Validation Plan for the SAWPA Cloud Seeding Program

Frank McDonough
Desert Research Institute

Desert Research Institute
Reno, NV

- Research institution part of the Nevada System for Higher Education
- Founded in 1959
- Staff of 400+ scientists conduct research on 300 projects
- Research topics include:
  - global climate change,
  - water quality and availability
  - air quality,
  - the sustainability of desert lands
  - life in extreme environments
  - education
  - and much more

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Cloud Seeding Program

- Research started in 1960s.
- Led several well funded BoR programs including the 1970s – 80s.
  - Sierra Cooperative Pilot Program
  - Skywater Research Program
- Designed and operated the Nevada state research/operational cloud seeding program (1976-2010).
- Pioneered the use of remote-controlled high-altitude generators
- Designed the current ice nuclei (AgI + NaCl) used by most cloud seeding project
- Pioneered the use of trace chemistry to help validate cloud seeding programs
- Developed high-resolution numerical models and plume models for cloud seeding research.
- Current research and operational projects in CA, NV, AZ, CO.

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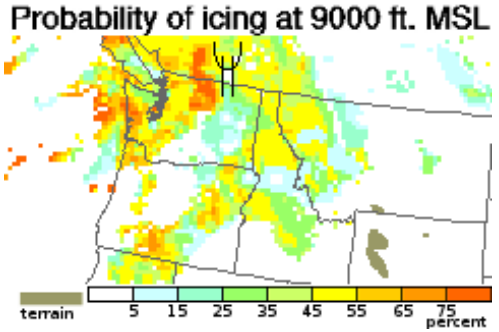
Frank McDonough - Research Meteorologist

- Aircraft icing research 1996-2012.
  - Participated in several aircraft icing research campaigns
  - Co-developed the NOAA operational Current and Forecast Icing Products https://www.aviationweather.gov/icing/fip
- Cloud seeding/mountain meteorology research 2014-current.



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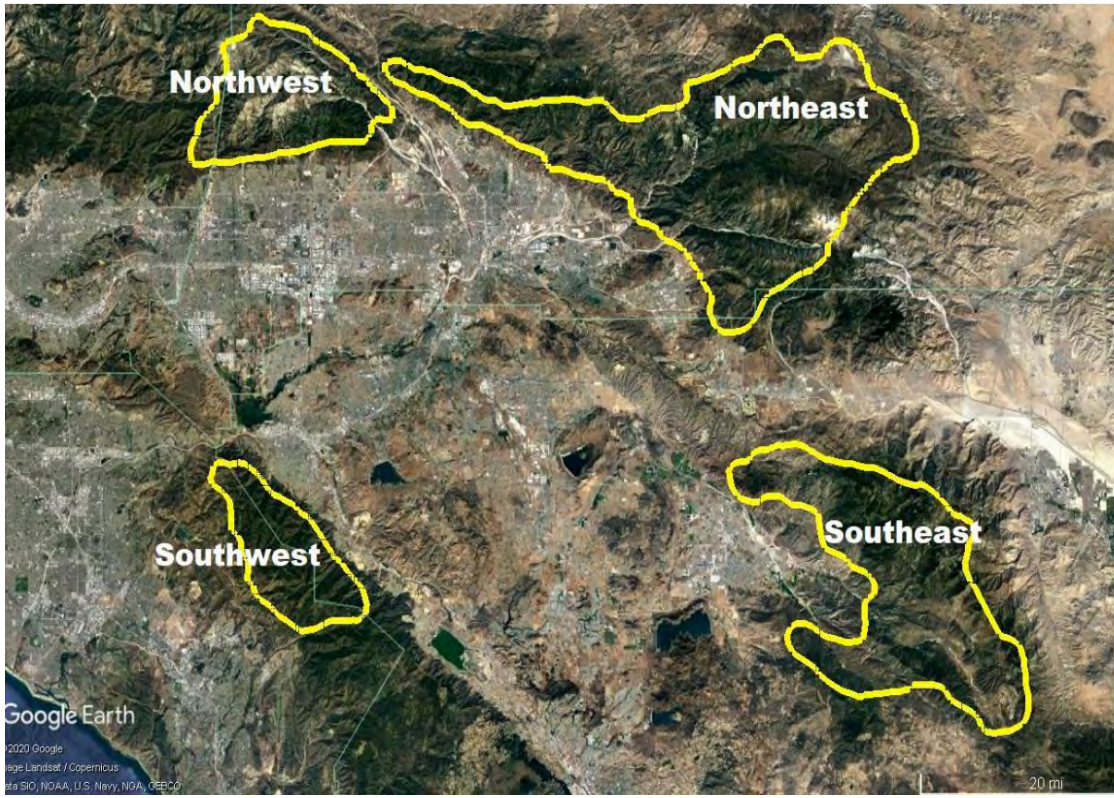
Santa Ana River Watershed Weather Modification and Feasibility Study - NAWC

Most snowfall occurs above 5,000 feet and areas above 7,000 feet observe 100-150 inches annually.

81% of the 58 winter storms studied were ‘seedable’

79% of these storms could have been seeded from the ground.

Identified 4 target areas



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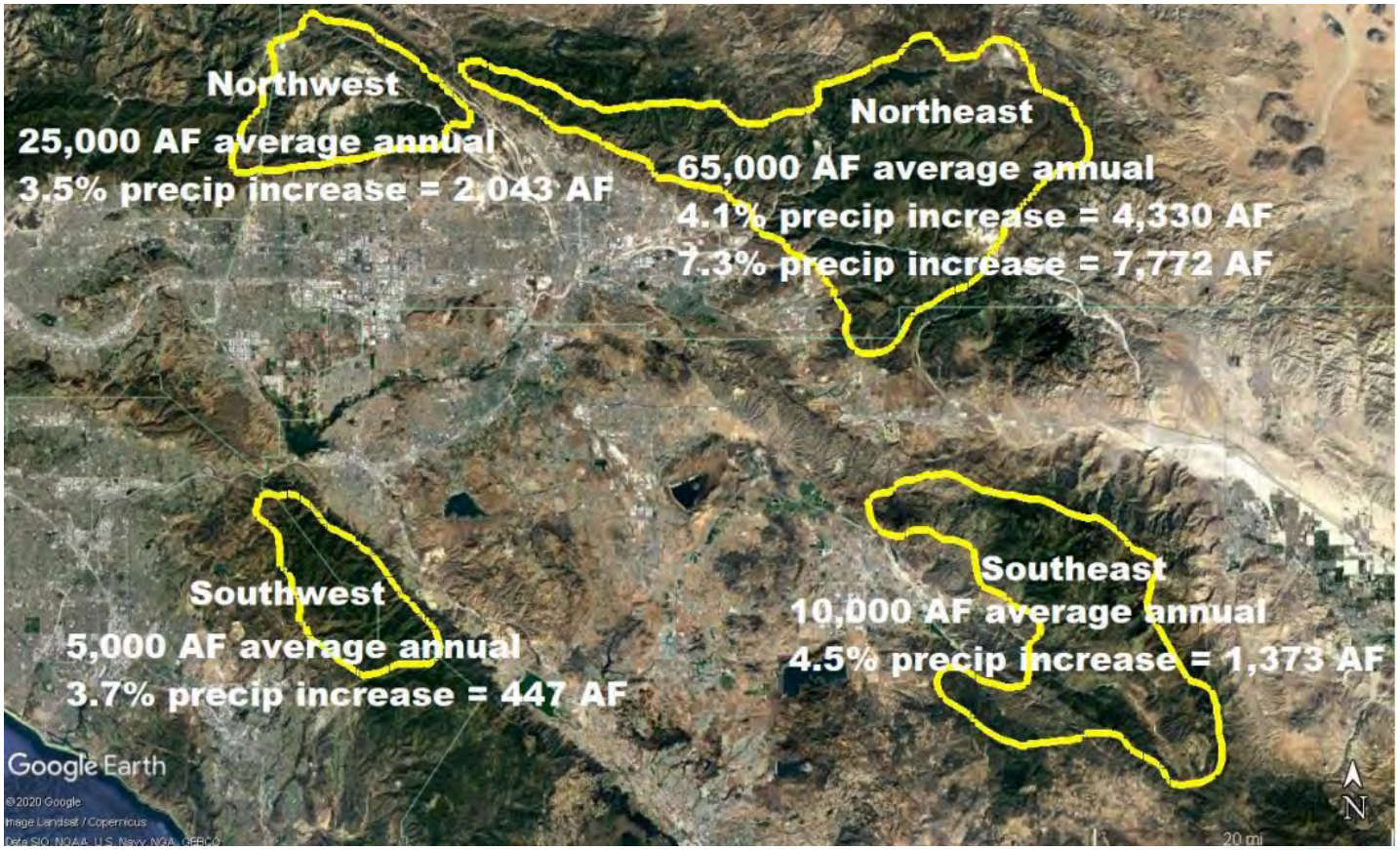
Santa Ana River Watershed Weather Modification and Feasibility Study – NAWC

Average precipitation and runoff increases predicted from cloud seeding in the study,



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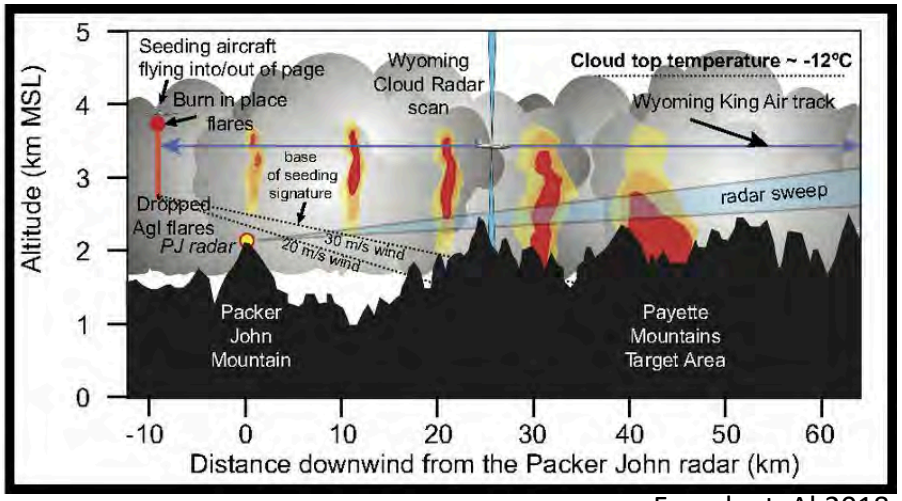
Validating Cloud Seeding Programs: 3 primary methods

Physical Case Studies: Observe cloud seeding insitu

- Clearly observe cloud seeding during individual storms
- Are clouds being seeded
- Are these cases representative.



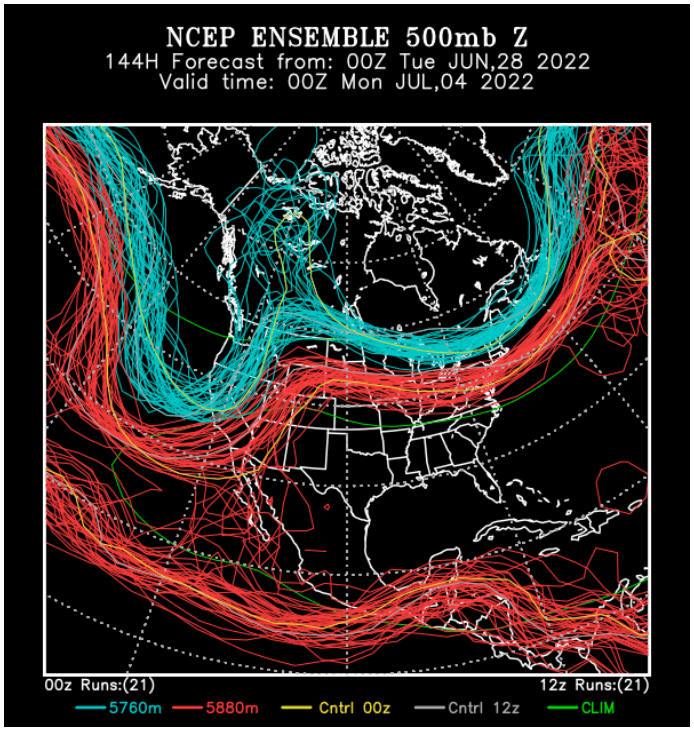
French et. Al.2018

Randomized – statistical (target-control)

- Lots of storms needed
- Control area needs to be chosen carefully.
- Very useful if seeding is proven in target area (physical studies)

Modeling – Ensembles

- Run the same storms many times with minor tweaks to the input data.
- Generate lots of data, then can do statistical analyses.
- True answer in between the extremes.



Validation Plan for SAWPA seeding program

Task 1 – Score the seeding program. Review all of the storms crossing the area during operational winter and assess the cloud seeding operations.

Task 2. Targeting assessment using snow chemistry.

Task 3. Calculating the seeding snow water equivalent (SWE) or rainfall increases for each of the seeded storms.

Task 4. Precipitation, Full Seasonal Target-Control Evaluations.

Task 5. Streamflow Analysis Target-Control Evaluation.

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Task 1 – Independently review all of the storms crossing the area during operational winter season and assess the cloud seeding operations.

Storm hours/Seeding Hours	Seedable storm period (hr)	Unseedable Storm period (hr)
Cloud seeding generators running (hr)	Yes Yes	No Yes
Cloud seeding generators not running (hr)	Yes No	No No

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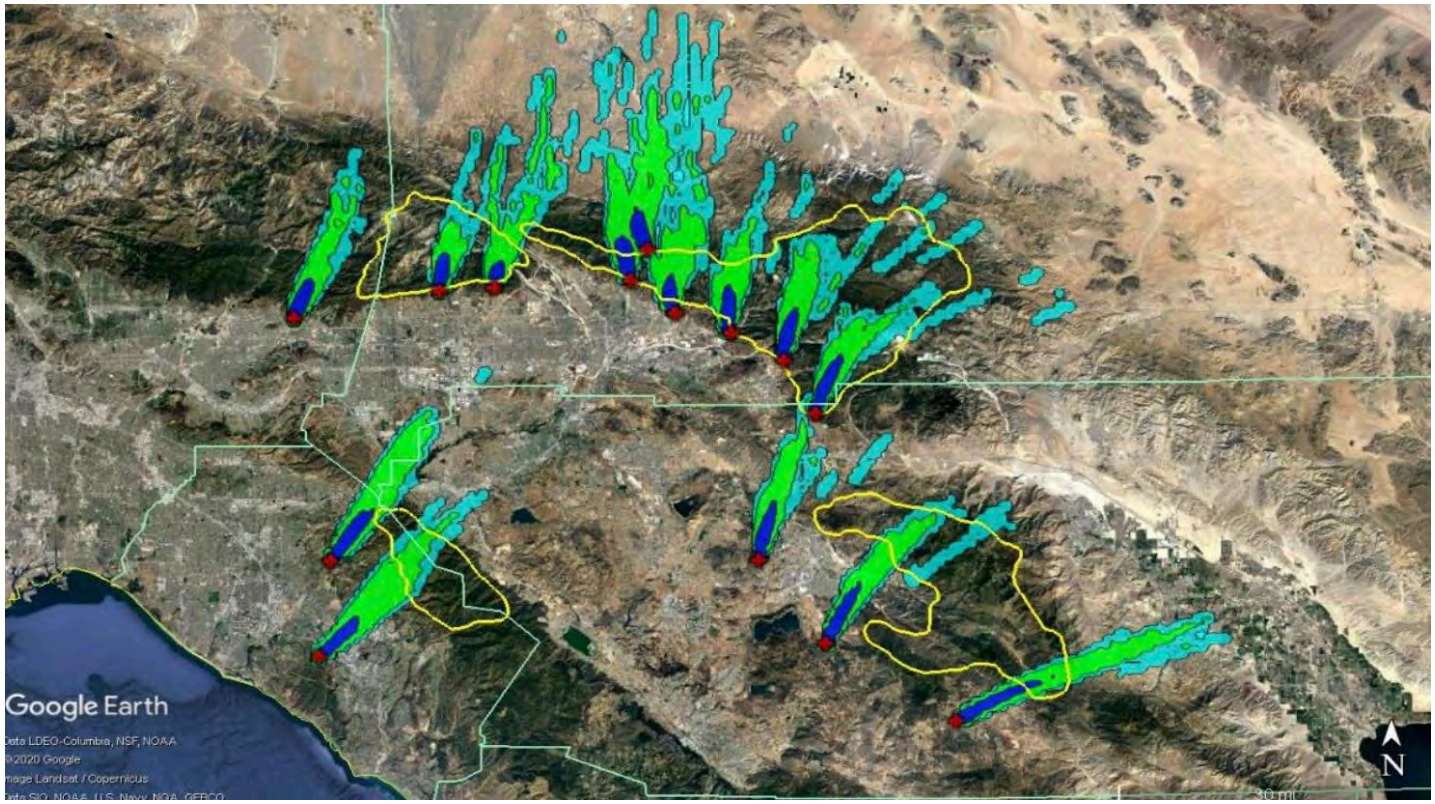
Task 2 - Targeting assessment using snow chemistry.

Plume modeling from the NAWC Report



From NAWC Feasibility Study – Case Study

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Task 2 - Targeting assessment using snow chemistry.

Ensure that IN released from generator network are reaching target areas.

Snow chemistry looking for silver.

2 storms

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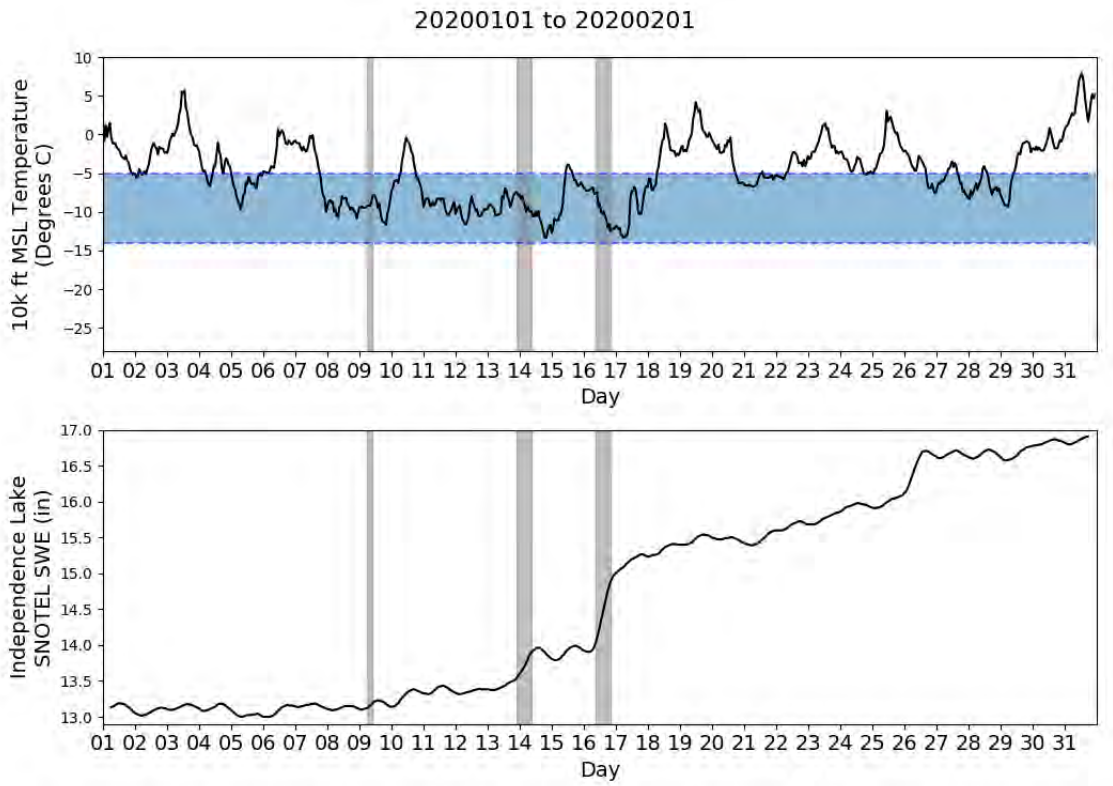
Task 3 - Calculating the seeding snow water equivalent (SWE) or rainfall increases for each of the seeded storms

Analyze winter precipitation periods when seeding was operational and estimate increases using relationships developed over the Sierra.



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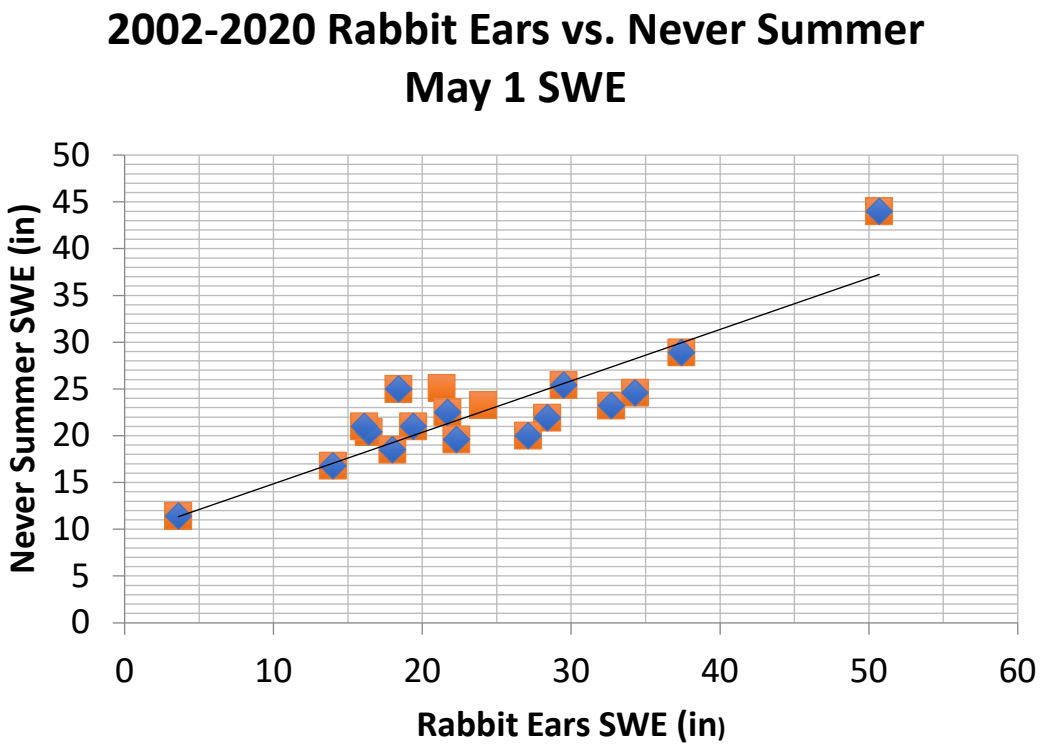
Task 4 - Precipitation, Full Seasonal Target-Control Evaluation (Mountain comparisons)

Identify suitable mountain control area(s)

Develop unseeded seasonal precipitation relationships

Compare seeded year(s) to the historical relationships - expect more precipitation in target areas compared to what the unseeded relationship would suggest.



Example from CO: blue boxes and trend line unseeded years, orange seeded years. Never Summer seeded.

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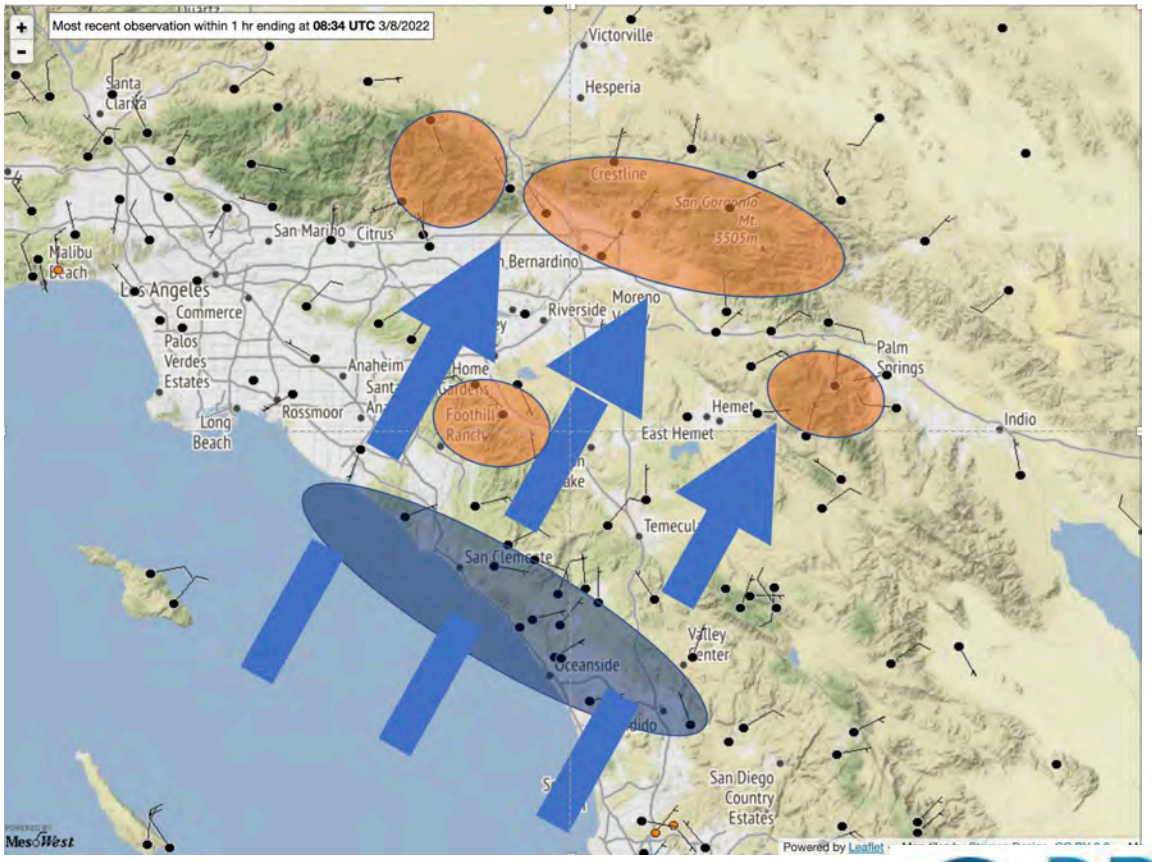
Task 4 - Precipitation, Full Seasonal Target-Control Evaluation (Coast-Mountain comparison)

Identify suitable control areas along coast.

Develop unseeded seasonal precipitation relationships

Compare seeded year(s) to the historical relationships - expect more precipitation in target areas compared to what the unseeded relationship would suggest.



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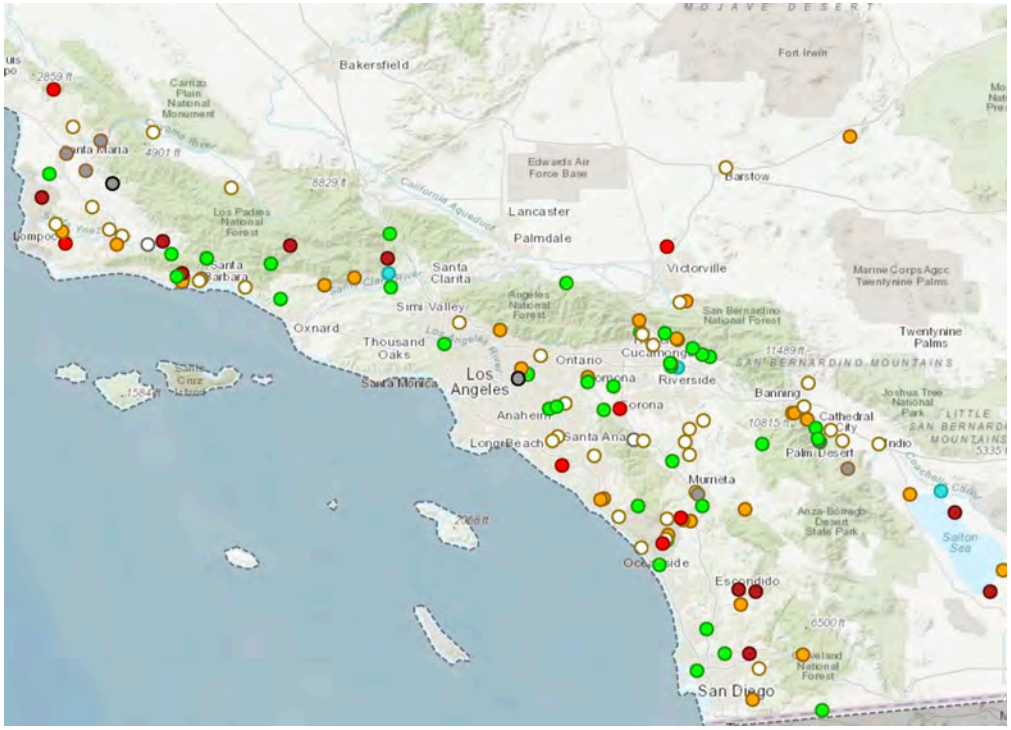
Task 5 - Runoff, Full Seasonal Target-Control Evaluation

Identify suitable control area gauged streams.

Develop unseeded seasonal runoff relationships between target gauges and control gauges.

Compare seeded year(s) to the historical relationships - expect more runoff in target areas compared to what the unseeded relationship would suggest.



Streamflow gauges in southern CA

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Thank You/Questions?

Homeless Encampment Impacts on Water Quality – Dry Weather Conditions

Santa Ana Watershed Project Authority (SAWPA)

August 16, 2022

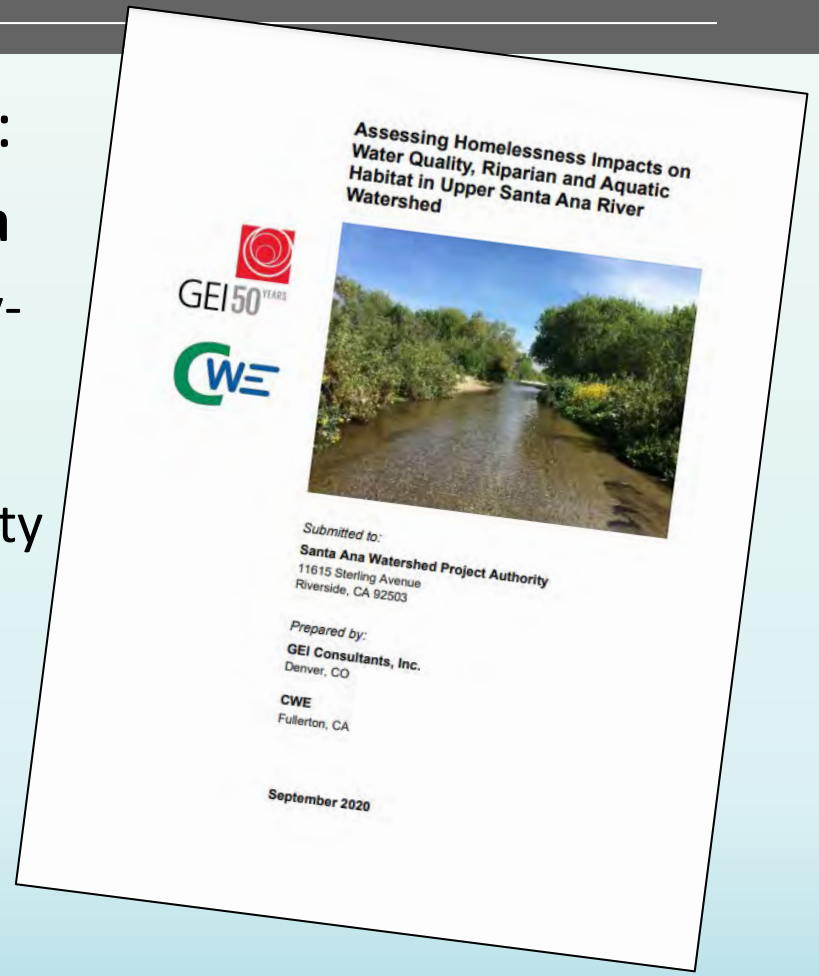
GEI Consultants
Consulting Engineers and Scientists

CDM Smith

PROJECT BACKGROUND

GEI and partner CWE completed a two-part study in 2020:

- **Task 1 – Literature Review and Assessment of Existing Data**
  - Assessed current nature and extent of stream and waterbody-adjacent homeless encampments in the upper watershed
  - Summarized best available information about relationships between homeless encampments and impacts to water quality and riparian/aquatic habitats
- **Task 2 – Preparation of Preliminary Monitoring Program**
  - Developed proposed program to assess potential impacts of homeless encampments on water quality and habitat


Assessing Homelessness Impacts on Water Quality, Riparian and Aquatic Habitat in Upper Santa Ana River Watershed

GEI 50 YEARS

CWE

Submitted to:
Santa Ana Watershed Project Authority
11615 Sterling Avenue
Riverside, CA 92503

Prepared by:
GEI Consultants, Inc.
Denver, CO

CWE
Fullerton, CA

September 2020

<u>Outcome</u>: SAWPA and the San Bernardino and Riverside County MS4 agencies funded a preliminary dry weather monitoring program for 2021-2022 fiscal year

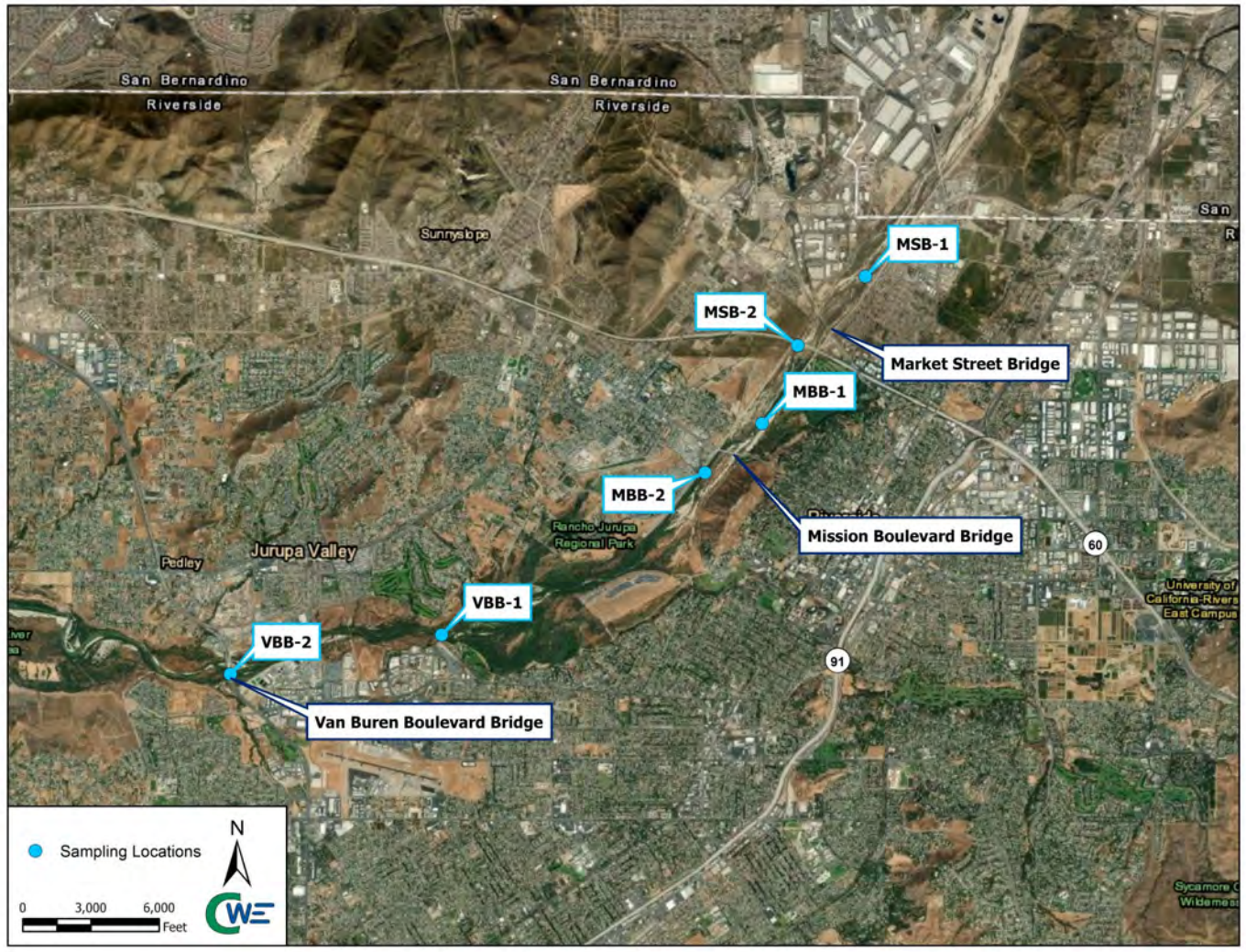
PROJECT OBJECTIVES

- Assess potential impacts of three areas of concentrated homeless encampment activity on water quality during dry weather conditions; and
- Quantify potential water quality and trash deposition impacts caused by homeless encampments
- Provide recommendations for next steps, as appropriate.

PROJECT ASSESSMENT LOCATIONS

- Assessments conducted upstream (#1) and downstream (#2) of three areas of homeless encampments:
  - *Market Street Bridge (MSB)*
  - *Mission Boulevard Bridge (MBB)*
  - *Van Buren Boulevard Bridge (VBB)*
- Population Assessment (August 2021)
  - *MSB, 163 encampments*
  - *MBB, 111 encampments*
  - *VBB, 146 encampments*

} Estimate 800-1,200 people



HOMELESS ENCAMPMENT LOCATIONS – AERIAL IMAGERY

THE VIEW ON THE GROUND…

SAMPLE COLLECTION

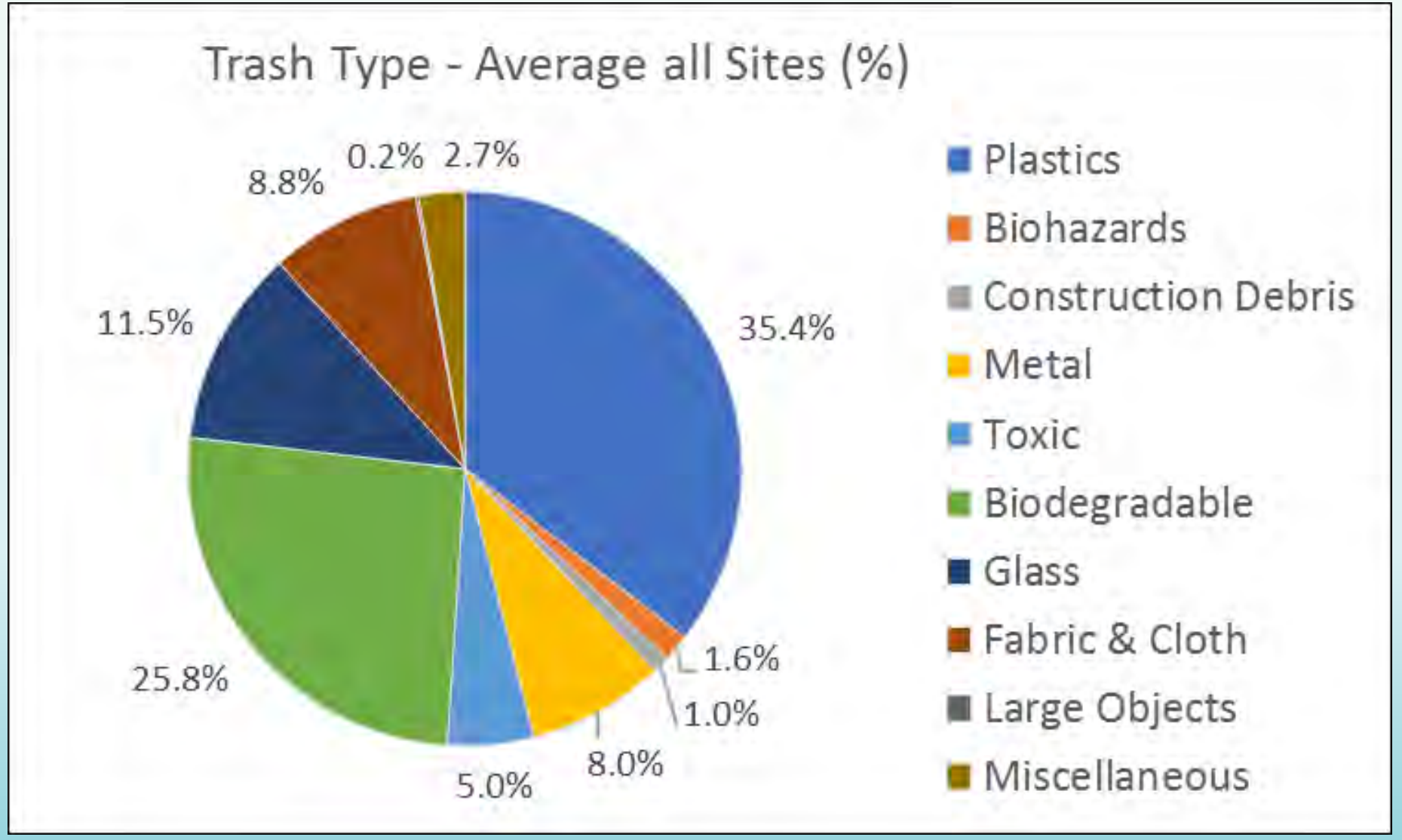
- Four dry weather sampling events completed
  - September 21, 2021
  - October 21, 2021
  - November 18, 2021
  - January 6, 2022 (followed 2-week wet weather event)
- Data collection:
  - Water samples analyzed for total suspended solids (TSS), *E. coli*, and human bacteria marker HF183
  - Sonde measurements for temperature, dissolved oxygen, pH, specific conductivity and turbidity
  - Rapid trash assessment using California State Water Resources Control Board protocols
  - Bacteria markers for dogs (DG37) and pigs (Pig2Bac) added to final two sample events (November and January)

RAPID TRASH ASSESSMENT FINDINGS (4 SAMPLE EVENTS)

Site	Range of Trash Weight (lbs)	Average Trash Weight (lbs)	Rating*
MSB-1	3.9 - 9.7	6.3	Suboptimal
MSB-2	10.5 – 33.2	18.9	Mostly Poor
MBB-1	9.0 – 37.5	24.7	Marginal
MBB-2	33.7 – 46.8	38.6	Marginal
VBB-1	3.3 – 26.8	14.1	Marginal to Suboptimal
VBB-2	9.9 – 40.6	28.2	Marginal

* Rating ranges from Optimal to Poor; scoring based on a combination of factors including hazard of waste to human health, environment and weight

TYPES OF TRASH OBSERVED (AVERAGE - ALL SITES AND DATES)



SUMMARY OF FINDINGS – TRASH & *E. COLI*

- Rapid Trash Assessments
  - Based on other regional trash studies including ocean beaches, volume/weight of trash is considered significant
  - Trash (by weight) was typically greater downstream of areas of concentrated homeless encampments
  - Generally improved trash conditions observed at all monitoring sites following December wet weather event
- *E. coli* Results
  - Typically observed in higher concentrations below areas of homeless encampments, but…
  - Overall trend in Santa Ana River is increased *E. coli* concentrations from the most upstream site to the most downstream site
    - Same pattern observed in other Santa Ana River studies – is this pattern related to homeless encampment activity or other sources of bacteria?

SUMMARY OF FINDINGS – BACTERIA SOURCE ANALYES

- Human Marker (HF183)
  - Observed at some sites, especially Van Buren Bridge encampment area, but always at low levels (below laboratory detection limit)
  - Suggests homeless encampment activity is not an important source of *E. coli* – at least under dry weather conditions
- Dog (DG37) and Pig (Pig2Bac) Markers (analyzed only two of four sample events)
  - Dog – Only observed at one site in November; result was below detection limit
  - Pig – Significant detections in November and January at the downstream Mission Blvd Bridge site and upstream/downstream of the Van Buren Bridge sites
    - Pigs may be a significant contributor of *E. coli* in at least portions of the river
    - Study area under a bacteria TMDL. Previous studies indicated presence of important source of "unaccounted for" bacteria in the river – pigs may be important contributor.

FERAL PIGS

- “The pigs were particularly active in the early 1990s, when officials estimated 300 to 400 roamed the Santa Ana River bottom. They frequently terrorized neighborhoods and farmland, even spooking horses” (Orange County Register, January 14, 2022)

A feral pig is seen in an unknown location. The pigs — which are mainly descendants of domestic pigs who escaped or were set free from old farms — have been spotted in Riverside County and throughout California for decades. (File photo courtesy of California Department of Fish and Wildlife)

REPORT SUMMARY

- Final report submitted to SAWPA in June 2022
- Middle Santa Ana River (MSAR) TMDL Task Force added pig marker analysis to selected MSAR watershed monitoring sites as part of ongoing regional bacteria monitoring program to determine spatial/temporal extent of presence of pig source bacteria
  - Preliminary findings to date show continued presence of pig source bacteria
- Need for additional study
  - Study report does not recommend additional study of impacts to water quality from homeless encampments, under dry weather conditions, however…
  - SAWPA may want to consider funding additional monitoring studies to evaluate potential impacts under wet weather conditions

STAFF RECOMMENDATIONS & NEXT STEPS

- Proposed monitoring under a Phase 2 would address wet weather conditions (~$750,000):
  - May not be needed for assessing homelessness water quality impacts
  - Could be considered for wet weather TMDL evaluation (Middle Santa Ana River [MSAR] TMDL Task Force)
- MSAR TMDL Task Force is conducting additional Pig (Pig2Bac) Marker monitoring, which may provide better insight to the contribution of wild pigs in the SAR
- SAWPA Member Agency GMs requested information about the responsibility of controlling wild pig population in the Santa Ana River:
  - Link to Department of Fish and Wildlife Wild Pig management Program: https://wildlife.ca.gov/Conservation/Mammals/Wild-Pig


Questions