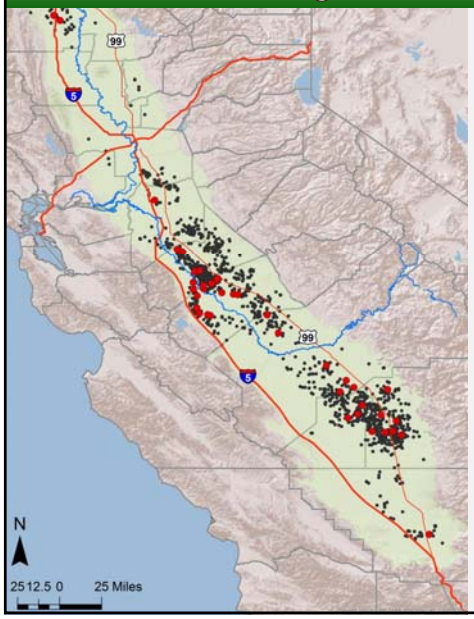
Central Valley Dairy Representative Monitoring Program – Status Update



Biannual Stakeholder Meeting

Central Valley Regional Water Quality Control Board

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

October 4, 2016

LUHDORFF & SCALMANINI CONSULTING ENGINEERS

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Presentation Overview

1. Representative Monitoring Program Overview
2. Lagoon Investigations
   - Results: seepage rates, mass loading, correlation to groundwater quality, geophysical imaging
   - Workplan implementation
3. Field Research Studies
4. Development of Recommendations
5. Summary

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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

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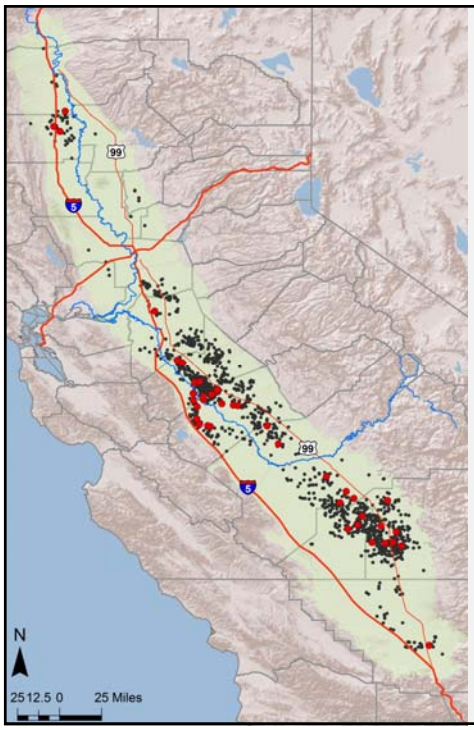

Basics

- 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
- >16,000 raw data points per year

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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

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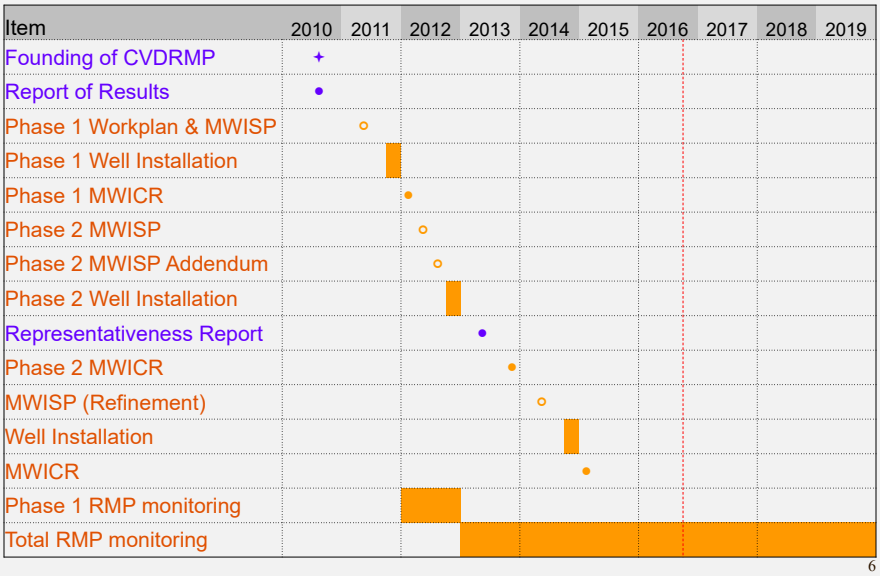
MW Installation and Monitoring Activities



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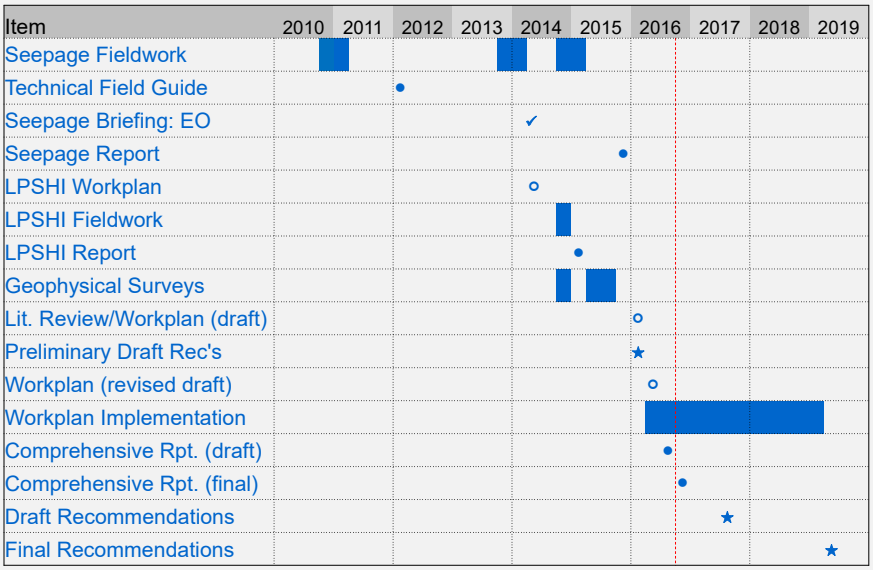
Lagoon Investigations



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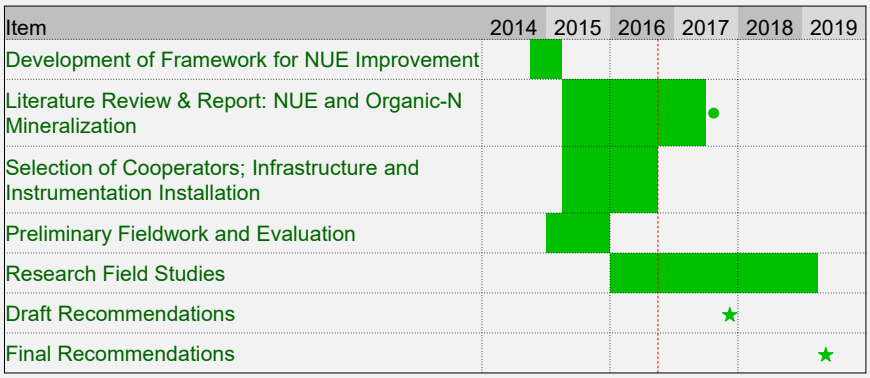
Improving Nutrient Use Efficiency



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Lagoon Investigations

Objective: *Generate a knowledge base to aid in evidence-informed decisions regarding the fate of earthen dairy lagoons*

Questions to answer

1. At what rates does lagoon liquor percolate and how does this compare to NRCS design seepage rates?
2. Are there significant seepage differences between lagoons (e.g., between sandy vs. clay-rich soils)?
3. How do lagoon loading rates to the subsurface compare to crop land loading rates?
4. How do loading rates compare to groundwater quality?
5. What is the extent of local impacts to groundwater quality?

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Lagoon Investigation Fieldwork Matrix

Site/Lagoon	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Water Balance Test			✓			✓			✓	✓	✓	✓			✓		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
Lagoon Perimeter Soil Borings		✓	✓		✓		✓	✓	✓			✓	✓	✓	✓	✓	✓										
Monitoring Wells	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓		✓			
Geophysical Survey	✓	✓	✓	✓	✓				✓		✓	✓			✓	✓	✓	✓									

- Minimal or no lagoon construction records
- Lagoon ages: <10 to ~50 years
- Lagoon depths: 8-30 feet
- Native materials: sand, loamy sand, sandy loam, loam, clay loam, silty clay

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Seepage rates relatively small, invariable N-loading minor compared to forage fields

- 0.0 – 2.2 mm d^{-1} (n=16)
- Median = 0.7 mm d^{-1}
- Outlier: 2.9 mm d^{-1} (possible exposed gravel strata)
- Seepage rates moderated by sealing effect of manure
- NRCS design seepage rate = 0.86 mm d^{-1}
- Proportional comparison *lagoons:manured fields*
  - N-loading rates 2:1 to 3:1
  - Occupied area 1:76
  - N mass contribution 2-4% : 96-98%
- Results consistent with academic literature and "*Addressing Nitrate in California's Drinking Water*"

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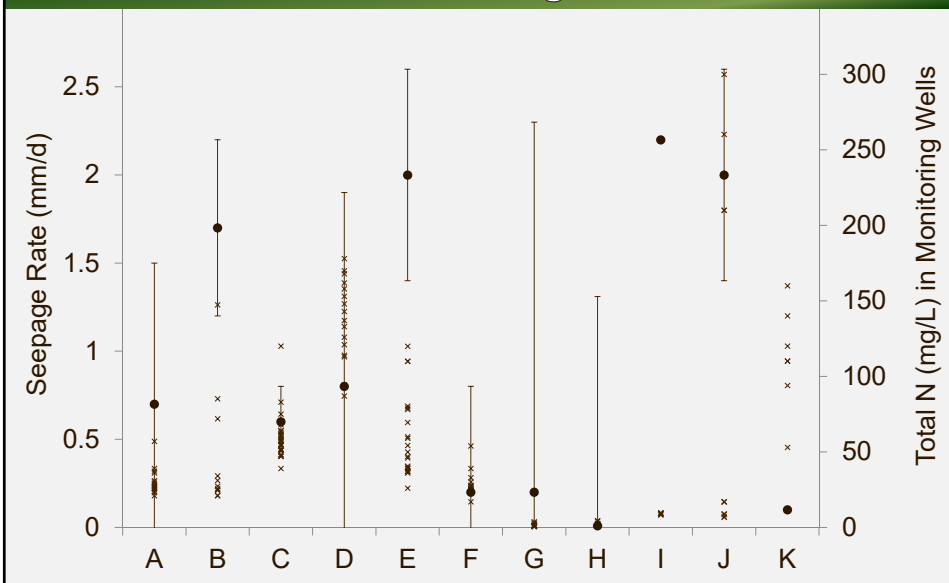
No correlation between seepage rates and total N concentrations in monitoring wells



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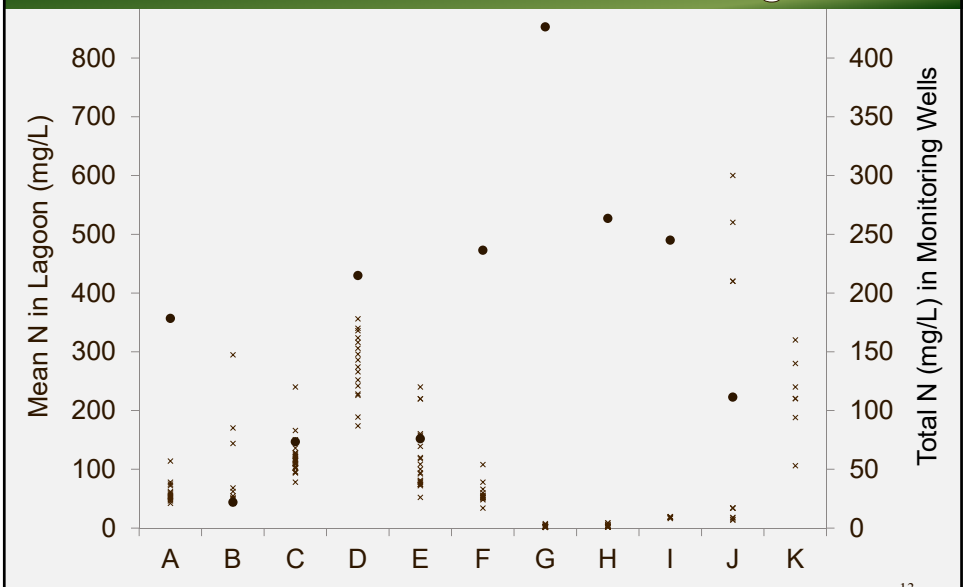
No correlation between lagoon N concentrations and total N concentrations in monitoring wells



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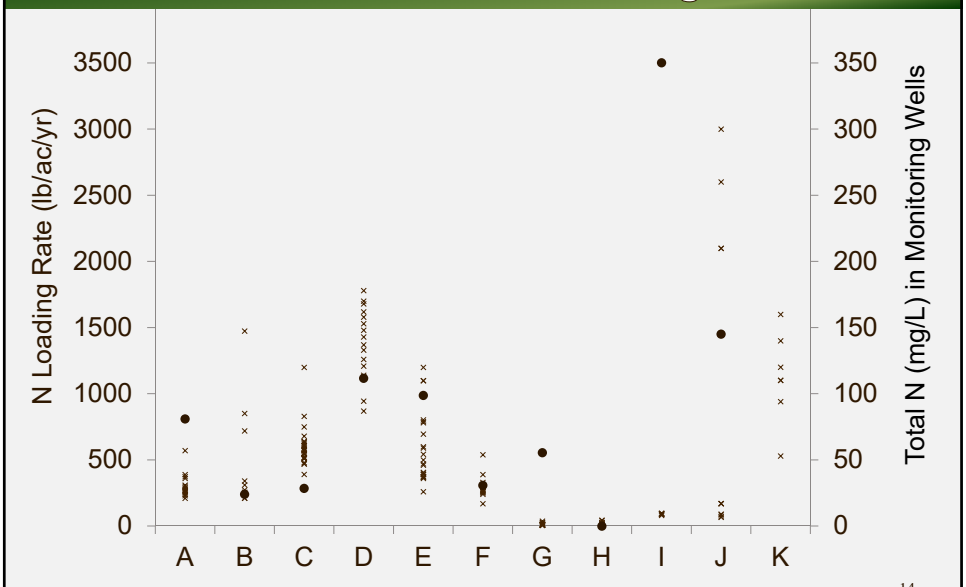
No correlation between lagoon N emissions and total N concentrations in monitoring wells



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Electrical Resistivity Profiling of Earthen Materials

- Measure of the resistance of a volume of material to the flow of electrical current
- Variables affecting ER: mineralogy, porosity, permeability, water content, salinity of pore water
- Gravel/sand more resistive than silt/clay
- ER of saturated materials GREATLY affected by free ions in solution
- Earth materials invaded by highly conductive fluids (e.g., lagoon nutrient water) exhibit **anomalously low** ER

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Electrical Resistivity Profiling – Interpretation and Color Scheme

- ER values are relative to a starting model based on all measurements in a given survey (unique for every survey)
- Cannot compare results from one survey to another
- Changes of ER are more important than absolute values
- Hot colors (orange and red) delineate **anomalously low** ERs; interpreted as areas invaded by highly conductive water
    - Hot colors may represent different ERs between surveys

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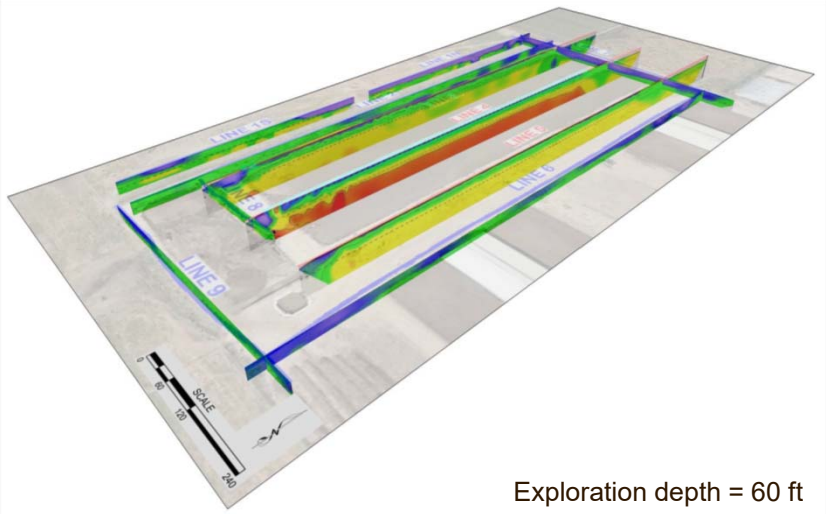
ER Profiles – Example 1



Exploration depth = 60 ft

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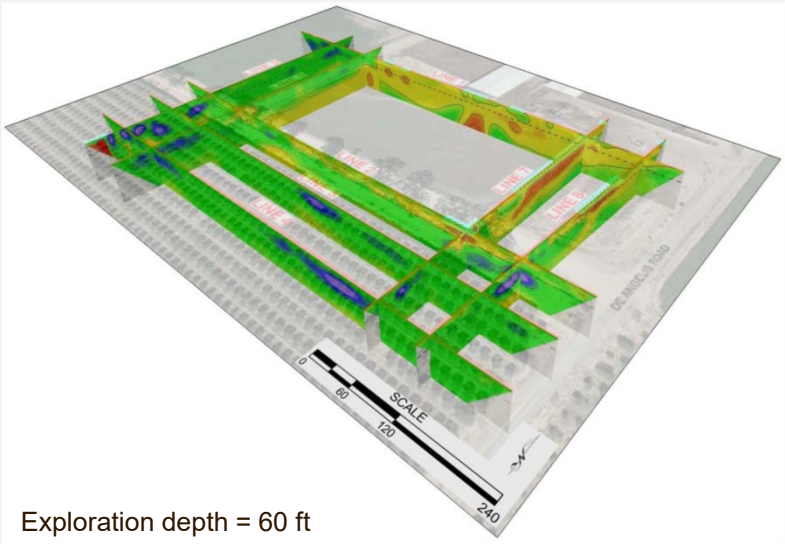
ER Profiles – Example 2



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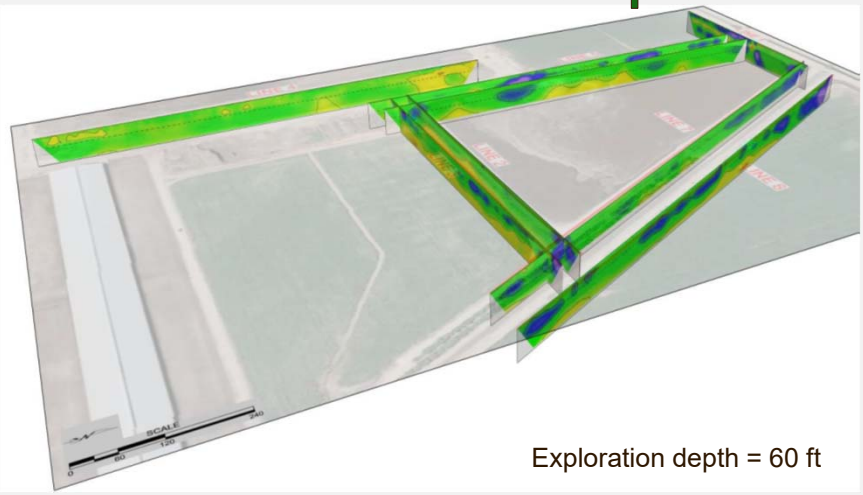
ER Profiles – Example 3



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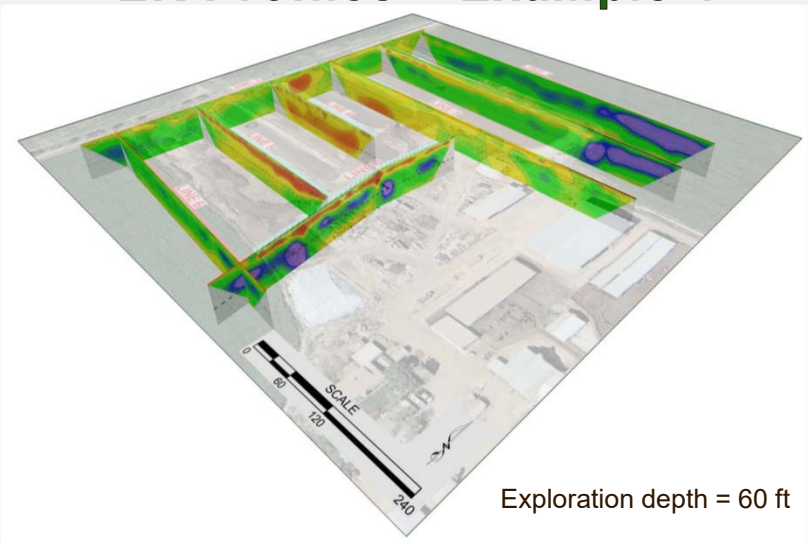
ER Profiles – Example 4



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Current Lagoon Investigations
(Implementation of Lagoon Workplan)

- Soil treatment of lagoon banks (current use on dairies, practicality, cost, effectiveness, safety issues)
- Partial synthetic liners for lagoon banks (liner apron)
- Survey of owners/designers of synthetic-lined lagoons
  - ~60 surveys sent out
- Lagoon closure considerations

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Activities in Winter 2016/17
(Implementation of Lagoon Workplan)

Conduct geoelectric leak detection surveys in conjunction with measurement via LCRS and whole-lagoon seepage testing

- What is the magnitude and range of whole-lagoon seepage rates from operational synthetic lined dairy lagoons, and can it be measured with the water balance method?
- How does the seepage rate relate to the size of identified leaks?

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Reductions in N leaching are achievable and quantifiable

CVDRMP pursues a data-supported path to *performance improvement* of nutrient management with targeted research projects on select dairies

1. Demonstrate that the concept of the Nitrogen Use Efficiency (NUE) is universally applicable, while actions to achieve improvements may differ from site to site
2. Document currently achieved NUEs under different conditions (as-is conditions)
3. Show the extent of improvement under different conditions
4. Document the level of effort and challenges associated with improvement under different conditions, including costs

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GW protection cannot be assumed or guaranteed based on implementation of particular MPs

Examples of Management Practices

1. Conduct irrigation system performance evaluation
2. Use weather-based irrigation scheduling
3. Convert to surge irrigation if appropriate
4. Include perennial crop in rotation (e.g., alfalfa)
5. Apply fertilizer N in small multiple doses rather than single large doses

Management Practice: Activity, process, operational range, condition, technology, or structure to reduce N leaching

- Carried out at different intensity, frequency, and with various degrees of care (i.e., effectiveness)
- Therefore, a single MP has non-unique effects on subsurface mass fluxes and on groundwater quality

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Internal draft recommendations toward improving MPs and water quality are being developed

Examples of 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. Use of domestic well testing data to document trends

Scheduled for public release in draft form sometime in 2017

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Summary

CVDRMP continues to demonstrate by action

- Proactive, science-based, innovative, ***successful*** 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 management practices are being identified, vetted & solidified through field testing and MAC/GTAC discussions and are scheduled for public release in draft form in 2017

Thank you

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