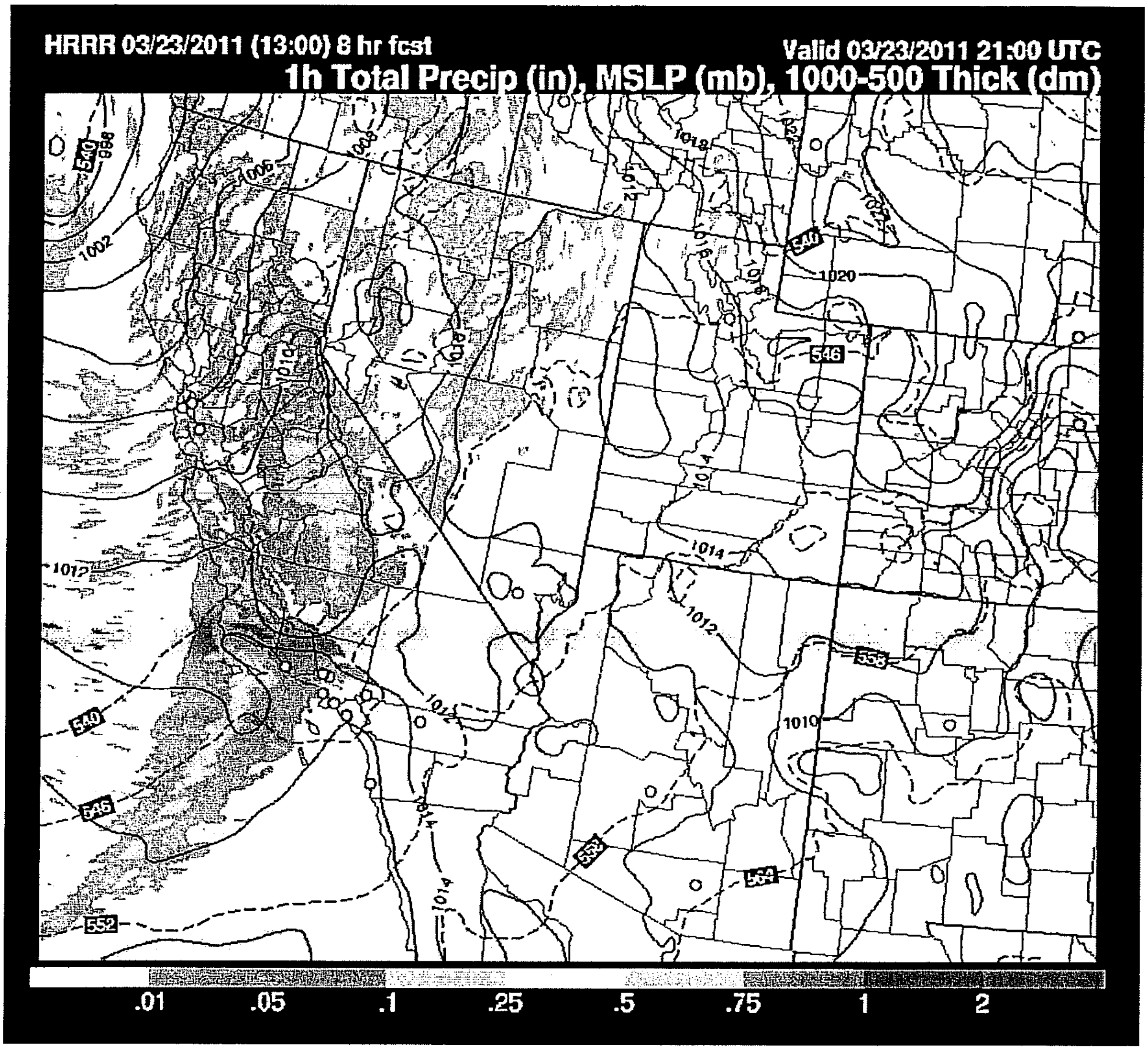

Figure 3.19 HRRR model eight-hour forecast of one-hour precipitation from 1300-1400 PDT March 23, 2011

Based on the design of the program (Section 3.2) which is focused on seeding convection bands, and the seeding techniques as described in Sections 3.5-3.6, it can be seen that forecasts of convective band locations are not a requirement when using the ground-based seeding sites. Seeding decisions for ground-based sites can be made using real-time radar information, indicating when a convection band is approaching a particular seeding site. Forecasts of convection band locations are useful, however, when dealing with airborne seeding. Flight plans need to be filed, discussions between the meteorologist and pilot need to occur prior to take-off, and the seeding aircraft needs time to reach altitude and intercept the approaching band(s). This means that an accurate forecast lead time of at least 90-120 minutes is useful when aircraft seeding is conducted. The value of accurate forecasts of convection band locations can be seen in this scenario. Figure 3.19 is an example of such a forecast. NAWC's experience with forecasts of this type from the HRRR model was that these forecasts are typically very good.

The precipitation type forecasts (e.g., Figure 3.19) are useful when considering suspension criteria.

3.8.2 HYSPLIT Model

The HYSPLIT (HYbrid Single-Particle Lagrangian Integrated Trajectory) model is the newest version of a complete system for computing simple air parcel trajectories to complex dispersion and deposition simulations. As a result of a joint effort between NOAA and Australia's Bureau of Meteorology, the model has recently been upgraded. New features include improved advection algorithms, updated stability and dispersion equations, a new graphical user interface, and the option to include modules for chemical transformations. Without the additional dispersion modules, HYSPLIT computes the advection of a single pollutant particle, or simply its trajectory.

The dispersion of a pollutant is calculated by assuming either puff or particle dispersion. In the puff model, puffs expand until they exceed the size of the meteorological grid cell (either horizontally or vertically) and then split into several new puffs, each with its share of the pollutant mass. In the HYSPLIT particle model, a fixed number of initial particles are advected about the model domain by the mean wind field and a turbulence component. The model's default configuration assumes a puff distribution in the horizontal and particle dispersion in the vertical direction. In this way, the greater accuracy of the vertical dispersion parameterization of the particle model is combined with the advantage of having an ever-expanding number of particles represent the pollutant distribution.

The model can be run interactively on the Web through the READY system on the

NOAA site, or the code executable and meteorological data can be downloaded to a Windows PC. The Web version has been configured with some limitations to avoid computational saturation of the web server. The registered PC version is complete with no computational restrictions, except that the user must download the necessary meteorological data files. The unregistered version is identical to the registered version except that it will not work with forecast meteorology data files.

NAWC completed the required registration for use of the HYSPLIT model for the 2010-2011 rainy season. It was then used to predict the transport and diffusion of silver iodide seeding material during storm situations in Santa Barbara County during the 2010-2011 and 2011-2012 rainy seasons. This feature addresses the potential targeting of seeding effects in the intended target areas. For example, HYSPLIT runs can be used to help decide which flare sites should be used given a set of specific meteorological conditions. Another area of concern in conducting the Santa Barbara seeding program is to adhere to suspension criteria. These criteria often have areas to be avoided in seeding (e.g. recent burn areas). This was the situation last winter. HYSPLIT model runs are useful in this regard. HYSPLIT runs can be made from archived model data, which are available back to 2007. Mr. David Yorty attended a workshop on the used of the HYSPLIT model held in Washington, D.C. on June 22-24, 2011. NOAA's Air Resources Laboratory sponsored this workshop. A certificate of completion is provided in Mr. Yorty's resume provided in Appendix C.

Another very useful tool in avoiding seeding impacts in areas identified in the suspension criteria are the vertical wind displays from the Vandenberg AFB NEXRAD radar. Figure 3.20 provides an example. Winds in the vertical at 1000 foot intervals are displayed over approximately a one hour period in ~6 minute time steps. NAWC has frequently used the winds at the 850-mb level (~4,000 feet) as an indicator of the mean direction that a seeding plume would transported. For example, in Figure 3.20 the 4,000 foot wind at the last time period (1429 PDT) is from 180^0 at 30 knots with south-southeast winds at lower levels of 2,000 and 3,000 feet. This would mean that the seeding material released from a burning flare under these conditions would be transported to the north-northwest, then north, and subsequently to the north-northeast as the plume rises above the surface.

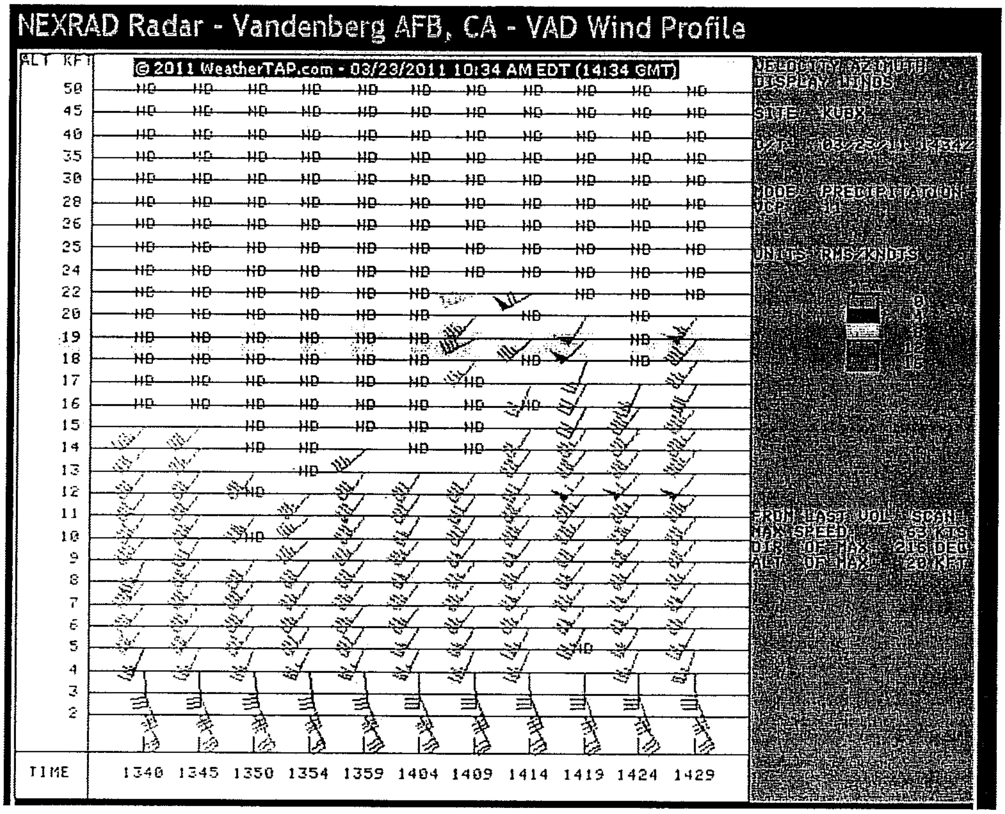

Figure 3.20 Vandenberg AFB NEXRAD vertical winds display at 0640-0729 PDT, March 23, 2011

Examples of the HYSPLIT model output are provided for three different ground seeding events. The first example is for seeding from the West Camino Cielo site during the November 20, 2010 storm event. Figure 3.21 shows the HYSPLIT output, which depicts the horizontal dispersion (a plume depiction with relative concentrations of seeding material), taking the plume over the upper Santa Ynez target area.

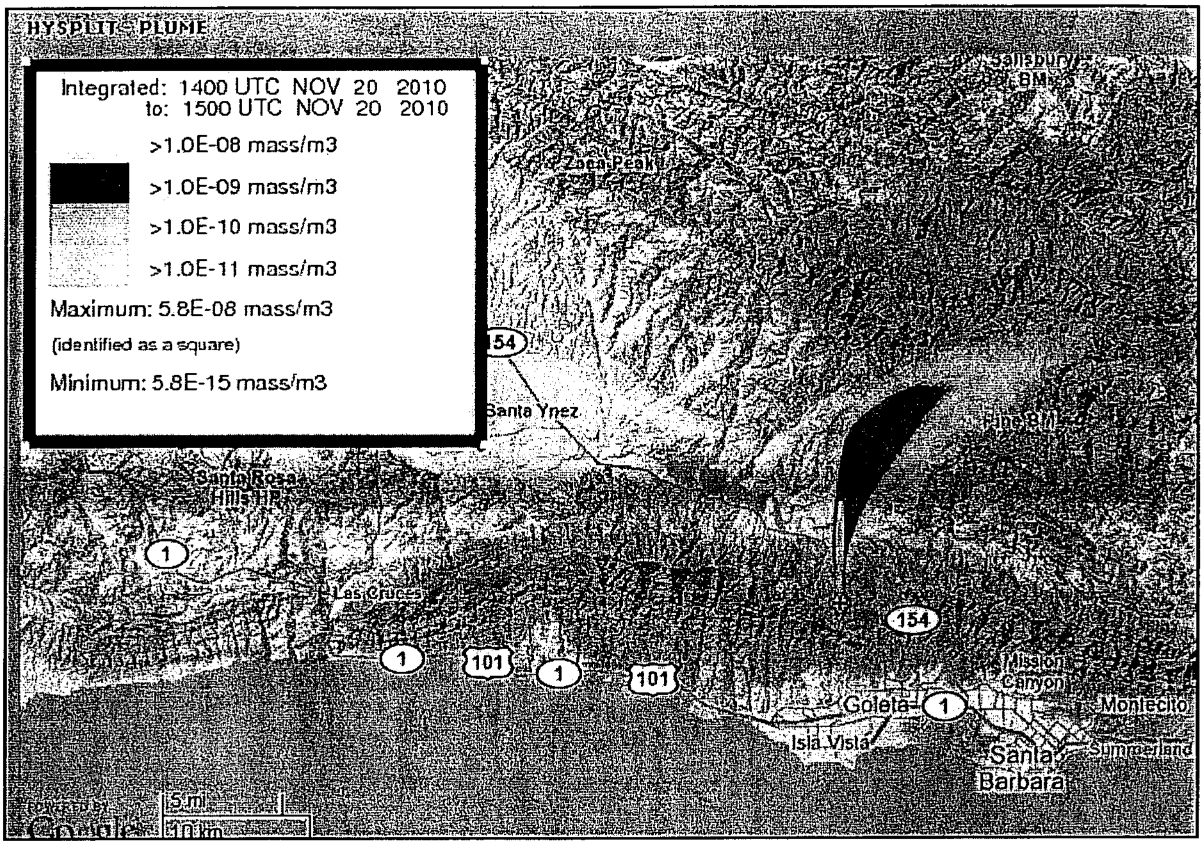

Figure 3.21 HYSPLIT one-hour simulation for November 20, 2010 showing horizontal plume dispersion and concentration from a flare burn at West Camino Cielo

Figure 3.22 provides similar HYSPLIT output for a ground release from the Sudden Peak site on the afternoon of February 18, 2011. This simulation predicted that the seeding material would remain somewhat to the west of the target area. If this model guidance were relied upon entirely, seeding would not have been conducted in this case. However, this type of model guidance is not the sole determining factor in making seeding decisions at this point in the program's development. Since the seeding targets are convection bands, this model output could be interpreted as indicating the seeding plume moved northwestward initially, with upper portions of the plume subsequently moving northward as they became entrained into the convection band. The upward vertical velocities associated with the convection band can have a great deal of small-scale variation, and this may not be well represented by the computer model. This would suggest that some of the seeding material would have a more easterly trajectory as it rose and interacted with the convection band microphysics, causing fallout to occur in the intended target area. This is a very common scenario during stronger storms in Santa Barbara County where the surface and low-level winds are from the southeast, and exhibit a veering pattern, becoming more southerly or southwesterly with increasing height.

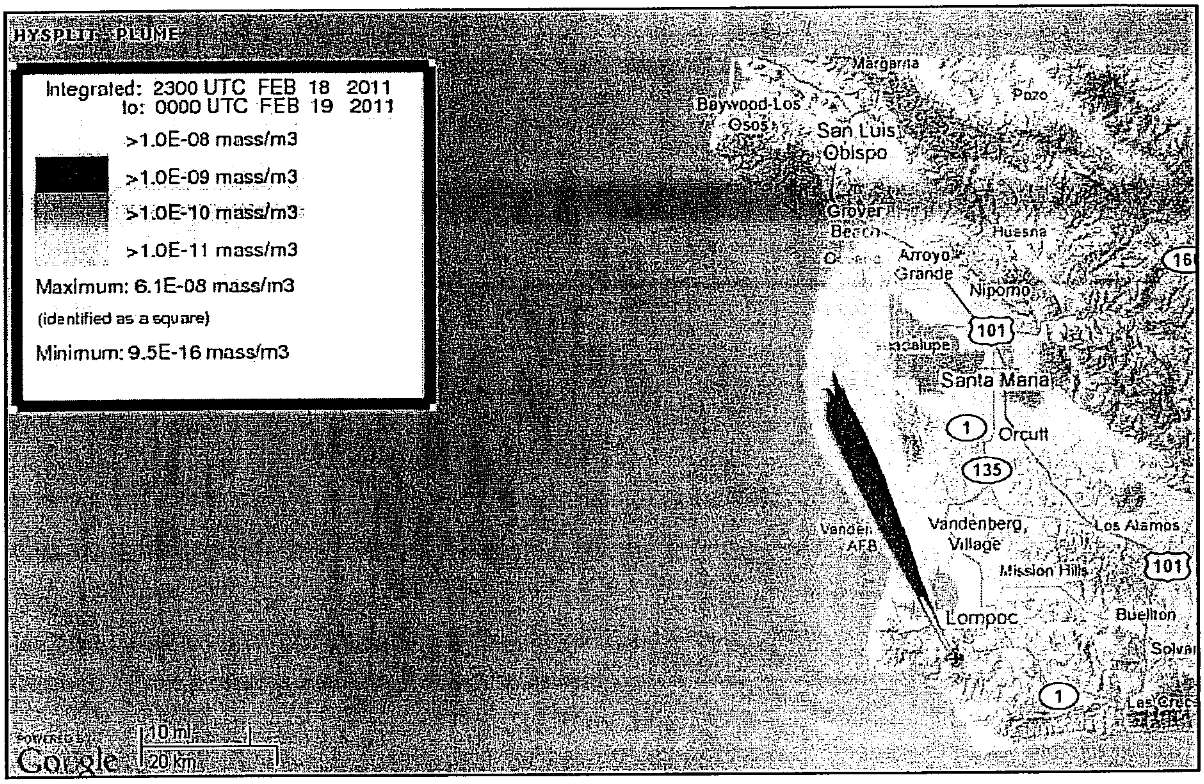

Figure 3.22 HYSPLIT one-hour simulation for February 18, 2011 showing horizontal plume dispersion and concentration from a flare burn at Sudden Peak

Figure 3.23 provides the HYSPLIT model output for a release at the Sudden Peak site on March 23, 2011. This output produces a curved trajectory with the plume beginning to move more towards the northeast as it rises and encounters more southwesterly flow. This is another example of southeasterly low-level winds storm winds veering to become more southerly or southwesterly with increasing height.

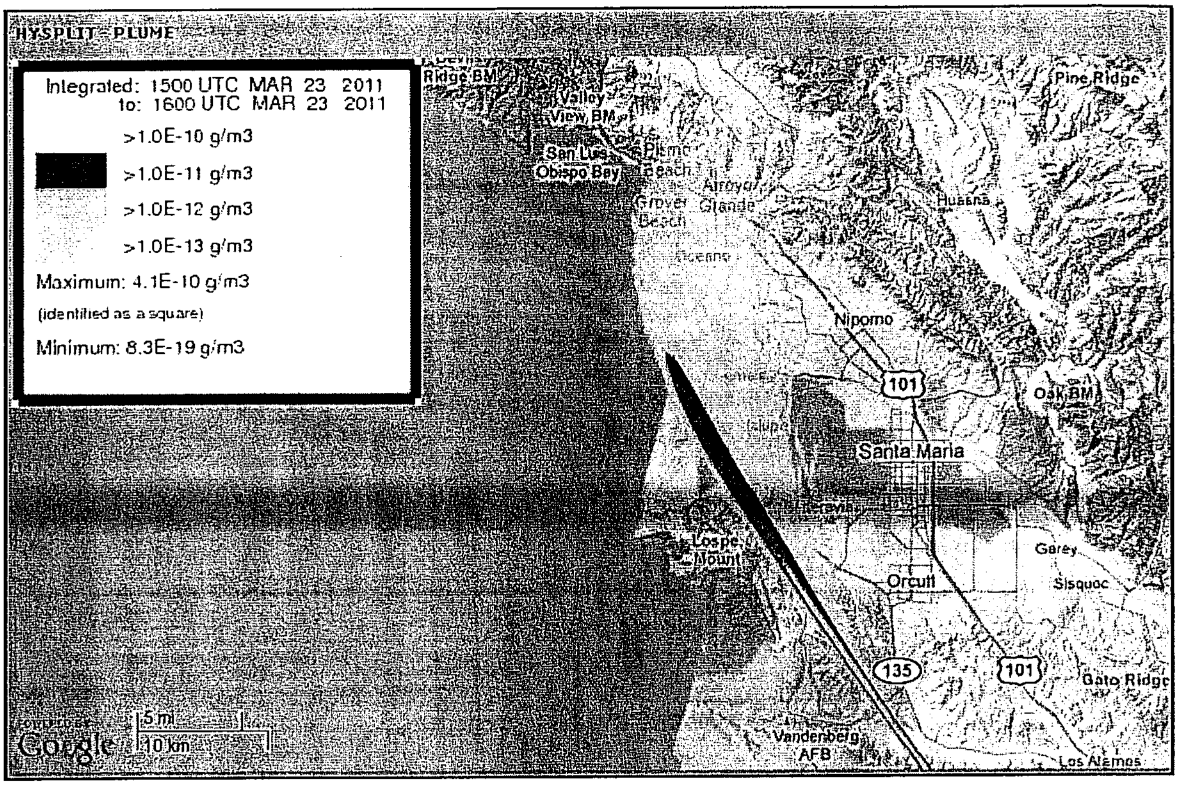

Figure 3.23 **HYSPLIT one-hour simulation for March 23, 2011 showing horizontal plume dispersion and concentration from a flare burn at Harris Grade**

3.9 Operations Center and Operations Plan

Operations during the four month seeding period (Dec. 1, 2012 to Mar. 31, 2013 will be conducted from NAWC's operations center at its corporate headquarters in Sandy, Utah. This operations center is equipped with personal computers and Internet access, as well as the software required to activate the AHOGS sites. NAWC project meteorologists also have computers in their homes allowing operations to be conducted from their private residences. This provision is quite useful since the Santa Barbara program is a 24/7 operation. For events occurring outside NAWC's normal business hours (a rather frequent occurrence), operations will be conducted from the meteorologist's residences.

A variety of weather products available via the internet will be utilized to direct the cloud seeding program. These products will include: surface and upper-air observations, analyses and forecasts, weather satellite information (both visible and infrared), weather radar data including VAD winds, lighting information, precipitation data and NWS watches and warnings. Detailed information on rainfall, surface winds and temperature will be available from an array of Alert stations that the Agency operates and maintains within the County. NAWC is very familiar with the acquisition and utilization of the ALERT data. Similar information is available from adjacent counties as well, which provides very useful information in terms of, for example, the amount of precipitation reaching the ground versus the radar depictions of echo intensities.

As in previous seasons, a detailed operations plan (developed specifically for the Santa Barbara Program) will be available as a reference for all program personnel.

3.10 Communications

NAWC personnel shall keep the Agency informed of the program status at all times including information on any equipment failures and proposed personnel changes. NAWC's designated contact for operational information will be the project meteorologist. Personnel changes will not be made (except in emergency situations) without prior notification of designated Agency personnel. NAWC's project meteorologist shall notify Agency personnel at the initiation and conclusion of seeding activities and provide the Agency with records of seeding locations and duration at the conclusion of each storm event.

3.11 2012-2013 Operational Period and Target Area

As requested by the Agency, a four month project is proposed to be conducted during the 2012-2013 rainy season. This period would be December 1, 2012 through March 31, 2013. Only the Huasna-Alamo and Upper Santa Ynez areas would be targeted during this period.

3.12 Suspension Criteria

The Agency will provide modified suspension criteria to be used in the conduct of the 2012-2013 program.

3.13 Installation, Operations, Maintenance and Removal of Equipment

NAWC shall be responsible for the installation, operation, maintenance and removal of all equipment necessary to perform this work for the Agency. NAWC personnel assisted by our part time technician will perform the installation, maintenance and removal of the equipment.

3.14 Transportation, Board and Lodging

NAWC shall provide for all transportation, board and lodging requirements of NAWC personnel or subcontractors utilized by NAWC to perform this work. Transportation and storage of equipment shall also be provided by NAWC, as well as for NAWC vehicles needed on the project.

3.15 Reporting

NAWC will perform the necessary reporting functions at the State and Federal levels. This includes initial, interim and final reports on the program that are required to be submitted to the National Oceanic and Atmospheric Administration. NAWC assumes that, as in past seasons, the Agency will publish a Notice of intent in the local newspaper and coordinate this program with the California Department of Water Resources.

NAWC will prepare a final operations report by June 15, 2013. This report shall include a description of the equipment and techniques used, a log of all operations conducted, the total amount of seeding solution dispensed, a summary of overall weather conditions and storm events and an assessment of program results. Fifteen copies, one reproducible copy and one digital copy will be provided to the Agency following acceptance of a draft report submitted to the Agency.

3.16 Scheduling Considerations

NAWC will be able to respond quickly in setting up the seeding program. One reason for this fast response capability is due to the fact that most of the AHOGS equipment is already on site at the three ground sites. **Consequently, we could bring this ground-based program to operational status in two weeks or less following receipt of an approved contract.**

4.0 PROPOSAL REQUIREMENTS

The RFP contains a list of six items that are to be provided in response to the RFP. These items are discussed below. Most of these items have been discussed in previous sections of this proposal, but responses are summarized in the following sub-sections.

4.1 List of Equipment

X Weather radar- NAWC proposes the use of data from the National Weather Services (NWS) NEXRAD system. These sophisticated radars are owned, operated, calibrated and maintained by the NWS. The data will be processed, displayed and archived using an existing custom software package developed by NAWC for the Santa Barbara project. If aircraft are used on future programs, NAWC will utilize a Flight Aware or similar display system that provides aircraft location information along with the radar displays.

X Six remotely controlled silver iodide ground based flare racks owned by NAWC. NAWC had these units custom manufactured in Salt Lake City. All six currently located at the selected sites in an inactive status. All six would be activated for the 2012-2013 rainy season.

X NAWC will provide project vehicles as needed.

- NAWC owns and maintains four computers at its headquarters in Sandy, Utah that can be used to monitor the weather, run the HYSPLIT model and to fire the ground based flares in Santa Barbara County using a special Campbell Scientific software program that has been customized for the flare operations. A Comcast service provides high speed internet access.

- NAWC's four meteorologists located in Utah also have computers at their homes which can be used to monitor the weather, run the HYSPLIT model and operate the Santa Barbara flare sites.

4.2 Proposed Individuals or Firms Serving as Subcontractors

NAWC proposes to use Mr. Victor Lee as a part-time employee responsibility for the installation, restocking, maintenance and removal of the AHOGS seeding systems. Mr. Lee's resume is provided in Appendix C. NAWC will not employ any subcontractors in the performance of the 2012-2013 program.

4.3 Primary Personnel

Mr. Don Griffith, President of NAWC, will serve as overall program supervisor. He is an American Meteorological Society Certified Consulting Meteorologist (CCM) and holds the WMA Operator and Manager certifications. He has 44 years of weather modification experience, including several years of research and operations experience on this specific project. His resume is included in Appendix C.

Two additional NAWC personnel with direct experience on this project will be available as necessary for operations and support. They are Mr. Mark Solak and Mr. David Yorty. Mr. Solak has more than forty years experience in weather modification research and operations, holds the WMA Operator and Manager certifications, and is an AMS member. He has worked directly on this project in past seasons. Mr. Yorty, an AMS member and holder of the WMA Operator certification, also has worked on the project. Resumes for these individuals are also included in Appendix C.

4.4 NAWC's Previous Work Experience

NAWC is the longest-standing weather modification company in the world, with continuous active corporate experience in the discipline since it's founding in 1950. **NAWC has more weather modification experience in coastal southern California than any other firm. Most importantly, NAWC has more direct experience on the Santa Barbara project than any other firm. This corporate experience dates back to the 1950's.**

Specific programs of relevance to the conduct of this program are provided in Table 4-1. References, contact names and their telephone numbers are included in that table. A summary paper on the Santa Barbara project, with co-authors from the Agency, was published in the peer-reviewed section of the 2005 edition of the Weather Modification's Association *Journal of Weather Modification.* A copy of that paper is provided in Appendix A.

4.5 A Copy of a Final Report

The Agency is in possession of a number of prior operational final reports prepared by NAWC documenting our work on the Santa Barbara program. NAWC Report WM 12-1 (Griffith, D.A., and D. Yorty, 2011) is the most recent final report submitted to the Agency, in May 2012, describing the 2011-2012 weather modification operations conducted in Santa Barbara County for the Agency.

Table 4-1
Some Representative NAWC Weather Modification Programs

- Santa Barbara County operational winter seeding program, 2001-2011 rainy seasons. Airborne seeding and ground seeding using three to six high output, ground based flare sites and a cloud seeding aircraft. NEXRAD weather radar output used in place of project specific radar.

- Santa Barbara County operational winter seeding program, most winters 1978-1997. Seeding conducted using both ground based and aerial seeding. Weather radar support was provided by the Air Force from Vandenberg Air Force base until 1988. NAWC installed independent weather radar for program operations beginning in 1989.

- Upper Kings River winter seeding program for the Kings River Conservation District, ground based and aircraft seeding with weather radar control, 1988-1993, 2007-2011.

- Southern California Edison winter and summer seeding program for the Upper San Joaquin River Basin in the southern Sierra Nevada 1951-1987; 1990-1992. Ground based and airborne seeding.

- Los Angeles County Flood Control District winter operational seeding program in the San Gabriel Mountains. Ground based seeding program conducted each winter from 1961-1975. Program began again in spring of 1991 and continued in 1992, 1993, and 1997 to 2002, then suspended due to fire burn areas. NAWC has provided weather forecast support to this District since 2002 (contact, Bill Saunders, 626-458-6186).

- Sacramento Municipal Utility District winter weather forecast support and recommendations of silver iodide generators to be used during storm periods for their internally operated cloud seeding program; three year contract which began in the spring of 2004. Contract renewed and work continued through 2011 (contact, Dudley MsFadden, 916-732-5953).

- California Department of Water Resources, Northern California Drought relief program conducted during the 1988-89 winter season. NAWC conducted airborne seeding utilizing two seeding aircraft and supported with an on-site weather radar.

- Southern and Central Utah, State of Utah Division of Water Resources, operational winter cloud seeding program 1974-1983 and 1984-present. Ground generators used supplemented with aircraft seeding (up to four aircraft) in some of the winters. (contact, David Cole, 801-538-7269).

- Northern Utah, State of Utah Division of Water Resources, operational winter cloud seeding program 1988-present. Ground generator program (contact, David Cole, 801-538-7269).

- High Uinta Mountains, Utah, State of Utah Division of Water Resources, operational winter cloud seeding program 1977, 1989, 2003-2011 (contact, David Cole, 801-538-7269).

- El Cajon Dam drainage area, Honduras, 1993-95, and 1997. Airborne and ground based seeding program supported with an on-site weather radar

4.6 Insurance (Exhibit A)

The RFP asks for the provision of several types of insurance. These include Workers Compensation, Commercial/General Liability, Automobile Liability, Professional Liability (including errors and omissions), and Aircraft Liability insurance. NAWC agrees to provide these insurance policies in the amounts and terms specified in the RFP. No aircraft insurance will be required during the 2012-2013 rainy season program since no aircraft are to be used. The Agency, District and participating entities will be named additional insured's on these policies (with the exception of the Workers Compensation policy).

4.7 Bonding

The RFP mentions performance bonding and/or liquidated damages as a requirement in the terms of the contract. NAWC can provide bonding if required. We also understand the liquidated damages that will be assessed for loss of use of various types of project equipment. We will make every effort possible to insure there are not missed seeding opportunities on this program.

4.8 Costs

Proposed costs were submitted to the Agency under separate cover.

EXHIBIT B

PAYMENT ARRANGEMENTS
Periodic Compensation (with attached Schedule of Fees)

A. For CONTRACTOR services to be rendered under this contract, CONTRACTOR shall be paid a total contract amount, including cost reimbursements, not to exceed **$ 148,250**.

B. Payment for services and /or reimbursement of costs shall be made upon CONTRACTOR's satisfactory performance, based upon the scope and methodology contained in **EXHIBIT A** as determined by COUNTY. Payment for services and/or reimbursement of costs shall be based upon the costs, expenses, overhead charges and hourly rates for personnel, as defined in **Attachment B1** (Schedule of Fees). Invoices submitted for payment that are based upon **Attachment B1** must contain sufficient detail to enable an audit of the charges and provide supporting documentation if so specified in **EXHIBIT A.**

C. **Monthly**, CONTRACTOR shall submit to the COUNTY DESIGNATED REPRESENTATIVE an invoice or certified claim on the County Treasury for the service performed over the period specified. These invoices or certified claims must cite the assigned Board Contract Number. COUNTY REPRESENTATIVE shall evaluate the quality of the service performed and if found to be satisfactory and within the cost basis of **Attachment B1** shall initiate payment processing. COUNTY shall pay invoices or claims for satisfactory work within 30 days of presentation.

D. COUNTY's failure to discover or object to any unsatisfactory work or billings prior to payment will not constitute a waiver of COUNTY's right to require CONTRACTOR to correct such work or billings or seek any other legal remedy.

2012-2013 CLOUDSEEDING PROGRAM
ATTACHMENT B1

FIXED AND REIMBURSABLE COST FOR A 4 MONTH TWITCHELL RESERVOIR AND LAKE CACHUMA WATERSHEDS GROUND ONLY WEATHER MODIFICATION PROGRAM AND PAYMENT SCHEDULE

1.	**Set-up, Removal, and Reporting Fixed Costs** (includes $2,000,000 professional liability insurance)	$36,000
2.	**Monthly Fixed Costs**	
	Four months @ $23,000 fixed operating cost	$92,000
3.	**Estimated Reimbursable Costs**	
	Flare usage, 225 units @$90/ea.	$20,250
4.	**Estimated total cost**	**$148,250**

- **NOTE – invoicing schedule will be the following:**

½ the setup cost ($18,000) will be invoiced on December 1st, the beginning date of the program. The other ½ of the setup cost shall be invoiced upon receipt of the final report and upon agreement by Santa Barbara County Water Agency that all conditions of the contract are met. Monthly invoices for fixed costs as well as reimbursable costs shall be submitted at the end of each operational month.

EXHIBIT C
STANDARD INDEMNIFICATION AND INSURANCE PROVISIONS
for Cloud Seeding Program

1. Indemnity – CONTRACTOR shall defend, indemnify and save harmless the COUNTY, its officers, agents and employees from any and all claims, demands, damages, costs, expenses (including attorney's fees), judgments or liabilities arising out of this Agreement or occasioned by the performance or attempted performance of the provisions hereof; including, but not limited to, any act or omission to act on the part of the CONTRACTOR or his agents or employees or other independent contractors directly responsible to him; except those claims, demands, damages, costs, expenses (including attorney's fees), judgments or liabilities resulting from the sole negligence or willful misconduct of the COUNTY.

CONTRACTOR shall notify the COUNTY immediately in the event of any accident or injury arising out of or in connection with this Agreement.

2. Additional Insured – All policies, except for the Workers' Compensation, Errors and Omissions and Professional Liability and Automobile Liability policies, shall contain endorsements naming COUNTY and its officers, employees, agents and volunteers as additional insureds with respect to liabilities arising out of the performance of services hereunder. The additional insured endorsements shall not limit the scope of coverage for COUNTY to vicarious liability but shall allow coverage for COUNTY to the full extent provided by the policy.

3. Waiver of Subrogation Rights – CONTRACTOR shall require the carriers of required coverages to waive all rights of subrogation against COUNTY, its officers, employees, agents, volunteers, contractors and subcontractors. All general or auto liability insurance coverage provided shall not prohibit CONTRACTOR and CONTRACTOR's employees or agents from waiving the right of subrogation prior to a loss or claim. CONTRACTOR hereby waives all rights of subrogation against COUNTY.

4. Policies Primary and Non-Contributory – All policies required herein are to be primary and non-contributory with any insurance or self-insurance programs carried or administered by COUNTY.

5. Severability of Interests – CONTRACTOR agrees to ensure that coverage provided to meet these requirements is applicable separately to each insured and there will be no cross liability exclusions that preclude coverage for suits between CONTRACTOR and COUNTY or between COUNTY and any other insured or additional insured under the policy.

6. Proof of Coverage – CONTRACTOR shall furnish Certificates of Insurance to the COUNTY Department administering the Agreement evidencing the insurance coverage, including endorsements, as required, prior to the commencement of performance of services hereunder, which certificates shall provide that such insurance shall not be terminated or expire without thirty (30) days written notice to the Department, and CONTRACTOR shall maintain such insurance from the time CONTRACTOR commences performance of services hereunder until the completion of such services. Within fifteen (15) days of the commencement of this Agreement, CONTRACTOR shall furnish a copy of the Declaration

page for all applicable policies and will provide complete certified copies of the policies and endorsements immediately upon request.

7. Acceptability of Insurance Carrier – Unless otherwise approved by Risk Management, insurance shall be written by insurers authorized to do business in the State of California and with a minimum A.M. Best's Insurance Guide rating of A- VII.

8. Deductibles and Self-Insured Retention - Any and all deductibles or self-insured retentions in excess of $10,000 shall be declared to and approved by Risk Management.

9. Failure to Procure Coverage – In the event that any policy of insurance required under this Agreement does not comply with the requirements, is not procured, or is canceled and not replaced, COUNTY has the right but not the obligation or duty to cancel the Agreement or obtain insurance if it deems necessary and any premiums paid by COUNTY will be promptly reimbursed by CONTRACTOR or COUNTY payments to CONTRACTOR will be reduced to pay for COUNTY purchased insurance.

10. Insurance Review – Insurance requirements are subject to periodic review by COUNTY. The Risk Manager or designee is authorized, but not required, to reduce, waive or suspend any insurance requirements whenever Risk Management determines that any of the required insurance is not available, is unreasonably priced, or is not needed to protect the interests of COUNTY. In addition, if the Division of Risk Management determines that heretofore unreasonably priced or unavailable types of insurance coverage or coverage limits become reasonably priced or available, the Risk Manager or designee is authorized, but not required, to change the above insurance requirements to require additional types of insurance coverage or higher coverage limits, provided that any such change is reasonable in light of past claims against COUNTY, inflation, or any other item reasonably related to COUNTY's risk.

Any change requiring additional types of insurance coverage or higher coverage limits must be made by amendment to this Agreement. CONTRACTOR agrees to execute any such amendment within thirty (30) days of receipt.

Any failure, actual or alleged, on the part of COUNTY to monitor or enforce compliance with any of the insurance and indemnification requirements will not be deemed as a waiver of any rights on the part of COUNTY.

11. Insurance Specifications – CONTRACTOR agrees to provide insurance set forth in accordance with the requirements herein. If CONTRACTOR uses existing coverage to comply with these requirements and that coverage does not meet the specified requirements, CONTRACTOR agrees to amend, supplement or endorse the existing coverage to do so. The type(s) of insurance required is determined by the scope of the contract services.

Without in any way affecting the indemnity herein provided and in addition thereto, CONTRACTOR shall secure and maintain throughout the Agreement term the following types of insurance with limits as shown:

A Workers' Compensation/Employers Liability – A program of Workers' Compensation insurance or a state-approved, self-insurance program in an amount and form to meet all applicable requirements of the

Labor Code of the State of California, including Employer's Liability with one million dollar ($1,000,000) limits covering all persons including volunteers providing services on behalf of CONTRACTOR and all risks to such persons under this Agreement.

If CONTRACTOR has no employees, it may certify or warrant to COUNTY that is does not currently have any employees or individuals who are defined as "employees" under the Labor Code and the requirement for Workers' Compensation coverage will be waived by the County's Program Risk Administrator.

With respect to CONTRACTORS that are non-profit corporations organized under California or Federal law, volunteers for such entities are required to be covered by Workers' Compensation insurance.

B. Commercial/General Liability Insurance – CONTRACTOR shall carry General Liability Insurance written on Insurance Services Office (ISO) Form CG 00 01 12 07 covering CGL on an "occurrence" basis, covering all operations performed by or on behalf of CONTRACTOR with limits of not less than two million dollars ($2,000,000) per occurrence and not less than a two million dollar ($2,000,000) general aggregate limit.

C. Automobile Liability Insurance – Primary insurance coverage shall be written on ISO Form Number CA 00 01 covering any auto (Code 1), or if
Contractor has no owned autos, hired, (Code 8) and non-owned autos (Code 9), with limit no less than one million ($1,000,000) per accident for bodily injury and property damage.

If CONTRACTOR owns no autos, a non-owned auto endorsement to the General Liability policy described above is acceptable.

D. Professional Liability/Errors and Omission Insurance – CONTRACTOR shall carry Professional Liability Insurance with limits of not less than one million ($1,000,000) per claim or occurrence and not less than a two million ($2,000,000) aggregate limit.

If insurance coverage is provided on a "claims made" policy, the "retroactive date" shall be shown and must be before the date of the start of the contract work. The claims made insurance shall be maintained or "tail" coverage provided for a minimum of five (5) years after contract completion.

E. Umbrella Liability Insurance – An umbrella (over primary) or excess policy may be used to comply with limits or other primary coverage requirements. When used, the umbrella policy shall apply to bodily injury/property damage, personal injury/advertising injury and shall include a "dropdown" provision providing primary coverage for any liability not covered by the primary policy. The coverage shall also apply to automobile liability.