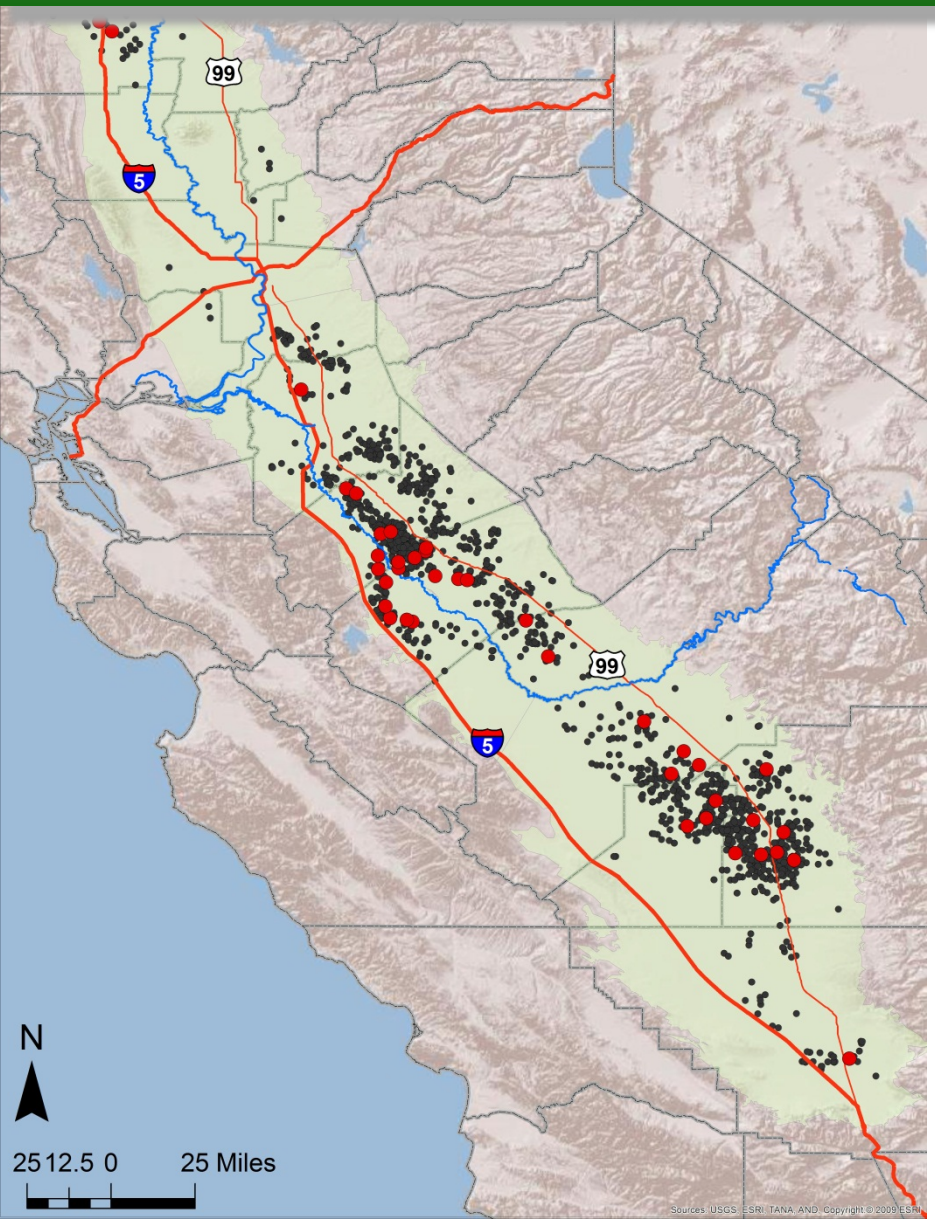
Central Valley Dairy Representative Monitoring Program – Status Update



Semi-Annual Stakeholder Meeting

Central Valley Regional Water Quality Control Board

11020 Sun Center Drive, Suite 200
Rancho Cordova, CA 95670

October 3, 2017

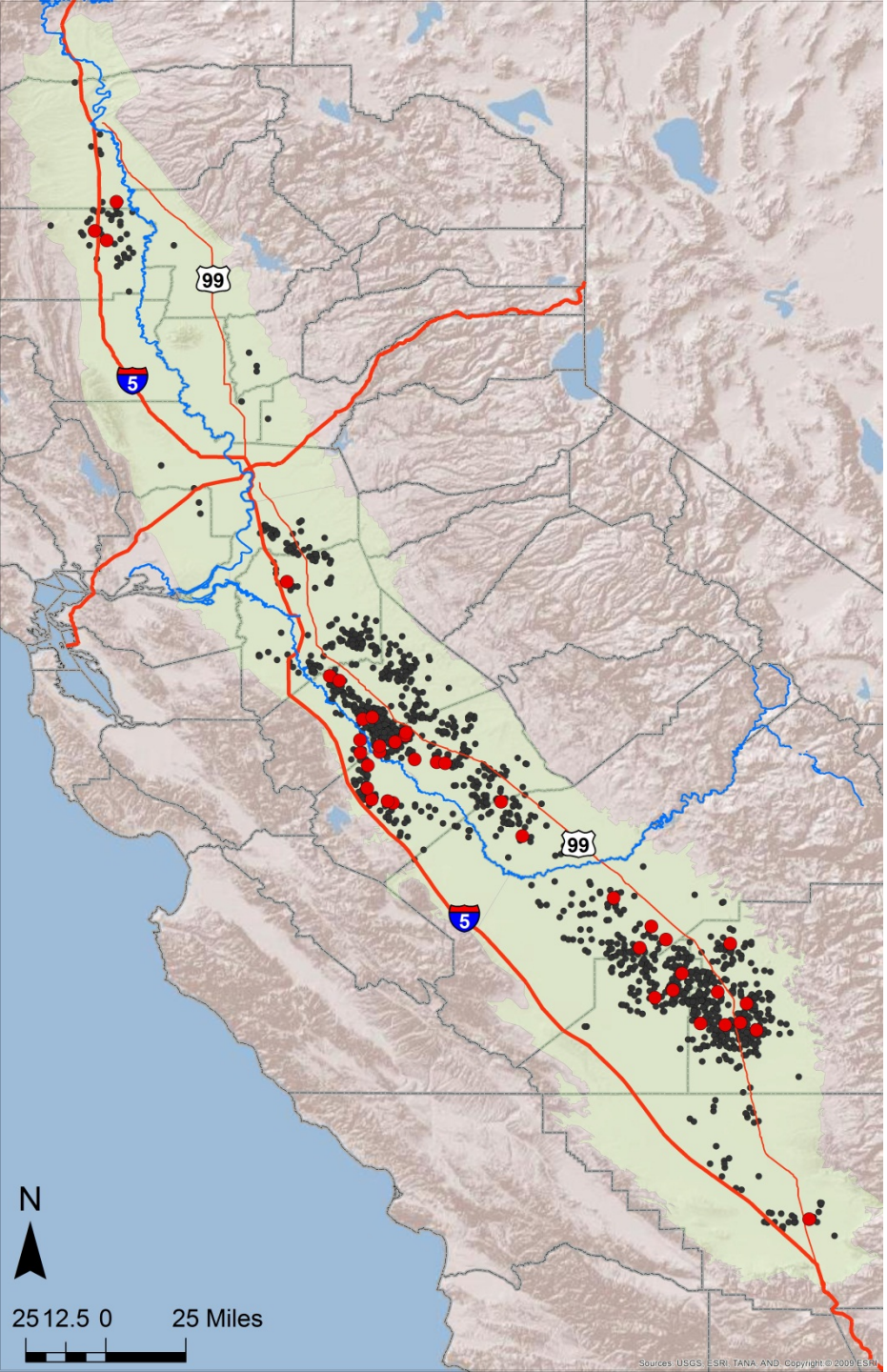
LUHDORFF & SCALMANINI
CONSULTING ENGINEERS

Presentation Overview

1. Representative Monitoring Program Overview
2. Recommendations Development
   - Focus Areas
   - Example: Improving whole-farm N-accounting
   - Lagoons (Results of 2016 Workplan Implementation)
   - Animal Housing: 2017 Corral Subsurface Hydrogeologic Investigation
3. Groundwater Quality Trend Analysis
4. Summary

Representative Monitoring Program

- A regulatory compliance monitoring program
- An alternative to site-by-site monitoring of ~1,130 dairies
- Collects data on a subset of dairies representative of the industry and pertinent site conditions
- Ultimately, will recommend improved practices for implementation on monitored and non-monitored dairies



- 42 monitored dairies
- 443 dedicated monitoring wells at 279 well sites
- Phased approach started Jan. 2012 (18 dairies)
- Fully implemented Jan. 2013 (+24 dairies)
- Monthly GW level monitoring
- Groundwater quality monitoring
    - quarterly: 9 constituents
    - annual: 22 constituents

2019 Summary Representative Monitoring Report

Pursuant to Reissued General Order

- Identify management practices (MPs) that are protective of groundwater quality for the range of conditions found at dairies covered by the RMP
  - RWQCB: protective = meeting drinking water quality objectives; for nitrate as N, 10 mg/L
- If currently required/used MPs are found not to be protective of groundwater quality, propose solutions and upgrades that will result in compliance
- Provide implementation schedules for MPs that are as short as practicable, supported with appropriate technical or economic justification, not to exceed 10 years from SRMR approval

Recommendations: Preliminary Focus Areas

1. Enhanced nitrogen mass accounting where needed
2. Enhanced nitrogen and irrigation water management where needed
3. Removal of a specific numeric ratio for N management in favor of more accurate site-specific benchmarking and incremental improvement over time
4. Development of stronger outreach and education to farm managers to develop specific skills
5. Examine options for implementing a stronger research and development program to support improvements over time
6. Continued use of the RMP to document water quality responses to the program over time
7. Fields, lagoons, animal housing

Improving whole-farm manure N accounting is critical, needs to result in action

Problem

General Order focuses on manure-N applications to fields, which are and will continue to be surrounded by large inaccuracies.

Approach

Improve whole-farm manure N accounting and devise a risk-based system (e.g., red, yellow, green) based on the potential for excessive manuring. Risk categories will have associated action items and schedules.

Concept

1. Identify on the farm scale if manure-N excretion is balanced with the ability to use manure-N on the farm for crop production under the consideration of the form of storage (i.e., liquid & solid manure (LM, SM)) and existing infrastructure to deliver LM to fields.
2. Tiered consequences and options for farmers according to risk category.

Components

1. N excretion per animal (specific to animal group)
   a) Best available excretion estimates
   b) Animal grouping
   c) Accuracy considerations
2. Total N excretion of the herd (sum of excretion by animal group)
   a) Estimation vs. counting of actual animals for calculation of total N
   b) Accuracy considerations
3. Bifurcation into liquid (LM) and solid (SM) manure streams
   a) Configuration of the dairy
   b) Seasonal operational considerations
   c) Accuracy considerations

Components (cont'd 1)

4. Estimation of N losses (e.g., NH4 volatilization) to get N available for land application
   a) One lump factor vs. different for LM and SM
   b) Accuracy considerations
5. Available land
   a) Total controlled and farmed acreage
   b) Manured acreage
   c) Acreage reached by LM conveyance infrastructure
6. Computation of mean maximum N loading rates (lbs/ac)
   a) Total N/ac
   b) LM/ac
   c) SM/ac

Components (cont'd 2)

7. Establish thresholds based on relative risk
   a) Consideration of LM and SM
   b) Consideration of crops grown
8. Consequences and options for farmers according to risk category
   a) Follow-up site visit and farm evaluation (scope, who does it, who pays?)
   b) Options: N export, expansion of land base, increase yields, expand LM conveyance, …
   c) Track progress/improvement
   d) Re-evaluate risk category

Deliverables and Considerations

A deliverable may be as simple as a new form sheet for producers to fill out but considerations are many:

1. Documentation of goals and rationale
   - Why are we doing something, how is it different from today, how does it improve things?
2. Action items for farmers (i.e., what do they need to do?)
3. Cost analysis, implementation schedules, incentive mechanisms
4. Role of CVDRMP and RWQCB

Recommendations Development: Lagoons

2014 Perimeter Subsurface Hydrogeologic Investigation

2015 Seepage Rates of Liquid Manure Lagoons in the Central Valley of California and Associated Subsurface Nitrogen Mass Emissions

2016 Lit. Review and Workplan – Controlling Seepage from Liquid Dairy Manure Lagoons in the CV

- 3 Draft recommendations
- 6 Items requiring additional work effort

2017 Evaluation of Earthen Liquid Manure Dairy Lagoons in the Central Valley of California: Seepage, Mass Emissions, and Effects on Groundwater Quality

Workplan Implementation

1. Explore use of soil treatment of lagoon banks (4Creeks)
2. Partial synthetic liners (4Creeks)
3. Lagoon closure considerations
4. Survey of owners/designers of synthetic lined lagoons (4Creeks)
5. Develop single-liner option w/o site-specific Anti-Degradation analysis
6. Electrical Leak Location (ELL) testing using ASTM D7007-15 (4Creeks)

CVDRMP will likely not recommend soil treatment of lagoon banks

Purpose Find out how frequently soil treatment of lagoon embankments is used as part of maintenance programs for earthen lagoons, and to gather information on its practicality, cost, effectiveness, and safety-related issues.

Process Interviewed experts from engineering firms, RWQCB, UC Davis, NRCS, and trade organizations.

Results None of the respondents had personal experience with such soil treatment, knowledge of colleagues with such experience, or primary/secondary knowledge of pertinent activities.

Conclusions Soil treatment of lagoon embankments is not commonly used as part of maintenance activities for existing lagoons. Since not a single case could be identified, information on practicality, cost, effectiveness, and safety could not be gathered.

CVDRMP will likely not recommend partial synthetic liners

Motivation Some studies suggest that seepage losses from the sidewalls of earthen lagoons may be higher than from the bottom due to wetting/drying cycles and limited sludge cover. Producers are concerned about whaling and their ability to remove settled solids from synthetic-lined lagoons using traditional means (excavator, loader).

Purpose Determine engineering feasibility (and cost) of installing a skirt-like synthetic liner.

Results Installation of skirt-liners is feasible but was found more expensive than a full synthetic liner due to the high cost associated with the construction of an anchor trench.

Conclusions Skirt-liners do not appear cost effective, regulatory feasibility is uncertain.

Recommendations will likely support existing lagoon closure procedures

Purpose Strengthen Provision 11 (General Order, p.24) by providing specificity and consistency to lagoon closure activities.

Process Reviewed existing data on N accumulation in lagoon subsoils, compare to 40-year N emissions.

Results Found only two journal articles with quantitative data; clay soils retain more N than sandy soils; only 5-13% of 40-yr N emissions retained in upper 1 to 3 feet of soil

Conclusions Excavation of soils makes little sense since lagoon seepage has been found to only contribute 2-4% of N mass loading compared to fields, and excavation would only remove a fraction of that. Upon lagoon closure, organic material should be removed (i.e., scrape to dirt), as currently done.

Today's synthetic-lined lagoons can be built, operated, and maintained to last

Purpose Address producers' concerns about the performance of synthetic-lined lagoons (e.g., whaling, defects, longevity, ability to remove settled solids using traditional means (excavator, loader).

Process Collected information from producers with synthetic-lined lagoons via survey, interviewed experts from engineering firms that design synthetic-lined lagoons

Results Contacted 39 dairies, obtained 13 responses (representing 21 lagoons, incl. 2 with double-liners); identified 20 issues/risks, 16 of which have been observed; all but one have a solution or mitigation (liner damage from gun shots)

Conclusions Today's synthetic-lined lagoons can be built, operated, and maintained to last

Single synthetic-lined lagoons can provide protection similar to double lined lagoons

Motivation Modernization of existing lagoons and construction of new lagoons is impeded by the high cost associated with Tier 1 and the unattainability/uncertainty associated with Tier 2. From 2012 to 2017, RB approved 10 Tier 2 single liner lagoons (none in 2016-17) and 13 Tier 1 lagoons.

Objective Develop single-liner option w/o necessity for site-specific Anti-Deg. analysis

Approach Test the utility of ASTM D7007 for dairy lagoons

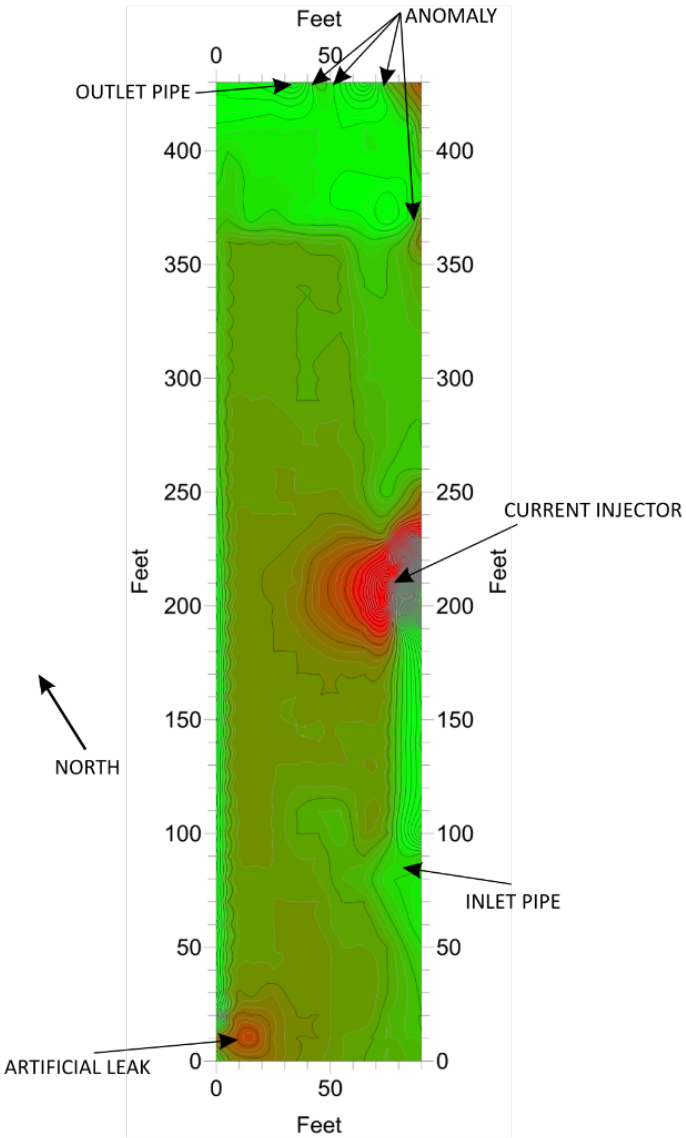
Results Tested 5 lagoons. Enhanced method by including:

- Re-testing after moving current injector, artificial leak
- Edge survey to improve accuracy near the waste line
- Operation from dry land instead of wading

Conclusions Method shows promise to be used as maintenance tool

Next Drain and repair leaks, re-test

ASTM D7007 example results: Voltage map



1. Identify current leaks
2. Drain lagoon
3. Visually confirm leak = hole
4. Fix hole
5. Fill lagoon
6. Re-test, improve boundary conditions if needed

Corral Subsurface Hydrogeologic Investigation

- Investigate nitrogen and salt accumulation in soils beneath corrals
- Complement groundwater quality data set from animal housing monitoring wells with samples from temporary boreholes
- Fieldwork completed in September 2017
- Report expected before year end, will discuss findings in context of pertinent academic literature

Corral Subsurface Hydrogeologic Investigation

- 13 dairies with corral soils ranging from sand to clay
- 13 corrals and 13 site-specific background locations
- 3 boring locations in corrals along slope (high, middle, low topography)
- Continuous soil coring to depth of 20 feet (ft) or first encountered groundwater (FEG), whichever comes first
- 9 depth intervals (0-1, 1-2, 2-3, 3-4, 4-6, 6-8, 8-12, 12-16, 16-20 ft)
- Depth compartments composited from 3 corral cores
- Drilling to 30 ft if FEG expected between 20 and 30 ft

Laboratory Analytical Methods for Soil

Constituent	Analytical Method	Reporting Limit
Soil Texture (% Sand, % Silt, % Clay)	S14.10 (hydrometer method)	0.1%
Water Content	loss in weight after drying	0.01%
Cation Exchange Capacity	S10.20	0.1 meq/100 g
Organic Carbon[a]	S9.20	0.01%
Nitrate & Nitrite (as N)[a]	S3.10	1.0 mg/kg
Total Kjeldahl Nitrogen-N[a]	S8.10	1.0 mg/kg
Potassium[a]	S5.10	0.5 mg/kg
Extractable Phosphate[a]	S4.10	2 mg/kg
Electrical Conductivity[b]	saturated paste	10 µS/cm

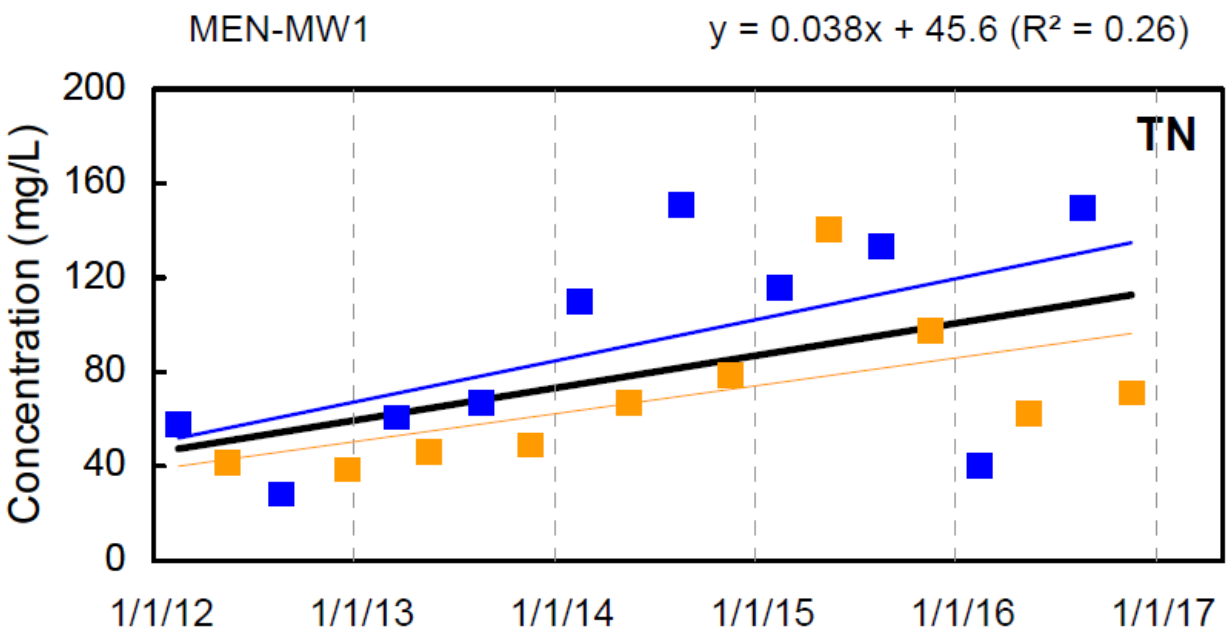
[a] Reported on a dry weight basis
[b] Reported on saturation paste extract

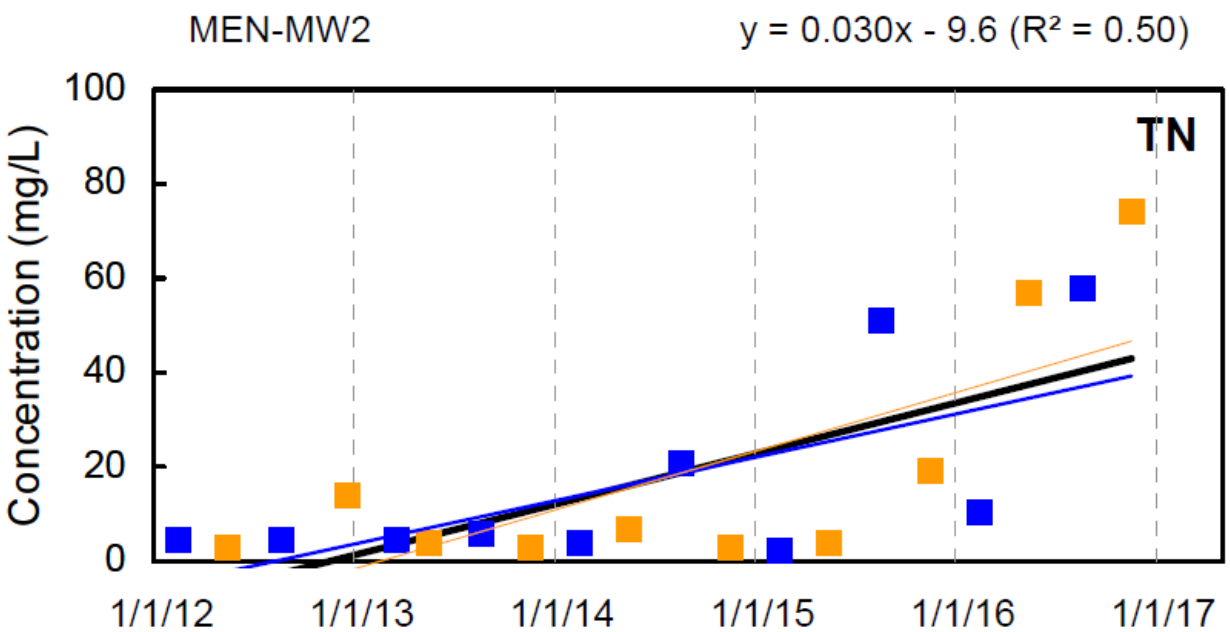
Laboratory Analytical Methods for Groundwater

Constituent	Analytical Method	Reporting Limit (mg/L)
Sodium	EPA 200.7	1.0
Potassium	EPA 200.7	1.0
Magnesium	EPA 200.7	1.0
Calcium	EPA 200.7	1.0
Chloride	EPA 300.0	0.5
Sulfate	EPA 300.0	1.0
Bicarbonate (as CaCO3)	SM2310B	5.0
Carbonate (as CaCO3)	SM2310B	5.0
Hydroxide (as CaCO3)	SM2310B	5.0
Phosphate (as PO4)	EPA 365.4	0.15
Total Dissolved Solids	SM2540C	10
Nitrate & Nitrite (as N)	EPA 300.0	0.5
Total Kjeldahl Nitrogen (as N)	EPA 351.2	0.2

Groundwater Quality Trend Analysis

1. Linear regression (parametric)
2. Mann-Kendall (nonparametric, linear)
3. Time series of box-and-whisker plots (parametric or nonparametric)
4. Locally Weighted Scatter Smoothing (LOWESS) (nonparametric, nonlinear)

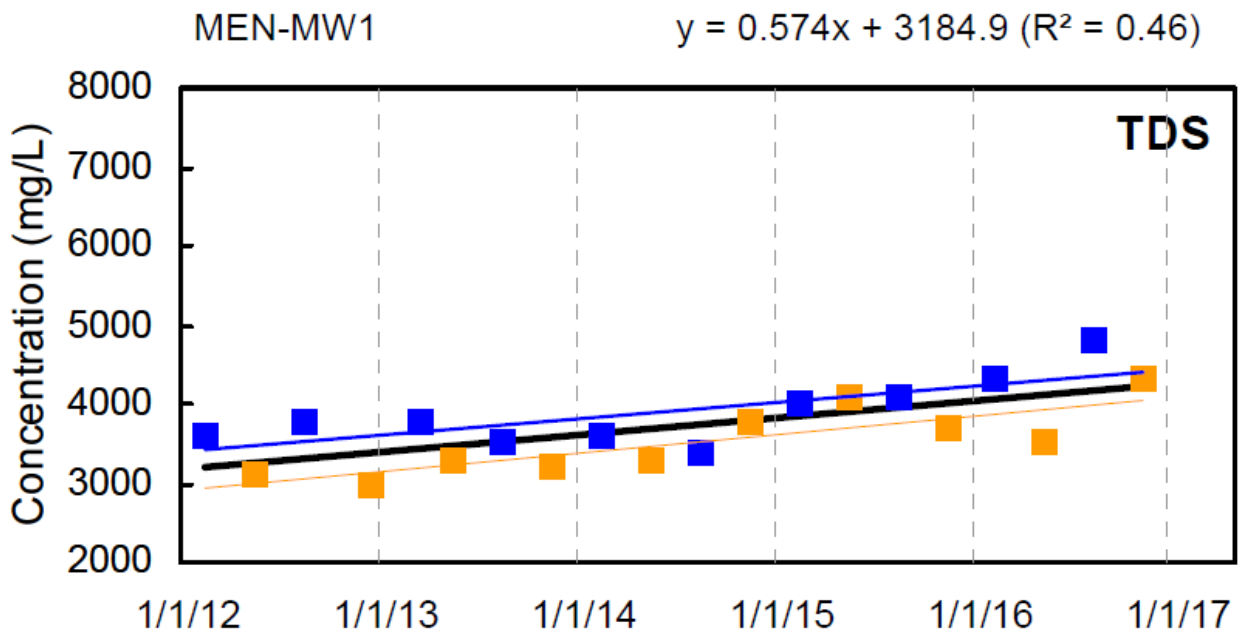


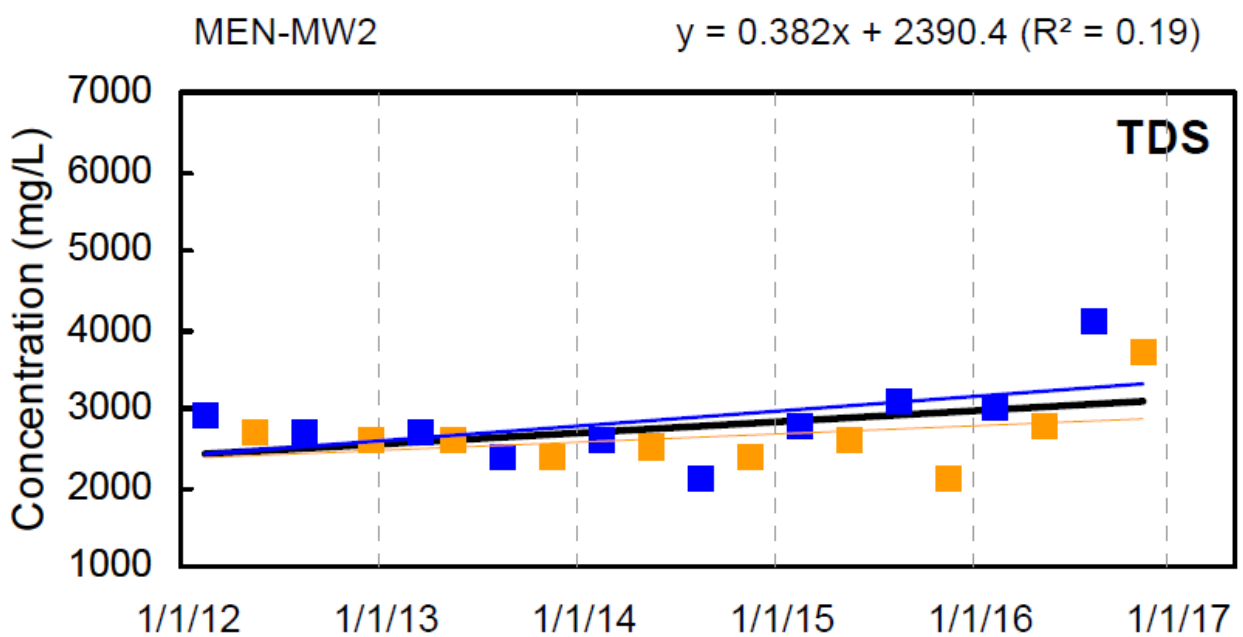


Black=quarterly data

Blue=Q1 &Q3

Orange=Q2 & Q4





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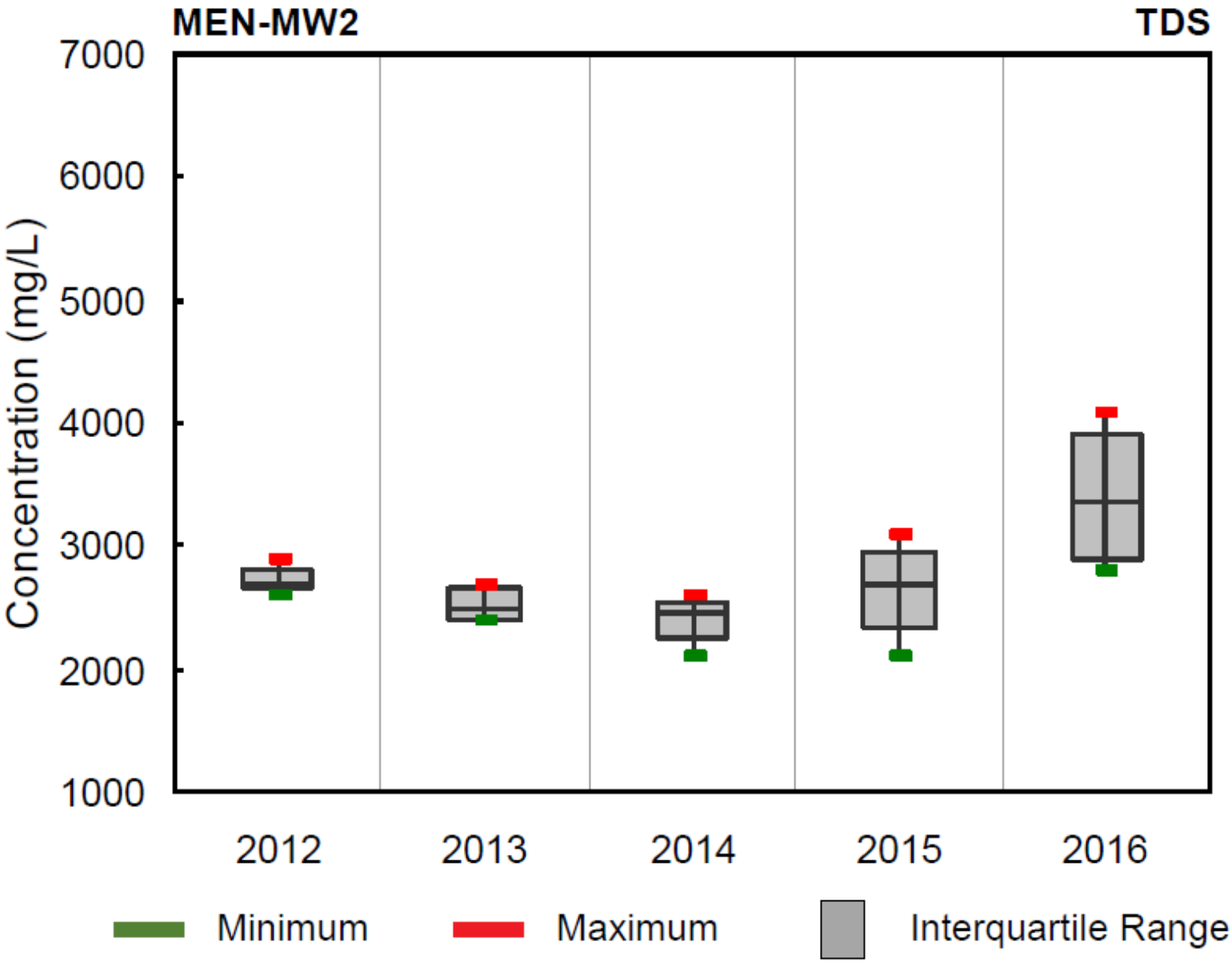
MEN-MW2
TDS
7000
6000
5000
4000
3000
2000
1000
Concentration (mg/L)
2012
2013
2014
2015
2016
Minimum
Maximum
Interquartile Range

Summary

CVDRMP continues to demonstrate by action

- Proactive, science-based, innovative, ***<u>successful</u>*** approaches and methods beyond GO-required monitoring

General Order's schedule is ambitious

- CVDRMP is on track to meet 2019 deadline for Summary Report
- Recommendations for solutions and upgrades are being developed, vetted & solidified

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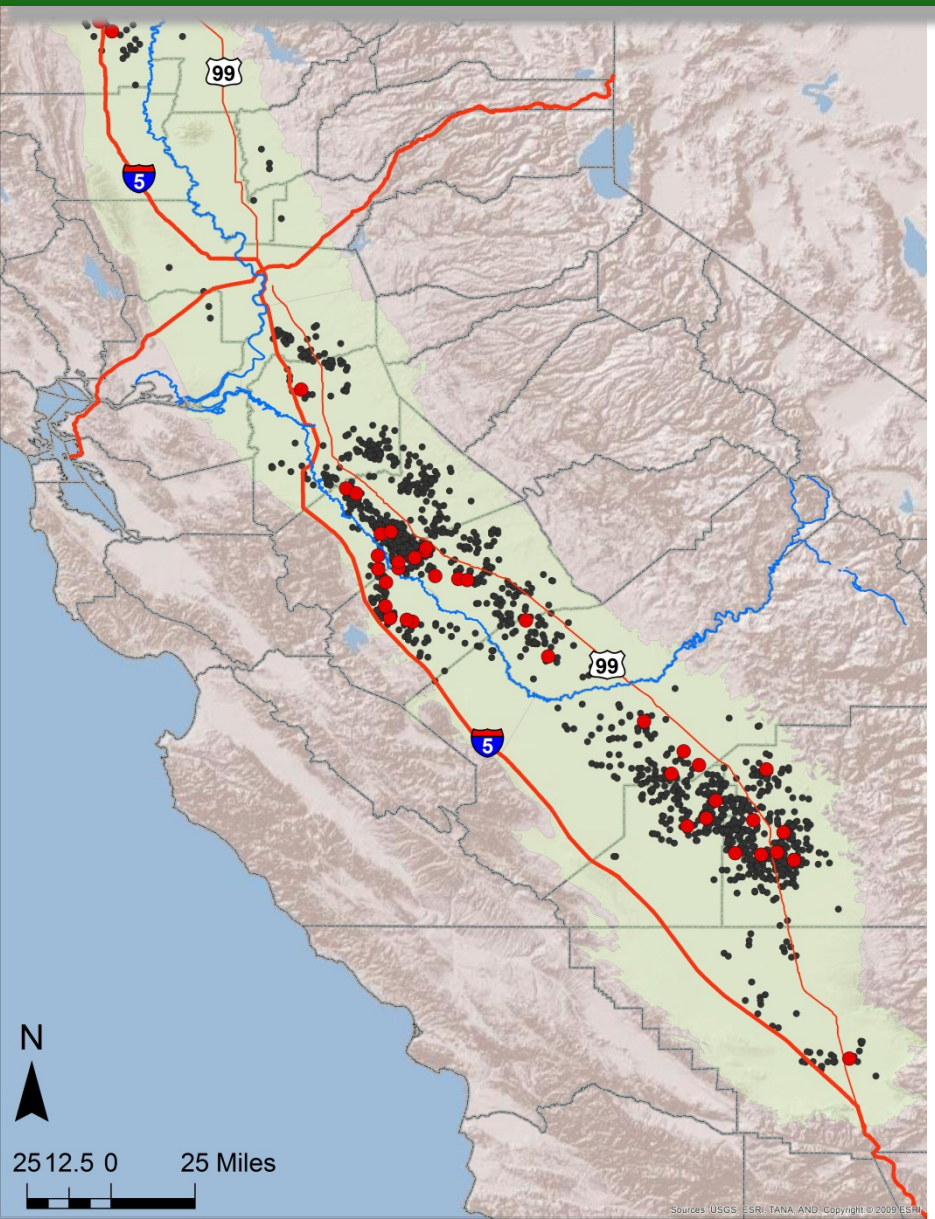

Thank you!

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