



SANTA ANA WATERSHED
PROJECT AUTHORITY

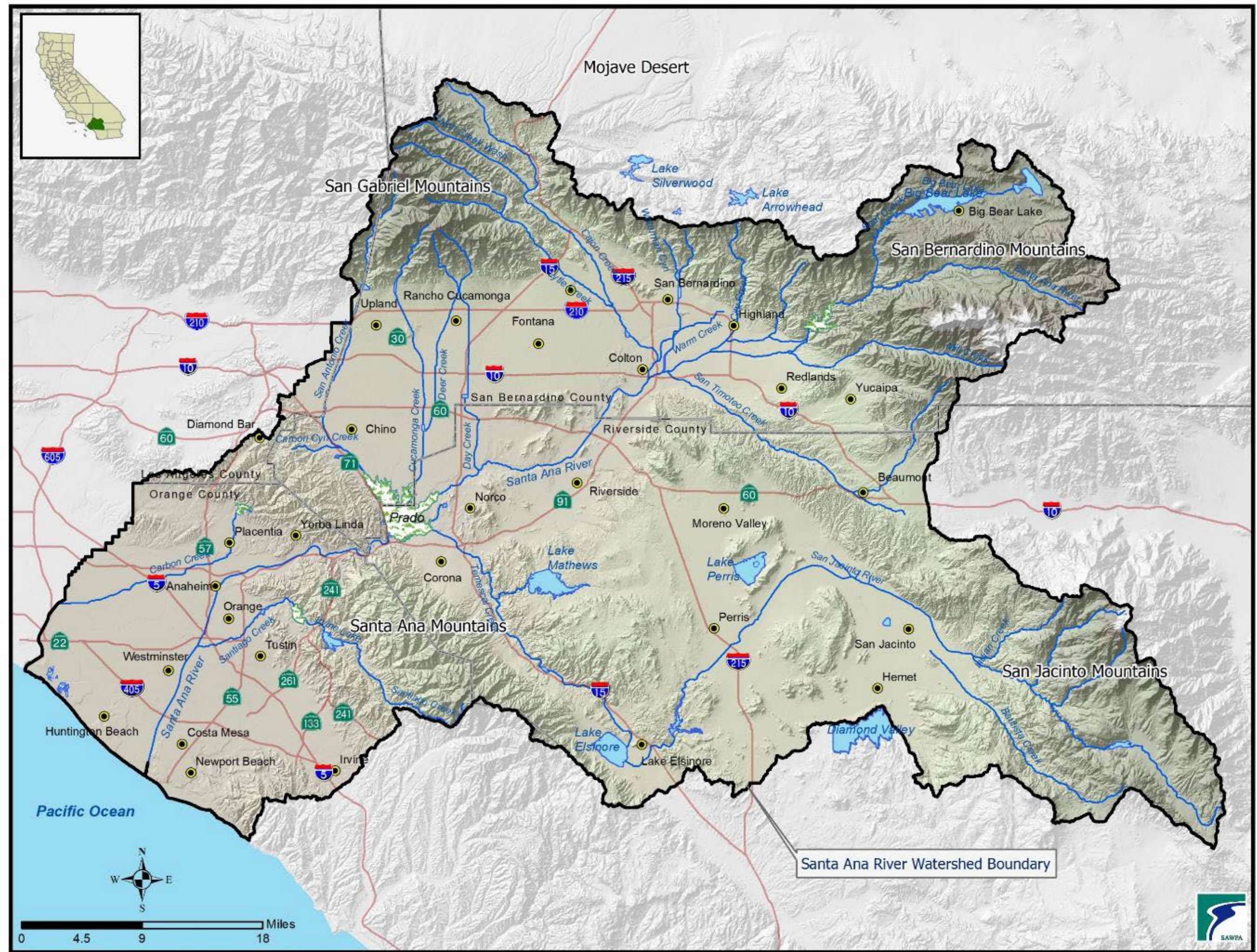
Santa Ana River Watershed Cloud Seeding Pilot Program

Jeff Mosher, General Manager

ACWA 2024 Fall Conference & Expo
Palm Desert, CA
December 4, 2024

Santa Ana River Watershed

- 6.2M people
- 2,650 square miles
- Covers parts of 3 counties (Orange, Riverside, and San Bernardino)
- 4 Mountain Ranges
 - Santa Ana
 - San Gabriel
 - San Bernardino
 - San Jacinto
- 2 National Forests



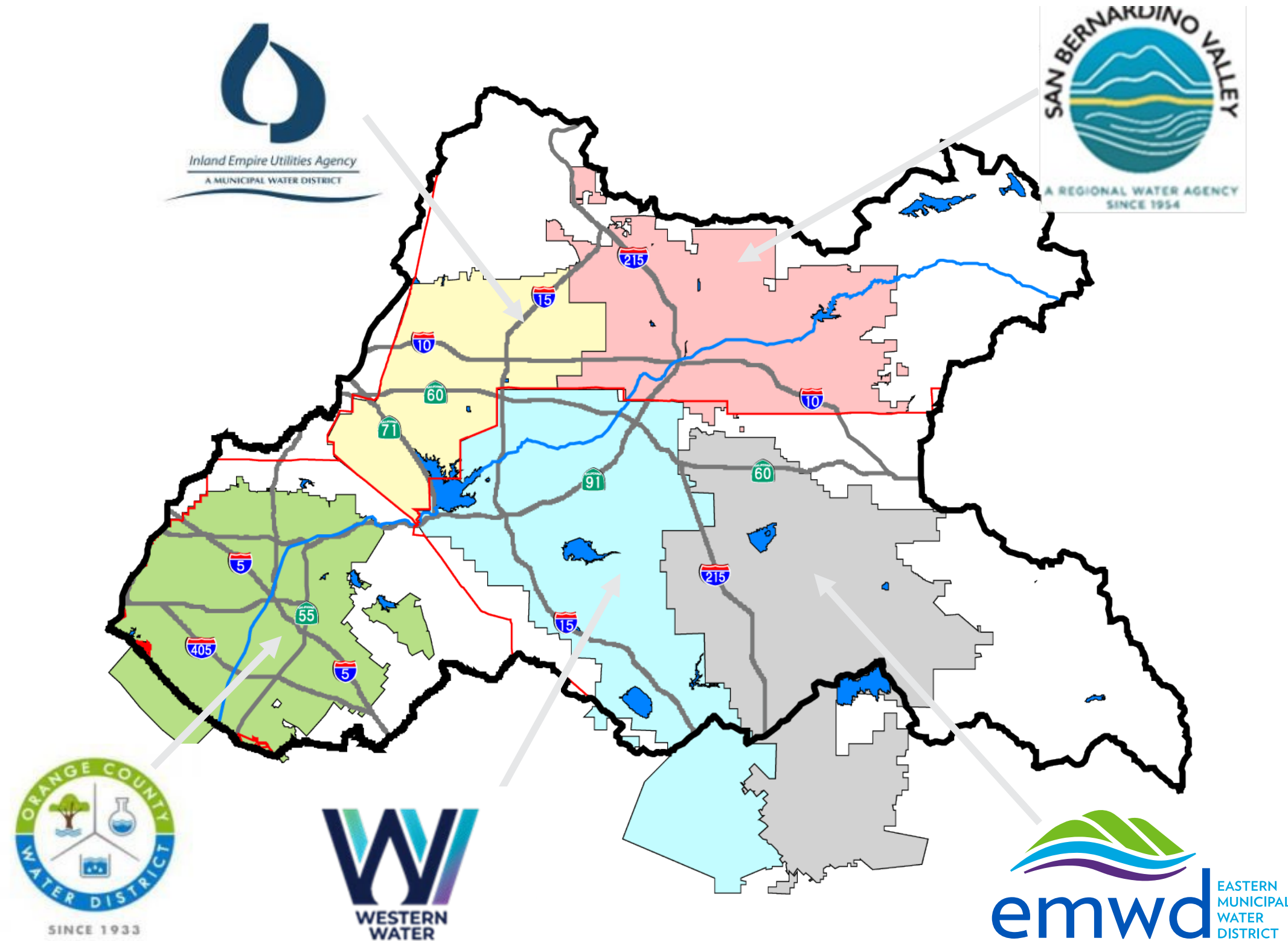
Santa Ana Watershed Project Authority

SAWPA Overview

- JPA with five member agencies
- Purpose:
 - Implement projects related to water quality and the protection of water resources in the Santa Ana River Watershed
- Role:
 - Develop and maintain regional plans, programs, and projects

Key activities include:

- Inland Empire Brine Line
- One Water One Watershed (OWOW) Plan
- Regional roundtables and task forces
- Various regional projects
- Latest: “Climate Adaptation and Resilience Plan” (CARP) for the watershed



Overview

- **Background**
 - Cloud Seeding
- **Cloud Seeding Pilot Study**
- **Operations – Year 1**
 - 2023-2024 Season
- **Validation – Year 1**
 - Preliminary results
- **Communications**
- **Year 2 of Pilot Study**
- **Recommendations**



How cloud seeding works

1

Silver iodide mixed with acetone is vaporized, releasing particles into the atmosphere.

2

Iodide particles rise into cold, high-altitude air, moisture in the air condenses to form ice crystals on particles.

3

As ice crystals grow they become heavy and fall back to Earth in the form of snow or, at warm temperatures, melt into rain.

Seeding generator

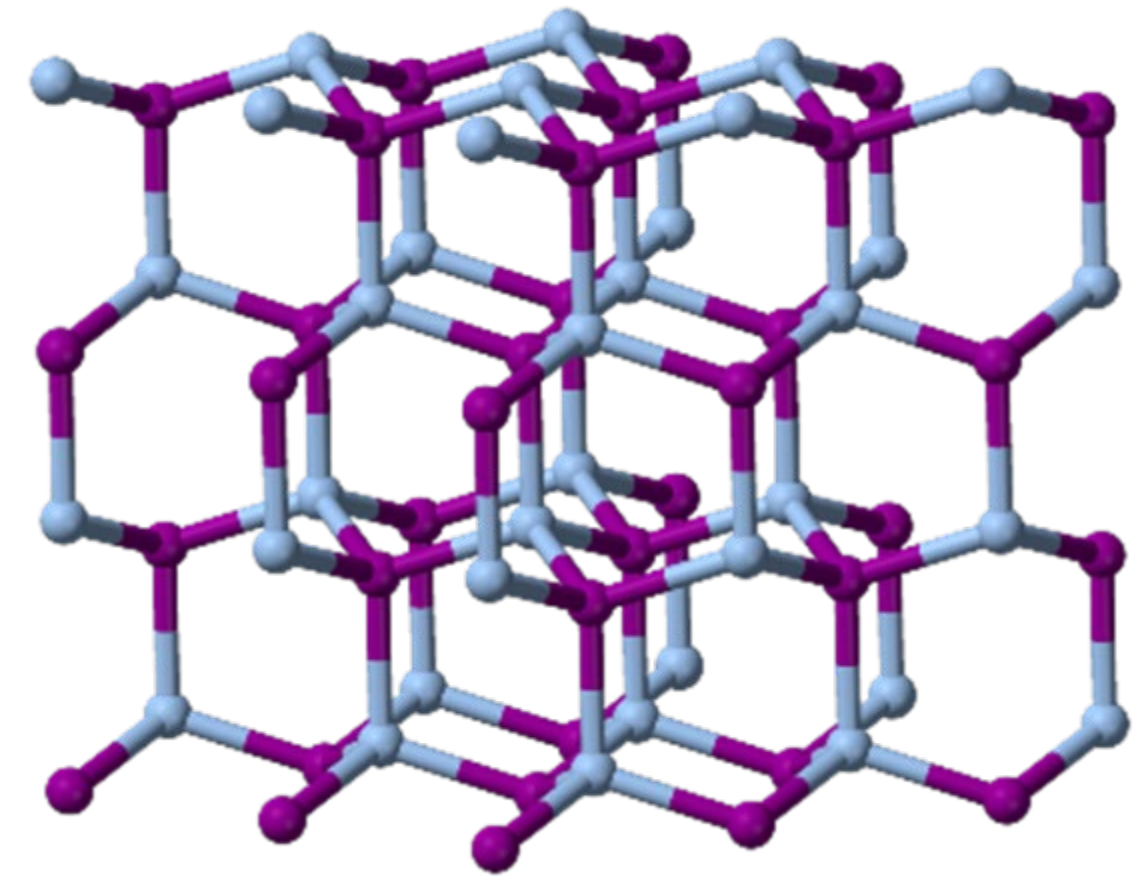
Wind direction

- Specific conditions required:
 - Storm clouds
 - Cloud type
 - Cloud depth
 - Cloud coverage
 - Wind direction
 - **Cloud temp $< -5^{\circ}\text{C}$**
 - **Supercooled Liquid Water (SLW)**
- Operations:
 - Meteorologist

Potential Environmental Effects

Silver iodide (AgI)

- Chemically inert and not soluble in water or biologically available
- Low toxicity and does not accumulate in soils above natural background levels



Silver Iodide (AgI) Particle

Cloud Seeding Licensing and Permitting

- Operators are licensed and carry liability insurance
- Suspension criteria turns off program during high precipitation and flood conditions
- No CA state permit required
- CEQA was conducted
- Reporting requirements after each year to DWR and NOAA



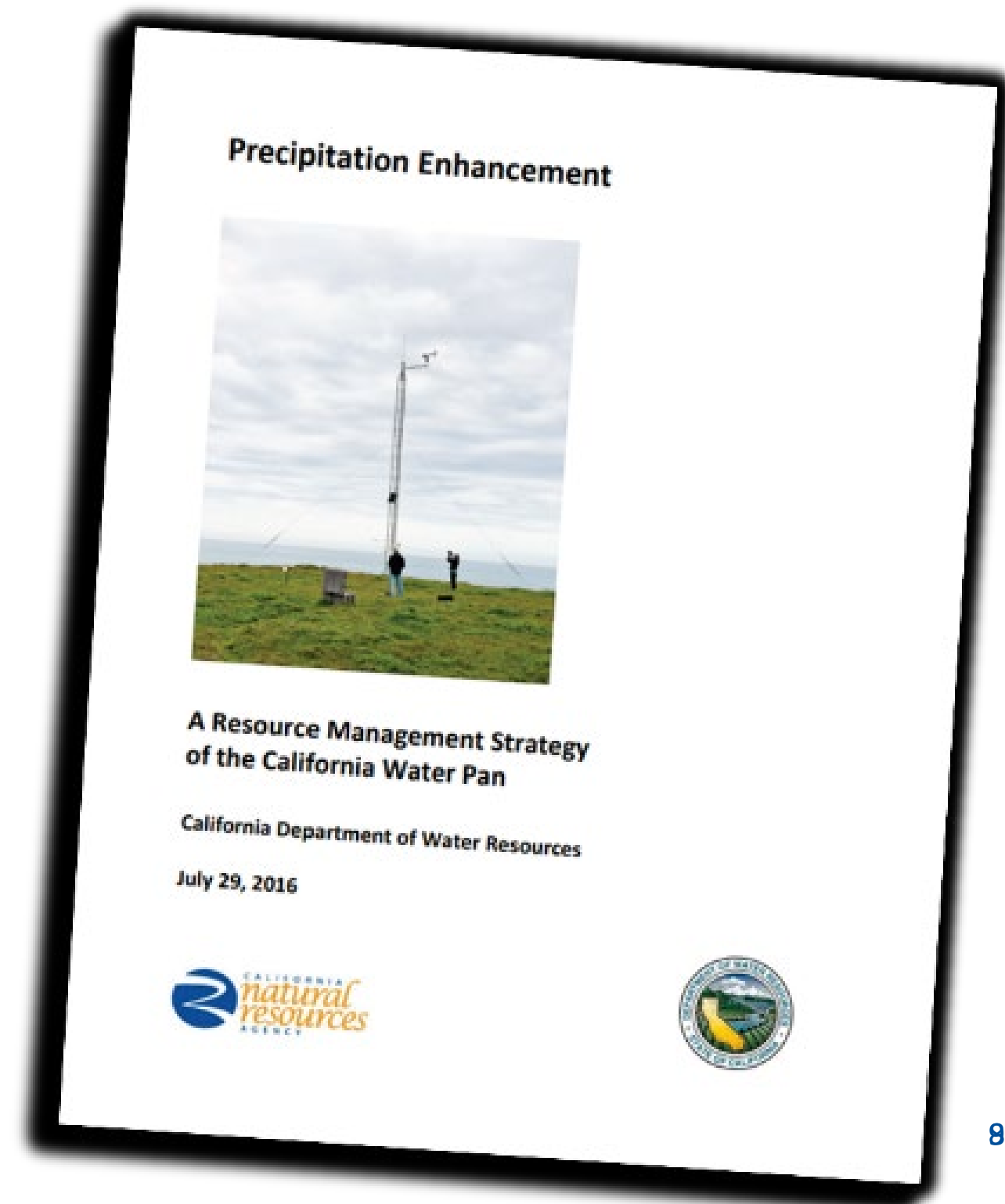
Water Rights

DWR “Precipitation Enhancement Report” (2016):

“State law says that water gained from cloud seeding is treated the same as **natural supply** in regard to water rights.”

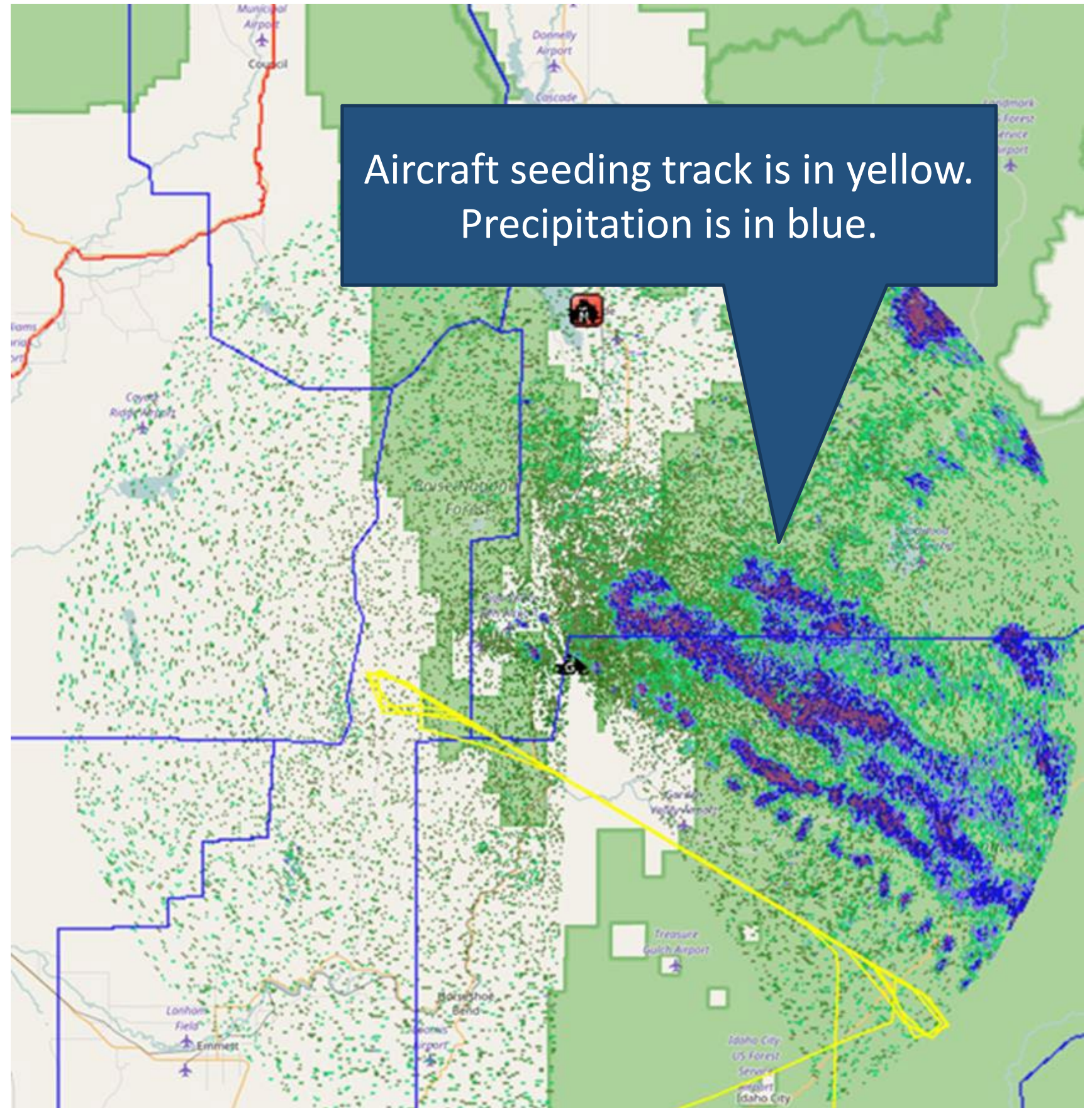
Source:

<https://cawaterlibrary.net/document/precipitation-enhancement-resource-management-strategy/>



Does Cloud Seeding Work?

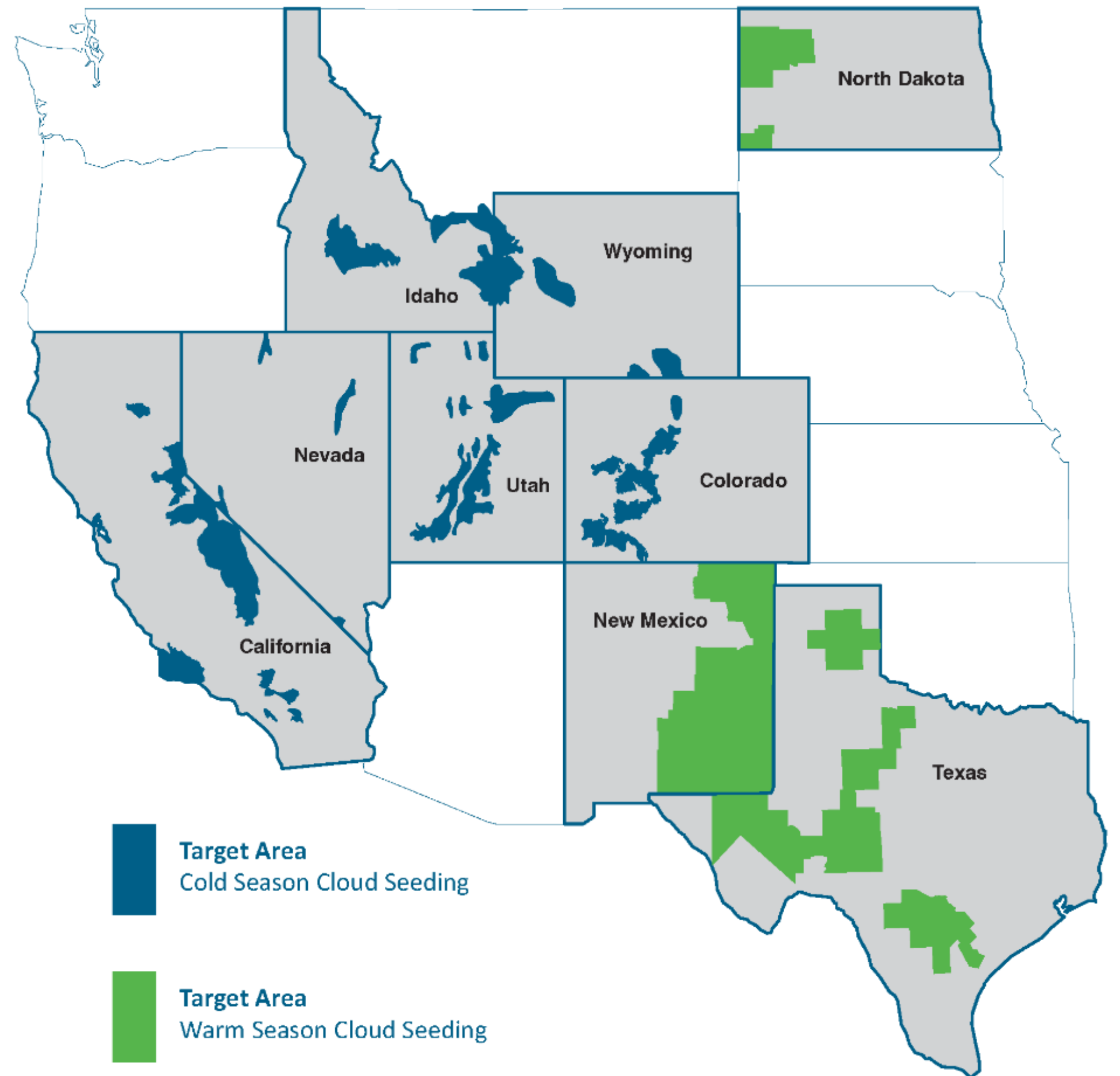
- 2017 Idaho Experiment (SNOWIE)
- National Center for Atmospheric Research (NCAR) was involved
- Use of seeding aircraft and Doppler Radar
- \$2.1M study



U.S. Projects

- 💧 Cold Season Cloud Seeding Leaders
 - CA, CO, ID, UT, WY, NV
 - Aerial release and ground-based units
- 💧 Applications
 - Power Utilities (hydropower)
 - Water Resource Agencies
 - Irrigation Districts
- 💧 Example California Projects
 - Santa Barbara County
 - San Luis Obispo County
- 💧 DWR position:
 - Cloud seeding is a “safe and effective means of augmenting local water supplies.”*

* Precipitation Enhancement: A Resource Management Strategy of the California Water Plan, DWR. July 29, 2016



Source: North American Weather Modification Council

Santa Ana River Watershed Cloud Seeding Pilot Program

Why consider cloud seeding in the Santa Ana River Watershed?

Precipitation – and flows in the Santa Ana River – have been trending down

- Cloud seeding increases precipitation (**with an emphasis as snow in upper elevations**)
- Produces a local water supply
- Potential to reduce reliance on imported water

Dry years and droughts occur

- Cloud seeding works in both dry and wet years

Cost effective

- The costs for a projected 8%-11% increase in streamflow is **\$50-\$100/AF**

Supports local water storage

- Natural infiltration
- Takes advantage of existing stormwater capture infrastructure

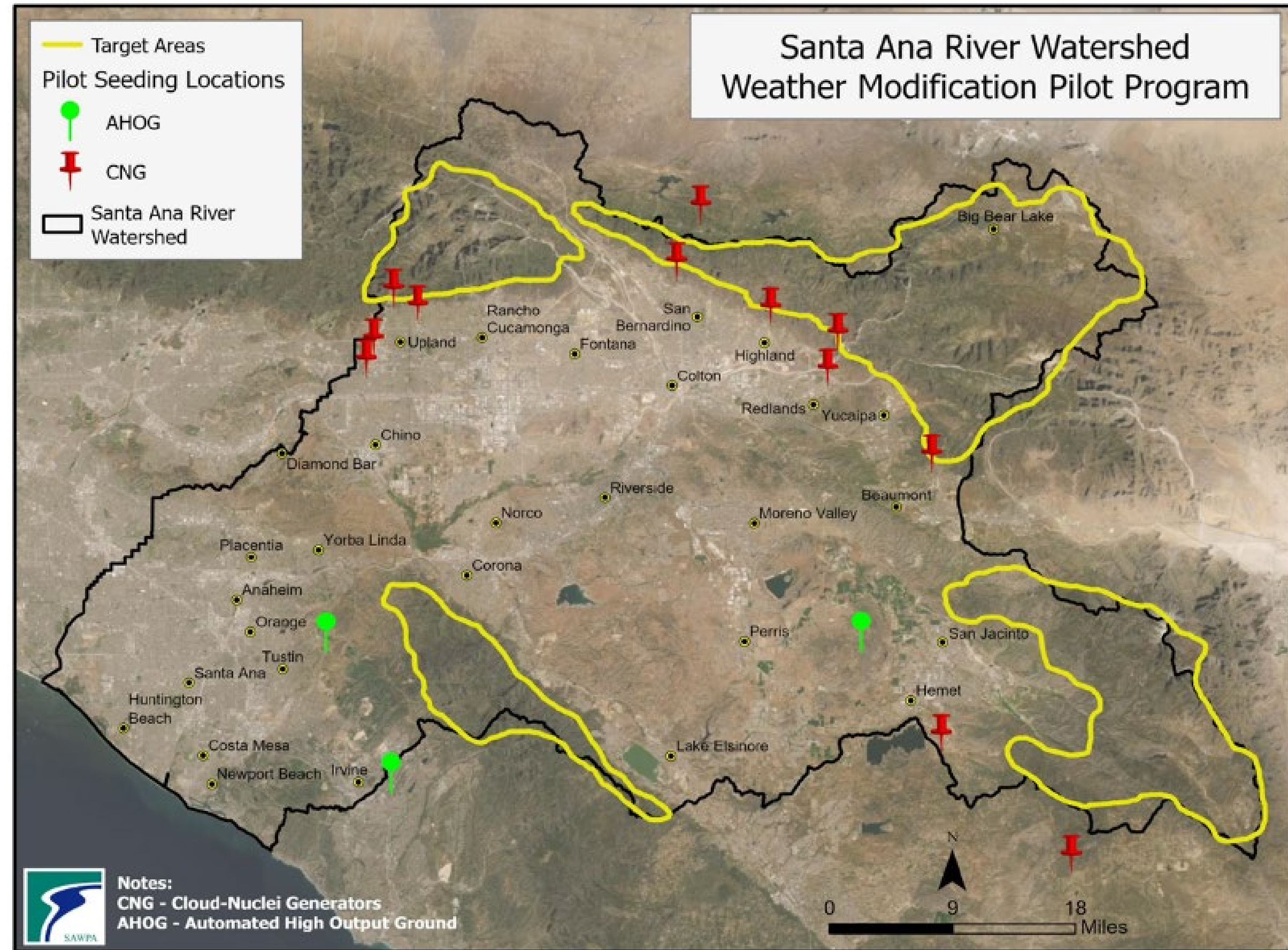
Cloud Seeding Pilot Project

Cloud Seeding Pilot Program

- 4-year study (Nov 15 – April 15)
- 4 Target Areas – NW, NE, SW, and SE.
- Use of 15 ground-based seeding units
- Use of a **Validation Study** to assess increases in precipitation

Planning

- Feasibility Study (2020)
- CEQA Study (2022)



Source: SAWPA Weather Modification Feasibility Study (2020)

Ground-Based Seeding Methods

CNG's (Cloud Nuclei Generators)



- Create a continuous plume
- Inexpensive to install and operate

AHOGS (Automated High Output Ground Seeding) Systems

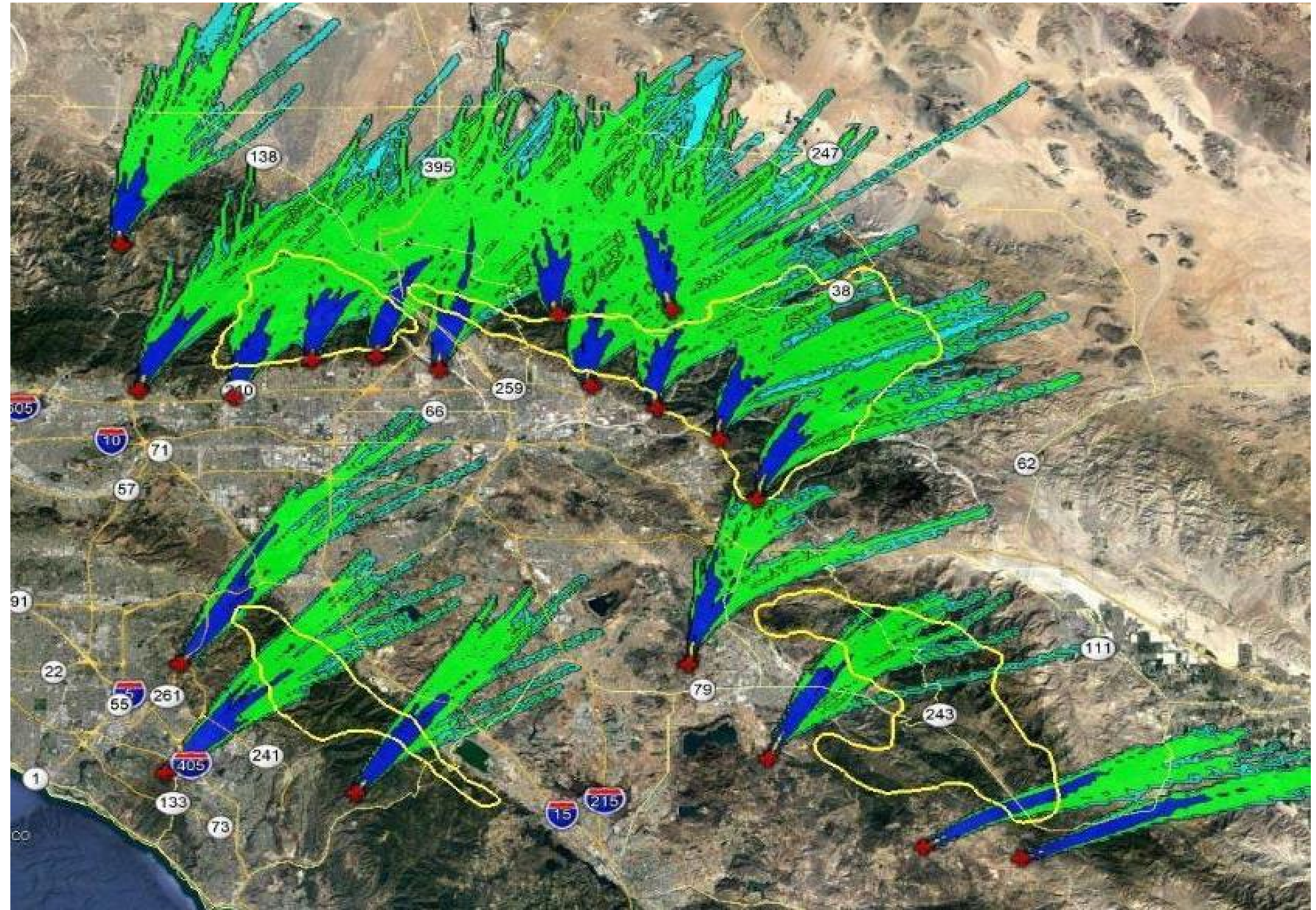


- Delivers higher concentration of silver iodide
- Operated remotely – rapid release

Pilot Project

Ground-Based Seeding Dispersion Model

- Show direction of Silver Iodide dispersion



Source: SAWPA Weather Modification Feasibility Study (2020)

Cloud Seeding Pilot Program Funding (\$1.6M)

Proposition 1 Round 2 Grant

- Department of Water Resources (DWR)

Agency Funding

- SAWPA Member Agencies
- 8 Additional local agencies



Year 1 Complete!

Operations

November 15, 2023 to April 15, 2024

Ground-Based Unit Locations

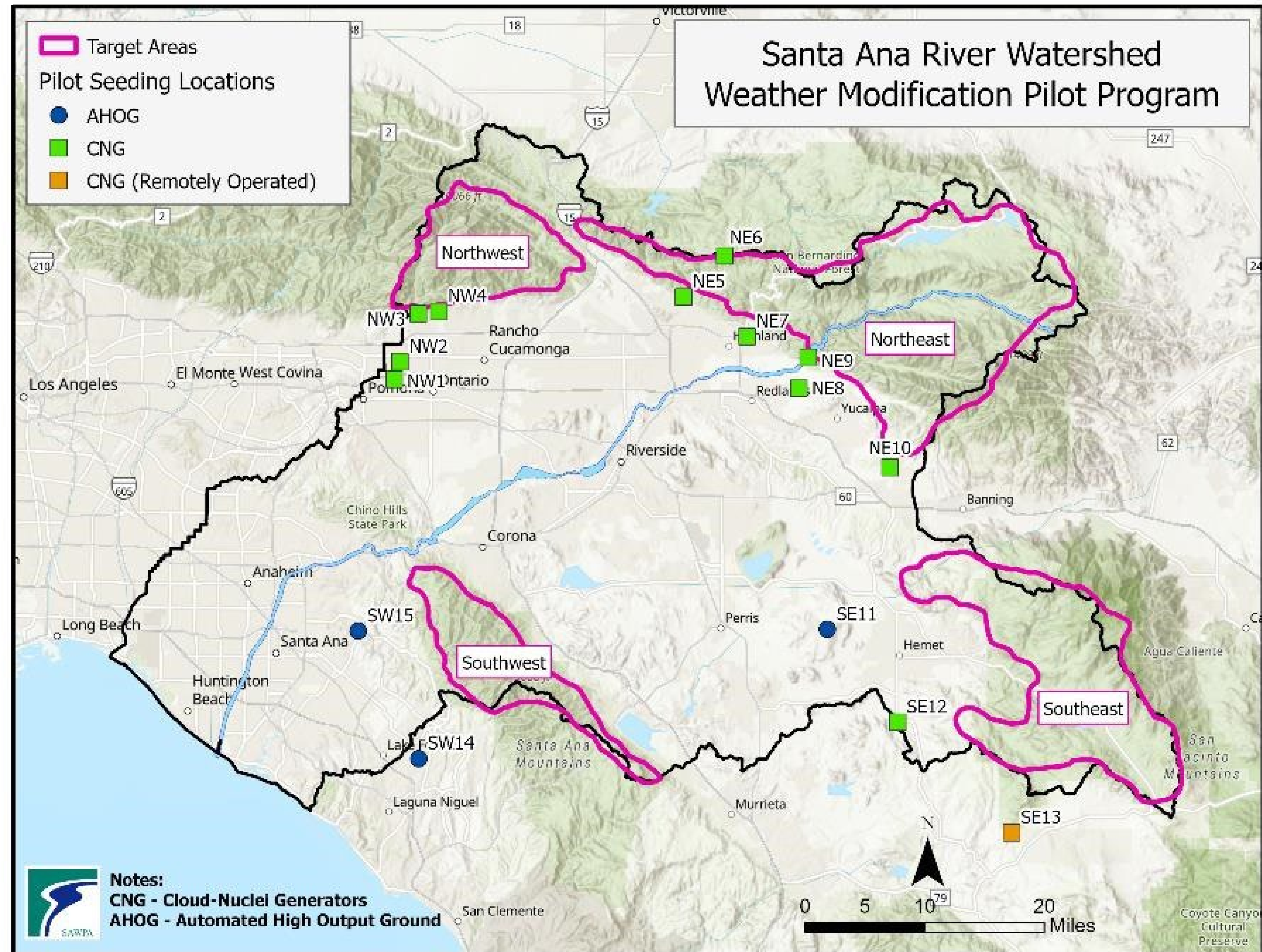
Not all units are operated during every storm

Units operated based on:

- Wind direction
- Type of storm
- Other meteorological factors

Cloud Seeding Operator (Meteorologist)

- Turns units on and off
- Extensive use of weather models



Example Ground-Based Seeding Sites



SW14:
El Toro Water District
(AHOGS)



NE9:
San Bernardino Valley Water
Conservation District (CNG)



NW2:
Chino Basin Water Conservation District
(CNG)

Cloud Seeding Suspension Criteria

Flood

- Quantitative precipitation forecast is >3 inches in 24 hours

Burn Scars

- Threat of debris flow
- Coordinate with flood control districts

Severe Weather

- Winter storm warnings
- Flash flood warnings
- Severe thunderstorm warnings

Real-Time Considerations:

1. Size of storm
2. Consecutive Storms
3. Input from Flood Control Districts on the potential for flooding and/or debris flows

Summary of 2023-2024 Cloud Seeding Operations

(12 storms seeded out of 20 total storms)

Units	Storm Periods	Nov 17-18	Dec 21-22	Dec 29-30	Jan 3	Jan 20-21	Jan 21-22	Feb 1	Feb 20-21	Mar 6-7	Mar 23-24	Mar 30-31	Apr 5	Apr 13-14
CNGs (Hours of Generator Runtime)	NW1			23	6.5			10	16.75	16	22	30	12.75	7
	NW2			23	7			9	16.25		20.25		9.25	7
	NW3	11.25	22	21	5.75			23.5	19.5	14	22.5	26.75	8.5	24.75
	NW4	13.25	20.75	22				23	19.75	14	22.5	27.75	8.5	25
	NE5		26.5	21.25	8.75	17.25	24.5			17	22.75	31.25	12.25	25.5
	NE6		21.5	9	12.25	17	14.25	11.75	18.25	14	18	31.25	14	20.25
	NE7		22.75	21	9	17			23	17.75	22.75	31.25	12.5	25.5
	NE8		22.25	18.75	9.75	18.5	23.25	7.75		15	20.5		13	25
	NE9		23	18.75	9.5	18.25	23.25	8	20.5		20.25	32.25	12.75	25.5
	NE10		24.25	21.25	9.25	17.75	24.75	23.5	24.25	18.75	22.5	31.25	12.25	25.25
	SE12		8.75	5.5	9.75			14		17	4.75	33	9	
	SE13		19	6.5	8	15.25	24.5	12.25		12.75	18.25	32.75	12.75	
AHOGS (Flares)	SE11		5		2		4	1				1	1	
	SW14		1	3		1	3			1		2	2	
	SW15									2			1	2

Preliminary Results

Validation

Pilot Program Validation



Key component of the Pilot Program

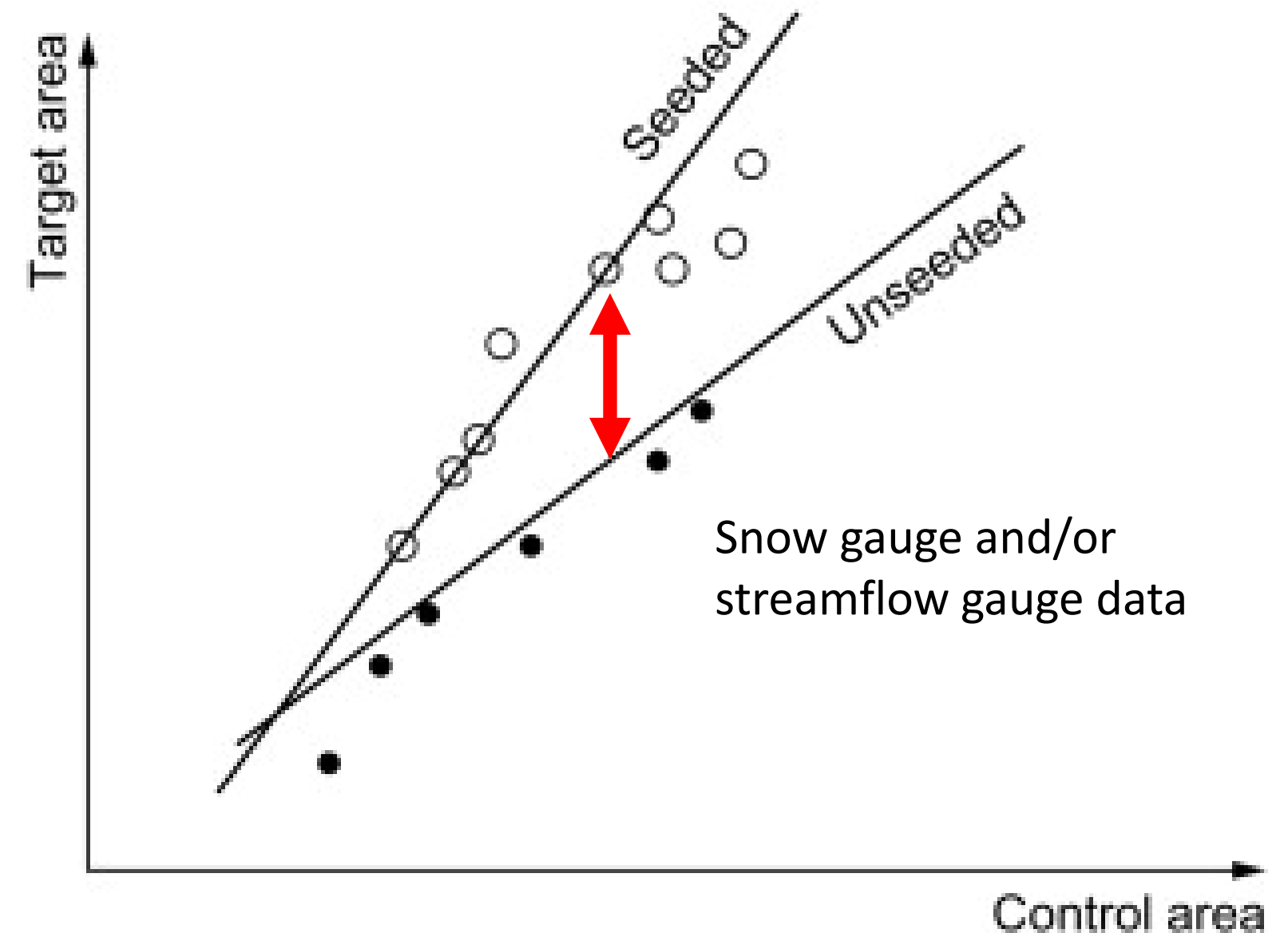
- Independent validation of the additional precipitation

Desert Research Institute (DRI)

- Research arm of the University of Nevada
- Perform validation:
 - Target and Control Analysis

Outcomes of Validation:

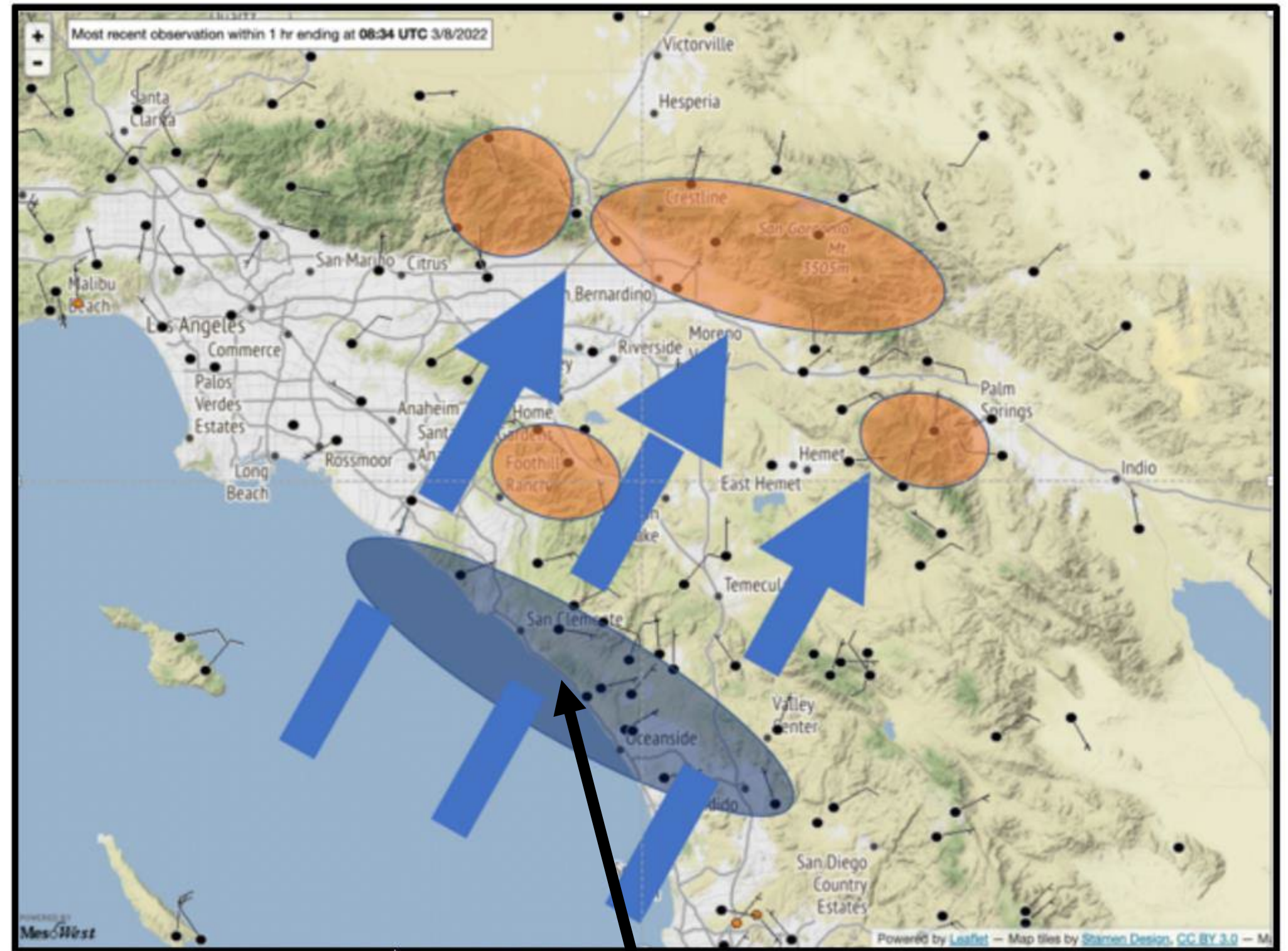
- Verify Increases in precipitation (snow and rain) and streamflows



Regression applications are used between the seeded and unseeded rainfall data of target (seeding) and control (nonseeding) areas.

Validation: Target/Control Analysis

- ❑ Select **Control** area
- ❑ Identify **precipitation gauges** for Target and Control areas
- ❑ Calculate the **statistical relationship** between target and control area gauges (unseeded years)
- ❑ For the **seeded storms**, compare precipitation to the historical relationship
- ❑ **Excess precipitation** can be attributed to cloud seeding



Control Area

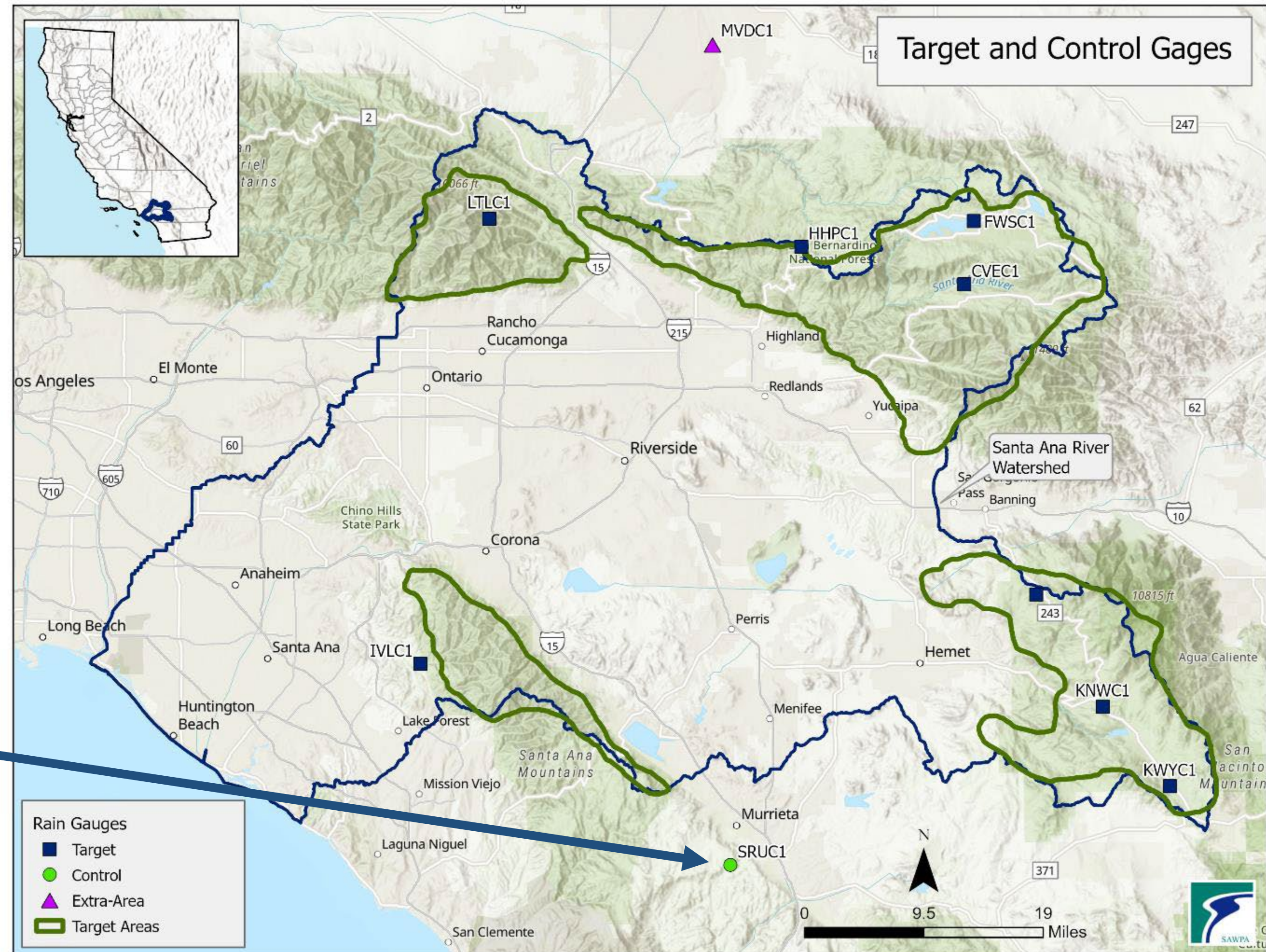
Target and Control Gauges

Target Areas:

- NE: 3 gauges
- NW: 1 gauge
- SE: 3 gauges
- SW: 1 gauge

Control:

- 1 gauge

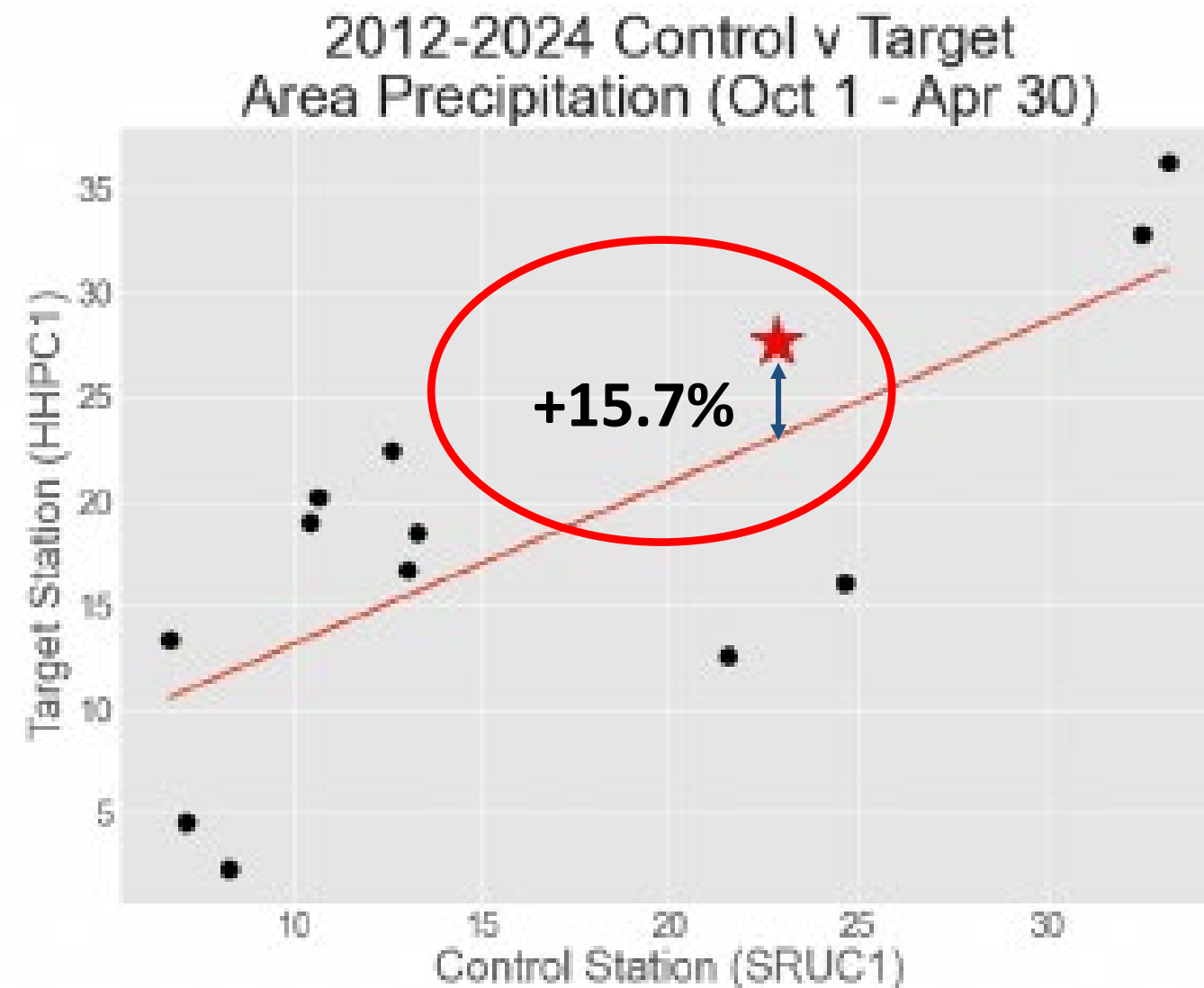


Northeast Target Area

★ Preliminary Results



Individual Snow Gauges (Year 1 – All Storms)

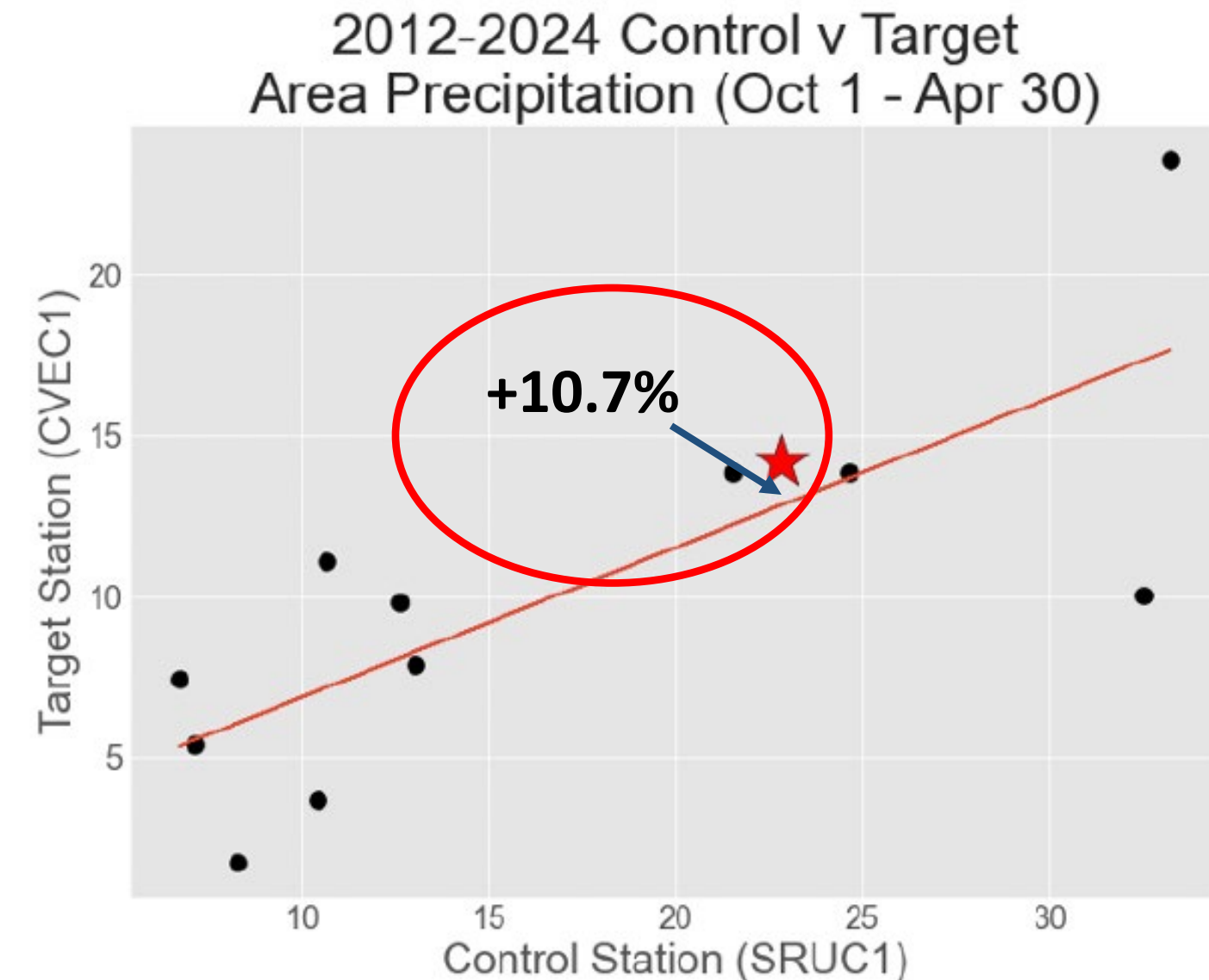


Heaps Peak (SB Mountains) – **Target**
vs Santa Rosa Plateau (San Ana Mountains) – **Control**

Expected Precip: **23.5 in**

Observed Precip: **27.2 in**

+15.7%



Converse (SB Mountains) – **Target**
vs Santa Rosa Plateau (San Ana Mountains) – **Control**

Expected Precip: **13.0 in**

Observed Precip: **14.4 in**

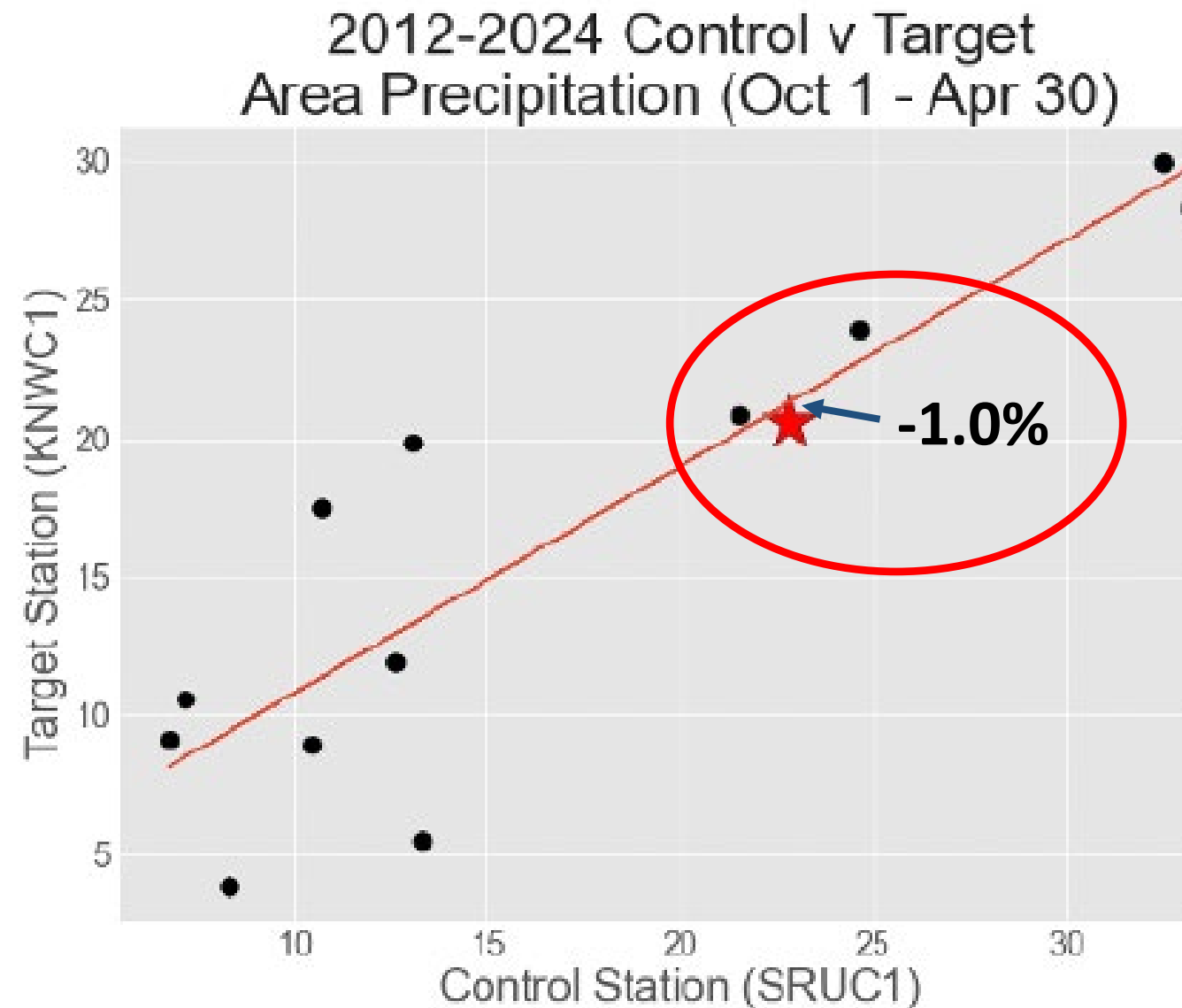
+10.7%

Southeast Target Area

★ Preliminary Results



Individual Snow Gauges (Year 1 – All Storms)

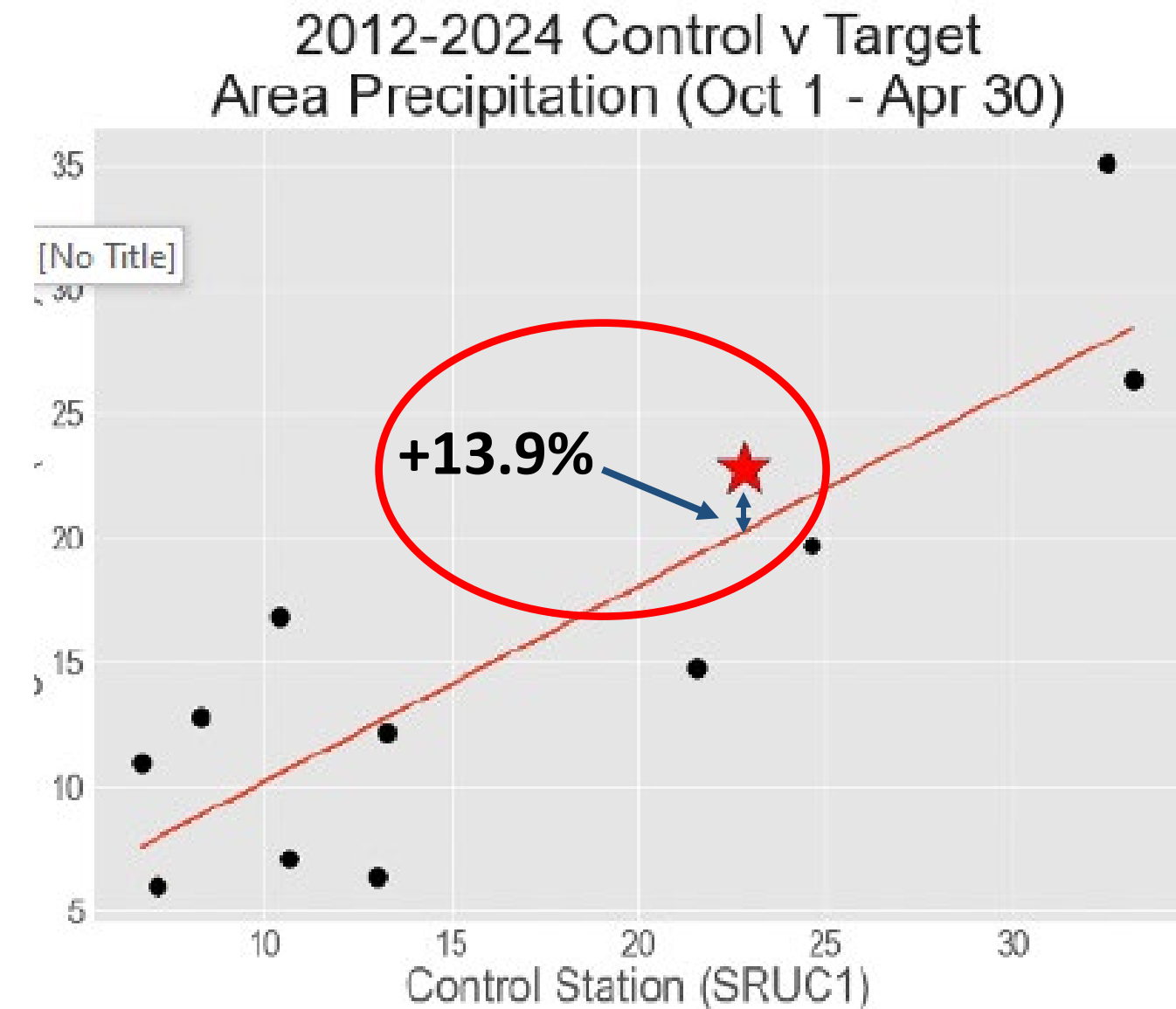


Keenwild (San Jacinto Mountains) – **Target**
vs Santa Rosa Plateau (San Ana Mountains) – **Control**

Expected Precip: **20.3 in**

Observed Precip: **20.1 in**

-1.0%



Vista Grande (San Jacinto Mountains) – **Target**
vs Santa Rosa Plateau (San Ana Mountains) – **Control**

Expected Precip: **20.1 in**

Observed Precip: **22.9 in**

+13.9%

+10.7%

Target-Control Increases by Target Area

Preliminary Results

- Calculate increases by the four target areas:

Total increase = Number of Generators x Increase in Precip x Footprint (of Generator)

	Year 1 (2023-2024)	Year 2	Year 3	Year 4
Northeast (San Bernardino Mts)	16,320 AF (10% increase in precip)			
Southeast (San Jacinto Mts)	3,974 AF (4.1% increase in precip)			
Northwest (San Gabriel Mts)	0 AF			
Southwest (San Ana Mts)	0 AF			
Total	20,294 AF			

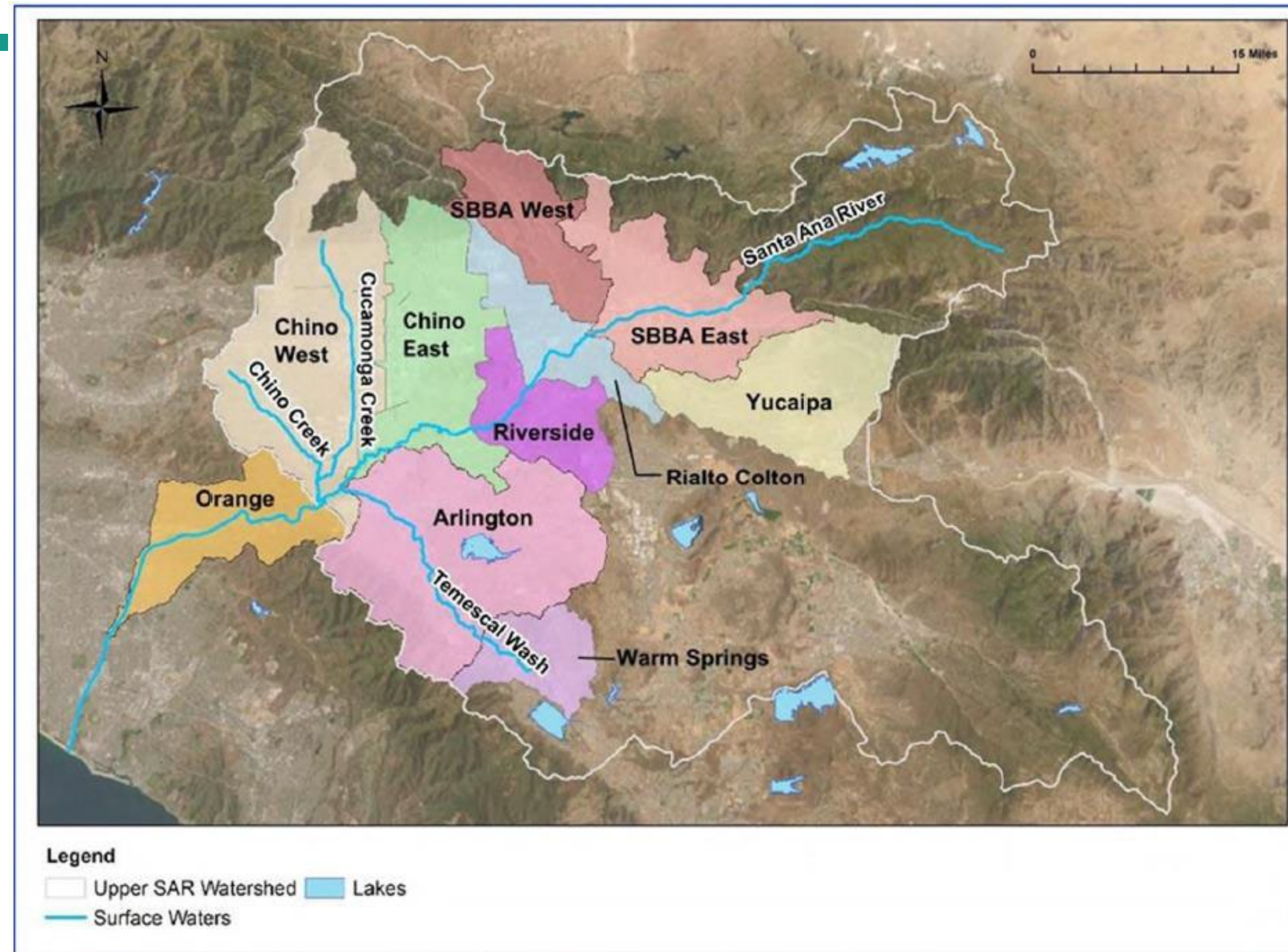
Cost per Acre-Foot:

~\$400,000 /
20,294 AF =

~\$20 per AF

Where does the additional water go?

- Who benefits?
- Use existing **HSPF surface water model** to show where the water ends up (i.e., 10 sub-basins)
- Data need:
 - ✓ Increased flows at stream gauges (from DRI)



Communications

Summary of Communications

- Communications Plan
- SAWPA’s Pilot Program webpage
 - Cloud seeding event chart
 - Over **151,000** page views between June 2023 and June 2024
- Communication materials
 - Brochure, fact sheet, FAQ, CEQA documents
 - Door hangers (as needed)
- Public comments and questions
- Respond to media inquiries
- Speakers' bureau (>80 presentations)
- Subject of TikTok, Instagram, and X videos

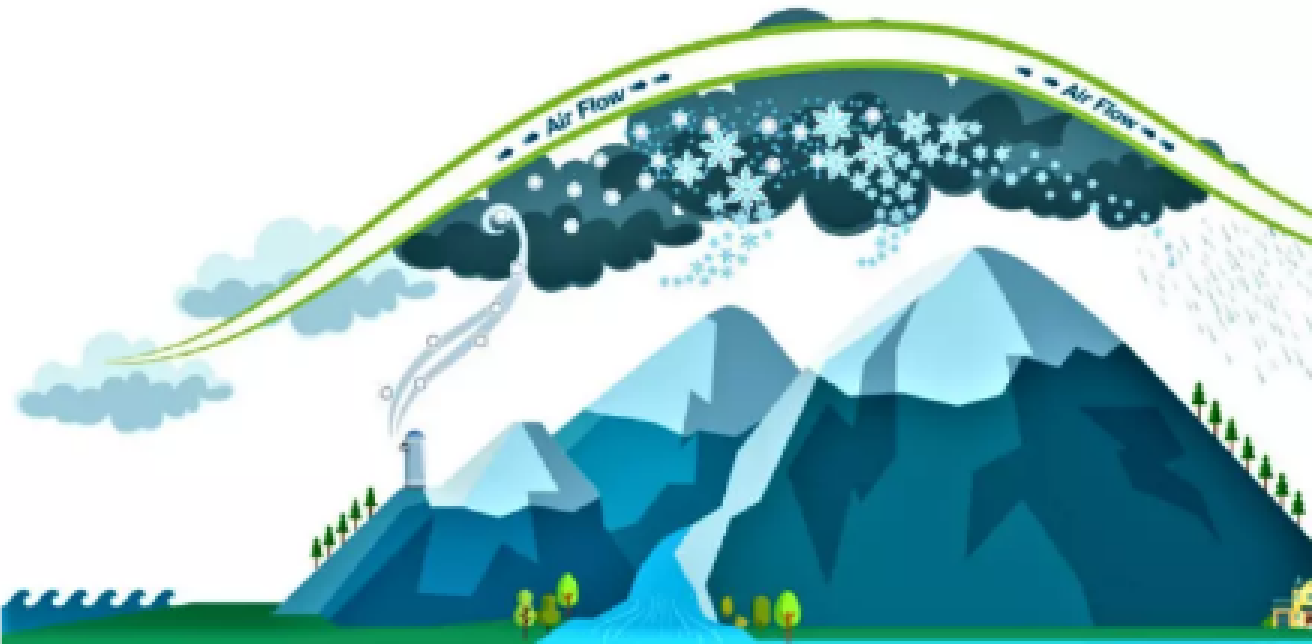
SAWPA Website: Cloud Seeding Event Chart

Month/Year	Start	End	Target Area(s)
December 2023	12/21/2023	12/22/2023	NW, NE, SW, and SE
	12/29/2023	12/30/2023	NW, NE, SW, and SE
January 2024	1/3/2024	1/3/2024	NW, NE, SE
	1/20/2024	1/21/2024	NE, SE, SW
	1/21/2024	1/22/2024	NE, SE, SW
February 2024	2/1/2024	2/1/2024	NW, NE, SE
	2/20/2024	2/21/2024	NW and NE
March 2024	3/6/2024	3/7/2024	NW, NE, SW, and SE
	3/23/2024	3/24/2024	NW, NE, SE
	3/30/2024	3/31/2024	NW, NE, SE, and SW
April 2024	4/5/2024	4/5/2024	NW, NE, SW, and SE
	4/13/2024	4/14/2024	NW, NE, SW

*Last updated: April 15, 2024

NEWS

New 4-year cloud-seeding pilot program hopes to make it rain in Santa Ana River watershed



An illustration shows how releasing silver iodide particles into storm clouds maximizes precipitation (Courtesy of SAWPA)

BY SARA CARDINE | STAFF WRITER

JAN. 13, 2024 4:43 PM PT

Using meteorology and chemistry to help prod Mother Nature, water of begun seeding storm clouds throughout the Santa Ana Watershed to bo

Daily Pilot – Jan 13, 2024

LA Times – Feb 24, 2024



Two ABC 7
(Riverside)
Segments (2024)

CALIFORNIA

The latest unfounded conspiracy theory: Cloud seeding is to blame for California's storms and flooding



Travis Longcore and others evacuated after an atmospheric river unleashed heavy rain in their Beverly Crest neighborhood. Conspiracy theorists blame cloud seeding for the intensity of recent storms. (Allen J. Schaben / Los Angeles Times)

BY SALVADOR HERNANDEZ | STAFF WRITER

FEB. 24, 2024 5 AM PT

When a water agency for most of California's Inland Empire and parts of Orange County started a pilot program to seed clouds in the region in November to see if it could

Common Topics for Public Comments

Governance and Permitting

- What approvals were required?
- How was the public involved?

Operations

- Does it work?
- Potential for flooding
- Potential for thunderstorms
- Potential for fire
- Contributing to contrails

Safety of Silver Iodide

- Human health
- Ecological health and impact on the environment

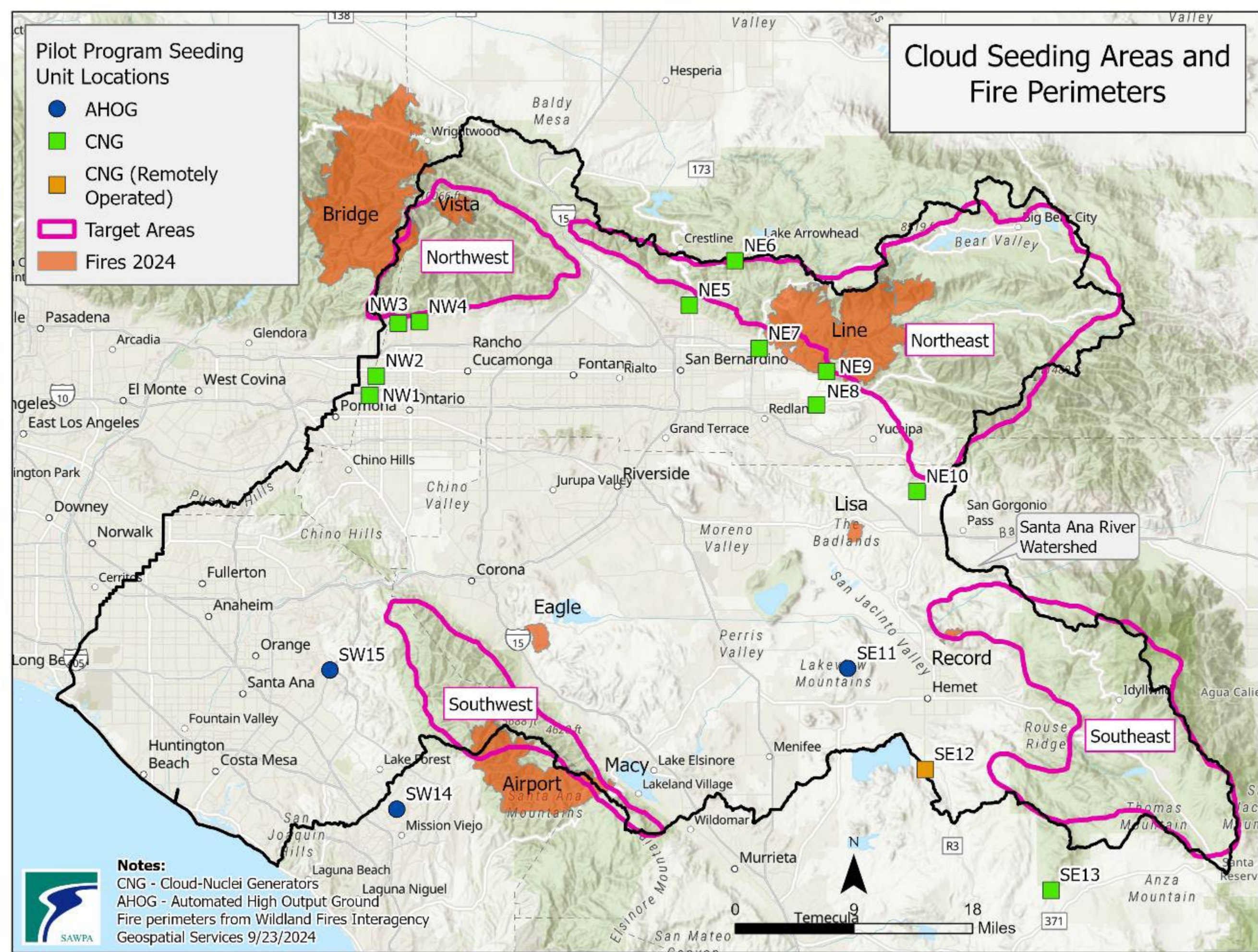
Potential Impacts

- People
- Pets
- Soil
- Streams
- Groundwater supplies



Year 2 of Pilot Study

Santa Ana River Watershed Fires (2024)



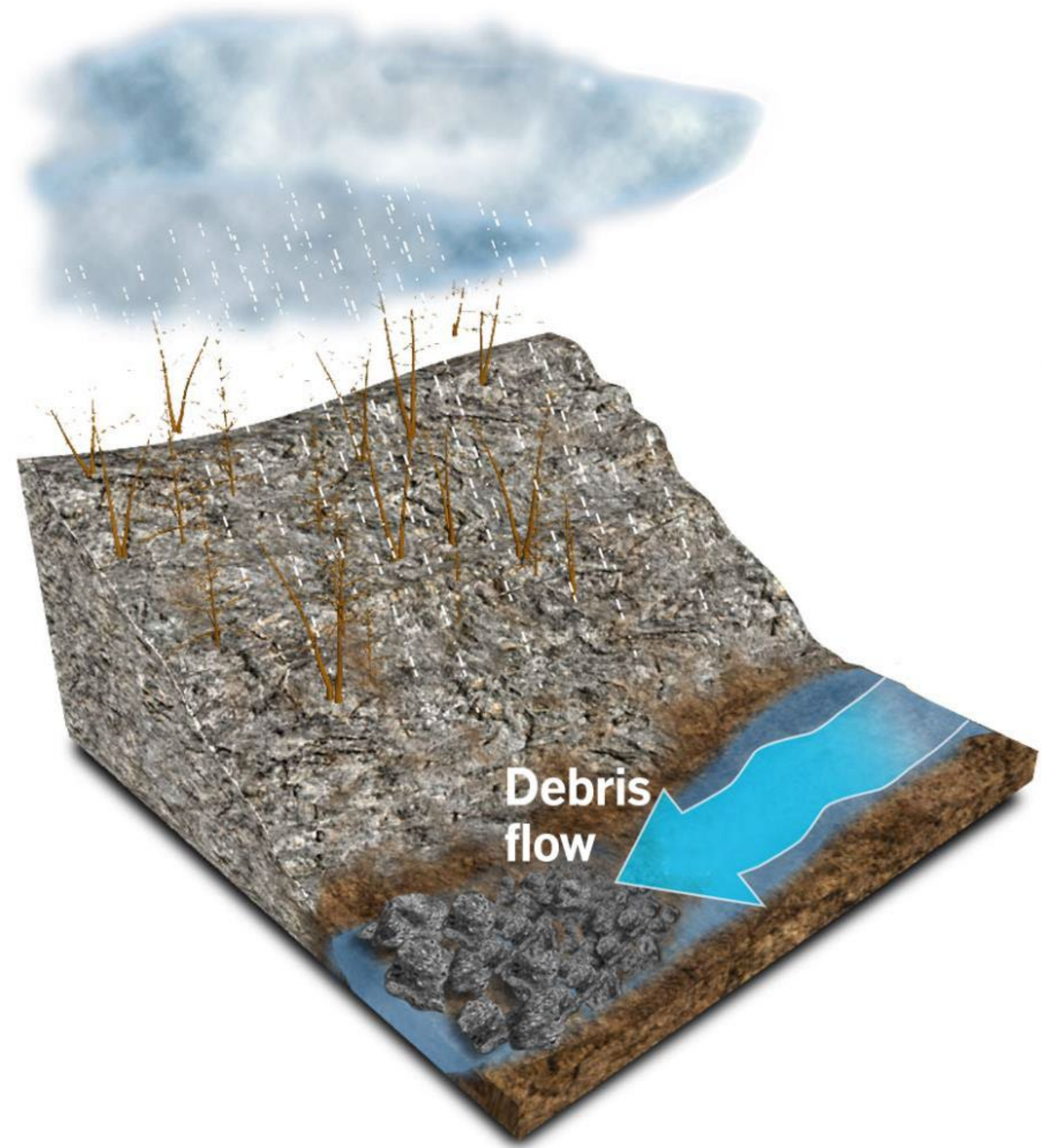
Flood Control District Input

San Bernardino County
Flood Control District

Riverside County Flood
Control District

Orange County Public
Works

Los Angeles County Flood
Control District



Pilot Program Schedule

Year 1

- | | |
|--|---------------------------------|
| • Year 1 Overview – SAWPA Commission | May 21, 2024 (public meeting) |
| • First Year Summary Report* | August 2024 (public document) |
| • Project Validation Year 1 Report* | December 2024 (public document) |
| • Surface water modeling analysis* | 2025 |

Year 2 **POSTPONED**

- | | | |
|---------------------------------|---------------------------|-----------------------|
| • Year 2 Equipment Mobilization | ~~October 2024~~ | October 2025 |
| • Year 2 Operations – Start | ~~Nov. 15, 2024~~ | Nov. 15, 2025 |
| • Year 2 Operations – End | ~~April 15, 2024~~ | April 15, 2025 |

*Including presentation to the SAWPA Commission

Cloud Seeding – Takeaway Messages

- Cloud seeding is a regional effort (e.g., counties, regional agency)
 - County or regional agency lead
 - Multiple partners (beneficiaries)
- Requires a suitable topography (mountains)
- Consider aerial or ground-based seeding or both
 - Drones could be a viable option in near future
- No guarantee of increase from year to year (but cost is low)
- Need to be able to capture the resulting snowmelt
- The public has many questions and can be very vocal
 - Safety, perceived impacts, potential consequences, etc.
- Ski resorts like it.

Thank You

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sawpa.gov

