# MONITORING AND REPORTING WORKPLAN

# AND

# MONITORING WELL INSTALLATION AND SAMPLING PLAN

## PHASE 2:

## REPRESENTATIVE GROUNDWATER MONITORING NETWORK DESIGN & MONITORING PROGRAM

## EXISTING MILK COW DAIRIES – CENTRAL VALLEY, CALIFORNIA

**FINAL**

*Prepared for*

Central Valley Dairy Representative Monitoring Program

June 6, 2012

This document has a companion Addendum dated August 8, 2012

LUHDORFF & SCALMANINI
CONSULTING ENGINEERS

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Vicki Kretsinger
Principal Hydrologist

Till Angermann
Senior Hydrogeologist


LSCE FILE NO. 12-7-019

LUHDORFF & SCALMANINI
CONSULTING ENGINEERS

GROUNDWATER RESOURCES
HYDROLOGY · DEVELOPMENT · MANAGEMENT

June 6, 2012
LSCE File No. 12-7-019

Mr. Clay Rodgers
Central Valley Regional Water Quality Control Board
1685 E Street
Fresno, CA 93706

**SUBJECT: SUBMITTAL OF MONITORING AND REPORTING WORKPLAN AND MONITORING WELL INSTALLATION AND SAMPLING PLAN PHASE 2 REPRESENTATIVE MONITORING PROGRAM EXISTING MILK COW DAIRIES, CENTRAL VALLEY, CALIFORNIA**

Dear Mr. Rodgers:

On behalf of the Central Valley Dairy Representative Monitoring Program (CVDRMP), Luhdorff and Scalmanini, Consulting Engineers (LSCE) has prepared the enclosed *Monitoring and Reporting Workplan and Monitoring Well Installation and Sampling Plan, Phase 2: Representative Groundwater Monitoring Network Design & Monitoring Program Existing Milk Cow Dairies – Central Valley, California* (Phase 2 RMP Workplan). Three copies of this report are enclosed, including one original and two additional copies. The Phase 2 RMP Workplan was prepared in response to the Central Valley Regional Water Quality Control Board's *Waste Discharge Requirements General Order No. R5-2007-0035 for Existing Milk Cow Dairies*, its revised Monitoring and Reporting Program, and its Conditional Approval of the Public Review Draft Phase 1 RMP Workplan.

Sincerely,

LUHDORFF AND SCALMANINI
CONSULTING ENGINEERS

Vicki Kretsinger
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*cc:* J.P. Cativiela, Central Valley Dairy Representative Monitoring Program
*ec (via emailed hyperlink):* Clay Rodgers, J.P. Cativiela

Enclosure – 3 copies of the Phase 2 RMP Workplan

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Attachment 1 Dairy Farm Site Maps with Monitoring Well Locations (dairy farms in the order shown in Table 1)
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Attachment 3 "Table 6. Additional Groundwater Monitoring" (Excerpt from *Revised Monitoring and Reporting Program Order No. R5-2007-0035 General Order for Existing Milk Cow Dairies*. February 23, 2011)

# 1 Introduction

This document was prepared in response to the Central Valley Regional Water Quality Control Board's (CVRWQCB) *Waste Discharge Requirements General Order No. R5-2007-0035 for Existing Milk Cow Dairies* (General Order) (CVRWQCB, 2007), its revised Monitoring and Reporting Program (MRP) (CVRWQCB, 2011a), and its Conditional Approval (CVRWQCB, 2011b) of the Public Review Draft Phase 1 Representative Monitoring Program (RMP) Workplan (LSCE, 2011; finalized without change January 2012).

### Central Valley Dairy Representative Monitoring Program

The Central Valley Dairy Representative Monitoring Program (CVDRMP) is a non-profit California corporation formed in 2010 to administer the Representative Monitoring Program (RMP). It is managed by a 12-member board of directors and has a current membership of approximately 1,200 dairies.

### Purpose

The purpose of this Phase 2 RMP Workplan is to seek CVRWQCB approval to continue with the implementation of the RMP. Specifically, it aims to satisfy the regulatory requirements for both the Monitoring and Reporting Workplan and the Monitoring Well Installation and Sampling Plan identified in the MRP.

### Goal

The goal of the RMP is to identify dairy farm practices protective of groundwater quality (including practices currently employed in response to the General Order) using a data collection and analysis effort that targets a subset of Central Valley dairy farms.

### Phase 1 RMP Workplan

The Phase 1 RMP Workplan (**Attachment 2**) provides comprehensive discussions and details of the:

- Regulatory background and stakeholder process;
- Rationale for the RMP and the focus on three types of management units (MUs) (i.e., liquid manure lagoons, corrals, and manure-fertigated fields);
- Method for selecting the area for the initiation of the RMP;
- Method for selecting individual dairy farms including the consideration of physical parameters and dairy farm operational characteristics;
- Rationale for the proportional distribution of monitoring wells over the MUs;
- Extrapolation of monitoring results to non-monitored dairies;
- Refinement and expansion of the RMP;
- Monitoring well construction, well development, and wellhead survey;
- Groundwater sampling procedures, sample handling and recordation, and quality assurance procedures;
- Scope and schedule (i.e., frequency) of groundwater monitoring activities; and
- Regulatory reporting commitments.

These discussions in the Phase 1 RMP Workplan remain applicable and are made part of this Phase 2 RMP Workplan by reference (see **Attachment 2**). Modifications thereto are explicit in the appropriate sections of this document.

### Developments since Approval of Phase 1 RMP Workplan

Since the conditional approval of the Phase 1 RMP Workplan (September 9, 2011), 108 nested monitoring wells (each nested well consists of two wells of different depths in a single borehole) were installed on 18 Phase 1 RMP dairy farms (LSCE, 2012). Monitoring activities in the Phase 1 network of monitoring wells (i.e., 108 newly installed nested monitoring wells and 18 existing monitoring wells) commenced in January 2012 and continue on a monthly schedule. A public meeting was held at the CVRWQCB offices in Rancho Cordova on January 24, 2012. Also, as set forth in the Phase 1 RMP Workplan, a Groundwater Technical Advisory Committee (GTAC) and a Multidisciplinary Advisory Committee (MAC) have been formed. An initial MAC meeting was held on April 17, 2012, where input was solicited on pertinent dairy management practices to be considered in the development of the Phase 2 RMP.

## 2 Proposed Phase 2 Representative Monitoring Program Well Network

This Phase 2 RMP Workplan provides a detailed plan for the geographic expansion of the RMP to all San Joaquin Valley counties (outside of Stanislaus and Merced counties), and selected counties in the Sacramento Valley, where dairy farming occurs, as conceptually proposed in the Phase 1 RMP Workplan. Specifically, as further discussed below, Phase 2 proposes groundwater monitoring in the counties of San Joaquin, Madera, Fresno, Kings, Tulare, Kern, Tehama, and Glenn. Two additional dairies were selected in Stanislaus County. Altogether, Phase 2 adds groundwater monitoring at 46 dairies, 164 existing monitoring wells, and 84 to-be-constructed monitoring wells to the program. Current CVDRMP membership, Phase 1 dairies, and proposed Phase 2 dairies are shown on **Figure 1**.

Phase 2 emphasizes groundwater monitoring adjacent to liquid manure lagoons and manure fertigated fields.

### Liquid Manure Lagoons

Interest in the performance of working lagoons remains high. Most of the existing dairy lagoons were constructed under applicable state law (California Code of Regulations Title 27) requiring that retention ponds receiving waste from confined animal facilities (e.g., dairies) be lined with or underlain by soils that contain at least 10% clay and not more than 10% gravel (10/10 design standard). This design standard does not specify a particular thickness of the liner or subsurface soil, and there is no requirement for construction quality assurance and control measures. Therefore, for most of the existing lagoons, design standards, as-built drawings, construction notes, geotechnical and chemical soil testing results are not available. This includes most of the lagoons on the Phase 1 dairies. It is assumed that those lagoons were constructed according to the 10/10 design standard or a lesser standard.

For comparative purposes, Phase 2 emphasizes groundwater monitoring near lagoons with engineered clay liners and plastic lined lagoons that have construction documentation available. CVDRMP dairies that were identified from CVRWQCB records, that have lagoons with engineered clay liners or plastic lined lagoons with construction documentation available, are shown in **Figure 2**. A few additional dairies that fit the above criteria were identified during file reviews.

### Manure-fertigated Fields

Recently, the California Nitrate Project (Harter et al., 2012) estimated that cropland in the Tulare Lake Basin and the Salinas Valley contributes 96% of the total nitrate loading to groundwater on an annual basis. This is in agreement with an earlier dairy-specific finding that cropland is the largest contributor to subsurface loading of salts and fertilizers (van der Schans et al., 2009). In addition, manure-fertigated fields provide the most promising opportunity to control leaching of excess salts and fertilizer through a variety of potential management adjustments, including methods of

application, application rate and timing, irrigation practices, crop types and cropping patterns, installation of tile drains, and return water recycling systems (Mathews et al., 2001; Harter et al., 2002).

To address geographic differences of field-specific management practices, Phase 2 proposes to expand the initial (i.e., Phase 1) monitoring network of wells in Stanislaus and Merced counties to the remaining San Joaquin Valley counties (i.e., counties of San Joaquin, Madera, Fresno, Kings, Tulare, and Kern) and to the northern Sacramento Valley (i.e., counties of Tehama and Glenn). Priority was given to dairies with existing monitoring wells, which includes CVDRMP reserve members and other member dairies that already have monitoring wells and report groundwater monitoring data to the CVRWQCB (**Figure 3**).

## Selection of Dairies

The proposed selection of 46 dairies for Phase 2 is summarized in **Table 1**. Herd size and animal housing information are summarized in **Table 2**. **Table 3** provides a summary of available information regarding engineered liners, existing monitoring wells, and expected depth to groundwater at these dairies. Greater depths to groundwater in large portions of the southern San Joaquin Valley, specifically in Madera, Fresno, Kings, Tulare, and Kern Counties, were a major factor that limited the selection of dairy farms for this program (**Figure 4**). Groundwater monitoring in areas of deeper groundwater is not a preferred choice due to (i) the increased delay between infiltration of irrigation water, percolation below the root zone, and resulting effects on groundwater chemistry and (ii) the decreased "signal strength"[1] of the groundwater quality changes in response to distinct irrigation/nutrient management practices. Deep groundwater poses major difficulties for establishing definitive relationships between specific farming practices and groundwater quality results. In addition, even if meaningful conclusions could be drawn from deep groundwater data, it would not be possible to accomplish the RMP's objective and develop Best Practicable Treatment or Control measures (BPTC's) by the 6-year horizon required by the General Order for the Summary Report. The selection of Phase 2 dairies aims to balance expanded monitoring activities on dairies situated on shallow groundwater (i.e., groundwater preferably less than 40 feet deep), where management practices can be directly evaluated, and dairies on relatively deeper groundwater (i.e., up to approximately 80 feet deep), where longer-term trends and, potentially, the effect of a thicker unsaturated zone on groundwater quality, can be evaluated.

Site maps for the selected dairies showing facility layout, fields, existing, and proposed to-be-installed monitoring wells are shown on individual maps in **Attachment 1** following the order shown in **Table 1**. The existence and adequacy of identified existing monitoring wells will be examined via site visits. During these site visits, locations for to-be-installed monitoring wells will be verified or adjusted, as needed. Dairy farmers will also be contacted directly to obtain additional information, as appropriate and available, on lagoon construction and well construction, borehole lithology, and groundwater monitoring records. Further, input from the MAC indicated the importance of capturing not only the diversity of commonly used irrigation systems across the Central Valley but also highlighted the importance of the differential efficiencies at which these systems are operated. Therefore, variables such as irrigation rates and durations will be examined in conjunction with crops grown on the selected farms. This constitutes a level of detail not considered during the development of the Phase 1 RMP. To facilitate the selection of Phase 2 dairies and ensure representativeness across the combined (i.e., Phases 1 and 2) program, this more detailed information will be collected from the Phase 1 dairies. Phase 2 dairy selections and individual monitoring well site locations will be refined based on the outcome of the above work efforts.

[1] Dispersion caused by the extended travel paths through a thick unsaturated zone causes mixing and a trend to more homogeneous concentrations. Distinct differences in leachate concentrations just below the root zone are moderated by this process. As a result, groundwater quality, even near the water table, is most likely reflective of an average of multiple leaching events over several irrigation seasons or even years.

MAC input also suggested the inclusion of some scrape dairies in the program that fertigate fields predominantly with dry manure rather than with liquid manure from the lagoon. Presently, two scrape dairies have been identified (Garcia and Sons Dairy in Kings County and Holstein Farms in Tulare County). The refinement of the dairy selection will examine options for additional scrape dairies.

# 3 Monitoring Well Construction

Monitoring well construction including well design, drilling and logging, well development, and wellhead survey will occur as outlined in Section 7 of the Phase 1 RMP Workplan (see **Attachment 2**) with the following substantive exceptions:

1. The borehole for the installation of the nested wells will have a diameter of nominally 12 inches or more to allow for 2 inches of separation between the well casings and the borehole wall, and between the well casings themselves.
2. Discrete soil samples will be obtained with a split-spoon sampler (18-inch advancement) every five feet unless adverse soil conditions are encountered (e.g., flowing sands).
3. Well development shall aim to produce water free of sand with a turbidity less than 50 NTU.

# 4 Groundwater Sampling

Groundwater sampling, including water level measurements, sampling procedures and instrumentation, sample handling and recordation, and quality assurance procedures, will occur as outlined in Section 8 of the Phase 1 RMP Workplan (see **Attachment 2**).

# 5 Groundwater Monitoring Program

Depending on the depth to groundwater, groundwater monitoring activities are differentiated in two tiers (see **Table 3**). Tier A monitoring activities are identical to the monitoring activities described in Section 9 of the Phase 1 RMP Workplan, (see **Attachment 2**) with the exception of the expanded sampling during the second groundwater sampling campaign. The full suite of analyses (see Table 6 of the Phase 1 RMP Workplan, see **Attachment 2**) will therefore only be performed once in the first year, and annually thereafter (**Table 4**). Tier A is proposed to be implemented on dairies with relatively shallow groundwater where changes in groundwater quality in response to changed management practices are more likely to be identified.

Tier B refers to sampling frequencies and suites of analyses according to the General Order revised MRP, Attachment A, Table 6 (page MRP-20) (**Attachment 3**) but includes more comprehensive field measurements (see **Table 4**). Tier B monitoring activities are proposed to be implemented on dairy farms with deeper groundwater levels commensurate with the expected delayed and moderated groundwater quality response to surface activities.

# 6 Reporting

## Monitoring Well Installation Completion Report

A Monitoring Well Installation Completion Report will be prepared in compliance with Item V, Attachment A of the General Order's MRP, including:

- detailed location and site maps;
- narrative and chronology of pertinent field activities;
- identification of contractors, geologists, engineers, and other key personnel;
- description of drilling methods;
- detailed monitoring well information (planned and actual locations, as-built drawings);
- driller's logs and lithologic logs;
- depth-to-groundwater measurements;
- field notes;
- monitoring well construction summary table;
- records and results of the well development and well survey; and
- purging records and indicator parameter measurements.

Groundwater quality sampling will commence after submittal of the MWICR.

### Annual Reporting

RMP Annual Reports will be prepared as described in Section 10.2 of the Phase 1 RMP Workplan (see **Attachment 2**), in compliance with the revised General Order MRP and applicable Standard Provisions and Reporting Requirements of the General Order, and in accordance with the goal of the RMP. The reports will present cumulative monitoring data collected for a given reporting period (i.e., calendar year) from all monitored dairies (i.e., combined data from all phases of the project as they become available). This includes groundwater monitoring data and non-groundwater data related to the management of and practices of corrals, lagoons, and manure-fertigated fields (see Section 5.2 of the Phase 1 RMP Workplan).

### Summary Report

As described in Section 10.3 of the Phase 1 RMP Workplan (see **Attachment 2**), a Summary Report will be prepared within 6 years of initiating Phase 1 sampling activities to provide a comprehensive synthesis of the RMP monitoring activities (all phases), results, and findings related to dairy management practices historically and currently employed by the monitored dairy farms, the effects of those practices on groundwater quality, and observed groundwater quality trends in response to modified practices during the first 6 years of the program. Similar to the RMP Annual Reports, the Summary Report will be prepared in compliance with the revised General Order MRP and applicable Standard Provisions and Reporting Requirements of the General Order, and in accordance with the goal of the RMP. The Summary Report will include the same components as the RMP Annual Reports, complemented by additional analyses of groundwater conditions and trends in relation to historical and/or modified management practices.

The Summary Report is intended to serve as a technical basis for evidence-based regulatory decision making. In this capacity, the Summary Report will analyze and discuss the effectiveness of dairy management practices and provide information that will be applicable to both monitored and non-monitored dairy farms.

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