NOV 2013

**To:**

**State Water Resources Control Board**

**Office of Chief Counsel**

**Jeanette L. Bashaw, Legal Analyst**

**1001 "I" Street, 22nd Floor**

**P O Box 100**

**Sacramento, CA 95812-0100**

**Date: October 29, 2013**

# Petition Under California Water Code Section 13320 for Review by the State Water Resources Control Board of Various Actions by the Central Valley Regional Water Quality Control Board Regarding Order No. R5-2013-0122.

## A. Introduction.

We, the Petitioners, are James G. Sweeney and Amelia M. Sweeney, and are small dairymen doing business as Sweeney Dairy. Our address is 30712 Road 170, Visalia, CA 93292. Our telephone number is (559) 280-8233 and our email address is japlus3@aol.com.

Pursuant to Section 13320 of the California Water Code, we hereby petition the State Water Resources Control Board (State Board) to review the following decisions and actions of the Central Valley Regional Water Quality Control Board (Regional Board) related to its adoption of its Waste Discharge Requirements General Order for Existing Dairies, Order No. R5-2013-0122 (2013 Dairy Order). We petition the State Board to review the contents of said Order, specifically the testing, monitoring and reporting requirements contained therein, and to grant us the relief we hereinafter request. The 2013 Dairy Order is quite long – 167 pages, including attachments - so it is incorporated herein by this reference.

## B. Pursuance of Administrative Remedies.

On or about August 9, 2013, the Regional Board posted on its website its Tentative General Waste Discharge Requirements for Dairies, its proposed 2013 Dairy Order, and a Notice that interested parties had 30 days within which to submit comments. The comment period would end on September 9, 2013. We submitted a comment letter, with numerous attachments, to the Regional Board on September 8, 2013 (comment letter), which we attach hereto and incorporate herein by this reference.[1] The Regional Board adopted the 2013 Dairy Order at its Board meeting on October 3, 2013.

## C. Legal Arguments and Authorities.

### 1. Lack of Notice and Denial of Due Process.

The Notice about the Tentative 2013 Dairy Order[2] was first posted on the Regional Board's website on or about August 9, 2013 at an obscure, difficult-to-find location. One would have to navigate through all of the following menu choices to stumble across the Notice and the Tentative 2013 Dairy Order and its Attachments:

-Public Notices

-Decisions Pending

-Tentative Orders

-All Other Orders for Future Board Meetings

-Reissuance of General Waste Discharge Requirements for Dairies

At the time, we did not know that the Third Appellate District Court had declared in November, 2012 that the Regional Board's prior General Waste Discharge Requirements for Dairies, No. R5-2007-0035 (2007 Dairy Order), was illegal, or that on April 16, 2013 the Superior Court for Sacramento County had thereupon ordered the Regional Board to set the 2007 Dairy Order aside[3].

No written notice regarding the proposed 2013 Dairy Order had been mailed to us. The only reason we became aware of these court decisions, of the proposed 2013 Dairy Order, and of its 30-day comment period ending September 9, 2013 was because one of the Regional Board staff members happened to call these matters to our attention on August 12, 2013.

We asked a few dairymen who are friends of ours and discovered that none of them were aware of the proposed 2013 Dairy Order, or of the comment period, and none had received written notice thereof. They were also unaware of the Courts' decisions with respect to the 2007 Dairy Order.

The landmark U. S. Supreme Court case of *Mullane v. Central Hanover Bank & Trust Company*, 339 U.S. 306 (1950), held that, under the protections afforded by the 14th Amendment of the United States Constitution, all persons are entitled to receive notice that is "reasonably calculated" to inform them of proceedings that will affect them. The Regional Board has a list of

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[1] Exhibit 1
[2] Exhibit A of Exhibit 1
[3] Exhibit 2

mailing addresses and email addresses for the dairy owners subject to their jurisdiction and purview, including us. The Regional Board obviously knew that we dairymen would be affected by the adoption of this proposed 2013 Dairy Order. Ironically, the Regional Board sent us an email on October 16, 2013, notifying us that it had adopted the 2013 Dairy Order, and we suspect it sent the same email announcement of the Order's adoption to many other dairymen.[4] Thus, under the holding of the *Mullane* case, the Regional Board denied due process to all dairymen and known dairy organizations when it failed to give notice of the comment period and of the date of the proposed adoption of the Order by a method "reasonably calculated" to inform them of the proceedings.

In addition, the 2013 Dairy Order is very long and complex. We needed far more than 30 days to adequately read, study and digest its contents. Thirty days was also insufficient for us to consult with expert consultants to develop and submit expert testimony and other additional relevant evidence. The Board's refusal to provide a much longer comment period effectively frustrated our ability to provide the fullest measure of response that we would have otherwise been capable of.

2. **The 2013 Dairy Order Violates Water Code Subsection 13267(b) and Code of Civil Procedure Subsections (b) and (c) (Abuse of Discretion and Lack of Evidence).**

Water Code subsection 13267 (b) states that, while the Regional Board has the authority to require dairymen to provide technical or monitoring program reports, "the burden, including costs, of these reports shall bear a reasonable relationship to the need for the report and the benefits to be obtained from the reports, and shall identify the evidence that supports requiring that person to provide the reports." Further, it must provide "a written explanation with regard to the need for the reports, and shall identify the evidence that supports requiring that person to provide the reports."

Under the Code of Civil Procedure, subsections 1094.5(b) and (c) also states that a state agency has abused its discretion if it has not proceeded in the manner required by law, or its order or decision is not supported by the findings, or its findings are not supported by the evidence.

It is our contention that the Regional Board's adoption of its 2013 Dairy Order fails to comply with Water Code subsection 13267(b), and that its findings and decisions with respect to the adoption of the Order and its various requirements are not supported by evidence, as required by CCP 1094.5(b) and (c).

One must look at the administrative record to determine whether an agency's adoption of an order meets the requirements described in Water Code subsection 13267(b) and in Code of Civil Procedure subsections 1094.5(b) and (c). Does the Order and/or its administrative record comply with section 13267(b) by sufficiently explaining the need for, and identifying the evidence

[4] Exhibit 3

supporting the need for, each and every required report? Does the Order and/or its administrative record establish that the need for each and every report justify the burden and costs imposed by them? Does the Order and/or its administrative record contain facts and evidence supporting the Regional Board's findings? And does the Order and/or its administrative record contain findings that support the Regional Board's adoption of the 2013 Dairy Order and each and every one of its testing, monitoring and reporting requirements?

In order to ascertain the above, on October 11, 2013 we submitted to the Regional Board a public records act request for copies of the administrative record for the 2013 Dairy Order. We received an email reply from the Regional Board staff on October 21, 2013, advising us that it will be months before the administrative record will be available.[5]

We know that the administrative record for the 2007 Dairy Order consisted of over 34,000 pages. Therefore, we suspect that the administrative record for the 2013 Dairy Order will be quite large. Principles of due process demand that we have the right to supplement this Petition for Review with augmented arguments after we have been provided with a copy of the administrative record and have had a reasonable amount of time thereafter to review and digest it.

In the meantime, we believe and contend that the 2013 Dairy Order violates the provisions of Water Code subsection 13267(b) and Code of Civil Procedure subsections 1094.5(b) and (c), and therefore the Order and its waste discharge requirements, including its testing, monitoring and reporting requirements, are illegal, unenforceable and must be set aside.

**3. The 2013 Dairy Order Violates Water Code Subsection 13263(a) (Economic Considerations).**

California Water Code Section 13240 states that "Each regional board shall formulate and adopt water quality control plans for all areas within the region. ... Such plans shall be periodically reviewed and may be revised." These plans must include its water quality objectives. Water Code Section 13241 declares that "such water quality objectives shall take into account "economic considerations."

Water Code Section 13263 (a) states that waste discharge requirements shall not only implement adopted water quality control plans, but they shall also "take into consideration ...the provisions of Section 13241 [which includes "economic considerations"]."

Paragraph 14, on page 3, of the 2013 Dairy Order recites that it implements its various basin water quality control plans, which include the water quality objectives set forth therein. The Order also recites that it constitutes general waste water discharge requirements for all dairies in its region.

[5] Exhibit 4

Our September 8, 2013 comment letter complained that the proposed 2013 Dairy Order violated the requirements of Water Code subsection 13263(a) by failing to take into account economic considerations for smaller dairies. Our letter pointed out that when the 2007 Dairy Order took effect, it governed over 1600 dairies. As of July, 2012, however, according to data provided to us by the Regional Board, there were 1221 dairies in the Regional Board's Region. And many dairies have sold out after July, 2012. Therefore, more than twenty five percent of the total dairies in the Central Valley Region have closed during the past four years.

We also called to the Regional Board's attention its own data, which showed the dairies that provided reports to the Fresno office in 2007 as compared to 2010:

| **Herd Size** | **2007** | **2010** | **Attrition** |
|---|---|---|---|
| Less than 400 cows | 56 | 30 | -26 = 46% attrition |
| 400 to 700 cows | 92 | 62 | -30 = 32% attrition |
| Over 700 cows | 485 | 455 | -30 = .6% attrition |
| Total | 633 | 547 | -86 = 13% overall attrition |

This data revealed that only about half the number of smaller dairies filed reports in 2010 as compared to the number of smaller dairies that filed reports in 2007. What was most meaningful in this data was the much higher rate of disappearance in the number of smaller dairies since the adoption of the 2007 Order.

The above phenomenon is not surprising. We had previously obtained the administrative record for the earlier 2007 Dairy Order. It consisted of 34,000 pages of documents and testimony, all of which we read. Our September 8, 2013 comment letter to the Board, on pages 2 through 4, enumerated all of the testimony that had been presented to the Regional Board in 2007 about how expensive the reporting requirements set forth in the 2007 Dairy Order would be, and how especially unbearable it would be for smaller dairies.

Yet, the Board ended up granting no exemptions or waivers of any kind in the 2007 Dairy Order based on herd size, despite the fact that no evidence appeared in the 2007 administrative record showing that smaller dairies were as capable as larger dairies in dealing with the additional economic burdens of complying with the testing, monitoring and reporting requirements contained in the 2007 Order. And no evidence appeared in the administrative record that disputed the abundant testimony that the proposed 2007 Order would be harmful, even fatal, to smaller dairies.

Our 2013 comment letter pointed out how we own and operate a small dairy, milking about 290 cows. Small dairies, such as ours, are under greater economic stress than larger, more efficient dairies and, therefore, we are less able to handle the high costs involved in complying with the various waste discharge and reporting requirements described in the proposed 2013 Dairy Order. Our 2013 comment letter also attached a letter from our lender that confirmed that our dairy facility and the dairy facilities of our size have become worthless – they are worth nothing.[6]

Not only is it generally accepted that small dairies are less able to deal with the high regulatory costs, but on the basis of cow numbers, we also showed in our 2013 comment letter that small dairies pose a dramatically smaller threat to the groundwater. The Regional Board recently prepared a report entitled 2011 Compliance by Dairy Size Annual Report, which lists each dairy within the region:[7] In 2011, 1,596,230 dairy cows populated the Central Valley Region. The 155 smallest dairies had 31,357 cows. The three largest dairies had 31,676 cows. The 38 largest dairies had 228,435 cows while the 430 smallest dairies had 228,211 cows. Hence, dairies with 301 to 700 cows represent 12.6% of the cows in the Central Valley Region, while dairies with 300 cows or less represent only 1.69% of the cows in the Region.

Water Code subsection 13269 (a) (3) gives the regional boards the authority to *waive* monitoring requirements where it determines that certain discharges "do not pose a significant threat to water quality." We noticed that the Regional Board exempted farming operations under 60 acres in its Waste Discharge Requirements General Order for Growers in the Tulare Lake Basin (R5-2013-0120), which it just adopted on September 19, 2013. Its rationale for doing so was that such small operations only represent about 4% of the irrigated acres in the Basin. While the Board felt that a 4% impact by small farms was small enough to justify exempting them, it never explained or justified why small dairies having only a 1.7% impact did not deserve a similar exemption.

Our 2013 comment letter also pointed out that other Regional Boards have been sensitive to the issue of smaller dairies. Both the North Coast Regional Water Quality Control Board and the San Francisco Bay Regional Water Quality Control Board have recognized how smaller dairies have a much smaller impact on groundwater, and how they are less able to bear the same regulatory expenses and burdens that larger dairies can. Both Regional Boards saw fit to adopt special performance and reporting relief for dairies under 700 cows (See Orders R1-2012-0003 and R2-2003-0094, respectively).

In the case of the North Coast Region's Order R1-2012-0003, it declares that "this Order applies to dairies that pose a low or insignificant risk to surface water or groundwater." The Order goes on to say that "economics were considered, *as required by law,* during the development of these objectives," and "that a waiver of WDRs [waste discharge requirements] for a specific type of discharge is in the public best interest." (Emphasis mine) In the case of the San Francisco Bay Region, it requires smaller dairies to complete and file a two-page "Reporting Form" which does not require the involvement of expensive engineers. We also noted that the San Joaquin Valley Air Pollution Control District exempts smaller dairies from many of its requirements.

The 2013 Dairy Order, and we suspect its administrative record, does not show that the Order complies with Water Code subsection 13263(a). We believe and contend that the 2013 Dairy

[6] Exhibit C of Exhibit 1
[7] Exhibit D of Exhibit 1

Order, as general waste discharge requirements, and as an implementation of the basin water quality plans, must also take into account current "economic considerations." But the 2013 Dairy Order does not reflect any of this. It specifically fails to implement water quality objectives and impose general waste discharge requirements that will be within the economic means of smaller dairies – operations that have to deal with disproportionately higher per cow monitoring and reporting costs. Indeed, the proposed Order fails to address the special economic circumstances of smaller dairies in any way whatsoever.

Half of the cows in our herd are Jerseys. We attached to our comment letter an article entitled "Study Pinpoints Sustainability of Jersey Milk Product."[8] It dealt with recent studies about how Jerseys have a lesser impact on the environment than Holsteins do; they produce less waste and use less water per the same amount of milk product. The 2013 Dairy Order fails to address this issue.

The Regional Board's failure to adopt either exemptions, waivers or other special relief for dairies under some reasonable herd size from most or all of the 2013 Order's requirements, not only violates subsection 13263 (a) of the Water Code, it also puts smaller dairies in the Central Valley region at a greater competitive disadvantage with larger dairies in the Central Valley, and at a competitive disadvantage with small dairies in the North Coast and San Francisco Bay regions.

## 4. As a Set of General Waste Discharge Requirements, the 2013 Dairy Order Violates Water Code Section 13263(i). It Should Not Apply to All Dairies.

The 2013 Dairy Order states on page 2 that it "serves as general waste discharge requirements for discharges of waste from existing milk cow dairies of *all* sizes." (Emphasis ours)

Water Code subsection 13263 (i) provides in part:

"The state board or a regional board may prescribe general waste discharge requirements for a category of discharges if the state board or that regional board finds or determines that *all* of the following criteria apply to the discharges in that category: (Emphasis ours)

(1) The discharges are produced by the same or similar operations.

...

(2) The discharges require the same or similar treatment standards.

..."

The 2013 Dairy Order is a set of general waste discharge requirements that apply to *all* dairies in the Central Valley Region, regardless of size. But subsection 13263 (i) requires the Board to determine whether there are reasonably distinguishable differences such that dairies should be

[8] Exhibit E of Exhibit 1

divided into different categories for which different general waste discharge requirements should apply.

As demonstrated above, (1) smaller dairies produce significantly less dairy waste than larger dairies, and (2) smaller dairies are also significantly less able to bear the costs imposed by the general waste discharge requirements imposed under your proposed 2013 Order. We believe and contend that there is no substantial evidence in the administrative record that supports the Regional Board's determination that smaller dairies are the same as or are similar operations to larger dairies, and that they should be treated the same under the same General Order. They are not similar in terms of the magnitude of their potential impact to groundwater or in their ability to bear the regulatory costs imposed upon them. We believe that 13263 (i) imposes upon the Regional Board the duty to divide dairies into two or more categories on which different general waste discharges would be imposed on each category. For this reason, the 2013 Dairy Order violates the provisions of Water Code section 13267(i) and is therefore illegal, unenforceable and should be set aside.

Also, as conditions differ from dairy to dairy, the most appropriate type of treatment standards may be different as well. Yet, the 2013 Dairy Order does not address or take into account any of these differences.

5. **The Revised Order Is Not Based On and Fails To Implement the Most Modern and Meaningful Scientific Findings and Technologies.**

Subsection 13263 (e) of the Water Code provides in part that "All [waste discharge] requirements shall be reviewed periodically." If new and more cost effective ways can accomplish the same purpose, we contend that the above section imposes on the Regional Board a legal duty to review such issues and revise its requirements accordingly. The analysis and deliberations leading up to the Regional Board's adoption of the 2013 Dairy Order provided the Board the perfect opportunity to make such a review.

Our September 8, 2013 comment letter submitted the following research papers to the Regional Board for review and consideration, and we asked that they be made part of the administrative record:

1. "Saturated Zone Denitrification: Potential for Natural Attenuation of Nitrate Contamination in Shallow Groundwater Under Dairy Operations," a paper resulting from a research project conducted in 2004-2005 at a Merced County dairy and at a Kings County dairy, and involving a network of 21 groundwater monitoring wells. The study was conducted by the Lawrence Livermore National Laboratory and the University of California, Davis and was funded by a grant from the State Water Resources Control Board. The paper was published in *Environmental Science and Technology*, 41:759-765 (2007).[9]

[9] Exhibit F of Exhibit 1

2. "Impact of Dairy Operation on Groundwater Quality," a report dated August 8, 2006. It was a research project conducted in 2003-2005 by the Lawrence Livermore National Laboratory and the University of California, Davis and was funded by the State Water Resources Control Board. The study was conducted by using an extensive network of groundwater monitoring wells installed at three dairies in Kings County, one dairy in Merced County and on dairy in Stanislaus County.[10]

3. "Manure Waste Ponding and Field Application Rates," dated March, 1973. It was a study conducted by the University of California Agricultural Extension Service, the University of California, Davis and the State Water Resources Control Board. The study involved 25 dairy manure holding ponds located in Stanislaus, San Joaquin and San Bernardino counties.[11]

4. "When Does Nitrate Become a Risk for Humans?" This 2008 paper was co-authored by a team of eight scientists from universities in the United States, the U.K., Netherlands and France, and the paper was published in the *Journal of Environmental Quality*, 37:291-295 (2008).[12]

These attached documents represent scientific research papers and reports that should have been considered by the Regional Board before adopting its final 2013 Dairy Order. One paper shows that the amount of seepage or leakage from dairy wastewater lagoons is minor because of the sealing properties of manure, particularly when considered in the context of the small amount of surface area that lagoons represent in comparison to the entire surface area of a dairy site and its associated cropland. This sealing and minor seepage has been determined to occur regardless of whether the lagoons were constructed in heavy clay or very sandy soils.

Another paper shows that there are bacteria below ground surface that denitrify nitrates in lagoon seepage water such that there is a significant conversion of the nitrates (NO3) in the lagoon seepage water into inert, non-toxic nitrogen gas (N2), Indeed, it has been found that complete denitrification has occurred at approximately 40 feet below ground surface, and that this occurs regardless of the soil types involved.

One of the papers ascertained that there are certain compounds and gasses in manure water that can be used to determine whether it is water from dairy lagoons or from waste applied in irrigation water that may have infiltrated into first encountered groundwater. Tests exist that detect the presence or absence of tritium in groundwater and that measure 4He. These tests can determine the age of the groundwater. In other words, testing methods exist that can show whether a dairy's operations have actually impacted the tested groundwater, or whether the nitrates encountered came from sources other than the dairy operation. We submitted testimony in our comment letter about a dairyman who built a new dairy facility ten years ago in Madera County. He was required by the County to test the water for nitrates from his newly drilled domestic and irrigation well. The tests revealed high nitrates, even though no animals had yet

[10] Exhibit G of Exhibit 1
[11] Exhibit H of Exhibit 1
[12] Exhibit I of Exhibit 1

been brought to the new facility and even though there were no dairy facilities within ten miles of his new dairy site. This shows how simple testing for the presence of nitrates is inadequate to prove their source.

One of the foregoing papers established that ammonium and other undesirable constituents found in lagoon seepage water adhere to the soil particles immediately beneath the lagoon and do not migrate into lower groundwater tables. Even salt has been found to seep out of the bottoms of lagoons in very small amounts.

We also see from one of the papers that the very underpinnings of the need to regulate nitrates is being challenged; that the health threats of nitrates are misplaced or overstated at the levels commonly found in our Valley groundwater. In any event, the paper insists that more research needs to be done to see whether the current allowable limits for nitrates should be significantly relaxed, and whether there is a more cost effective way to address whatever health risks are ultimately found to *actually* exist.

We noticed that the 2013 Dairy Order makes periodic references to the Brown, Vance Report. This report, entitled, "Review of Animal Waste Management Regulations: Evaluation of Alternative Confined Animal Facilities Criteria to Protect Groundwater Quality from Releases.", is a report released in November, 2004 by Brown, Vance & Associates, an engineering firm engaged by the San Jose State University Foundation, and which was funded by a grant from the State Water Resources Control Board. The report, with its Appendices, is very long - about 120 pages - so we will not attach a copy herewith, but the Regional Board and its staff have been in possession of it since its release in 2004. It needs to be pointed out that the report was produced before the more recent research papers (Exhibits F, G and I of Exhibit 1) were published. Indeed, most of Brown's observations and recommendations have been subsequently undermined, put into question and/or otherwise debunked by these studies and reports. In addition, the Brown report's assessment of the average costs of its recommended measures, having been arrived at in 2002, are now wildly obsolete and therefore inapplicable in light of the dramatically changed revenue and cost conditions that currently exist in the dairy industry. The Brown, Vance report should be disregarded as support for much of the contents of the 2013 Dairy Order.

In short, old and new research and advanced technologies that presently exist show that there are more accurate and less expensive means for evaluating groundwater contamination risk, of determining non-contamination of groundwater, and of using less expensive practices that can prevent such contamination. In light of the above research papers, the administrative record will have to contain substantial evidence supporting the need for each and every test, and for the monitoring program and reports required by the 2013 Order that the Board adopted. Moreover, such evidence must have been submitted by qualified experts, and must conclusively prove that the conclusions arrived at in the above research papers were in error.

As mentioned earlier, it will be some time before we receive the administrative record. We will also need an adequate amount of time to review its contents. When that has occurred, we will bring to the State Board's attention what we have found. In the meantime, we believe that most of the 2013 Dairy Order's testing, monitoring and reporting requirements are primitive, antiquated, obsolete, unjustified, unsupported with substantial evidence and provide nothing of real value except for lining the pockets of engineers, consultants and laboratories.

## 5. Does the Raw Data Collected by the Regional Board From Tulare Lake Basin Dairy Groundwater Monitoring Wells Over the Last Ten Years Support the Need for Such Testing and Monitoring?

Our comment letter dated September 8, 2013 pointed out that we have seen letters sent in 2003 by the Regional Board staff to a particular Tulare County dairyman. The first letter required the dairyman to submit test results from his deep irrigation wells. When one of the wells showed a nitrate-nitrogen level of 22 mg/L, the Regional Board required the dairyman to install a network of groundwater monitoring wells and to begin sending quarterly test results to the Board thereafter. We understand that a large number of dairymen were required to install monitoring wells at about the same time. We assume that the Regional Board has been continuously receiving test data from these wells over the last ten years. In fact, the 2013 Dairy Order states on page 5:

"23. Groundwater monitoring shows that many dairies in the Region have impacted groundwater quality. ... Prior to the issuance of the 2007 General Order, the Central Valley Water Board requested monitoring at 80 dairies with poor waste management practices in the Tulare Lake Basin. This monitoring has also shown groundwater impacts under many of these dairies, including where groundwater is as deep as 120 feet and in areas underlain by fine-grained sediments."

Our ability to adequately comment on the 2013 Dairy Order depended on us being able to see and evaluate *all* of the actual test results, reports and other data submitted to the Regional Board from all of the monitoring wells at all of these "80 dairies" in the Tulare Lake Basin, and from any other dairy in the Tulare Lake Basin that installed monitoring wells, during and after 2003. We recently made a public records act request for copies of all of said test results, reports and data. We were advised by email on September 26, 2013 that these records consist of 21,000 pages and that copies of them will cost us $2100.00.[13] We cannot afford this amount. However, the Regional Board should have reviewed this data and produced a summary, analysis or report, which we are now asking for, if such exist.

## 6. A General Indictment of the Regional Board.

The Porter-Cologne Act, enacted in 1969, created the regional water quality control boards. Thus, the Regional Board has been in the business of protecting the quality of our groundwater for the last 43 years. It and its staff have been collecting and studying data for over four decades. It has promulgated rules and regulations and imposed them and its management practices and waste discharge requirements on dairymen during this time. Dairymen, for the most part, have dutifully implemented the management practices prescribed and required by the Regional Board over the last 43 years. Yet, after all these decades of protecting groundwater and assuring people that the practices and measures it imposed were necessary and sufficient in achieving the same, a

[13] Exhibit 5

recent lawsuit has now caused the Regional Board to admit in its 2013 Dairy Order that it had been wrong; that the dairies supervised and regulated by it for the last 43 years have indeed continued to pollute groundwater, even though they have been following the Regional Board's orders and requirements. On page 9 of the 2013 Dairy Order, paragraph 34 admits that after 43 years of collecting data and information from dairies, the Regional Board does do not know if the management practices it has imposed upon dairies are effective.

This 2013 Order seeks a continuation of its extensive, intrusive and costly program of collecting data and submitting reports. After 43 years, the Regional Board should have collected more than enough data and studied all available research on the topic. Its shameful admissions are a disgraceful indictment of the agency's performance over a very long time. Moreover, we see no evidence in the Order that the Regional Board is acknowledging or implementing the most recent research or technologies.

The Regional Board's staff are full-time employees who are deemed to be "professional" water quality experts. The burden must be on them to show us - the people who will be affected by this Order - precisely and accurately why each and every one of the management practices, tests, monitoring programs and reporting requirements set forth in this Order are necessary, that they are not excessive in their burdens, and that they reflect the best and most cost effective means based on the most recent research and technologies. In contrast, we dairymen do not possess the data the Regional Board has collected, and we do not have the time or resources to become experts. We expect the Regional Board to lay everything out in detail – to plainly connect the dots. Anything less will be treated as a denial of due process, a failure to support the Order with substantial evidence, and a violation of the applicable provisions of the Water Code.

## D. Appeal and Petition for Review/ Actions Requested of State Board.

Pursuant to Section 13320 of the California Water Code, we hereby appeal to the State Board regarding the following decisions and actions of the Regional Board, and we petition the State Board to review the same and grant us the hereinafter requests:

We petition the State Board to determine and declare that the 2013 Dairy Order and its testing, monitoring and reporting requirements do not comply with applicable law, including the provisions of Water Code sections 13263 and 13267, as well as Code of Civil Procedure section 1094.5, and that said Order and the general waste discharge requirements set forth therein are not supported by the evidence. Therefore, the 2013 Dairy Order is illegal, invalid, unenforceable and should be set aside.

A copy of this Petition, together with all exhibits, has been mailed to the Central Valley Regional Board.

Respectfully submitted,

James G. Sweeney Amelia M. Sweeney

James G. Sweeney Amelia M. Sweeney Dated: October 29, 2013

# Exhibit 1

JAMES G. & AMELIA M. SWEENEY
30712 ROAD 170, VISALIA, CA 93292 559-280-8233
japus3@aol.com

September 8, 2013

Allan Cregan
Central Valley Regional Water Quality Control Board
1685 "E" Street
Fresno, CA 93706

Re: Tentative General Waste Discharge Requirements for Existing Dairies
R5-2007-0035R

Dear Mr. Cregan:

We are James and Amelia Sweeney, and we carry on a small dairy operation at 30712 Road 170, Visalia, Tulare County, California. Please treat this letter as our public comment to your Tentative General Waste Discharge Requirements for Existing Dairies (2013 Order). Please make it and all of our attached Exhibits a part of the administrative record for the 2013 Order.

**We Are Being Denied Due Process.**

We attach a copy of your Notice about this Tentative 2013 Order.[1] It was first posted on your website on or after August 9, 2013. It was posted at an obscure, difficult-to-find location. One would have to navigate through all of the following menu choices to stumble across the Notice and the Tentative 2013 Order (and its Attachments):

Public Notices
- Decisions Pending
  - Tentative Orders
    - All Other Orders for Future Board Meetings
      - Reissuance of General Waste Discharge Requirements for Dairies

Indeed, we would have had no idea that the Third Appellate District Court had declared in November, 2012 that your prior General Waste Discharge Requirements for Dairies, No. R5-2007-0035 (2007 Order), was illegal, or that on April 16, 2013 the Superior Court for Sacramento County had ordered the Central Valley Regional Water Quality Control Board (Regional Board) to set aside the 2007 Order.

No written notice regarding your proposed 2013 Order has been mailed to us. The only reason we became aware of these court decisions and of your Tentative 2013 Order and its 30-day comment period ending September 9, 2013 was because one of your staff members happened to call them to our attention on August 12, 2013.

[1] Exhibit A

We recently asked a few dairymen who are friends of ours, and discovered that none of them had received written notice of the Tentative 2013 Order or of the comment period. They, too, were unaware of the 2013 Order and unaware of the Courts' decisions with respect to the 2007 Order.

The landmark U. S. Supreme Court case of *Mullane v. Central Hanover Bank & Trust Company*, 339 U.S. 306 (1950), held that, under the protections afforded by the 14th Amendment of the United States Constitution, all persons are entitled to receive notice that is "reasonably calculated" to inform them of proceedings that will affect them. The Regional Board has a list of mailing addresses for each dairy owner subject to their jurisdiction and purview, including us, who they know will or could be affected by the adoption of this proposed 2013 Order. As a result, under the doctrine of the *Mullane* case, the Regional Board has denied us of due process, as well as all other dairymen and known dairy organizations to whom they failed to give actual notice.

Moreover, your proposed 2013 Order is long and complex. We need far more than 30 days to adequately read, study and digest its contents and, where necessary, to engage expert consultants to assist us in the process and perhaps prepare expert testimony and relevant evidence for submission. We hereby request that the Regional Board grant an extension of the comment period for at least 60 additional days. The Board's refusal or the granting of a lesser extension would be unreasonable and a further denial of due process, not only to us but to all dairymen affected by the adoption of this proposed 2013 Order.

In the meantime we will do the best we can given this inadequate comment period, and we present the following comments and evidence regarding your 2013 Order:

**The Water Code Requires the Adoption and Implementation of Water Quality Objectives and the Adoption of Waste Discharge Requirements That Take Into Consideration Economic Conditions. Your Basin Plans and Your Proposed 2013 Order Do Not Do So.**

According to a recent report by the California Milk Advisory Board, the California dairy industry is responsible for 443,574 jobs, $63 billion in economic activity, and provides one fifth of the nation's milk supply.[2]

When the 2007 Order took effect, it governed over 1600 dairies. As of July, 2012, however, according to data provided to me by the Regional Board, there were 1221 dairies in the Regional Board's Region. Many dairies have sold out since then. Therefore, more than twenty five percent of the total dairies in the Central Valley Region have closed during the past four years.

Earlier, we had requested data from the Regional Board staff that would reveal the report filing rate of dairies, broken down by herd size. In response to our request, Jorge Baca, from the Regional Board, provided us with data concerning the dairies dealt with by its Fresno office. This data shows the following with respect to the dairies that provided reports to the Fresno office in 2007 as compared to 2010:

---

[2] Exhibit B

| Herd Size | 2007 | 2010 | Attrition |
|---|---|---|---|
| Less than 400 cows | 56 | 30 | -26 = 46% attrition |
| 400 to 700 cows | 92 | 62 | -30 = 32% attrition |
| Over 700 cows | 485 | 455 | -30 = .6% attrition |
| Total | 633 | 547 | -86 = 13% overall attrition |

This data reveals that only about half the number of smaller dairies filed reports in 2010 as compared to the number of smaller dairies that filed reports in 2007. What was most meaningful in this data was the much higher rate of disappearance in the number of small dairies since the adoption of the 2007 Order.

But the above phenomenon is not surprising at all. The administrative record (AR) of your earlier 2007 Order consists of 34,000 pages of documents and testimony. We have read all of these pages and found that a great deal of testimony was presented concerning how expensive the reporting requirements set forth in the 2007 Order would be, and how especially unbearable it would be for smaller dairies:

(1) Ms. Asgill, an agricultural economist, testified that because of the proposed 2007 general waste discharge requirements for dairies, "we are probably looking at the smaller dairies going under. Probably those dairies that we [are] usually fond of protecting – dairies under 500 milking cows - will be going out." (Administrative Record (AR) 000444)

(2) A letter from the State Department of Food and Agriculture Board mentioned that Governor Schwarzenegger "made a commitment to reject new regulations that unfairly impact small business. ... It is expected that new and existing regulations will be reviewed for economic impact to small business. ... we encourage the RWQCB to review your proposal ... propose alternatives that are less burdensome." (AR 007297)

(3) The Federal government presented input: The EPA's Small Business Advocacy Panel submitted its recommendation to streamline the reporting requirements and that operations under 1000 animal units should be exempted from certain requirements. (AR 02397)

(4) The State Water Resources Control Board expressed concern in its submission during the hearings that the proposed requirements "may have significant adverse economic impact on small business." The State Board went on to recommend "different compliance or reporting requirements ... which would take into account the resources available to small business ... [and] exemption or partial exemption from regulatory requirements for small business." (AR 019632)

(5) Even Regional Board member Dr. Longley expressed concern: "Whereas larger dairies, a 10,000 cow dairy, would be able to absorb the costs, a 100 cow dairy is going to be faced with possible disaster." (AR 002163)

(6) In response to a written question submitted by Baywatch, Sierra Club, California Sportfishing Protection Alliance and Waterkeeper Alliance, the Regional Board staff assured them that "the Board has the option of limiting the application of this order based on the *size of herd*," and that "waste discharge requirements or a *waiver* of waste discharge requirements would be adopted for facilities that are not covered by the order." (AR 000583)

However, the Board ended up granting no waivers of any kind in the 2007 Order based on herd size, despite the fact that no evidence was presented into the 2007 administrative record showing that smaller dairies were as capable as larger dairies in dealing with the additional economic burdens of complying with the reporting and other requirements contained in the 2007 Order. And no evidence was presented that disputed the abundant testimony that the proposed 2007 Order would be harmful, even fatal, to smaller dairies.

We own and operate a small dairy, milking about 290 cows. Small dairies, such as ours, are under greater economic stress than larger, more efficient dairies and, therefore, we are less able to handle the high costs involved in complying with the various waste discharge and reporting requirements described in your proposed 2013 Order. We attach a copy of a letter from our lender that confirms that our dairy facility and the dairy facilities of our size have become worthless – namely, they are worth nothing.[3]

Your proposed 2013 Order will eventually require all dairies to line wastewater lagoons and to install individual groundwater monitoring well systems. It looks like complying with the requirement of lining wastewater lagoons will cost the average 300 cow dairy over $200,000.00. In our case, this would cost more than the net worth of our entire dairy facility. Many of the larger dairy operations, however, are relatively new and were required to install monitoring wells and line their ponds during construction so they will be relatively unaffected by many of these new requirements.

Complying with the requirement of each dairy installing its own network of groundwater monitoring wells on its dairy site will also be tremendously expensive. DAIRY CARES of Sacramento recently estimated that the average cost of installing an individual groundwater monitoring well system on a dairy would be $42,000.00, and thousands of dollars each year thereafter for ongoing sampling, testing and reporting. The cost of groundwater monitoring well programs, both the installation and the periodic reporting costs, would, for the most part, be the same for small dairies as they would be for large dairies. This means that the cost per cow will be much greater for smaller dairies than for larger ones.

California Water Code Section 13240 states that "Each regional board shall formulate and adopt water quality control plans for all areas within the region. ... Such plans *shall be periodically reviewed* and may be revised." (Emphasis ours) These plans must include its water quality objectives. Water Code Section 13241 declares that "such water quality objectives shall take into account "economic considerations." Paragraph 14, on page 3, of your proposed 2013 Order recites that it implements its various basin water quality control plans, which include the water quality objectives set forth therein. Your proposed Order also recites that it constitutes general waste water discharge requirements for dairies in its region. Water Code Section 13263 (a) also

[3] Exhibit C

states that waste discharge requirements shall not only implement adopted water quality control plans, but they shall also "take into consideration ...the provisions of Section 13241 [which includes "economic considerations"]."

In order to show that your proposed 2013 Order complies with the above code sections, you must show that you have recently reviewed your basin water quality plans and ensured that they take into account recent economic considerations. We also believe your proposed 2013 Order, as general waste discharge requirements, and as an implementation of your basin water quality plans, must also take into account current "economic considerations." But your proposed 2013 Order does not reflect any of this. It specifically fails to implement water quality objectives and impose general waste discharge requirements that will be within the economic means of smaller dairies – operations that have to deal with disproportionately higher per cow monitoring and reporting costs. Indeed, the proposed Order fails to address the special economic circumstances of smaller dairies in any way whatsoever.

Not only is it generally accepted that small dairies are less able to deal with the high regulatory costs, but on the basis of cow numbers, we can also show that small dairies pose a dramatically smaller threat to the groundwater. The Regional Board recently prepared a report entitled 2011 Compliance by Dairy Size Annual Report, which lists each dairy within the region:[4] In 2011, 1,596,230 dairy cows populated the Central Valley Region. The 155 smallest dairies had 31,357 cows. The three largest dairies had 31,676 cows. The 38 largest dairies had 228,435 cows while the 430 smallest dairies had 228,211 cows. Hence, dairies with 301 to 700 cows represent 12.6% of the cows in the Central Valley Region, while dairies with 300 cows or less represent only 1.69% of the cows in the Region.

Half of the cows in our herd are Jerseys. We attach an article entitled "Study Pinpoints Sustainability of Jersey Milk Product."[5] It deals with recent studies about how Jerseys have a lesser impact on the environment than Holsteins do; they produce less waste and use less water per the same amount of milk product. Your proposed 2013 Order fails to take this into account.

Water Code subsection 13269 (a) (3) gives the regional boards the authority to *waive* monitoring requirements where it determines that certain discharges "do not pose a significant threat to water quality." Other Regional Boards have been sensitive to the issues of the lower impact of smaller dairies and to economic considerations. Both the North Coast Regional Water Quality Control Board and the San Francisco Bay Regional Water Quality Control Board have recognized how smaller dairies have a much smaller impact on groundwater, and how they are less able to bear the same regulatory expenses and burdens that larger dairies can. Both Regional Boards saw fit to adopt special performance and reporting relief for dairies under 700 cows (See Orders R1-2012-003 and R2-2003-0094, respectively). (EE)

In the case of the North Coast Region's Order R1-2012-0003, it declares that "this Order applies to dairies that pose a low or insignificant risk to surface water or groundwater." The Order goes on to say that "economics were considered, *as required by law,* during the development of these

[4] Exhibit D
[5] Exhibit E
EE Exhibit EE

objectives," and "that a waiver of WDRs [waste discharge requirements] for a specific type of discharge is in the public best interest." (Emphasis mine)

In the case of the San Francisco Bay Region, it requires smaller dairies to complete and file a two-page "Reporting Form" which does not require the involvement of expensive engineers.

It should also be noted that the San Joaquin Valley Air Pollution Control District exempts smaller dairies from many of its requirements.

If the Regional Board fails to adopt either exemptions, waivers or other special relief for dairies under some reasonable herd size from most or all of the 2013 Order's requirements, then its failure to do so will violate sections 13241 and 13263 (a) of the Water Code. It will put smaller dairies in the Central Valley region at a greater competitive disadvantage with larger dairies in the Central Valley, and at a competitive disadvantage with small dairies in the North Coast and San Francisco Bay regions. Actually, the new costs that will be imposed by the 2013 Order will be beyond the financial means of us and many other smaller dairies.

Your Tentative 2013 Order is the result of a successful lawsuit filed by the Asociacion de Gente Unida Por de Agua, et al, which sought the imposition of much stricter wastewater requirements for dairies. An advocate of such stricter requirements would likely argue that the purpose and benefit of this proposed Order is to ensure better quality drinking water, especially for those living in rural areas who depend on domestic well tap water. But did they consider how all that will matter to the many dairy workers who may lose their jobs as a result of these more costly requirements? We talk about the American dream, where immigrants were able to come to this country and start new businesses. But the cost of excessive governmental regulation is contributing to the extinction of this dream. What are the chances today of a Hispanic immigrant having any chance of starting a small dairy and succeeding? Instead of creating an environment where small, sustainable dairies can succeed, we are creating one that is toxic to the small family dairy, and that promotes their replacement by larger and larger mega dairies.

**As a Set of General Waste Discharge Requirements, Your Proposed 2013 Order, As It is Currently Written, Should Not Apply to All Dairies.**

Your proposed 2013 Order states on page 2 that it "serves as general waste discharge requirements for discharges of waste from existing milk cow dairies of *all* sizes." (Emphasis ours)

Water Code subsection 13263 (i) provides in part:

"The state board or a regional board may prescribe general waste discharge requirements for a category of discharges if the state board or that regional board finds or determines that *all* of the following criteria apply to the discharges in that category:

(1) The discharges are produced by the same or similar operations.

...

(2) The discharges require the same or similar treatment standards.

. . ."

As presently written, the proposed 2013 is a set of general waste discharge requirements that apply to *all* dairies in the Central Valley Region, regardless of size. But subsection 13263 (i) requires the Board to determine whether there are reasonably distinguishable differences such that dairies should be divided into different categories for which different general waste discharge requirements should apply.

As demonstrated, (1) smaller dairies produce significantly less dairy waste than larger dairies, and (2) smaller dairies are also significantly less able to bear the costs imposed by the general waste discharge requirements imposed under your proposed 2013 Order. The Regional Board simply cannot find or determine that smaller dairies are the same as or are similar operations to larger dairies. They are not similar in terms of the magnitude of their potential impact to groundwater or in their ability to bear the regulatory costs imposed upon them. We believe that 13263 (i) imposes upon the Regional Board the duty to divide dairies into two or more categories and impose different general waste discharges on each category. Also, as conditions differ from dairy to dairy, the most appropriate type of treatment standards may be different as well. Yet, your 2013 Order does not address or take into account any of these differences.

**The Revised Order Is Not Based On and Fails To Implement the Most Modern and Meaningful Scientific Findings and Technologies.**

Subsection 13263 (e) of the Water Code provides in part that "All [waste discharge] requirements shall be reviewed periodically." If new and more cost effective ways can accomplish the same purpose, we contend that the above section imposes on the Regional Board a legal duty to review such issues and revise its requirements accordingly.

We attach to this letter the following documents and ask that they be made part of the administrative record:

1. "Saturated Zone Denitrification: Potential for Natural Attenuation of Nitrate Contamination in Shallow Groundwater Under Dairy Operations," a paper resulting from a research project conducted in 2004-2005 at a Merced County dairy and at a Kings County dairy, and involving a network of 21 groundwater monitoring wells. The study was conducted by the Lawrence Livermore National Laboratory and the University of California, Davis and was funded by a grant from the State Water Resources Control Board. The paper was published in *Environmental Science and Technology*, 41:759-765 (2007).[6]

2. "Impact of Dairy Operation on Groundwater Quality," a report dated August 8, 2006. It was a research project conducted in 2003-2005 by the Lawrence Livermore National

[6] Exhibit F

Laboratory and the University of California, Davis and was funded by the State Water Resources Control Board. The study was conducted by using an extensive network of groundwater monitoring wells installed at three dairies in Kings County, one dairy in Merced County and on a dairy in Stanislaus County.[7]

3. "Manure Waste Ponding and Field Application Rates," dated March, 1973. It was a study conducted by the University of California Agricultural Extension Service, the University of California, Davis and the State Water Resources Control Board. The study involved 25 dairy manure holding ponds located in Stanislaus, San Joaquin and San Bernardino counties.[8]

4. "When Does Nitrate Become a Risk for Humans?" This 2008 paper was co-authored by a team of eight scientists from universities in the United States, the U.K., Netherlands and France, and the paper was published in the *Journal of Environmental Quality*, 37:291-295 (2008).[9]

These attached documents represent scientific research papers and reports that should be considered by the Regional Board before adopting its final 2013 Order. These documents show that competent research has demonstrated that the amount of lagoon seepage or leakage is minor because of the sealing properties of manure, and particularly when considered in the context of the small amount of surface area that lagoons represent in comparison to the entire surface area of a dairy site and its associated cropland. This sealing and minor seepage has been determined to occur regardless of whether the lagoons were constructed in heavy clay or very sandy soils. Moreover, research shows that there are bacteria below ground surface that denitrify nitrates in lagoon seepage water, such that there is a significant conversion of the nitrates (NO3) in the lagoon seepage water into inert, non-toxic nitrogen gas (N2), Indeed, it has been found that complete denitrification has occurred at approximately 40 feet below ground surface, and that this occurs regardless of the soil types involved.

Modern research has also ascertained that there are certain compounds and gasses in manure water that can be used to determine whether it is water from dairy lagoons or from waste applied in irrigation water that may have infiltrated into first encountered groundwater. Tests exist that detect the presence or absence of tritium and that measure 4He. These tests can determine the age of the groundwater. In other words, testing methods exist that can show whether a dairy's operations have actually impacted the tested groundwater, or whether the nitrates encountered came from sources other than the dairy operation. I am aware of a situation where a dairyman built a new facility ten years ago in Madera County. He was required by the County to test the water for nitrates from his newly drilled domestic and irrigation well. The tests revealed high nitrates, even though no animals had yet been brought to the new facility and even though there were no dairy facilities within ten miles of his new dairy site. This shows how simple testing for the presence of nitrates is inadequate to prove their source.

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[7] Exhibit G
[8] Exhibit H
[9] Exhibit I

Modern research has also established that ammonium and other undesirable constituents found in lagoon seepage water adhere to the soil particles immediately beneath the lagoon and do not migrate into lower groundwater tables. Even salt has been found to seep out of the bottoms of lagoons in very small amounts.

We also see from one of the papers that the very underpinnings of the need to regulate nitrates is being challenged; that perhaps the health threats of nitrates are misplaced or overstated at the levels commonly found in our Valley groundwater. In any event, the paper insists that more research needs to be done to see whether the current allowable limits for nitrates should be significantly relaxed, and whether there is a more cost effective way to address whatever health risks are ultimately found to *actually* exist.

We noticed that your 2013 Order makes periodic references to the Brown, Vance Report. This report, entitled, "Review of Animal Waste Management Regulations: Evaluation of Alternative Confined Animal Facilities Criteria to Protect Groundwater Quality from Releases.", is a report released in November, 2004 by Brown, Vance & Associates, an engineering firm engaged by the San Jose State University Foundation, and which was funded by a grant from the State Water Resources Control Board. The report, with its Appendices, is very long - about 120 pages - so we will not attach a copy herewith, but the Regional Board and its staff have been in possession of it since its release in 2004. It needs to be pointed out that the report was produced before the more recent research papers (Exhibits E, F, and H) were published. Indeed, most of Brown's observations and recommendations have been subsequently undermined, put into question and/or otherwise debunked by these studies and reports. In addition, the Brown report's assessment of the average costs of its recommended measures, having been arrived at in 2002, are now wildly obsolete and therefore inapplicable in light of the dramatically changed revenue and cost conditions that currently exist in the dairy industry. The Brown, Vance report should be disregarded as supporting the contents of much of the 2013 Order.

In short, old and new research and advanced technologies that presently exist show that there are more accurate and less expensive means for evaluating groundwater contamination risk, of determining non-contamination of groundwater, and of using less expensive practices that can prevent such contamination. Most of your 2013 Order's reporting requirements are primitive, antiquated, obsolete, and provide nothing of real value, except for lining the pockets of engineers, consultants and laboratories. It is evident that your Regional Board and its staff has not sufficiently examined and considered the most recent research and the most advanced testing technologies. At least, we see no evidence of it in your proposed 2013 Order. Rather, your Order reflects an abject absence of the most modern knowledge available, similar to the stubborn adherence to Flat-Earth beliefs during the Renaissance.

**We Need to See the Raw Data Collected by the Regional Board From All Tulare Lake Basin Dairy Site Groundwater Monitoring Wells Over the Last Ten Years.**

We have seen letters sent in 2003 by the Regional Board staff to a particular Tulare County dairyman. The first letter required the dairyman to submit test results from his deep irrigation wells. When one of the wells showed a nitrate-nitrogen level of 22 mg/L, the Regional Board required the dairyman to install a network of groundwater monitoring wells and to begin sending quarterly test results to the Board thereafter. We understand that a large number of dairymen were required to install monitoring wells at about the same time. We assume that the Regional Board has been continuously receiving test data from these wells over the last ten years. Provocatively, your proposed 2013 Order states on page 5:

"23. Groundwater monitoring shows that many dairies in the Region have impacted groundwater quality. ... Prior to the issuance of the 2007 General Order, the Central Valley Water Board requested monitoring at 80 dairies with poor waste management practices in the Tulare Lake Basin. This monitoring has also shown groundwater impacts under many of these dairies, including where groundwater is as deep as 120 feet and in areas underlain by fine-grained sediments."

Our ability to adequately comment on your 2013 Order depends on us being able to see and evaluate *all* of the actual test results, reports and other data submitted to the Regional Board from all of the monitoring wells at all of these "80 dairies" in the Tulare Lake Basin, and from any other dairy in the Tulare Lake Basin that installed monitoring wells, during and after 2003. Therefore, we hereby make a request in this letter, under the Public Records Act, for copies of all of said test results, reports and data. We understand that these dairies need to retain their privacy, so we have no objection to you redacting from each document the name and address of each dairy. But we need to be able to identify each dairy so that we can connect all the test results, reports and other data from each monitoring well located at each dairy. One suggestion would be for you to assign a separate number to each dairy and identify each dairy's monitoring well by a letter. For example, if the number "23" is assigned to a dairy and the letter "B" identifies a specific monitoring well on that dairy, then that monitoring well would be identified as "23-B." Each test report would also bear the "23-B" label. Also, as to each monitoring well, you need to inform us as to its location on the dairy site, such as "upgradient from lagoons," or "near lagoons," or "downgradient from lagoons," the depth of the well, the location of the screening, and everything else that is needed to establish the meaningfulness of the data. Please promptly advise us when the copies are available and the cost of same.

We do not expect to receive the copies requested above by the comment period deadline. But since our evaluation of this data is important to our ability to meaningfully complete our comments, it is another compelling reason why the comment period needs to be extended.

**Burden of Proof.**

Water Code subsection 13267 (b) states that, while you have the authority to require dairymen to provide technical or monitoring program reports, you must provide "a written explanation with regard to the need for the reports, and shall identify the evidence that supports requiring that person to provide the reports."

The Porter-Cologne Act, enacted in 1969, created the regional water quality control boards. Thus, your agency has been in the business of protecting the quality of our groundwater for the last 43 years. You and your staff have been collecting and studying data for over four decades. You have promulgated rules and regulations and imposed them and your management practices and waste discharge requirements on dairymen during this time. After all these decades of assuring people that these practices and measures were sufficient in protecting groundwater, a lawsuit has now led you into saying that you have been wrong; that dairies supervised and regulated by you for the last 43 years do indeed continue to pollute groundwater. Indeed, on page 9 of your proposed Order, paragraph 34 admits that after 43 years of collecting data and information from dairies, you do not know if the management practices you have imposed upon dairies are effective. Your 2013 Order seeks even more extensive data and reports. After 43 years, you should have collected more than enough data and studied all available research on the topic. Such shameful admissions are a disgraceful indictment of your agency's performance over a very long time. Moreover, we see no evidence in your Order that you are acknowledging or implementing the most recent research or technologies. And what about your credibility? If you admit to being so wrong before, how can one feel comfortable with any assurances you give us now?

Your staff are full-time employees who are deemed to be "professional" water quality experts. The burden must be on you/them to show us - the people who will be affected by your Order - precisely and accurately why each and every one of the management practices and reporting requirements set forth in your Order are necessary and that they reflect the best and most cost effective means based on the most recent research and technologies. In contrast, we dairymen do not possess the data you have collected, and we do not have the time or resources to become experts. We expect you to lay everything out in detail - plainly and fairly connect the dots. Anything less, will be treated as a denial of due process, a failure to support your Order with substantial evidence, and a violation of the applicable provisions of the Water Code.

**Conclusion.**

The Regional Board characterizes dairymen as villains who do not care about the environment. Nothing could be further from the truth. We drink the water. Farmers appreciate the resources that they have been blessed with and are committed to pass these precious resources to their children. My wife, Amelia, and I started our small dairy from scratch 24 years ago. Our dairy has provided an excellent environment for our children to grow up. Our daughter Lena just started medical school at UCSF. Our son Matthew is a senior at UCLA and another daughter Theresa is a sophomore at Cornell University. Our children have learned that success takes hard work and dedication. Sweeney Dairy has won multiple awards for production as well as being the highest quality (lowest somatic cell count) milk producer in Tulare County for 19 of the past 20 years. We have earned the respect of our peers. We host visitors from throughout the world as well as classes from Stanford for the past two years. I think that each Stanford student who has visited our farm has appreciated the opportunity to see firsthand how their food is produced. One student commented "that Lena is lucky to have grown up in a postcard".

Respectfully submitted,

James Sweeney

Amelia Sweeney

# Exhibit A

**Central Valley Regional Water Quality Control Board**

9 August 2013

**NOTICE**
**TENTATIVE GENERAL WASTE DISCHARGE REQUIREMENTS**
**FOR**
**EXISTING MILK COW DAIRIES**

**TO ALL CONCERNED PERSONS AND AGENCIES:**

Enclosed are tentative general waste discharge requirements that will rescind and replace Order R5-2007-0035, Waste Discharge Requirements General Order for Existing Milk Cow Dairies (the "Dairy General Order"). The Central Valley Water Board is proposing revisions to the existing Dairy General Order to comply with a Writ of Mandate issued by the Sacramento County Superior Court following the decision of the Third District Court of Appeal in *Asociación de Gente Unida por el Agua v. Central Valley Regional Water Quality Control Bd.* (2012) 210 Cal.App.4th 1255. These revisions include modifications to the Dairy General Order, the Dairy General Order's Monitoring and Report Program, Attachment A to the Dairy General Order (Information Sheet), and adjustments made to attachments C, D, and E to reflect the modifications in the Dairy General Order.

Any comments or recommendations you may have concerning the enclosed tentative Dairy General Order must be submitted to this office by **5:00 p.m. on 9 September 2013** in order for us to give them full consideration prior to the 3/4 October 2013 meeting of the Central Valley Water Board. Comments received after this time will not be considered or included in the administrative record unless allowed by the Chair. Comments should be submitted via e-mail to Alan Cregan (acregan@waterboards.ca.gov) or hard copies may be submitted to:

Central Valley Regional Water Quality Control Board
Attn: Alan Cregan
1685 "E" Street
Fresno, CA 93706.

Interested parties are advised that the full text of the tentative Dairy General Order and the related attachments are available on the Central Valley Water Board's web site at *http://www.waterboards.ca.gov/centralvalley/board_decisions/tentative_orders/index.shtml* under the heading of "Discharger-Specific Orders for Future Board Meetings.

A public hearing concerning this matter will be conducted during the Central Valley Water Board meeting scheduled for:

DATE: 3/4 October 2013
TIME: 8:30 a.m.
PLACE: Regional Water Quality Control Board, Central Valley Region
11020 Sun Center Drive #200
Rancho Cordova, CA

An alternate meeting location in Stockton, California is possible. Interested parties will need to check the agenda that will be available 10 days prior to the Board meeting for the location.
http://www.waterboards.ca.gov/centralvalley/board_info/meetings/index.shtml#2013

Anyone without access to the Internet who needs a paper copy of the tentative Dairy General Order, or anyone who has questions regarding the tentative Dairy General Order, the tentative Monitoring and Reporting Program, or any of the attachments, should contact Alan Cregan at (559) 445-6185 or by e-mail at acregan@waterboards.ca.gov.

Clay L. Rodgers

CLAY L. RODGERS
Assistant Executive Officer

Enclosures: Table of Contents
Tentative Reissued Waste Discharge Requirements General Order
- Table 1 – Schedule of Submittals

Tentative Revised Monitoring and Reporting Program
- Attachment A of the Revised Monitoring and Reporting Program

Attachment A - Tentative Information Sheet
- Table 1 - Regional, State, and National Pond Liner Design Requirements

Attachment B – Waste Management Plan for the Production Area
Attachment C – Nutrient Management Plan
Attachment D - Manure/Process Wastewater Tracking Manifest
Attachment E – Definitions
Attachment F – Acronyms and Abbreviations
Standard Provisions and Reporting Requirements

cc w/o enc.: Patrick Pulupa, Office of Chief Counsel, State Water Resources Control Board, Sacramento

# Exhibit 2

FILED
ENDORSED
APR 17 2013
By FRANK TEMMERMAN
Deputy Clerk

SUPERIOR COURT OF THE STATE OF CALIFORNIA
IN AND FOR THE COUNTY OF SACRAMENTO

| | |
|---|---|
| ASOCIACION DE GENTE UNIDA POR EL AGUA, a California unincorporated association, and ENVIRONMENTAL LAW FOUNDATION, a California nonprofit organization,<br><br>Petitioners,<br><br>v.<br><br>CENTRAL VALLEY REGIONAL WATER QUALITY CONTROL BOARD, a California state agency,<br><br>Respondent.<br><br>COMMUNITY ALLIANCE FOR RESPONSIBLE ENVIRONMENTAL STEWARDSHIP, a California corporation,<br><br>Intervenor | Case No. 34-2008-00003604-CU-WM-GDS<br>(Related Case No. 2008-00003603-CU-WM-GDS)<br><br>**~~[PROPOSED]~~ WRIT OF MANDATE**<br><br>Honorable Timothy M. Frawley<br>Dept. 29 |

**BY FAX**

CIVIL 29 APR 17 2013 FILED

To Defendant/Respondent Central Valley Regional Water Quality Control Board:

YOU ARE HEREBY COMMANDED, under seal of this Court, to do the following:

1. Set aside the Waste Discharge Requirements General Order for Existing Milk Cow Diaries (Order No. R5-2007-0035) and reissue the permit only after application of, and compliance with, the State's anti-degradation policy (Resolution No. 68-16), as interpreted by the Court of Appeal in its opinion, including, without limitation, adequate findings that any allowed discharges to high quality water:

a. Will be consistent with maximum benefit to the people of the State;

b. Will not unreasonably affect present and anticipated beneficial use of the affected waters;

c. Will not result in water quality less than that prescribed in applicable water quality objectives; and

d. That waste-discharging activities will be required to use the best practicable treatment or control of the discharge necessary to assure that:

i. A pollution or nuisance will not occur, and

ii. The highest water quality consistent with the maximum benefit to the people of the State will be maintained.

2. The writ further commands Defendant/Respondent to make and file a Return within 180 days, setting forth what they have done to comply.

3. Plaintiffs/Petitioners shall recover their costs on appeal in the amount of $3,485.63, as reflected in the Notice of Amended Costs on Appeal, filed February 22, 2013.

4. The Court retains jurisdiction to consider any motions for an award of attorneys' fees.

IT IS SO ORDERED, ADJUDGED, AND DECREED.

Dated: April 17, 2013

Timothy M. Frawley
Judge of the Superior Court of California
County of Sacramento

APPROVED AS TO FORM:

Date: __________________

Laurel Firestone
Community Water Center
Attorney for Petitioners Asociacion De Gente Unida El Agua and Environmental Law Foundation

Date: __________________

Lynne Saxton
Saxton & Associates
Attorney for Petitioners Asociacion De Gente Unida El Agua and Environmental Law Foundation

Date: __________________

Teri Ashby
Office of the Attorney General of California
Attorney for Respondent Central Valley Regional Water Quality Control Board

Date: __________________

Theresa Dunham
Somach Simmons & Dunn
Attorney for Intervenor Community Alliance for Responsible Environmental Stewardship

# Exhibit 3

-----Original Message-----
From: lyris <lyris@swrcb18.waterboards.ca.gov>
To: Jim Sweeney <japlus3@aol.com>
Sent: Wed, Oct 16, 2013 4:39 pm
Subject: Reissued Waste Discharge Requirements General Order for Existing Milk Cow Dairies

Water Boards This is a message from the California Regional Water Quality Control Board, Central Valley (5).

On 3 October 2013, the Central Valley Regional Water Quality Control Board adopted Reissued Waste Discharge Requirements General Order No. R5-2013-0122 for Existing Milk Cow Dairies (Reissued Dairy General Order). A copy of the Reissued Dairy General Order may be downloaded at http://www.waterboards.ca.gov/centralvalley/water_issues/dairies/dairy_program_regs_requirements/index.shtml.

If you have any questions regarding the Reissued Dairy General Order, please contact Doug Patteson at (559) 445-5116 or by email at dpatteson@waterboards.ca.gov.

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You are currently subscribed to reg5_dairy_program as: japlus3@aol.com.
To unsubscribe click here: leave-521345-614515.54ece50309388ee9a769c3c1e2b7e13c@swrcb18.waterboards.ca.gov

# Exhibit 4

**From:** Sholes, David@Waterboards <David.Sholes@waterboards.ca.gov>
**To:** japlus3 <japlus3@aol.com>
**Cc:** Essary, Dale@Waterboards <Dale.Essary@waterboards.ca.gov>; Patteson, Doug@Waterboards <Doug.Patteson@waterboards.ca.gov>; Rodgers, Clay@Waterboards <Clay.Rodgers@waterboards.ca.gov>
**Subject:** Further response to your information request regarding the re-issued Dairy General Order
**Date:** Mon, Oct 21, 2013 1:07 pm

Mr. Sweeney:

You have asked for "all material considered in the new/revised dairy general order." For a regulatory program as complex as the Board's Dairy Program, this is an exceptionally broad request, as this material is contained in numerous file locations throughout the Board's multiple offices. The material that was considered by the Board includes, among other things: the draft, tentative, and final versions of the General Order, the comments on the General Order and our responses to those comments, industry studies and academic literature that support the issuance of the General Order, audio recordings of the hearing, representative groundwater monitoring program reports, and the groundwater monitoring data that you previously requested but have thus far declined to pay for or pick up.

Over the course of the next few months (at a minimum), it is likely that Board staff will be compiling what is referred to as the "administrative record" for the General Order. The administrative record is an indexed and collated copy of all the material that the Board relied upon to arrive at the decision to issue the General Order. The process of compiling an administrative record involves careful deliberation on the part of Board staff, management, and legal counsel to make sure that all the material that received consideration makes it into the record.

However, this process is just getting started; the Board's legal requirement to compile this record comes from California Code of Regulations, title 23, section 2050.5, and this regulation is only triggered after a petition is submitted to the State Water Board, and after the State Water Board requests a complete administrative record from the Regional Board. After the State Water Board requests the record, the Regional Board has 30 days to provide this record. As I've mentioned, though a petition has not yet been filed, the Board is anticipating a petition and is therefore beginning this process now.

The Board followed this process after a petition was filed regarding the 2007 General Order, and this is why you have a digital copy of the Board's 34,000 page administrative record for the 2007 General Order. The Board understands that you want a copy of the new administrative record that we are just starting to prepare, and we can certainly let you know when we have finished compiling this record. It is also likely that we will scan and make digital copies of the new administrative record, which means that digital copies of that record will be available to you solely at the cost of duplicating the CD-ROMs. However, as mentioned above, this record won't be compiled for a matter of months, at a minimum.

If you are still interested in obtaining copies of individual files that the Board considered in issuing the reissued General Order before we finish compiling the administrative record, our files and records are always available for your inspection during normal business hours, or we can make copies of identifiable records for you at the cost of $.10 per page.

Thank you for your interest in our regulatory process.

David Sholes

Senior Engineering Geologist

Ag/Planning Unit

(559) 445-6279

# Exhibit C

FARM CREDIT WEST
Committed. Experienced. Trusted.

Tulare Dairy Center
304 E. Tulare Avenue
Tulare, California 93274
559-688-7844 FAX: 559-686-5924
www.FarmCreditWest.com

August 29, 2013

James G. Sweeney
30712 Road 170
Visalia, CA 93291

Dear Jim,
As I have discussed with you by telephone, your dairy facility was appraised as a country home site rather than a dairy facility. As of late, appraisals have given little or no value to dairy facilities that milk less than 1,000 cows. Since I am not an appraiser, I cannot rationalize why the smaller dairy facilities are given no value, however, I can surmise that with the number of cows milked at a smaller facility, the dairy does not make an economic unit. If there is any bright side to this conclusion, I must state that your dairy has not been singled out and other small facilities have experienced the same appraisal conclusion.

Should you have any further questions regarding the appraisal results, please do not hesitate to contact me.

Russ Souza
Russ Souza
Vice President

# Exhibit D

**From:** Japlus3 <japlus3@aol.com>
**To:** lasallem <lasallem@lightspeed.net>
**Subject:** Sweeney
**Date:** Thu, Aug 15, 2013 9:11 am

Mike,
Auditing the "Compliance by Dairy Size 2011 Annual Report" I found some interesting things.
They say there is 1316 dairies of which 1299 filed reports. There are only 1221 on their report with 1,596,230 cows.
The small dairies <300 cows have 26,989 cows on 138 dairies or 1.69% of the total cows.
The 3 largest dairies have 31,676 cows.
The 155 smallest dairies have 31,537 cows.
If the cost of a monitoring well is $30,000, then these 155 dairies would pay $4,650,000 for monitoring wells while the 3 largest probably already have them.
The 38 largest dairies have 228,435 cows.
The 430 smallest have 228,211.
Monitoring wells for this group would run $12,900,000 while the 38 largest likely already have them.
Thanks for all the help.
Jim

start 1600
lost 24% of dairies

# Compliance by Dairy Size 2011 Annual Report

| Dairy Size (No. of mature cows) | No. of Dairies in size category | No. of 2011 ARs Submitted | 2011 AR Compliance Rate |
|---|---|---|---|
| Large (>700) | 736 | 732 | 99.5% |
| Medium (300–700) | 418 | 411 | 98.3% |
| Small (<300) | 162 | 156 | 96.3% |

AR = Annual Report

**From:** Essary, Dale@Waterboards <Dale.Essary@waterboards.ca.gov>
**To:** Japlus3 <japlus3@aol.com>
**Cc:** Ralph, James@Waterboards <James.Ralph@waterboards.ca.gov>; Mayer, Alex@Waterboards <Alex.Mayer@waterboards.ca.gov>; Landau, Ken@Waterboards <Ken.Landau@waterboards.ca.gov>; Patteson, Doug@Waterboards <Doug.Patteson@waterboards.ca.gov>
**Subject:** RE: Sweeney
**Date:** Mon, Aug 5, 2013 9:17 am
**Attachments:** Compliance_by_Dairy_Size_(2).pptx (99K), Copy_of_Dairy_Population_CIWQS_7-31-12.xlsx (128K)

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Mr. Sweeney,

Attached is the spreadsheet that was converted from a CIWQS report generated on 31 July 3013 to satisfy your information request. Please note that the report's total dairy count does not match the sum of totals listed in the slide depicting 2011 Annual Report compliance rates (also attached). We think the reason for this discrepancy is that the data used to generate the table in the slide inadvertently excluded the Redding dairies (shown in red in the spreadsheet). Also note that including the Redding dairies in the slide would have resulted in a slight increase in overall compliance rates (by perhaps a decimal point), as Redding's compliance rate was 100%.

If you have any questions regarding this matter, please let me know.

Dale E.

**From:** Japlus3 [mailto:japlus3@aol.com]
**Sent:** Monday, July 29, 2013 11:14 AM
**To:** Ralph, James@Waterboards; Essary, Dale@Waterboards; Landau, Ken@Waterboards; Mayer, Alex@Waterboards
**Subject:** Sweeney

Mr.. Ralph,

My wife and I are preparing our Petition for Review which we intend to file with the State Water Resources Control Board and we are requesting the chart used in your testimony relating to cow numbers and compliance rates. We formally request a list of each dairy with corresponding cow numbers for each one. Any other evidence presented at the hearing that was not provided to us prior to the hearing would be appreciated. Thank you for your prompt consideration.

Jim Sweeney

26989

| WDID | Mature (milk + dry) cows | Facility Name | Facility Street | Facility City | Facility Zip | |
|---|---|---|---|---|---|---|
| 5D165055N01 | 0 | V & F DAIRY | 18321 IDAHO | LEMOORE | 93245 | |
| 5C54NC00226 | 0 | WEST BARDSLEY DAIRY | 4505 4th AVENUE | HANFORD | 93230 | |
| 5C54NC00231 | 0 | MAYFLOWER DAIRY | 5038 AVENUE 216 | TULARE | 93274 | |
| 5D165077N01 | 0 | 4K FAMILY PARTNERSHIP DAIRY | 12615 IONA | HANFORD | 93230 | moved |
| 5D165078001 | 0 | ROBERT BRAZIL DAIRY | 15035 8TH | HANFORD | 93230 | |
| 5D165087001 | 0 | J & F DAIRY | 19090 FARGO | LEMOORE | | |
| 5C205009001 | 0 | MCREE EAST DAIRY | 11812 AVENUE 18 | CHOWCHILLA | 93610 | |
| 5D165110N01 | 0 | MANUEL TOSTE DAIRY | 6431 HANFORD-ARMONA | HANFORD | 93230 | |
| 5D545042N03 | 0 | COLLEGE OF THE SEQUOIAS DAIRY | 12764 AVENUE 224 | TULARE | 93274 | @ Airess |
| 5D545074N01 | 0 | RANCHO NUEVO DAIRY | 20969 ROAD 52 | TULARE | 93274 | |
| 5C54NC00030 | 0 | GALHANO DAIRY | 27827 Road 60 | VISALIA | 93277 | |
| 5C16NC00041 | 0 | former Dias Riverbend Dairy | 2319 6TH | KINGSBURG | 93631 | Sold |
| 5C16NC00054 | 0 | former VL FURTADO DAIRY (vacant) | 7249 14TH | HANFORD | 93230 | ——— |
| 5C16NC00064 | 0 | JOHN & NATALIE TOSTE DAIRY | 21519 ELGIN | LEMOORE | 93245 | |
| 5C16NC00074 | 0 | vacant DAIRY | 7155 21 1/2 | Lemoore | 93245 | ——— |
| 5C16NC00080 | 0 | BEZERRA-NADER DAIRY | 9900 21st | Lemoore | 93245 | |
| 5C16NC00099 | 0 | VALLEY VIEW DAIRY #2 | 15010 5th | HANFORD | 93230 | |
| 5B20NC00037 | 0 | DEFENSE RANCH DAIRY | 10726 AVENUE 19 | CHOWCHILLA | 93610 | |
| 5C10NC00042 | 0 | IRAIZOZ DAIRY | 5265 CRAWFORD | REEDLEY | 93654 | |
| 5C10NC00125 | 0 | MACHADO DAIRY | 4423 CENTRAL | FRESNO | 93706 | |
| 5C10NC00058 | 0 | RIVER OAKS DAIRY | 3621 MOUNT WHITNEY | LATON | 93242 | |
| 5C10NC00070 | 0 | QUIST DAIRY | 5500 JENSEN | FRESNO | 93706 | Sold out |
| 5C10NC00073 | 0 | FRANK ROSA DIARY | 910 KLEPPER | CARUTHERS | 93725 | |
| 5A11NC00044 | 0 | Edwin Clementino Dairy | 3669 County Rd U | Orland | 95963 | |
| 5C245001001 | 0 | Jose and Maria Texeira Dairy | 17994 Terceira | Los Banos | 93635 | |
| 5B50NC00172 | 0 | David Vaz Dairy | 2512 Shiells | Newman | 95360 | |
| 5B50NC00182 | 0 | Clinton Dairy | 11119 Cleveland | Oakdale | 95361 | |
| 5B50NC00200 | 0 | Manuel Furtado Dairy #3 | 11530 Alvarado | Oakdale | 95361 | |
| 5B50NC00233 | 0 | Joe B. Coelho Dairy | 648 Faith Home | Turlock | 95380 | |
| 5B50NC00238 | 0 | Gioletti Dairy, Inc. | 10007 Fulkerth | Ceres | 95380 | |
| 5B50NC00239 | 0 | John Brasil Heifers | 6730 Harding | Turlock | 95380 | ——— |
| 5B24NC00023 | 0 | Tony & Judy Brasil Dairy | 2670 Hull | Atwater | 95301 | |
| 5B50NC00264 | 0 | Sallaberry Dairy | 5608 Morgan | Turlock | 95380 | |
| 5B24NC00026 | 0 | Fmr. John and Angela Cardoso Dairy #2 | 10743 Rose | Atwater | 95317 | |
| 5B50NC00282 | 0 | Linhares Dairy | 4319 Walnut | Turlock | 95380 | |
| 5B24NC00065 | 0 | H & D Silveira Dairy | 1473 Washington | El Nido | 95317 | |
| 5B24NC00083 | 0 | Bill Gomes Dairy | 857 Hunt | Gustine | 95322 | |
| 5B24NC00096 | 0 | A & J Dairy | 29558 Marshall | Gustine | 95322 | |
| 5B24NC00100 | 0 | Silva & Silva Dairy | 28753 Sullivan | Gustine | 95322 | |
| 5B39NC00121 | 0 | Betschart & Sons Dairy Inc | 20675 Austin | Manteca | 95337 | |
| 5B24NC00127 | 0 | Deoclecio Silveira and Son Dairy | 19664 Crane | Hilmar | 95324 | |
| 5B24NC00146 | 0 | Oslo Dairy | 20334 Oslo | Hilmar | 95324 | |

1,596,230

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|---|---|---|---|---|---|
| 5B39NC00152 | 0 | Reeve Road Heifer Ranch | 21070 Reeve | Tracy | 95304 |
| 5B24NC00170 | 0 | Amos A Rocha Goat Dairy | 5242 Dwight | Livingston | 95334 |
| 5B24NC00178 | 0 | Gallo Willow Dairy | 2973 N Weir | Livingston | 95334 |
| 5B24NC00193 | 0 | Antonio Texeira Dairy | 13497 Mercey Springs | Los Banos | 93635 |
| 5B24NC00199 | 0 | Formerly Paolo Silva and Sons Dairy | 18785 Ward | Los Banos | 93635 |
| 5B50NC00031 | 0 | Duarte-Acres Holsteins | 8413 Faith Home | Ceres | 95307 |
| 5B24NC00219 | 0 | Former Manuel Teixeira Dairy | 3026 Gurr | Merced | 95301 |
| 5B50NC00035 | 0 | Formerly: Vierra Livestock | 730 Monte Vista | Ceres | 95307 |
| 5B50NC00047 | 0 | Aguiar & Bento Dairy | 10342 Crows Landing | Crows Landing | 95313 |
| 5B50NC00050 | 0 | Triple A Dairy | 9120 Crows Landing | Crows Landing | 95313 |
| 5B50NC00054 | 0 | Silva Family Dairy, Inc. | 1301 Fulkerth | Crows Landing | 95313 |
| 5A34NC00032 | 0 | Alves Dairy | 11326 Franklin | Elk Grove | 95757 |
| 5B24NC00239 | 0 | Mary Lino & Bernice Aguiar Dairy | 2163 Rahilly | Merced | 95340 |
| 5B24NC00241 | 0 | Paul and Paula Floriano Dairy | 2618 Reilly | Merced | 95340 |
| 5B24NC00257 | 0 | Melo & Sons Dairy | 6054 Turlock | Snelling | 95369 |
| 5B50NC00071 | 0 | Antonio Mendes Dairy | 5730 Monte Vista | Denair | 95316 |
| 5B24NC00273 | 0 | Empty (was A-D Dairy) | 23489 Second | Stevinson | 95324 |
| 5B50NC00096 | 0 | Jose & Maria Teixeira Dairy | 4131 California | Modesto | 95358 |
| 5B24NC00283 | 0 | Golf Link Road Dairy | 10220 Golf Link | Turlock | 95380 |
| 5B50NC00153 | 0 | Texeira Dairy | 5701 Parker | Modesto | 95355 |
| 5B34NC00025 | 0 | Gary Pellandini Dairy | 13020 Pellandini | Galt | 95632 |
| 5B34NC00029 | 0 | Santos Dairy | 2307 Bradbury | Turlock | 95380 |
| 5B34NC00032 | 0 | Americo Machado Dairy | 10469 Dillard | Wilton | 95693 |
| 5B50NC00026 | 23 | Maria Brasil Dairy | 7725 Central | Ceres | 95307 |
| 5A11NC00037 | 28 | Paul Schmidt Dairy | 4721 County Road L | Orland | 95963 |
| 5A52NC00037 | 30 | Duivenvoorden Farms | 19490 Draper | Cottonwood | 96022 |
| 5A11NC00020 | 40 | Pedrozo Dairy | 7713 County Rd 24 | Orland | 95963 |
| 5C16NC00083 | 50 | DALLAS STONE DAIRY | 13380 9th | HANFORD | 93230 |
| 5A11NC00012 | 50 | Leonardo Dairy | 2695 County Rd W | Glenn | 95943 |
| 5B24NC00132 | 70 | Silva Dairy | 22120 Crane | Hilmar | 95324 |
| 5B24NC00286 | 70 | Pepper Dairy | 13942 Pepper | Turlock | 95380 |
| 5B50NC00287 | 72 | Delio Silveira Dairy | 6816 Washington | Turlock | 95380 |
| 5C54NC00269 | 75 | TULARE JOINT UNION HIGH SCHOOL DAIRY | 591 BARDSLEY | TULARE | 93274 |
| 5B24NC00109 | 77 | Dean and Olivia Shepherd Dairy | 22646 American | Hilmar | 95324 |
| 5A11NC00047 | 80 | Tommy Thomas Dairy | 3915 Hwy 99 West | Orland | 95963 |
| 5B50NC00279 | 80 | Santa Rita Dairy | 5225 Tegner | Turlock | 95380 |
| 5B10NC00003 | 87 | RIVAS DAIRY | 41198 VALERIA | DOS PALOS | 93620 |
| 5B24NC00053 | 90 | Matos Dairy | 227 El Nido | El Nido | 95317 |
| 5B34NC00016 | 90 | Vanderspek Dairy | 13611 Christensen | Galt | 95632 |
| 5C10NC00104 | 96 | JOE C DIAS & SON DAIRY | 437 MOUNT WHITNEY | RIVERDALE | 93656 |
| 5C54NC00124 | 100 | SANTOS JER-Z DAIRY | 25199 ROAD 164 | VISALIA | 93292 |
| 5B24NC00312 | 100 | J & A Rocha Dairy #2 | 3874 Hunt | Gustine | 95322 |
| 5A11NC00043 | 105 | Creek Dairy | 3414 County Rd S | Orland | 95963 |

1413 20

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|---|---|---|---|---|---|
| 5C205014N01 | 114 | PIMENTEL DAIRY | 18177 ROAD 10 1/2 | CHOWCHILLA | 93610 |
| 5A11NC00034 | 117 | Timinsky Dairy | 3552 County | Orland | 95963 |
| 5B50NC00087 | 118 | Silveira Dairy | 3254 Albers | Modesto | 95357 |
| 5B24NC00213 | 122 | Joseph Nunes Dairy | 3460 Elliott | Merced | 95340 |
| 5A11NC00045 | 125 | S/K Dairy | 7170 Cutting | Orland | 95963 |
| 5A52NC00028 | 131 | Alderson Dairy | 22495 Thomes | Gerber | 96035 |
| 5A115008001 | 132 | John Machado Dairy | 6230 County Rd 7 | Orland | 95963 |
| 5B39NC00057 | 135 | Sited Oak Dairy | 26972 Dustin | Acampo | 95220 |
| 5B39NC00153 | 135 | Salvador Dairy (Reeve Rd) | 20711 Reeve | Tracy | 95304 |
| 5A57NC00022 | 135 | UC Davis Animal Science Dairy | 201 Dairy | Davis | 95616 |
| 5B24NC00276 | 135 | Joseph Nunes Dairy | 2373 Wainwright | Stevinson | 95374 |
| 5B24NC00136 | 139 | Adriana & Orlando Gomes Dairy | 21625 Geer | Hilmar | 95324 |
| 5B34NC00030 | 140 | Bay Meadow Farms | 10326 Walnut | Galt | 95632 |
| 5B39NC00149 | 145 | Ornellas Dairy #2 | 20634 Lammers | Tracy | 95304 |
| 5B24NC00206 | 145 | Paul Floriano Dairy | 3843 Bradshaw | Atwater | 95301 |
| 5C10NC00137 | 149 | ADAMS DAIRY | 16661 FOWLER | SELMA | 93662 |
| 5A52NC00025 | 150 | Smith Family Dairy | 8523 Central | Gerber | 96035 |
| 5A11NC00031 | 150 | Kania Dairy | 6583 County Road 6 | Orland | 95963 |
| 5B395039001 | 155 | L&M Dairy | 13944 Brennan | Escalon | 95320 |
| 5A34NC00034 | 156 | Double D Dairy #2 | 10837 Franklin | Elk Grove | 95757 |
| 5B50NC00199 | 157 | Formerly: Willem Postma Dairy #3 | 10201 Workman | Oakdale | 95361 |
| 5B39NC00126 | 158 | Melvin D. Luis Dairy | 20454 Oleander | Manteca | 95337 |
| 5B50NC00230 | 160 | Blue Island Dairy | 5531 Ehrlich | Turlock | 95380 |
| 5B24NC00055 | 160 | Manuel Cipriano and Son Dairy | 10864 Hwy 59 | El Nido | 95317 |
| 5A34NC00035 | 160 | Da Silva Dairy | 2909 Korn | Elk Grove | 95757 |
| 5B24NC00196 | 163 | Luis Jerseys Dairy | 17512 Phillips | Los Banos | 95635 |
| 5A52NC00029 | 165 | Shasta View Farms Gerber Travis & Allison Cardoza | 22560 Thomes | Gerber | 96035 |
| 5B34NC00009 | 165 | Dallas Barcelos Dairy | 12206 Bruceville | Elk Grove | 95757 |
| 5A11NC00053 | 170 | Vogt's Holstein Dairies #2 | 7255 Cutler Ave | Orland | 95963 |
| 5B24NC00153 | 170 | Matias & Sons Dairy | 7078 Tegner | Hilmar | 95324 |
| 5B50NC00041 | 174 | Germann Bros Dairy | 1236 Taylor | Ceres | 95307 |
| 5A11NC00033 | 175 | Hillside Farms | 3719 County Rd C | Orland | 95963 |
| 5A34NC00028 | 175 | Cal Denier Dairy, LLC | 11735 Carroll | Elk Grove | 95757 |
| 5B24NC00209 | 180 | (Former) Manuel Texeira Dairy #3 | 1486 Buhach | Atwater | 95301 |
| 5C54NC00174 | 182 | ED SOUZA & SON DAIRY | 15390 AVENUE 244 | TULARE | 93274 |
| 5B24NC00287 | 182 | Santa Rita Dairy | 1008 Verduga | Turlock | 95380 |
| 5B39NC00105 | 185 | U-BAR Dairy | 11100 Liberty | Galt | 95632 |
| 5A115007001 | 190 | Innisfail Dairy | 6368 County Rd 7 | Orland | 95963 |
| 5B24NC00168 | 190 | Mayo Dairy #2 | 12191 Childs | Le Grand | 95333 |
| 5B39NC00109 | 195 | Woods Dairy | 14250 De Vries | Lodi | 95240 |
| 5B50NC00133 | 195 | Pacheco Dairy | 13390 Mc Farland | Galt | 95632 |
| 5B24NC00179 | 200 | Silva Joe I & Son Dairy | 14944 Badger Flat | Los Banos | 93635 |
| 5B50NC00055 | 200 | A & G Dairy Farms | 1713 Fulkerth | Crows Landing | 95313 |

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|---|---|---|---|---|---|
| 5B34NC00027 | 200 | De Melo Dairy | 10145 Pringle | Galt | 95632 |
| 5A11NC00039 | 201 | Amaral Dairy | 4715 County Rd N | Orland | 95963 |
| 5C16NC00100 | 205 | GARCIA & SONS DAIRY | 15405 17th | LEMOORE | 93245 |
| 5B50NC00295 | 205 | Edy-Star Farms | 1437 Oakdale Waterford | Waterford | 95386 |
| 5B39NC00111 | 208 | Frank Chaves & Sons Dairy #2 | 12021 Harney | Lodi | 95240 |
| 5A52NC00036 | 209 | Bob Fumasi Dairy | 1015 5th | Orland | 94963 |
| 5B20NC00010 | 210 | MICHAEL MCREE SOUTH DAIRY | 11304 Avenue 18 | CHOWCHILLA | 93610 |
| 5A11NC00046 | 210 | Corona Dairy | 4918 Hwy 99 West | Orland | 95963 |
| 5B39NC00101 | 210 | Silva Brothers Dairy #2 | 25723 Elliot | Galt | 95632 |
| 5B50NC00208 | 215 | Ed Hirdes Dairy | 2131 Blaker | Turlock | 95380 |
| 5B50NC00128 | 215 | Hendrix Dairy | 2901 Keyes | Modesto | 95358 |
| 5B24NC00207 | 217 | Antonio and Lucilia Amaral Dairy | 5520 Brooks | Merced | 95340 |
| 5B39NC00155 | 219 | Robert Moniz Dairy | 12770 Schulte | Tracy | 95377 |
| 5B34NC00010 | 219 | Harry Kneppel Dairy | 7816 Camp | Elk Grove | 95757 |
| 5D165150N01 | 220 | CLARENCE DUTRA DAIRY | 9887 FLINT | HANFORD | 93230 |
| 5C54NC00018 | 220 | L K RANCHES DAIRY | 29007 Road 56 | Visalia | 93277 |
| 5B50NC00206 | 220 | Arjen Zylstra Dairy | 3307 Blaker | Turlock | 95380 |
| 5B24NC00270 | 220 | Borba & Borba Dairy | 20755 River | Stevinson | 95374 |
| 5B34NC00015 | 224 | Pearson and Coupe Dairy | 11098 Boessow | Galt | 95632 |
| 5B24NC00189 | 225 | Banos Royal Farms | 15475 Henry Miller | Los Banos | 93635 |
| 5B50NC00042 | 225 | John Brasil Dairy #3 | 2642 Tuolumne | Ceres | 95307 |
| 5B24NC00148 | 230 | A&M Teixeira Dairy | 20777 Riverside | Hilmar | 95324 |
| 5C245022001 | 233 | Terra Dairy | 8988 Meadow | Winton | 95388 |
| 5C54NC00230 | 235 | TERRA LINDA HEIFERS | 23119 ROAD 44 | TULARE | 93274 |
| 5B50NC00202 | 235 | Gilbert Teixeira Dairy #2 | 2254 Eucalyptus | Patterson | 95363 |
| 5A11NC00040 | 237 | Manny Aguiar Dairy | 4628 County Rd P | Orland | 95963 |
| 5B50NC00251 | 240 | Azevedo Dairy | 5437 Main | Turlock | 95380 |
| 5B24NC00251 | 240 | Del Toro Dairy | 1730 Vassar | Merced | 95340 |
| 5C54NC00172 | 244 | FOUR K DAIRY (VACANT) | 5147 AVENUE 228 | TULARE | 93274 |
| 5C245007001 | 250 | Jose De Melo Dairy | 15049 Midway | Los Banos | 93635 |
| 5B50NC00303 | 250 | F & M Areias Dairy | 5855 Milnes | Modesto | |
| 5B24NC00072 | 250 | Fahey Dairy | 28326 Fahey | Gustine | 95322 |
| 5A34NC00031 | 250 | Double D Dairy | 6213 Eschinger | Elk Grove | 95757 |
| 5B34NC00013 | 250 | Van Steyn Dairy #3 | 8383 Lambert | Elk Grove | 95758 |
| 5B39NC00120 | 252 | John & Lisa Botelho Dairy | 10378 Airport | Manteca | 95336 |
| 5B50NC00261 | 254 | Mulder Dairy | 2230 Mitchell | Turlock | 95380 |
| 5B50NC00268 | 255 | Tony F. Gomes Dairy | 4218 Prairie Flower | Turlock | 95380 |
| 5C10NC00008 | 256 | CSUF DAIRY | 2415 San Ramon | FRESNO | 93740 |
| 5B50NC00158 | 256 | Ed Machado Dairy #2 | 5001 Shiloh | Modesto | 95358 |
| 5B50NC00274 | 260 | Joe Sousa Jr Dairy | 1519 Prairie Flower | Turlock | 95380 |
| 5B24NC00176 | 260 | Empty (was Tres Amigos Dairy) | 3737 Weir | Livingston | 95334 |
| 5B24NC00177 | 260 | Manuel & Carlos Bettencourt Dairy | 4100 Weir | Livingston | 95334 |
| 5D545096N01 | 261 | SUNNYVALE DAIRY | 2608 AVENUE 199 | TULARE | 93274 |

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| 5B395024001 | 265 | Faria Dairy #3 | 11495 Van Allen | Escalon | 95320 |
| 5B24NC00134 | 265 | Nelson Dairy | 19481 Geer | Hilmar | 95324 |
| 5B10NC00004 | 270 | CODERVIEW HOLSTEINS DAIRY | 40396 VALERIA | DOS PALOS | 93620 |
| 5C10NC00134 | 270 | VERWEY DAIRY | 12063 MANNING | FRESNO | 93706 |
| 5C10NC00091 | 270 | J & F MARTINS DAIRY #2 | 541 WOOD | LATON | 93242 |
| 5A11NC00029 | 271 | Silveira Jersteins Dairy | 6951 County Road 32 | Orland | 95963 |
| 5B50NC00039 | 273 | Germano & Jacinta Soares Dairy #2 | 2506 Taylor | Ceres | 95307 |
| 5B50NC00138 | 273 | L & L Pires Dairy | 7713 Maze | Modesto | 95358 |
| 5B50NC00197 | 275 | Manuel G Raulino Dairy | 9625 Warnerville | Oakdale | 95361 |
| 5B50NC00211 | 275 | Fmr: Joe Bettencourt Dairy | 9730 Bradbury | Turlock | 95380 |
| 5B24NC00067 | 275 | Lazy A Holsteins | 28336 Bambauer | Gustine | 95322 |
| 5A34NC00026 | 275 | Luis A Pimentel Dairy | 11375 Bruceville | Elk Grove | 95757 |
| 5B39NC00084 | 276 | Dasilva Dairy Farms LLC #2 | 24628 Mariposa | Escalon | 95320 |
| 5D545155N01 | 280 | SWEENEY DAIRY | 30712 ROAD 170 | VISALIA | 93292 |
| 5B24NC00048 | 280 | Melo Dairy | 11675 Laguna | Dos Palos | 93620 |
| 5B24NC00063 | 280 | Luis Correia Dairy | 11132 Schultz | El Nido | 95317 |
| 5B39NC00094 | 280 | Luis Dairy | 6519 Griffith | Marysville | 95901 |
| 5B24NC00113 | 280 | Joe Egli and Sons Dairy | 21810 August | Hilmar | 95324 |
| 5B24NC00147 | 280 | Antonio Silveira Dairy | 8187 Prairie Flower | Hilmar | 95324 |
| 5A34NC00033 | 280 | Pimentel Dairy | 11391 Franklin | Elk Grove | 95757 |
| 5A11NC00013 | 282 | Manuel Rocha Dairy | 4975 2nd | Orland | 95963 |
| 5A11NC00016 | 282 | Nick Beglinger Dairy | 7329 County Road 16 | Orland | 95963 |
| 5B24NC00292 | 285 | Antonio Cabral Dairy | 5968 Eucalyptus | Winton | 95388 |
| 5B24NC00042 | 288 | Jose & Teresa Soares Dairy #2 | 7581 Merced | Delhi | 95315 |
| 5C10NC00039 | 290 | DREAM DAIRY | 4050 North | Fresno | 93706 |
| 5B50NC00273 | 290 | A & G Azevedo Dairy | 536 Prairie Flower | Turlock | 95380 |
| 5B50NC00164 | 290 | Morris Jersey Girls Dairy | 3230 Vivian | Modesto | 95358 |
| 5B24NC00162 | 291 | Sousa Dairy | 18005 Williams | Hilmar | 95324 |
| 5A52NC00042 | 292 | Belo Dairy | 25115 Clark | Orland (Capay) | 95963 |
| 5C16NC00079 | 293 | D BRAZIL DAIRY | 9244 1 1/2 | HANFORD | 93230 |
| 5B50NC00174 | 293 | Formerly: Westside Holsteins | 807 Villa Manucha | Newman | 95360 |
| 5B24NC00101 | 293 | Former Praia Holsteins | 5672 Whitworth | Gustine | 95322 |
| 5C54NC00128 | 300 | DYT DAIRY | 15276 IVANHOE | VISALIA | 93291 |
| 5B50NC00207 | 300 | Gomes Heifer Ranch | 737 Blaker | Turlock | 95380 |
| 5B50NC00229 | 300 | Antonio Brasil Dairy | 818 Commons | Turlock | 95380 |
| 5B50NC00249 | 300 | J-S Jiminez Dairy | 3928 Linwood | Turlock | 95380 |
| 5B50NC00271 | 300 | Jim Vieira and Son Dairy #2 | 3100 Prairie Flower | Turlock | 95380 |
| 5B50NC00306 | 300 | Denizma Dairy / Bud Postma Dairy | 6249 Parker | Modesto | 95355 |
| 5B39NC00114 | 300 | J J J Dairy | 7575 Live Oak | Lodi | 95240 |
| 5B24NC00215 | 300 | Black Rascals Jerseys | 5733 Fox | Merced | 95340 |
| 5B50NC00154 | 300 | Double S Ranch | 2007 Redwood Rd | Modesto | 95351 |
| 5B50NC00103 | 301 | J-D Brasil Dairy | 5600 Clayton | Turlock | 95380 |
| 5C54NC00207 | 307 | DELTA VIEW #2 | 30297 ROAD 56 | VISALIA | 93291 |

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| 5C54NC00239 | 310 | PEREIRA DAIRY | 5780 AVENUE 296 | VISALIA | 93291 |
| 5A11NC00049 | 310 | Boer Dairy/ M&H Jerseys | 6355 County Rd 42 | Willows | 95988 |
| 5B50NC00247 | 315 | R & S Dairy | 9500 Linwood | Turlock | 95380 |
| 5B39NC00104 | 315 | Greendale Dairy | 8220 Liberty | Galt | 95632 |
| 5B39NC00058 | 317 | Faria Dairy | 8450 Jahant | Acampo | 95220 |
| 5C10NC00126 | 320 | FREA DAIRY LLC | 6205 Brawley | Fresno | 93706 |
| 5B39NC00129 | 320 | Manuel A Silveira Dairy | 28533 Two Rivers | Manteca | 95336 |
| 5B50NC00149 | 320 | Bento Bovine Dairy | 5612 Paradise | Modesto | 95358 |
| 5B50NC00307 | 325 | KB Dairy #1 | 5254 Langworth | Oakdale | 95361 |
| 5B24NC00024 | 329 | Tony and Judy Brasil Dairy | 2669 Hull | Atwater | 95301 |
| 5C10NC00110 | 330 | GOLDEN GENES DAIRY | 15669 VALENTINE | CARUTHERS | 93609 |
| 5B50NC00190 | 330 | KB Dairy #2 | 5237 Langworth | Oakdale | 95361 |
| 5B395026001 | 330 | Pires Dairy | 23800 Jack Tone | Acampo | 95220 |
| 5B39NC00079 | 330 | Brasil and Sons Dairy No 2 | 21768 Lone Tree | Escalon | 95320 |
| 5B24NC00181 | 330 | Den-K Holsteins, Inc. | 13235 Baker | Los Banos | 93635 |
| 5C54NC00179 | 333 | JERSEY SKY DAIRY | 3926 Avenue 232 | Tulare | 93274 |
| 5B24NC00313 | 333 | Antero Borges Dairy | 2226 Hull | Atwater | 95301 |
| 5B50NC00223 | 334 | King Dairy | 5524 Central | Turlock | 95380 |
| 5B50NC00187 | 335 | W & J Dairy | 12100 Fogarty | Oakdale | 95361 |
| 5B24NC00197 | 335 | Soares Dairy Farms, Inc. | 21948 Pioneer | Los Banos | 93635 |
| 5A11NC00050 | 339 | Gomes Holstein Dairy, Inc. | 2397 County Rd R | Willows | 95988 |
| 5B24NC00050 | 339 | M& A Dairy #2 | 13459 Turner Island | Dos Palos | 93620 |
| 5B39NC00123 | 339 | Bettencourt & Borges Dairy | 10700 Louise | Manteca | 95336 |
| 5A31NC00022 | 340 | FG Dairy/ Frank G Machado Dairy | 6241 Catlett | Lincoln | 95648 |
| 5A115000001 | 340 | Couto Dairy | 1980 County Rd QQ | Willows | 95988 |
| 5B24NC00088 | 340 | Oliviera Dairy | 28399 Husman | Gustine | 95322 |
| 5B24NC00217 | 340 | JSJ Farms Dairy | 3874 Franklin | Merced | 95348 |
| 5B34NC00021 | 340 | Cardoso Dairy | 10380 Kost | Galt | 95632 |
| 5B24NC00092 | 345 | Luis T Sousa Dairy | 10860 Ingomar Grade | Gustine | 95322 |
| 5B39NC00135 | 345 | Gawne Organic Dairy | 17463 Gawne | Stockton | 95205 |
| 5B24NC00271 | 345 | Dias Family Dairy | 21330 Second | Stevinson | 95374 |
| 5B24NC00274 | 345 | Azevedo Organics | 22368 Second | Stevinson | 95374 |
| 5C16NC00124 | 350 | JERSEY JUNCTION DAIRY | 16831 JACKSON | LEMOORE | 93245 |
| 5D165051N01 | 350 | SOZINHO DAIRY #3 | 11235 8 1/2 | HANFORD | 93230 |
| 5C54NC00241 | 350 | SANTA ANITA DAIRY | 5792 Avenue 248 | Tulare | 93274 |
| 5C245013001 | 350 | Maria Silveira Dairy | 10511 Ingomar Grade | Gustine | 95322 |
| 5B395023001 | 350 | M & M Moules Dairy | 12951 Harney | Lodi | 95240 |
| 5B39NC00064 | 350 | Vander Meulen Dairy | 20250 Avena | Escalon | 95320 |
| 5B24NC00218 | 350 | Xaiver Cattle-Holsteins | 2892 Gurr | Atwater | 95301 |
| 5B24NC00297 | 352 | Hultgren Dairy | 8878 Palm | Winton | 95388 |
| 5A11NC00019 | 357 | Melo Dairy | 7399 County Rd 21 | Orland | 95963 |
| 5B50NC00105 | 357 | Coelho Dairy | 3130 De Witt | Modesto | 95357 |
| 5B24NC00293 | 357 | Cardoso Dairy | 2720 Kenney | Winton | 95388 |

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| 5B50NC00212 | 358 | McFarlane Farms | 1424 Bradbury | Turlock | 95380 |
| 5B50NC00253 | 360 | Arlinda Holsteins | 6325 Main | Turlock | 95380 |
| 5B50NC00308 | 360 | Fire Lakes Jerseys | 11301 Bradbury | Turlock | 95380 |
| 5A34NC00024 | 360 | J & M Dairy | 11910 Bruceville | Elk Grove | 95757 |
| 5B24NC00133 | 365 | J L B DAIRY | 7884 Faith Home | Hilmar | 95324 |
| 5B34NC00026 | 365 | Van Steyn Dairy No. 2 | 13039 Pellandini | Galt | 95632 |
| 5D105032N01 | 370 | J & F COELHO DAIRY | 5614 BLYTHE | FRESNO | 93706 |
| 5C54NC00066 | 370 | DEL OASIS DAIRY | 32210 ROAD 92 | VISALIA | 93291 |
| 5C245033001 | 370 | MDC Dairy | 11071 Youngstown | Turlock | 95380 |
| 5B39NC00065 | 370 | Fragoso Dairy #2 | 13845 Brennan | Escalon | 95320 |
| 5B24NC00078 | 370 | Rego Dairy #2 | 6255 Haley | Gustine | 95322 |
| 5B24NC00107 | 370 | Dominic and Mary Coelho Dairy | 20775 American | Hilmar | 95324 |
| 5B39NC00136 | 370 | Manuel & Maria Silva Dairy | 15420 Hwy 4 | Stockton | 95215 |
| 5C10NC00129 | 375 | MEDEIROS HEIFER RANCH | 1253 LEWISTON | RIVERDALE | 93656 |
| 5A04NC00035 | 375 | Schroer Diary (Sierra Rose) | 8984 Aguas Frias | Chico | 95928 |
| 5C54NC00240 | 380 | Vacant Dairy | 2946 TULARE | TULARE | 93274 |
| 5D165101N01 | 380 | MATTOS DAIRY #4 | 4555 KANSAS | HANFORD | 93230 |
| 5B24NC00061 | 380 | Antonio Azevedo Dairy #4 | 1257 Roosevelt | El Nido | 95317 |
| 5B24NC00099 | 380 | Rego Dairy #1 | 30747 Snyder | Gustine | 95322 |
| 5C54NC00137 | 385 | DOUBLE M JERSEYS DAIRY | 11595 AVENUE 164 | TIPTON | 93272 |
| 5B39NC00068 | 385 | M & A Dairy, LP | 14691 Brennan | Escalon | 95320 |
| 5B50NC00272 | 390 | Johal Dairy | 315 Prairie Flower | Turlock | 95380 |
| 5B24NC00105 | 390 | Ahlem West Dairy | 25511 American | Hilmar | 95322 |
| 5B50NC00022 | 390 | John C Rocha & Son Dairy | 718 Barnhart | Ceres | 95307 |
| 5B50NC00160 | 390 | W-D Ranch, Inc. | 137 Texas | Modesto | 95358 |
| 5B39NC00082 | 391 | John & Dan Vierra Dairy | 22075 Lone Tree | Escalon | 95320 |
| 5C205006001 | 395 | CABRAL DAIRY | 8612 ROAD 24 | MADERA | 93637 |
| 5B24NC00121 | 395 | Bill R Sousa Dairy | 7126 Central | Hilmar | 95324 |
| 5D165140N01 | 400 | ANTHONY & ROBERT BRAZIL DAIRY/SUNSHINE DAIRY | 13419 7TH | HANFORD | 93230 |
| 5C54NC00155 | 400 | FARIA & SONS DAIRY | 2507 SHIRK | VISALIA | 93277 |
| 5C245042001 | 400 | Joe Gomes Dairy #1 (Swanson Rd) | 17265 Swanson | Delhi | 95315 |
| 5B395009001 | 400 | Doornenbal Dairy #2 | 16348 Van Allen | Escalon | 95320 |
| 5B50NC00293 | 400 | WD Dairy | 843 Helena | Waterford | 95386 |
| 5B24NC00080 | 400 | Lima Dairy / A & L Dairy | 28471 Hulen | Gustine | 95322 |
| 5B24NC00091 | 400 | Praia Dairy | 5245 Hwy 33 | Gustine | 95322 |
| 5B39NC00139 | 400 | E & R Prins Dairy #2 | 9863 Van Allen | Stockton | 95215 |
| 5A345002001 | 400 | Carmo Dairy | 10775 Franklin | Elk Grove | 95757 |
| 5B34NC00033 | 401 | B & J Dairy | 10300 Dillard | Winton | 95693 |
| 5B39NC00116 | 404 | Van Exel Dairy #2 | 18948 Thornton | Lodi | 95242 |
| 5B50NC00222 | 405 | Dave Chaves Dairy | 6006 Central | Turlock | 95380 |
| 5B50NC00110 | 405 | G3 Enterprises | 9323 Dusty | Modesto | 95357 |
| 5B24NC00114 | 412 | Nascimento J & M Dairy | 23970 August | Hilmar | 95324 |
| 5B24NC00227 | 412 | Oak Valley Dairy | 13656 Hwy 59 | Merced | 95348 |

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| 5B39NC00074 | 415 | C.G. Van Vliet Dairy | 30158 Hwy 120 | Escalon | 95320 |
| 5B39NC00119 | 420 | Brasil & Machado Dairy #2 | 23400 Airport | Manteca | 95337 |
| 5B39NC00103 | 424 | Brooks & Erman Ranch | 25873 Kennefick | Galt | 95632 |
| 5B39NC00151 | 425 | Joe L Pimentel Dairy | 20246 Lammers | Tracy | 95304 |
| 5C54NC00142 | 428 | KNEVELBAARD DAIRY | 14229 AVENUE 228 | TULARE | 93274 |
| 5C245012001 | 430 | Luis C Nunes & Sons Dairy #2 | 10268 Hwy 33 | Gustine | 95322 |
| 5B50NC00244 | 430 | Sam Koostra Dairy | 5837 Hultberg | Turlock | 95380 |
| 5B50NC00040 | 430 | JNM Dairy | 2912 Taylor | Ceres | 95307 |
| 5B24NC00047 | 434 | O'Banion Ranches | 15775 Indiana | Dos Palos | 93620 |
| 5B24NC00275 | 435 | A-C Vierra Dairy #2 | 4971 Van Clief | Stevinson | 95374 |
| 5B24NC00269 | 438 | 3 D Dores Dairy | 20751 River | Stevinson | 95374 |
| 5B24NC00249 | 440 | George Nunes Dairy | 3105 Trindade | Atwater | 95301 |
| 5C10NC00043 | 441 | ASTIASUAIN DAIRY | 22654 JEFFERSON | REEDLEY | 93654 |
| 5B24NC00077 | 443 | Tony Oliviera Jr. Dairy | 27506 Gun Club | Gustine | 95322 |
| 5B50NC00090 | 443 | Carl Ott & Sons Dairy | 2437 Baker | Modesto | 95358 |
| 5C54NC00267 | 450 | FOUR STAR DAIRY #3 | 2393 AVENUE 224 | TULARE | 93274 |
| 5A52NC00027 | 450 | Martin Dairy | 21632 Dusty | Red Bluff | 96080 |
| 5C245043001 | 450 | Sousa Dairy | 22578 Henry Miller | Los Banos | 95635 |
| 5B24NC00084 | 450 | P&D Dairy West | 29633 Husman | Gustine | 95322 |
| 5B39NC00085 | 450 | Da Silva Dairy Farms, LLC #3 | 24197 Mariposa | Escalon | 95320 |
| 5B24NC00194 | 450 | Luis Dairy Mercey Springs | 21750 Mercey Springs | Los Banos | 93635 |
| 5C54NC00196 | 455 | MENDONCA DAIRY | 17641 I | TULARE | 93274 |
| 5B10NC00005 | 455 | TRIPLE F DAIRY | 41883 MERRILL | DOS PALOS | 93620 |
| 5B395010001 | 455 | Rui & Jennifer Brasil Dairy | 29094 Lemon | Escalon | 95320 |
| 5B50NC00289 | 455 | John Thomas Dairy | 10408 Bradbury | Turlock | 95380 |
| 5B39NC00137 | 455 | J & M Silveira Dairy | 5710 Jack Tone | Stockton | 95215 |
| 5C54NC00057 | 460 | TIERSMA DAIRY | 9232 Avenue 320 | VISALIA | 93291 |
| 5B50NC00179 | 460 | Ardis Farms | 9402 Alvarado | Oakdale | 95761 |
| 5B50NC00186 | 460 | Furtado Dairy #1 | 5507 Ellenwood | Oakdale | 95361 |
| 5B24NC00118 | 460 | Joe Gomes Dairy #2(Bloss Rd) | 23839 Bloss | Hilmar | 95324 |
| 5B50NC00084 | 460 | F & M Areias Dairy | 1030 Albers | Modesto | 95357 |
| 5B50NC00143 | 460 | John Bos Dairy | 4524 Milnes | Modesto | 95357 |
| 5B24NC00140 | 463 | Silveira Dairy, Inc. | 20271 Johnson | Hilmar | 95324 |
| 5B50NC00263 | 465 | Former Avila Dairy | 539 Morgan | Turlock | 95380 |
| 5B24NC00187 | 465 | Robert L Silva Dairy | 20508 Cotton | Los Banos | 93635 |
| 5C10NC00080 | 467 | COUTO DAIRY | 4870 DAVIS | RIVERDALE | 93656 |
| 5B39NC00128 | 469 | Brasil and Machado Dairy | 6052 Trahern | Manteca | 95337 |
| 5D545134N01 | 470 | VIDA BOA #2 DAIRY | 15011 AVENUE 240 | TULARE | 93274 |
| 5B50NC00089 | 470 | Diamond O Dairy | 2743 Baker | Modesto | 95358 |
| 5B50NC00277 | 472 | Da Rosa Dairy | 1131 Story | Turlock | 95380 |
| 5B39NC00110 | 472 | Frank Chaves & Sonsa Dairy #1 | 13080 Harney | Lodi | 95240 |
| 5B50NC00044 | 472 | Jose Avila Dairy | 6001 Zeering | Ceres | 95307 |
| 5B50NC00262 | 475 | Joe Borba Dairy, Inc. | 3431 Moffett | Turlock | 95380 |

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| 5B39NC00091 | 475 | Salvador Dairy | 17782 Seidner | Escalon | 95320 |
| 5B24NC00142 | 475 | Live Oak Dairy | 21052 Johnson | Hilmar | 95324 |
| 5D545128001 | 477 | JOE C. PIRES, JR., DAIRY | 13806 Ave 152 | TIPTON | 93272 |
| 5B24NC00124 | 477 | Deoclecio Silveira & Son Dairy | 6271 Columbus | Hilmar | 95324 |
| 5C16NC00044 | 480 | FRANCISCO RIBEIRO DAIRY | 6505 10TH | HANFORD | 93230 |
| 5B50NC00177 | 480 | Manuel Furtado Dairy #2 | 11070 Alvarado | Oakdale | 95361 |
| 5B50NC00194 | 480 | Fmr. Nelson Silveira Dairy | 6133 Smith | Oakdale | 95361 |
| 5C16NC00088 | 483 | ED PAULO & SONS DAIRY | 13245 9th | HANFORD | 93230 |
| 5B50NC00067 | 483 | Ray-Lin Dairy | 5712 Hickman | Denair | 95316 |
| 5B24NC00295 | 483 | Jose C. Pereira Dairy | 3470 Oakdale | Winton | 95388 |
| 5B24NC00298 | 483 | Matos Dairy | 7660 Palm | Winton | 95388 |
| 5C54NC00209 | 486 | A & L DAIRY | 23863 ROAD 48 | TULARE | 93274 |
| 5C16NC00053 | 490 | BRASIL DAIRY | 4998 EXCELSIOR | HANFORD | 93230 |
| 5A345100001 | 490 | Joe Avis Dairy | 4400 Point Pleasant | Elk Grove | 95757 |
| 5B395054001 | 491 | Morris Dairy | 8892 Van Allen | Stockton | 95215 |
| 5C54NC00152 | 495 | F & F Heifers | 25897 ROAD 108 | TULARE | 93274 |
| 5C54NC00268 | 500 | CURTI FAMILY FARMS | 19493 ROAD 30 | TULARE | 93274 |
| 5C54NC00184 | 500 | GREEN OAKS DAIRY | 4125 AVENUE 236 | TULARE | 93274 |
| 5C54NC00186 | 500 | ALVIN SOUZA DAIRY #2 | 20795 Road 52 | Tulare | 93274 |
| 5B10NC00006 | 500 | WILLIAM HUNGER RANCHES DAIRY | 18146 DIXON | DOS PALOS | 93620 |
| 5B20NC00011 | 500 | VITORIA FARMS DAIRY | 12433 Avenue 24 | CHOWCHILLA | 93610 |
| 5A52NC00043 | 500 | Brentwood Farms Dairy | 24540 Clark | Orland (Capay) | 95963 |
| 5A11NC00035 | 500 | Martins Family Dairy | 4489 County Rd E | Orland | 95963 |
| 5B50NC00183 | 500 | Crane Villa Dairy | 6624 Crane | Oakdale | 95361 |
| 5B50NC00214 | 500 | Groppetti Dairy | 11601 Simmerhorn | Galt | 95632 |
| 5B50NC00242 | 500 | A & C Azevedo Dairy | 207 Holland | Turlock | 95380 |
| 5B50NC00250 | 500 | John Nunes Dairy #2 | 4207 Linwood | Turlock | 95380 |
| 5B395049001 | 500 | RELM Dairy | 6721 Perrin | Manteca | 95337 |
| 5B24NC00028 | 500 | Jorge Dairy | 10358 White Crane | Atwater | 95301 |
| 5B24NC00085 | 500 | P & D Dairy | 28209 Husman | Gustine | 95322 |
| 5B24NC00141 | 506 | Jade Jersey Dairy | 20326 Johnson | Hilmar | 95324 |
| 5B50NC00137 | 506 | De Carvalho Brothers Dairy | 8342 Maze | Modesto | 95358 |
| 5C54NC00123 | 509 | FM RANCH #3 | 1474 HIGHWAY 99 | TIPTON | 93272 |
| 5B39NC00093 | 509 | Holmes Brothers Dairy | 16048 Sexton | Escalon | 95320 |
| 5B24NC00152 | 509 | Wickstrom Brothers Dairy | 7706 Tegner | Hilmar | 95324 |
| 5C16NC00070 | 510 | MENDES & TOSTE WEST DAIRY | 23568 FARGO | LEMOORE | 93245 |
| 5A52NC00035 | 510 | Poldervaart Dairy | Post | Orland (Capay) | 95607 |
| 5B50NC00228 | 510 | Five Star Dairy #2 | 5324 Clayton | Turlock | 95380 |
| 5B50NC00297 | 510 | Lockwood III Dairy | 15343 Tim Bell | Waterford | 95386 |
| 5B24NC00059 | 510 | Pedretti Ranches | 2331 Roosevelt | El Nido | 95317 |
| 5B39NC00148 | 510 | John Borges Dairy | 25834 Kasson | Tracy | 95304 |
| 5B50NC00081 | 510 | Mensonides Dairy | 8730 Keyes | Hughson | 95326 |
| 5B50NC00130 | 510 | A & M Azevedo Dairy | 5454 Keyes | Modesto | 95358 |

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| 5B50NC00151 | 515 | Furtado Farms, Inc. | 3449 Paradise | Modesto | 95358 |
| 5B34NC00028 | 516 | Joe Vitoria Dairy | 13340 Sargent | Galt | 95632 |
| 5B39NC00060 | 517 | Matos Brothers Dairy | 26857 Ritz | Acampo | 95220 |
| 5B24NC00282 | 518 | John M. Azevedo Dairy | 20167 Fowler | Turlock | 95380 |
| 5C16NC00072 | 520 | JOE L. DIAS & SON DAIRY | 12700 7th | HANFORD | 93230 |
| 5B50NC00286 | 520 | John Nunes Dairy #1 | 1318 Washington | Turlock | 95380 |
| 5B24NC00051 | 520 | Antonio Azevedo | 11775 Arbor | El Nido | 95317 |
| 5B39NC00113 | 520 | Fialho & Sons Dairy | 13310 Kettlemen | Lodi | 95240 |
| 5C505022001 | 525 | Gil Tex Dairy | 5601 Mountain View | Turlock | 95382 |
| 5B50NC00203 | 525 | Azevedo Dairy, Inc. | 1343 Magnolia | Patterson | 95363 |
| 5B39NC00138 | 525 | A. B. Brazil Dairy | 18338 Mariposa | Stockton | 95215 |
| 5A34NC00025 | 525 | Duarte Family Dairy | 11711 Bruceville | Elk Grove | 95757 |
| 5B24NC00279 | 525 | QMS Dairy | 18851 Clausen | Turlock | 95380 |
| 5B24NC00139 | 528 | B & D Dairy | 9579 Hultberg | Hilmar | 95324 |
| 5C245011001 | 529 | M & A Dairy | 14651 Carlucci | Dos Palos | 93620 |
| 5C54NC00117 | 530 | FRANCO & SONS DAIRY #1 | 14111 AVENUE 220 | TULARE | 93274 |
| 5B24NC00150 | 530 | Ken Van Foeken Dairy | 22338 Short | Hilmar | 95324 |
| 5B50NC00140 | 530 | Pinecrest Jersey Farm | 4318 Mc Gee | Modesto | 95357 |
| 5C20NC00012 | 531 | BANOS DAIRY | 4667 AVENUE 23 1/2 | CHOWCHILLA | 93610 |
| 5B50NC00170 | 531 | Monster Dairy | 1054 Lundy | Newman | 95360 |
| 5B24NC00029 | 533 | Full Circle Dairy | 6800 East | Ballico | 95303 |
| 5B50NC00176 | 535 | Brum De Visser Dairy | 4500 Albers | Oakdale | 95361 |
| 5B50NC00280 | 535 | Lorinda Dairy | 619 Vincent | Turlock | 95380 |
| 5A34NC00027 | 535 | G. Simoes Dairy, Inc. | 11768 Carroll | Elk Grove | 95757 |
| 5B50NC00276 | 536 | Boer Jersey Dairy | 501 Story | Turlock | 95380 |
| 5B39NC00125 | 536 | Van Rys Dairy | 13293 Louise | Manteca | 95336 |
| 5C54NC00052 | 540 | FM RANCH #4 | 18354 Avenue 304 | VISALIA | 93292 |
| 5B20NC00045 | 540 | ANDRADE DAIRY | 10221 AVENUE 21 1/2 | CHOWCHILLA | 93610 |
| 5A11NC00014 | 540 | Vogts Holstein Dairies #1 | 7831 Capay | Orland | 95963 |
| 5B395033001 | 540 | Jose H. Correia Dairy | 24586 Lone Tree | Escalon | 95320 |
| 5B39NC00059 | 540 | Kooyman & Son Dairy | 6787 Jahant | Acampo | 95220 |
| 5B39NC00102 | 540 | Toledo Dairy | 26222 Elliott | Galt | 95632 |
| 5B24NC00198 | 540 | O & L Dairy | 22678 Pioneer | Los Banos | 93635 |
| 5B50NC00156 | 540 | Willem Postma Dairy #2 | 3250 Santa Fe | Modesto | 95357 |
| 5B50NC00157 | 540 | P.M.B. Dairy | 2248 Service | Modesto | 95358 |
| 5B34NC00014 | 540 | Cal-Denier Dairy LLC | 10715 Arno | Galt | 95632 |
| 5C54NC00108 | 545 | COITO DAIRY | 12735 AVENUE 192 | TULARE | 93274 |
| 5B395040001 | 545 | Stuyt Dairy | 22000 Mariposa | Escalon | 95320 |
| 5B50NC00038 | 546 | Salvador Dairy (Monte Vista Rd) | 1331 Monte Vista | Ceres | 95307 |
| 5C54NC00083 | 547 | FERNJO DAIRY #3 | 14213 AVENUE 232 | TULARE | 93274 |
| 5B50NC00281 | 547 | J & R Areias Dairy | 1109 Vincent | Turlock | 95380 |
| 5D165054N01 | 550 | MEMORARE DAIRY | 17250 MEDFORD | STRATFORD | 93266 |
| 5D545164N01 | 550 | SHIRK DAIRY | 2820 SHIRK | VISALIA | 93277 |

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| 5A11NC00011 | 550 | Simson Dairy | 2945 County Rd V | Orland | 95963 |
| 5B50NC00189 | 550 | Langworth Dairy | 5306 Langworth | Oakdale | 95361 |
| 5B39NC00075 | 550 | Doornenbal Dairy #3 | 19325 Lone Tree | Escalon | 95320 |
| 5B24NC00155 | 551 | Silva Dairy Farms #1 | 20633 Turner | Hilmar | 95324 |
| 5B24NC00126 | 552 | Diniz Dairy | 9558 Columbus | Hilmar | 95324 |
| 5C10NC00001 | 554 | TNT DAIRY | 20800 EXCELSIOR | RIVERDALE | 93656 |
| 5C54NC00020 | 555 | SUNSET DAIRY | 29049 Road 68 | VISALIA | 93277 |
| 5B39NC00163 | 555 | Fragoso Dairy | 14089 Brennan | Escalon | 95320 |
| 5B24NC00186 | 555 | Carlos and Deolinda Lopes Trust Dairy | 17273 Cotton Gin | Los Banos | 93635 |
| 5D165100001 | 557 | TONY COX & FAMILY DAIRY | 3594 12 3/4 AVENUE | HANFORD | 93230 |
| 5C54NC00210 | 560 | AC ENTERPRISES DAIRY | 15499 ROAD 72 | TIPTON | 93272 |
| 5C16NC00050 | 560 | DUTRA & DUTRA DAIRY | 7480 5TH | HANFORD | 93230 |
| 5C245034001 | 560 | PH Ranch #3 | 11586 Shaffer | Winton | 95388 |
| 5B50NC00193 | 560 | River Oak Dairy | 5831 River | Oakdale | 95361 |
| 5B39NC00146 | 560 | Empty (was Ferreira & Silva Dairy) | 6204 Grant Line | Tracy | 95304 |
| 5B24NC00165 | 560 | Clover Prairie Farms | 22682 Williams | Hilmar | 95324 |
| 5B50NC00104 | 560 | Alexander Dairy | 2054 Crawford | Modesto | 95355 |
| 5B24NC00062 | 569 | Hath Dairy | 508 Roosevelt | El Nido | 95317 |
| 5C205021001 | 570 | EUGENIO AZEVEDO DAIRY #2 | 24699 AVENUE 11 | MADERA | 93637 |
| 5C16NC00045 | 570 | MANUEL GASPAR & SON DAIRY | 7801 7 1/2 | HANFORD | 93230 |
| 5C245024003 | 570 | Tavares Farms Family Trust Dairy | 1192 Gerard | Merced | 95340 |
| 5B50NC00142 | 570 | John Boere Dairy | 8973 Milnes | Modesto | 95355 |
| 5B50NC00184 | 572 | 6-X Dairy #2 | 6960 Crane | Oakdale | 95361 |
| 5C16NC00121 | 573 | SALT OF THE EARTH DAIRY | 19883 LAUREL | STRATFORD | 93266 |
| 5A11NC00036 | 574 | Schager Dairy | 4924 County Rd KK | Orland | 95963 |
| 5B50NC00246 | 574 | Vitorino & Sons Dairy | 3918 Kilroy | Turlock | 95380 |
| 5D165067N01 | 575 | RANCHO DEL SOL DAIRY | 13301 9TH AVENUE | HANFORD | 93230 |
| 5D105029001 | 575 | KYLE MEDEIROS DAIRY | 19436 EAST | LATON | 93242 |
| 5A11NC00021 | 575 | Bekendam Dairy | 6314 County Rd 24 | Orland | 95963 |
| 5B50NC00216 | 575 | S A S Dairy #2 | 12712 Bradbury | Turlock | 95380 |
| 5B395019001 | 575 | D J Caton Dairy | 15634 Steingul | Escalon | 95320 |
| 5B24NC00086 | 575 | Anthony L. Lopes Jr. Dairy | 28366 Husman | Gustine | 95322 |
| 5B50NC00043 | 575 | Nelson Farms | 5931 Tuolumne | Ceres | 95307 |
| 5B50NC00062 | 575 | K & R Blount Dairy | 724 Ruble | Crows Landing | 95313 |
| 5B34NC00031 | 575 | Ernie Moules Dairy | 12406 Clay Station | Herald | 95638 |
| 5D155078N01 | 579 | MCFARLAND DAIRY | 31348 HANAWALT | MCFARLAND | 93250 |
| 5D165061001 | 580 | 4-C's DAIRY #1 | 10482 14 1/2 | LEMOORE | 93245 |
| 5D165079001 | 580 | GALHANDRO DAIRY | 9240 19 1/2 | LEMOORE | 93245 |
| 5C16NC00001 | 580 | WHITE RIVER DAIRY | 20784 Laurel | Stratford | 93266 |
| 5C54NC00119 | 580 | BLUEGRASS DAIRY | 1260 Mariposa | Visalia | 93291 |
| 5C16NC00049 | 580 | VITOR BORBA DAIRY | 7410 7TH | HANFORD | 93230 |
| 5A11NC00010 | 580 | Alves Dairy | 2439 County | Glenn | 95943 |
| 5B50NC00243 | 580 | Eleanor Brindeiro Dairy | 5612 Hultberg | Turlock | 95380 |

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| 5B24NC00112 | 585 | Broder Farms | 22245 August | Hilmar | 95324 |
| 5B24NC00290 | 585 | Machado Gabriel & Sons Dairy | 12464 Vincent | Turlock | 95380 |
| 5B50NC00152 | 585 | A P Avila and Sons Dairy | 8178 Paradise | Modesto | 95358 |
| 5B39NC00073 | 586 | Manuel Da Silva Dairy (Henry Rd) | 16551 Henry | Escalon | 95320 |
| 5C16NC00047 | 590 | D & E DAIRY | 6780 Excelsior | Hanford | 93230 |
| 5B50NC00260 | 590 | John Brasil Dairy #3 | 1707 Mitchell | Turlock | 95380 |
| 5B50NC00023 | 590 | Frank M Silva Dairy | 300 Barnhart | Ceres | 95307 |
| 5C16NC00081 | 595 | DUTRA DAIRY | 6398 16th | HANFORD | 93230 |
| 5B24NC00220 | 595 | Tony Meirinho and Sons Dairy #3 | 4890 Healy | Merced | 95340 |
| 5B20NC00019 | 600 | TONY MACHADO DAIRY | 13611 Avenue 23 1 /2 | CHOWCHILLA | 93610 |
| 5C10NC00100 | 600 | JOE D. COELHO DAIRY | 6503 WEST | FRESNO | 93706 |
| 5C245024001 | 600 | Frank S Dores & Sons Dairy | 25469 Hearst | Gustine | 95322 |
| 5B50NC00215 | 600 | Carlos Estacio & Sons Dairy | 8900 Bradbury | Turlock | 95380 |
| 5B395030001 | 600 | Uly Mendoza's Dairy | 8940 Melton | Manteca | 95337 |
| 5B50NC00270 | 600 | San Isidro Supercross Jersey | 4413 Prairie Flower | Turlock | 95380 |
| 5B39NC00122 | 600 | J. Meneses & Sons Dairy | 12477 Jameson | Manteca | 95336 |
| 5B24NC00175 | 600 | Gallo Bamboo Dairy | 2363 N Howard | Livingston | 95334 |
| 5B50NC00119 | 600 | Meikle Ranch | 1685 Hart | Modesto | 95358 |
| 5C16NC00051 | 603 | SILVA & SON DAIRY | 8331 EXCELSIOR | HANFORD | 93230 |
| 5B50NC00037 | 604 | Trinkler / Sinclear Dairy | 1001 Monte Vista | Ceres | 95307 |
| 5C16NC00059 | 606 | PAULO HOLSTEINS DAIRY | 8161 Iona | Hanford | 93230 sold out |
| 5B395032001 | 607 | Tony Borba Dairy, Inc. | 23844 Dodds | Escalon | 95320 |
| 5A11NC00041 | 608 | Zuppan Dairy | 4740 County Rd QQ | Orland | 95963 |
| 5A11NC00009 | 609 | Pinheiro & Deniz Dairy | 2630 County Rd T | Glenn | 95943 |
| 5B50NC00256 | 610 | Carl & Laurie Vieira Dairy | 1518 Mitchell | Turlock | 95381 |
| 5B50NC00020 | 613 | Luis Azevedo Dairy | 8407 Mitchell | Ceres | 95307 |
| 5B24NC00044 | 615 | California Cloverleaf Farm | 22323 Monte Vista | Denair | 95316 |
| 5B24NC00128 | 617 | P & L Souza Dairy | 20633 Crane | Hilmar | 95324 |
| 5A52NC00038 | 620 | Alston Dairy 1 | 1010 Hwy 99W | Orland | 95963 |
| 5B24NC00075 | 620 | J & A Dairy | 29687 Fentem | Gustine | 95322 |
| 5B50NC00033 | 620 | Jemdale Holsteins | 10218 Fulkerth | Ceres | 95307 |
| 5B50NC00091 | 620 | Wyeth Dairy, Inc. | 7319 Beckwith | Modesto | 95358 |
| 5B50NC00267 | 621 | Jim Vieira & Son Dairy | 2401 Newman | Turlock | 95380 |
| 5D165106N01 | 623 | THOMAS DAIRY | 20111 EXCELSIOR | RIVERDALE | 93656 |
| 5B24NG00160 | 623 | D & E Jerseys | 9375 Washington | Hilmar | 95324 |
| 5B24NC00129 | 624 | Silva Dairy Farms #2 | 20316 Crane | Hilmar | 95324 |
| 5B50NC00057 | 625 | Morris Family Enterprises Dairy | 836 Linwood | Crows Landing | 95313 |
| 5B20NC00033 | 630 | HANSEN & SONS DAIRY | 13348 AVENUE 20 | CHOWCHILLA | 93610 |
| 5A51NC00013 | 630 | Van Warmerdam Dairy (Cornelius Ave) | 1616 Cornelius | Nicolaus | 95659 |
| 5B24NC00245 | 630 | T & C Louters Dairy | 921 Sandy Mush | Merced | 95341 |
| 5B50NC00080 | 630 | John Jorge Dairy | 3031 Berkeley | Hughson | 95326 |
| 5B39NC00150 | 632 | Ornellas Dairy #1 | 20749 Lammers | Tracy | 95304 |
| 5B39NC00070 | 633 | Pereira Dairy | 27181 Carter | Escalon | 95320 |

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| 5B20NC00044 | 634 | DR DAIRY | 16554 ROAD 9 | CHOWCHILLA | 93610 |
| 5B50NC00146 | 635 | Art Silva Dairy | 5201 Milnes | Modesto | 95357 |
| 5C54NC00201 | 640 | LEGACY DAIRY | 20385 ROAD 36 | TULARE | 93274 |
| 5C54NC00191 | 640 | RIBEIRO JERSEYS DAIRY | 2865 WEST PROSPERITY | TULARE | 93274 |
| 5B24NC00159 | 640 | Branco Dairy | 7965 Washington | Hilmar | 95324 |
| 5C16NC00119 | 645 | CUNHA DAIRY #1 | 6680 16th | HANFORD | 93230 |
| 5C16NC00024 | 645 | FAGUNDES AGRIBUSINESS DAIRY | 7546 8 1/2 | Hanford | 93230 |
| 5B24NC00208 | 649 | Azevedo Dairy | 238 Buhach | Merced | 95342 |
| 5C245039001 | 650 | Flores Dairy | 1935 Youd | Winton | 95388 |
| 5B34NC00011 | 650 | Van Steyn Dairy | 11823 Carroll | Elk Grove | 95757 |
| 5B50NC00145 | 650 | 6-X #1 Dairy | 9848 Milnes | Modesto | 95357 |
| 5B50NC00173 | 651 | Antone L Gomes and Sons Dairy | 519 Stuhr | Newman | 95360 |
| 5D545012N01 | 655 | JOHN MENDONCA & SON DAIRY | 2785 COLPIEN | TULARE | 93274 |
| 5B24NC00027 | 655 | Jose & Teresa Soares Dairy #3 | 9780 Sunset | Atwater | 95301 |
| 5C16NC00118 | 657 | PAULO BROTHERS DAIRY | 8730 IONA | HANDFORD | 93230 |
| 5C15NC00042 | 659 | F & J DELANO #2 DAIRY | 12876 HIETT AVE | MCFARLAND | 93250 |
| 5B50NC00235 | 660 | D & M Dairy | 4419 Faith Home | Turlock | 95380 |
| 5B50NC00255 | 660 | Carl Vieira Dairy | 1101 Mitchell | Turlock | 95380 |
| 5B50NC00257 | 660 | Machado Dairy | 7413 Mitchell | Turlock | 95380 |
| 5B24NC00073 | 660 | Vio-Mar Dairy | 28543 Fahey | Gustine | 95322 |
| 5B24NC00087 | 660 | Luis C Nunes and Sons Dairy #1 | 29191 Husman | Gustine | 95322 |
| 5B24NC00211 | 661 | Manuel and Maria Azevedo Dairy | 3493 BVD | Merced | 95348 |
| 5B24NC00248 | 661 | Larry Silveira Dairy | 3301 Thrift | Merced | 95340 |
| 5B24NC00250 | 661 | Manuel Vieira Jr Dairy | 5843 Utah | Merced | 95348 |
| 5B39NC00117 | 663 | De Ruyter Dairy | 27947 Airport | Manteca | 95337 |
| 5B39NC00066 | 665 | Nissen Dairy, Inc. | 17263 Brennan Rd | Escalon | 95320 |
| 5D105037N01 | 666 | SID DE BOER DAIRY | 21622 CEDAR | LATON | 93242 |
| 5B24NC00231 | 667 | Mariposa Dairy / Henry Tavares #3 | 7205 Mariposa | Merced | 95340 |
| 5B39NC00132 | 669 | Quaresma Ranch | 24897 Union | Manteca | 95337 |
| 5C10NC00088 | 670 | M & A DAIRY | 15959 MARKS | CARUTHERS | 93609 |
| 5B24NC00070 | 670 | Manuel Mendes Dairy | 29744 Cottonwood | Gustine | 95322 |
| 5B39NC00145 | 674 | Silva Brothers Dairy | 1999 Grant Line | Tracy | 95304 |
| 5B395007001 | 675 | Nascimento Dairy | 15620 Jacktone | Lodi | 95240 |
| 5B24NC00280 | 675 | F & A Lemos Dairy | 14371 East | Turlock | 95380 |
| 5B39NC00061 | 679 | Jim Bylsma Dairy | 24065 Arthur | Escalon | 95320 |
| 5B39NC00063 | 680 | Peter de Visser Dairy | 21268 Avena | Escalon | 95320 |
| 5B39NC00108 | 680 | Simoes Dairy | 7406 Cotta | Lodi | 95242 |
| 5B24NC00149 | 680 | Silveira Holsteins | 23356 Short | Hilmar | 95324 |
| 5B24NC00174 | 680 | John Lourenco Dairy | 16126 W Sunset | Livingston | 95334 |
| 5B50NC00097 | 680 | Tony & Fatima Garcia Dairy | 6455 California | Modesto | 95358 |
| 5C54NC00024 | 685 | JNA BRASIL DAIRY | 6323 AVENUE 280 | VISALIA | 93277 |
| 5B24NC00190 | 687 | Nunes Bros Inc Dairy | 22116 Hwy 152 | Los Banos | 93635 |
| 5C16NC00052 | 688 | VL FURTADO DAIRY | 3855 7TH | HANFORD | 93230 |

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| 5C10NC00118 | 688 | RAVEN DAIRY | 9203 CLARKSON | SELMA | 93662 |
| 5C10NC00135 | 690 | AMERICAN DAIRY | 5525 SOUTH POLK | FRESNO | 93706 |
| 5C10NC00093 | 690 | FLYING W DAIRY | 2160 ELKHORN | CARUTHERS | 93609 |
| 5C10NC00068 | 690 | SOZINHO DAIRY # 5 | 2585 CHATEAU-FRESNO | FRESNO | 93706 |
| 5A52NC00030 | 690 | Ferreira & Son Dairy | 11953 Tyler | Red Bluff | 96080 |
| 5C245037001 | 690 | Rick Jones Farms | 1511 Van Clief | Stevinson | 95374 |
| 5B50NC00168 | 690 | Live Oak Dairy C | 25719 Hale | Newman | 95360 |
| 5B50NC00181 | 690 | Claribel Farms | 11043 Claribel | Oakdale | 95361 |
| 5B24NC00082 | 690 | Martins Brothers Dairy Farms #2 | 1369 Hunt | Gustine | 95322 |
| 5B24NC00234 | 690 | Manuel Oliviera Dairy | 4235 Oak | Merced | 95340 |
| 5B24NC00277 | 690 | Joe Coelho Dairy | 18637 Bradbury | Turlock | 95380 |
| 5B50NC00144 | 690 | Prins Dairy | 6001 Milnes | Modesto | 95357 |
| 5A115003001 | 695 | Silveira Dairy / Creekside Farms | 6259 County Rd 25 | Orland | 95963 |
| 5B50NC00285 | 695 | Bar Vee Dairy, Inc. | 3031 Washington | Turlock | 95380 |
| 5A58NC00019 | 695 | Staas Farms | 3754 Virginia | Wheatland | 95692 |
| 5B50NC00122 | 695 | Couchman Farms | 3107 Illinois | Modesto | 95358 |
| 5D165092N01 | 700 | HAROLD DRAGT & SONS #2 DAIRY | 9455 SECOND | HANFORD | 93230 |
| 5A11NC00052 | 700 | Van Tol Brothers Dairy | 2451 County Rd TT | Willows | 95988 |
| 5A485000001 | 700 | Double G Dairy | 8118 Sikes | Dixon | 95620 |
| 5B24NC00117 | 700 | Seward Farms | 23204 Bloss | Hilmar | 95324 |
| 5B50NC00025 | 700 | Frank J Bettencourt & Sons Dairy | 8331 Central | Ceres | 95307 |
| 5B50NC00148 | 700 | Inderbitzen Farms | 6930 Paradise | Modesto | 95358 |
| 5B50NC00163 | 700 | Raymond Alamo Dairy | 3501 Vivian | Modesto | 95358 |
| 5C54NC00111 | 702 | SIMOES & RIBEIRO DAIRY | 14537 AVENUE 248 | TULARE | 93274 |
| 5C505018001 | 705 | Bergwerff Farms, Inc. | 7113 Mettler | Oakdale | 95361 |
| 5B24NC00180 | 705 | Soares Dairy Farms | 14515 Badger Flat | Los Banos | 93635 |
| 5B24NC00258 | 707 | Pareira Dairy, LP | 2487 Turlock | Snelling | 95365 |
| 5C505011001 | 713 | J & B Dairy-Rodden Road | 8673 Rodden | Oakdale | 95361 |
| 5C54NC00229 | 715 | F & L BARCELLOS DAIRY | 14581 ROAD 80 | TIPTON | 93272 |
| 5B50NC00227 | 717 | Alden Peterson & Sons Dairy, Inc. | 1431 Central | Turlock | 95380 |
| 5C10NC00094 | 719 | FONTES DAIRY FARMS-DAIRY 1 | 5512 DAVIS | RIVERDALE | 93656 |
| 5B24NC00216 | 719 | AAA Jersey Dairy | 1912 Franklin | Merced | 95340 |
| 5C54NC00135 | 720 | F L DAIRY | 10181 Avenue 412 | DINUBA | 93618 |
| 5B50NC00278 | 720 | Brindiero & Danbom Dairy Farms | 5831 Tegner | Turlock | 95380 |
| 5B24NC00102 | 720 | Live Oak Dairy B | 21334 American | Hilmar | 95324 |
| 5B24NC00267 | 720 | Oliveira Dairy | 3991 Lander | Stevinson | 95374 |
| 5C54NC00092 | 724 | MARTIN DAIRY | 14861 AVENUE 144 | TIPTON | 93272 |
| 5C245030001 | 725 | Vieira Dairy Farm | 511 Applegate | Atwater | 95301 |
| 5B50NC00225 | 725 | William Katen Dairy | 3800 Central | Turlock | 95380 |
| 5B50NC00069 | 725 | John & Maria Machado Dairy | 11706 Keyes | Denair | 95316 |
| 5B50NC00045 | 727 | Francisco Mendonca Dairy | 12467 Carpenter | Crows Landing | 95313 |
| 5D165053N01 | 730 | RICHARD SIMAS DAIRY | 17571 FLINT | HANFORD | 93230 |
| 5D545069001 | 730 | SOUTH CORNER DAIRY | 10167 352 | VISALIA | 93291 |

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| 5D545137N01 | 730 | FERNJO DAIRY #2 | 14428 AVENUE 232 | TULARE | 93274 |
| 5C16NC00087 | 734 | JERSEY CREEK DAIRY | 14857 5TH | HANFORD | 93230 |
| 5C54NC00169 | 736 | LEGACY RANCH DAIRY | 11941 Road 80 | Tipton | 93272 |
| 5D545095001 | 740 | LERDA FARMS DAIRY | 18797 ROAD 142 | TULARE | 93274 |
| 5B20NC00002 | 740 | LASALLE DAIRY | 10663 7 1/2 | FIREBAUGH | 93622 |
| 5B39NC00097 | 740 | Silva Brothers Dairy #3 | 5601 Escalon-Bellota | Farmington | 95230 |
| 5B24NC00158 | 740 | Fanelli Dairy | 7689 Washington | Hilmar | 95324 |
| 5B50NC00116 | 740 | Island Dairy | 8937 Grayson | Modesto | 95358 |
| 5C16NC00078 | 742 | SHINING STAR HOLSTEINS | 3604 HOUSTON | HANFORD | 93230 |
| 5B50NC00049 | 742 | Carvalho Dairy | 11443 Crows Landing | Crows Landing | 95313 |
| 5C54NC00198 | 750 | MACHADO DAIRY | 20180 ROAD 36 | TULARE | 93274 |
| 5C54NC00049 | 750 | HENRY BROWER DAIRY | 23620 180 | LINDSAY | 93247 |
| 5C54NC00078 | 750 | VIDA BOA DAIRY #1 | 15125 AVENUE 240 | TULARE | 93274 |
| 5C54NC00122 | 750 | JACOBUS DEGROOT DAIRY #2 | 8827 AVENUE 312 | VISALIA | 93291 |
| 5C54NC00141 | 750 | KAMPEN RANCHES DAIRY | 33689 ROAD 108 | VISALIA | 93291 |
| 5B39NC00140 | 750 | E & R Prins Dairy #1 | 10385 Van Allen | Stockton | 95215 |
| 5B50NC00034 | 750 | Marchy Dairy | 943 Grayson | Ceres | 95307 |
| 5B24NC00262 | 751 | Joe Nunes and Sons Dairy | 1904 Edminister | Stevinson | 95374 |
| 5C54NC00041 | 757 | CARTMILL DAIRY | 5182 Avenue 248 | TULARE | 93274 |
| 5B24NC00285 | 760 | Alves & Son Dairy | 13745 Newport | Turlock | 95380 |
| 5B50NC00129 | 762 | MB-Lucky Lady Farms | 1218 Keyes | Modesto | 95358 |
| 5C54NC00281 | 763 | TIEMERSMA DAIRY | 29981 ROAD 60 | VISALIA | 93291 |
| 5B50NC00070 | 764 | Silva Family Dairy | 5719 Merriam | Denair | 95316 |
| 5D16517N01 | 770 | FRANK FAGUNDES DAIRY | 10522 15TH | HANFORD | 93230 |
| 5B24NC00041 | 770 | Caetano Dairy | 9436 Griffith | Delhi | 95315 |
| 5B50NC00139 | 770 | Joe Henriques Dairy | 8255 Maze | Modesto | 95351 |
| 5B50NC00162 | 770 | Manuel A Soares Dairy | 7018 Vivian | Modesto | 95351 |
| 5C54NC00035 | 775 | HETTINGA CATTLE DAIRY | 27596 ROAD 68 | VISALIA | 93277 Sold out |
| 5C54NC00171 | 775 | WATTE BROS DAIRY #2 | 4125 AVENUE 216 | TULARE | 93274 |
| 5B24NC00161 | 775 | Faustino Dairy | 9735 Washington | Hilmar | 95324 |
| 5C54NC00036 | 776 | FRANK L. PIRES III DAIRY | 4728 AVENUE 248 | TULARE | 93274 |
| 5B395021001 | 776 | Machado Dairy #2 | 19405 Mariposa | Stockton | 95215 |
| 5B24NC00222 | 776 | Nunes Dairy | 1730 Healy | Merced | 95340 |
| 5B24NC00263 | 776 | Couto Dairy | 1499 Edminster | Stevinson | 95374 |
| 5B50NC00092 | 777 | Durrer Dairy | 8861 Beckwith | Modesto | 95358 |
| 5B20NC00032 | 780 | FRANK PARREIRA DAIRY | 17493 AVENUE 20 | MADERA | 93637 |
| 5B50NC00284 | 780 | J & J Toste Dairy, Inc. | 2207 Walnut | Turlock | 95380 |
| 5B34NC00022 | 780 | Pacheco Dairy | 3701 Langworth | Modesto | 95357 |
| 5B50NC00219 | 782 | Santos Dairy | 6125 Central | Turlock | 95380 |
| 5B24NC00032 | 784 | Magneson Dairy | 10235 El Capitan | Ballico | 95303 |
| 5C505019001 | 785 | Martin Land and Cattle | 6100 Hinds | Oakdale | 95361 |
| 5B39NC00071 | 785 | Frank & Carol Borba Dairy | 25381 Dodds | Escalon | 95320 |
| 5B39NC00118 | 788 | Frank Teicheira & Son Dairy | 27527 Airport | Manteca | 95337 |

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| 5C16NC00016 | 789 | GREEN OAKS DAIRY | 15410 Excelsior | Hanford | 93230 |
| 5C54NC00246 | 790 | former PALM DAIRY (temporarily vacant) | 22901 ROAD 28 | TULARE | 93274 |
| 5B24NC00076 | 790 | Joe and Maria Mendonca Dairy | 27435 Gun Club | Gustine | 95322 |
| 5B50NC00098 | 791 | Zylstra Andrew Dairy #2 | 7801 Carpenter | Modesto | 95358 |
| 5A11NC00048 | 793 | Leo Martin Dairy | 7266 Lindsay | Orland | 95963 |
| 5B24NC00268 | 793 | Souza Bros Dairy | 3887 McCullagh | Stevinson | 95374 |
| 5B50NC00112 | 793 | Van Der Hoek Dairy | 337 Gates | Modesto | 95358 |
| 5C54NC00007 | 800 | SIMOES BROS. DAIRY #4 | 21399 ROAD 76 | TULARE | 93274 |
| 5C54NC00016 | 800 | FM RANCH DAIRY #2 | 196 OLIVE | TIPTON | 93272 |
| 5C16NC00030 | 800 | ANTONIO GARCIA DAIRY | 6571 FARGO | HANFORD | 93274 |
| 5C54NC00188 | 800 | PEDRO DAIRY | 26946 ROAD 108 | VISALIA | 93291 |
| 5B39NC00095 | 800 | Bartelink Dairy | 12637 Van Allen | Escalon | 95320 |
| 5D105035N01 | 802 | LIVING WATERS DAIRY | 2871 CLARKSON | SELMA | 93662 |
| 5C54NC00132 | 803 | N2 DAIRY | 12671 AVE 200 | TULARE | 93274 |
| 5B50NC00290 | 803 | Sousa Family Dairy | 12801 Bradbury | Turlock | 95380 |
| 5C16NC00028 | 807 | CAETANO DAIRY | 4356 KANSAS | HANFORD | 93230 |
| 5B24NC00221 | 808 | Tony J Machado DY | 2222 Healy | Merced | 95340 |
| 5D165075N01 | 810 | RODRIGUES DAIRY | 18280 FAIRFAX | LEMOORE | 93245 |
| 5C54NC00182 | 810 | DAVID BAKKER DAIRY | 22000 ROAD 28 | TULARE | 93274 |
| 5D165099N01 | 815 | VEENENDAAL DAIRY | 4119 HOUSTON | HANFORD | 93230 |
| 5C54NC00126 | 820 | BAKKER DAIRY | 29800 Road 60 | Vislia | 93291 |
| 5B50NC00248 | 820 | John Brasil & Sons Dairy #2 | 9018 Linwood | Turlock | 95380 |
| 5B24NC00224 | 820 | PH Ranch #2 | 2618 Hwy 59 | Merced | 93540 |
| 5B50NC00078 | 820 | Foster Dairy Farms #2 | 1530 Hall | Hickman | 95323 |
| 5B34NC00018 | 825 | T H Mello Dairy | 9390 Harvey | Galt | 95623 |
| 5C54NC00051 | 827 | BORBA & SONS DAIRY | 13010 Avenue 120 | Tipton | 93272 |
| 5B24NC00205 | 827 | Migliazzo & Sons Dairy | 3645 Bradshaw | Atwater | 95301 |
| 5C54NC00094 | 830 | MENDONSA FAMILY FARMS DAIRY | 12750 AVENUE 160 | TIPTON | 93272 |
| 5C16NC00025 | 830 | SOARES 5 JERSEY DAIRY | 8483 15TH | HANFORD | 93230 |
| 5B395008001 | 830 | Manuel & Rosa Teixeira Dairy | 11493 Davis | Lodi | 95242 |
| 5B24NC00214 | 830 | Blue Sky Dairy | 4390 Fox | Merced | 95340 |
| 5B39NC00099 | 832 | Armelim Amaral Dairy | 26298 Groves | Farmington | 95230 |
| 5B50NC00209 | 833 | A & C Vierra Dairy #1 | 931 Blaker | Turlock | 95380 |
| 5B24NC00244 | 839 | Sandy Mush Crosses | 5241 Sandy Mush | Merced | 95340 |
| 5C16NC00077 | 840 | MELLO-D JERSEYS INC. | 15739 GRANGEVILLE | HANFORD | 93230 |
| 5B50NC00118 | 840 | Nutcher Farms | 5213 Grayson | Modesto | 95358 |
| 5B24NC00183 | 845 | John Machado Dairy | 22495 China Camp | Los Banos | 93635 |
| 5B34NC00019 | 845 | Tony Mello and Sons #2 | 10090 Kost | Galt | 95632 |
| 5C16NC00102 | 849 | C & C HOLSTEINS DAIRY | 13243 HOUSTON | HANFORD | 93230 |
| 5B395016001 | 850 | Deuel Vocational Institute Dairy | 23500 Kasson | Tracy | 95376 |
| 5B24NC00060 | 850 | Joe Lopes Dairy | 1581 Roosevelt | El Nido | 95317 |
| 5B50NC00093 | 850 | Blue Star Dairy | 5254 Blue Gum | Modesto | 95358 |
| 5B24NC00291 | 850 | Victor Fiorini Dairy | 12926 Vincent | Turlock | 95380 |

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| 5D165093N01 | 853 | BARRETO & SILVEIRA DAIRY | 11305 2ND | HANFORD | 93230 |
| 5B24NC00116 | 853 | Tell Dairy | 20717 Bloss | Hilmar | 95324 |
| 5B50NC00231 | 855 | Stardum Holsteins | 5725 Ehrlick | Turlock | 95380 |
| 5D165084001 | 857 | MARTIN & MARTINS DAIRY | 12281 14 TH | HANFORD | 93230 |
| 5B50NC00051 | 857 | Tony F. Melo & Sons #2 | 1866 Fulkerth | Crows Landing | 95313 |
| 5B24NC00157 | 859 | 6D Dores Dairy | 25762 Turner | Hilmar | 95304 |
| 5C15NC00039 | 860 | T & W FARMS #2 DAIRY | 5959 HOUGHTON | BAKERSFIELD | 93313 |
| 5B50NC00046 | 860 | Alvernaz Dairy, Inc. | 10562 Crows Landing | Crows Landing | 95313 |
| 5B50NC00095 | 860 | Peder Hoy Dairy, Inc. | 6000 California | Modesto | 95358 |
| 5B50NC00120 | 860 | Frank Gwerder Dairy | 1007 Hart | Modesto | 95351 |
| 5B50NC00291 | 864 | Roestar Dairy | 10407 Bradbury | Turlock | 95380 |
| 5B395020001 | 871 | Kaehler Dairy Farm | 1025 Armstrong | Lodi | 95242 |
| 5B50NC00232 | 875 | Silva's Holsteins | 6706 Elaine | Turlock | 95380 |
| 5A58NC00016 | 875 | Skiff Ranch | 24323 Skiff | Escalon | 95320 |
| 5C15NC00027 | 882 | RITCHIE & RITCHIE DAIRY | 12421 MELCHER | MCFARLAND | 93250 |
| 5C10NC00096 | 883 | JOHN BOS DAIRY | | | |
| 5B50NC00021 | 885 | Gonsalves Dairy | 3636 Monte Vista | Ceres | 95307 |
| 5D545097N01 | 890 | GOMES DAIRY | 20433 ROAD 28 | TULARE | 93274 |
| 5B24NC00071 | 890 | Manuel Lopes Dairy | 28470 Cottonwood | Gustine | 95322 |
| 5B50NC00292 | 897 | N & C Silveira Dairy | 6025 Hultberg | Turlock | 95380 |
| 5D545016001 | 900 | Two Star Dairy | 3451 Blackstone | TULARE | 93274 |
| 5B50NC00205 | 900 | Jose Soares Dairy #4 | 9207 American | Hilmar | 95324 |
| 5B50NC00221 | 900 | Jordao Dairy | 6025 Central | Turlock | 95380 |
| 5B50NC00300 | 900 | Diamond B Dairy | 3137 Tuolumne | Ceres | 95307 |
| 5B39NC00067 | 900 | G & H Dairy #2 | 16475 Brennan | Escalon | 95320 |
| 5B24NC00156 | 900 | B-6 Dairy | 22014 Turner | Hilmar | 95324 |
| 5B50NC00136 | 900 | Bento Dairy | 7500 Maze | Modesto | 95358 |
| 5B34NC00012 | 900 | Joe Simoes & Sons Dairy, Inc. | 6900 Lambert | Elk Grove | 95757 |
| 5B50NC00141 | 900 | Martins Dairy | 10043 Milnes | Modesto | 95367 |
| 5D155080N01 | 902 | PANAMA RANCH DAIRY | 6219 PANAMA | BAKERSFIELD | 93307 |
| 5D165063N01 | 905 | JOE MACHADO DAIRY | 8800 LANSING | HANFORD | 93230 |
| 5C16NC00069 | 910 | TONY MARTIN DAIRY | 6240 21st | LEMOORE | 96245 |
| 5B50NC00220 | 910 | Double Cross Dairy | 7025 Central | Turlock | 95380 |
| 5B395012001 | 910 | Manuel Da Silva Dairy | 15836 Steingul | Escalon | 95320 |
| 5B50NC00237 | 915 | Lucas Dairy | 11204 Fulkerth | Turlock | 95380 |
| 5B50NC00121 | 917 | Verburg and Sons Dairy | 1142 Hart | Modesto | 95351 |
| 5C54NC00279 | 920 | TONY & JULIE JORGE DAIRY | 4645 AVENUE 120 | CORCORAN | 93212 |
| 5C16NC00008 | 920 | SANTOS DAIRY NO. 1 | 18104 Everett | KINGS COUNTY | 93242 |
| 5A11NC00018 | 920 | Chris Verboom Dairy | 5943 County Rd 17 | Orland | 95963 |
| 5B395041001 | 920 | Vander Werff - Rigg Dairy | 24567 Lone Tree | Escalon | 95320 |
| 5B39NC00078 | 920 | Doornenbal Dairy | 19116 Lone Tree | Escalon | 95320 |
| 5B50NC00058 | 920 | Art Silva and Son Dairy | 12636 Main | Crows Landing | 95313 |
| 5C205007N01 | 925 | MR DAIRY | 18899 ROAD 16 | CHOWCHILLA | 93610 |

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| 5B24NC00111 | 925 | Azevedo Dairy | 21480 August | Hilmar | 95324 |
| 5B24NC00299 | 930 | Fred Sherman Dairy | 5600 Palm | Winton | 95388 |
| 5C54NC00178 | 935 | LITTLE ROCK DAIRY | 7325 AVENUE 144 | TIPTON | 93273 |
| 5C54NC00116 | 938 | ELBOW CREEK DAIRY | 34537 ROAD 124 | VISALIA | 93291 |
| 5C54NC00217 | 940 | WHITE GOLD DAIRY | 7585 AVENUE 152 | TIPTON | 93272 |
| 5C54NC00233 | 940 | FM RANCH DAIRY #1 | 16777 I | TULARE | 93274 |
| 5C16NC00029 | 943 | S I C DAIRY | 3772 10th | HANFORD | 93230 |
| 5B24NC00238 | 943 | Matos Dairy | 100 Quinley | Merced | 95340 |
| 5B50NC00171 | 948 | Lopes Family Dairy | 25900 McClintock | Newman | 95360 |
| 5C54NC00038 | 949 | TRIPALM DAIRY | 2429 Idaho | HANFORD | 93230 |
| 5B24NC00040 | 949 | Manuel & Maria Cardoso & Sons Dairy | 16489 August | Delhi | 95315 |
| 5D165073001 | 950 | WARMERDAM DAIRY | 11336 7TH AVENUE | HANFORD | 93230 |
| 5C54NC00110 | 950 | BEN MENDONCA & FAMILY DAIRY | 19517 ROAD 124 | TULARE | 93274 |
| 5C16NC00063 | 950 | FIVE J'S DAIRY | 4947 DENVER | Kingsburg | 93631 |
| 5C10NC00065 | 950 | JOSE RIBEIRO & SON DAIRY | 3666 MT. WHITNEY | LATON | 93242 |
| 5C245041001 | 950 | Raphael Pacheco Dairy | 22884 Ingomar Grand | Los Banos | 93635 |
| 5A58NC00017 | 950 | Staas Farms, Inc. | 4501 Virginia | Marysville | 95901 |
| 5C10NC00113 | 952 | GODINHO HOLSTEINS DAIRY | 21505 HAYES | RIVERDALE | 93656 |
| 5B39NC00143 | 954 | Five Star Dairy | 18700 Bacchetti | Tracy | 95304 |
| 5C54NC00106 | 955 | LITTLE H DAIRY | 15804 AVENUE 248 | VISALIA | 93292 |
| 5C16NC00026 | 959 | LOG HAVEN DAIRY | 7755 FARGO | HANFORD | 93230 |
| 5D165096N01 | 960 | HAKKER DAIRY | 12499 IDAHO | HANFORD | 93230 |
| 5C54NC00194 | 960 | TRIPLE V DAIRY | 18193 I | TULARE | 93274 |
| 5B50NC00252 | 960 | Ray Souza Dairy | 11412 Main | Turlock | 95380 |
| 5B39NC00090 | 960 | Faria Dairy, Inc #1 | 13182 Robinson | Escalon | 95320 |
| 5C10NC00078 | 966 | GEORGENSON DAIRY | 1748 MT. WHITNEY | RIVERDALE | 93656 |
| 5C54NC00199 | 970 | ADRIANO NUNES DAIRY | 18675 ROAD 32 | TULARE | 93274 |
| 5C54NC00180 | 970 | WESTVIEW DAIRY | 20798 ROAD 28 | TULARE | 93274 |
| 5D105050N01 | 974 | ANTONIO RIBEIRO DAIRY | 430 MT WHITNEY | RIVERDALE | 93656 |
| 5B24NC00039 | 976 | Silveira Dairy | 12383 Schultz | Chowchilla | 93610 |
| 5B24NC00020 | 978 | Twin Star Dairy | 6480 Bailey | Atwater | 95301 |
| 5B24NC00046 | 978 | Manual Goncalves Dairy | 15782 Arroya | Dos Palos | 93620 |
| 5C54NC00212 | 980 | JIM BAKKER DAIRY | 30030 ROAD 60 | VISALIA | 93291 |
| 5D545038N01 | 980 | PONDEROSA DAIRY | 7480 AVENUE 160 | TIPTON | 93272 |
| 5C54NC00096 | 980 | T- BAR DAIRY | 14851 ROAD 168 | PORTERVILLE | 93257 |
| 5D165068N01 | 985 | M.F. ROSA DAIRY | 10090 2ND | HANFORD | 93230 |
| 5D545077001 | 985 | MACEDO BROTHERS DAIRY | 13804 ROAD 72 | TIPTON | 93272 |
| 5B395034001 | 985 | Koolhaas Dairy | 26805 Dodds | Escalon | 95320 |
| 5D165083001 | 988 | SIC DAIRIES DAIRY | 16283 18TH | LEMOORE | 93245 |
| 5C16NC00122 | 990 | PEDRO DAIRY | 21009 19TH | STRATFORD | 93266 |
| 5B34NC00023 | 990 | Van Warmerdam Dairy (Mc Kenzie Rd) | 12121 Mc Kenzie | Galt | 95632 |
| 5B24NC00255 | 994 | Toste Dairy | 609 Santa Fe Grade | Newman | 95360 |
| 5D165071N01 | 995 | EDEN-VALE DAIRY | 6944 21 1/2 | LEMOORE | 93245 |

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| 5B24NC00163 | 995 | Manuel Luis Dairy | 19051 Williams | Hilmar | 95324 |
| 5C54NC00026 | 1000 | BAR 99 INC. DAIRY | 29401 ROAD 68 | VISALIA | 93277 |
| 5C54NC00107 | 1000 | FERNJO DAIRY #1 | 23135 ROAD 148 | TULARE | 93274 |
| 5C16NC00071 | 1000 | BROWN'S DAIRY | 14803 GRANGEVILLE | HANFORD | 93230 |
| 5B24NC00019 | 1000 | Joe C Lourenco and Sons Dairy #2 | 9701 Atwater-Jordan | Atwater | 95301 |
| 5B50NC00265 | 1000 | Alfred C Nunes | 5119 Morgan | Turlock | 95380 |
| 5B24NC00090 | 1000 | Live Oak Dairy E | 8450 Hwy 33 | Gustine | 95322 |
| 5D165066N01 | 1006 | BENFICA DAIRY | 15505 19TH | LEMOORE | 93245 |
| 5C16NC00076 | 1015 | R&R FARMS | 5811 E. LACEY | HANFORD | 93230 |
| 5B24NC00164 | 1018 | Live Oak Dairy D | 22651 Williams | Hilmar | 95324 |
| 5C54NC00224 | 1020 | ALVIN SOUZA DAIRY #5 | 6141 AVENUE 184 | TULARE | 93274 |
| 5C54NC00136 | 1023 | DOUBLE OAK DAIRY | 3573 Oakdale | TULARE | 93274 |
| 5D165082001 | 1025 | BAR M RANCH | 14025 JACKSON | HANFORD | 93230 |
| 5C16NC00015 | 1030 | CONTENTE & COMPANY DAIRY | 7900 15th | HANFORD | 93230 |
| 5C16NC00037 | 1030 | GIACOMAZZI DAIRY | 9624 6TH | HANFORD | 93230 |
| 5A11NC00026 | 1034 | Maarten Poldervaart Dairy | 6916 County Road 30 | Orland | 95963 |
| 5D545103001 | 1035 | BAR 99, INC. | 8061 AVENUE 360 | VISALIA | 93291 |
| 5C16NC00023 | 1035 | MID VALLEY MILK COMPANY DAIRY | 7594 KENT | HANFORD | 93230 |
| 5C245029001 | 1035 | Evaristo Vaz Dairy | 21876 Sunset | Los Banos | 93635 |
| 5C54NC00079 | 1040 | TRI-STAR DAIRY | 18357 AVENUE 152 | PORTERVILLE | 93257 |
| 5B395044001 | 1045 | Vander Schaff Dairy #2 | 15355 Van Allen | Escalon | 95320 |
| 5C54NC00218 | 1050 | CODORNIZ DAIRY | 17993 ROAD 96 | TULARE | 93274 |
| 5C54NC00042 | 1050 | WESTHILL DAIRY | 3986 Avenue 248 | TULARE | 93274 |
| 5C54NC00082 | 1050 | TRI-J DAIRY | 11951 ROAD 96 | PIXLEY | 93256 |
| 5B24NC00034 | 1050 | Faust Family Dairy | 10077 Avenue 26 | Chowchilla | 93610 |
| 5B50NC00301 | 1050 | CMA Livestock | 10119 August | Turlock | 95380 |
| 5A345001001 | 1050 | B & J Dairy | 9950 Arno | Galt | 95632 |
| 5C54NC00200 | 1055 | COUNTRYSIDE DAIRY | 20991 Road 36 | Tulare | 93274 |
| 5C505030001 | 1055 | J&J DeRaadt Dairy | 6460 Smith | Oakdale | 95361 |
| 5B50NC00165 | 1057 | Joe and Pauline Meirinho Dairy | 3354 Whitmore | Modesto | 95358 |
| 5C10NC00153 | 1060 | VALDEMAR F. PIRES DAIRY | 15336 10th AVENUE | HANFORD | 93230 |
| 5C54NC00238 | 1064 | DL & A DAIRY | 5295 AVENUE 224 | TULARE | 93274 |
| 5B24NC00225 | 1064 | Anselmo Souza Dairy | 6600 Hwy 59 | Merced | 95344 |
| 5C205008N01 | 1070 | DOMINGOS RIBEIRO DAIRY | 12718 AVENUE 25 | CHOWCHILLA | 93610 |
| 5B24NC00192 | 1070 | Oakdale Farms, Inc. | 22759 Mercey Springs | Los Banos | 93635 |
| 5D105043001 | 1075 | SOZINHO JERSEY'S DAIRY | 13019 CLOVIS | SELMA | 93662 |
| 5B50NC00201 | 1077 | Stueve Certified Organic Dairy | 4206 Bentley | Oakdale | 95361 |
| 5C54NC00211 | 1080 | DEL - ARCO DAIRY | 15506 ROAD 80 | TIPTON | 93272 |
| 5C54NC00265 | 1080 | M & L DAIRY | 13511 ROAD 120 | TIPTON | 93272 |
| 5D545145001 | 1080 | HARMONY FARMS | 18279 AVENUE 184 | STRATHMORE | 93267 |
| 5B20NC00008 | 1080 | ALFRED SOARES DAIRY | 21282 ROAD 6 | CHOWCHILLA | 93610 |
| 5C54NC00019 | 1090 | FRANK C. LAWRENCE DAIRY | 28476 Road 52 | VISALIA | 93277 |
| 5C16NC00046 | 1090 | ALVARO MACHADO DAIRY | 5230 9 th | Hanford | 93230 |

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| 5C54NC00054 | 1093 | MANCEBO HOLSTEINS #2 DAIRY | 23792 ROAD 140 | TULARE | 93274 |
| 5B50NC00191 | 1093 | DeSimas & Bairos Dairy | 4137 Oakdale-Waterford | Oakdale | 95361 |
| 5B50NC00288 | 1093 | Manuel Azevedo Dairy | 2800 White | Turlock | 95380 |
| 5B50NC00113 | 1093 | Van Der Hoek & Sons Dairy #2 | 1636 Gates | Modesto | 95358 |
| 5B50NC00117 | 1093 | Borges Farms | 5148 Grayson | Modesto | 95358 |
| 5B24NC00098 | 1095 | Frank Azevedo Dairy | 30711 Pfitzer | Gustine | 95322 |
| 5B50NC00086 | 1099 | J & B Dairy | 3037 Albers | Modesto | 95357 |
| 5D165074N01 | 1100 | J & F MARTINS DAIRY | 7622 14TH | HANFORD | 93230 |
| 5C205029N01 | 1100 | COSTA VIEW DAIRY NORTH | 9499 AVENUE 20 | CHOWCHILLA | 93610 |
| 5D545062001 | 1100 | HAROLD DRAGT & SONS DAIRY #1 | 4590 AVENUE 304 | VISALIA | 93291 |
| 5C54NC00193 | 1100 | FOUR J FARMS DAIRY | 1223 STANFORD | PIXLEY | 93256 |
| 5C10NC00079 | 1100 | MONTEIRO BROS. DAIRY #2 | 4604 HARLAN | RIVERDALE | 93656 |
| 5B39NC00080 | 1100 | Brasil and Sons Dairy 1 | 20623 Lone Tree | Escalon | 95320 |
| 5B24NC00229 | 1100 | Joe & Renee Barroso Dairy | 6902 Legrand | Merced | 95340 |
| 5B50NC00073 | 1100 | Edwin H Smith & Sons Dairy | 4836 Quincy | Denair | 95316 |
| 5D165083N01 | 1105 | SOZINHO DAIRY #1 | 11447 8 1/2 | HANFORD | 93230 |
| 5B50NC00065 | 1105 | Dirk-C Holsteins Operations | 1933 Hall | Denair | 95316 |
| 5C54NC00161 | 1110 | J & E DAIRY #1 | 3231 OAKMORE | TULARE | 93274 |
| 5B24NC00235 | 1113 | Carlos Lourenco Dairy | 6557 Oak | Merced | 95340 |
| 5C245040001 | 1115 | Fagundes Brothers Dairy #2 | 14478 Cox Ferry | Snelling | 95369 |
| 5C54NC00280 | 1116 | L & L MORAIS DAIRY | 7330 AVENUE 190 | TULARE | 93274 |
| 5B24NC00054 | 1116 | Brasil Dairy | 13701 Hwy 59 | El Nido | 95317 |
| 5C54NC00170 | 1120 | MILK RIVER DAIRY | 34292 ROAD 124 | VISALIA | 93231 |
| 5B39NC00127 | 1120 | Gerrit Hofman Dairy | 4820 Perrin | Manteca | 95337 |
| 5B50NC00048 | 1120 | Arthur Vitoria Dairy | 14018 Crows Landing | Crows Landing | 95313 |
| 5C16NC00042 | 1121 | WEST WING DAIRY | 7721 FLINT | HANFORD | 93230 |
| 5C10NC00141 | 1124 | TONY SOUZA DAIRY | 7530 DAVIS | SELMA | 93662 |
| 5C15NC00022 | 1124 | BIDART DAIRY NO. 3 | 25820 STOCKDALE | BAKERSFIELD | 93314 |
| 5D165057001 | 1135 | ANGIOLA DAIRY | 5339 AVENUE 120 | CORCORAN | 93212 |
| 5C54NC00060 | 1135 | G-P DAIRY | 8676 AVENUE 360 | VISALIA | 93291 |
| 5C54NC00228 | 1145 | WATTE BROS DAIRY | 6020 AVENUE 200 | TULARE | 93274 |
| 5C54NC00055 | 1149 | PEREIRA FAMILY DAIRY | 21387 ROAD 152 | TULARE | 93274 |
| 5D545146N01 | 1149 | JOHN JACOBI DAIRY | 10723 AVENUE 408 | DINUBA | 93618 |
| 5D545099001 | 1150 | FIVE STAR DAIRY | 13167 ROAD 144 | TIPTON | 93272 |
| 5C245024002 | 1150 | Correia Family Dairy | 26380 Fahey | Gustine | 95322 |
| 5B50NC00296 | 1150 | Diamond S Ranch, Inc. | 600 Roberts Ferry | Waterford | 95386 |
| 5B50NC00077 | 1150 | Alberto Dairy | 11737 Blue Gum | Hickman | 95323 |
| 5B50NC00100 | 1150 | Clarot Farms, Inc. | 7260 Carpenter | Modesto | 95358 |
| 5C10NC00123 | 1154 | BLACK DIAMOND DAIRY | 18789 FRUIT | RIVERDALE | 93656 |
| 5C16NC00082 | 1157 | JVD DAIRY | 4595 HOUSTON | HANFORD | 93230 |
| 5B395018001 | 1157 | Silva Brothers Dairy | 12997 Peltier | Acampo | 95220 |
| 5C54NC00064 | 1160 | GOLDEN WEST DAIRY | 12031 Avenue 352 | VISALIA | 93291 |
| 5D545150N01 | 1160 | ATSMA DAIRY | 11021 AVENUE 120 | PIXLEY | 93256 |

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| 5C54NC00154 | 1161 | FARIA FARMS INC. DAIRY | 13927 Road 136 | TIPTON | 93272 |
| 5D16515N01 | 1165 | DIAS & DIAS DAIRY COMPLEX | 6740 CORONA AVENUE | KINGSBURG | 93631 |
| 5C10NC00120 | 1165 | GERRIT VISSER & SONS DAIRY | 18437 MARKS | RIVERDALE | 93656 |
| 5B50NC00083 | 1165 | Postma Dairy #1 | 1412 Albers | Modesto | 95357 |
| 5C16NC00123 | 1170 | JOAQUIM MATTOS & FAMILY DAIRY | 4790 KANSAS | HANFORD | 93230 |
| 5B50NC00259 | 1170 | John Brasil & Sons Dairy | 2613 Mitchell | Turlock | 95380 |
| 5A58NC00018 | 1170 | Tollcrest Dairy | 3355 Virginia | Wheatland | 95692 |
| 5B24NC00252 | 1170 | Double B Dairy | 5817 Worden | Merced | 95340 |
| 5B24NC00317 | 1170 | Dairy Central | 6626 Central | Hilmar | 95324 |
| 5C54NC00037 | 1172 | CALDWELL DAIRY | 7908 Avenue 280 | VISALIA | 93277 |
| 5C15NC00051 | 1175 | JAI-ALAI DAIRY | 26101 EDISON | ARVIN | 93203 |
| 5C54NC00125 | 1175 | Golden J Dairy | 13075 Avenue 200 | Tulare | 93274 |
| 5D545138N01 | 1177 | OAK CREEK JERSEYS | 8083 AVENUE 160 | TIPTON | 93272 |
| 5B39NC00142 | 1178 | Moreda Valley Dairy | 20967 Paradise | Tracy | 95304 |
| 5D105042N01 | 1183 | BIG DE CATTLE DAIRY | 2947 MANNING | FRESNO | 93706 |
| 5B24NC00095 | 1185 | D & D Holsteins Dairy | 26135 Malta | Gustine | 95322 |
| 5B50NC00102 | 1185 | Postma Dairy #1 | 3700 Claus | Modesto | 95357 |
| 5A34NC00029 | 1186 | Tollenaar Holsteins/Tollenaar Dairy | 11450 Carroll | Elk Grove | 95757 |
| 5C205031001 | 1188 | AJF DAIRY | 23435 ROAD 12 | CHOWCHILLA | 93610 |
| 5D545171001 | 1190 | EAST VIEW DAIRY | 10485 AVENUE 352 | VISALIA | 93291 |
| 5B24NC00172 | 1190 | Antonio Teixeira Dairy | 10986 Livingston -Cressey | Livingston | 95334 |
| 5D165085001 | 1195 | HENRY VEENENDAAL DAIRY | 3678 HOUSTON | HANFORD | 93230 |
| 5B39NC00154 | 1196 | Henry Tosta Dairy | 20662 San Jose | Tracy | 95304 |
| 5C10NC00119 | 1197 | A & TO DAIRY | 19249 FRUIT | RIVERDALE | 93656 |
| 5C54NC00023 | 1200 | BRASIL'S UDDER DAIRY | 28723 Road 56 | Visalia | 93277 |
| 5C15NC00038 | 1200 | Faial Farms Dairy | 13714 Stine Road | Bakersfield | 93714 |
| 5C54NC00076 | 1200 | JACOBUS DEGROOT DAIRY #1 | 31847 ROAD 92 | VISALIA | 93291 |
| 5D155054N01 | 1200 | ROSA DAIRY | 4714 BEAR MOUNTAIN | BAKERSFIELD | 93307 |
| 5B50NC00066 | 1200 | Foster Dairy Farms #4 | 5372 Hickman | Denair | 95361 |
| 5C54NC00216 | 1204 | GOLDEN STATE DAIRY | 11425 ROAD 112 | TIPTON | 93272 |
| 5C54NC00134 | 1207 | HENRY A. GARCIA DAIRY | 12521 AVENUE 200 | TULARE | 93274 |
| 5C54NC00208 | 1208 | AIROSO DAIRY | 18809 ROAD 64 | TULARE | 93274 |
| 5B50NC00052 | 1208 | Edelweiss Dairy | 2306 Fulkerth | Crows Landing | 95313 |
| 5A11NC00017 | 1210 | Northwind Dairy | 5944 County | Orland | 95963 |
| 5C54NC00295 | 1220 | SUNRISE DAIRY | 8022 AVENUE 368 | DINUBA | 93618 |
| 5B50NC00079 | 1220 | Foster Dairy Farms #3 | 1825 Hickman | Hickman | 95323 |
| 5C54NC00183 | 1223 | TERRA LINDA DAIRY | 4525 AVENUE 232 | TULARE | 93274 |
| 5D545091001 | 1228 | SOUSA & SOUSA III DAIRY | 13510 ROAD 72 | TIPTON | 93272 |
| 5C16NC00003 | 1235 | LOPES DAIRY | 18682 IDAHO AVENUE | LEMOORE | 93245 |
| 5D105026N01 | 1240 | MILKY WAY DAIRY | 10610 WHITESBRIDGE | FRESNO | 93706 |
| 5C205004N01 | 1245 | EUGENIO AZEVEDO DAIRY | 22355 AVENUE 8 | MADERA | 93637 |
| 5B24NC00145 | 1245 | T & M Borba Dairy | 6275 Mitchell | Hilmar | 95324 |
| 5C54NC00288 | 1250 | CIRCLE V DAIRY | 14760 AVENUE 208 | TULARE | 93274 |

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| 5D545011N01 | 1250 | ANKERIDGE DAIRY | 17873 AVENUE 256 | Visalia | 93292 |
| 5C54NC00190 | 1250 | H & L DAIRY | 8651 Avenue 388 | Dinuba | 93618 |
| 5D155073N01 | 1250 | DE VRIES DAIRY #3 | 30586 ELMO | MCFARLAND | 93250 |
| 5C16NC00097 | 1254 | LONE STAR DAIRY | 8637 JACKSON | HANFORD | 93230 |
| 5B24NC00253 | 1254 | Silveira Bros. Dairy #1 | 27890 Brazo | Newman | 95360 |
| 5D545053N01 | 1259 | ED BROWER DAIRY | 18514 Avenue 248 | Exeter | 93221 |
| 5B395043001 | 1259 | E Luis & Sons Dairy, Inc. | 18035 Jacob Brock | Lodi | 95242 |
| 5B39NC00141 | 1259 | Manuel & Jeannette Borges Dairy | 10408 Van Allen | Stockton | 95215 |
| 5B24NC00272 | 1259 | Dores Dairy AGP #1 | 22846 Second | Stevinson | 95374 |
| 5B24NC00130 | 1265 | Joe Oliveira Dairy | 19104 Crane | Hilmar | 95324 |
| 5D105038001 | 1270 | NASH FARMS INC. DAIRY | 4109 CONEJO | SELMA | 93662 |
| 5B24NC00110 | 1275 | Nyman Brothers Dairy | 20445 August | Hilmar | 95324 |
| 5B24NC00173 | 1280 | AAA Dairy / Amaral and Amaral Dairy | 11159 Peach | Livingston | 95334 |
| 5D545021N01 | 1285 | TONY A. NUNES DAIRY | 33640 Road 124 | VISALIA | 93291 |
| 5D155083001 | 1285 | T & W FARMS DAIRY #3 | 6921 BEAR MOUNTAIN BOULEVARD | BAKERSFIELD | 93313 |
| 5B24NC00309 | 1285 | Coelho Farms LP | 5615 Ave 24 | Chowchilla | 93610 |
| 5B50NC00074 | 1286 | Ahlem Farms Vista | 6401 Taylor | Denair | 95316 |
| 5B24NC00281 | 1290 | Richlee Farms LLC | 13831 East | Turlock | 95380 |
| 5B39NC00076 | 1294 | Creekside Dairy | 23234 Lone Tree | Escalon | 95320 |
| 5B39NC00130 | 1301 | Machado Dairy Farms #1 | 28128 Two Rivers | Manteca | 95337 |
| 5B50NC00059 | 1305 | Ahlem Farms Jerseys | 825 Ruble | Crows Landing | 95313 |
| 5C505024001 | 1310 | Hillview Dairy | 4125 Bentley | Oakdale | 95361 |
| 5C54NC00257 | 1315 | SBS AG DAIRY | 7119 AVENUE 204 | TULARE | 93274 |
| 5B50NC00147 | 1315 | Andrew Zylstra Dairy Inc (#1) | 2655 Monte Vista | Modesto | 95351 |
| 5D16509002 | 1320 | PARREIRA DAIRY | 18081 17TH | STRATFORD | 93266 |
| 5C16NC00043 | 1320 | JOE V. PIMENTEL DAIRY | 4625 6th | Hanford | 93230 |
| 5C10NC00089 | 1321 | MORNING STAR DAIRY | 10032 Elkhorn | Burrel | 93656 |
| 5C16NC00012 | 1323 | JD MELLO DAIRY | 15609 Grangeville | HANFORD | 93230 |
| 5C16NC00031 | 1323 | HETTINGA RANCH DAIRY | 4615 EXCELSIOR | HANFORD | 93230 |
| 5C54NC00235 | 1330 | MS MONTEIRO & SONS DAIRY | 3515 AVENUE 228 | TULARE | 93274 |
| 5D165094N01 | 1332 | PHOENIX DAIRY | 10736 1 1/2 | HANFORD | 93230 |
| 5D105039N01 | 1338 | LEONARDO BROS DAIRY | 16508 CLOVIS | SELMA | 93662 |
| 5D155063001 | 1350 | DESPERADO DAIRY | 31740 TAYLOR | MCFARLAND | 93250 |
| 5B10NC00009 | 1350 | SOUSA DAIRY | 7709 AVENUE 376 | DINUBA | 93618 |
| 5C10NC00082 | 1350 | MONTEIRO BROS. DAIRY #1 | 5336 HARLAN | RIVERDALE | 93656 |
| 5B24NC00243 | 1350 | Homen Dairy Farms LP | 5511 Sandy Mush | Merced | 95340 |
| 5B50NC00075 | 1350 | Foster Dairy Farms #5 | 4412 Hickman | Denair | 95316 |
| 5B24NC00264 | 1350 | Michael Brasil Dairy | 18254 First | Stevinson | 95374 |
| 5B50NC00111 | 1350 | Roest Family Dairy | 2472 Gates | Modesto | 95358 |
| 5B50NC00132 | 1350 | Rocking S Dairy #1 | 3301 Ladd | Modesto | 95356 |
| 5C205024N01 | 1352 | SILVEIRA DAIRY | 11277 AVENUE 21 1/2 | CHOWCHILLA | 93610 |
| 5D105045N01 | 1360 | WHITNEY OAKS DAIRY | 2465 MOUNT WHITNEY | RIVERDALE | 93656 Sold out |
| 5B24NC00056 | 1360 | V & R Dairy | 7618 Hwy 59 | El Nido | 95317 |

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| 5D545104001 | 1362 | P & M DAIRY | 9535 Avenue 160 | TIPTON | 93272 |
| 5C54NC00067 | 1370 | RED ROSE DAIRY | 8950 AVENUE 360 | VISALIA | 93291 |
| 5C16NC00089 | 1374 | FERNANDES DAIRY | 16452 11th | HANFORD | 93230 |
| 5B50NC00218 | 1378 | Tony F Melo & Sons Dairy | 730 Bystrum | Turlock | 95380 |
| 5D545047001 | 1380 | HOMESTEAD DAIRY | 10178 AVE 352 | VISALIA | 93291 |
| 5B24NC00064 | 1380 | Coelho Frank & Sons L.P.Dairy | 2031 Washington | El Nido | 95317 |
| 5B24NC00288 | 1380 | Jose & Teresa Soares Dairy | 11076 Vincent | Turlock | 95380 |
| 5B395027001 | 1383 | Frank J Borges Dairy | 8350 Brady | Manteca | 95337 |
| 5C10NC00034 | 1387 | SOUZA'S DAIRY #2 | 2200 MARKS | FRESNO | 93706 |
| 5B20NC00024 | 1392 | JOE BERTAO & SONS DAIRY | 11270 AVENUE 21 | CHOWCHILLA | 93610 |
| 5B50NC00082 | 1395 | Postma Dairy #2 | 1439 Albers | Modesto | 95357 |
| 5C54NC00120 | 1398 | CHRIS DE JONG DAIRY | 14153 Road 168 | Porterville | 93257 |
| 5D105011001 | 1400 | SOZINHO DAIRY #2 | 8489 Elkhorn | Selma | 93662 |
| 5D155072N01 | 1400 | GOLDEN J DAIRY | 11699 STRADLEY | MCFARLAND | 93250 |
| 5B24NC00201 | 1400 | Antonio Brasil Dairy | 15373 Flanagan | Dos Palos | 93620 |
| 5B34NC00024 | 1400 | New Hope Dairy, LLC | 9551 New Hope | Galt | 95632 |
| 5B50NC00241 | 1408 | Germano & Jacinta Soares Dairy #1 | 9201 Hilmar | Turlock | 95380 |
| 5C505027001 | 1410 | Hilltop Holsteins | 4900 Dodds | Oakdale | 95361 |
| 5B50NC00294 | 1411 | Michel Ranch | 744 McEwen | Waterford | 95386 |
| 5D165097N01 | 1412 | DROOGH DAIRY | 23535 GRANGEVILLE | LEMOORE | 93245 |
| 5C54NC00118 | 1415 | B & D DAIRY | 10438 AVENUE 320 | VISALIA | 93291 |
| 5C16NC00062 | 1420 | WILLOW GROVE FARMS DAIRY | 6267 5th | Hanford | 93230 |
| 5B24NC00108 | 1424 | Larry Peterson Dairy | 21189 American | Hilmar | 95324 |
| 5D545151N01 | 1430 | JOE PINHEIRO & SONS DAIRY | 13881 Road 120 | Tipton | 93272 |
| 5C16NC00067 | 1430 | HOLLAND'S DAIRY | 3533 GRANGEVILLE | HANFORD | 93230 |
| 5C54NC00151 | 1433 | BEL R. MARTIN & SONS DAIRY | 12131 AVENUE 200 | TULARE | 93274 |
| 5C54NC00044 | 1440 | ALVIN SOUZA DAIRY #9 | 23343 Road 60 | TULARE | 93274 |
| 5C54NC00189 | 1440 | GTA DAIRY | 16197 AVENUE 172 | TULARE | 93274 |
| 5A11NC00028 | 1440 | Goedhart Dairy | 7084 County Road 31 | Orland | 95963 |
| 5C16NC00116 | 1445 | VACA VIEW DAIRY | 7205 HOUSTON | HANFORD | 93230 |
| 5B24NC00261 | 1445 | Amaral & Amaral Dairy | 5301 De Angelis | Stevinson | 95374 |
| 5B20NC00026 | 1446 | Machado Farms Dairy | 20400 Avenue 17 1/2 | Madera | 93637 |
| 5D545142N01 | 1449 | JOAQUIN TOLEDO JR. DAIRY | 3800 AVENUE 176 | CORCORAN | 93212 |
| 5C16NC00086 | 1450 | LU - AR DAIRY | 6121 15th | HANFORD | 93230 |
| 5B50NC00108 | 1450 | Hidden Valley Dairy | 8611 Dos Rios | Modesto | 95358 |
| 5C10NC00112 | 1469 | MEDEIROS DAIRY | 608 RIVERDALE | LATON | 93242 |
| 5C205017N01 | 1470 | AVILA FAMILY DAIRY | 13644 AVENUE 18 1/2 | CHOWCHILLA | 93610 |
| 5C16NC00075 | 1480 | JCJ DAIRY INC | 6269 LACEY | HANFORD | 93230 |
| 5B24NC00256 | 1480 | Fagundes Bros. Dairy #1 | 2510 Turlock | Snelling | 95369 |
| 5D545135N01 | 1481 | DE JONG DAIRY | 14153 ROAD 168 | PORTERVILLE | 93257 |
| 5D545083001 | 1486 | DENNIS VANDERHAM & SONS DAIRY | 13955 ROAD 80 | TIPTON | 93272 |
| 5C505017001 | 1487 | W & J Dairy #2 | 9161 Warnerville | Oakdale | 95361 |
| 5D545140N01 | 1491 | PALM DAIRY | 20303 ROAD 140 | TULARE | 93274 |

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| 5C10NC00066 | 1494 | AJ SLENDERS DAIRY | 625 COLEMAN | LATON | 93242 |
| 5B50NC00240 | 1495 | Garcia's Registered Jerseys | 1018 Hickman | Turlock | 95380 |
| 5B24NC00097 | 1495 | Jose V. Silveira Dairy | 10652 Newsome | Gustine | 95322 |
| 5D165109001 | 1500 | DOUBLE N DAIRY | 12700 EVERETT | HANFORD | 93230 |
| 5C54NC00046 | 1500 | MELVIN SIMOES DAIRY #3 | 10248 AVENUE 184 | TULARE | 93274 |
| 5C245019001 | 1500 | Tierra Buena Ranch | 8632 Meadow | Winton | 95388 |
| 5B24NC00030 | 1500 | De Jong Bros Dairy | 11006 East | Ballico | 95303 |
| 5B24NC00106 | 1500 | Bettencourt & Marson Dairy | 18128 American | Hilmar | 95324 |
| 5B50NC00030 | 1500 | El Katrina Dairy Farms #1 | 501 El Katrina | Ceres | 95307 |
| 5B50NC00036 | 1500 | S & S Dairy Inc | 348 Monte Vista | Ceres | 95307 |
| 5B24NC00120 | 1502 | Sunwest Jersey Dairy | 22270 Bloss | Hilmar | 95324 |
| 5B39NC00056 | 1505 | DeWitt Dairy | 6610 Collier | Acampo | 95220 |
| 5D545055001 | 1512 | PACHECO & FAGUNDES DAIRY | 23388 ROAD 180 | LINDSAY | 93247 |
| 5D105046N01 | 1525 | JOE R. GARCIA DAIRY | 20677 EAST | LATON | 93242 |
| 5B50NC00226 | 1535 | A & M De Souza Dairy | 3030 Central | Turlock | 95380 |
| 5B24NC00278 | 1535 | Joe O Rocha Dairy Inc. | 18451 Bradbury | Turlock | 95380 |
| 5C54NC00069 | 1537 | VAN RYN DAIRY | 37943 Road 144 | Visalia | 93292 sold out |
| 5D545090001 | 1540 | RIB-ARROW DAIRY | 18287 ROAD 136 | TULARE | 93274 |
| 5D545152001 | 1541 | KOETSIER DAIRY | 6901 AVENUE 280 | VISALIA | 93277 |
| 5D545064N01 | 1545 | H & T DAIRY | 13213 ROAD 80 | TIPTON | 93272 |
| 5C16NC00022 | 1545 | KANSAS HOLSTEIN DAIRY | 8480 KANSAS | HANFORD | 93230 |
| 5C54NC00159 | 1548 | PIRES DAIRY | 13464 AVE 152 | TIPTON | 93272 |
| 5C54NC00204 | 1550 | VANDEN BRINK DAIRY #2 | 14854 AVENUE 120 | PIXLEY | 93272 |
| 5C15NC00083 | 1550 | AFFENTRANGER & SONS DAIRY | 18107 KRATZMEYER | BAKERSFIELD | 93314 |
| 5C16NC00033 | 1550 | WEST CREEK DAIRY | 8409 5th | HANFORD | 93230 |
| 5C10NC00040 | 1550 | BILL IDSINGA DAIRY | 6043 MADERA | KERMAN | 93630 |
| 5B39NC00144 | 1550 | Kisst Dairy | 20000 Cedar | Tracy | 95304 |
| 5C505029001 | 1552 | Dotinga Dairy | 5737 Crow | Oakdale | 95361 |
| 5D545147N01 | 1554 | JOE MACEDO & SONS DAIRY | 14685 96 | TIPTON | 93272 |
| 5D545131N01 | 1558 | FOUR J JERSEYS #2 DAIRY | 19199 ROAD 80 | TULARE | 93274 |
| 5B24NC00052 | 1564 | Antonio Azevedo Dairy #1 | 2025 El Nido | El Nido | 95317 |
| 5C10NC00122 | 1567 | PACHECO DAIRY | 1108 PLUMAS | KERMAN | 93630 |
| 5B50NC00094 | 1570 | Genasci Dairy, Inc. | 6555 Blue Gum | Modesto | 95358 |
| 5B24NC00260 | 1575 | Fagundes Bros. Dairy #4 | 14877 Cox Ferry | Snelling | 95340 |
| 5C54NC00105 | 1580 | OAKBEND DAIRY | 23561 ROAD 168 | TULARE | 93274 |
| 5B39NC00077 | 1580 | Frank N Rocha Dairy LP | 23125 Lone Tree | Escalon | 95320 |
| 5C54NC00236 | 1581 | OAKVIEW DAIRY | 6775 AVENUE 232 | TULARE | 93274 |
| 5B39NC00087 | 1581 | Machado Dairy Farms #3 | 11685 Mariposa | Stockton | 95215 |
| 5C10NC00109 | 1584 | RUANN DAIRY | 7285 Davis | Riverdale | 93656 |
| 5B50NC00188 | 1585 | Hoekstra Dairy | 10836 Hwy 120 | Oakdale | 95361 |
| 5C54NC00187 | 1591 | DENNIS BOERTJE & SON DAIRY | 37404 ROAD 132 | VISALIA | 93292 |
| 5C54NC00077 | 1600 | Poplar Lane Dairy | 6780 Avenue 144 | Tipton | 93272 |
| 5A11NC00027 | 1600 | Van Tol Dairy No 2 | 6756 County Rd 30 | Orland | 95963 |

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| 5B39NC00115 | 1600 | De Snayer Dairy | 23243 Rond | Lodi | 95242 |
| 5B50NC00027 | 1600 | Ackerman Dairy, Inc. | 6942 Central | Ceres | 95307 |
| 5D545015001 | 1605 | PACIFIC SUN DAIRY | 9086 AVENUE 144 | TIPTON | 93272 |
| 5B24NC00236 | 1605 | Joe Lima Dairy | 5217 Oak | Merced | 95340 |
| 5C54NC00112 | 1610 | SIERRA VISTA DAIRY | 15434 Avenue 192 | Tulare | 93274 |
| 5B24NC00200 | 1610 | Manuel Godinho Dairy | 12710 Wilson | Los Banos | 93635 |
| 5C54NC00185 | 1617 | SEPEDA BROTHERS DAIRY | 18316 ROAD 128 | TULARE | 93274 |
| 5B50NC00107 | 1620 | Machado Edward A Dairy | 8600 Dos Rios | Modesto | 95358 |
| 5C54NC00270 | 1625 | BORBA DAIRY | 14836 ROAD 200 | PORTERVILLE | 93257 |
| 5B24NC00045 | 1628 | Sierra Vista Dairy LP | 22426 Monte Vista | Denair | 95316 |
| 5C15NC00004 | 1630 | ANSONEA DAIRY | 5250 DI GIORGIO | BAKERSFIELD | 93307 |
| 5B395042001 | 1636 | Van Exel Dairy #1 | 20002 Thornton | Lodi | 95242 |
| 5C10NC00085 | 1640 | COELHO FARMS DAIRY | 21655 Cornelia | Riverdale | 93656 |
| 5D545030N01 | 1650 | AMSTEL DAIRY | 6194 AVENUE 228 | TULARE | 93274 |
| 5C54NC00093 | 1650 | FIVE STAR II DAIRY | 14552 AVENUE 152 | TIPTON | 93272 |
| 5B50NC00131 | 1650 | Rocking S Dairy #2 | 2330 Ladd | Modesto | 95356 |
| 5C54NC00006 | 1663 | PETE VANDER POEL DAIRY | 19493 Road 140 | TULARE | 93274 |
| 5D545111001 | 1667 | MOUNTAIN VIEW DAIRY | 37248 ROAD 144 | VISALIA | 93292 |
| 5B24NC00185 | 1668 | Joe Nunes Dairy | 22484 W. China Camp | Los Banos | 93635 |
| 5C54NC00177 | 1673 | A & R VIEIRA DAIRY | 9225 AVENUE 152 | TIPTON | 93272 |
| 5C245021001 | 1675 | JVJ Dairy #2 - Parkview Dairy | 13640 Collier | Delhi | 95315 |
| 5D545114001 | 1676 | BORGES DAIRY | 16371 ROAD 136 | TIPTON | 93272 |
| 5C54NC00249 | 1700 | BRASIL & SONS DAIRY | 14913 Road 80 | Tipton | 93727 |
| 5C54NC00014 | 1700 | J & A Dairy | 12212 Avenue 176 | Tulare | 93274 |
| 5B24NC00237 | 1700 | Melo Dairy | 1319 Quinley | Merced | 95340 |
| 5C54NC00157 | 1706 | TONY S. MENDONCA & SONS DAIRY | 11679 AVENUE 200 | TULARE | 93274 |
| 5C10NC00131 | 1708 | SOUZA'S DAIRY | 8555 VALENTINE | FRESNO | 93706 |
| 5C54NC00010 | 1710 | ENDEAVOR GOLD DAIRY | 21573 Road 28 | TULARE | 93724 |
| 5C10NC00092 | 1710 | A.F. MENDES DAIRY | 22700 CORNELIA | RIVERDALE | 93656 |
| 5D545013N01 | 1712 | AVENUE 128 DAIRY | 13002 Avenue 128 | TIPTON | 93272 |
| 5D105036N01 | 1714 | FRANK S. BROWN CO. DAIRY | 22045 VALENTINE | RIVERDALE | 93656 |
| 5D545160001 | 1714 | Mario Simoes Jr. Dairy | 7405 AVE 216 | TULARE | 93274 |
| 5C54NC00162 | 1718 | JOE SIMOES FAMILY DAIRY | 13440 ROAD 136 | TIPTON | 93272 |
| 5D545139N01 | 1725 | MANCEBO DAIRY | 14891 AVE 232 | TULARE | 93274 |
| 5C54NC00095 | 1725 | LOS ROBLES DAIRY | 17393 Road 216 | PORTERVILLE | 93257 |
| 5D155086N01 | 1725 | Peterson Dairy | 30999 PETERSON | MCFARLAND | 93250 |
| 5B50NC00029 | 1725 | Trinkler Dairy Farms | 7251 Crows Landing | Ceres | 95307 |
| 5D155060001 | 1729 | PETRISSANS DAIRY | 5111 BEAR MOUNTAIN | BAKERSFIELD | 93313 |
| 5B39NC00100 | 1737 | Rock Creek Dairy | 29770 Hwy 4 | Farmington | 95230 |
| 5D165005001 | 1738 | JOHN DE JONG DAIRY | 3742 LACEY | HANFORD | 93230 |
| 5D101039001 | 1740 | FRED RAU DAIRY | 10255 MANNING | FRESNO | 93706 |
| 5D545087001 | 1740 | SIERRA VIEW DAIRY | 13376 AVENUE 224 | TULARE | 93274 |
| 5B50NC00275 | 1740 | GJ Silva & Son Dairy | 3107 Prairie Flower | Turlock | 95380 |

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| 5D165030001 | 1750 | MENDES & TOSTE DAIRY | 8519 24TH | LEMOORE | 93245 |
| 5D545052001 | 1750 | TRI BACK DAIRY, LLC | 9045 AVENUE 368 | DINUBA | 93618 |
| 5C16NC00039 | 1750 | C. MATTOS & SONS DAIRY | 17800 4TH | HANFORD | 93230 |
| 5B24NC00131 | 1760 | Hilmar Holsteins, Inc. | 21859 Crane | Hilmar | 95324 |
| 5C54NC00213 | 1777 | VP FARMS DAIRY | 15503 Road 96 | Tulare | 93274 |
| 5C54NC00221 | 1800 | SUN VALLEY DAIRY | 255 ROAD 128 | DELANO | 93215 |
| 5D545031N01 | 1800 | ARTHUR LEYENDEKKER DAIRY | 9001 AVENUE 360 | VISALIA | 93291 |
| 5C10NC00013 | 1800 | THOMMEN DAIRY | 53955 NEES | FIREBAUGH | 93622 |
| 5B395025001 | 1800 | Wagner Dairy | 22176 Skiff | Escalon | 95320 |
| 5B24NC00166 | 1800 | Vierra Ranch Dairy | 23160 Williams | Hilmar | 95324 |
| 5B24NC00123 | 1802 | Wickstrom Jersey Farms, Inc. | 5638 Columbus | Hilmar | 95324 |
| 5C54NC00056 | 1803 | ISLAND DAIRY FARMS | 7435 AVENUE 360 | KINGSBURG | 93631 |
| 5B395035001 | 1820 | Joe Da Silva Dairy (Dodds Rd) | 27398 Dodds | Escalon | 95320 |
| 5B24NC00259 | 1825 | Fagundes Bros. Dairy #3 | 2852 Turlock | Snelling | 95369 |
| 5C54NC00040 | 1828 | MILK MAID DAIRY | 35826 Road 100 | VISALIA | 93291 |
| 5B50NC00076 | 1828 | Foster Dairy Farms #6 | 6111 Monte Vista | Denair | 95316 |
| 5C54NC00144 | 1840 | NUNES & SONS DAIRY | 690 OAKDALE | TULARE | 93274 |
| 5B395006001 | 1840 | Lima Ranch | 13436 Thornton | Lodi | 95242 |
| 5B50NC00159 | 1840 | Manuel Morris Dairy | 3647 Shiloh | Modesto | 95351 |
| 5D545002001 | 1841 | TRIPLE H DAIRY #1 | 13255 AVENUE 212 | TULARE | 93274 |
| 5D545113001 | 1850 | RICHARD WESTRA DAIRY | 4070 AVENUE 256 | Tulare | 93274 |
| 5D545156001 | 1850 | HYNES DAIRY | 4497 Colpien Rd | TULARE | 93274 |
| 5B50NC00068 | 1850 | Haringa Dairy | 14842 Keyes | Denair | 95316 |
| 5C54NC00089 | 1855 | SCHOTT DAIRY | 13602 ROAD 96 | TIPTON | 93272 |
| 5C54NC00103 | 1880 | ALVIN SOUZA DAIRY #1 | 6305 AVENUE 176 | TULARE | 93274 |
| 5B24NC00203 | 1880 | JVJ Dairy #3 | 1320 Arboleda | Merced | 95340 |
| 5C205011001 | 1885 | TRIANGLE M DAIRY | 11302 AVENUE 18 1/2 | CHOWCHILLA | 93610 |
| 5B24NC00122 | 1892 | Martins Bros Dairy | 6041 Central | Hilmar | 95324 |
| 5D545161N01 | 1900 | F & J DELANO DAIRY | 14180 AVENUE 16 | DELANO | 93215 |
| 5C16NC00101 | 1900 | BERNARD TE VELDE DAIRY #1 | 1305 IONA | HANFORD | 93230 |
| 5B24NC00296 | 1900 | Milk Made Dairy | 7509 Oakdale | Snelling | 95369 |
| 5C54NC00222 | 1910 | DELTA VIEW FARMS DAIRY | 4775 AVENUE 304 | VISALIA | 93291 |
| 5C10NC00140 | 1912 | GREEN VALLEY DAIRY | 2685 MADERA | KERMAN | 93630 |
| 5C245023001 | 1918 | Maximinio Silviera Dairy | 4210 Lingard | Merced | 95340 |
| 5B395050001 | 1920 | Dutra Farms, Inc. | 5496 Ripon | Manteca | 95337 |
| 5D545107001 | 1925 | COSTA DAIRY | 29134 ROAD 56 | VISALIA | 93277 |
| 5C54NC00080 | 1935 | HERITAGE DAIRY | 15651 Avenue 192 | Tulare | 93274 |
| 5C54NC00227 | 1950 | RIO BLANCO DAIRY | 5041 AVENUE 192 | TULARE | 93274 |
| 5D545130001 | 1980 | GERRIT GRIFFIOEN DAIRY | 7901 AVENUE 368 | DINUBA | 93618 |
| 5C16NC00021 | 1980 | MATTOS BROTHERS DAIRY | 4017 KANSAS AVENUE | HANFORD | 93230 |
| 5C16NC00040 | 1980 | JOE B. PACHECO DAIRY | 16025 6 1/2 | HANFORD | 93230 |
| 5B24NC00167 | 1980 | Mayo Dairy #1 | 11923 Childs | Le Grand | 95333 |
| 5B24NC00066 | 1998 | Live Oak Dairy F | 13310 Eagle Field | Firebaugh | 93622 |

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| 5D545059001 | 2000 | VANDERHAM DAIRY | 8150 AVENUE 360 | VISALIA | 93291 |
| 5D545168001 | 2000 | ROBERT VANDER EYK DAIRY | 9441 AVENUE 104 | PIXLEY | 93256 |
| 5C10NC00081 | 2000 | MOUNT WHITNEY DAIRY | 2792 MT. WHITNEY | RIVERDALE | 93656 |
| 5C54NC00250 | 2016 | LOU-MAR DAIRY | 14870 AVE 152 | TIPTON | 93272 |
| 5D545172001 | 2040 | EL MONTE DAIRY | 10410 Avenue 160 | Tipton | 93272 |
| 5C10NC00117 | 2050 | SWEET HAVEN DAIRY | 10467 KAMM | RIVERDALE | 93656 |
| 5B50NC00061 | 2050 | Albert Mendes Dairy | 1100 Ruble | Crows Landing | 95313 |
| 5B50NC00161 | 2050 | Tony Morris Dairy | 6506 Vivian | Modesto | 95358 |
| 5B395004001 | 2052 | John A Machado Dairy Farms | 24916 Manteca | Manteca | 95336 |
| 5D545032N01 | 2060 | CLEARLAKE DAIRY | 24643 ROAD 36 | TULARE | 93274 |
| 5C54NC00176 | 2070 | DE JONG DAIRY | 13076 AVENUE 368 | VISALIA | 93292 |
| 5C10NC00048 | 2070 | JESSIE P. SILVA DAIRY | 3451 HARLAN | LATON | 93242 |
| 5B39NC00131 | 2070 | Raymond M. & Sue Quaresma Dairy | 26290 Union | Manteca | 95337 |
| 5B39NC00062 | 2078 | Edward Nunes Dairy | 17399 Avena | Escalon | 95320 |
| 5C54NC00048 | 2095 | ROB VAN GROUW DAIRY | 32843 Road 76 | VISALIA | 93291 |
| 5D545060001 | 2100 | RANCHO SIERRA VISTA DAIRY | 32866 Road 108 | Visalia | 93291 |
| 5D545141001 | 2100 | HIGHSTREET DAIRY | 15503 AVENUE 240 | TULARE | 93274 |
| 5B24NC00081 | 2100 | Barmac Dairy | 5070 Hunt | Gustine | 95322 |
| 5B39NC00107 | 2100 | Castelanelli Bros Dairy | 401 Armstrong | Lodi | 95242 |
| 5C54NC00232 | 2110 | DJ DAIRY | 4390 AVENUE 352 | TRAVER | 93631 |
| 5B39NC00088 | 2115 | John Vander Schaaf #3 Dairy | 13775 Murphy | Escalon | 95320 |
| 5D165091N01 | 2127 | VALADAO DAIRY | 17293 9 1/2 | HANFORD | |
| 5C54NC00145 | 2131 | NUNES BROS. DAIRY | 20439 ROAD 124 | TULARE | 93274 |
| 5D155056N01 | 2153 | DAVID VANDER SCHAAF DAIRY | 7524 FAIRFAX | BAKERSFIELD | 93307 |
| 5C15NC00003 | 2160 | G3 DAIRY | 5829 PANAMA | BAKERSFIELD | 93307 |
| 5D545071003 | 2165 | KROES DAIRY SOUTH | 8360 AVENUE 144 | TIPTON | 93272 |
| 5C54NC00045 | 2170 | VAN BEEK BROTHERS DAIRY | 14808 ROAD 152 | TIPTON | 93272 |
| 5C16NC00056 | 2170 | HIGH ROLLER DAIRY | 14782 8th | HANFORD | 93230 |
| 5C10NC00061 | 2172 | A & M FARMS DAIRY | 10350 MANNING | FRESNO | 93706 |
| 5B24NC00135 | 2175 | Nylund Dairy Farms | 20723 Geer | Hilmar | 95324 |
| 5C16NC00006 | 2190 | DE GROOT DAIRIES-NORTH | 2446 Grangeville | HANFORD | 93230 |
| 5B50NC00269 | 2190 | Lumar Dairy Farms | 7215 Prairie Flower | Turlock | 95380 |
| 5D545102001 | 2200 | VANDER TUIG DAIRY | 20127 ROAD 164 | STRATHMORE | 93267 |
| 5D155065001 | 2200 | OASIS HOLSTEINS DAIRY | 18041 Palm | SHAFTER | 93263 |
| 5B50NC00196 | 2213 | Willy Creek Ranch Dairy | 12530 Warnerville | Oakdale | 95361 |
| 5B50NC00053 | 2237 | Alamo Dairy | 1500 Fulkerth | Crows Landing | 95313 |
| 5B24NC00119 | 2262 | Claus Dairy Farms | 21670 Bloss | Hilmar | 95324 |
| 5B395046001 | 2266 | Flying M Dairy | 26230 Union | Manteca | 95337 |
| 5D545023001 | 2300 | PINHEIRO DAIRY | 20997 Road 180 | STRATHMORE | 93267 |
| 5C54NC00098 | 2300 | TOP O' THE MORN FARMS | 17324 ROAD 136 | TULARE | 93274 |
| 5C10NC00017 | 2300 | MAPLE DAIRY | 19860 Maple | LATON | 93242 |
| 5B50NC00254 | 2300 | Robert Gioletti & Sons Dairy | 10213 Main | Turlock | 95380 |
| 5B50NC00109 | 2300 | Tony Meirinho and Sons Dairy #1 | 1685 Dunn | Modesto | 95358 |

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|---|---|---|---|---|---|
| 5B24NC00137 | 2304 | Yosemite Jersey Dairy | 21522 Geer | Hilmar | 95324 |
| 5D545037001 | 2320 | RON VERHOEVEN FAMILY DAIRY | 4975 AVENUE 120 | CORCORAN | 93212 |
| 5D165120001 | 2325 | FELICITA DAIRY | 22154 ROAD 20 | TULARE | 93274 |
| 5C54NC00063 | 2350 | CASCADE DAIRY | 24116 ROAD 28 | TULARE | 93274 |
| 5B24NC00226 | 2350 | 5 H Farms | 5851 Hwy 59 | Merced | 95340 |
| 5B24NC00294 | 2397 | P H Ranch, Inc. | 6335 Oakdale | Winton | 95388 |
| 5C205023N01 | 2400 | TROOST DAIRY | 27000 ROAD 9 | CHOWCHILLA | 93610 |
| 5C54NC00081 | 2400 | GMC DAIRY | 4738 AVENUE 120 | CORCORAN | 93212 |
| 5B24NC00069 | 2400 | Silveira Bros Dairy #2 | 12081 Cherokee | Gustine | 95322 |
| 5B50NC00312 | 2400 | Couco Creek Dairy | 3303 Washington | Turlock | 95381 |
| 5D545039N01 | 2415 | CHRIS & JOHN JONGSMA DAIRY | 15759 AVENUE 128 | TIPTON | 93272 |
| 5D545041001 | 2415 | MELLEMA DAIRY | 9420 AVENUE 320 | VISALIA | 93291 |
| 5B39NC00089 | 2420 | Vander Schaff Dairy | 12739 Murphy | Escalon | 95320 |
| 5B50NC00115 | 2445 | Val Martins Dairy | 3655 Gates | Modesto | 95358 |
| 5D155059N01 | 2452 | PALLA ROSA FARMS DAIRY #3 | 12841 Bear Mountain | BAKERSFIELD | 93311 |
| 5D545117001 | 2456 | JAMES JONGSMA DAIRY | 9229 Road 164 | Pixley | 93256 |
| 5D165098001 | 2491 | DEGROOT DAIRIES-SOUTH | 3101 GRANGEVILLE | HANFORD | 93230 |
| 5D155087001 | 2500 | WHITESIDE DAIRY | 16477 SCOFIELD | WASCO | 93280 |
| 5B24NC00125 | 2500 | James Ahlem Dairy | 9483 Columbus | Hilmar | 95324 |
| 5B50NC00056 | 2500 | Moonshine Dairy | 22922 Kilburn | Crows Landing | 95313 |
| 5B50NC00072 | 2500 | Ahlem's Foothills Farms | 15453 Monte Vista | Denair | 95316 |
| 5B39NC00092 | 2520 | G & H Dairy | 16996 Sexton | Escalon | 95320 |
| 5B24NC00232 | 2530 | Hoogendam Dairy | 1650 Mcnamara | Merced | 95340 |
| 5C54NC00205 | 2550 | SOUTH CREEK DAIRY | 11450 AVENUE 64 | EARLIMART | 93219 |
| 5D165103N01 | 2550 | DOVER DAIRY | 4265 DOVER | HANFORD | 93230 |
| 5C20NC00001 | 2564 | MILK TIME DAIRY | 12519 ROAD 16 | MADERA | 93637 |
| 5D545054N01 | 2575 | WILLIAM & JOHN JONGSMA DAIRY | 11598 ROAD 152 | PIXLEY | 93256 |
| 5D545080001 | 2590 | KROES DAIRY | 8509 AVE 152 | TIPTON | 93272 |
| 5D545098001 | 2595 | FLINT DAIRY | 6511 FLINT | HANFORD | 93230 |
| 5D545122N01 | 2600 | DE GROOT DAIRY #4 | 15419 AVENUE 96 | PIXLEY | 93256 |
| 5C10NC00116 | 2605 | FONTES DAIRY FARMS-DAIRY 2 | 20334 POLK | RIVERDALE | 93656 |
| 5D105049N01 | 2610 | JOHN DE GROOT & SON DAIRY | 6105 LINCOLN | FRESNO | 93706 |
| 5D165047002 | 2622 | JIM NACE DAIRY | 16026 Road 64 | TIPTON | 93272 |
| 5D165046N01 | 2640 | CADILLAC RANCH DAIRY | 5387 KENT | HANFORD | 93230 |
| 5D545127N01 | 2640 | CURTI FAMILY INC. | 3235 AVENUE 199 | Tulare | 93274 |
| 5D545040N02 | 2650 | RYNSBURGER DAIRY | 18591 Avenue 192 | STRATHMORE | 93267 |
| 5B24NC00143 | 2650 | Borba Dairy Farms | 5297 Kelley | Hilmar | 95324 |
| 5B24NC00103 | 2670 | Charles Ahlem Ranch | 23546 American | Hilmar | 95324 |
| 5C16NC00111 | 2678 | MANUEL & ALDA LAWRENCE DAIRY | 12871 KENT | HANFORD | 93230 |
| 5C15NC00035 | 2700 | KOOTSTRA DAIRY | 13628 ADOBE ROAD | BAKERSFIELD | 93307 |
| 5D165056001 | 2701 | MEDEIROS & SON DAIRY | 14235 KENT | HANFORD | 93230 |
| 5C54NC00219 | 2725 | LEGACY RANCH 2 (DAIRY) | 8660 AVENUE 96 | PIXLEY | 93256 |
| 5C54NC00192 | 2750 | WILL DE GROOT DAIRY | 15417 AVENUE 104 | PIXLEY | 93256 |

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|---|---|---|---|---|---|
| 5B24NC00037 | 2750 | DeJager Dairy #1 North | 11375 Ivy Ave | Chowchilla | 93610 |
| 5B24NC00068 | 2750 | Tony L. Lopes Dairy LP #1 | 27500 Bunker | Gustine | 95322 |
| 5B24NC00246 | 2750 | 3-M Dairy, Inc. | 3510 Sandy Mush | Merced | 95340 |
| 5B24NC00182 | 2760 | Rodoni Dairy Farms, LP | 18037 Center | Los Banos | 93635 |
| 5B24NC00242 | 2775 | Rock-Shar Dairy | 3025 Sandy Mush | Merced | 95340 |
| 5B24NC00308 | 2776 | R.V. Dairy | 8000 Meadow | Winton | 95388 |
| 5A57NC00024 | 2800 | Cache Creek Dairy | 31503 County Rd 26 | Woodland | 95695 |
| 5D545094001 | 2860 | LOUIE DE GROOT DAIRY | 15081 AVENUE 104 | PIXLEY | 93256 |
| 5B24NC00144 | 2870 | Valsigna Dairy | 6071 Larson | Hilmar | 95324 |
| 5D545092001 | 2900 | MARIO SIMOES FAMILY DAIRY #1 | 13185 AVENUE 136 | TIPTON | 93272 |
| 5B39NC00072 | 2911 | George Tevelde Dairy | 27815 Dodds | Escalon | 95320 |
| 5C16NC00094 | 2944 | FOUR STAR DAIRY | 18886 4th | HANFORD | 93230 |
| 5D545017001 | 2949 | PACHECO DAIRY | 5730 AVENUE 256 | TULARE | 93274 |
| 5C54NC00003 | 3043 | HOLSTEIN FARMS DAIRY | 4315 AVENUE 176 | TULARE | 93274 |
| 5C15NC00020 | 3074 | MC MOO FARMS DAIRY | 11663 Buena Vista | BAKERSFIELD | 93311 |
| 5C54NC00220 | 3090 | DAIRYLAND FARMS DAIRY | 15982 ROAD 152 | TIPTON | 93272 |
| 5B50NC00127 | 3090 | Alamo Farms | 5000 Keyes | Modesto | 95358 |
| 5B24NC00094 | 3095 | Frank J Gomes Dairy #2 | 870 Kniebes | Gustine | 95322 |
| 5B24NC00093 | 3100 | John B Pires Dairy | 1622 Kniebes | Gustine | 95322 |
| 5D155084001 | 3105 | AUKEMAN DAIRY | 28349 LOS ANGELES | SHAFTER | 93263 |
| 5C15NC00036 | 3130 | J & R DAIRY | 4403 BEAR MOUNTAIN | BAKERSFIELD | 93313 |
| 5B39NC00147 | 3130 | Fred A Douma Dairy Partnership | 28524 Kasson | Tracy | 95304 |
| 5B50NC00024 | 3130 | Double D Dairy | 2207 Roberts | Ceres | 95307 |
| 5C54NC00025 | 3140 | MOONLIGHT DAIRY | 5061 AVENUE 280 | VISALIA | 93277 |
| 5C205026001 | 3150 | DIEPERSLOOT RANCH DAIRY | 14303 AVENUE 14 | MADERA | 93637 |
| 5D155057002 | 3150 | VANDEN BERGE DAIRY | 11701 OLD RIVER ROAD | BAKERSFIELD | 93311 |
| 5D155070N01 | 3150 | RICHMAR FARMS DAIRY | 1129 SHAFTER | BAKERSFIELD | 93307 |
| 5D155064001 | 3175 | BEAR MOUNTAIN DAIRY | 4551 BEAR MOUNTAIN | BAKERSFIELD | 93313 |
| 5B395022001 | 3185 | Seifert Dairy Farm | 8505 Collier | Acampo | 95220 |
| 5B39NC00069 | 3190 | Temple Creek Dairy | 26250 Carter | Escalon | 95320 |
| 5C54NC00065 | 3200 | R & S DAIRY | 15992 Avenue 192 | Tulare | 93274 |
| 5C10NC00151 | 3250 | OPEN SKY DAIRY | 12103 Elkhorn | Burrel | 93607 |
| 5C15NC00040 | 3250 | H & P DAIRY | 5021 BEAR MOUNTAIN | BAKERSFIELD | 93307 |
| 5C10NC00050 | 3250 | L& J VANDERHAM DAIRY | 10772 MT. WHITNEY | RIVERDALE | 93656 |
| 5B24NC00035 | 3250 | Vista Verde Dairy | 8923 Bliss | Chowchilla | 93610 |
| 5C15NC00085 | 3268 | NEWHOUSE DAIRY | 16130 BEAR MOUNTAIN | BAKERSFIELD | 93313 |
| 5D545044002 | 3277 | DICK VANDERHAM DAIRY | 12565 AVENUE 152 | TIPTON | 93272 |
| 5C15NC00009 | 3300 | VERMEER & GOEDHART DAIRY | 18683 MAGNOLIA | SHAFTER | 93263 |
| 5D155093001 | 3300 | BAR-DR DAIRY | 27125 POND | WASCO | 93280 |
| 5B24NC00036 | 3300 | De Jager Dairy So. | 8002 Bliss | Chowchilla | 93610 |
| 5D545106001 | 3325 | HETTINGA FARMS DAIRY | 13400 AVENUE 120 | PIXLEY | 93256 sold |
| 5A48NC00017 | 3325 | Heritage Dairy | 7755 Midway | Dixon | 95620 |
| 5D545100001 | 3350 | FRIESIAN FARMS DAIRY | 5593 AVENUE 176 | TULARE | 93274 |

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|---|---|---|---|---|---|
| 5C54NC00075 | 3350 | GRACELAND DAIRY | 18150 ROAD 112 | TULARE | 93274 Sold |
| 5C54NC00070 | 3353 | RIBEIRO DAIRY | 17983 ROAD 128 | TULARE | 93274 |
| 5B24NC00265 | 3376 | Anchor J Dairy | 24507 First | Stevinson | 95374 |
| 5D545084N01 | 3380 | S & S DAIRY | 5311 AVE 272 | VISALIA | 93277 |
| 5D545022N01 | 3385 | CURTIMADE DAIRY | 18337 ROAD 24 | Tulare | 93274 |
| 5D545042002 | 3400 | JR DAIRY | 13508 ROAD 104 | TIPTON | 93272 |
| 5D545126N01 | 3400 | GERBEN LEYENDEKKER DAIRY #1 | 8517 AVE 360 | VISALIA | 93291 |
| 5B20NC00027 | 3400 | DOUBLE DJ FARMS DAIRY | 14768 AVENUE 27 | CHOWCHILLA | 93610 |
| 5C54NC00138 | 3409 | ROCKY ROAD DAIRIES #1 | 8715 AVENUE 368 | DINUBA | 93618 |
| 5C205028N01 | 3428 | FABLAND FARMS DAIRY | 12852 Road 9 | Madera | 93637 |
| 5C54NC00074 | 3450 | HOFFMAN DAIRY | 21346 ROAD 140 | TULARE | 93274 |
| 5B24NC00104 | 3450 | Ahlem Farms Partnership | 24093 American | Hilmar | 95324 |
| 5C10NC00060 | 3460 | BAR NONE/VAN DER HOEK DAIRY | 15886 LASSEN | HELM | 93627 |
| 5D545135002 | 3487 | FERN OAK FARMS DAIRY | 17001 AVENUE 160 | PORTERVILLE | 93274 |
| 5B24NC00025 | 3495 | Gallo Cottonwood Dairy | 10561 Hwy 140 | Atwater | 95301 |
| 5C10NC00030 | 3530 | SHADY ACRES DAIRY #2 | 15391 ELKHORN | Helm | 93627 |
| 5D545166001 | 3552 | AUKEMAN FARMS DAIRY | 17297 Road 96 | Tulare | 93274 |
| 5C54NC00011 | 3582 | RIVERVIEW DAIRY | 9295 AVENUE 88 | PIXLEY | 93256 |
| 5D545045001 | 3600 | DE BOER DAIRY | 14976 Avenue 168 | Tulare | 93274 |
| 5C15NC00019 | 3600 | BOSCHMA & SONS DAIRY | 24794 SHERWOOD | WASCO | 93280 |
| 5C54NC00090 | 3605 | D & V DAIRY | 15625 AVENUE 144 | TIPTON | 93272 |
| 5D165082002 | 3650 | DIAMOND D LLC DAIRY | 9423 IDAHO | HANFORD | 93230 |
| 5D155066001 | 3707 | PALLA ROSA FARM BV DAIRY | 18904 BEAR MOUNTAIN | BAKERSFIELD | 93311 |
| 5D545036003 | 3744 | ELKHORN DAIRY | 10400 AVENUE 368 | VISALIA | 93291 |
| 5B24NC00171 | 3787 | 140 Cattle Company Dairy | 15751 Hwy 140 | Livingston | 95334 |
| 5D155080001 | 3800 | TJAARDA DAIRY | 19211 Magnolia | SHAFTER | 93263 |
| 5C54NC00002 | 3900 | DYKSTRA DAIRY | 6801 Avenue 176 | Tulare | 93274 |
| 5C16NC00117 | 3900 | JOHN VISSER DAIRY | 3601 LACEY | HANFORD | 93230 |
| 5D155058N01 | 3950 | AJB RANCH DAIRY | 28724 STOCKDALE HWY | BAKERSFIELD | 93314 |
| 5D545043002 | 3967 | HAMSTRA DAIRY COMPLEX | 7590 AVENUE 260 | TULARE | 93274 |
| 5D155082001 | 4000 | BELLANAVE DAIRY | 14461 TAFT | BAKERSFIELD | 93311 |
| 5C15NC00046 | 4025 | TRILOGY DAIRY | 17661 BEAR MOUNTAIN | BAKERSFIELD | 93313 |
| 5D545033N01 | 4035 | BOSMA MILK COMPANY DAIRY | 13805 Avenue 160 | TIPTON | 93272 |
| 5B39NC00106 | 4038 | Weststeyn Dairy #2 | 1763 Hewitt Rd | Linden | 95236 |
| 5C16NC00020 | 4083 | RIVER RANCH DAIRY | 6155 JACKSON | HANFORD | 93230 |
| 5D545120001 | 4114 | NORTHSTAR DAIRY | 12718 Road 144 | TIPTON | 93272 |
| 5C10NC00055 | 4120 | J & D WILSON & SONS DAIRY | 11720 MT. WHITNEY | RIVERDALE | 93656 |
| 5D155073001 | 4200 | GOYENETCHE DAIRY | 6041 Brandt | Buttonwillow | 93206 |
| 5C245038001 | 4200 | Forebay Farms Dairy | 13699 Cherokee | Gustine | 95322 |
| 5B24NC00038 | 4200 | DeJager Dairy #2 North | 11140 Ivy Ave | Chowchilla | 93610 |
| 5C15NC00084 | 4203 | LAKEVIEW FARMS DAIRY | 17702 BEAR MOUNTAIN | BAKERSFIELD | 93311 |
| 5D545084002 | 4300 | SCHEENSTRA DAIRY | 16800 ROAD 96 | TIPTON | 93272 |
| 5C15NC00047 | 4350 | T & W FARMS DAIRY | 18346 OLD RIVER | Bakersfield | 93311 |

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|---|---|---|---|---|---|
| 5C54NC00043 | 4410 | SIERRA VALLEY DAIRY | 7976 AVENUE 84 | PIXLEY | |
| 5B24NC00021 | 4430 | Gallo Columbard Dairy | 91 Bert Crane | Atwater | 95301 |
| 5D545075N01 | 4500 | G.J. TE VELDE RANCH DAIRY | 5850 AVENUE 160 | TIPTON | 93272 |
| 5D545050001 | 4518 | RANCHO TERESITA DAIRY | 21744 ROAD 152 | TULARE | 93274 |
| 5D545162001 | 4630 | CORNERSTONE DAIRY | 8769 AVENUE 128 | TIPTON | 93272 |
| 5D165070001 | 4700 | LONE OAK FARMS DAIRY #1 | 13866 4TH AVENUE | HANFORD | 93230 |
| 5D545109001 | 4700 | MILKY WAY DAIRY | 34800 Road 80 | VISALIA | 93291 |
| 5C16NC00019 | 4750 | VALLEY VIEW FARMS DAIRY | 15673 5 1/2 | HANFORD | 93230 |
| 5C245026001 | 4750 | Hillcrest Dairy | 1901 Hayden | Le Grand | 95322 |
| 5D545061001 | 4776 | BOS DAIRY | 20397 ROAD 152 | TULARE | 93274 |
| 5C15NC00045 | 4850 | WEST-STAR NORTH DAIRY | 26953 RIVERSIDE | BUTTONWILLOW | 93313 |
| 5C54NC00156 | 4900 | RIVERBEND DAIRY | 20799 ROAD 132 | TULARE | 93274 |
| 5C205022N01 | 4950 | TRI-IEST DAIRY | 16500 AVENUE 14 | MADERA | 93637 |
| 5D105007001 | 4950 | ZONNEVELD DAIRIES COMPLEX | 1560 CERINI | LATON | 93242 |
| 5C54NC00005 | 4970 | K & M VISSER DAIRY | 9279 Avenue 96 | PIXLEY | 93256 |
| 5B20NC00046 | 5003 | IEST FAMILY FARMS DAIRY | 14576 AVENUE 14 | MADERA | 93637 |
| 5B20NC00039 | 5072 | NEVA GAYLE FARMS DAIRY | 7500 AVENUE 14 | MADERA | 93637 |
| 5D545115001 | 5168 | JER-Z- BOYS DAIRY #1 | 11001 AVE 112 | PIXLEY | 93256 |
| 5C15NC00050 | 5260 | MAYA DAIRY | 18451 WILDWOOD | BUTTONWILLOW | 93206 |
| 5B20NC00018 | 5365 | DIAMOND H DAIRY | 9564 Avenue 18 1/2 | CHOWCHILLA | 93610 |
| 5D155079001 | 5400 | WEST KERN DAIRY | 14467 TAFT | BAKERSFIELD | 93311 |
| 5C15NC00048 | 5450 | CARLOS ECHEVERRIA & SONS DAIRY | 20229 Old River | Bakersfield | 93311 |
| 5D155092001 | 5450 | Western Sky Dairy | 18501 Old River Road | Bakersfield | 93311 |
| 5D545158001 | 5550 | C & A HOLSTEINS (DAIRY) | 7957 AVENUE 84 | PIXLEY | 93256 |
| 5B20NC00020 | 5550 | FAGUNDES DAIRY | 23732 ROAD 12 | CHOWCHILLA | 93610 |
| 5C54NC00017 | 5750 | HORIZON JERSEYS DAIRY | 8798 AVENUE 160 | TIPTON | 93272 |
| 5D155061002 | 5854 | POSO CREEK FAMILY DAIRY | 13437 GUN CLUB | WASCO | 93280 |
| 5C54NC00009 | 6000 | JOHN VANDER POEL DAIRY | 8001 ROAD 104 | PIXLEY | 93256 |
| 5D545085001 | 6060 | DOUBLE J DAIRY | 6656 Avenue 328 | VISALIA | 93291 |
| 5D165069001 | 6400 | DAVID TE VELDE DAIRY | 5001 4TH AVENUE | HANFORD | 93230 |
| 5C54NC00013 | 6707 | SOUTH LAKES DAIRY | 5595 AVENUE 96 | PIXLEY | 93256 |
| 5D155058002 | 6850 | MAPLE DAIRY | 15857 BEAR MOUNTAIN | BAKERSFIELD | 93311 |
| 5B20NC00028 | 6876 | COSTA VIEW FARMS DAIRY #2 | 16800 ROAD 15 | MADERA | 93637 |
| 5C54NC00181 | 6900 | PACIFIC RIM DAIRY | 13406 ROAD 24 | TULARE | 93212 |
| 5C205037001 | 7050 | VLOT DAIRY & HEIFER RANCH | 20330 ROAD 4 | CHOWCHILLA | 93610 |
| 5C15NC00002 | 7750 | BIDART DAIRY NO. 2 | 20400 OLD RIVER | Bakersfield | 93311 |
| 5D545093001 | 9360 | MEADOWLAKE DAIRY | 6802 AVENUE 120 | TIPTON | 93272 |
| 5C54NC00008 | 9800 | BOSMAN DAIRY | 4805 AVENUE 144 | TIPTON | 93272 |
| 5D545071006 | 10776 | VANDER EYK & SON DAIRY COMPLEX | 10001 ROAD 80 | PIXLEY | 93256 |
| 5D545163001 | 11100 | HILARIDES DAIRY | 24163 ROAD 188 | LINDSAY | 93247 |

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# Exhibit E

# Study Pinpoints Sustainability of Jersey Milk Production

With over 40% of milk produced in the United States utilized in the manufacture of cheese, using nutrient-dense milk produced by smaller Jersey cattle results in substantial reductions in water and land usage, fuel consumption, waste output, and greenhouse gas emissions compared to using Holstein milk.

Per unit of cheese, the Jersey carbon footprint *(total $CO_2$-equivalents)* is 20% less than that of Holsteins.

These were the key findings from a life-cycle assessment study presented by Dr. Jude Capper of Washington State University on July 13, 2010 at the Joint Association Meetings of five North American scientific societies for animal agriculture, including the American Dairy Science Association and the American Society of Animal Science.

"Not only does the Jersey population conserve finite resources needed for cheese production," Capper observed, "the total environmental impact is lower."

Conclusions were based on a year of herd performance information from nearly two million dairy cows in over 13,000 herds in 45 states.

*New science probes environmental impacts of milk produced by the two major breeds related to greatest utilization—making cheese*

### Study Parameters

Capper and coauthor Dr. Roger Cady (Elanco Animal Health) broke new ground with this study by analyzing farm milk production required for the annual manufacture of 500,000 metric tons (1.1 billion pounds) of Cheddar cheese.

They compared two production systems, one using the large breed Holstein cow (average mature bodyweight, 1,500 lbs.) and the other the smaller Jersey cow (1,000 lbs.). Characteristically, the Jersey produces less milk measured by volume, but containing substantially higher fat and protein content. For the manufacture of Cheddar cheese, expected yields are 12.5 lbs. cheese per hundredweight (cwt.) from Jersey milk compared to 10.1 lbs./cwt. from Holstein milk.

Capper and Cady quantified the environmental impacts of producing Cheddar cheese from these different milks. The production system model included all primary crop and milk production practices up through and including milk harvest. It did not include transportation to the manufacturing plant, production and sales systems.

### Key Findings

To produce 500,000 metric tons of Cheddar cheese (1.1 billion pounds):

- 8.8 billion pounds of Jersey milk was needed, which was 19% less than the required amount of Holstein milk (10.9 billion pounds).
  - More Jerseys (91,460 animals) were needed to produce the same amount of cheese as Holsteins. That represents just 0.5% of the total U.S. dairy cattle population.
  - Despite the greater number of animals, the total body mass of the Jersey population was 26% smaller (276 million fewer total pounds) compared to the Holstein population.
  - Total feed consumption decreased by 1.75 million tons with Jerseys, and Jerseys produced 2.5 million tons less manure compared to Holsteins.
- Water use was reduced by 32% with Jerseys, conserving 66.5 billion gallons of water, equivalent to the needs of 657,889 U.S. households.
- The land requirement dropped by 240,798 acres (376 sq. miles), which was 11% less than that required to support cheese production from Holsteins.
- The Jersey system used less fossil fuels than the Holstein system. The savings of 517,602 million BTUs in fossil fuel consumption is equivalent to

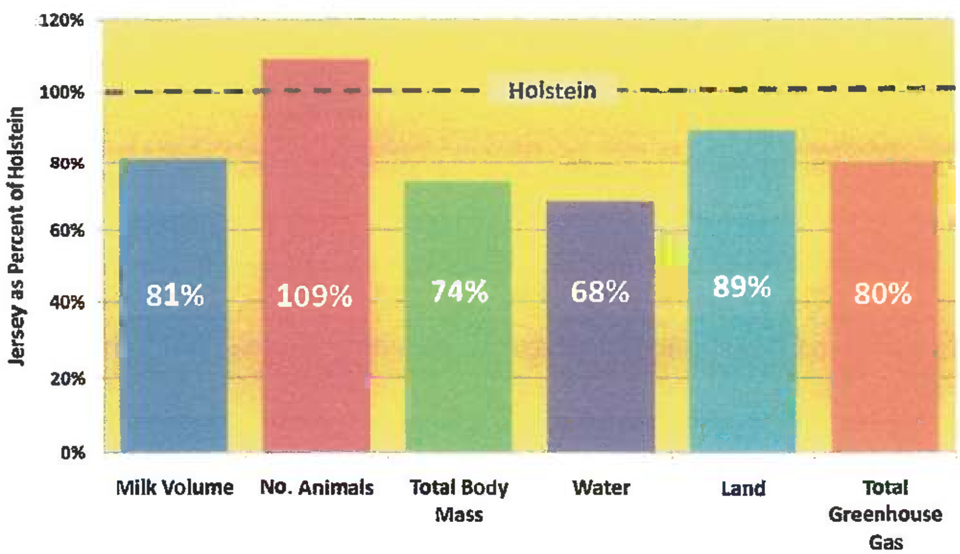


Fig. 1 Resources used and environmental impact per unit of cheese manufactured, comparing Jersey to Holstein milk production

freeing up the energy necessary to heat 6,335 U.S. homes per year.

- The 20% reduction in the carbon footprint for the Jersey system is equivalent to removing 443,900 cars from the road annually.

> **Cheese production from Jersey milk conserves resources and reduces environmental impact. The two-fold advantage that the Jersey has is that they weigh so much less and the milk they produce is a more nutrient-dense product.**
>
> *Jude L. Capper*
> *Washington State University*

### Jerseys Reduce and Dilute Maintenance Overhead

The study's findings are explained by Jersey breed-specific characteristics that both reduce and dilute maintenance overhead in the production system. The lower total body mass of the Jersey system reduces maintenance costs per animal, and the greater nutrient density of Jersey milk dilutes maintenance resource requirements, especially for water, over more units of cheese.

"Water use in Jerseys comes down because there is more fat and protein in milk," Capper noted. "The savings is not just water intake for the smaller animals, but will carry through in transport and processing the milk into cheese.

"This study demonstrates that the number of animals in a population is not a good proxy for body mass," Capper added.

"In previous work, we assumed that the number of animals in a system equaled bodyweight. More animals meant greater bodyweight and thus greater environmental impact.

"In this study, because Jerseys weigh so much less than Holsteins, even though more animals are needed to produce the same amount of cheese, the total body mass comes down," she said. "Going forward, we need to account for differences in body size among animals.

"To produce the same amount of cheese, you need more Jersey animals," concluded Capper. "Holsteins do have an advantage in milk yield per animal.

"That is overcome by the two-fold advantage that the Jersey has. The animals weigh so much less and the milk they produce is a more nutrient-dense product."

A detailed research report is in preparation for submission to a peer-reviewed scientific journal.

Funding for this research was provided by National All-Jersey Inc., formed in 1957 to promote the increased production and sale of Jersey milk and milk products. For more information, call 614/861-3636 or email naj@usjersey.com.

Table 1. Milk production, cheese yield and herd dynamics for Jersey and Holstein production systems evaluated

| | Holstein | Jersey |
|---|---|---|
| Daily milk yield *(lb)* | 62 | 46 |
| Fat *(%)* | 3.8 | 4.8 |
| Protein *(%)* | 3.1 | 3.7 |
| Cheese yield *(lb/cwt)** | 10.1 | 12.5 |
| Calving interval *(mo)* | 14.1 | 13.7 |
| Annual herd turnover *(%)* | 34.5 | 30.0 |
| Expected number of lactations* | 2.54 | 3.00 |
| Age at first calving *(mo.)* | 26.1 | 25.3 |
| Heifer:cow ratio* | 0.86 | 0.83 |
| Mature cow body weight *(lb)* | 1,500 | 1,000 |

* Estimated as functions of data accessed
Source: DRMS, DairyMetrics™, accessed November 9, 2009

## Breed has significant implications for nutrient management, CAFO permitting

A recently published report in the *Journal of Dairy Science* documents the differences in manure and nitrogen excreted by Jersey and Holstein cows—differences large enough, the study's authors say, to merit consideration in nutrient management plans and CAFO permitting.

With the changes in the definition of concentrated animal feeding operations and the inclusion of smaller farms, nutrient management planning is a priority. The standard estimates for manure and nutrient excretion used by engineers and regulatory agencies are, however, based only on Holstein studies.

The research team included Katharine Knowlton, associate professor at Virginia Tech; Vic Wilkerson, formerly at the ARS Nutrient Conservation and Metabolism Laboratory and now with Land O'Lakes Purina Feed LLC; David Casper, previously a USDA research scientist at Beltsville, Md., and now vice-president of nutrition with Agri-King; and David Mertens of the U.S. Dairy Forage Research Center. They analyzed nutrient excretion data from Jersey and Holstein cows collected at the former Energy Metabolism Unit within the USDA-Agricultural Research Service facility at Beltsville.

Data were obtained from Jersey and Holstein cows at 49, 154 and 271 days in milk in open-circuit respiration chambers allowing for collection and precise measurement of feed intake, feed refusals, milk, feces and urine. All cows had had at least two calves. Average daily production was 51 lbs. fat-corrected milk for Jerseys, and 69 lbs. for Holsteins. Average bodyweight was 940 lbs. for Jerseys, 1,385 lbs. for Holsteins.

Jersey cows consumed less dry matter (71% of Holstein intake) and less water (62% of Holsteins). Dry matter intake per unit of bodyweight was not significantly different, nor was there a breed difference in dry matter digestibility.

Manure excretion was lower in Jersey cows and generally proportional to changes in feed intake. Jersey cows excreted 33% less wet manure (total of wet feces and urine). Total nitrogen excretion was lower by 29%.

"The effect of breed on manure and nutrient excretion has significant nutrient management implications," the authors wrote. "The revised federal CAFO regulations (and the CAFO permitting programs of many states) define CAFO by a specified number of cows, making no distinction among breeds or cow size." The differences between Jerseys and Holsteins, they suggest, are "large enough to merit consideration in nutrient management planning and CAFO permitting. Accounting for breed differences in manure excretion will support more effective nutrient management planning on dairy farms."

Funds for this research were provided by the AJCC Research Foundation.

*Knowlton, K.A., V.A. Wilkerson, D.P. Casper, and D.R. Mertens. 2010. Manure nutrient excretion by Jersey and Holstein cows. J. Dairy Science. 93:407-412.*

# Jersey vs Holstein Manure Production

| Jersey | | | | | |
|---|---|---|---|---|---|
| **Variables (grams per day)** | **N** | **Mean** | **Std. Dev.** | **Minimum** | **Maximum** |
| DAYS in LACTATION | 24 | 157.88 | 94.37 | 39.00 | 299.00 |
| DAYS PREGNANT | 24 | 70.33 | 75.98 | 0.00 | 221.00 |
| DAILY EXCREMENT (WET FECES & URINE) | 24 | 50200.53 | 9192.16 | 33615.71 | 71071.43 |
| EXCR N | 24 | 324.19 | 56.30 | 230.41 | 433.36 |
| DAILY INTAKE | 24 | 30023.78 | 5506.11 | 20134.57 | 41132.29 |
| INTAKE DM | 24 | 15847.17 | 3041.57 | 10303.68 | 21039.70 |
| INTAKE N | 24 | 448.40 | 86.51 | 294.43 | 606.38 |
| DAILY FECES | 24 | 33288.89 | 7310.56 | 19614.29 | 45847.14 |
| FECES DM | 24 | 5595.36 | 1159.48 | 3414.45 | 7893.50 |
| FEC M | 24 | 162.69 | 36.71 | 105.44 | 255.51 |
| DAILY URINE | 24 | 16911.64 | 4233.13 | 12534.29 | 31418.57 |
| URINE N | 24 | 161.50 | 25.50 | 123.43 | 229.04 |
| DIET Dry Matter | 24 | 52.74 | 2.77 | 48.14 | 57.29 |
| DIET N | 24 | 2.83 | 0.04 | 2.76 | 2.90 |
| DIET NDF | 24 | 41.01 | 5.20 | 35.42 | 58.65 |
| DIET ADF | 24 | 24.66 | 1.66 | 22.47 | 27.86 |
| DIET GE | 24 | 4.59 | 0.07 | 4.47 | 4.70 |
| DAILY MILK | 24 | 20622.36 | 6249.73 | 6470.00 | 30561.43 |
| DAILY MILKFAT | 24 | 1029.51 | 282.35 | 360.38 | 1475.80 |
| MILK FAT % | 24 | 5.09 | 0.71 | 4.08 | 6.65 |
| MILK PROT % | 24 | 3.70 | 0.36 | 3.22 | 4.76 |
| BODY WEIGHT (kgs) | 24 | 412.02 | 68.01 | 341.20 | 649.80 |

| Holstein | | | | | |
|---|---|---|---|---|---|
| **Variables (grams per day)** | **N** | **Mean** | **Std. Dev.** | **Minimum** | **Maximum** |
| DAYS in LACTATION | 21 | 148.81 | 91.75 | 44.00 | 297.00 |
| DAYS PREGNANT | 21 | 41.57 | 66.35 | 0.00 | 179.00 |
| DAILY EXCREMENT (WET FECES & URINE) | 21 | 74245.23 | 11784.27 | 50555.71 | 94034.29 |
| EXCR N | 21 | 454.87 | 73.64 | 318.65 | 580.34 |
| DAILY INTAKE | 21 | 42131.99 | 6862.48 | 28236.71 | 50211.29 |
| INTAKE DM | 21 | 22344.14 | 3893.50 | 14228.59 | 28659.53 |
| INTAKE N | 21 | 631.03 | 111.93 | 403.53 | 813.32 |
| DAILY FECES | 21 | 51627.87 | 12269.92 | 29015.71 | 70492.86 |
| FECES DM | 21 | 8106.60 | 1707.77 | 4814.58 | 10680.37 |
| FEC M | 21 | 242.21 | 56.30 | 143.09 | 327.14 |
| DAILY URINE | 21 | 22617.36 | 4031.16 | 13878.57 | 30571.43 |
| URINE N | 21 | 212.66 | 29.72 | 163.80 | 273.06 |
| DIET DM(Dry Matter) | 21 | 52.99 | 2.87 | 48.11 | 58.18 |
| DIET N | 21 | 2.82 | 0.05 | 2.74 | 2.90 |
| DIET NDF | 21 | 42.01 | 5.69 | 35.46 | 59.25 |
| DIET ADF | 21 | 25.01 | 1.60 | 22.30 | 27.81 |
| DIET GE | 21 | 4.59 | 0.08 | 4.44 | 4.70 |
| DAILY MILK | 21 | 33921.96 | 11149.92 | 9700.00 | 49122.86 |
| DAILY MILKFAT | 21 | 1236.81 | 327.41 | 475.30 | 1626.88 |
| MILK FAT% | 21 | 3.80 | 0.61 | 2.84 | 5.05 |
| MILK PROT% | 21 | 3.19 | 0.40 | 2.60 | 4.04 |
| BODY WEIGHT (kgs) | 21 | 634.89 | 46.05 | 561.80 | 715.50 |

**From:** Cherie Bayer
**Sent:** Tuesday, August 20, 2013 8:34 AM
**To:** Kristin Barlass Paul
**Subject:** RE: Jersey Carbon Footprint

Kristin, good morning to you.

Attached is the summary (on page 19) published in Jersey Journal. This is the complete article, which provides the detail:

J Dairy Sci. 2010 Jan;93(1):407-12. doi: 10.3168/jds.2009-2617.

**Manure nutrient excretion by Jersey and Holstein cows.**

Knowlton KF, Wilkerson VA, Casper DP, Mertens DR.

**Source**

Department of Dairy Science, Virginia Polytechnic Institute and State University, Blacksburg 24061, USA. knowlton@vt.edu

**Abstract**

The objective of this study was to evaluate feces, urine, and N excretion by Jersey and Holstein cows. Sixteen multiparous cows (n=8 per breed) were fed 2 experimental rations at calving in a switchback experimental design. Diets were 50% forage and based on corn meal (control) or whole cottonseed. Half the cows in each breed started on the control diet and half started on the whole cottonseed diet. Cows were switched to the other diet at 60 d in milk and switched back to their original diet at 165 d in milk. Pairs of cows were moved into open-circuit respiration chambers on d 49, 154, and 271 of lactation for 7-d measurement periods. While in the chambers, total collection of feed refusals, milk, recovered hair, feces, and urine was conducted. No effect of the interaction of diet and breed was observed for measures of nutrient digestibility and manure excretion. Total daily manure excretion was lower in Jersey cows than in Holstein cows, with reductions generally proportional to changes in feed intake. Jersey cows consumed 29% less feed and excreted 33% less wet feces and 28% less urine than Holstein cows. Intake, fecal, and urinary N were reduced by 29, 33, and 24%, respectively, in Jersey cows compared with Holstein cows. Equations from American Society of Agricultural and Biological Engineers underpredicted observed values for all manure measures evaluated (urine, manure solids, N, wet manure), and breed bias was observed in equations predicting excretion of urine, N, and wet manure. Although these equations include animal and dietary factors, intercepts of regression of observed values on predicted values differed between Holsteins and Jerseys for those 3 measures. No breed bias was observed in the prediction of manure solids excretion, however,

making that equation equally appropriate for Jerseys and Holsteins. The effect of breed on manure and nutrient excretion has significant nutrient management implications.

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The spreadsheet online is http://www.usjersey.com/Reference/nutrientproduction_usdadata.xls

Please contact me if I can be of further assistance. Thank you and have a good day.

Sincerely,

Cherie

**From:** Kristin Barlass Paul
**Sent:** Tuesday, August 20, 2013 7:23 AM
**To:** Cherie Bayer
**Subject:** FW: Jersey Carbon Footprint

Good Morning Cherie,

I was thinking we had some research from Katharine Knowlton on this, but I'm having problems locating it. Can you help?

Thanks,

Kristin

**From:** Japlus3 [mailto:japlus3@aol.com]
**Sent:** Monday, August 19, 2013 9:51 PM
**To:** Kristin Barlass Paul
**Subject:** Re: Jersey Carbon Footprint

Kristin,

Thanks, but is there something with the actual pounds of manure produced per day? There is an environmental group which claims cows produce 106 pounds of manure per day which I find hard to believe.

Thanks,

# Exhibit F

# Saturated Zone Denitrification: Potential for Natural Attenuation of Nitrate Contamination in Shallow Groundwater Under Dairy Operations

M. J. SINGLETON,*,† B. K. ESSER,† J. E. MORAN,† G. B. HUDSON,† W. W. MCNAB,‡ AND T. HARTER§

*Chemical Sciences Division, Lawrence Livermore National Laboratory, Environmental Restoration Division, Lawrence Livermore National Laboratory, and Department of Land, Air, and Water Resources, University of California at Davis*

We present results from field studies at two central California dairies that demonstrate the prevalence of saturated-zone denitrification in shallow groundwater with $^3H/^3He$ apparent ages of <35 years. Concentrated animal feeding operations are suspected to be major contributors of nitrate to groundwater, but saturated zone denitrification could mitigate their impact to groundwater quality. Denitrification is identified and quantified using N and O stable isotope compositions of nitrate coupled with measurements of excess $N_2$ and residual $NO_3^-$ concentrations. Nitrate in dairy groundwater from this study has $\delta^{15}N$ values (4.3–61‰), and $\delta^{18}O$ values (−4.5–24.5‰) that plot with $\delta^{18}O/\delta^{15}N$ slopes of 0.47–0.66, consistent with denitrification. Noble gas mass spectrometry is used to quantify recharge temperature and excess air content. Dissolved $N_2$ is found et concentrations well above those expected for equilibrium with air or incorporation of excess air, consistent with reduction of nitrate to $N_2$. Fractionation factors for nitrogen and oxygen isotopes in nitrate appear to be highly variable at a dairy site where denitrification is found in a laterally extensive anoxic zone 5 m below the water table, and at a second dairy site where denitrification occurs near the water table and is strongly influenced by localized lagoon seepage.

## Introduction

High concentrations of nitrate, a cause of methemoglobinemia in infants (*1*), are a national problem in the United States (*2*), and nearly 10% of public drinking water wells in the state of California are polluted with nitrate at concentrations above the maximum contaminant level (MCL) for drinking water set by the U.S. Environmental Protection Agency (*3*). The federal MCL is 10 mg/L as N, equivalent to the California EPA limit of 45 mg/L as $NO_3^-$ (all nitrate concentrations are hereafter given as $NO_3^-$). In the agricultural areas of California's Central Valley, it is not uncommon to have nearly half the active drinking water wells produce groundwater with nitrate concentrations in the range considered to indicate anthropogenic impact (>13–18 mg/L) (*2, 4*). The major sources of this nitrate are septic discharge, fertilization using natural (e.g., manure) or synthetic nitrogen sources, and concentrated animal feeding operations. Dairies are the largest concentrated animal operations in California, with a total heard size of 1.7 million milking cows (*5*).

Denitrification is the microbially mediated reduction of nitrate to gaseous $N_2$, and can occur in both unsaturated soils and below the water table where the presence of $NO_3^-$, denitrifying bacteria, low $O_2$ concentrations, and electron donor availability exist. In the unsaturated zone, denitrification is recognized as an important process in manure and fertilizer management (*6*). Although a number of field studies have shown the impact of denitrification in the saturated zone (e.g., *7, 8–11*), prior to this study it was not known whether saturated zone denitrification could mitigate the impact of nitrate loading at dairy operations. The combined use of tracers of denitrification and groundwater dating allows us to distinguish between nitrate dilution and denitrification, and to detect the presence of pre-modern water at two dairy operations in the Central Valley of California, referred to here as the Kings County Dairy (KCD) and the Merced County Dairy (MCD; Figure 1). Detailed descriptions of the hydrogeologic settings and dairy operations at each site are included as Supporting Information.

## Materials and Methods

**Concentrations and Nitrate Isotopic Compositions.** Samples for nitrate N and O isotopic compositions were filtered in the field to 0.45 $\mu$m and stored cold and dark until analysis. Anion and cation concentrations were determined by ion chromatography using a Dionex DX-600. Field measurements of dissolved oxygen and oxidation reduction potential (using Ag/AgCl with 3.33 mol/L KCl as the reference electrode) were carried out using a Horiba U-22 water quality analyzer. The nitrogen and oxygen isotopic compositions ($\delta^{15}N$ and $\delta^{18}O$) of nitrate in 23 groundwater samples from KCD and MCD were measured at Lawrence Berkeley National Laboratory's Center for Isotope Geochemistry using a version of the denitrifying bacteria procedure (*12*) as described in Singleton et al. (*13*). In addition, the nitrate from 17 samples was extracted by ion exchange procedure of (*14*) and analyzed for $\delta^{15}N$ at the University of Waterloo. Analytical uncertainty (1$\sigma$) is 0.3‰ for $\delta^{15}N$ of nitrate and 0.5‰ for $\delta^{18}O$ of nitrate. Isotopic compositions of oxygen in water were determined on a VG Prism isotope ratio mass spectrometer at Lawrence Livermore National Laboratory (LLNL) using the $CO_2$ equilibration method (*15*), and have an analytical uncertainty of 0.1‰.

**Membrane Inlet Mass Spectrometry.** Previous studies have used gas chromatography and/or mass spectrometry to measure dissolved $N_2$ gas in groundwater samples (*16–19*). Dissolved concentrations of $N_2$ and Ar for this study were analyzed by membrane inlet mass spectrometry (MIMS), which allows for precise and fast determination of dissolved gas concentrations in water samples without a separate extraction step, as described in Kana et al. (*20, 21*). The gas abundances are calibrated using water equilibrated with air under known conditions of temperature, altitude, and humidity (typically 18 °C, 183 m; and 100% relative humidity). A small isobaric interference from $CO_2$ at mass 28 ($N_2$) is corrected based on calibration with $CO_2$-rich waters with known dissolved $N_2$, but is negligible for most samples. Samples are collected for MIMS analysis in 40 mL amber

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‡ Environmental Restoration Division, Lawrence Livermore National Laboratory.

§ University of California at Davis.

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Published on Web 01/03/2007

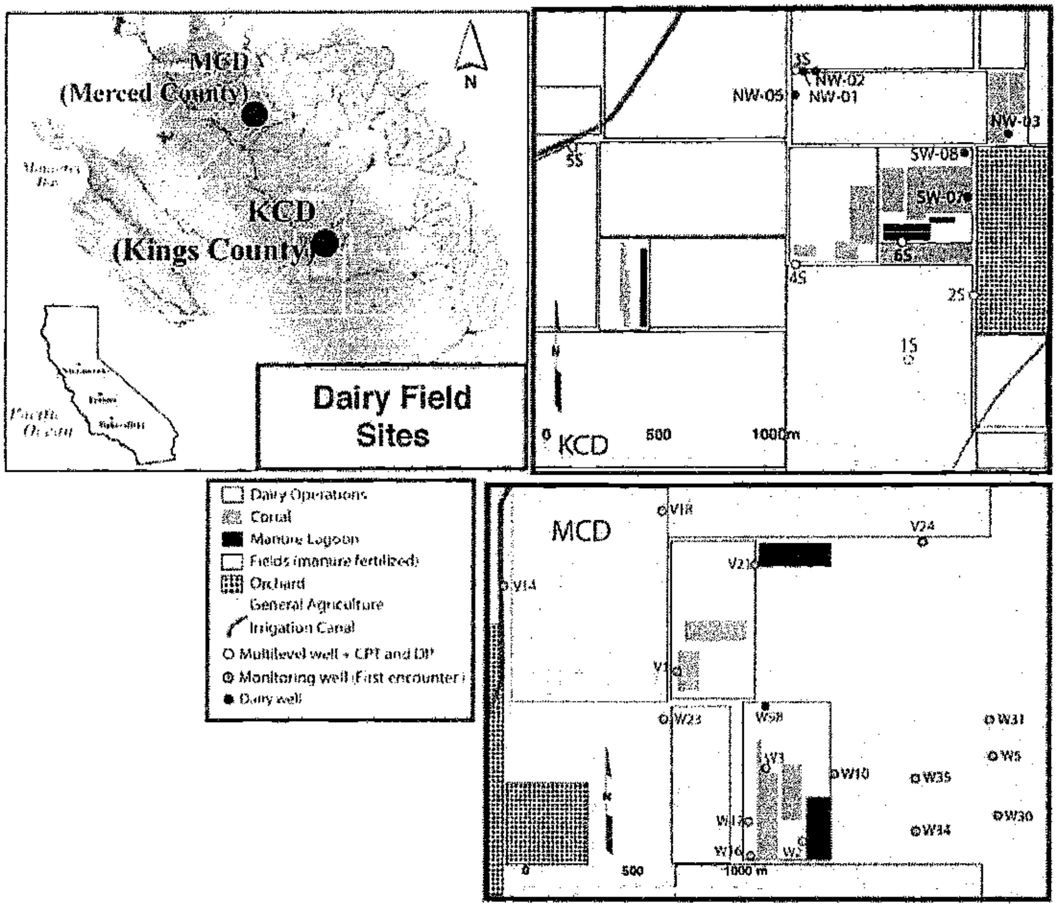


**FIGURE 1. Location of dairy study sites, and generalized maps of each dairy showing sample locations relative to lagoons and dairy operations.**

glass VOA vials with no headspace that are kept cold during transport, and then analyzed within 24 h.

**Noble Gases and $^3$H/$^3$He Dating.** Dissolved noble gas samples are collected in copper tubes, which are filled without bubbles and sealed with a cold weld in the field. Dissolved noble gas concentrations were measured at LLNL after gas extraction on a vacuum manifold and cryogenic separation of the noble gases. Concentrations of He, Ne, Ar, and Xe were measured on a quadrupole mass spectrometer. The ratio of $^3$He to $^4$He was measured on a VG5400 mass spectrometer. Calculations of excess air and recharge temperature from Ne and Xe measurements are described in detail in Ekwurzel (*22*), using an approach similar to that of Aeschbach-Hertig et al. (*23*).

Tritium samples were collected in 1 L glass bottles. Tritium was determined by measuring $^3$He accumulation after vacuum degassing each sample and allowing 3–4 weeks accumulation time. After correcting for sources of $^3$He not related to $^3$H decay (*24, 25*), the measurement of both tritium and its daughter product $^3$He allows calculation of the initial tritium present at the time of recharge, and apparent ages can be determined from the following relationship based on the production of tritiogenic helium ($^3He_{trit}$):

$$\text{Groundwater Apparent Age (years)} = -17.8 \times \ln(1 + {}^3He_{trit}/{}^3H)$$

Groundwater age dating has been applied in several studies of basin-wide flow and transport (*25–27*). The reported groundwater age is the mean age of the mixed sample, and furthermore, is only the age of the portion of the water that contains measurable tritium. Average analytical error for the age determinations is ±1 year, and samples with $^3$H that is too low for accurate age determination (<1 pCi/L) are reported as >50 years. Significant loss of $^3$He from groundwater is not likely in this setting given the relatively short residence times and high infiltration rates from irrigation. Apparent ages give the mean residence time of the fraction of recently recharged water in a sample, and are especially useful for comparing relative ages of water from different locations at each site. The absolute mean age of groundwater may be obscured by mixing along flow paths due to heterogeneity in the sediments (*28*).

## Results and Discussion

**Nitrate in Dairy Groundwater.** Nitrate concentrations at KCD range from below detection limit (BDL, <0.07 mg/L) to 274 mg/L. Within the upper aquifer, there is a sharp boundary between high nitrate waters near the surface and deeper, low nitrate waters. Nitrate concentrations are highest between 6 and 13 m below ground surface (BGS) at all multilevel wells (0.5 m screened intervals), with an average concentration of 98 mg/L. Groundwater below 15 m has low nitrate concentrations ranging from BDL to 2.8 mg/L, and also has low or nondetectable ammonium concentrations. The transition from high to low nitrate concentration corresponds to decreases in field-measured oxidation–reduction potential (ORP) and dissolved oxygen (DO) concentration. ORP values are generally above 0 mV and DO concentrations are >1 mg/L in the upper 12 m of the aquifer, defining a more oxidizing zone (Figure 2). A reducing zone is indicated below

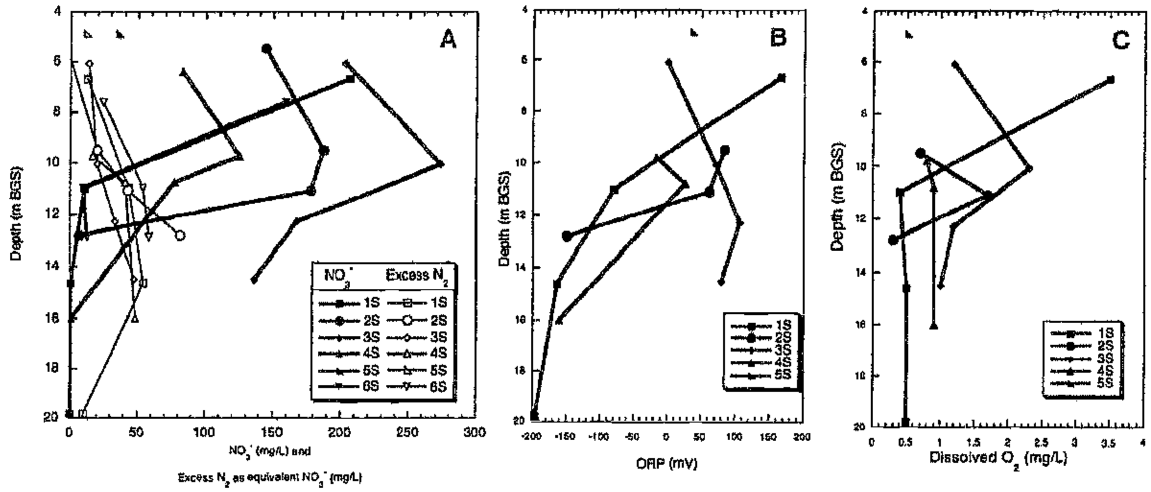


**FIGURE 2. (A) Average excess $N_2$ and nitrate concentrations, (B) oxidation−reduction potential (ORP), and (C) dissolved oxygen in multilevel monitoring wells at the KCD site.**

12 m by ORP values as low as −196 mV and DO concentrations <1.2 mg/L. Vertical head varies by less than 10 cm in the upper aquifer multilevel wells.

Nitrate concentrations at MCD monitoring wells sampled for this study range from 2 to 426 mg/L with an average of 230 mg/L. Several wells (W-02, W-16, and W-17) located next to a lagoon and corral have lower nitrate but high ammonium concentrations (Table 1 in Supporting Information). The MCD wells are all screened at the top of the unconfined aquifer except W98, a supply well that is pumped from approximately 57 m BGS. Nitrate concentrations observed for this deeper well are <1 mg/L.

**Dissolved Gases.** Nitrogen gas, the comparatively conservative product of denitrification, has been used as a natural tracer to detect denitrification in the subsurface (*16−18*). Groundwater often also contains $N_2$ beyond equilibrium concentrations due to incorporation of excess air from physical processes at the water table interface (*23, 29, 30*). In the saturated zone, total dissolved $N_2$ is a sum of these three sources:

$$(N_2)_{dissolved} = (N_2)_{equilibrium} + (N_2)_{excess\ air} + (N_2)_{denitrification}$$

By normalizing the measured dissolved concentrations as $N_2/Ar$ ratios, the amount of excess $N_2$ from denitrification can be calculated as

$$(N_2)_{denitrification} = \left(\left(\frac{N_2}{Ar}\right)_{measured} - \left(\frac{N_{2equilibrium} + N_{2excess\ air}}{Ar_{equilibrium} + Ar_{excess\ air}}\right)\right) Ar_{measured}$$

where the $N_2$ and Ar terms for equilibrium are calculated from equilibrium concentrations determined by gas solubility. The $N_2/Ar$ ratio is relatively insensitive to recharge temperature, but the incorporation of excess air must be constrained in order to determine whether denitrification has shifted the ratio to higher values (*19*). Calculations of excess $N_2$ based on the $N_2/Ar$ ratio assume that any excess air entrapped during recharge has the ratio of $N_2/Ar$ in the atmosphere (83.5). Any partial dissolution of air bubbles would lower the $N_2/Ar$ ratio (*30, 31*), thus decreasing the apparent amount of excess $N_2$.

For this study, Xe and Ne derived recharge temperature and excess air content were determined for 12 of the monitoring wells at KCD and 9 wells at MCD. For these sites, excess $N_2$ can be calculated directly, accounting for the contribution of excess air and recharge temperature. Site representative mean values of recharge temperature and excess air concentration are used for samples without noble gas measurements. Mean annual air temperatures at the KCD and MCD sites are 17 and 16 °C, respectively (*32*), and the Xe-derived average recharge temperatures for the KCD and MCD sites are 19 and 18 °C. Recharge temperatures are most likely higher than mean annual air temperature because most recharge is from excess irrigation during the summer months. The average amount of excess air indicated by Ne concentrations is $2.2 \times 10^{-3}$ $cm^3$(STP)/g $H_2O$ for KCD and $1.7 \times 10^{-3}$ $cm^3$(STP)/g $H_2O$ for MCD. From these parameters, we estimate the site representative initial $N_2/Ar$ ratios including excess air to be 41.2 for KCD and 40.6 for MCD. Measured $N_2/Ar$ ratios greater than these values are attributed to production of $N_2$ by denitrification.

The excess $N_2$ concentration can be expressed in terms of the equivalent reduced nitrate that it represents in mg/L $NO_3^-$ based on the stoichiometry of denitrification. Considering excess $N_2$ in terms of equivalent $NO_3^-$ provides a simple test to determine whether there is a mass balance between nitrate concentrations and excess $N_2$. From Figure 2, there does not appear to be a balance between nitrate concentrations and excess $N_2$ in KCD groundwater, since nitrate concentrations in the shallow wells are more than twice that of equivalent excess $N_2$ concentrations in the anoxic zone. There are multiple possible causes of the discrepancy between $NO_3^-$ concentrations and excess $N_2$ concentrations including (1) the $NO_3^-$ loading at the surface has increased over time, and denitrification is limited by slow vertical transport into the anoxic zone, (2) mixing with deeper, low initial $NO_3^-$ waters has diluted both the $NO_3^-$ and excess $N_2$ concentrations, or (3) some dissolved $N_2$ has been lost from the saturated zone. All three processes may play a role in N cycling at the dairies, but we can shed some light on their relative importance by considering the extent of denitrification and then constraining the time scale of denitrification as discussed in the following sections.

**Isotopic Compositions of Nitrate.** Large ranges in $\delta^{15}N$ and $\delta^{18}O$ values of nitrate are observed at both dairies (Figure 3). Nitrate from KCD has $\delta^{15}N$ values of 4.3−61.1‰, and $\delta^{18}O$ values of −0.7−24.5‰. At MCD, nitrate $\delta^{15}N$ values range from 5.3 to 30.2‰, and $\delta^{18}O$ values range from −0.7 to 13.1‰. The extensive monitoring well networks at these sites increase the probability that water containing residual nitrate from denitrification can be sampled.

Nitrate $\delta^{15}N$ and $\delta^{18}O$ values at both dairies are consistent with nitrification of ammonium and mineralized organic N

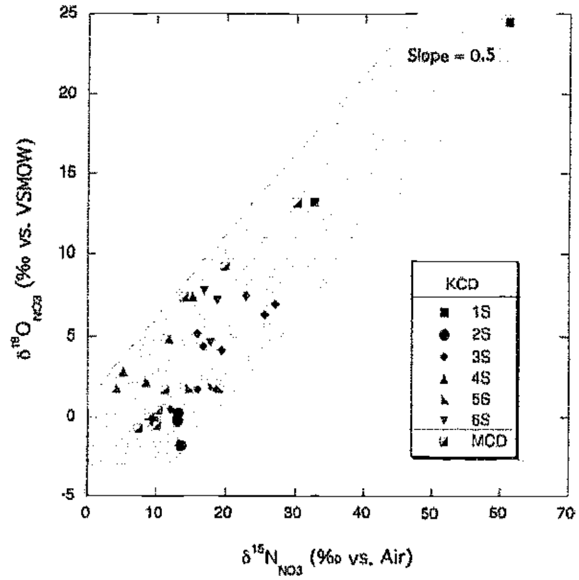


**FIGURE 3. Oxygen and nitrogen isotopic composition of nitrate in dairy groundwater from multilevel monitoring wells at KCD and first encounter wells at MCD. The shaded region indicates a slope of 0.5 for a range of starting compositions. Calculated slopes for linear fits to multilevel wells at KCD and first encounter wells at MCD range from 0.47 to 0.60.**

compounds from manure-rich wastewater, which is stored and used as a fertilizer at both dairy sites. At some locations, nitrification has been followed by denitrification. Prior to nitrification, cow manure likely starts out with a bulk $\delta^{15}N$ value close to 5‰, but is enriched in $^{15}N$ to varying degrees due to volatile loss of ammonia, resulting in $\delta^{15}N$ values of 10–22‰ in nitrate derived from manure (*33, 34*). Culture experiments have shown that nitrification reactions typically combine 2 oxygen atoms from the local pore water and one oxygen atom from atmospheric $O_2$ (*35, 36*), which has a $\delta^{18}O$ of 23.5‰ (*37*). Different ratios of oxygen from water and atmospheric $O_2$ are possible for very slow nitrification rates and low ammonia concentrations (*38*), however for dairy wastewater we assume that the 2:1 relation gives a reasonable prediction of the starting $\delta^{18}O$ values for nitrate at the two dairies based on the average values for $\delta^{18}O$ of groundwater at each site (−12.6‰ at KCD and −9.9‰ at MCD). Based on this approach, the predicted initial values for $\delta^{18}O$ in nitrate are −0.7‰ at KCD and 1.1‰ at MCD. Samples with the lowest nitrate $\delta^{15}N$ values have $\delta^{18}O$ values in this range, and are consistent with nitrate derived from manure. There is no strong evidence for mixing with nitrate from synthetic nitrogen fertilizers, which are used occasionally at both sites, but typically have low $\delta^{15}N$ values (0–5‰) and $\delta^{18}O$ values around 23‰ (*39*).

Denitrification drives the isotopic composition of the residual nitrate to higher $\delta^{15}N$ and $\delta^{18}O$ values. The stable isotopes of nitrogen are more strongly fractionated during denitrification than those of oxygen, leading to a slope of approximately 0.5 on a $\delta^{18}O$ vs $\delta^{15}N$ diagram (*34*). Nitrate $\delta^{15}N$ and $\delta^{18}O$ values at individual KCD multilevel well sites are positively correlated with calculated slopes ranging from 0.47 to 0.60; the slope of first encounter well data at MCD is 0.66 (Figure 3). These nitrate $\delta^{15}N$ and $\delta^{18}O$ values indicate that denitrification is occurring at both sites. Because a wide range of fractionation factors are known to exist for this process (*40*), it is not possible to determine the extent of denitrification using only the isotopic compositions of nitrate along a denitrification trend, even when the initial value for manure-derived nitrate can be measured or calculated.

**Extent of Denitrification.** The concentrations of excess $N_2$ and residual nitrate can be combined with the isotopic composition of nitrate in order to characterize the extent of denitrification. In an ideal system, denitrification leads to a regular decrease in nitrate concentrations, an increase in excess $N_2$, and a Rayleigh-type fractionation of N and O isotopes in the residual nitrate (Figure 4). In the Rayleigh fractionation model (*41*) the isotopic composition of residual nitrate depends on the fraction of initial nitrate remaining in the system ($f = C/C_{\mathrm{initial}}$), the initial $\delta^{15}N$, and the fractionation factor ($\alpha$) for denitrification:

$$\delta^{15}N = (1000 + \delta^{15}N_{\mathrm{initial}})\, f^{(\alpha-1)} - 1000$$

The fractionation factor $\alpha$ is defined from the isotopic ratios of interest ($R = {}^{15}N/{}^{14}N$ and ${}^{18}O/{}^{16}O$):

$$\alpha = \frac{(R)_{\mathrm{Product}}}{(R)_{\mathrm{Reactant}}}$$

This fractionation can also be considered as an enrichment factor ($\epsilon$) in ‰ units using the approximation $\epsilon \approx 1000 \ln \alpha$. The extent of denitrification can be calculated as $1 - f$. Rather than relying on an estimate of initial nitrate concentration, the parameter $f$ is determined directly using field measurements of excess $N_2$ in units of equivalent reduced $NO_3^-$:

$$f = C_{NO_3^-}/(C_{NO_3^-} + C_{\mathrm{excess}\ N2})$$

Heterogeneity in groundwater systems can often complicate the interpretation of contaminant degradation using a Rayleigh model (*42*). Denitrified water retains a proportion of its excess $N_2$ concentration (and low values of $f$) during mixing, but the isotopic composition of nitrate may be disturbed by mixing since denitrified waters contain extremely low concentrations of nitrate (<1 mg/L). The sample from 1S with a $f$ value close to zero and a $\delta^{15}N$ value of 7.6‰ was likely denitrified and is one example of this type of disturbance. However, in general, groundwater samples from the same multilevel well sites at KCD fall along similar Rayleigh fractionation curves, indicating that the starting isotopic composition of nitrate and the fractionation factor of denitrification vary across the site (Figure 4).

Values of $\delta^{15}N$ and $f$ calculated from nitrate and excess $N_2$ fall along Rayleigh fractionation curves with enrichment factors ($\epsilon$) ranging from −57‰ to −7‰ for three multilevel well sites at KCD and first encounter wells at MCD. As expected for denitrification, the enrichment factors indicated for oxygen are roughly half of those for nitrogen. The magnitude of these enrichment factors for N in residual nitrate are among the highest reported for denitrification, which typically range from −40‰ to −5‰ (*34, 40*). Partial gas loss near the water table interface at MCD could potentially increase the value of $f$, resulting in larger values of $\epsilon$. Gas loss is unlikely to affect fractionation factors at KCD since most excess $N_2$ is produced well below the water table. Considering the large differences observed for denitrification fractionation factors within and between the two dairy sites, it is not sufficient to estimate fractionation factors for denitrification at dairies based on laboratory-derived values or field-derived values from other sites. The appropriate fractionation factors must be determined for each area, and even then the processes of mixing and gas loss must be considered in the relation between isotopic values and the extent of denitrification. Nevertheless, direct determination of the original amount of nitrate using dissolved $N_2$ values significantly improves our ability to determine the extent of denitrification in settings where the initial nitrate concentrations are highly variable.

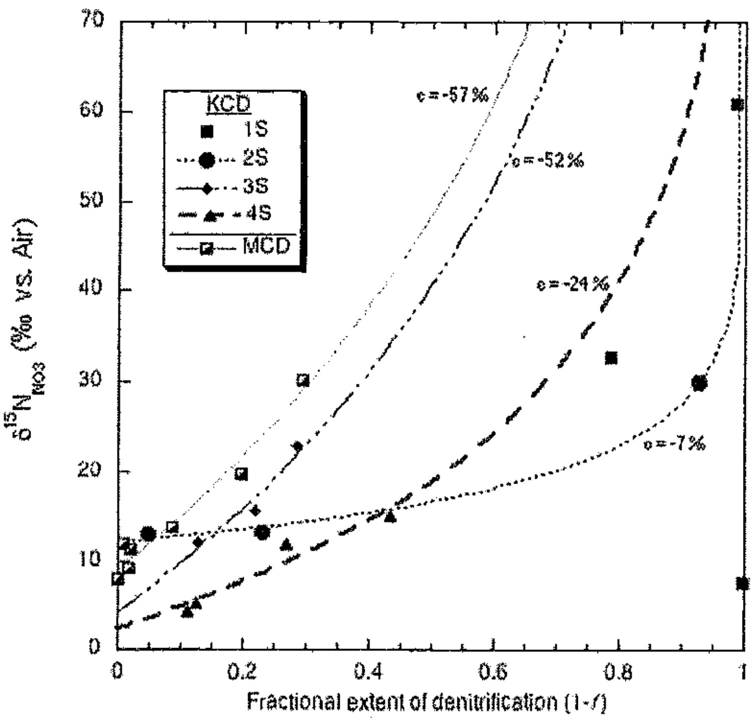


**FIGURE 4.** Nitrate $\delta^{15}N$ values plotted against the fractional extent of denitrification $(1 - f)$ based on excess $N_2$ and residual nitrate. Enrichment factors (ε) are calculated by fitting the Rayleigh fractionation equation to data from three multilevel well sites at KCD and wells at MCD.

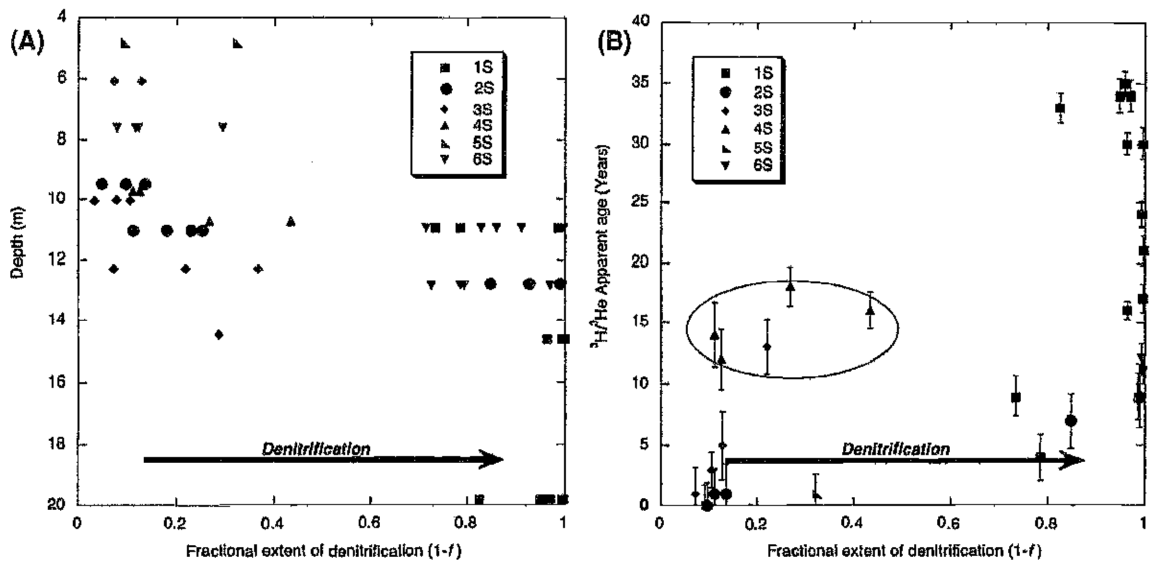


**FIGURE 5.** Sample depth (A) and $^3H/^3He$ apparent age (B) plotted against the fractional extent of denitrification $(1 - f)$. Samples at two sites have experienced less denitrification than is typical for samples with $^3H/^3He$ apparent age >8 years (circled, see text).

**Time Scale of Denitrification.** Modern water (i.e., groundwater containing measurable tritium) is found at all multilevel wells completed in the upper aquifer at KCD, the deepest of which is 20 m BGS. The upper aquifer below KCD has $^3H/^3He$ apparent ages of <35 years. At well 1D1 (54 m BGS), the lower aquifer has no measurable $NO_3^-$ and tritium below 1 pCi/L, indicating a groundwater age of more than 50 years. The sum of nitrate and excess $N_2$ is highest in the young, shallow dairy waters at KCD. Samples with $^3H/^3He$ ages >29 years were below the MCL for nitrate prior to denitrification. These results are consistent with an increase in nitrate loading at the surface, which followed the startup of KCD operations in the early 1970s.

The extent of denitrification at KCD is related to both depth and groundwater residence times based on $^3H/^3He$ apparent ages (Figure 5). There is a sharp transition from high nitrate waters to denitrified waters between 11 and 13 m depth across the KCD site. This transition is also related to the apparent age of the groundwater, as the high nitrate waters typically have apparent ages of between 0 and 5 years, and most samples with ages greater than 8 years are significantly or completely denitrified. There are five samples that do not follow this pattern. These outliers are from sites 3S and 4S where the shallow groundwater has much higher $^3H/^3He$ apparent ages due to slow movement around clay zones at the screened intervals for these samples. The existence of older water that is not significantly impacted by denitrification indicates that it is the physical transport of water below the transition from oxic to anoxic conditions rather than the residence time that governs denitrification in this system.

At the MCD site, groundwater $^3H/^3He$ apparent ages indicate fast transit rates from the water table to the shallow monitoring wells. Most of the first encounter wells have apparent ages of <3 years, consistent with the hydraulic analysis presented by Harter et al. (*5*). The very fast transit times to the shallow monitoring wells at MCD allow for some constraints on minimum denitrification rates at this site. Based on the comparison of the calculated ages with the initial tritium curve, these shallow wells contain a negligible amount of old, $^3H$-decayed water. In shallow wells near lagoons (e.g., W-16 and V-21), the observed excess $N_2$ (equivalent to 71 and 40 mg/L of reduced $NO_3^-$) accumulated over a duration of less than 1 year, indicating that denitrification rates may be very high at these sites. Complete denitrification of groundwater collected from well W-98 (excess $N_2$ equivalent to 51 mg/L $NO_3^-$) was attained within approximately 31 years, but may have occurred over a short period of time relative to the mean age of the water.

**Occurrence of Denitrification at Dairy Sites.** The depth at which denitrified waters are encountered is remarkably similar across the KCD site. This transition is not strongly correlated with a change in sediment texture. The denitrified waters at all KCD wells coincide with negative ORP values and generally low dissolved $O_2$ concentrations. Total organic carbon (TOC) concentration in the shallow groundwaters range from 1.1 to 15.7 mg/L at KCD, with the highest concentrations of TOC found in wells adjacent to lagoons. The highest concentrations of excess $N_2$ are found in nested well-set 2S, which is located in a field downgradient from the lagoons. However, sites distal to the lagoons (3S and 4S) that are apparently not impacted by lagoon seepage (*43*) also show evidence of denitrification, suggesting that direct lagoon seepage is not the sole driver for this process.

The chemical stratification observed in multilevel wells at the KCD site demonstrates the importance of characterizing vertical variations within aquifers for nitrate monitoring studies. Groundwater nitrate concentrations are integrated over the high and low nitrate concentration zones by dairy water supply wells, which have long screened intervals from 9 to 18 m BGS. Water quality samples from these supply wells underestimate the actual nitrate concentrations present in the uppermost oxic aquifer. Similarly, first encounter monitoring wells give an overestimate of nitrate concentrations found deep in the aquifer, and thus would miss entirely the impact of saturated zone denitrification in mitigating nitrate transport to the deep aquifer.

Monitoring wells at MCD sample only the top of the aquifer, so the extent of denitrification at depth is unknown, except for the one deep supply well (W98), which has less than 1 mg/L nitrate and an excess $N_2$ content consistent with reduction of 51 mg/L $NO_3^-$ to $N_2$. This supply well would be above the MCL for nitrate without the attenuation of nitrate by denitrification. The presence of ammonium at several of the wells with excess $N_2$ indicates a component of wastewater seepage in wells located near lagoons, where mixing of oxic waters with anoxic lagoon seepage may induce both nitrification and denitrification. Wells that are located in the surrounding fields have high $NO_3^-$ concentrations, and do not have any detectable excess $N_2$, a result consistent with mass-balance models of nitrate loading and groundwater nitrate concentration (*5*).

While dairy operations seem likely to establish conditions conducive to saturated zone denitrification, the prevalence of the phenomenon is not known. Major uncertainties include the spatial extent of anaerobic conditions, and transport of organic carbon under differing hydrogeologic conditions and differing nutrient management practices. Lagoon seepage may also increase the likelihood of denitrification in dairy aquifers. The extent to which dairy animal and field operations affect saturated zone denitrification is an important consideration in determining the assimilative capacity of underlying groundwater to nitrogen loading associated with dairy operations.

## Acknowledgments

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## Supporting Information Available

A table of chemical, isotopic, and dissolved gas results from this study, a plot of apparent age with depth, and detailed descriptions of the study sites. This material is available free of charge via the Internet at http://pubs.acs.org.

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**Supporting Information for "Saturated Zone Denitrification: Potential for Natural Attenuation of Nitrate Contamination in Shallow Groundwater Under Dairy Operations"** by M. J. Singleton[1*], B. K. Esser[1], J. E. Moran[1], G. B. Hudson[1], W. W. McNab[2], and T. Harter[3]

**Contents: 7 Pages, 1 Figure, and 1 Table**

Description of Dairy Sites

*Study Site 1:*

Study Site #1 is located at a dairy operation in Kings County, CA (KCD). Manure management practices employed at KCD, with respect to corral design, runoff capture and lagoon management are typical of practices employed at other dairies in the region. KCD has close to the 1000-cow average for dairies in the area, and operates three clay-lined wastewater lagoons that receive wastewater after solids separation. Wastewater is used for irrigation of 500 acres of forage crops (corn and alfalfa) on the dairy and on neighboring farms; dry manure is exported to neighboring farms.

KCD is located in the Kings River alluvial fan, a sequence of layered sediments transported by the Kings River from the Sierra Nevada to the low lying southern San Joaquin Valley of California (*1, 2*). The site overlies an unconfined aquifer, which has been split into an upper aquifer from 3m to 24m below ground surface (BGS) and a lower aquifer (>40 m BGS) that are separated by a gap of unsaturated sediments. Both aquifers are predominantly composed of unconsolidated sands with minor clayey sand layers. The lower unsaturated gap was likely caused by intense regional groundwater pumping, and a well completed in this unsaturated zone has very low gas pressures. There are no persistent gradients in water table levels across the KCD site, but in general, regional groundwater flow is from the NW to SE due to topographic flow on the Kings River fan. The water table is located about 5 m BGS. Local recharge is dominated by vertical fluxes from irrigation, and to a lesser extent, leakage from adjacent unlined canals. Transient cones of depression are induced during groundwater pumping from dairy operation wells.

The regional groundwater is highly impacted by agricultural activities and contains elevated concentrations of nitrate and pesticides (*3, 4*).

KCD was instrumented with five sets of multi-level monitoring wells and one "up-gradient" well near an irrigation canal. These wells were installed in 2002, and sampled between Feb. 2002 and Aug. 2005. The multi-level wells have short (0.5 m) screened intervals in order to detect heterogeneity and stratification in aquifer chemistry. One monitoring well was screened in the lower aquifer, 54m BGS. The remaining monitoring wells are screened in the upper aquifer from 5m to 20m BGS. In addition, there are eight dairy operation wells that were sampled over the course of this study. These production wells have long screens, generally between 9 to 18 meters below ground surface (BGS).

*Study Site 2:*

The second dairy field site is located in Merced County, CA. The Merced County dairy (MCD) lies within the northern San Joaquin Valley, approximately 160 km NNW from the KCD site. The site is located on the low alluvial fans of the Merced and Tuolumne Rivers, which drain the north-central Sierra Nevada. Soils at the site are sand to loamy sand with rapid infiltration rates. The upper portion of the unconfined alluvial aquifer is comprised of arkosic sand and silty sand, containing mostly quartz and feldspar, with interbedded silt and hardpan layers. Hydraulic conductivities were measured with slug tests and ranged from $1 \times 10^{-4}$ m/s to $2 \times 10^{-3}$ m/s with a geometric mean of $5 \times 10^{-4}$ m/s (*5*). Regional groundwater flow is towards the valley trough with a gradient of approximately 0.05% to 0.15%. Depth to groundwater is 2.5 m to 5 m BGS. The climate is Mediterranean with annual precipitation of 0.5 m, but groundwater recharge is on the order of 0.5–0.8 m per year with most of the recharge originating from excess irrigation water (*3*). Transit times in the unsaturated zone are relatively short due to the shallow depth to groundwater and due to low water holding capacity in the sandy soils. Shallow water tables are managed through tile drainage and groundwater pumping specifically for drainage. The MCD site is instrumented with monitoring wells that are screened from 2-3 m BGS to a depth of 7-9 m BGS. The wells access the upper-most part of the unconfined aquifer, hence, the most recently recharged groundwater (6). Recent investigations showed strongly elevated nitrate levels in this shallow groundwater originating largely from applications of liquid dairy manure to field crops, from corrals, and from manure storage lagoons (6). For this study, a subset of 18 wells was sampled. A deep domestic well was also sampled at MCD. This domestic well is completed to 57 m BGS, and thus samples a deeper part of the aquifer than the monitoring well network.

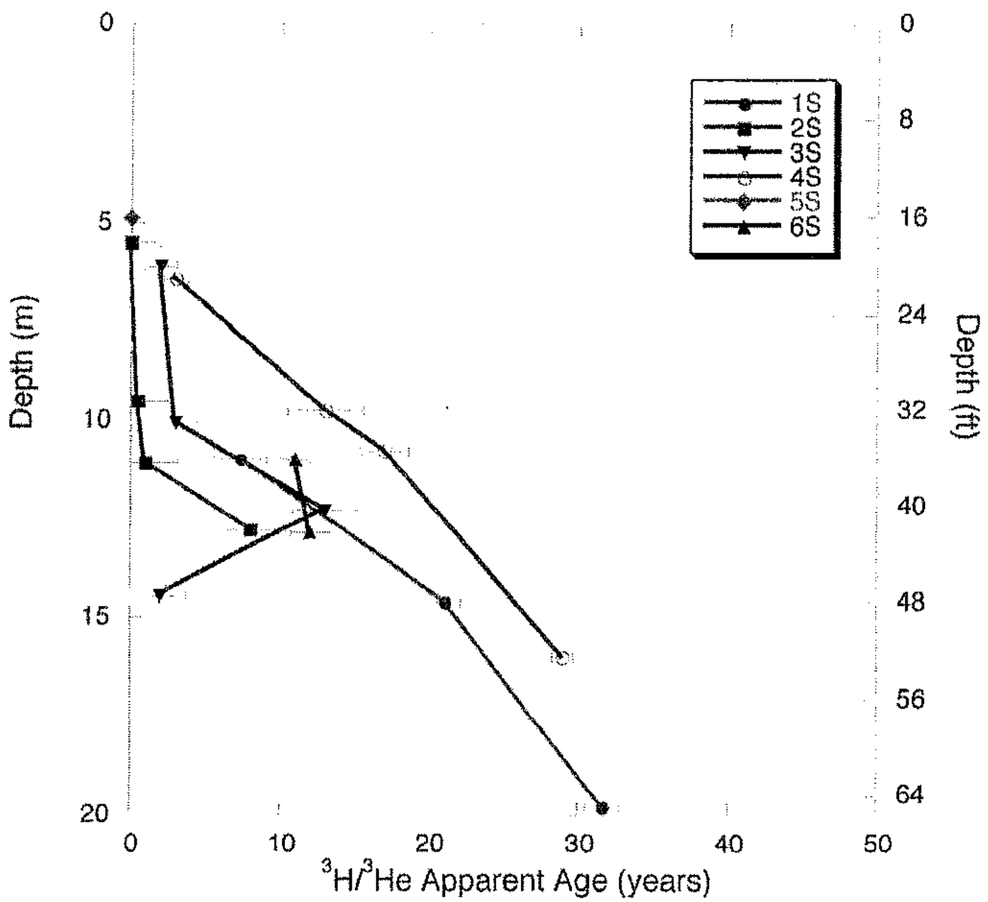


Figure S1. Groundwater $^{3}H/^{3}He$ apparent ages from multilevel monitoring wells at KCD. Error bars show analytical error.

Table S1. Chemical, dissolved gas, and isotopic compositions for multilevel groundwater monitoring wells and lagoons. Average values are given for wells sampled more than onc
Excess $N_2$ values in **bold** are fully constrained by noble gas determinations of excess air and recharge temperature.

| Site | Depth of multi-level well (m) | $Cl^-$ (mg/L) | $NO_3^-$ (mg/L) | $NH_4^+$ (mg/L) | ORP | DO (mg/L) | TOC (mg/L) | $\delta^{18}O$ $H_2O$ (‰ SMOW) | $\delta^{15}N$ $NO_3^-$ (‰ Air) | $\delta^{18}O$ $NO_3^-$ (‰ SMOW) | $^3H/^3He$ age (yr) | +/- (yr) | Excess air determined from Ne (cc STP/g) | Recharge Temp. from Xe (°C) | +/- (°C) | $^3H$ pCi/L | +/- (pCi/L) | $N_2/Ar$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| KCD-CANAL-1 | | 1.5 | 1.2 | 0.2 | | 10.0 | | -12.9 | | | | | | | | 13.3 | 0.6 | |
| KCD-LAGOON-1 | | 304.5 | 28.6 | 360.8 | | 0.4 | 480.0 | -10.2 | | | | | | | | | | 68 |
| KCD-LAGOON-2 | | 265.2 | 13.9 | 292.1 | | 0.5 | 490.0 | -10.0 | | | | | | | | | | 58 |
| KCD-LAGOON-3 | | 212.2 | 22.4 | 181.3 | | 0.5 | 420.0 | -9.9 | | | | | | | | | | 41 |
| KCD-1D1 | 54.3 | 1.9 | 0.2 | <0.1 | -264 | 0.2 | 0.8 | -13.7 | 7.1 | | >50 | | 3.40E-03 | 15 | 1.2 | 0.5 | 0.1 | 41 |
| KCD-1S1 | 6.7 | | 206.0 | | 166 | 3.5 | | -12.7 | | | | | | | | | | 46 |
| KCD-1S2 | 11.0 | 52.5 | 11.1 | 0.3 | -79 | 0.4 | 2.5 | -12.8 | 46.9 | 18.8 | 7.3 | 1.8 | <1E-4 | 16 | 1.1 | 32.0 | 1.2 | 62 |
| KCD-1S3 | 14.6 | 36.0 | 0.5 | 1.3 | -164 | 0.5 | 1.3 | -12.9 | 7.6 | | 21.1 | 1.1 | 2.82E-03 | 14 | 1.1 | 31.4 | 1.2 | 63 |
| KCD-1S4 | 19.8 | 9.8 | 0.4 | 2.5 | -196 | 0.5 | 1.1 | -13.3 | | | 31.7 | 1.1 | 4.02E-03 | 16 | 1.1 | 28.3 | 1.1 | 46 |
| KCD-2S1 | 5.5 | 107.7 | 144.5 | <0.1 | | | 5.0 | -12.3 | | | 0.0 | 2.0 | 1.70E-03 | 19 | 1.0 | 21.9 | 0.9 | 39 |
| KCD-2S2 | 9.5 | 95.0 | 187.2 | 0.6 | 84 | 0.7 | 4.2 | -12.2 | 13.1 | -0.2 | 0.5 | 2.2 | 1.78E-03 | 22 | 1.1 | 19.5 | 0.8 | 49 |
| KCD-2S3 | 11.1 | 101.1 | 178.2 | 0.1 | 62 | 1.7 | 3.0 | -12.1 | 13.2 | 0.2 | 1.0 | 2.1 | <1E-4 | 21 | 1.1 | 19.3 | 0.8 | 62 |
| KCD-2S4 | 12.8 | 72.7 | 7.1 | 1.0 | -149 | 0.3 | 1.8 | -12.4 | 29.9 | | 8.0 | 2.4 | <1E-4 | 23 | 1.8 | 19.8 | 0.8 | 10( |
| KCD-3S1 | 6.1 | 170.4 | 203.1 | 0.4 | 0 | 1.2 | 5.3 | -11.7 | 14.5 | 2.4 | 2.0 | 1.0 | 1.42E-03 | 19 | 1.1 | 17.8 | 0.7 | 46 |
| KCD-3S2 | 10.1 | 255.6 | 273.6 | <0.1 | 72 | 2.3 | 14.2 | -11.2 | | | 3.0 | 1.4 | 6.35E-04 | 21 | 1.1 | 21.2 | 0.9 | 49 |
| KCD-3S3 | 12.3 | 162.7 | 167.8 | 0.5 | 107 | 1.2 | 9.0 | -11.9 | 15.8 | 5.2 | 13.0 | 2.2 | 1.30E-03 | 18 | 1.0 | 16.4 | 0.8 | 53 |
| KCD-3S4 | 14.5 | 194.0 | 136.4 | <0.1 | 79 | 1.0 | 5.6 | -11.8 | 22.9 | 7.4 | 2.0 | 1.7 | <1E-4 | 20 | 1.0 | 18.6 | 0.7 | 59 |
| KCD-4S1 | 6.4 | 127.0 | 83.3 | <0.1 | | | | | 8.6 | 2.2 | 3.0 | 0.8 | 3.35E-04 | 20 | 1.0 | 35.6 | 1.4 | |
| KCD-4S2 | 9.8 | 32.1 | 125.4 | 0.4 | -16 | 0.8 | 1.1 | -11.8 | 4.7 | 2.3 | 13.0 | 2.5 | 5.07E-03 | 18 | 1.3 | 20.3 | 0.8 | 51 |
| KCD-4S3 | 10.8 | 42.3 | 77.1 | 0.5 | 27 | 0.9 | 1.1 | -12.0 | 13.5 | 6.1 | 17.0 | 1.6 | 3.54E-03 | 19 | 1.2 | 22.7 | 0.9 | 60 |
| KCD-4S4 | 16.0 | 35.0 | 0.9 | 1.8 | -161 | 0.9 | 3.5 | -13.0 | | | 29.0 | 0.7 | | 18 | 1.0 | 46.5 | 1.7 | 61 |
| KCD-5S1 | 4.9 | 14.5 | 35.4 | 1.3 | 37 | 0.5 | 1.5 | -13.4 | 18.9 | 1.8 | <1 | | <1E-4 | 18 | 1.0 | 12.5 | 0.6 | 46 |
| KCD-6S1 | 12.9 | 129.3 | 12.7 | 20.4 | | 1.0 | 15.7 | -11.9 | 12.1 | | 12.0 | 1.3 | <1E-4 | | | 29.1 | 1.1 | 70 |
| KCD-6S2 | 11.0 | 140.6 | 10.1 | 3.2 | | 1.2 | 14.6 | -11.8 | | | 11.0 | 1.0 | <1E-4 | | | 33.3 | 1.2 | 67 |
| KCD-6S3 | 7.6 | 129.5 | 159.3 | 0.9 | | | 6.7 | -11.6 | 19.0 | 7.7 | | | 2.13E-04 | | | 33.9 | 1.3 | 51 |
| KCD-NW-01 | 9-18 | 140.8 | 114.7 | 1.9 | | 1.9 | | -12.0 | 15.0 | | | | | | | | | 54 |
| KCD-NW-02 | 9-18 | 163.4 | 75.2 | 3.4 | | 1.3 | | -12.0 | 18.2 | | | | | | | 17.0 | 0.9 | 71 |
| KCD-NW-03 | 9-18 | 100.3 | 67.2 | <0.1 | | | | | | | | | | | | | | |
| KCD-NW-04 | 9-18 | 2.8 | 2.0 | <0.1 | | | | -13.7 | | | >50 | | 7.72E-04 | 12 | 0.9 | 0.2 | 0.2 | |
| KCD-NW-06 | 9-18 | 92.8 | 48.6 | 2.6 | | | | -12.2 | 17.2 | | | | | | | 22.9 | 1.2 | 61 |
| KCD-SW-02 | 9-18 | 52.6 | 91.0 | <0.1 | | | | -12.7 | 23.5 | | | | | | | 24.8 | 1.4 | |
| KCD-SW-03 | 9-18 | 45.1 | 29.2 | 1.9 | | 1.5 | | -12.4 | 27.3 | | | | | | | 30.4 | 1.3 | 57 |
| KCD-SW-07 | 9-18 | 165.5 | 25.8 | <0.1 | | | | | | | | | | | | | | |
| KCD-SW-08 | 9-18 | 184.1 | 116.6 | 2.3 | | 3.8 | | -10.9 | 16.9 | | | | | | | 19.7 | 0.8 | 53 |
| MCD-LAGOON | | 514.0 | <0.1 | 691.8 | | | | | | | | | | | | | | 62 |
| MCD-V-01 | 7.0 | 317.8 | 425.1 | <0.1 | 111 | 5.6 | 12.7 | -9.3 | 13.9 | 7.4 | 12.0 | 1.7 | <1E-4 | 25 | 1.2 | 36.0 | 1.4 | 61 |
| MCD-V-14 | 7.6 | 71.4 | 316.0 | <0.1 | | | 5.8 | | 11.2 | 1.7 | 2.0 | 2.9 | 1.26E-03 | 18 | 1.0 | 12.4 | 0.5 | 41 |
| MCD-V-18 | 6.1 | 77.2 | 195.5 | 1.7 | 193 | 3.3 | 8.1 | | 10.1 | -0.5 | | | | | | 12.2 | 0.5 | 39 |
| MCD-V-21 | 9.1 | 145.5 | 163.1 | <0.1 | 147 | 1.4 | 22.6 | -9.1 | 19.9 | 9.2 | <1 | | | | | 15.3 | 0.6 | 61 |
| MCD-V-24 | 9.1 | 30.2 | 201.5 | <0.1 | 161 | 7.0 | 5.4 | -10.5 | 7.4 | -0.7 | <1 | | 4.31E-04 | 20 | 1.0 | 13.8 | 0.6 | 37 |
| MCD-V-99 | | 73.0 | 303.2 | 2.4 | | | 12.2 | | 10.3 | 0.4 | 1.0 | 2.1 | <1E-4 | 19 | 1.0 | 14.5 | 0.6 | 39 |
| MCD-W-02 | 7.0 | 226.1 | 2.0 | 148.5 | | 0.6 | 12.7 | -9.1 | | | | | | | | 17.9 | 0.7 | 12( |
| MCD-W-03 | 7.0 | 82.2 | 341.8 | 0.7 | | 0.8 | 14.5 | -10.5 | | | 3.0 | 3.1 | 2.13E-03 | 17 | 1.0 | 13.7 | 0.6 | 45 |
| MCD-W-05 | 7.0 | 48.3 | 230.6 | <0.1 | | | | -10.7 | 6.8 | | | | | | | 14.5 | 0.8 | 39 |
| MCD-W-10 | 9.1 | 55.5 | 426.1 | <0.1 | 171 | | 11.7 | -10.3 | 9.1 | 0.0 | 3.0 | 3.4 | 2.52E-03 | 19 | 1.1 | 13.5 | 0.6 | 44 |
| MCD-W-16 | 9.1 | 298.9 | 6.1 | 113.9 | 176 | 0.7 | 9.1 | -8.1 | | | <1 | 0.7 | <1E-4 | | | 18.9 | 0.9 | 13( |
| MCD-W-17 | 9.1 | 136.9 | 171.7 | 26.7 | 208 | 0.7 | 9.8 | -9.4 | 30.2 | 13.1 | | | <1E-4 | | | 15.9 | 0.7 | 90 |
| MCD-W-23 | 9.1 | 80.9 | 356.1 | 1.9 | 121 | 1.1 | 10.4 | -10.2 | | | 2.0 | 2.8 | 1.65E-03 | 20 | 1.0 | 13.9 | 0.5 | 43 |
| MCD-W-30 | 9.1 | 49.1 | 324.8 | <0.1 | | | | -9.9 | 5.3 | | 1.0 | 2.3 | 1.23E-03 | 17 | 0.8 | 16.3 | 0.9 | 38 |
| MCD-W-31 | 9.1 | 40.8 | 187.9 | <0.1 | | | | -10.9 | 8.0 | | <1 | | 1.82E-03 | | | 15.9 | 0.7 | 40 |
| MCD-W-34 | 7.3 | 63.4 | 185.6 | <0.1 | | | | -10.8 | 7.9 | | 1.0 | 3.8 | 2.77E-03 | 17 | 0.8 | 13.7 | 0.7 | 41 |
| MCD-W-35 | 7.3 | 159.6 | 304.4 | <0.1 | | | | -9.7 | 11.8 | | <1 | | 1.52E-03 | 17 | 0.8 | 16.3 | 0.8 | 41 |
| MCD-W-98 | 57 | 69.6 | 0.4 | <0.1 | | | 2.1 | -10.6 | | | 31.0 | 0.6 | 1.76E-03 | 18 | 1.0 | 21.8 | 0.9 | 64 |

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# Exhibit G

# California GAMA Program: Impact of Dairy Operations on Groundwater Quality

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*Appendix B:* McNab, W. W., Singleton, M. J., Moran, J. E., and Esser, B. K., 2007. Assessing the impact of animal waste lagoon seepage on the geochemistry of an underlying shallow aquifer. *Environmental Science & Technology* 41, 753-758.

## EXECUTIVE SUMMARY

A critical component of the California State Water Board's Groundwater Ambient Monitoring and Assessment (GAMA) Program is to assess the major threats to groundwater resources that supply drinking water to Californians (BELITZ et al., 2003). Nitrate is the most pervasive and intractable contaminant in California groundwater and is a focus of special studies under the GAMA program.

This report assesses the impact of Central Valley dairy operations on underlying groundwater quality and on groundwater processes using new tools developed during the course of the study. During the investigation, samples were collected and analyzed from a total of five dairies in the San Joaquin-Tulare Basins of California: three in Kings County, one in Stanislaus County, and one in Merced County (Figure 1). The study investigated water samples from production wells, monitor wells, and manure lagoons..

The three primary findings of this research are that dairy operations do impact underlying groundwater quality in California's San Joaquin Valley, that dairy operations also appear to drive denitrification of dairy-derived nitrate in these groundwaters, and that new methods are available for characterization of nitrate source, transport and fate in the saturated zone underlying dairy operations.

This study demonstrated groundwater quality impact at three sites using a multi-disciplinary approach, and developed a new tool for source attribution in dairy groundwater. Negative groundwater quality impacts from dairy-derived nitrate were demonstrated using groundwater chemistry, nitrate isotopic composition, groundwater age, and transport modeling. A significant advance in characterization of groundwaters for nitrate source determination was the use of groundwater dissolved gas content to distinguish dairy wastewater irrigation from dairy wastewater lagoon seepage, both of which contributed to dairy groundwater contamination.

The demonstration of saturated-zone denitrification in dairy groundwaters is important in assessing the net impact of dairy operations on groundwater quality. The extent of denitrification can be characterized by measuring "excess" nitrogen and nitrate isotopic composition while the location of denitrification can be determined using a bioassay for denitrifying bacteria that developed in this research. In both northern and southern San Joaquin Valley sites, saturated-zone denitrification occurs and mitigates the impact of nitrogen loading on groundwater quality.

Other new methods developed during the course of this study include the field determination of denitrification in groundwater (allowing siting of monitor wells and mapping of denitrifying zones) and characterization of aquifer heterogeneity using direct-push drilling and geostatistics (allowing development of more accurate groundwater transport models). Application of these new methods in conjunction with traditional hydrogeologic and agronomic methods will allow a more complete and accurate understanding of the source, transport and fate of dairy-derived nitrogen in the subsurface.

## STUDY SITES: HYDROGEOLOGIC SETTING

Two concentrations of dairies exist in the Central Valley of California, which is a low relief structural basin that is from 60 to 100 km wide and 700 km long. Both centers are in the southern two-thirds of the basin - the northern concentration is in Merced and Stanislaus Counties, and the southern concentration is in Kings and Tulare Counties. Both concentrations of dairies occur in the San Joaquin Valley Groundwater Basin, as designated by the California Department of Water Resources (2003). The San Joaquin Valley groundwater basin comprises two of the Central Valley's three large structural sub-basins: the San Joaquin Basin and the Tulare Basin. In this document, we will use "San Joaquin Valley Basin" and "San Joaquin-Tulare Basin" interchangeably.

During the investigation, samples were collected and analyzed from a total of five dairies in the San Joaquin-Tulare Basins of California: three in Kings County, one in Stanislaus County, and one in Merced County (Figure 1). Groundwater samples were collected from production wells on each of the dairies. On three of the dairies, samples were also collected from monitoring wells: one of sites in Kings County was instrumented by LLNL, and the two sites in Stanislaus and Merced Counties were instrumented by UC-Davis. Samples were collected from manure lagoons at four of the sites.

### *Northern Sites*

The two northern sites (SCD and MCD) are part of an extensive shallow groundwater monitoring network on five representative dairies set up by Thomas Harter of UC-Davis and the UC Cooperative Extension. The following description of the study area and the dairies is adapted from Harter et al. (2002).

The northern sites study area is in the central-eastern portion of the northern San Joaquin Valley, an area of low alluvial plains and fans bordered by the San Joaquin River to the west, tertiary upland terraces to the east, the Stanislaus River to the north, and the Merced River to the south. The region has a long history of nitrate and salt problems in groundwater (LOWRY, 1987; PAGE and BALDING, 1973).

The main regional aquifer is in the upper 100-200 m of basin deposits, which consist of Quaternary alluvial and fluvial deposits with some interbedded hardpan and lacustrine deposits. Groundwater generally flows from the ENE to the WSW following the slope of the landscape. The average regional hydraulic gradient ranges from approximately 0.05% to 0.15%. The water table at the selected facilities is between 2 and 5 m below ground surface. Measured K values range from 0.1 to 2 x $10^{-3}$ m/s, as consistent with the predominant texture of the shallow sediments.

The dominant surface soil texture is sandy loam to sand underlain by silty lenses, some of which are cemented with lime. Water holding capacity is low and water tables are locally high (and maintained by community drainage systems and shallow groundwater pumping). Border flood irrigation of forage crops has historically been the dominant cropping system among dairies in the study area. Low-salinity (0.1–0.2 μS/cm) surface water from the Sierra Nevada is the main source of irrigation water.

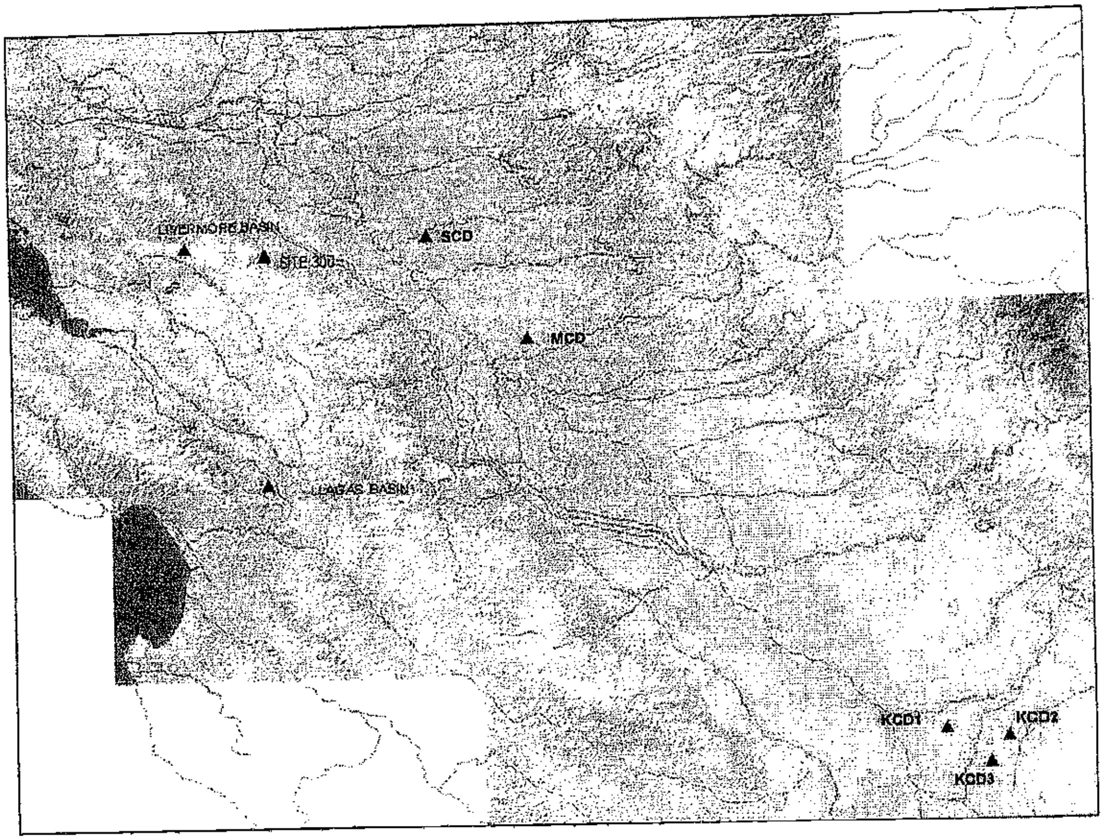


**Figure 1. Dairy Field Sites in the Central Valley.**

Dairy Field Sites in the Central Valley Dairy study sites in Kings County (KCD1, KCD2, and KCD3), Merced County (MCD) and Stanislaus County (SCD) are shown with red triangles. Other sites where LLNL has conducted groundwater nitrate studies are shown with blue triangles

A number of hydrogeologic criteria make the area suitable as a field laboratory for investigating recharge water quality from dairies: 1) Groundwater in the area is highly vulnerable because of the sandy soils with high infiltration rates and shallow water tables. 2) The shallow groundwater table and small long-term fluctuations in water level (1-2 m) allow sampling from vertically narrow groundwater zones with well-defined recharge source areas. 3) These same two factors also allow installation of a relatively inexpensive fixed-depth monitoring well network that is also inexpensive to sample.

The five dairy facilities in the UC-Davis network are progressive with respect to herd health, product quality, and overall operations. Improvements in manure and pond management have continually occurred since the inception of the project. The dairies are located in a geographic and hydrogeologic environment that is representative of many other dairies on the lowlands of the northern San Joaquin Valley. The manure management practices employed at these dairies over the past 35 years, particularly with respect to corral design, runoff capture, and lagoon management, have been recognized by industry, regulators, and university extension personnel as typical or even progressive relative to other California dairies (see references in HARTER et al., 2002). Over the past 30– 40 years, the herd size on these dairies has continually grown from less than 100 at their inception to over 1000 animal units in the 1990s.

In 1993, UC-Davis installed 6 to 12 monitoring wells on each dairy for a total of 44 wells. Monitoring wells are strategically placed upgradient and downgradient from fields receiving manure water, near wastewater lagoons (ponds), and in corrals, feedlots, and storage areas (henceforth referred to as ''corrals''). Wells are constructed with PVC pipe (3 or 5 cm diameter) and installed to depths of 7–10 m. The wells are screened from a depth of 2–3 m below ground surface to a depth of 10 m. Water samples collected from monitoring wells are representative of only the shallowest "first-encounter" groundwater.

***Southern Sites***

To augment the UC-Davis dairy monitoring network, LLNL chose to establish sites in the southern San Joaquin Valley groundwater basin. LLNL developed a list a five potential cooperators, sampled three sites, and chose to instrument one site. The cooperators were chosen with the expertise and assistance of the University of California Cooperative Extension (Thomas Harter, Carol Collar and Carol Frate). Sampling sites were chosen from the list of cooperator dairies using regional water quality data, including NAWQA data from the USGS and water quality dairy data from the Central Regional Water Quality Control Board (Fresno office). The site chosen for more extensive instrumentation was chosen with the following criteria: 1) a cooperative operator, 2) a shallow depth to groundwater to allow cost-effective installation of multi-level wells and synoptic soil-groundwater surveys, 3) a dairying operation typical for the region, and 4) regional evidence for nitrate contamination and denitrification.

The three dairies sampled are within the Tulare Lake Groundwater Subbasin of the San Joaquin Valley Groundwater Basin (CALIFORNIA DWR, 2003) (Figure 1). The sites are located south of the Kings River and north-northeast of the Tulare Lake basin, the natural internal drainage for this hydrologically closed system. Groundwater hydraulic gradients are regionally from the Kings River toward Tulare Lake, but are generally low and are locally influenced by recharge from unlined irrigation canals and by agricultural and municipal groundwater extraction. Surface soils at these sites are predominantly Nord series (USDA NATIONAL RESOURCE CONSERVATION SERVICE, 2006), and are developed on distal Kings River alluvial fan deposits (WEISSMANN et al., 2003; WEISSMANN et al., 1999; WEISSMANN and FOGG, 1999; WEISSMANN et al., 2002a), which in general are less sandy and have more fine-grained interbeds than the sediments in the northern UC-Davis monitoring network. Groundwater levels in the area are in general deeper (50-200' below ground surface) and more variable (50' over 2-5 years) than in the north. A deeper depth to groundwater and heavier textured soils indicate that southern groundwaters should be less vulnerable to contamination than northern groundwaters. The regional groundwater is highly impacted by agricultural activities and contains elevated concentrations of nitrate and pesticides (BUROW et al., 1998b; BURROW et al., 1998).

Two of the three dairies sampled (KCD2 and KCD3) have deep water tables typical of the region. The one dairy that LLNL instrumented is located in an area to the west of Hanford characterized by a shallow perched aquifer, with depth to groundwater on the order of 15 feet. California Department of Water Resources (DWR) water level data for wells in the area indicate that this perched aquifer developed in the mid-1960's in response to local groundwater overdrafting (CARLE et al., 2005), and is separated by an unsaturated zone from the deeper regional aquifer (that is sampled by wells on KCD2 and KCD3 to the east and south of Hanford).

The three dairy sites sampled by LLNL in Kings County each have close to the average of 1000 dairy cows, fed in free stalls with flush lanes. The manure management practices employed at these dairies, with respect to corral design, runoff capture, and lagoon management, are typical or progressive relative to other California dairies (see references in HARTER et al., 2002). The most intensively studied dairy, KCD1, operates three clay-lined wastewater lagoons that receive wastewater after solids separation. Wastewater is used for irrigation of 500 acres of forage crops (corn and alfalfa) on the dairy and on neighboring farms; dry manure is exported to neighboring farms. This dairy is also immediately adjacent to another dairy operation, and many of the conclusions regarding nitrate impact apply to dairy practices shared by both operations.

## STUDY SITES: SAMPLING AND INSTRUMENTATION

### *Kings County Dairy Site 1 (KCD1)*

Kings County Dairy #1 (KCD1; see Figure 1, Appendix A-Figure 1, and Appendix B-Figure 1), was the primary site in Kings County, and was sampled on multiple occasions, from existing production wells, from LLNL-installed monitor wells, from manure lagoons and irrigation canals, and with direct push soil and water sampling methods. A total of 31 days were devoted to collecting 139 water samples at the site, including 29 direct push samples, 17 surface water samples from 3 manure lagoons and a nearby irrigation canal, 16 groundwater samples from 9 production wells, and 60 groundwater samples from 17 monitor wells. A large number of subsurface soil samples were also collected, both as continuous drill core and as depth-discrete grab samples. Production and monitor wells were sampled on semi-regular intervals between August 2003 and August 2005.

KCD1 was instrumented with five sets of multi-level monitoring wells and one "up-gradient" well near an irrigation canal (Figure 2). The multi-level well "clusters" consisted of wells installed in separate boreholes approximately 5' apart. A first set of three nested 2" wells in one cluster was installed in September 2003. In August 2004, three new well clusters were installed, each with four 2" wells. Also at that time, an upgradient 2" well was installed, and a small cluster of three 1.25" wells were installed. Two aquifers underlie the KCD1 dairy site, a shallow perched aquifer and a more regionally extensive deep aquifer. The deep aquifer is instrumented with one 2" well screened at 178-180' below ground surface (bgs) that was installed in September 2003. The remaining monitor wells are all in the shallow perched aquifer and are screened between 18' and 65' bgs.

In August 2004, shortly before the second sets of well clusters were installed, a CPT/DP survey (see methods section) was conducted across the site (Figure 3). Depth discrete water and soils samples were collected at this time, after which the holes were grouted and abandoned. With the exception of the upgradient monitor well near the canal, CPT/DP sites included locations near all of the multi-level monitor well clusters.


**Figure 2. KCD1 Dairy Field Site.**
KCD1 site, showing monitor wells and direct-push locations. Sites 1, 2, 3, and 4 (S1 through S4) are all multi-level two-inch monitor well clusters; site 5 (S5) is a single two-inch first-encounter well. The Site 1 cluster (S1) also includes a well in the deep aquifer. Direct-push (DP) and cone penetrometer (CPT) holes are also shown. CPT/DP was done at all multi-level well sites; it was not done at the single-level 5S site. Inset shows application of manure lagoon wastewater for furrow irrigation of silage corn crops at the site.

The production wells are screened in both the shallow and deep aquifer, and have 20-30' long screens. Domestic supply wells, one of which was sampled, are screened in the deep aquifer, and typically have 20' long screens. Agricultural supply wells, eight of which were sampled, typically have 30' long screens, with the top of the screen at 30' bgs. Information on screen length and depth is from conversations with the water well company which installed the more recent wells and has extensive experience in the region.

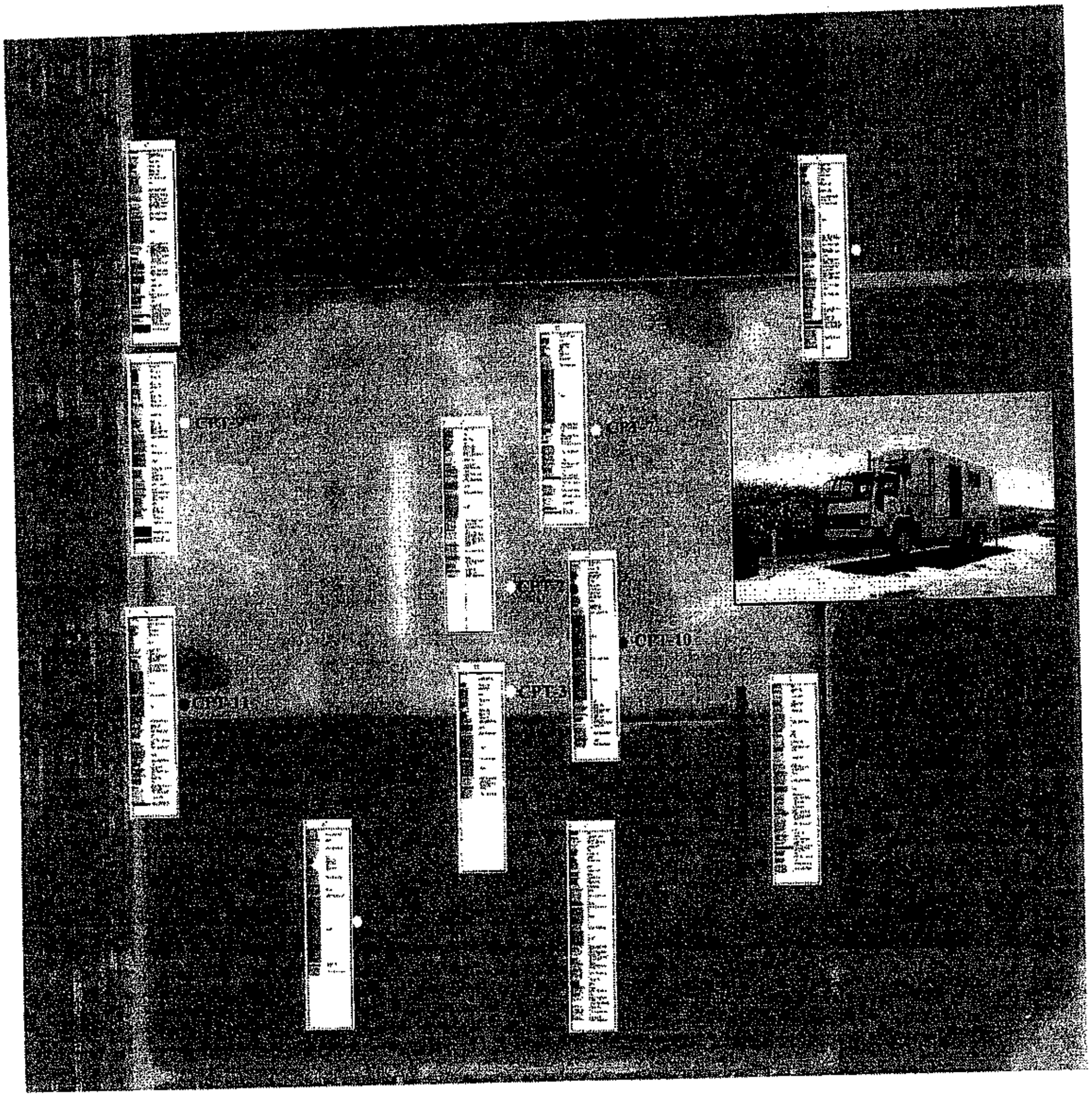

**Figure 3. KCD1 field site with CPT/DP locations.**
Soil Behavior Type (SBT) profiles from Direct-Push Cone Penetrometer Testing on the KCD1 dairy field site. Large inset shows direct-push rig.

### *Kings County Dairy Sites 2 and 3 (KCD2 and KCD3)*

The second and third Kings County dairy sites (Figure 1) were sampled during initial screening of Kings County sites in August 2003. At each site, groundwater pumped from a domestic supply well was analyzed for inorganic cations and anions (including nitrate, nitrite and ammonia), dissolved gases by membrane-inlet mass spectrometry, and tritium/helium-3 mean groundwater age by noble gas mass spectrometry. Groundwater in the area is 120-150 feet below ground surface, and the Corcoran Clay is generally 400-450' below ground surface and 90-100' thick. At each site, groundwater was sampled from wells screened between 200 and 300 feet below ground surface.

The second dairy was sampled again in April 2005. On this occasion, groundwater from the same domestic supply well sampled in 2003 was re-sampled, and manure lagoon and field water from six sampling locations was sampled. The groundwater was analyzed as before; while the lagoon water samples were analyzed for inorganic cations and anions (including nitrate, nitrite and ammonia), and dissolved gases by membrane-inlet mass spectrometry.

### *Merced and Stanislaus Dairy Sites (MCD and SCD)*

MCD and SCD (Figure 1, Appendix A-Figure 1: The Merced County and Stanislaus County Dairies (MCD and SCD) were sampled on three occasions: August 2003, April 2005 and June 2005. Almost 40 samples were taken broken down as follows: 30 MCD samples and 9 SCD samples; 28 groundwater samples from 22 wells, 1 lagoon water sample, and 1 tile drain sample. Groundwater samples were analyzed for field parameters (temperature, conductivity, dissolved oxygen and ORP); inorganic cations and anions (including nitrate, nitrite and ammonia), dissolved gases by membrane-inlet mass spectrometry, tritium/helium-3 mean groundwater age by noble gas mass spectrometry, stable isotopic composition of nitrate and water, and organic co-contaminants. Tritium/helium-3 samples were not taken from the surface water sampling sites. These sites and data from these sites are described in Harter et al. (2002)

## METHODS

### *Cone Penetrometer (CPT) and Direct Push (DP) Methods*

Standard cone penetrometer/direct push methods were used to characterize the shallow hydrostratigraphy at the site. The survey was accomplished using a 20-25 ton CPT rig and accompanying support rig. The dead weight of the CPT rig was used to push the cone penetrometer to depths up to 90 feet using a hydraulic ram located at the center of the truck. Soil parameters such as cone bearing, sleeve friction, friction ratio and pore water pressure were measured as the cone penetrometer was advanced. These measurements were sent through the cone rods to the CPT rig's on-board data acquisition system. All data was processed in real time in the field, and CPT plots of tip resistance, sleeve friction; friction ratio and pore pressure were provided in the field along with a table of interpreted soil parameters. For development of geostatistical models of subsurface hydraulic properties, soil behavior types determined by CPT (ROBERTSON et al., 1983) were calibrated and validated against a 200-foot continuous core log recovered from the first site (Figure 4.)

After CPT logging, a second hole was developed for collecting depth-discrete groundwater and soil samples using direct push methods. For water, a Hydropunch groundwater sample was taken at specified depth intervals. The Hydropunch operates by pushing 1.75-inch diameter hollow rods with a steel tip. A filter screen is attached to the tip. At the desired sampling depth, the rods are retracted, exposing the filter screen and allowing for groundwater infiltration. A small diameter bailer is then used to collect groundwater samples through the hollow rod. Typically, 4 or more 40 ml VOA vials were collected. For soil, a piston-type soil sampler was used to collect undisturbed soil samples (12" long x 1" diameter) that were stored on ice or dry ice immediately upon retrieval. After completion of logging and sampling, CPT/DP sampling holes were grouted under pressure with bentonite using the support rig.

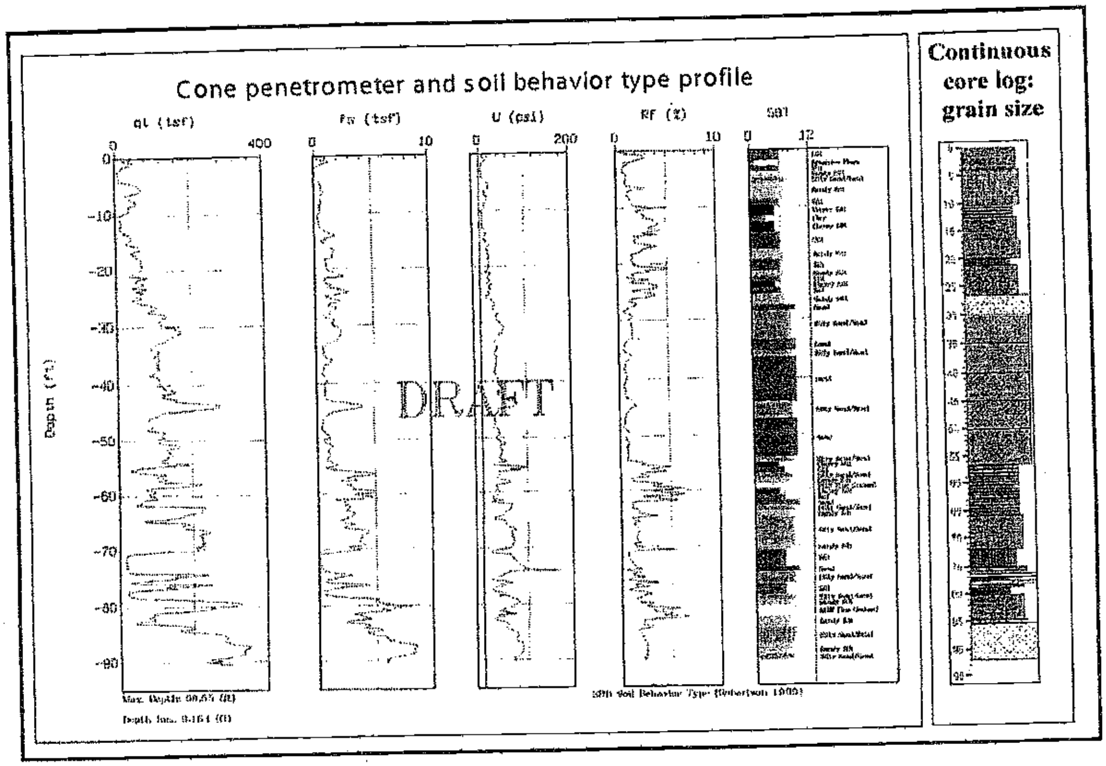

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**Figure 4. KCD Field Site CPT Logs.**
Comparison of soil behavior type (SBT) profile derived from CPT data to sediment texture profile as logged by a State of California certified drilling geologist at the KCD1 Site 1. Depth is shown in feet below ground surface. The thick sequence of sand between 25 and 55 feet shows up in both profiles, as does the confining unit at about 80 feet.

### *Standard Drilling Methods*

Monitor wells were emplaced using standard methods. The first and deepest 200-foot bore-hole was drilled with a mud-rotary rig; subsequent wells were drilled using hollow-stem auger. In the deep 200-foot hole, continuous log core was recovered and logged by a State-certified geologist (Figure 4) and down-hole geophysical data were obtained, including caliper, gamma ray, electro-magnetic induction, and spontaneous potential and resistivity logs. Wells were cased with either 2" or 1.25" PVC pipe with short (generally 2') slotted screens and sand packs, and completed with a sanitary seal. Early wells (installed in 2003) were completed with stovepipe installation, which were subsequently converted to ground-level flush-mount installations in 2004 to accommodate farm activities. All wells installed in 2004 were completed with a flush-mount installation. The 2"-diameter wells were developed using standard bail, surge and pump methods.

### *Sample Collection and Field Parameters*

Groundwater samples were collected after purging the well by either pumping or bailing, after determining water level against a marked datum. Groundwater from production wells was sampled, whenever possible, from upstream of any storage or pressure tank. A variety of methods were used to draw samples from monitor wells, depending on their diameter. Two-inch diameter monitor wells were sampled with a Grundfoss MP-1 submersible pump and Teflon-lined sample line. Smaller 1.25"-diameter monitor wells were sampled with small-diameter Teflon bailers or with a bladder pump and Teflon sample line.

When practical, field measurements of temperature (°C), conductivity (µS/cm), pH, dissolved oxygen (mg/L) and oxidation reduction potential (mV using Ag/AgCl with 3.33 mol/L KCl as the reference electrode) were carried out using a Horiba U-22 ® water quality analyzer. Sampling protocols were specific for different sets of analytes (see sampling sheet in Appendix C), and differed with regard to filtration, sample volume and container, the presence of headspace, and the use of gloves.

### *Chemical Composition Analysis*

Samples for anions and cations were filtered in the field to 0.45 µm, and stored cold and dark until analysis. Anion ($NO_3^-$, $SO_4^{2-}$, $Cl^-$, $F^-$, $Br^-$, $PO_4^{3-}$, $NO_2^-$) and cation ($Ca^{2+}$, $Mg^{2+}$, $Na^+$, $K^+$, $Li^+$, $NH_4^+$) concentrations were determined by ion chromatography using a Dionex DX-600. Total inorganic and organic carbon (TIC/TOC) was determined on unfiltered samples poisoned with mercuric chloride using a carbon analyzer (OI Analytical TOC Analyzer 1010). Dissolved inorganic carbon (DIC) concentrations were estimated in the water samples by employing the PHREEQC geochemical model (PARKHURST and APPELO, 2002) to achieve charge balance in the samples by adjusting and speciating DIC at the measured pH values. Dissolved organic carbon was also measured in a subset of samples as $CO_2$ gas pressure after acidification with orthophosphoric acid.

Sediment sulfur and carbon content was determined by elemental analysis by Actlabs (Ancaster, Ontario, Canada). Total C and S were determined on an ELTRA CS 2000 carbon sulfur analyzer. A weighed sample is mixed with iron chips and a tungsten accelerator and is then combusted in an oxygen atmosphere at 1370C. The moisture and dust are removed and the $CO_2$ gas and $SO_2$

gas are measured by a solid-state infrared detector. Sulphate S was determined by elemental analysis of the residue from roasting at 850° C. Reduced S was determined by difference. Carbonate C was determined by digestion of the sample in 2 N perchloric acid followed by coulometric titration. Graphitic C was determined by elemental analysis of the residue from roasting at 600° C. Organic C was determined by difference.

### *Stable Isotope Mass Spectrometry*

Samples for nitrate N and O isotopic compositions are filtered in the field to 0.45 μm, and stored cold and dark until analysis. Anion and cation concentrations are determined by ion chromatography using a Dionex DX-600. The nitrogen and oxygen isotopic compositions ($\delta^{15}N$ and $\delta^{18}O$) of nitrate in 26 groundwater samples from KCD1 and MCD were measured at Lawrence Berkeley National Laboratory's Center for Isotope Geochemistry using a version of the denitrifying bacteria procedure (CASCIOTTI et al., 2002) as described in Singleton et al. (SINGLETON et al., 2005). In addition, the nitrate from 34 samples were extracted by ion exchange procedure of (SILVA et al., 2000) and analyzed for $\delta^{15}N$ at the University of Waterloo. Analytical uncertainty is 0.3 ‰ for $\delta^{15}N$ of nitrate and 0.5‰ for $\delta^{18}O$ of nitrate.

Isotopic compositions of hydrogen and oxygen in water ($\delta^{2}H$ and $\delta^{18}O$) were determined at LLNL using a VG Prism II ® isotope ratio mass spectrometer, and are reported in per mil values relative to the Vienna Standard Mean Ocean Water (VSMOW). Isotopic composition of oxygen in water using the $CO_2$ equilibration method (EPSTEIN and MAYEDA, 1953), and have an analytical uncertainty of 0.1‰. Hydrogen isotope compositions were determined using the Zn reduction method (COLEMAN et al., 1982)

### *Membrane Inlet Mass Spectrometry (Excess $N_2$)*

Previous studies have used gas chromatography and/or mass spectrometry to measure dissolved $N_2$ gas (BOHLKE and DENVER, 1995; MCMAHON and BOHLKE, 1996; VOGEL et al., 1981; WILSON et al., 1990; WILSON et al., 1994). Both methods require extraction of a gas sample, which adds time and can limit precision. Membrane inlet mass spectrometry (MIMS) allows precise and fast determination of the concentrations of nitrogen, oxygen and argon dissolved in groundwater samples without a separate extraction step. This method has been used to document denitrification in estuarine and ocean settings (AN et al., 2001; KANA et al., 1994), as well as for detection of volatile organic compounds in water (KETOLA et al., 2002). The MIMS technique has also proven useful for determining excess $N_2$ from denitrification in groundwater systems (BELLER et al., 2004).

Samples for $N_2$, $O_2$, Ar, $CO_2$ and $CH_4$ concentration were analyzed by MIMS. A water sample at atmospheric pressure is drawn into the MIMS through a thin silicone rubber tube inside a vacuum manifold. Dissolved gases readily permeate through the tubing into the analysis manifold, and are analyzed using a quadrupole mass spectrometer. Water vapor that permeates through the membrane is frozen in a dry ice cold trap before reaching the quadrupole. The gas abundances are calibrated using water equilibrated with air under known conditions of temperature, altitude and humidity (typically 18 °C, 183 m, and 100% relative humidity). A small isobaric interference from $CO_2$ at mass 28 ($N_2$) is corrected based on calibration with $CO_2$-rich waters with known dissolved $N_2$, but is negligible for most samples. Typical sample size is 5 mL, and each analysis takes approximately 3 minutes. Dissolved oxygen, methane, carbon dioxide and argon content are measured at the same time as nitrogen. Samples are collected for MIMS analysis in 40 mL amber glass VOA vials, with no headspace, and kept cold during transport. Samples are analyzed within 24 hours to minimize the risk of gas loss or biological fractionation of gas in the sample container. The MIMS is field portable, and can be used on site when fieldwork requires extended time away from the laboratory, or when samples cannot be readily transported to the laboratory.

### *Noble Gas Mass Spectrometry ($^3H/^3He$ dating)*

Dissolved noble gas samples are collected in copper tubes, which are filled without bubbles and sealed with a cold weld in the field. Dissolved noble gas concentrations were measured at LLNL after gas extraction on a vacuum manifold and cryogenic separation of the noble gases. Concentrations of He, Ne, Ar and Xe were measured on a quadrupole mass spectrometer. Calculations of excess air and recharge temperature from Ne and Xe measurements are described in detail in Ekwurzel (2004), using an approach similar to that of Aeschbach-Hertig et al. (2000). The ratio of $^3He$ to $^4He$ was measured on a VG5400 mass spectrometer.

Tritium samples are collected in 1 L glass bottles. Tritium was determined by measuring $^3He$ accumulation after vacuum degassing each sample and allowing three to four weeks accumulation time. After correcting for sources of $^3He$ not related to $^3H$ decay (AESCHBACH-HERTIG et al., 1999; EKWURZEL et al., 1994), the measurement of both tritium and its daughter product $^3He$ allows calculation of the initial tritium present at the time of recharge, and apparent ages can be determined from the following relationship based on the production of tritiogenic helium ($^3He_{trit}$):

$$\text{Groundwater Apparent Age (years)} = -17.8 \times \ln\left(1 + {}^3He_{trit}/{}^3H\right)$$

The reported groundwater age is the mean age of the mixed sample, and furthermore, is only the age of the portion of the water that contains measurable tritium. Average analytical error for the age determinations is ±1 year, and samples with $^3H$ that is too low for accurate age determination (<1 pCi/L) are reported as >50 years. Loss of $^3He$ from groundwater is not likely in this setting given the relatively short residence times, lack of water table fluctuations, and high infiltration rates from irrigation. Groundwater age dating has been applied in several studies of basin-wide flow and transport (EKWURZEL et al., 1994; POREDA et al., 1988; SCHLOSSER et al., 1988; SOLOMON et al., 1992). Mean $^3H$-$^3He$ apparent ages are determined for water produced from 20 KCD monitor wells at depths of 6 m to 54 m, and from 14 sites at MCD. The apparent ages give a measure of the time elapsed since water entered the saturated zone, but only of tritium-containing portion of the groundwater sample. Apparent ages therefore give the mean residence time of the fraction of recently recharged water in a sample, and are especially useful for comparing relative ages of water from different locations at each site. The absolute mean age of groundwater may be obscured by mixing along flow paths due to heterogeneity in the sediments (WEISSMANN et al., 2002b).

### *Quantitative Real-Time Polymerase Chain Reaction (rt-qPCR)*

We have developed a simple bioassay to quantify populations of denitrifying bacteria in moderate amounts of aquifer material (on the order for a few grams of sediment or filtrate). The method detects the presence of bacterial genes that encode nitrite reductase, a central enzyme involved in denitrification. The assay is not species-specific, but rather a functional test for the presence of bacterial populations capable of nitrite reduction. Nitrite reduction is considered to be the "committed" step in denitrification, and bacteria capable of nitrite reduction are generally also capable of nitric and nitrous oxide reduction to nitrogen gas (TIEDJE, 1988). Currently, the assay provides valuable information on the distribution of denitrifying bacteria populations in aquifers. Ultimately, data on denitrifier populations (i.e., biomass) can be used in combination with specific (i.e., biomass-normalized) denitrification rate constants to determine subsurface denitrification rates.

Real-time, quantitative Polymerase Chain Reaction (rt-qPCR) analysis (Gibson et al., 1996; Heid et al., 1996; Holland et al., 1991), specifically the 5'-nuclease or TaqMan® assay, was chosen for this assay because it offers many advantages over traditional methods used to detect specific bacterial populations in environmental samples, such as DNA: DNA hybridization (Beller et al. 2002). Although most real-time PCR applications to date have involved the detection and quantification of pathogenic bacteria in food or animal tissue, the technique has recently been used to quantify specific bacteria in environmental samples (Hristova et al., 2001; Suzuki et al., 2000; Takai and Horikoshi, 2000).

Real-time qPCR is a rapid, sensitive, and highly specific method. The rt-qPCR assay developed targets two variants of the nitrite reductase gene: *nirS* (Fe-containing nitrite reductase) and *nirK* (Cu-containing nitrite reductase). Homologous gene sequences were used to develop a primer/probe set that encompasses functional *nir* genes of known denitrifying soil bacteria (including heterotrophic and autotrophic species) and that does not result in false positive detection of genes that are not associated with denitrification. The rt-qPCR primers and probes were designed based on multiple alignments of 14 *nirS* and 20 *nirK* gene sequences available in GenBank. During development of the assay, the first nitrite reductase gene (*nirS*) reported in an autotrophic denitrifying bacterium (*T. denitrificans*) was sequenced and amplified, and demonstrated to have high homology to *nirS* in a phylogenetically diverse set of heterotrophic denitrifying bacteria.

Real-time PCR was also be used to quantify total eubacterial population, based on detection of the sequence encoding the eubacterial 16S rRNA subunit, which is specific for bacteria.

### *Wastewater Co-Contaminants*

A number of co-contaminants expected to occur on a dairy farm from the dairy operation proper or from associated field crop production were determined using GC-MS or LC-MS. Co-contaminants targeted included herbicides, pesticides, VOCs, fecal sterols, caffeine and nonylphenol. The analysis of these compounds and a discussion of their distribution at the dairy sites is in Moran et al. (2006).

## DATA

Chemical, isotopic, dissolved gas, and groundwater age data for the KCD1 and MCD sites are discussed in Appendix A and Appendix B, and are tabulated in Table 1 of Appendix A and Table 1 of Appendix B. Chemical composition, stable isotope, and groundwater age data for KCD2, KCD3 and SCD2 are tabulated in Table 1 of the main report. In addition, membrane inlet mass spectrometry data for KCD2 is presented graphically in Figures 8 and 9. Neither Appendix A nor Appendix B contains sediment C and S data or bacterial population data, which are discussed below.

### *Sediment Data*

In zones sampled for groundwater at the KCD1 site, sediment texture as determined from well logging, CPT and laser diffraction particle size analysis ranges from sand to clayey silt (with trace to >95% fines). Sedimentary carbonate C is extremely low (generally < 0.003 wt %); organic C is low but generally detectable (0.05-0.10 wt %), although occasional beds have 0.1-1.3% organic C; sulfate S ranges from nondetectable (<0.017) to 0.08 wt%; and reduced S is only detectable in a few wells (<0.01 to 0.15 wt %). For organic C and total S, no strong vertical gradients exist, and no significant difference exists between sediment in the oxic groundwater column, sediment in the anoxic water column, and sediment at the interface. Sediment data are summarized in Table 2, and represented graphically in Figures 5 and 6.

### *Bacterial Population Data*

In this study we use the abundance of the *nir* gene, as determined by rt-qPCR, to map the vertical distribution of denitrifying bacterial populations in the saturated zone. We use the abundance of the eubacterial 16S rRNA gene, as determined by rt-PCR, to map the vertical distribution of total eubacteria in the subsurface. The analyses were performed on soil returned from four locations at the KCD1 dairy during the course of the DP sampling survey in August 2003. Soil samples were placed on ice upon recovery, and subsequently stored frozen until analysis. Total *nir* data are reported as gene copies per 5 g of sediment, and comprise both *nirS* and *nirK* assay results. Total eubacteria data are reported as cells per 5 g sediment. The data are tabulated in Table 3 and in Figure 7.

Relative abundances of *nirS*, *nirK* and eubacteria are consistent with previous studies in non-groundwater systems: *nirS* and *nirK* gene copies typically constitute ~5% and ~0.1% of total bacteria, respectively. Total *nir* abundance varies by almost four orders of magnitude and is not well-correlated with total eubacteria ($R^2 \sim 0.19$ for 5 locations with multiple depths). Peak populations occur either at or below the redoxicline where strong vertical gradients exist in ORP, nitrate and excess nitrogen. Where *nir* abundance is high, total *nir* gene copies tend to constitute a larger fraction of total bacteria (up to 18%).

The presence of high and localized *nir* populations near the interface between oxic high-nitrate groundwater and suboxic low-nitrate groundwater indicates active denitrification is occurring near that interface.

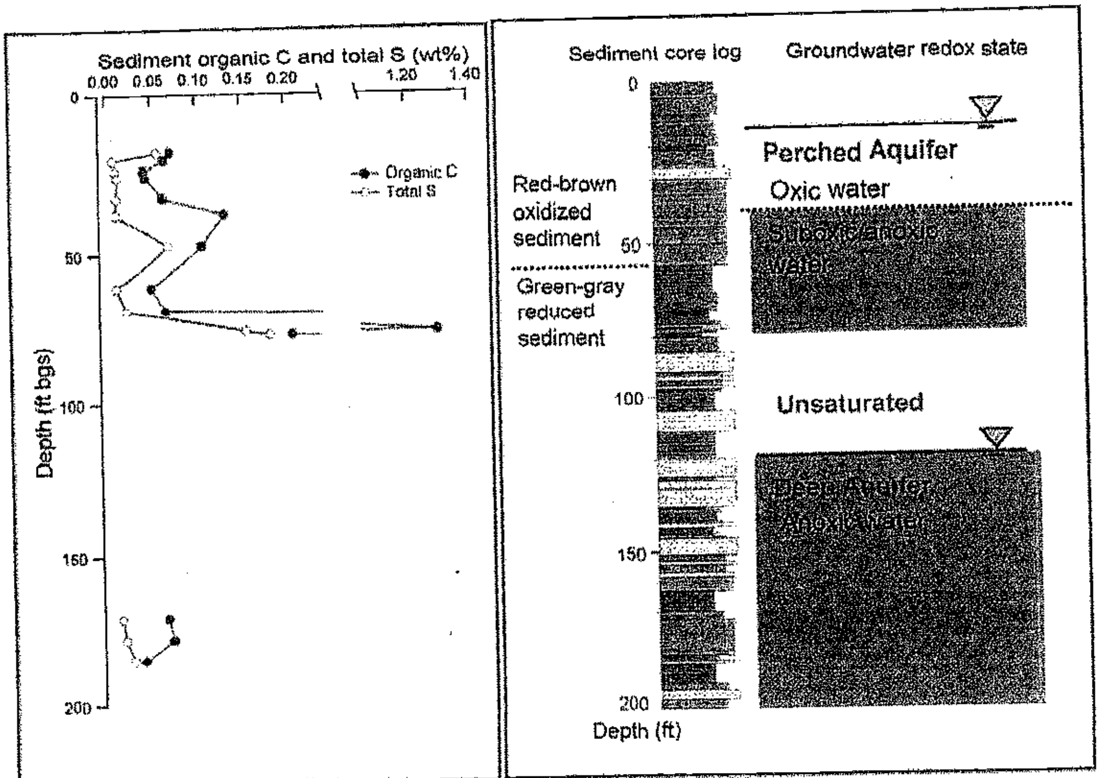


**Figure 5. KCD1 Well Cluster 1 sediment composition, texture & groundwater oxidation state**
Sediment composition and texture and groundwater oxidation state at KCD1 Site 1. From left to right are shown profiles of sediment organic carbon and total sulfur, sediment iron oxidation state as indicated by sediment color, a continuous core log of sediment texture (yellow sands, brown silty sands, and red silts), the location of the perched and deep aquifer along with groundwater oxidation state (as determined by dissolved oxygen and oxidation-reduction potential probes and the presence of hydrogen sulfide gas).

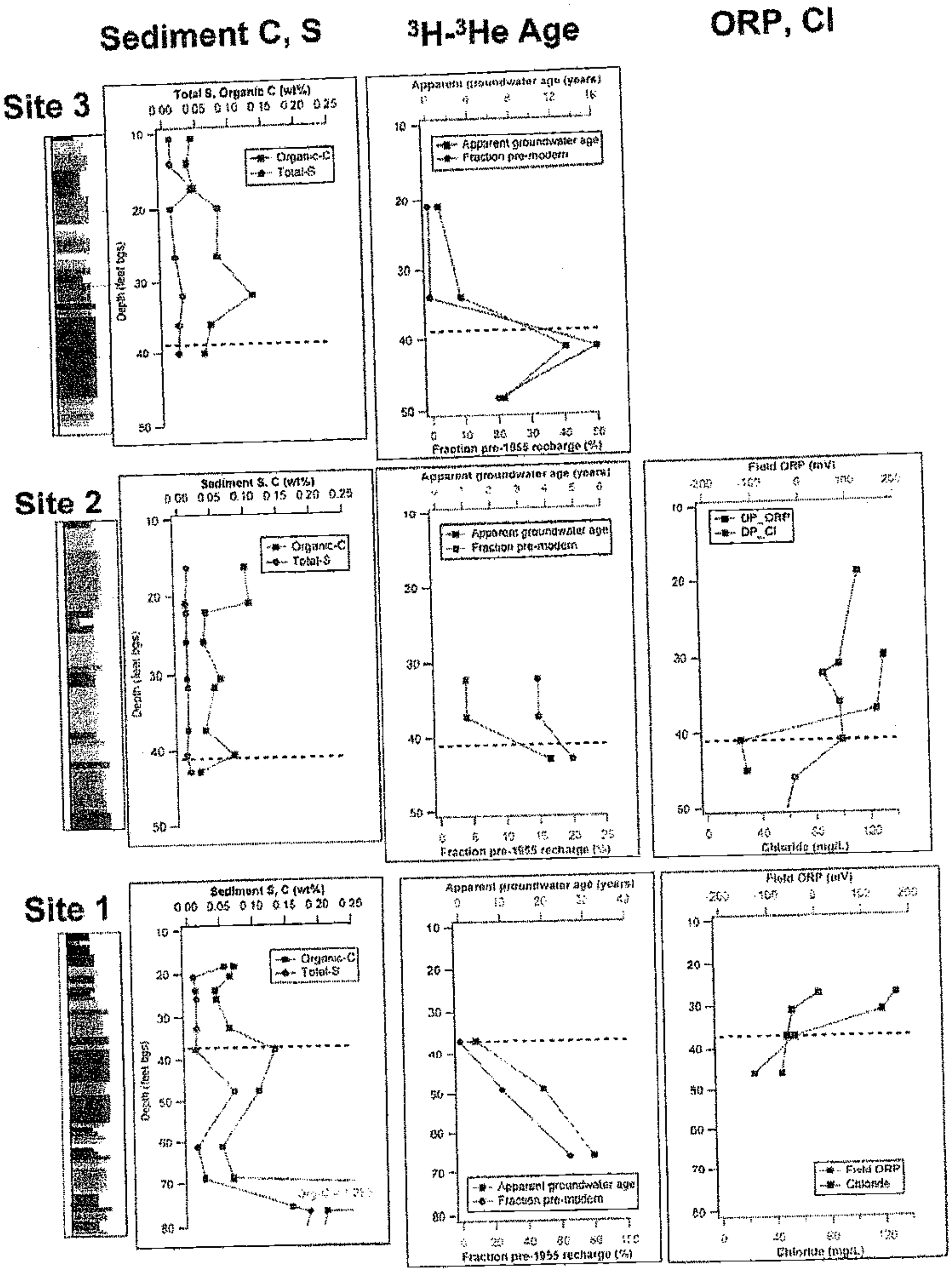


**Figure 6. KCD1 depth profiles of sediment and water properties.**

KCD1 soil behavior type, sediment organic carbon and total sulfur, $^{3}H$-$^{3}He$ groundwater age and fraction pre-modern water, field oxidation-reduction potential (ORP) and dissolved chloride content. The dashed line indicates the transition from nitrate to dissolved nitrogen from denitrification.

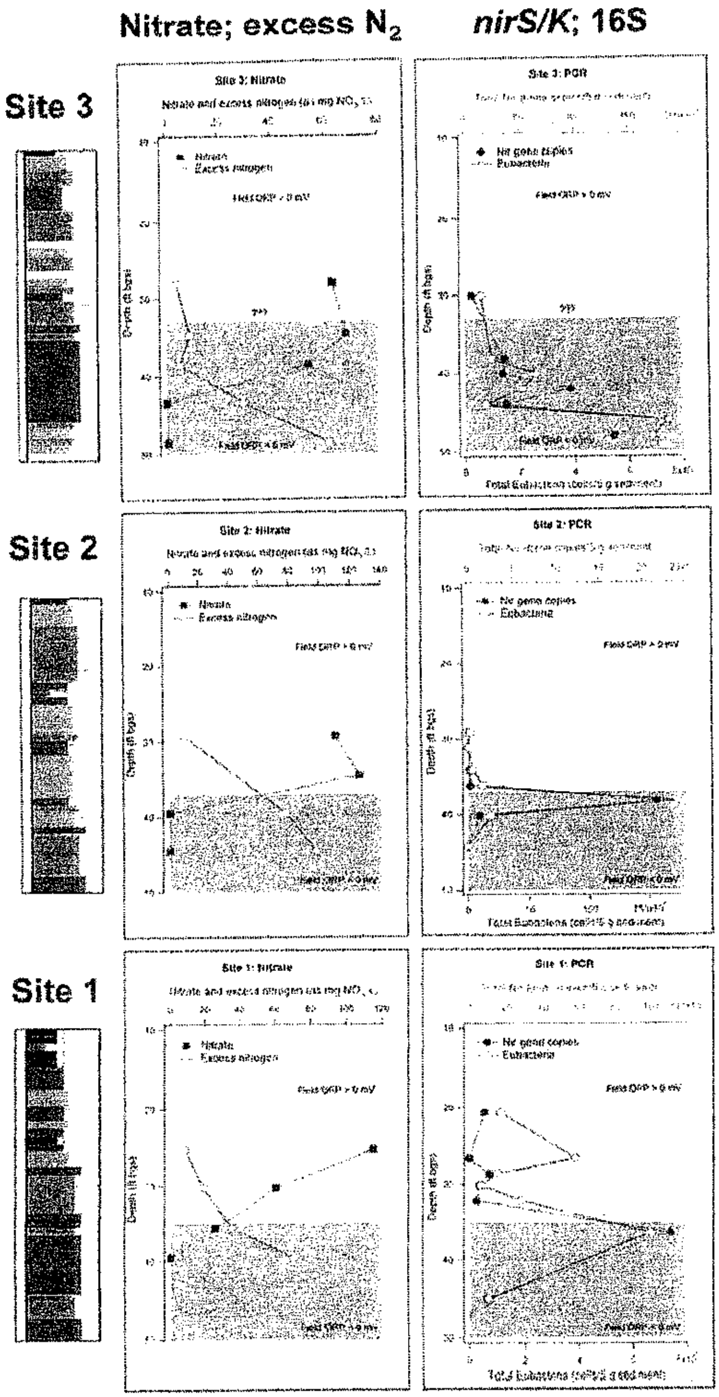


**Figure 7. KCD1 depth profiles of nitrogen speciation and bacterial populations.**

KCD1 depth profiles of soil behavior type, nitrate, excess nitrogen, total nir gene copies, and total eubacteria. The colored fields indicated water oxidation state based on field ORP.

## RESULTS AND DISCUSSION

### *Saturated-Zone Denitrification at KCD1 and MCD*

Appendix A is a manuscript prepared for submittal to a peer-review journal. The manuscript addresses evidence for saturated-zone denitrification in groundwaters impacted by dairy operations. The manuscript abstract follows.

Results from field studies at two central California dairies (KCD1 and MCD) demonstrate the prevalence of saturated-zone denitrification in shallow groundwater with $^3H/^3He$ apparent ages of 30 years or younger. Confined animal feeding operations are suspected to be major contributors of nitrate to groundwater but saturated zone denitrification could effectively mitigate their impact to groundwater quality. Denitrification is identified and quantified using stable isotope compositions of nitrate coupled with measurements of excess $N_2$ and residual $NO_3^-$. Nitrate in dairy groundwater from this study has $\delta^{15}N$ values (4.3–61 ‰), and $\delta^{18}O$ values (-4.5–24.5 ‰) that plot with a $\delta^{18}O/\delta^{15}N$ slope of 0.5, consistent with denitrification. Dissolved gas compositions, determined by noble gas mass spectrometry and membrane inlet mass spectrometry, are combined to document denitrification and to determine recharge temperature and excess air content. Dissolved $N_2$ is found at concentrations well above those expected for equilibrium with air or incorporation of excess air, consistent with reduction of nitrate to $N_2$. Fractionation factors for oxygen and nitrogen isotopes appear to be smaller ($\varepsilon_N \approx$ -10‰; $\varepsilon_O \approx$ -5‰) at a location where denitrification is found in a laterally extensive anoxic zone 5 m below the water table, compared with a site where denitrification occurs near the water table and is strongly influenced by localized lagoon seepage ($\varepsilon_N \approx$ -50‰; $\varepsilon_O \approx$ -25‰).

### *Spatial Distribution of Saturated-Zone Denitrification at KCD1*

At the KCD1 site, multiple lines of evidence indicate saturated-zone denitrification. These include the presence of excess nitrogen from denitrification at depth, the correlation between nitrate-$\delta^{15}N$ and $-\delta^{18}O$ (which has a slope characteristic of denitrification), and the presence of denitrifying bacteria (which occur at above background levels only where excess nitrogen is present). The lateral extent of denitrification at the site and the excess nitrogen and isotopic evidence for denitrification at the site are discussed in Appendix B. Bacterial distributions give valuable evidence for the localization of denitrification.

Denitrifying bacteria populations at the KCD1 site have a high dynamic range, with peak populations occurring at the oxic-anoxic interface in the perched aquifer where strong gradients in oxidation-reduction potential, nitrate and excess nitrogen exist. Denitrifying bacteria populations are not well correlated with total bacteria ($R^2$ ~ 0.19 for 5 locations with multiple depths). The relative population abundances of *Nir* gene copies, however, are consistent with previous studies in non-groundwater systems: *nirS* and *nirK* gene copies typically constitute ~5% and ~0.1% of total bacteria.

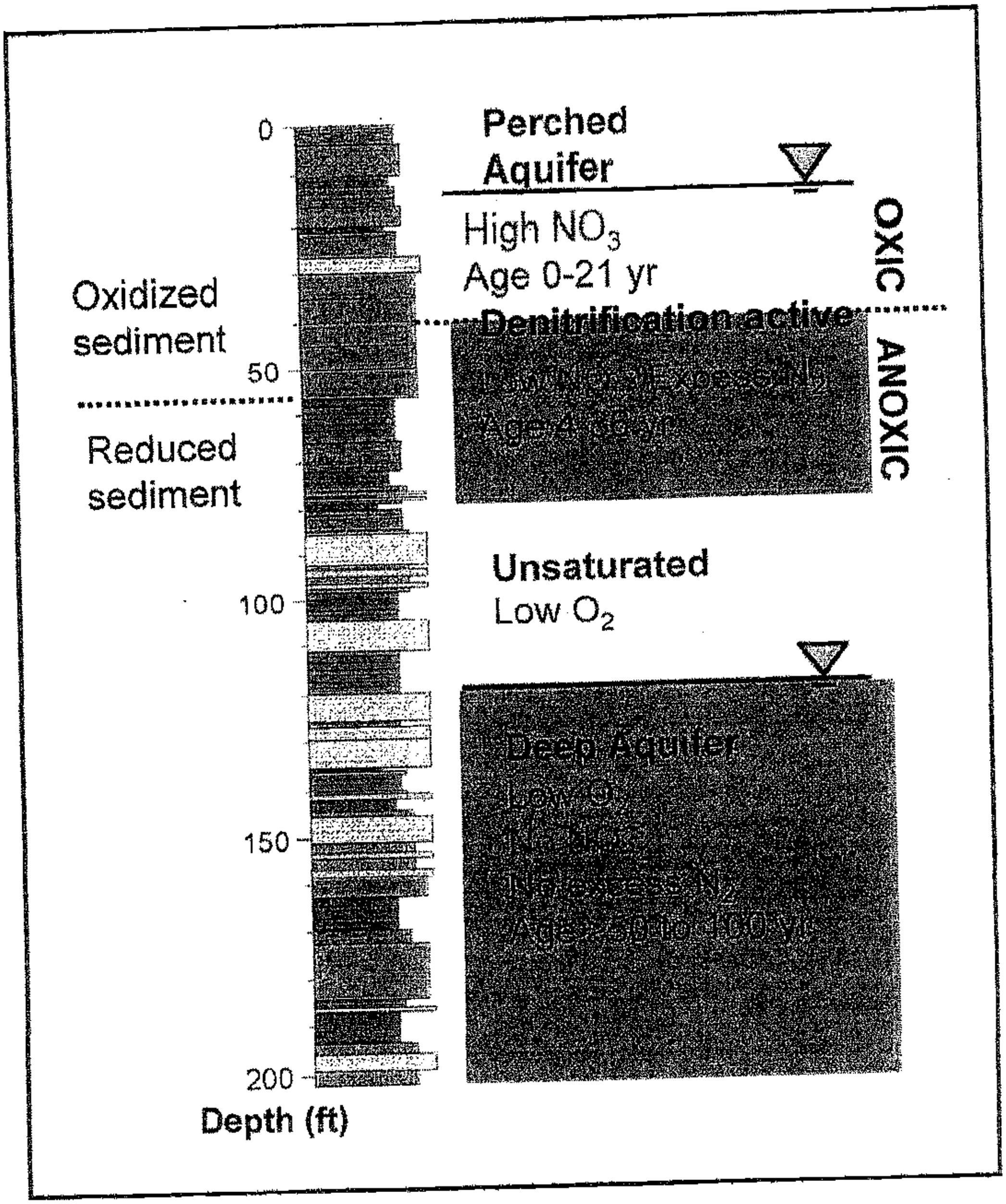


**Figure 8. KCD1 site saturated-zone denitrification.**

The depth of oxic-anoxic interface is remarkably constant at 37-41 feet below ground surface (Figure 7). This transition is not strongly correlated with lithology or sediment composition (organic-C or total-S content), although it generally occurs in sand. At the irrigated field monitoring sites, the redox interface corresponds to the interface between shallower "young" groundwater (having young apparent $^{3}H$-$^{3}He$ ages and low mixing ratios of pre-1955 water) and deeper "old" groundwater (with higher fractions of pre-modern water) (Figure 8). The depth of the zone corresponds to the top of several agricultural production pump screens in the area, suggesting that pumping may be a factor.

### *Saturated-Zone Denitrification at the Northern Dairy Sites*

Both of the northern San Joaquin Valley dairy sites (MCD and SCD) are a part of the northern San Joaquin Valley monitoring network described in Harter et al. (2002). Chemical data from these sites have been used to calibrate and validate regional models for nitrogen loading to the shallow groundwater system (VAN DER SCHANS, 2001). The wells sampled are all shallow piezometers that draw first-encounter water, with the exception of one deeper domestic supply well (W-98, Table 1 of Appendix A). A significant finding of the current study is that evidence for saturated-zone denitrification at MCD and SCD only exists in first-encounter wells that are predicted by other criteria (groundwater gradient, the presence of ammonia, total dissolved solids, etc) to be impacted by recharge from lagoons or corrals, i.e. from the dairy operation proper. Wells so impacted include W02, W03, W16, W17, V01, and V21 on the MCD site (Table 1 of Appendix A), and Y03 and Y10 on the SCD site (Table 1). No evidence for denitrification exists in first-encounter wells that are impacted only by wastewater irrigation of either field crops (MCD) or of orchards (SCD). This finding is significant in two respects:

- The UC-Davis nitrate loading model for the region is in agreement with available spatial and time-series groundwater nitrate concentration data. The model does not explicitly consider denitrification of nitrogen fluxes from lagoons and corrals. The absence of evidence for denitrification in first encounter groundwater impacted by wastewater irrigation validates the model assumption that denitrification is not occurring and strengthens confidence in the model as a predictive tool.

- The deep domestic well W-98 is predicted by the UC-Davis model to have approximately 50 mg/L nitrate (T. Harter, personal communication). Groundwater from this well actually has very low nitrate (0.4 mg/L), but does have 45 mg/L nitrate-equivalent of excess $N_2$ indicating that the mass fluxes and transport in the model are accurate. The mean $^3He/^3H$ groundwater age also matches well with model travel time predictions. The good agreement between predicted nitrate and excess nitrogen in W-98 is consistent with a groundwater impacted by wastewater irrigation in which denitrification is occurring at some depth below the water table, as is the case at KCD1 in Kings County.

- The association of denitrification with groundwater impacted by manure lagoon seepage is consistent with the findings from the KCD1 study (see Appendix B)

To the extent that saturated-zone denitrification is significant and is associated with nitrogen loading from wastewater irrigation from dairy operations (as has been shown on one site, and indicated on another), the process needs to considered when assessing total impact of dairy operations on the groundwater resource. The most effective way to characterize saturated-zone denitrification is the installation of multi-level monitor wells in conjunction with the determination of nitrate stable isotope composition and excess nitrogen content.

### *The Impact of Dairy Manure Lagoons on Groundwater Quality*

Appendix B is a manuscript prepared for submittal to a peer-review journal. The manuscript addresses the impact of dairy manure lagoon seepage on groundwater quality, and discusses a new tracer for manure lagoon seepage. The manuscript abstract follows.

Dairy facilities and similar confined animal operation settings pose a significant nitrate contamination threat to groundwater via oxidation of animal wastes and subsequent transport through the subsurface. While nitrate contamination resulting from application of animal manure as fertilizer to fields is well recognized, the impact of manure lagoon leakage on groundwater quality is less well characterized. For this study, a dairy facility located in the southern San Joaquin Valley of California (KCD1) has been instrumented with monitoring wells as part of a two-year multidisciplinary study to evaluate nitrate loading and denitrification associated with facility operations. Among the multiple types of data collected from the site, groundwater and surface water samples have been analyzed for major cations, anions, pH, oxidation-reduction potential, dissolved organic carbon, and selected dissolved gases ($CO_2$, $CH_4$, $N_2$, Ar, Ne). Modeling of geochemical processes occurring within the dairy site manure lagoons suggests substantial off-gassing of $CO_2$ and $CH_4$ in response to mineralization of organic matter. Evidence for gas ebullition is evident in low Ar and Ne concentrations in lagoon waters and in groundwaters downgradient of the lagoon, presumably as a result of gas "stripping". Shallow groundwaters with Ar and Ne contents less than saturation with respect to atmosphere are extremely rare, making the fractionated dissolved gas signature an effective tracer for lagoon water in underlying shallow groundwater. Preliminary evidence suggests that lagoon water rapidly re-equilibrates with the atmosphere during furrow irrigation, allowing this tracer to also distinguish between seepage and irrigation as the source of lagoon water in underlying groundwater. Together with ion exchange and mineral equilibration reactions, identification of lagoon seepage helps to constrain key attributes of the local groundwater chemistry, including input and cycling of nitrogen, across the site.

### *A New Tracer for Manure Lagoon Seepage*

The manuscript in Appendix B uses only data collected from the KCD1 site. We also see evidence for gas stripping in lagoon waters from the KCD2 site (Figure 9). To further test the hypothesis that gas stripping in biologically active manure lagoons, we sampled manure lagoon water from several locations at KCD2 site. At this site, manure-laden water flows from free stall flush lanes to a settling lagoon (Lagoon 1) through an intake near the bottom of the lagoon to a larger holding lagoon (Lagoon 2) to a distribution standpipe to furrows in nearby fields. Samples were collected from the surface of Lagoon 1 near the outtake from the flush lanes, from the outlet of Lagoon 1 into Lagoon 2, from the surface of Lagoon 2 near the intake to the field distribution system, from a distribution standpipe, and from a field furrow about halfway down the length of the furrow. At the time of sample collection in April 2005, water in the distribution standpipe and in the field furrows was entirely from the manure lagoon, and was not mixed with well water or canal water. The results are shown in Figure 10.

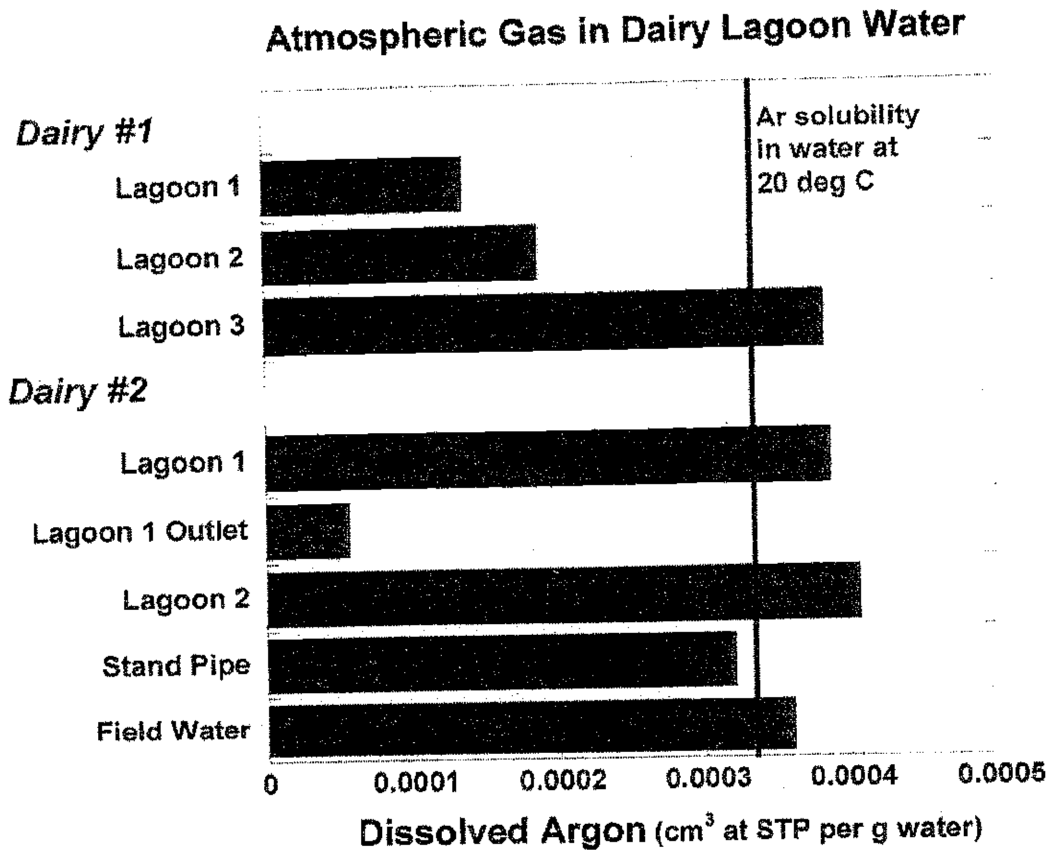


**Figure 9. KCD1 and KCD2 manure lagoon dissolved argon content.**

As discussed in Appendix B, biological activity in the lagoon consumes oxygen and strips atmospheric gases from the lagoon water through ebullition of carbon dioxide and methane. This effect of this activity is evident in the absence of detectable oxygen in any of the lagoon samples, and in lagoon water argon partial pressures that are close to or far below saturation argon partial pressures. For non-reactive gases such as argon, the "gas-stripping" effect is most evident in the sample drawn from the outlet of Lagoon 1 into Lagoon 2, which presumably represents water from near the bottom of Lagoon 1. This sample has extremely low argon, and may be representative of lagoon seepage through the bottom or sides of the lagoon. Atmospheric re-equilibration does not take place until the water is delivered to the field – the water sample drawn from the distribution standpipe has no detectable oxygen, while surface water from half-down a furrow is at about 40% saturation. We suspect that percolation through the soil zone and through an oxic vadose zone, which is characterized by incorporation of excess air, will result in complete re-equilibration or over-equilibration with soil gases.

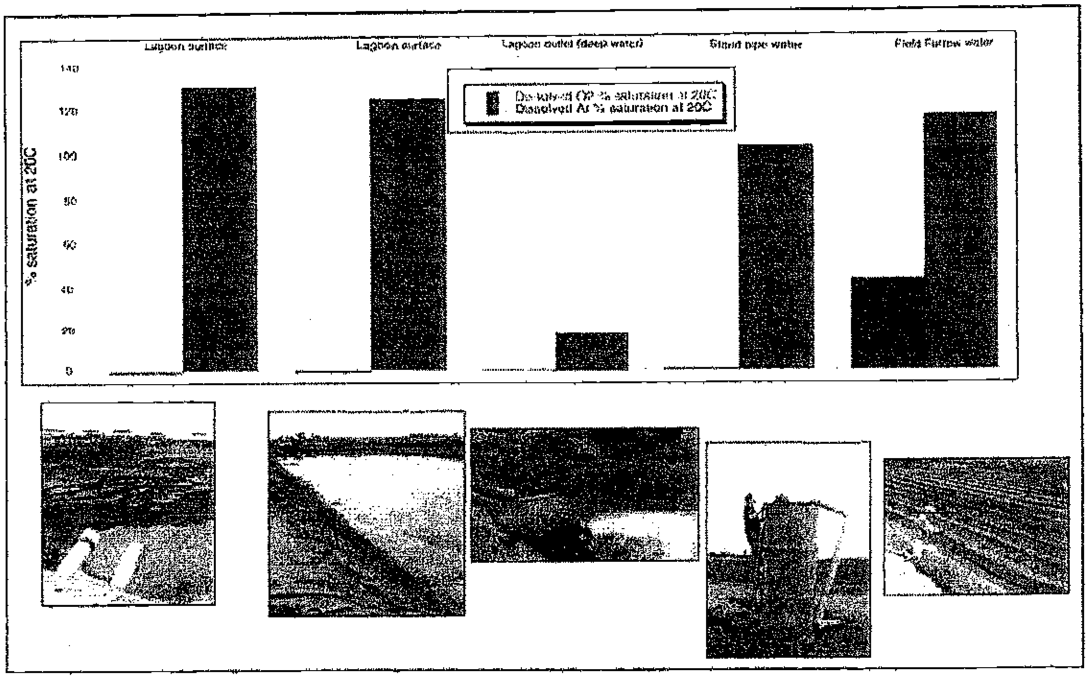


**Figure 10. Dissolved argon and oxygen at KCD2.**
The evolution of dissolved argon and dissolved oxygen along a "flow path" at KCD2. From left to right in figure: Lagoon 1 surface water , Lagoon 2 surface water, Lagoon 1 outlet into Lagoon 2, an irrigation standpipe, and a field furrow. Note that the Lagoon 1 outlet precedes the Lagoon 2 surface water in the "flow path". See text for explanation.

Dissolved gas samples from a number of manure lagoons on five dairy sites (KCD1, KCD2, MCD, and SCD) are characterized in general by deficiency in reactive and non-reactive atmospheric gases, and in detail by a wide range in non-reactive gas pressures from near equilibrium to far below equilibrium. The only other mechanism known to produce such signals is methane production either in marine sediments or in the deep subsurface in association with natural gas formation (see references in Appendix B). Currently the presence of an air "deficit" (i.e. atmospheric noble gases below saturation values) in shallow groundwater samples associated with dairy operations can be considered as indicative of the presence of a manure lagoon seepage component. To determine the mixing ratio of lagoon seepage with other water sources, however, will require a more quantitative understanding on the dissolved gas content in manure lagoons and manure lagoon seepage.

### *Source, Fate and Transport of Dairy Nitrate at KCD1*

Harter et al. (2002) have demonstrated that dairy operations in the northern San Joaquin Valley strongly impact groundwater quality, resulting in first-encounter water that is high in salinity and inorganic nitrogen. On the KCD1 site in the southern San Joaquin Valley, a number of observations indicate that the dairy operation and associated wastewater irrigation are the source of high nitrate in first encounter groundwaters at the site:

- The isotopic composition of nitrate-N and –O is consistent with a manure or septic nitrogen source (see Appendix A).

- The young age of the first encounter waters (Figure 6 and 8), which we have accurately simulated using an irrigation recharge model (see groundwater transport discussion below) are inconsistent with transport from offsite locations.

- Nitrate co-contaminants can be traced to a specific application event on the site (see MORAN, 2006). In a subset of wells on the site, norflurazon and its degradation product, desmethylnorflurazon, were detected. Norflurazon was applied to a corn field in excess of the intended amount approximately two years prior to sampling. The well closest to the field contains norflurazon; a more distal well contains the degradation product, desmethylnorflurazon.

The unconfined aquifer at KCD1 is strongly stratified with respect to electron donor concentration (oxygen and nitrate), redox state (ORP), and excess nitrogen (Figures 5 and 6). The transition zone is sharp: nitrate levels can drop from significantly above maximum contaminant levels to nondetectable over a depth range of five feet. Our data indicate that the water immediately below the transition zone also has a significant wastewater component:

- Low-nitrate groundwaters nitrate isotopic compositions that are consistent with denitrification of manure or septic source nitrate.

- Some low-nitrate waters have below-saturation dissolved gas pressures that indicate a component of manure lagoon seepage (see Appendix B and discussion below.)

- Groundwater transport modeling (see discussion below) that assumes recharge dominated by wastewater irrigation accurately simulates the mean age and pre-modern mixing rations for low-nitrate groundwaters below the transition zone.

The strong spatial association of high denitrifier bacterial populations (Figure 6) with the transition zone is consistent with active denitrification occurring in this zone and being at least one source of denitrified groundwater seen below the zone. We cannot currently convert *nir* gene copy populations into denitrification rates, and so cannot estimate what fraction of denitrification occurs in the transition zone and what fraction occurs upgradient (proximal to a manure lagoon seepage plume, for example). What is clear, however, is that active denitrification is currently occurring on the dairy site in localized subsurface zones.

The relationship of the dairy operation (including wastewater irrigation and manure lagoon seepage) to nitrate mitigation through the establishment of redox stratification and the enhancement of saturated-zone denitrification is more complex. Any model of the evolution of redox stratification and denitrification must first provide an electron donor and then produce a sharp transition zone (~5 feet in vertical extent) at a remarkably uniform depth across the site (~35-40 feet bgs). A number of hypotheses can be put forward:

- Lateral transport of manure lagoon seepage.

- Field irrigation with dairy wastewater (assuming vertical percolation through a homogeneous soil column that contains a solid-phase electron donor).
- Agricultural pumping and nitrogen loading from dairy operations (assuming strong lateral transport of nitrate through a heterogeneous aquifer).

### *The Impact of Lagoon Seepage on Groundwater Quality*

The first hypothesis is discussed in McNab et al. (Appendix B and Figure 11).

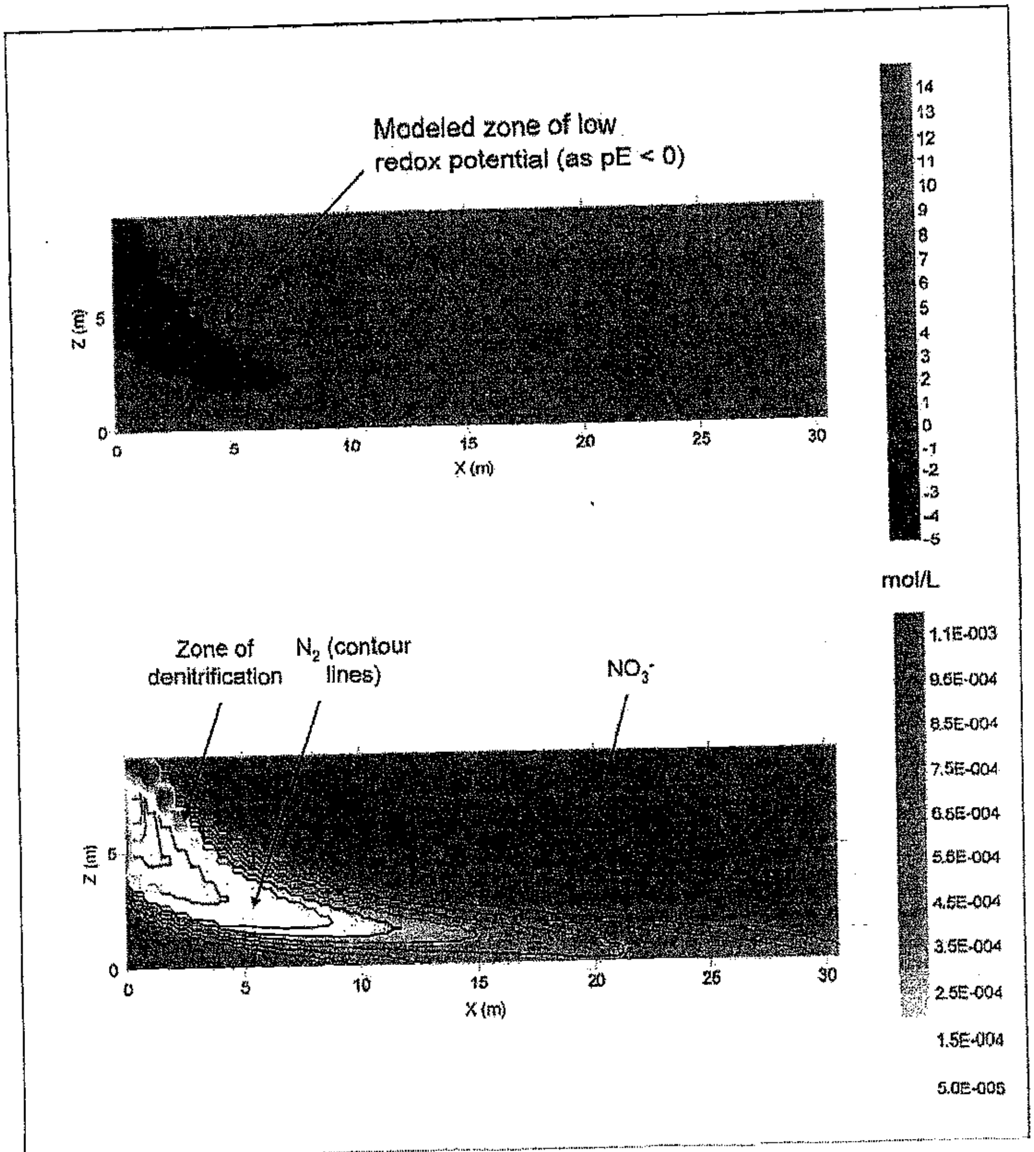


**Figure 11. Simulation of transport of lagoon seepage through groundwater.**
Simulation of the influence of seepage from a dairy wastewater lagoon on groundwater chemistry. See Appendix B for details on modeling.

McNab et al. assume that oxidation of organic carbon derived from manure creates the reducing conditions and provides the electron donor necessary for denitrification. While manure lagoon seepage is associated with excess nitrogen and does appears to drive denitrification locally, reactive transport modeling of lagoon seepage shows that the modeled zone of denitrification does not extend far from the lagoon, and that the modeled zone of low redox potential (where pE < 0) is localized (Figure 11). These model results are driven by the relative magnitudes of lagoon seepage and wastewater irrigation percolation rates, and are consistent with dissolved gas evidence indicating that lagoon seepage is not a major component in most site groundwaters. We conclude that manure lagoon seepage is not the cause of the laterally extensive reduced zone observed at the KCD1 site.

### *The Impact of Dairy Wastewater Irrigation on Groundwater Quality*

Reactive transport modeling of vertical flow under an irrigated field indicates that vertical redox stratification can be created without a lagoon influence when dairy wastewater percolates through a soil column containing organic carbon in low permeability micro-environments. Attempts to simulate the development of redox stratification in the absence of a sedimentary electron donor were not successful.

We employed a reactive modeling approach using PHREEQC that addresses multispecies solute transport, soil-water reactions (mineral phase equilibria and ion exchange), and reaction kinetics for redox reactions involving nitrogen species as means for identifying the potential roles of different electron donors in the denitrification process at the site. The model parameters are shown below:

Parameters

- 10-m column
  - 10 volume elements (mobile pore water)
  - 10 volume elements (immobile pore water)
- Initial sediment composition:
  - 25% Quartz
  - 15% Na-montmorillonite (ion exchanger)
  - 15% K-mica ("C" model; no K-mica = "X" model)
  - 1% Goethite (HFO surface)
  - 0.02 mol/kg organic carbon

Step 1: Set up initial conditions

- Flush column with 300 pore volumes:
  - 1 mM NaCl
  - mM KCl
- After flushing
  - Equilibrium with $CO_2$(g) and $O_2$(g), calcite, and dolomite
  - Undersaturated with gypsum

Step 2: Simulate irrigation

- Flush column with 2 pore volumes with a mixture of agricultural well water and lagoon water (~0.02 M NH4+; ~0.01 M K+) – agricultural well water.
- Allow equilibration with calcite, ion exchanger, and HFO surface.

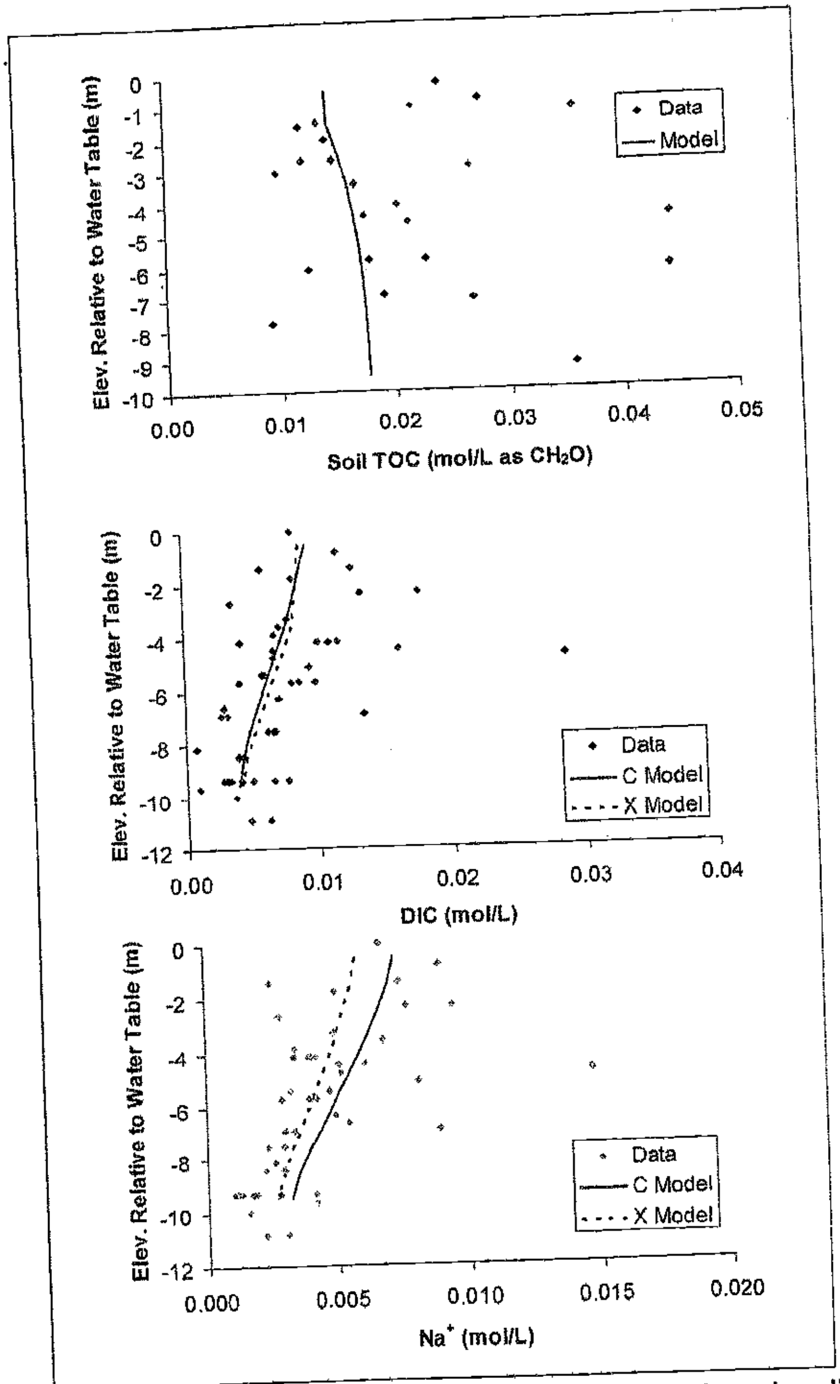


**Figure 12. Simulation of dairy wastewater percolation through sediment.**
Model results from simulation of vertical percolation of dairy wastewater through a sediment column containing organic carbon in low-permeability environments. See text for explanation.

Results from the reactive transport simulations results generally match most major cation and anion distributions with depth (Figure 12 and Figure 13). Moreover, the quantities of organic carbon required to produce a redox front (via diffusion-limited transport through low-permeability lenses) are consistent with measurements from soil samples (which are low). These results do not depend on any lagoon influence. Reactive transport modeling of vertical flow under the irrigated field demonstrates that general geochemistry in wells distal from the manure lagoons can be explained *without* postulating a lagoon influence, if the aquifer has reducing capacity.

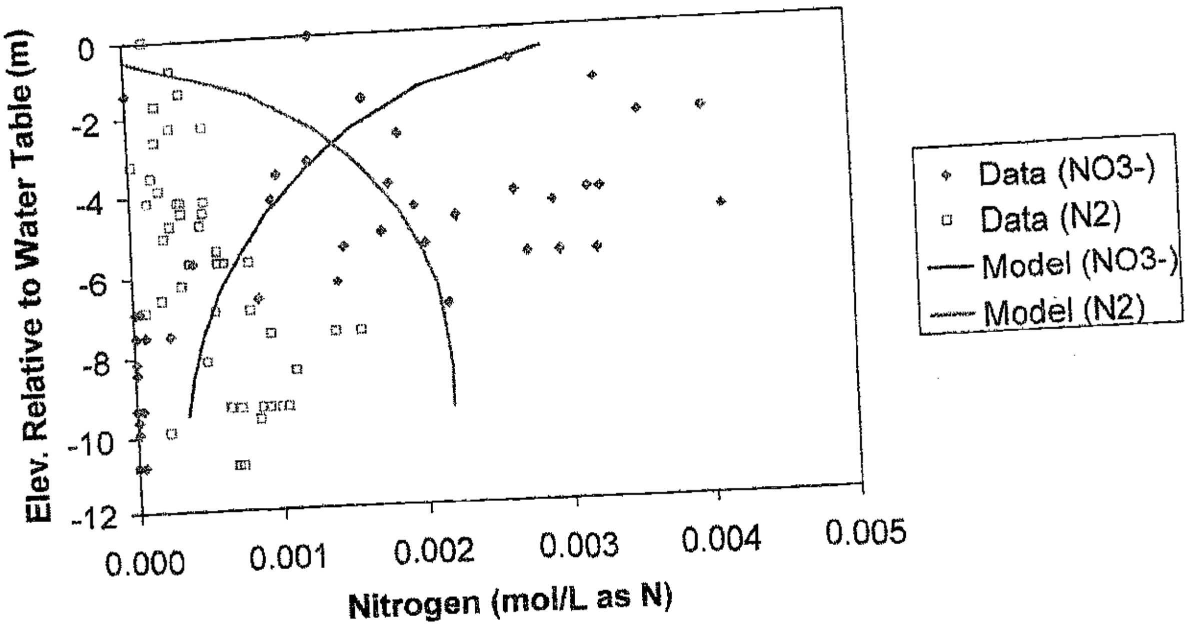


**Figure 13. Simulation of denitrification associated with dairy wastewater percolation.** Saturated-zone denitrification in a simulation of vertical percolation of dairy wastewater through a sediment column containing organic carbon in low-permeability environments. See text for explanation.

A number of lines of evidence exist that indicate that reducing groundwater conditions are common in the region surrounding the KCD1 site. At a number of NAWQA sites in the region that are not believed to be impacted by dairy wastewater, nitrate in deeper waters is nondetectable and iron and manganese concentrations are high, an association consistent with suboxic or anoxic conditions (BUROW et al., 1998a; BUROW et al., 1998b). The most convincing evidence comes from the deep well at the KCD1 site (KCD1-1D, Table 1 in Appendix A). Groundwater in the lower aquifer sampled by this well is tritium dead with a mean groundwater age in excess of 50 years. Radiogenic $^4$He content indicates an age on the order of 100 years or more. Neither nitrate nor excess nitrogen is present, indicating that source waters were low in inorganic nitrogen species. This groundwater has extremely low chloride and has isotopically lighter water than water sampled in the perched aquifer. Finally, this groundwater is reduced as indicated by both field ORP and DO measurements, and measurements of volatile sulfide compounds in the water. These observations are consistent with recharge by source waters unimpacted by agriculture and the occurrence of naturally reducing conditions along the flow path. The electron donor driving the evolution of the natural reducing system is unclear. The water is low in TOC (0.8 mg/L). Sediment organic C and reduced S contents are generally low (< 0.1 wt %), but are sufficient to produce reducing conditions, particularly since sediments with organic carbon contents of over 1 wt% have been characterized (Figures 5 and 6). Reducing conditions may have also been created during recharge (in the hyporheic zone during riverbank infiltration).

The existence of regionally reducing conditions is also evident in the redox state of sedimentary iron in site sediments. Above approximately 60' bgs, sediment core is stained with orange, red and brown ferric iron oxides; below 60', this stain is not present (Figures 5 and 8). The existence of a denitrification zone approximately 20-25' above the iron reduction zone is consistent with the energetics of these reactions.

Given the presence of reducing conditions within the aquifer, one-dimensional transport through homogeneous media can drive the development of redox stratification and saturated-zone denitrification within the shallow aquifer. This process, however, can only reproduce the sharpness and uniform depth of the observed groundwater redox stratification 1) if a layer of laterally extensive reducing sediment exists at the groundwater redox boundary or 2) if a sharp transition in sediment reducing capacity exists at or near the depth of the water redox transition. Neither of these conditions is observed at the KCD1 site. The redox boundary is not correlated with sediment texture, nor do any gradients exist in sedimentary organic C, total S, or reduced S that correlate with the depth of the redox boundary.

### *The Impact of Pumping and Wastewater Irrigation on Groundwater Quality*

A number of processes that may contribute to strong vertical stratification of groundwater flow and chemistry are not adequately simulated in a one-dimensional homogeneous model. To explore the effect of aquifer heterogeneity and lateral transport on groundwater flow and transport at the KCD1 site, we used the numerical flow and transport model NUFT to simultaneously simulate three-dimensional variably-saturated groundwater flow processes including canal recharge, agricultural pumping, and irrigation (Carle et al., 2005). Heterogeneity of sandy, silty, and clayey zones in the system was characterized stochastically by applying transition probability geostatistics to data from 12 CPT logs that vertically transect the perched aquifer. In the first iteration of this model, nitrate in surface irrigation was simulated as a tracer rather than as a reactive species.

***Groundwater Hydrology.*** In the distal reaches of the Kings River within the Tulare Lake Basin, groundwater is extracted from both a perched zone (less than ~ 25 m deep) and a deep zone. Before the 1950's, water levels were nearly equal in both zones (DWR data). Overdraft in the deep zone has caused water level declines of over 100 feet (30 m). Perched zone water level elevations, where they exist, persist well above the deep zone, as evident from DWR water level elevation maps for 2001-2002. The Kings River, unlined ditches and canals, and irrigation appear to provide recharge to sustain the perched aquifer. Crop irrigation uses canal diversions and both shallow and deep groundwater.

At and near the KCD1 site, groundwater level elevations in different wells screened in the perched aquifer are remarkably similar over time and correlate to canal diversions. This suggests canal leakage and irrigation from canal diversions provides substantial recharge to the perched aquifer. Leakage from the canal is estimated at 10% by the irrigation district.

Several dairies are located within the area of the perched aquifer. KCD1 is located about one mile east of the canal. The dairy grows much of its own feed – corn and alfalfa. The crops are irrigated primarily with water pumped from the shallow aquifer. Crops are fertilized largely by mixing in effluent from the dairy operation that is collected in a lagoon. The lagoon water and other fertilizers provide sources of nitrate that appear to impact upper portions of the perched aquifer, but not lower portions of the perched aquifer or the deep aquifer. Other nearby farms also irrigate with canal diversions or groundwater pumped from the deep aquifer. Thus, overdraft from the deep aquifer helps, in part, to sustain the perched aquifer.

The modeling approach was designed to include consideration of the major factors and processes affecting groundwater flow, nitrate transport, and groundwater age dating:

- *Heterogeneity*: Use hydrofacies-based geostatistics.
- *Variably Saturated Flow:* Couple vadose zone and saturated zone using LLNL's NUFT code.
- *Boundary Head Conditions:* Use time-series DWR water levels in perched and deep zone.
- *Perched and Deep Zone:* Use modeling to determine leakage that maintains perched condition.
- *Canal Leakage and Irrigation:* Distinguish different sources with different tracer simulations.
- *Tritium/Helium-3 Age Dating:* Add decay to tracer simulations, simulate apparent age estimate.
- *Groundwater Mixing:* Keep track of proportions of groundwater from different sources.

***Heterogeneity***. Based on our interpretation of lithologic and CPT logs, we defined three hydrofacies: "sand", "silt", and "clayey" categories. We quantified vertical and horizontal spatial variability with a transition probability matrix using the CPT data categorized as hydrofacies. The solid lines in the probability matrices (Figure 14) represent 1-D Markov chain models used to develop stochastic simulations of hydrofacies architecture at the site.

The hydraulic properties of the hydrofacies categories were estimated from a combination of pump test analysis, soil core measurements, and model calibration.

| HYDROFACIES | K (m/d) | POROSITY |
|---|---|---|
| Sand | 30 | 0.40 |
| Silt | 0.24 | 0.43 |
| Clayey | 0.014 | 0.45 |
| Sandy Loam Soil | 3.0 | 0.41 |
| Aquitard | 1.4e-6 | 0.45 |
| Canal (sandy) | 10.0 | 0.41 |

A Van Genuchten model was used to predict unsaturated hydraulic conductivity and capillary pressure. A continuous 1-m thick aquitard layer at 46-47 m elevation sustains the perched aquifer conditions. This aquitard layer correlates to a distinctive clay layer identified in our initial characterization lithologic log.

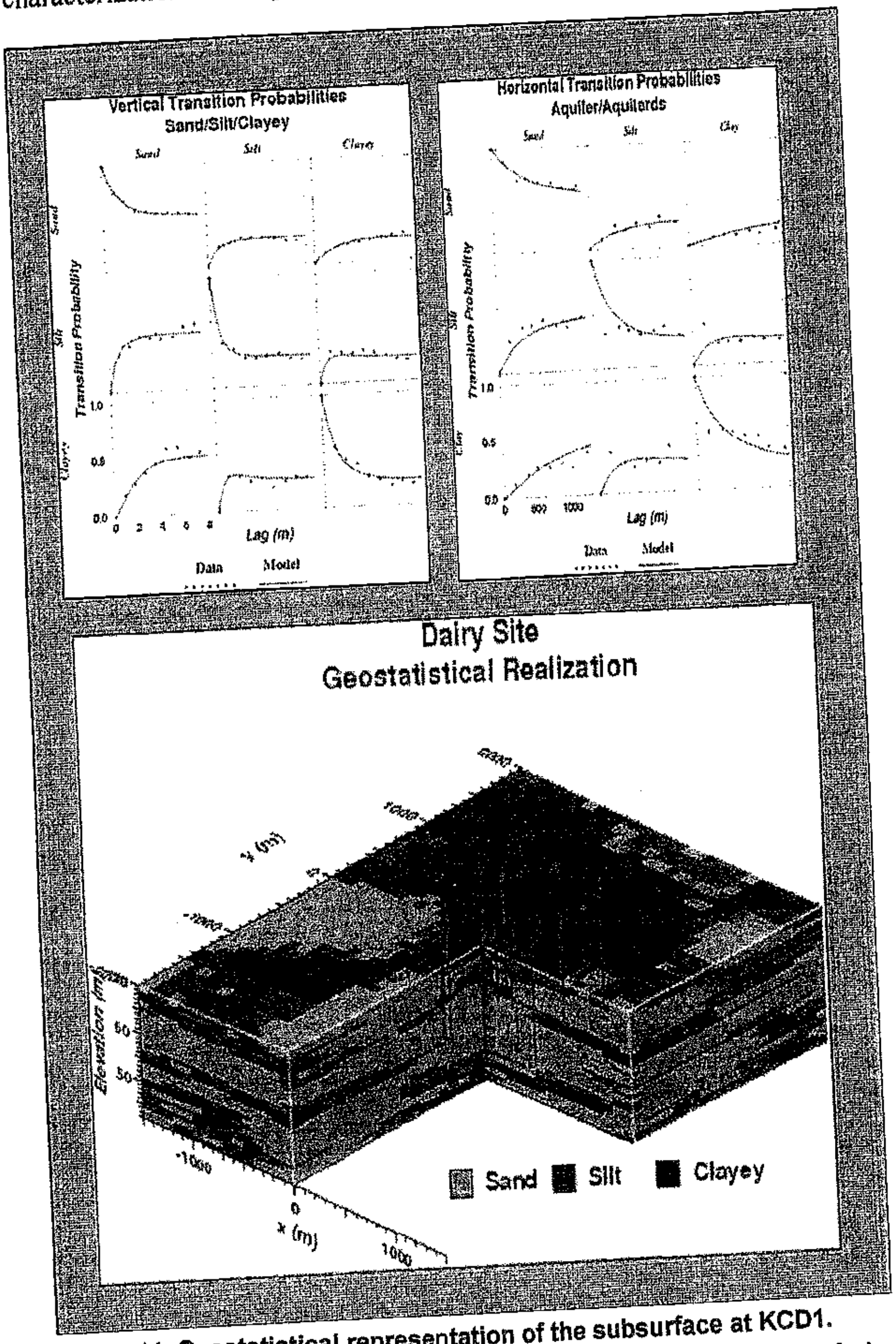


**Figure 14. Geostatistical representation of the subsurface at KCD1.**
Transition probability matrices and geostatistical representation of hydrofacies architecture for the KCD1 site. See text for explanation.

***Flow and transport simulation (Figure 15 and 16).*** We used LLNL's NUFT code to simulate variably saturated **flow** according to the Richards equation (Figure 15). The simulation runs from late 1949 through 2001. Initial conditions are equilibrated to local head measurements and rainfall recharge of 1 cm/year. For boundary conditions, x-direction and bottom boundaries were conditioned to observed piezometric heads. A fully saturated initial condition is applied to the canal when canal diversions occur (between early April and early October). In the simulation, the six site production wells were pumped during irrigation season a rate greater and proportionate to crop evapotranspiration (ET). Recharge from irrigation was distributed proportionately to crop (ET), with about 25 cm/yr within the dairy crop fields and 10 cm/yr in surrounding areas.

In the simulation, piezometric head in the perched aquifer remains relatively steady, although in fall 1992 (during a drought) head is noticeably lower. However, head in the deep aquifer drops considerably since the 1950s, to the extent that the top of the deep zone begins to desaturate in the 1960s. In effect, the aquifer system near the dairy field site now functions like two unconfined aquifers stacked on top of each other. This is consistent with the observed separation of the DWR water levels between shallow and deep wells in the 1960s.

We used LLNL's NUFT code to simulate tracer **transport** from different recharge sources (Figure 16). The three primary recharge sources near the dairy site are canal, dairy crop irrigation, and irrigation from surrounding areas. The transport simulation results indicate that nitrate entering the saturated zone from dairy crop irrigation is contained in the upper parts of the aquifer. Nitrate containment occurs within the high permeability sand-dominated perched aquifer because the dairy irrigation wells screened in the perched aquifer effectively capture nearly all recharge from dairy crop irrigation. The dairy irrigation wells pump groundwater at rates far higher than the recharge from dairy crop irrigation. The dairy irrigation wells also extract groundwater originating from irrigation of surrounding areas, canal leakage, and older groundwater

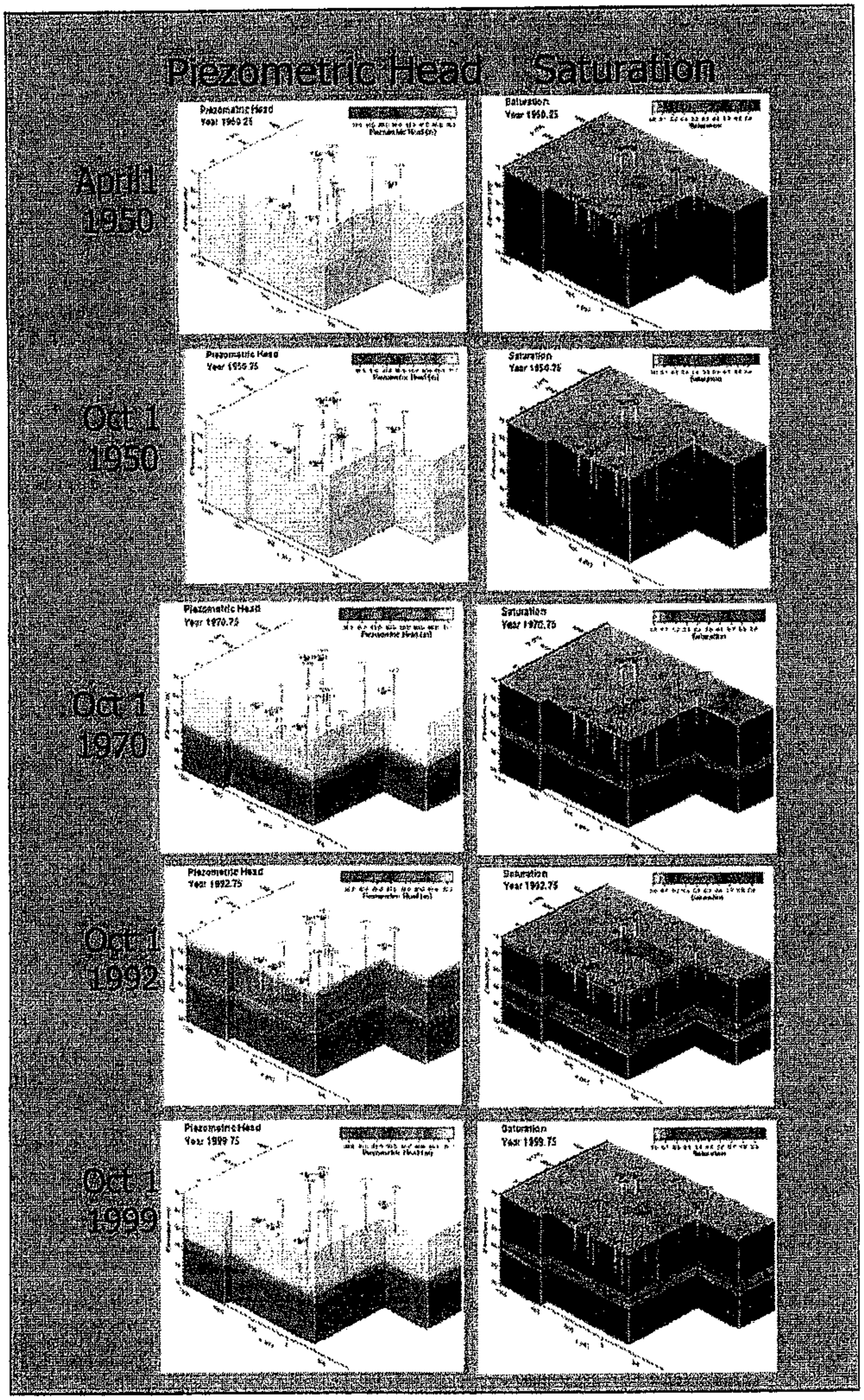


**Figure 15. Simulation of groundwater flow at KCD1.**

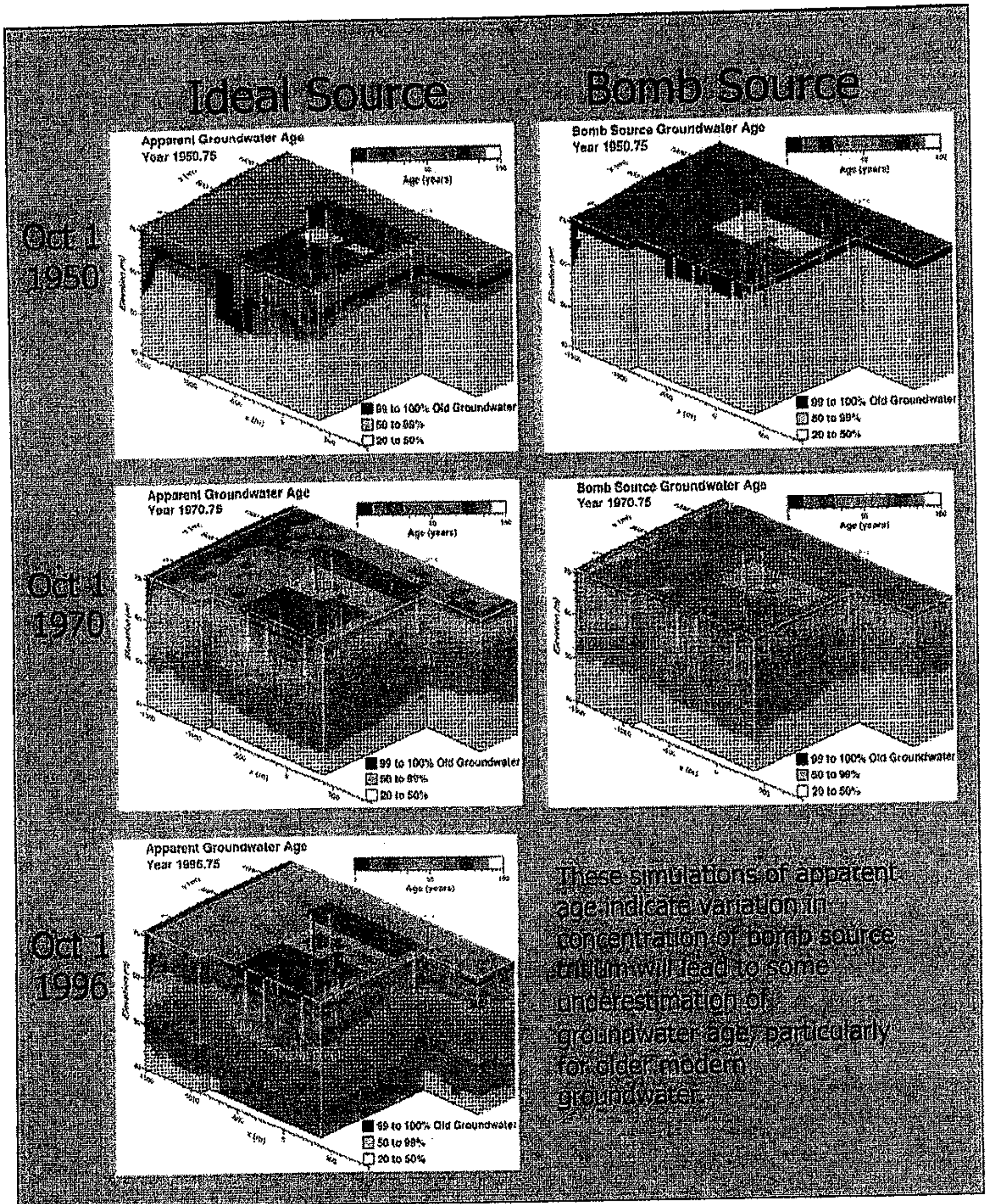


**Figure 17. Simulation of apparent groundwater age at KCD1.**

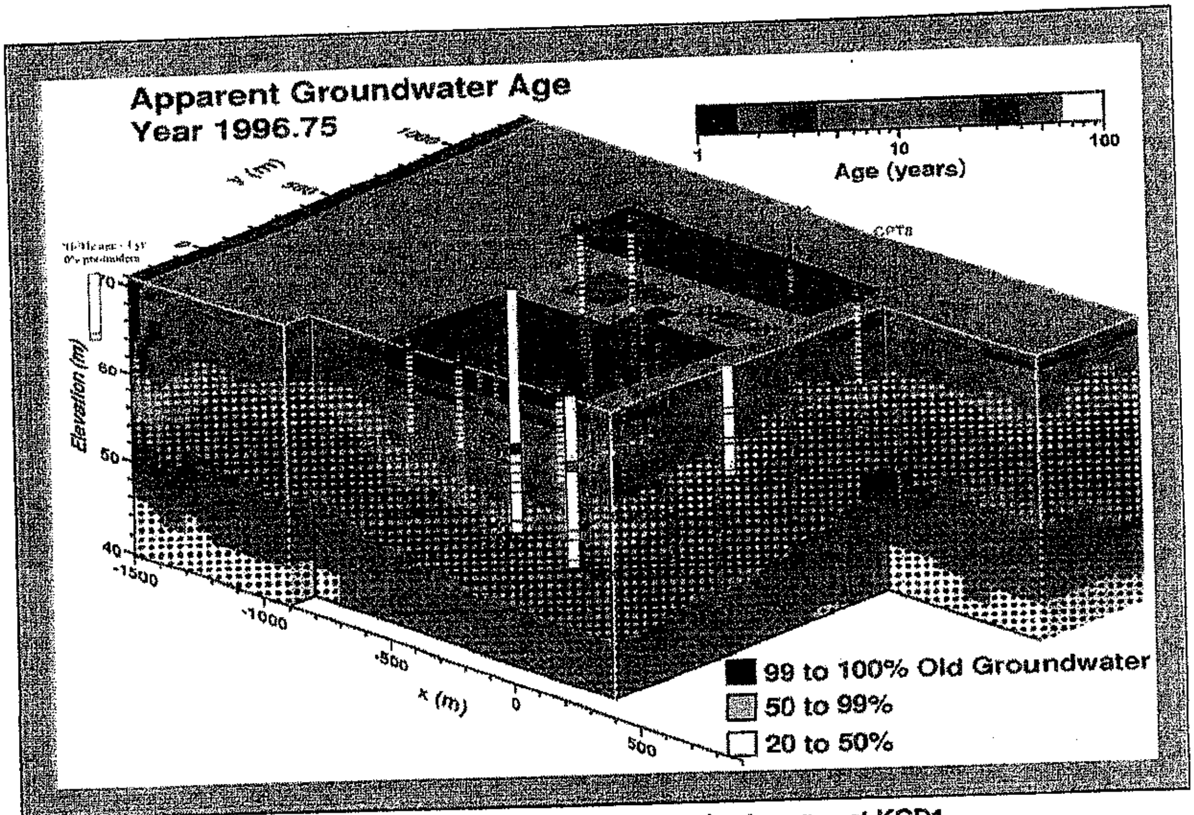


**Figure 18. Comparison of measured and simulated groundwater ages at KCD1.**
Agreement between measured and simulated apparent groundwater age at KCD1. See text for explanation.

The simulation of apparent age show excellent agreement for the southern Site 1 and Site 4 wells south of the dairy operation (Figure 18). At these well cluster locations, simulated ages are less than measured tritium/helium-3 ages in shallow groundwater at these sites because the simulations assumed that $^3$He begins accumulating at the ground surface and not the water table. Current modeling efforts address this effort and produce better agreement for shallow groundwater. At Site 2 to the southeast of the dairy operation, measured groundwater ages are younger than simulated ages. This difference may indicate the absence of a shallow clayey zone at this location. These simulations of apparent age indicate variation in concentration of bomb source tritium will lead to some underestimation of groundwater age, particularly for older modern groundwater.

***Conclusions.*** Coupling flow and transport simulations with groundwater age data and geostatistical simulations of hydraulic properties provides invaluable insights. Heterogeneity plays a large role in creating the perched aquifer and in causing vertical compartmentalization of flow patterns. The hydrofacies architecture consists of laterally continuous sand with interbeds of silt and clayey zones. Maintaining head and saturation in perched zone requires a continuous ~3 foot-thick clay layer at ~ 85 feet bgs. Flow simulation desaturates upper portions of the deep zone below the confining layer, and is consistent with observation of de-saturated zone below ~ 80 feet bgs.

The perched zone draws older water and recharge mostly from irrigation and less so from canal leakage. The dairy site pumps more groundwater from the perched aquifer than is recharged by crop irrigation, and thus physically contains lateral and vertical migration of nitrate contamination. High nitrate irrigation water penetrates to depths below the sharp redox gradient. Without denitrification, nitrate concentrations would be greater below the redox gradient, as is consistent with the presence of excess nitrogen in this zone.

The NUFT model presented here does not simulate transport of reactive constituents such as oxygen, nitrate, sulfate and organic carbon, and does not directly address the sharpness and uniform depth of the redox gradient in the shallow groundwater system. The strong vertical compartmentalization of the groundwater flow created by agricultural pumping and the location of the redox gradient close to the top of the production well screens, however, suggest that agricultural pumping and lateral groundwater flow may be important controls on the development of redox stratification in the shallow aquifer.

### *The Development of Reducing Conditions in Dairy Site Groundwaters*

At three sites in this study (KCD, SCD, and MCD), dairy operations have been demonstrated to impact groundwater quality. At all three sites, nitrogen mitigation (either through denitrification or denitrification) has been demonstrated in groundwater impacted by manure lagoon seepage, a finding consistent with geochemical reactive transport modeling. At two of the sites (KCD and MCD), denitrification has also been demonstrated to occur in deeper waters impacted by irrigation with dairy wastewater. For denitrification to occur in the saturated zone, dissolved oxygen must be absent or present in very low concentrations. A key question, then, in assessing the ability of a groundwater to assimilate nitrate loading is what mechanism drives the development of reducing conditions necessary for denitrification to occur.

At the best studied site, KCD1, evidence exists for both natural and anthropogenic influence on the development of suboxic and anoxic groundwater. The deep aquifer at the KCD1 site consists of old water un-impacted by agricultural inputs. The water is tritium-dead and has a radiogenic $^4He$ age of approximately 100 years. In addition to having a mean age that pre-dates the intensification of agricultural activities, especially with regards to fertilizer usage and manure production, the deep aquifer groundwater has a chemical composition that indicates the absence of significant agricultural input. Salinity, dissolved organic C, nitrate and excess nitrogen are all low. This water is also anoxic, with nondetectable dissolved oxygen, detectable hydrogen sulfide, and low ORP. The electron donor responsible for reducing conditions is not known. Groundwater DOC is low, as is sediment solid-phase total S and organic C. Reduced sediment phases, however, are sufficient to create reducing conditions, even for slow redox processes such as solid-phase autotrophy given the age of the water. These observations all indicate that regionally reducing conditions un-related to agricultural activities do exist at the KCD1 site. Rates of denitrification in this deep system are unconstrained but may be slow and controlled by the abundance or reactivity of solid-phase electron donors.

The perched shallow aquifer is impacted by agricultural operations. Total inorganic nitrogen ($NO_3 + NO_2 +$ excess $N_2$) shows a secular trend with apparent groundwater age, with the highest concentrations in the youngest water. The isotopic composition of high-nitrate waters indicates a wastewater source. Groundwater transport modeling indicates that irrigation dominates recharge in the perched aquifer. Irrigation with dairy wastewater results in the percolation of high-nitrate water to the water table and the penetration of this water to a depth controlled by agricultural pumping (Figure 16). Both the vertical and later transport of irrigation water is controlled by agricultural pumping. The perched aquifer is also strongly stratified with respect to oxidation state, nitrate distribution, and denitrification activity. Denitrification under irrigated fields occurs where oxic high-nitrate irrigation water mixes with older anoxic water. The mixing or "reaction" zone is sharp and at constant depth, and may be controlled by agricultural pumping.

What is the electron donor for the denitrification observed at the oxic-anoxic interface? Sediment organic-C and total-S concentrations in the deep and perched aquifer are comparable and are sufficient (assuming most of the S to be present in reduced phases) to create reducing conditions and support denitrification. At one shallow site (Site 3) upgradient of the main dairy operation, PCR data do indicate the presence of autotrophic bacteria capable of using reduced S as an electron donor, and geochemical modeling is consistent with pyrite oxidation. This evidence is not seen at the other sites, however, and the vertical variability in sediment C and S, does not explain the sharpness or location of the oxic-anoxic interface. Total organic carbon in site groundwaters varies from < 1 to 20 mg/L. (Neither other potential dissolved-phase electron donors such as thiosulfate nor the reactivity or bioavailability of the dissolved organic carbon was characterized.) Geochemical modeling is consistent with organic C oxidation, although simple models that assume shallow and deep waters have similar initial chemical compositions do not match observed compositions tightly. These observations, coupled with the lack of evidence for widespread distribution of autotrophic denitrifying bacteria in active denitrification zones, indicate that heterotrophy dominates the observed denitrification in the agriculturally-impacted perched aquifer. Simulations of irrigation and pumping at the KCD1 site indicate that groundwater flow at this site is strongly vertically compartmentalized. Te location of the redox gradient close to the top of the production well screens suggests that agricultural pumping and lateral groundwater flow in conjunction may be important controls on the development of chemical and redox stratification in the shallow aquifer.

The conceptual model, then, is of a regionally extensive deep aquifer that is naturally reducing and is unimpacted by agricultural operations overlain by a shallow aquifer that in its upper strata is strongly stratified, is reducing, and is the site of active denitrification of dairy-derived nitrate, and that these conditions in the shallow aquifer are driven by irrigation with dairy wastewater and groundwater pumping for dairy operations. This proposition, that denitrification in shallow nitrate-impacted aquifers is driven by dairy operations, is consistent with observations at not only the KCD1 site but also with evidence for denitrification at the MCD and SCD sites. The implication is that to assess net impact of dairy operations on groundwater quality, one must consider denitrification in the saturated zone.

## CONCLUSIONS

The three primary findings of this research are that dairy operations do impact underlying groundwater quality in California's San Joaquin Valley, that dairy operations also appear to drive denitrification of dairy-derived nitrate in these groundwaters, and that new methods are available for characterization of nitrate source, transport and fate in the saturated zone underlying dairy operations.

Groundwater quality impact has been demonstrated at three sites, with a site in the southern San Joaquin Valley, KCD1, being the best characterized. High nitrate in groundwaters underlying these dairy sites can be attributed to dairy operations using a number of methods, including

- Chemical composition and nitrogen speciation.
- Nitrate isotopic composition.
- Groundwater dissolved gas content and composition.
- Groundwater age
- Reactive transport and flow modeling

The use of chemical composition, nitrogen speciation, and nitrate isotopic composition are well described in the literature. The use of dissolved gas content to identify manure lagoon seepage is new, and is introduced in this research. Groundwater age and transport simulations can be used to trace contaminants back to their source.

In both northern and southern San Joaquin Valley sites, saturated-zone denitrification occurs and mitigates the impact of nitrogen loading on groundwater quality. At the southern KCD1 site, the location and extent of denitrification in the upper aquifer is driven by irrigation with dairy wastewater and groundwater pumping. The extent of denitrification can be characterized by measuring "excess" nitrogen and nitrate isotopic composition while the location of denitrification can be determined using a PCR bioassay for denitrifying bacteria that developed in this research. The demonstration of saturated-zone denitrification in dairy groundwaters is important in assessing the net impact of dairy operations on groundwater quality.

New tools available for research on dairy groundwater include the determination of groundwater dissolved gas content to distinguish dairy wastewater irrigation from dairy wastewater lagoon seepage, field determination of excess nitrogen to identify denitrification in synoptic surveys and to characterize the extent of denitrification in monitor and production well samples, bioassay of aquifer sediment and water samples for the presence of denitrifying bacteria, characterization of aquifer heterogeneity using direct-push drilling and geostatistical simulation methods. Application of these new methods in conjunction with traditional hydrogeologic and agronomic methods will allow a more complete and accurate understanding of the source, transport and fate of dairy-derived nitrogen in the subsurface, and allow more quantitative estimates of net impact of dairy operations on underlying groundwater.

## PUBLICATIONS AND PRESENTATIONS

*Peer-Reviewed Presentations*

McNab W. W., Singleton M. J., Moran J. E., and Esser B. K. (2007) Assessing the impact of animal waste lagoon seepage on the geochemistry of an underlying shallow aquifer. *Environmental Science & Technology* **41**(3), 753-758.

Singleton M. J., Esser B. K., Moran J. E., Hudson G. B., McNab W. W., and Harter T. (2007) Saturated zone denitrification: Potential for natural attenuation of nitrate contamination in shallow groundwater under dairy operations. *Environmental Science & Technology* **41**(3), 759-765.

*Conference presentations*

Carle S. F., Esser B. K., McNab W. W., Moran J. E., and Singleton M. J. (2005) Simulation of canal recharge, pumping, and irrigation in a heterogeneous perched aquifer: Effects on nitrate transport and denitrification (abstr.). *25th Biennial Groundwater Conference and 14th Annual Meeting of the Groundwater Resources Association of California (Sacramento, CA; October 25-26, 2005).*

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## Table 1: KCD2, KCD3, & SCD Site Data

**Field Parameters, chemical compositon, groundwater age, recharge temperature, excess air, stable isotopic composition, excess nitrogen**

(Unless otherwise indicated, all analytes are reported as mg/L; nitrate is reported as nitrate)

| Name | Collection date | pH | DO | TOC | $Na^+$ | $K^+$ | $Ca^+$ | $Mg^{++}$ | $Cl^-$ | $SO_4^-$ | $NO_3^-$ | $NO_2^-$ | $NH_4^+$ | excess $N_2$ ($NO_3^-$ equiv) | $Br^-$ | $F^-$ | $Li^-$ | $PO_4^-$ | $^3H/^3He$ age (yr) | Recharge T (°C) | Excess air (cc STP/g) | $H_2O$-$\delta^{18}O$ (‰ SMOW) | $NO_3^-$-$\delta^{15}N$ (‰ Air) | $NO_3^-$-$\delta^{18}O$ (‰ SMOW) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| KCD2 DW-1 | 2005/04/26 | 6.2 | 0.2 | | 105 | 1 | 10 | 0 | 64 | 41 | 7 | 0.11 | <0.02 | 2 | 0.21 | 0.06 | 0.005 | 0.99 | | 15 | 8.8E-03 | -11.1 | | |
| KCD3 DW-1 | 2003/08/21 | | | | 87 | 0 | 54 | 1 | 134 | 57 | 9 | 1.22 | nd | | 0.05 | 0.14 | nd | | | | | -11.7 | 17.7 | 10.6 |
| SCD1 Y-03 | 2005/03/08 | 6.8 | 0.6 | 18 | 215 | 4 | 124 | 55 | 59 | 199 | 185 | 0.41 | <0.02 | 37 | 0.36 | 0.11 | 0.007 | <0.04 | | | 2.5E-01 | -9.8 | | |
| SCD1 Y-10 | 2005/03/08 | 7.0 | 5.3 | 3 | 82 | 137 | 110 | 81 | 143 | 16 | 42 | 1.31 | 137 | nd | 0.54 | 0.17 | 0.008 | <0.04 | | 18 | 9.8E-04 | -9.1 | | |
| SCD1 Y-13 | 2003/08/26 | 7.5 | | | 28 | 5 | 146 | 41 | 48 | 169 | 58 | | <0.02 | | 0.15 | 0.43 | 0.005 | 0.22 | >50 | 16 | 2.0E-02 | -11.0 | | |
| SCD1 Y-14 | 2003/08/26 | 7.3 | | | 63 | 5 | 146 | 55 | 57 | 233 | 167 | 0.05 | <0.02 | nd | 0.12 | 0.26 | 0.003 | 0.22 | | | | -11.5 | | |
| SCD1 Y-15 | 2003/08/26 | 7.3 | | | 50 | 5 | 44 | 54 | 50 | 98 | 62 | 0.01 | <0.02 | | 0.12 | 0.23 | 0.006 | 0.24 | | | | -9.7 | | |
| SCD1 Y-16 | 2003/08/26 | 7.0 | | | 48 | 3 | 181 | 43 | 34 | 172 | 201 | 0.02 | <0.02 | nd | | 0.07 | 0.009 | 0.29 | 9 | 17 | 1.4E-02 | -10.3 | | |
| SCD1 Y-17 | 2003/08/26 | 7.2 | | | 145 | 6 | 223 | 69 | 75 | 486 | 178 | | <0.02 | nd | 0.40 | 0.15 | 0.004 | 0.24 | 9 | | 1.6E-03 | -10.5 | | |
| SCD1 Y-18 | 2003/08/26 | 7.1 | | | 132 | 7 | 138 | 45 | 52 | 205 | 207 | 0.07 | <0.02 | nd | | 0.17 | 0.009 | 4.44 | 8 | 17 | 8.0E-03 | -9.6 | | |

## Table 2: KCD1 Site Sediment C, S Data

| KCD well cluster | Texture | Depth (ft) | Total C (wt%) | Tot C (2sd) | Carb C (wt%) | Carb C (2sd) | Org C (wt%) | Org C (2sd) | Total S (wt%) | Total S (2sd) | Sulfate S (wt%) | Sulfate S (2sd) | Reduced S (wt%) | Reduced S (2sd) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Site 1 | Silty Sand | 18 | 0.079 | 0.008 | 0.007 | 0.002 | 0.072 | 0.008 | 0.057 | 0.006 | 0.054 | 0.011 | | |
| Site 1 | Clayey Silt | 21 | 0.065 | 0.007 | | | 0.065 | 0.007 | 0.009 | 0.004 | | | | |
| Site 1 | Sandy Silt | 24 | 0.042 | 0.005 | | | 0.042 | 0.005 | 0.011 | 0.004 | | | | |
| Site 1 | Clayey Silt | 26 | 0.044 | 0.005 | | | 0.044 | 0.005 | 0.013 | 0.004 | | | | |
| Site 1 | Sand | 33 | 0.064 | 0.006 | | | 0.064 | 0.006 | 0.012 | 0.004 | 0.017 | 0.011 | | |
| Site 1 | Sand | 38 | 0.138 | 0.014 | 0.006 | 0.002 | 0.132 | 0.014 | 0.011 | 0.004 | 0.022 | 0.011 | 0.047 | 0.013 |
| Site 1 | Sand | 48 | 0.108 | 0.011 | 0.002 | 0.001 | 0.107 | 0.011 | 0.070 | 0.007 | | | | |
| Site 1 | Silt | 61 | 0.050 | 0.005 | | | 0.050 | 0.005 | 0.011 | 0.004 | 0.019 | 0.011 | | |
| Site 1 | Sandy Silt | 69 | 0.066 | 0.007 | | | 0.066 | 0.007 | 0.022 | 0.004 | 0.077 | 0.011 | 0.078 | 0.019 |
| Site 1 | Silty Sand | 76 | 1.299 | 0.130 | | | 1.299 | 0.130 | 0.155 | 0.016 | 0.034 | 0.011 | 0.147 | 0.021 |
| Site 1 | Sand | 77 | 0.207 | 0.021 | | | 0.207 | 0.021 | 0.181 | 0.018 | 0.019 | 0.011 | | |
| Site 1 | Sandy Silt | 171 | 0.074 | 0.007 | 0.011 | 0.002 | 0.064 | 0.008 | 0.012 | 0.004 | 0.015 | 0.011 | | |
| Site 1 | Sand | 178 | 0.072 | 0.007 | 0.003 | 0.002 | 0.069 | 0.007 | 0.016 | 0.004 | | | | |
| Site 1 | Silt | 185 | 0.037 | 0.005 | | | 0.037 | 0.005 | 0.025 | 0.004 | | | | |
| Site 2 | Sand | 16 | 0.101 | 0.010 | | | 0.101 | 0.010 | 0.012 | 0.004 | | | | |
| Site 2 | Sand | 21 | 0.107 | 0.011 | | | 0.107 | 0.011 | 0.009 | 0.004 | | | | |
| Site 2 | Silt | 22 | 0.040 | 0.005 | | | 0.040 | 0.005 | 0.010 | 0.004 | | | | |
| Site 2 | Sandy Silt | 26 | 0.036 | 0.005 | | | 0.036 | 0.005 | 0.009 | 0.004 | | | | |
| Site 2 | Sand | 31 | 0.061 | 0.006 | | | 0.061 | 0.006 | 0.009 | 0.004 | 0.017 | 0.011 | | |
| Site 2 | Clayey Silt | 32 | 0.052 | 0.005 | | | 0.052 | 0.005 | 0.010 | 0.004 | | | | |
| Site 2 | Sand | 37 | 0.037 | 0.005 | | | 0.037 | 0.005 | 0.010 | 0.004 | 0.022 | 0.011 | | |
| Site 2 | Sandy Silt | 41 | 0.080 | 0.008 | | | 0.080 | 0.008 | 0.007 | 0.004 | | | | |
| Site 2 | Sand | 43 | 0.028 | 0.005 | | | 0.028 | 0.005 | 0.012 | 0.004 | 0.020 | 0.011 | | |
| Site 3 | Sandy Silt | 11 | 0.043 | 0.005 | | | 0.043 | 0.005 | 0.011 | 0.004 | 0.021 | 0.011 | | |
| Site 3 | Silt | 14 | 0.035 | 0.005 | | | 0.035 | 0.005 | 0.011 | 0.004 | | | | |
| Site 3 | Sandy Silt | 17 | 0.045 | 0.005 | | | 0.045 | 0.005 | 0.041 | 0.007 | 0.038 | 0.005 | | |
| Site 3 | Sand | 20 | 0.083 | 0.008 | | | 0.083 | 0.008 | 0.011 | 0.004 | | | | |
| Site 3 | Sand | 27 | 0.080 | 0.008 | | | 0.080 | 0.008 | 0.015 | 0.004 | | | | |
| Site 3 | Sand | 32 | 0.147 | 0.015 | 0.014 | 0.002 | 0.132 | 0.015 | 0.025 | 0.004 | 0.035 | 0.011 | | |
| Site 3 | Sand | 36 | 0.073 | 0.007 | 0.004 | 0.002 | 0.068 | 0.007 | 0.019 | 0.004 | 0.023 | 0.011 | | |
| Site 3 | Sand | 40 | 0.059 | 0.006 | 0.002 | 0.001 | 0.057 | 0.006 | 0.018 | 0.004 | 0.016 | 0.011 | | |
| Site Temp | Clayey Silt | 5 | 0.187 | 0.019 | | | 0.187 | 0.019 | 0.010 | 0.004 | 0.019 | 0.011 | | |
| Site Temp | Clayey Silt | 8 | 0.107 | 0.011 | 0.001 | 0.001 | 0.106 | 0.011 | 0.008 | 0.004 | 0.016 | 0.011 | | |
| Site Temp | Clayey Silt | 8 | 0.181 | 0.018 | | | 0.181 | 0.018 | 0.020 | 0.004 | 0.015 | 0.011 | | |
| Site Temp | Sandy Silt | 14 | 0.070 | 0.007 | | | 0.070 | 0.007 | 0.009 | 0.004 | 0.023 | 0.011 | | |
| Site Temp | Clayey Silt | 16 | 0.058 | 0.006 | | | 0.058 | 0.006 | 0.011 | 0.004 | 0.021 | 0.011 | | |
| Site Temp | Clayey Silt | 23 | 0.035 | 0.005 | | | 0.035 | 0.005 | 0.008 | 0.004 | 0.019 | 0.011 | | |
| Site Temp | Sand | 27 | 0.029 | 0.005 | | | 0.029 | 0.005 | 0.007 | 0.004 | 0.017 | 0.011 | | |
| Site Temp | Clayey Silt | 28 | 0.050 | 0.005 | | | 0.050 | 0.005 | 0.008 | 0.004 | | | | |
| Site Temp | Sand | 36 | 0.057 | 0.006 | 0.003 | 0.002 | 0.053 | 0.006 | 0.008 | 0.004 | 0.016 | 0.011 | | |

## Table 3. KCD1 Sediment PCR Data

| KCD1 Well Cluster | Depth (ft) | Total *Nir* (gene copies/ 5 g sediment) | Total eubacteria (cells/ 5 g sediment) |
|---|---|---|---|
| Site 1 | 21 | 7.9E+03 | 1.1E+06 |
| Site 1 | 27 | nd | 3.9E+06 |
| Site 1 | 29 | 1.1E+04 | 1.0E+06 |
| Site 1 | 30 | 5.1E+03 | 3.9E+05 |
| Site 1 | 32 | 3.8E+03 | 1.9E+06 |
| Site 1 | 36 | 1.1E+05 | 6.7E+06 |
| Site 1 | 45 | 9.5E+03 | 6.9E+05 |
| Site 2 | 29 | 9.6E+04 | 2.0E+06 |
| Site 2 | 31 | 1.1E+04 | 5.4E+05 |
| Site 2 | 34 | 1.6E+05 | 3.8E+06 |
| Site 2 | 36 | 2.8E+05 | 1.2E+07 |
| Site 2 | 38 | 2.2E+07 | 1.7E+08 |
| Site 2 | 40 | 1.3E+06 | 1.9E+07 |
| Site 2 | 44 | 5.6E+03 | 1.4E+05 |
| Site 3 | 30 | 6.6E+03 | 5.9E+05 |
| Site 3 | 38 | 3.6E+04 | 9.6E+05 |
| Site 3 | 40 | 3.4E+04 | 2.6E+06 |
| Site 3 | 42 | 9.6E+04 | 2.1E+06 |
| Site 3 | 44 | 3.7E+04 | 7.4E+05 |
| Site 3 | 46 | 1.9E+05 | 7.5E+06 |
| Site 3 | 48 | 1.4E+05 | 6.9E+06 |
| Site 4 | 28 | 2.5E+04 | 6.9E+05 |
| Site 4 | 33 | 3.0E+04 | 1.1E+06 |
| Site 4 | 43 | 1.9E+05 | 1.8E+06 |
| Site 4 | 45 | 9.1E+04 | 4.9E+05 |
| Site 4 | 47 | 7.2E+04 | 5.2E+05 |
| Site 4 | 49 | 4.6E+04 | 1.7E+06 |

# Exhibit H

# MANURE WASTE PONDING AND FIELD APPLICATION RATES

March 1973

## PART I

Study Findings

&

Recommendation

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NTRODUCTION

Manure holding ponds are utilized to economically collect and store dairy and poultry waste waters. In most cases, the effluent from the ponds is used for irrigation. In others, the effluent is first recycled by re-using it for subsequent flushing. Whatever the mode of operation of the ponds, it is important to know how much, if any, deep percolation occurs; what is the fate of salts and nitrogenous substances; what are the changes in other chemical constituents; and what bacterial processes occur in the ponds.

OBJECTIVES OF THIS STUDY:

1. Water Quality of Ponds

   Manure holding ponds were studied to determine the salts, nitrogen status, biochemical oxygen demand (B.O.D.) and temperatures as a function of time and depth within ponds.

2. Seepage from Ponds

   The bottom of the ponds and the soil immediately beneath the ponds were studied for sealing time, salinity, nitrogen movement, and the depth of water movement.

   Soil solutions beneath the ponds were studied under shallow and deep water table conditions to determine manure ponding effects upon water tables.

   The potential for leakage with time after pond construction was studied under various soil and water table conditions.

3. Field Application of Manure

   Cropped soils were sampled to determine salt and nitrogen movement under various manure loadings.

Soil samples were taken after application of manure from two sources, pond effluent and dry manure. Manure was spread at various rates to determine crop usage of nitrogen and downward movement of salts and nitrogen with varying soil profile conditions.

CONCLUSIONS:

1. Water Quality of Ponds

   Total dissolved salts (T.D.S.) in the ponds increase linearily with time and is a function of loading. Virtually no salt is lost from the ponds. Nitrogen is principally in the ammoniacal form. The ammonium increases with time, but not at the same rate as salts. The highest concentration of nitrate ever found was 40 ppm ($NO_3^-$). Most ponds contain 9 to 18 ppm $NO_3^-$. Ammonium N was found up to 1200 ppm.

   Nitrogen input from animal waste was calculated. From pond water analyses, losses of ammonia and gaseous N were found to be from 20 percent to 50 percent of total inputs over a 12-month period. B.O.D. increases primarily with loading, but seems to vary greatly with water temperatures. Ponds have a B.O.D. stratification.

2. Seepage from Ponds

   Manure ponds seal under all soil conditions. The time required for sealing varies with soil texture and loading.

   Sandy loam, loams and clay loam soils seal under a reasonable manure loading rate equal to waste from 100 cows per ten-acre-foot pond size in less than 30 days.

   Loamy sands seal in 30 to 60 days under reasonable loading. At a high rate equal to waste from 180 cows per ten-acre-foot pond size, sealing occurred in 30 days.

Ponds constructed in high water table conditions, that is water table at the pond bottom or above, sealed at the same rate as ponds with a deep water table. Nitrate and salt concentrations in soil solutions under ponds were found to be about the same under high water table conditions as under ponds with deep water tables.

The potential gradient to produce leakage, using tensiometer-type ceramic probes with mercury manometers, showed parallel results to the soil solution probes. Either type of instrumentation shows quantitative data.

Under high water table conditions, if the pond water is drawn below the water table level, an apparent upward gradient may occur and seepage may occur for 10 to 20 days following refilling with manured water.

Lateral movement from ponds seems not to exist. The maximum downward movement found, after manure sealing, was one millimeter per day under the coarsest soil conditions. The quantities of salt and nitrate moving through the soil profile are low.

3. Field Application of Manure

Summer corn and winter oats were used to test manure application rates. Permanent pastures were also examined.

a. Dry manure application rates of 10 to 20 yards per acre, resulted in low nitrogen and soluble salt measurements in the soil solution beneath the root zone. These constituents were about the same as when commercial fertilizers were applied at recommended rates. High manure rates (40 to 50 yards per acre) produced high nitrate and salt concentrations in the soil solution below the root zone.

b. Some soils studied had an impervious layer beneath the root zone, called a claypan or hardpan. The soil solution immediately above these layers was found to have low concentrations of nitrates, but high concentrations of salts.

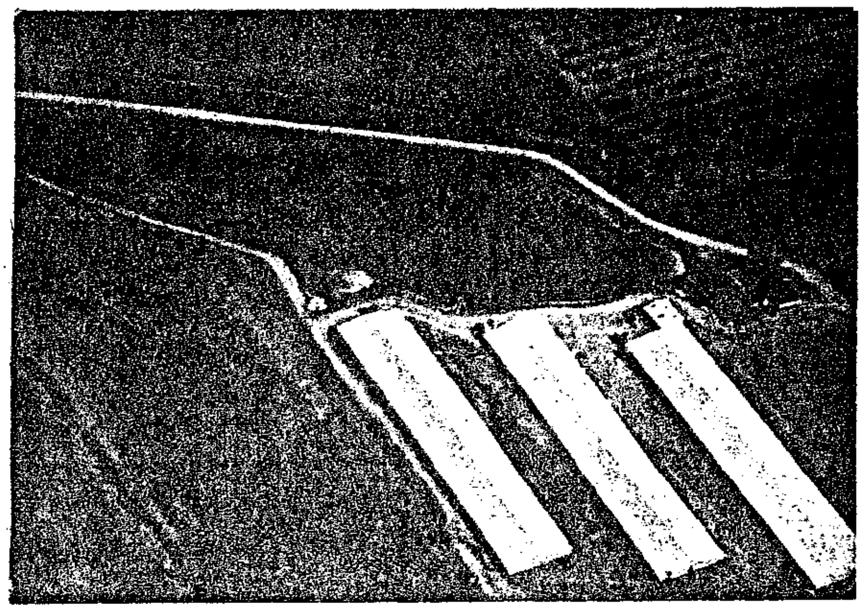
# MANAGEMENT PRACTICES DEVELOPING

# in the

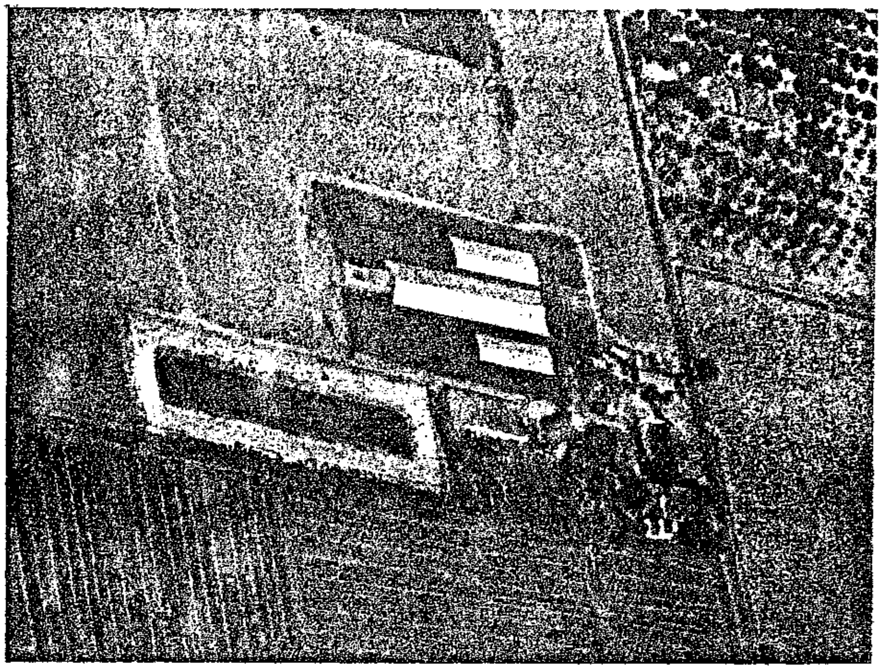
# SAN JOAQUIN VALLEY

## Poultry and Dairy Ponds

Poultry and dairy holding ponds are usually close to animal housing. Pond effluent is spread on the adjacent farm land.

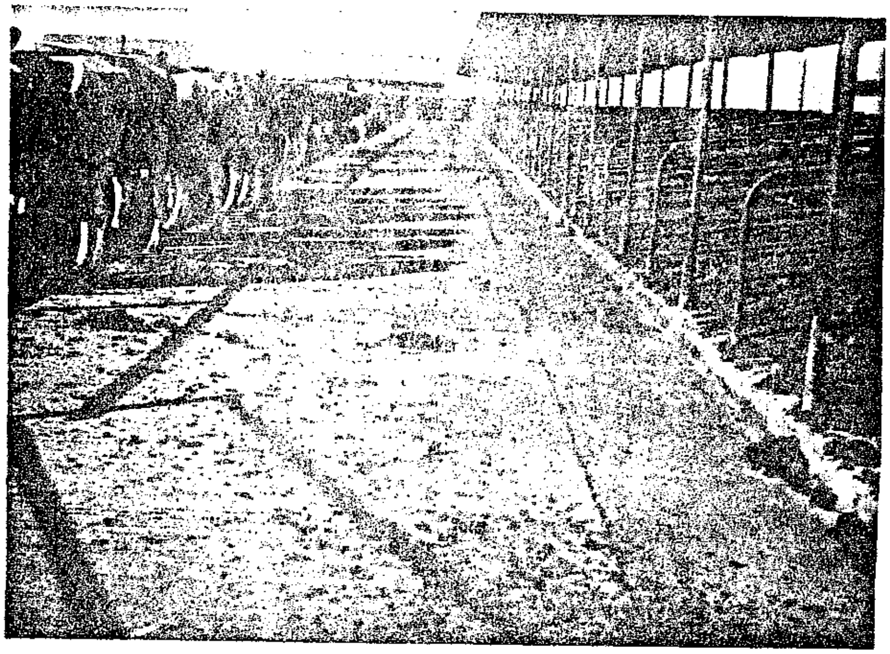


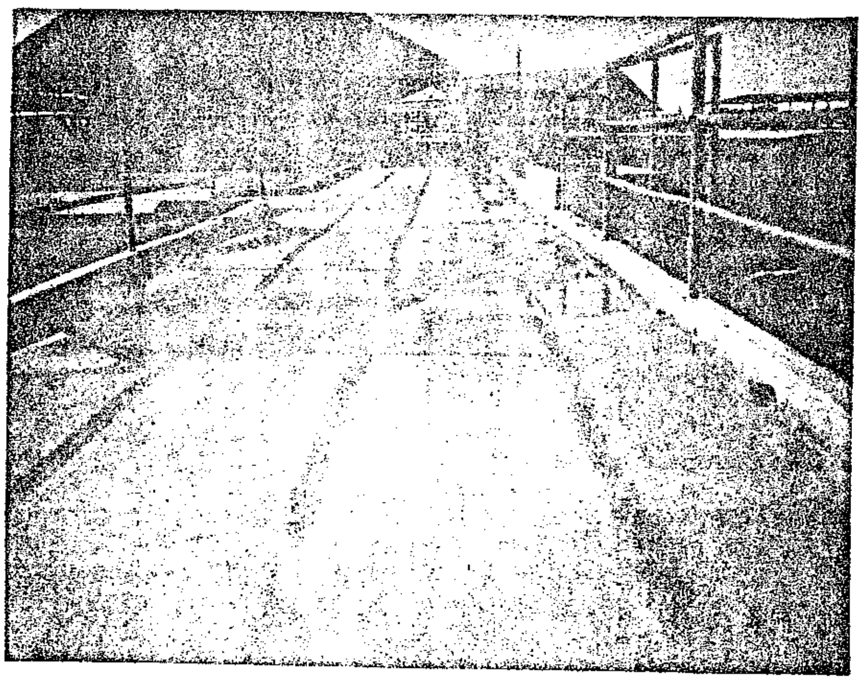
Poultry housing, pond, and adjacent farm land.



Dairy lot, pond, and adjacent cropland

Dairy feeding areas and paved lanes may be flushed with recycled manure pond water.

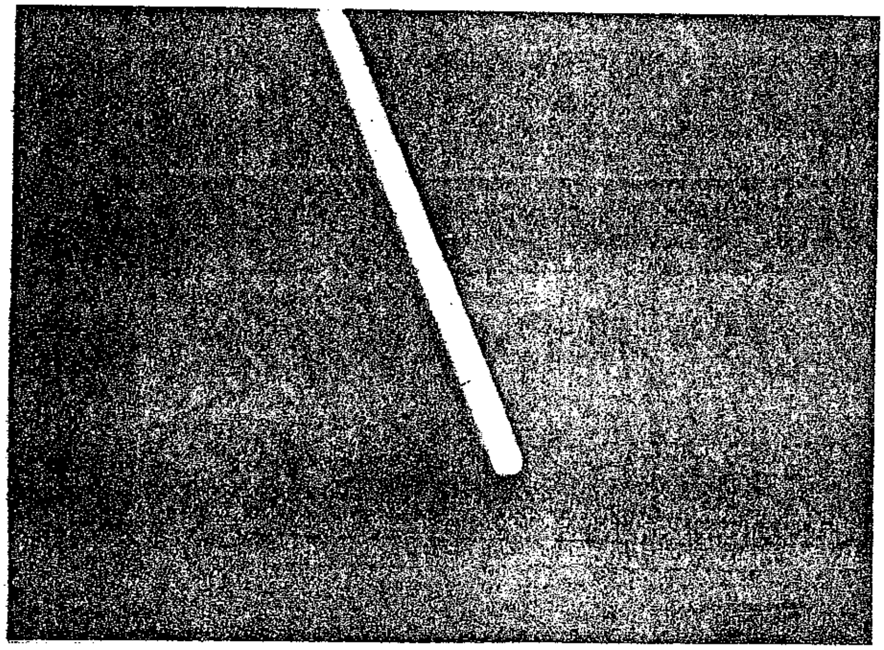




Recently flushed lanes

For this study, soil solutions under the ponds were extracted with suction devices using porous ceramic cups. The soil solution was drawn into the cup for sampling. Ceramic cups can also be used to monitor soil moisture potential gradients.

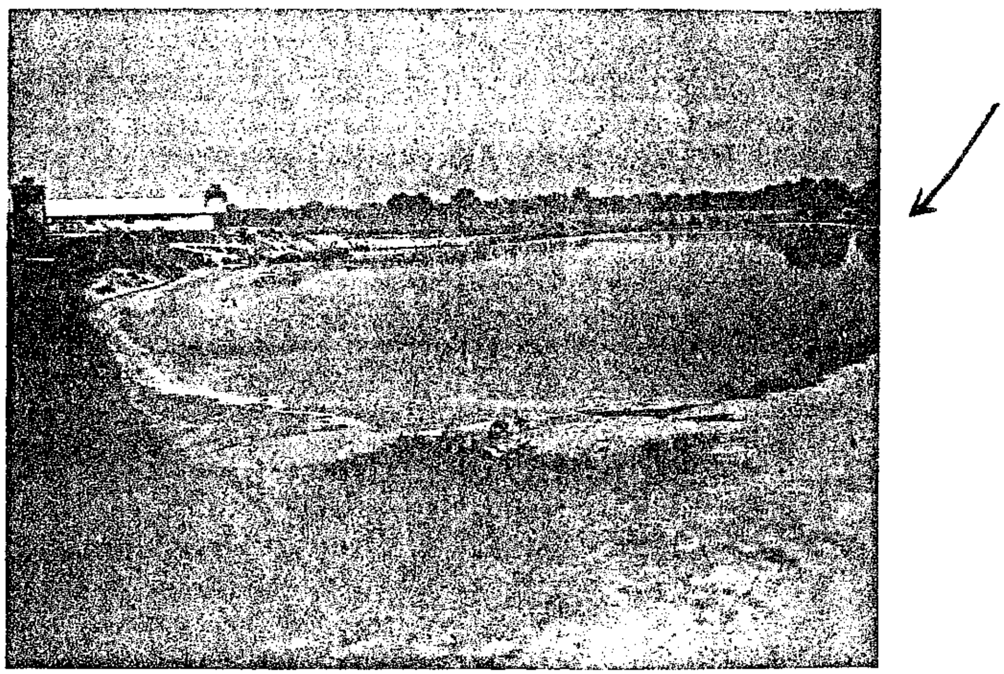
Soil sampling under ponds can be accomplished when ponds are emptied. Soil sampling can then be used to verify soil solution values.



Ceramic cups for placement under ponds for monitoring purposes

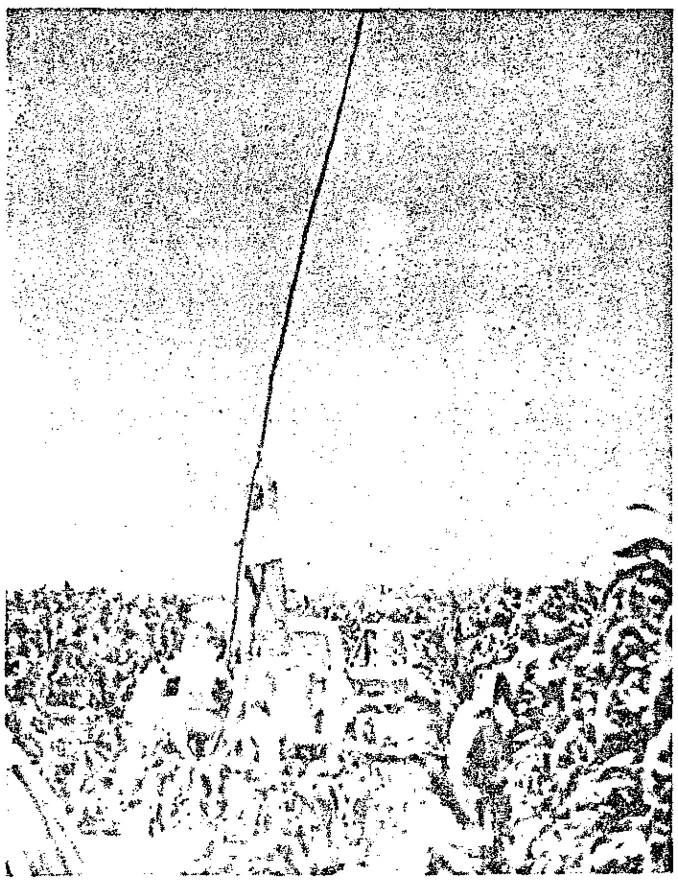
Mercury manometers for measuring soil moisture pressure and tubes for extracting soil solutions.

Pond management includes the use of ducks for scum control. Inlet from buildings upper left. Ducks in foreground and outlet pump (arrow) in upper right.

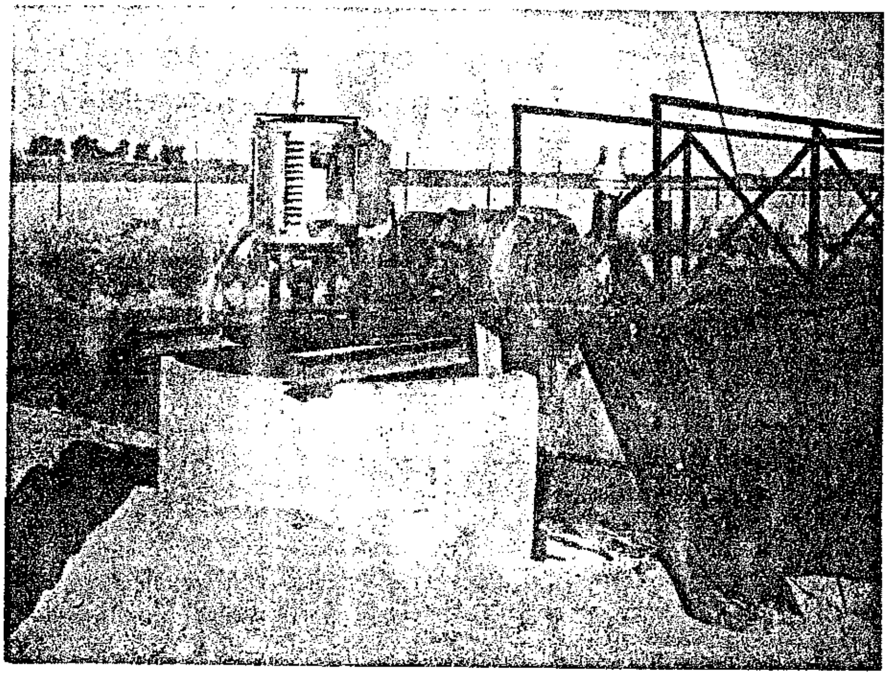


Reasonable rates of manure to apply to crops are determined by nutrient requirements of the crop. Maintenance of a favorable salt balance is extremely important to the long-term survival of California agriculture. Field sampling was used to study soils for nitrates and salinity under varying conditions.

Deep, open soils with considerable depth were compared to shallow claypan and hardpan soils which have restrictive layers, a short depth beneath the crop roots. Soil augers were used in the study of this corn field.



Both manure pond effluent and dried manure are used as fertilizer in most parts of California. Pond water may be recycled for washing down feeding and other paved areas before it is used for irrigation.



Recycle - Pump

Similar pump for manure delivery to irrigation system

EXPERIMENTAL SITES

Twenty-five manure holding ponds were studied. The ponds were located in Merced, Stanislaus, San Joaquin and San Bernardino counties. These areas have some of the highest animal and poultry populations in the state of California. Ponds were selected to represent the range of soil textures from sands to clay loams, water table depths, and the varying age of ponds generally found in these areas. Fifteen of these ponds were instrumented with porous ceramic cups for measuring the rate of seepage and the concentration of nutrients. Ten ponds were used for determining changes in the pond water during use.

In one case, a ten-year-old manure pond was emptied, and sampling was conducted under the pond to a depth of ten feet to determine the fate of salts and nutrients.

Ten cropped fields were sampled which had a known manure fertilizer history, ·anging from 10 to 20 years. These fields represented soils with restrictive layers and soils without such layering. Soil samples, at one-foot increments, were sampled to a restricting layer (claypan or hardpan). The open soil sites without restricting layers were sampled to a depth of 40 to 50 feet.

DISCUSSION

The Porter-Cologne Water Quality Control Act charges the State Water Resources Control Board (SWRCB) with the responsibility for regulating waste water quality from agricultural operations. Included among these waste waters are those coming from poultry and dairy husbandry. In the past, some waste waters from the poultry and dairy operations flowed into nearby stream beds where they either became part of the surface stream or percolated into gravelly stream beds and commingled with ground waters. Such waste waters were often high in B.O.D.; nitrates and related compounds; total dissolved solids; various esthetically offensive constituents; and miscellaneous organisms, such as bacteria. For the protection of nearly every beneficial use, therefore, it is imperative that improved practices be adopted.

The recycling and land disposal of manure waters is one of a number of alternatives available for handling of animal wastes. Other alternatives include combustion, spreading, composting and feeding.

Waste holding ponds have a number of desirable characteristics. They are esthetically inoffensive, having very little odor. They facilitate fly and mosquito control. The manure wastes can be readily applied to surrounding cropland by blending with irrigation water. Overflow of manure to adjacent water courses is eliminated. Seepage from ponds contains low concentrations of nitrate. In addition, the technology is currently available to effectively monitor the performance of ponds.

Seepage of water from manure-laden ponds in loamy sand to clay soils was tudied and is in the order of one millimeter per day after 30 days. The gradients indicative of moisture movement were nonexistent after 60 days under all ponds studied. Lateral movement does not occur. The maximum movement found was about one millimeter depth of water per day under the coarsest soil conditions. The quantities of salt and nitrate that are moving through the soil profile are extremely small.

After thirty months, the soil solutions below the manure ponds have a lower concentration of all nutrients than adjacent well waters. No observable changes have occurred in nearby well and ground water during this period.

Significant stratification of nitrates and B.O.D. within the waste ponds appears to exist with increased anaerobic activity, and a lowering of nitrates occurring with depth.

RECOMMENDATIONS

Total salinity (T.D.S.) within the ponds increases linearily fairly rapidly according to loading. Because of salt increases, at present loadings of 15,000 chickens or 100 dairy cows per acre of surface, it is recommended that the ponds be emptied at 2- to 3-week intervals, or when T.D.S. approaches 1000 ppm. Irrigation blending and disposal to cropland is a suggested use for the effluent. Irrigation blending is usually a necessity after winter storage between irrigation seasons.

From the result of these studies, it does not appear necessary to recommend any artificial seal inside the manure holding reservoirs.

When double cropping is practiced (winter cereals and summer field corn or summer sorghum) or where irrigated permanent pasture is grown, manure loadings up to 10 to 20 yards per acre did not materially increase nitrates or salinity (T.D.S.) in percolating waters. Studies on several different soils, and with varying depths to an impermeable layer, indicate a reasonable manure loading is one consistant with crop needs for nitrogen.

The salts (T.D.S.) available under the suggested 10 to 20 yards per acre "reasonable" manure-loading rate did not show a higher T.D.S. or nitrate level in the soil solution than in adjacent well waters. These rates (10 to 20 yards per acre) will supply about 200 pounds of nitrogen and 2000 pounds of salts per acre.

# MANURE WASTE PONDING AND FIELD APPLICATION RATES

March 1973

Part II

Technical Report

University of California
Agricultural Extension
Stanislaus, San Joaquin, and Merced Counties

MANURE WASTE PONDING AND

FIELD APPLICATION RATES

TECHNICAL REPORT

The technical data in Part II of this study is the result of nearly three years of intensive field investigations and laboratory analyses on the part of many Agricultural Extension and County laboratory personnel.

The objectives were to investigate many animal manure and commercial fertilizer trials and observe the fate of the fertilizer materials and salts on cropped soils.

In order to meet these objectives, the State Water Resources Control Board cooperated with the University of California, Agricultural Extension, and the Kearney Foundation in field research studies in the San Joaquin Valley.

Funds were made available to Agricultural Extension on a contractual basis and the staff of the State Water Resources Control Board provided technical assistance in delineating those parameters pertinent to SWRCB.

Technical assistance in soil physics was furnished by the staff of the Department of Water Science and Engineering, University of California, Davis. Technical expertise concerning soil and water chemistry, animal husbandry, etc., was provided by Agricultural Extension personnel.

EXPERIMENTAL METHODS

1. Nitrogen and Salt Content of Manure Pond Waters

Manure water from holding ponds that is reused to flush additional manure from production areas contains progressively higher nitrogen and salt contents. The rate of such a build-up and its concomitant effects upon fertilized crops are important to both livestock producers and to SWRCB in protecting the waters of the state.

Irrigation water movement rates were studied before filling ponds with manured water. As ponds were being filled, sealing time was determined. In addition, reference stakes were located within some ponds to measure depth changes with time to further measure rate of water loss from the ponds.

4. Manure Disposal Areas and Commercial Fertilizer Trials

Soils were examined for movement of nutrients and salts where known manure history could be documented.

Soils with crops of winter cereals followed by corn for silage were examined where manure had been the principle fertilizer used. A commercially fertilized apricot plot and a commercially fertilized permanent pasture plot were sampled and analyzed.

RESULTS

1. Nitrogen and Salt Content of Pond Waters

Cows excrete approximately 0.4 pounds of nitrogen per day, and chickens excrete about 0.003 pounds of nitrogen per day in the form of nitrogenous materials.

These nitrogenous materials are oxidized, under aerobic conditions, to nitrates--the most soluble form of nitrogen--and can move readily through the soil with water. In an anaerobic aquatic movement, nitrates are converted to nitrogen gas, a process commonly known as denitrification. Periodically, pond waters were analyzed for nitrate and ammonium-nitrogen and compared to calculated amounts of manure input. At the end of a 22-month period, total dissolved nitrogen content of a manure pond was determined.

During this period, a typical pond (Table 1) had received the waste from 43,000 chickens. This loading rate corresponds to total nitrogen additions equivalent to 1950 mg/l nitrogen, but only 450 mg/l nitrogen was found in the ammonium form, and 4.3 mg/l in the nitrate-nitrogen form.

Table 1.

Changes in nitrate-nitrogen, salt content, and B.O.D. at the one-foot depth of a typical manure pond during a 22-month period.

| Dates | Nitrate-Nitrogen mg/1 | Salt Content, mg/1 * | B.O.D., ppm ** |
|---|---|---|---|
| 12/8/70 | 1.1 | 448 | 76 |
| 2/6/71 | 1.7 | 1645 | -- |
| 3/8/71 | 2.3 | 1632 | 400 |
| 7/21/71 | 3.6 | 1696 | 580 |
| 8/20/71 | 4.0 | 2816 | 480 |
| 8/23/71 | 4.8 | 2880 | 400 |
| 8/31/71 | 5.1 | 2944 | 380 |
| 6/27/72 | 4.4 | 3084 | 650 |
| 8/9/72 | 5.2 | 3178 | 235 |
| 10/5/72 | 4.3 | 3392 | 450 |

* Salt measurements were $EC_e$ (mmho's/cm) and calculated to salt content, mg/1 using factor of 640.

** The City of Modesto, Water Quality Control Division, cooperated in B.O.D. determinations for this study.

Soil solutions were not obtained from the porous cups at the one-foot or two-foot depths below the pond bottoms (Table 5). This lack of extraction was not due to failure of the experimental apparatus, but was due to the extremely low water-conducting properties of the soil. This very reduced conduction confirmed the sealing of the pond bottoms. Moreover, auger samples (Table 7) indicated that the soils were blue-black, dense and not saturated.

Table 3.

The nitrate-nitrogen, salt content, pH, and B.O.D. of a typical dairy manure pond at one-foot intervals between the pond surface and the bottom.

| Depth Feet | Nitrate-Nitrogen mg/1 | | Ammonium-Nitrogen mg/1 | Salt Content mg/1 | | pH | | B.O.D. ppm | |
|---|---|---|---|---|---|---|---|---|---|
| | 1971 | 1972 | 1972 | 1971 | 1972 | 1971 | 1972 | 1971 | 1972 |
| 1 | 6.4 | 6.0 | 500 | 1523 | 2020 | 7.9 | 8.0 | 137 | 250 |
| 2 | 7.0 | 6.5 | 550 | 1728 | 2140 | 7.2 | 7.4 | 116 | 260 |
| 3 | 6.1 | 6.0 | 600 | 1561 | 2040 | 7.7 | 7.9 | 120 | 280 |
| 4 | 5.9 | 5.8 | 650 | 1504 | 2230 | 7.8 | 7.9 | 123 | 270 |
| 5 | 6.1 | 6.0 | 650 | 1523 | 2300 | 7.9 | 8.0 | 125 | 250 |
| 6 | 5.7 | 5.5 | 700 | 1600 | 2300 | 7.8 | 7.8 | 117 | 240 |
| 7 | 3.7 | 2.7 | 1000 | ---- | ---- | Slurry | --- | 1040 | 1500 |

Table 5.

Typical nitrate and salt content values of the soil solution beneath ponds. Soil solution was extracted by ceramic cups.

DEEP WATER TABLE

| Depth Feet | Nitrate-Nitrogen, mg/l before filling | Nitrate-Nitrogen, mg/l 7 months after filling | Salt Content, mg/l** before filling | Salt Content, mg/l** 7 months after filling |
|---|---|---|---|---|
| 2 | -- | -- | -- | -- |
| 5 | 1.3 | 1.6 | 2640 | 640 |
| 10 | 1.1 | 1.4 | 960 | 1624 |
| 14 | 1.3 | 1.9 | 1920 | 1344 |

Table 6.

Typical nitrate and salt content values of the soil solution beneath pond.*

SHALLOW WATER TABLE

| Depth, Feet | Nitrate-Nitrogen, mg/l 7 months before filling | Ammonium-Nitrogen, mg/l 7 months before filling | Nitrate-Nitrogen, mg/l 7 months after filling | Ammonium-Nitrogen, mg/l 7 months after filling | Salt Content, mg/ before filling | Salt Content, mg/ aft |
|---|---|---|---|---|---|---|
| 1 | 2.2 | 1.0 | 0.6 | 7.11 | 2560 | 1184 |
| 5 | 2.8 | 1.0 | 0.3 | 2.24 | 640 | 864 |
| Water Table | 2.8 | 1.0 | 0.3 | 2.24 | 384 | 864 |

* Water Table Depth 20 inches

**Salt measurements were $EC_e$(mmho's) and calculated to salt content, mg/l using factor 640.

Table 8.

Typical nitrate-nitrogen and salt content values of the soil solution in soil immediately adjacent to a pond. A soil auger was used to remove samples for analyses nine months after filling.

| Depth Feet | Nitrate-Nitrogen mg/1 | Salt Content mg/1* |
|---|---|---|
| 1 | 5.3 | 550 |
| 2 | 4.4 | 301 |
| 3 | 4.1 | 333 |
| 4 | 2.6 | 305 |
| 5 | 4.3 | 307 |
| 6 | 8.2 | 269 |
| | Bottom of Pond | |
| 7 | 5.0 | 371 |
| 8 | 3.8 | 371 |
| 9 | 3.4 | 250 |
| 10 | 2.6 | 243 |
| 11 | 5.3 | 243 |
| 12 | 3.4 | 275 |
| 13 | 2.4 | 256 |
| 14 | 2.9 | 192 |
| 15 | 2.7 | 211 |
| 16 | 2.9 | 210 |
| 17 | 3.4 | 282 |
| 18 | 2.9 | 281 |
| 19 | 2.7 | 282 |

* Salt measurements were $EC_e$ (mmho's) and calculated to salt content, mg/1, using factor of 640.

Table 9.

Typical Manometer Readings in Centimeters of Mercury

Hydraulic Gradient $\Phi_2 - \Phi_1 / L$

Loamy Sand, 20 Inches to Water Table

| | | Depth | Readings | Gradient |
|---|---|---|---|---|
| | 0 | 1 foot | 5 feet | $\Phi_2 - \Phi_1/L$ |
| Infiltration of Pure Water | 29.0 (cm) | 31.0 (cm) | 32.5 (cm) | +4 |
| Days Manure Added 1 | | 32.8 | 33.2 | +2 |
| 3 | | 33.6 | 33.2 | +1.1 |
| 5 | | 33.5 | 33.2 | +1 |
| 9 | | 33.5 | 33.2 | +1 |
| 15 | | 33.5 | 33.2 | +1 |
| 22 | | 33.4 | 33.1 | +1 |
| 24 | | 33.3 | 33.2 | +1 |
| 26 | | 32.3 | 32.2 | +1 |
| 31 Pond Full of Manure Water | | 32.1 Sealed | 32.1 Sealed | 0 |

Seal Complete 31 Days

WATER TABLE ANALYSIS

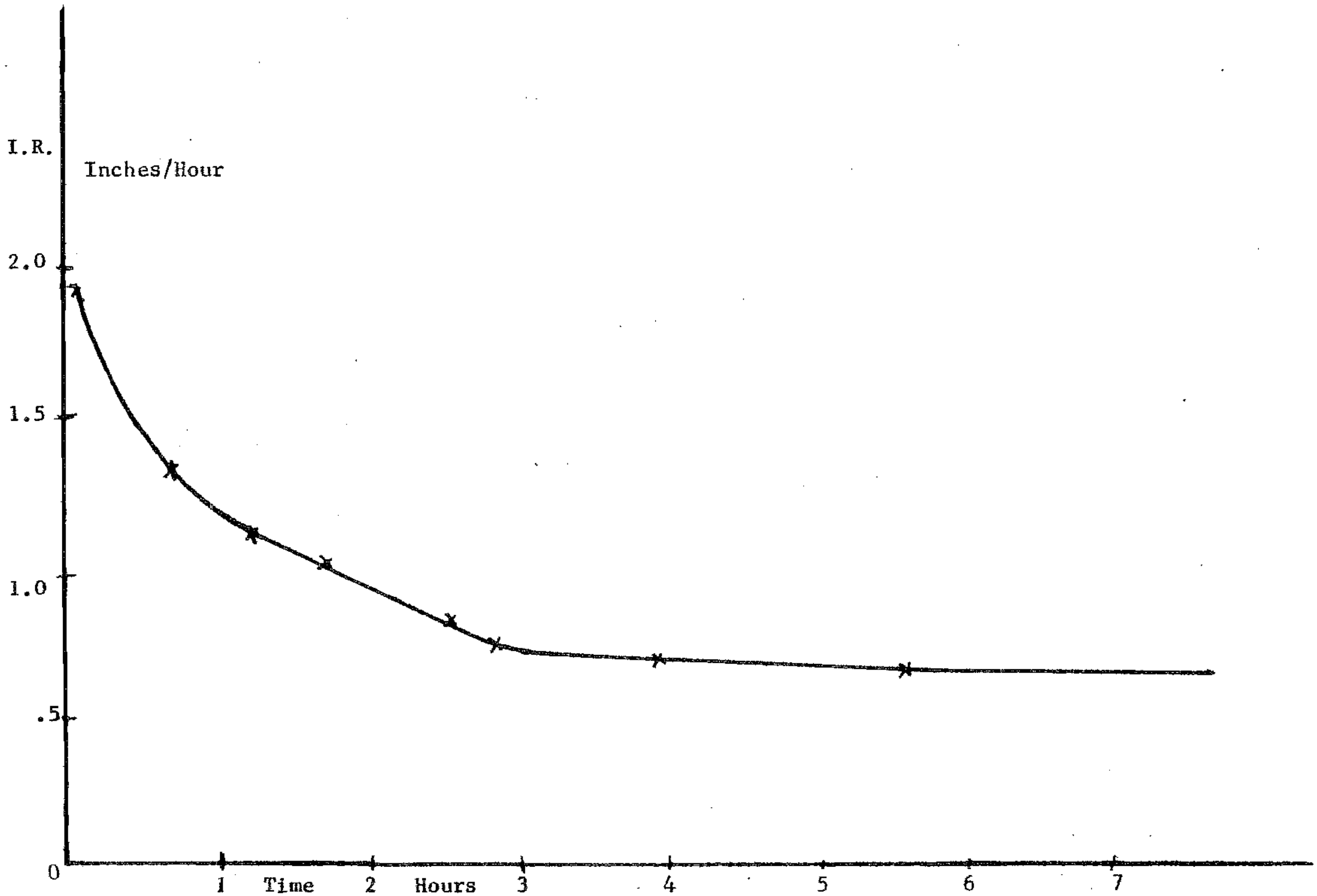
| Time Days | pH | EC | Ca+Mg ME/1 | Nitrate-Nitrogen mg/1 | Total Nitrogen mg/1 |
|---|---|---|---|---|---|
| 0 | 7.36 | .24 | 6.2 | 3.5 | 80 |
| 31 | 7.36 | .24 | 6.2 | 2.8 | 80 |

Graph 2

I.R. (Infiltration Rate) Before Manure

20" Water Table

Loamy Sand Soil



## Manure Disposal on Cropped Soils

### High Application Rates

The amounts of nutrients and salts available for leaching were studied when high manure rates were used on open, deep soils and soils underlain by restrictive layers.

High manure usage of 40 yards per acre on open soils showed salt and nitrogen movement toward the underground, Table 9. Forty yards per acre is equivalent to 24 dry tons of manure per acre and is equivalent to the manure from approximately 9 to 10 cows per acre. The downward movement of nitrogen (Graph 4) compares applications of 12 yards per acre to 40 yards per acre. The downward movement of T.D.S.(Graph 5) compares applications of 12 yards per acre to 40 yards per acre. The fluctuations in amounts of nitrogen and salt in about five-foot increments (Graphs 4 and 5) suggest annual movement due to the leaching fractions of irrigations.

High manure usage with restrictive layers is shown in Table 10. In this table, nitrate-nitrogen has accumulated on the pan to some extent, but the crops have used considerable amounts of the surface nitrogen. Salinity accumulation on the pan is shown in Table 11. The high application rate of manure preceded sampling by eleven months (Table 11).

Table 9. (cont'd)

| Depth Feet | pH | $EC_e$ | Ca+Mg ME/L | Nitrate-Nitrogen mg/1 | Ammonium-Nitrogen mg/1 | Total Nitrogen mg/1 |
|---|---|---|---|---|---|---|
| 24 | 7.1 | 0.32 | 1.8 | 17.5 | -0- | Trace |
| 25 | 7.2 | 0.39 | 3.0 | 18.0 | -0- | Trace |
| 26 | 7.0 | 0.37 | 2.4 | 18.5 | -0- | Trace |
| 27 | 7.1 | 0.37 | 1.6 | 18.0 | -0- | Trace |
| 28 | 7.1 | 0.29 | 2.0 | 21.0 | -0- | Trace |
| 29 | 7.2 | 0.46 | 2.4 | 21.6 | -0- | Trace |
| 30 | 7.0 | 0.47 | 3.6 | 22.5 | -0- | Trace |
| 31 | 7.2 | 0.32 | 1.8 | 16.0 | -0- | Trace |
| 32 | 7.5 | 0.36 | 3.2 | 19.5 | -0- | Trace |
| 33 | 7.0 | 0.31 | 3.2 | 17.2 | -0- | Trace |
| 34 | 7.2 | 0.41 | 2.6 | 26.0 | -0- | Trace |
| 35 | 7.3 | 0.51 | 3.2 | 38.0 | -0- | Trace |
| 36 | 7.1 | 0.57 | 3.6 | 40.0 | -0- | Trace |
| 37 | 7.4 | 0.38 | 2.2 | 24.0 | -0- | Trace |
| 38 | 7.4 | 0.41 | 2.4 | 25.0 | -0- | Trace |
| 39 | 7.2 | 0.53 | 3.8 | 44.5 | -0- | Trace |
| 40 | 7.0 | 0.62 | 3.8 | 37.0 | -0- | Trace |
| WELL WATER ANALYSIS AT DAIRY | | | | | | |
| | 6.5 | .25 | 2.0 | 3.5 | -0- | -0- |

Graph 5

Salinity Profile for Open Soil
CROP: 1960-1972 Corn-Oats
FERTILIZER: 12Yds/A Dairy Manure + 150#N/A
Versus
40 Yds/A Dairy Manure + 150#N/A

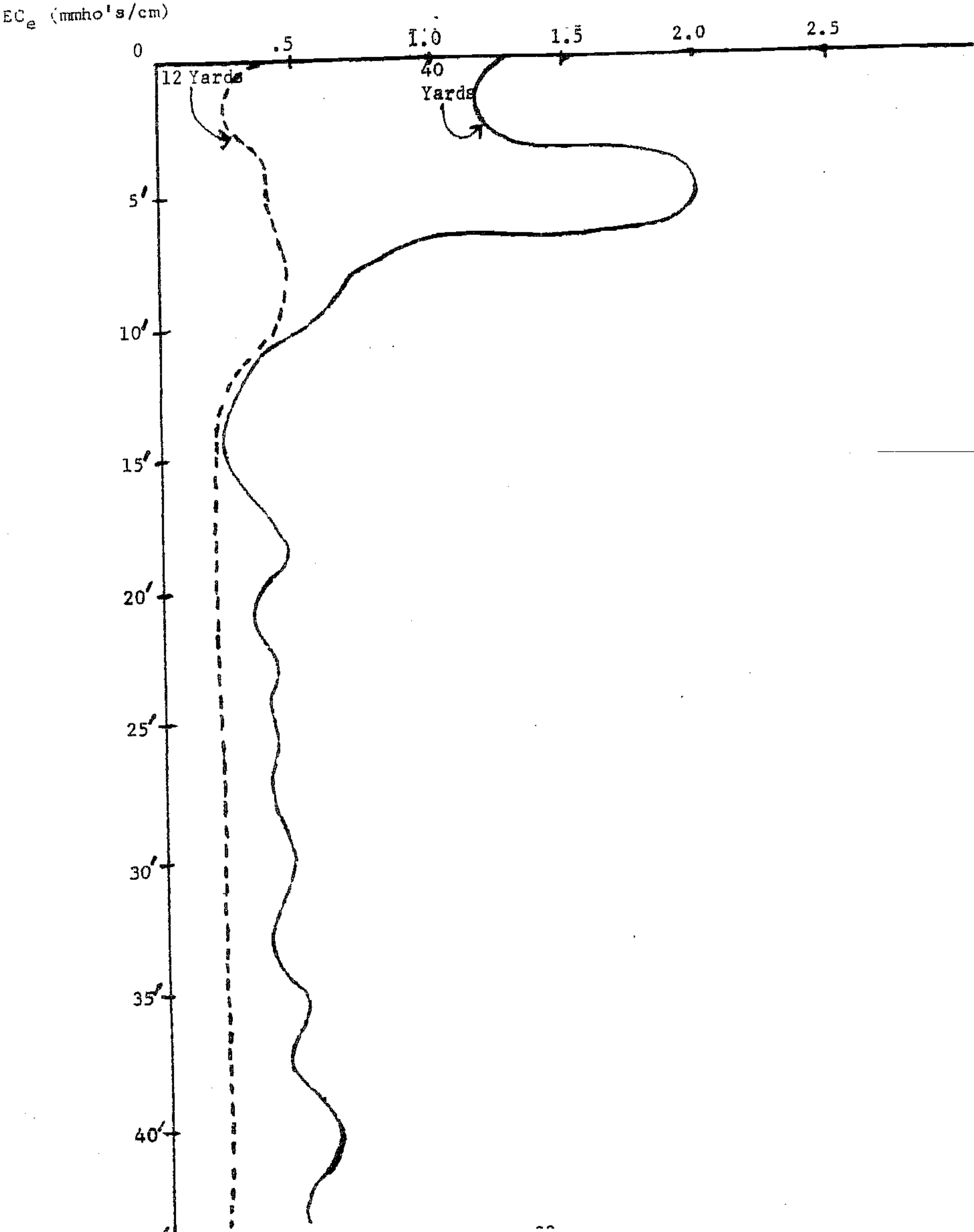


Table 11.

Typical soil analysis of cropland: 15 years corn-oats, 10 years 40 yards per acre manure plus 150 pounds nitrogen applied to corn.

Sampled in May, 1972 Previous to Annual Manure Application.

| Depth Feet | pH | $EC_e$ | Ca+Mg ME/L | Nitrate-Nitrogen mg/1 | Total Nitrogen mg/1 |
|---|---|---|---|---|---|
| 0-1 | 6.97 | .28 | 2.2 | 4.8 | 740 |
| 1-2 | 6.95 | .35 | 3.2 | .7 | 200 |
| 2-3 | 7.00 | .32 | 2.4 | .4 | 80 |
| 3-4 | 7.00 | .32 | 2.4 | .5 | 120 |
| 4-5 | 7.00 | .24 | 1.4 | 8.5 | 60 |
| 5-6 | 7.10 | .36 | 1.4 | 7.7 | 40 |

Hardpan at 6 Feet

Table 12.

Soil analysis September 1972,(end of corn season). 1960-1972 corn oats: 150 pounds nitrogen (commercial), 12 yards manure 1971: 3 irrigations barn wash water,1972.

| Depth Feet | | pH | $EC_e$ | Ca+Mg ME/L | Ammonium-Nitrogen mg/1 | Nitrate-Nitrogen mg/1 | Total Nitrogen mg/1 |
|---|---|---|---|---|---|---|---|
| 0-1 | | 6.3 | 0.28 | 1.2 | -0- | 0.5 | 540 |
| 2 | | 6.5 | 0.25 | 1.6 | 6.12 | 0.26 | 200 |
| 3 | | 6.4 | 0.30 | 1.2 | -0- | 0.33 | 140 |
| 4 | | 6.4 | 0.30 | 1.4 | -0- | 0.48 | 140 |
| 5 | | 6.8 | 0.31 | 1.8 | -0- | 0.77 | 140 |
| 6 | | 6.7 | 0.34 | 1.2 | -0- | 1.17 | 140 |
| 7 | | 6.6 | 0.35 | 1.9 | -0- | 1.53 | 140 |
| 8 | | 6.5 | 0.36 | 2.0 | -0- | 1.66 | 100 |
| 9 | | 6.4 | 0.41 | 2.6 | -0- | 2.10 | 140 |
| 10 | | 6.5 | 0.38 | 2.4 | -0- | 2.28 | 80 |
| 11 | | 6.5 | 0.29 | 1.8 | -0- | 1.60 | 40 |
| 12 | | 6.7 | 0.25 | 1.4 | -0- | 1.08 | 20 |
| 13 | | 6.4 | 0.25 | 1.6 | -0- | 0.96 | 60 |
| 14 | | 6.4 | 0.22 | 1.4 | -0- | 0.96 | 60 |
| 15 | | 6.6 | 0.20 | 1.4 | -0- | 0.65 | 20 |
| 16 | | 6.6 | 0.20 | 1.2 | -0- | 0.66 | 60 |
| 17 | HP | 6.6 | 0.36 | 2.4 | -0- | 1.22 | 80 |
| 18 | HP | 6.7 | 0.30 | 1.8 | -0- | 0.74 | 80 |

Table 13.

Soil analysis of cropland 1972. History: Pasture, liquid manure only.*

| Depth Feet | Nitrate-Nitrogen mg/l | Total Nitrogen mg/l |
|---|---|---|
| 0-1 | 20 | 860 |
| 1-2 | 100 | 240 |
| 2-3 | 82 | 200 |
| 3-4 | 24 | 180 |
| 4-5 | 23 | 80 |
| 5-6 | 27 | 60 |
| 6-7 | 3.8 | 60 |
| 7-8 | 25.5 | 50 |

Hardpan at 8 Feet

* 800 cows per 120 acres
Milk barn water approximately 10 percent of total manure produced = total manure from 80 cows per 120 acres or 2 cows per 3 acres.

Table 14.

Commercial fertilizer only, soil analysis 1972. History: Pasture, commercial nitrogen only, (100 pounds of nitrogen per year).

| Depth Feet | Nitrate-Nitrogen mg/l | Total Nitrogen mg/l |
|---|---|---|
| 0-1 | 9.5 | 860 |
| 1-2 | 6.0 | 420 |
| 2-3 | 5.8 | 140 |
| 3-4 | 3.4 | 160 |
| 4-5 | 2.9 | 160 |
| 5-6 | 2.8 | 100 |
| 6-7 | 18.4 | 60 |
| 7-8 | 2.2 | 60 |

Hardpan at 8 feet

Table 15.

Soil analysis 1972. History of an eight year commercial nitrogen apricot fertilizer plot. (50 N/A/Yr. versus 400 N/A/Yr.)

| | 50N | | 400 N | |
|---|---|---|---|---|
| Depth Feet | Nitrate-Nitrogen mg/1 | Total Nitrogen mg/1 | Nitrate-Nitrogen mg/1 | Total Nitrogen mg/1 |
| 0-1 | 5.3 | 700 | 142 | 980 |
| 1-2 | 12.0 | 520 | 175 | 600 |
| 2-3 | 12.0 | 440 | 23 | 300 |
| 3-4 | 3.7 | 300 | 24 | 220 |
| 4-5 | 6.3 | 300 | 54 | 300 |
| 5-6 | 2.9 | 380 | 57 | 460 |
| 6-7 | 3.4 | 240 | 16.3 | 300 |
| 7-8 | 4.8 | 180 | 10.0 | 200 |

lower and B.O.D. is higher. All factors of stratification appear to be favorable for rapid sealing with low losses of nutrients and salts.

Manure disposal to cropped lands needs further investigation However, under San Joaquin Valley cropping of corn silage (summer) and cereal oats (winter), "reasonable" manure rates seem to be in the range of 10 to 20 yards (6 to 12 tons) per acre per year. The results in this report indicate that these rates are not contributing significant salts for leaching through either deep, open, permeable soils or restricted soil profiles.

This study does indicate, under stratified soil conditions, large manure application rates based solely on nitrate-nitrogen can be safely used. Denitrification probably accounts for the losses in stratified soils. Salts, however, do accumulate on pan layers in greater amounts under heavy manure loading.

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# When Does Nitrate Become a Risk for Humans?

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# When Does Nitrate Become a Risk for Humans?

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Is nitrate harmful to humans? Are the current limits for nitrate concentration in drinking water justified by science? There is substantial disagreement among scientists over the interpretation of evidence on the issue. There are two main health issues: the linkage between nitrate and (i) infant methaemoglobinaemia, also known as blue baby syndrome, and (ii) cancers of the digestive tract. The evidence for nitrate as a cause of these serious diseases remains controversial. On one hand there is evidence that shows there is no clear association between nitrate in drinking water and the two main health issues with which it has been linked, and there is even evidence emerging of a possible benefit of nitrate in cardiovascular health. There is also evidence of nitrate intake giving protection against infections such as gastroenteritis. Some scientists suggest that there is sufficient evidence for increasing the permitted concentration of nitrate in drinking water without increasing risks to human health. However, subgroups within a population may be more susceptible than others to the adverse health effects of nitrate. Moreover, individuals with increased rates of endogenous formation of carcinogenic N-nitroso compounds are likely to be susceptible to the development of cancers in the digestive system. Given the lack of consensus, there is an urgent need for a comprehensive, independent study to determine whether the current nitrate limit for drinking water is scientifically justified or whether it could safely be raised.

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Is nitrate harmful to humans? Are the current limits for nitrate concentration in drinking water justified by science? These questions were addressed at a symposium on "The Nitrogen Cycle and Human Health" held at the annual meeting of the Soil Science Society of America (SSSA). Although they sound like old questions, it became clear there is still substantial disagreement among scientists over the interpretation of evidence on the issue—disagreement that has lasted for more than 50 years.

This article is based on the discussion at the SSSA meeting and subsequent email exchanges between some of the participants. It does not present a consensus view because some of the authors hold strongly divergent views, drawing different conclusions from the same data. Instead, it is an attempt to summarize, to a wider audience, some of the main published information and to highlight current thinking and the points of contention. The article concludes with some proposals for research and action. Because of the divergent views among the authors, each author does not necessarily agree with every statement in the article.

## Present Regulatory Situation

In many countries there are strict limits on the permissible concentration of nitrate in drinking water and in many surface waters. The limit is 50 mg of nitrate $L^{-1}$ in the EU and 44 mg $L^{-1}$ in the USA (equivalent to 11.3 and 10 mg of nitrate-N $L^{-1}$, respectively). These limits are in accord with WHO recommendations established in 1970 and recently reviewed and reconfirmed (WHO, 2004). The limits were originally set on the basis of human health considerations, although environmental concerns, such as nutrient enrichment and eutrophication of surface waters, are now seen as being similarly relevant. It is the health

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issues that are the main cause of disagreement; the contrasting views are set out in the following two sections.

## Nitrate and Health

There are two main health issues: the linkage between nitrate and (i) infant methaemoglobinaemia, also known as blue baby syndrome, and (ii) cancers of the digestive tract. The evidence for nitrate as a cause of these serious diseases remains controversial and is considered below.

### An Over-Stated Problem?

The link between nitrate and the occurrence of methaemoglobinaemia was based on studies conducted in the 1940s in the midwest of the USA. In part, these studies related the incidence of methaemoglobinaemia in babies to nitrate concentrations in rural well water used for making up formula milk replacement. Comly (1945), who first investigated what he called "well-water methaemoglobinaemia," found that the wells that provided water for bottle feeding infants contained bacteria as well as nitrate. He also noted that "In every one of the instances in which cyanosis (the clinical symptom of methaemoglobinaemia) developed in infants, the wells were situated near barnyards and pit privies." There was an absence of methaemoglobinaemia when formula milk replacements were made with tap water. Re-evaluation of these original studies indicate that cases of methaemoglobinaemia always occurred when wells were contaminated with human or animal excrement and that the well water contained appreciable numbers of bacteria and high concentrations of nitrate (Avery, 1999). This strongly suggests that methaemoglobinaemia, induced by well water, resulted from the presence of bacteria in the water rather than nitrate per se. A recent interpretation of these early studies is that gastroenteritis resulting from bacteria in the well water stimulated nitric oxide production in the gut and that this reacted with oxyhaemoglobin in blood, converting it into methaemoglobin (Addiscott, 2005).

The nearest equivalent to a present-day toxicological test of nitrate on infants was made by Cornblath and Hartmann (1948). These authors administered oral doses of 175 to 700 mg of nitrate per day to infants and older people. None of the doses to infants caused the proportion of heamoglobin converted to methaemoglobin to exceed 7.5%, strongly suggesting that nitrate alone did not cause methaemoglobinaemia. Furthermore, Hegesh and Shiloah (1982) reported another common cause of infant methaemoglobinaemia: an increase in the endogenous production of nitric oxide due to infective enteritis. This strongly suggests that many early cases of infant methaemoglobinaemia attributed at that time to nitrate in well water were in fact caused by gastroenteritis. Many scientists now interpret the available data as evidence that the condition is caused by the presence of bacteria rather than nitrate (Addiscott, 2005; L'hirondel and L'hirondel, 2002). The report of the American Public Health Association (APHA, 1950) formed the main basis of the current recommended 50 mg $L^{-1}$ nitrate limit, but even the authors of the report recognized that it was compromised by unsatisfactory data and methodological bias. For example, in many cases, samples of water from wells were only taken for nitrate analysis many months after the occurrence of infant methaemoglobinaemia.

About 50 epidemiological studies have been made since 1973 testing the link between nitrate and stomach cancer incidence and mortality in humans, including Forman et al. (1985) and National Academy of Sciences (1981). The Chief Medical Officer in Britain (Acheson, 1985), the Scientific Committee for Food in Europe (European Union, 1995), and the Subcommittee on Nitrate and Nitrite in Drinking Water in the USA (NRC, 1995) all concluded that no convincing link between nitrate and stomach cancer incidence and mortality had been established.

A study reported by Al-Dabbagh et al. (1986) compared incidence of cancers between workers in a factory manufacturing nitrate fertilizer (and exposed to a high intake of nitrate through dust) and workers in the locality with comparable jobs but without the exposure to nitrate. There was no significant difference in cancer incidence between the two groups.

Based on the above findings showing no clear association between nitrate in drinking water and the two main health issues with which it has been linked, some scientists suggest that there is now sufficient evidence for increasing the permitted concentration of nitrate in drinking water without increasing risks to human health (L'hirondel et al., 2006; Addiscott, 2005).

Space does not permit here to discuss other concerns expressed about dietary nitrate, such as risk to mother and fetus, genotoxicity, congenital malfunction, enlarged thryroid gland, early onset of hypertension, altered neurophysiological function, and increased incidence of diabetes. For differing views of other possible health concerns, see L'hirondel and L'hirondel (2002) and Ward et al. (2006).

Nitrate is made in the human body (Green et al., 1981), the rate of production being influenced by factors such as exercise (Allen et al., 2005). In recent years it has been shown that body cells produce nitric oxide from the amino acid L-arginine and that this production is vital to maintain normal blood circulation (Richardson et al., 2002) and protection from infection (Benjamin, 2000). Nitric oxide is rapidly oxidized to form nitrate, which is conserved by the kidneys and concentrated in the saliva. Nitrate can also be chemically reduced to nitric oxide in the stomach, where it can aid in the destruction of swallowed pathogens that can cause gastroenteritis.

Evidence is emerging of a possible benefit of nitrate in cardiovascular health. For example, the coronaries of rats provided water for 18 mo that contained sodium nitrate became thinner and more dilated that the coronaries of the rats in the control group (Shuval and Gruener, 1977). Nitrate levels in water showed a negative correlation coefficient with the standardized mortality ratio for all cardiovascular diseases (Pocock et al., 1980). In healthy young volunteers, a short-term increase in dietary nitrate reduced diastolic blood pressure (Larsen et al., 2006). Based on these data, one could hypothesize that nitrate might also play a role in the cardiovascular health benefit of vegetable consumption (many vegetables contain high concentrations of nitrate) (Lundberg et al., 2004).

## The Need for Caution

Although there is little doubt that normal physiological levels of nitric oxide play a functional role in vascular endothelial function and the defense against infections (Dykhuizen et al., 1996), chronic exposure to nitric oxide as a result of chronic inflammation has also been implicated, though not unequivocally identified, as a critical factor to explain the association between inflammation and cancer (Sawa and Oshima, 2006; Dincer et al., 2007; Kawanishi et al., 2006). Nitric oxide and NO-synthase are known to be involved in cancer-related events (angiogenesis, apoptosis, cell cycle, invasion, and metastasis) and are linked to increased oxidative stress and DNA damage (Ying and Hofseth, 2007). Rather than nitrate, the presence of numerous classes of antioxidants is generally accepted as the explanation for the beneficial health effects of vegetable consumption (Nishino et al., 2005; Potter and Steinmetz, 1996).

A recent review of the literature suggests that certain subgroups within a population may be more susceptible than others to the adverse health effects of nitrate (Ward et al., 2005). Although there is evidence showing the carcinogenity of N-nitroso compounds in animals, data obtained from studies that were focused on humans are not definitive, with the exception of the tobacco-specific nitrosamines (Grosse et al., 2006). The formation of N-nitroso compounds in the stomach has been connected with drinking water nitrate, and excretion of N-nitroso compounds by humans has been associated with nitrate intake at the acceptable daily intake level through drinking water (Vermeer et al., 1998). The metabolism of nitrate and nitrite, the formation of N-nitroso compounds, and the development of cancers in the digestive system are complex processes mediated by several factors. Individuals with increased rates of endogenous formation of carcinogenic N-nitroso compounds are likely to be susceptible. Known factors altering susceptibility to the development of cancers in the digestive system are inflammatory bowel diseases, high red meat consumption, amine-rich diets, smoking, and dietary intake of inhibitors of endogenous nitrosation (e.g., polyphenols and vitamin C) (de Kok et al., 2005; De Roos et al., 2003; Vermeer et al., 1998). In 1995, when the Subcommittee on Nitrate and Nitrate in Drinking Water reported that the evidence to link nitrate to gastric cancer was rather weak (NRC, 1995), the stomach was still thought to be the most relevant site for endogenous nitrosation. Previous studies, such as those reviewed in the NRC (1995) report, which found no link between nitrate and stomach cancer, concentrated on the formation of nitrosamines in the stomach. Recent work indicates that larger amounts of N-nitroso compounds can be formed in the large intestine (Cross et al., 2003; De Kok et al., 2005).

Some scientists argue that there are plausible explanations for the apparent contradictive absence of adverse health effects of nitrate from dietary sources (Van Grinsven et al., 2006; Ward et al., 2006). Individuals with increased rates of endogenous formation of carcinogenic N-nitroso compounds are more likely to be at risk, and such susceptible subpopulations should be taken into account when trying to make a risk-benefit analysis for the intake of nitrate. In view of these complex dose-response mechanisms, it can be argued that it is not surprising that ecological and cohort studies (e.g., Van Loon et al., 1998) in general do not provide statistically significant evidence for an association between nitrate intake and gastric, colon, or rectum cancers. The experimental design of most of these studies may not have been adequate to allow for the determination of such a relationship.

Population studies have the problem that factors influencing health tend to be confounded with each other. This necessitates molecular epidemiological studies aimed at improving methods for assessing exposure in susceptible subgroups. This approach requires the development of biomarkers that enable the quantification of individual levels of endogenous nitrosation and N-nitroso compounds exposure and methods for accurate quantification of exposure-mediating factors.

## Nitrate, Food Security, and the Environment

It is beyond dispute that levels of nitrate and other N-containing species have increased in many parts of the ecosystem due to increased use of fertilizers and combustion of fossil fuels. At present, 2 to 3% of the population in USA and the EU are potentially exposed to public or private drinking water exceeding the present WHO (and USA and EU) standard for nitrate in drinking water. The proportion of the exposed population in the emerging and developing economies is probably larger and increasing (Van Grinsven et al., 2006).

The environmental impacts of reactive N compounds are serious, and continued research on agricultural systems is essential to devise management practices that decrease losses and improve the utilization efficiency of N throughout the food chain. At the same time, the central role of N in world agriculture must be considered. Agriculture without N fertilizer is not an option if the 6.5 billion people currently in the world and the 9 billion expected by 2050 are to be fed (Cassman et al., 2003). Losses of reactive N compounds to the environment are not restricted to fertilizers: losses from manures and the residues from legumes can also be large (Addiscott, 2005). Research indicates that simply mandating a reduction in N fertilizer application rates does not automatically reduce N losses because there is typically a poor relationship between the amount of N fertilizer applied by farmers and the N uptake efficiency by the crops (Cassman et al., 2002; Goulding et al., 2000). Instead, an integrated systems management approach is needed to better match the amount and timing of N fertilizer application to the actual crop N demand in time and space. Such an approach would lead to decreased losses of reactive N to the environment without decreasing crop yields. Many of the potential conflicts between the agricultural need for N and the environmental problems caused by too much in the wrong place are being studied within the International Nitrogen Initiative (INI; http://initrogen.org/), a networking activity sponsored by several international bodies.

The adverse environmental impact of reactive N species (i.e., all N-containing molecules other than the relatively inert $N_2$ gas that comprises 78% of the atmosphere) deserves attention. Some of these molecules, such as nitrogen oxides, come from combustion of fossil fuels in automobiles and power plants. Agriculture, however, is the dominant source through the cultivation of $N_2$-fixing crops and the manufacture and use of N fertilizers (Turner and Rabalais, 2003). Both have increased greatly over the last few decades, and the trend is set to continue (Galloway et al., 2003; 2004). The subsequent N enrichment causes changes to terrestrial and aquatic ecosystems and to the environmental services they provide. Examples include nitrate runoff to rivers causing excessive growth of algae and associated anoxia in coastal and estuarine waters (James et al., 2005; Rabalais et al., 2001) and deposition of N-containing species from the atmosphere causing acidification of soils and waters and N enrichment to forests and grassland savannahs (Goulding et al., 1998). All of these impacts can radically change the diversity and numbers of plant and animal species in these ecosystems. Other impacts almost certainly have indirect health effects, such as nitrous oxide production, which contributes to the greenhouse effect and the destruction of the ozone layer, thereby allowing additional UV radiation to penetrate to ground level with the associated implications for the prevalence of skin cancers.

Losses of nitrate to drinking water resources are also associated with leaky sewage systems. Leaky sewage systems need to be improved for general hygiene considerations. This need is especially important in developing countries and poor rural areas that do not have well developed sewage and waste disposal infrastructure.

## Returning Question

In considering the management of nitrogen in agriculture and its fate in the wider environment, the debate keeps returning to the original question: "Is nitrate in drinking water really a threat to health?" Interpretations of the evidence remain very different (L'hirondel et al., 2006; Ward et al., 2006). The answer has a significant economic impact. The current limits established for ground and surface waters require considerable changes in practice by water suppliers and farmers in many parts of the world, and these changes have associated costs. If nitrate in drinking water is not a hazard to health, could the current limit be relaxed, perhaps to 100 mg $L^{-1}$? The relaxation could be restricted to situations where the predominant drainage is to groundwater. Such a change would allow environmental considerations to take precedence in the case of surface waters where eutrophication is the main risk, and N limits could be set to avoid damage to ecosystem structure and function. Phosphate is often the main factor limiting algal growth and eutrophication in rivers and freshwater lakes, so a change in the nitrate limit would focus attention on phosphate and its management—correctly so in the view of many environmental scientists (Sharpley et al., 1994). It is possible that a limitation on phosphate might lead to even lower nitrate limits in some freshwater aquatic environments to restore the diversity of submerged plant life (James et al., 2005). It could be argued that setting different limits, determined by health or environmental considerations as appropriate, is a logical response to the scientific evidence.

Given the criticisms of the scientific foundation of present drinking water standards and the associated cost-benefits of prevention or removal of nitrate in drinking water, we propose the need to consider the following issues in discussing an adjustment of the nitrate standards for drinking water:

- Nitrogen intake by humans has increased via drinking water and eating food such as vegetables.
- There is circumstantial and often indirect evidence of the enhanced risk of cancers of the digestive system after an increase in the concentration of nitrate in drinking water. There is an urgent need to synthesize existing data and understanding, or to carry out additional research if necessary, to reach clear and widely accepted conclusions on the magnitude of the risk. This will require greater collaboration between scientists who hold opposing views over the interpretation of currently available data. The possibility that subgroups within the population respond differently requires quantification and critical examination.
- Nitrogen oxides have a functional role in normal human physiology, but they are also involved in the induction of oxidative stress and DNA damage. The challenge is to quantify and evaluate these risks and benefits of nitric oxide exposure in relation to the intake of nitrate in drinking water. If humans have a mechanism to combat infectious disease with nitric oxide, produced from nitrate consumed in drinking water and food, what are the long-term effects of the nitric oxide benefits compared with the potential negative health effects from higher intake of nitrate?
- If the evaluation of potential adverse health effects from chronic exposure to nitrate levels in drinking water above 50 mg $L^{-1}$ demonstrates that these adverse effects can be considered minor compared with other issues of health loss associated with air pollution or life style, would the removal of nitrate from drinking water to meet the current allowable concentration standards be cost-efficient relative to other potential investments in health improvement?

Although science may not provide society with unequivocal conclusions about the relationship between drinking water nitrate and health over the short term, there are good reasons to further explore the issue (Ward et al., 2005). Unfortunately, it remains difficult to predict the health risks associated with chronic nitrate consumption from water that exceeds the current WHO drinking water standard. One complication is the endogenous production of nitrate, which makes it more difficult than previously realized to relate health to nitrate intake in water or food.

Practical management strategies to overcome inefficient use of nitrogen by crops and to minimize losses of nitrate and other N-containing compounds to the environment have to be developed for agricultural systems worldwide.

Given the lack of consensus, there is an urgent need for a comprehensive, independent study to determine whether the current nitrate limit for drinking water is scientifically justified or whether it could safely be raised. Meta-analyses are valuable tools for generating conclusions about specific chronic health effects (e.g., stomach cancer, colon cancer, bladder cancer, specific reproductive outcomes). Unfortunately, the number of suitable studies for any particular health effect is likely too small to be detected by meta-analyses (Van Grinsven et al., 2006). Empirical studies focused on susceptible subgroups, development of biomarkers for demonstration of endogenous nitrosation, and methods for accurate quantification of mediating factors may provide part of the answers. Moreover, there is also a separate need for determining water quality standards for environmental integrity of aquatic ecosystems. It is time to end 50 yr of uncertainty and move forward in a timely fashion toward science-based standards.

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# Exhibit 5

**From:** Essary, Dale@Waterboards <Dale.Essary@waterboards.ca.gov>
**To:** Japlus3 <japlus3@aol.com>
**Cc:** Patteson, Doug@Waterboards <Doug.Patteson@waterboards.ca.gov>; Rodgers, Clay@Waterboards <Clay.Rodgers@waterboards.ca.gov>; Pulupa, Patrick@Waterboards <Patrick.Pulupa@waterboards.ca.gov>
**Subject:** RE: Sweeney Dairy
**Date:** Thu, Sep 26, 2013 4:36 pm

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Hi Mr. Sweeney,

The 21,000 pages I advised you about are raw data extracted from either annual reports or stand-alone groundwater monitoring reports. Some of these annual reports and some of the groundwater reports have already been scanned. Those reports also contain other information not related to your request. We can provide you with the available scanned reports for those dairies you are interested in upon request. You would then need to go through the reports to find the data you are looking for. Also, some of the data you requested may not be in any of the scanned reports.

We are not able to convert any other information to electronic format. We can only make paper copies at 10 cents per copy.

Please let me know if you would like to proceed.

**From:** Japlus3 [mailto:japlus3@aol.com]
**Sent:** Thursday, September 26, 2013 8:40 AM
**To:** Essary, Dale@Waterboards
**Subject:** Sweeney Dairy

Dale,

Are all of the 21,000 pages that you advised me about by phone all of the raw data that I requested in my Public Records Request? If not, what do these pages represent? I am still waiting for a response on the cost of the copies and/or disks. I would appreciate a response by email as I am very busy today on the dairy and can respond later tonight if it is too expensive for us. Thank you for your consideration.

Jim Sweeney

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION
ORDER R5-2013-0122

REISSUED WASTE DISCHARGE REQUIREMENTS GENERAL ORDER
FOR
EXISTING MILK COW DAIRIES

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**CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD**
**CENTRAL VALLEY REGION**

ORDER R5-2013-0122

REISSUED WASTE DISCHARGE REQUIREMENTS GENERAL ORDER
FOR
EXISTING MILK COW DAIRIES

The California Regional Water Quality Control Board, Central Valley Region (Central Valley Water Board or Board), finds that:

## SCOPE OF COVERAGE OF THIS ORDER

1. This Order serves as general waste discharge requirements for discharges of waste from existing milk cow dairies (defined in Finding 7) of all sizes. This Order rescinds and replaces General Order R5-2007-0035 (the "2007 General Order"), which the Board originally issued on 3 May 2007.

2. This Order applies to owners and operators of existing milk cow dairies (hereinafter referred to as "Dischargers") that:

   (1) submitted a complete Report of Waste Discharge (ROWD) in response to the Central Valley Water Board's 8 August 2005 request for such a report (the "2005 ROWD Request Letter"), and

   (2) have not been expanded ("expansion" is defined in Attachment E) since 17 October 2005.

   After the Board issued the 2007 General Order, the Board notified the Dischargers that they were required to comply with the terms and conditions of that Order. After the Board issues this Order, the Board will notify the Dischargers that were previously regulated by the 2007 General Order that they will now be required to comply with the terms and conditions of this Order. Dischargers that do not qualify for coverage under this Order will be covered under separate general or individual waste discharge requirements or under a conditional waiver issued pursuant to Water Code section 13269.

## REASON FOR THE CENTRAL VALLEY WATER BOARD ISSUING THIS ORDER

3. The Central Valley Water Board possesses the authority to regulate waste discharges that could affect the quality of the waters of the state, which includes both surface water and groundwater. This authority is derived from the Porter-Cologne Water Quality Control Act (Division 7 of the Water Code).

4. Water Code section 13260 requires that any person discharging waste, or proposing to discharge waste, within the Central Valley Region, that could affect

the quality of the waters of the state (which includes both surface waters and groundwaters) to file a report of that discharge with the Central Valley Water Board.

5. The Central Valley Water Board generally regulates waste discharges by prescribing waste discharge requirements, which must implement the relevant water quality control plan. The Central Valley Water Board may prescribe general waste discharge requirements for a category of discharges if all the following criteria apply:

   a. The discharges are produced by the same or similar operations.

   b. The discharges involve the same or similar types of waste.

   c. The discharges require the same or similar treatment standards.

   d. The discharges are more appropriately regulated under general requirements than individual requirements.

6. In regulating waste discharges, the Central Valley Water Board implements State laws and regulations. California regulations governing discharges from confined animal facilities are contained in the Title 27 of the California Code of Regulations ("Title 27"), at sections 22560 et seq.

7. For the purposes of this Order, "existing milk cow dairies" means all dairies that were operating as of 17 October 2005, filed a complete ROWD in response to the 2005 ROWD Request Letter, and have not expanded ("expansion" is defined in Attachment E) since 17 October 2005.

8. Herd sizes at existing dairy operations vary as operators strive to maintain a consistent milk production. Maintaining consistent milk production requires a dairy operator to manage the herd by continually producing calves, some of which eventually replace the dairy's producing herd over time, while excess stock are marketed for beef production or herd replacement elsewhere.

9. Professionals at the University of California Davis estimate the normal variation in California dairy herd sizes ranges from about 10 to 15 percent.

10. For the purposes of this Order, existing herd size is defined as the maximum number of mature dairy cows reported in the ROWD filed in response to the 2005 ROWD Request Letter, plus or minus 15 percent of that reported number to account for the normal variation in herd sizes.

11. For the purposes of this Order, an increase in the number of mature dairy cows of more than 15 percent beyond the maximum number reported in the ROWD filed in response to the 2005 ROWD Request Letter is considered an expansion.

12. There are approximately 1,300 milk cow dairies within the Central Valley Region (Region) that will be required to operate under the requirements of this Order. Each facility represents a significant source of waste discharge with a potential to affect the quality of the waters of the State.

13. For the purposes of this Order, "waste" includes, but is not limited to, manure, leachate, process wastewater and any water, precipitation or rainfall runoff that contacts raw materials, products, or byproducts such as manure, compost piles, feed, silage, milk, or bedding.

14. This Order implements the requirements of State Water Resources Control Board Resolution 68-16 (*Statement of Policy with Respect to Maintaining High Quality of Waters in California*, referred to hereafter as the *State Anti-Degradation Policy*), the sections of Title 27 related to confined animal facilities, the Central Valley Water Board's Water Quality Control Plan for the Sacramento and San Joaquin River Basins (4$^{th}$ Ed.) and the Water Quality Control Plan for the Tulare Lake Basin (2$^{nd}$ Ed.) (Basin Plans), and other applicable plans and policies of the State Water Resources Control Board (State Water Board) and the Central Valley Water Board described in the Information Sheet, which is attached to and made part of this Order.

15. This reissued Order as originally issued was intended to enhance requirements on existing milk cow dairies, and recognized that this would mean that many Dischargers would need to make improvements at their facilities to meet these requirements. Because this is a reissued Order, it is recognized that some of the necessary improvements have already occurred. Improvements may include recycling flush water, grading, establishing setbacks, installing flow meters, exporting manure, leasing or purchasing land, etc. The Discharger may be able to make some of these improvements relatively quickly while some improvements may require more time to implement. It is reasonable to allow Dischargers time to phase in elements of the required Waste Management Plan and Nutrient Management Plan in order to adequately design and construct major infrastructure changes needed to comply with all the requirements of this Order. This Order requires Dischargers to make any necessary interim facility modifications first in order to prevent discharges to surface water, improve storage capacity, and improve the facility's nitrogen balance before completing any necessary infrastructure changes.

## CALIFORNIA ENVIRONMENTAL QUALITY ACT

16. The Central Valley Water Board is the lead agency with respect to the issuance of this Order under applicable provisions of the California Environmental Quality Act (CEQA)(Pub. Resources Code, § 21000 et seq.).

17. In accordance with CEQA, the Central Valley Water Board adopted a Negative Declaration in 1982 concurrently with the adoption of Central Valley Water Board Resolution 82-036 (Waiving Waste Discharge Requirements for Specific Types of Discharge), which waived waste discharge requirements for confined animal facilities where the Discharger complies with Central Valley Water Board guidelines. That waiver program expired on 1 January 2003.

18. Food and Agricultural Code section 33487 states that, "No environmental impact report may be required by any state agency for any activity of a dairy farm, including adoption of waste discharge requirements under Division 7 of the Water Code" under the following circumstances:

    (1) when the dairy will be constructed and operated in accordance with the minimum standards in Chapter 5 of the Food and Agricultural Code;

    (2) where the applicable local agencies have completed all necessary reviews and approvals including that required by CEQA; and

    (3) where a permit for construction was issued by a local agency on or after the effective date of Food and Agricultural Code section 33487 and construction has begun.

19. The benchmark for evaluating whether this Order will have impacts on the environment is the "environmental baseline." The environmental baseline normally consists of "a description of the physical environmental conditions in the vicinity of the project at the time...environmental analysis is commenced." (Cal. Code Regs., tit. 14, § 15125(a).) The receipt of a permit application is one event that can be used to mark the beginning of the environmental review process and therefore an appropriate date for the environmental baseline. (*Fat v. County of Sacramento* (2002) 97 Cal.App.4th 1270, 1278.) The Board solicited permit applications (ROWDs) from existing dairies on 8 August 2005. These reports were due on 17 October 2005.

    The information contained in the ROWDs submitted to the Board in 2005 presented Board staff with a description of the dairies as they existed at that date. The environmental baseline for the 2007 General Order therefore consisted of the milk cow dairies (defined by their size and scope of herd, facilities, and operation) as they and their surrounding physical environment existed on 17 October 2005. Dairy herd size fluctuation is accounted for in that the environmental baseline incorporates the normal 15 percent variation in the number of mature dairy cows contained in a given herd.

20. This Order, which supplements regulatory requirements already imposed on the existing dairy discharges under the 2007 General Order and which is designed to enhance the protection of groundwater resources, is exempt from the provisions of CEQA in accordance with the following categorical exemptions:

    a. California Code of Regulations, title 14, section 15301, which exempts the "operation, repair, maintenance, [and] permitting ... of existing public or private structures, facilities, mechanical equipment, or topographical features" from environmental review. Eligibility under the Dairy General Order is limited to milk cow dairies that were existing facilities as of 17 October 2005, and the Order does not authorize the expansion of these facilities. The restoration of, or improvements to, dairy waste management systems to ensure proper function in compliance with this Order will involve minor alterations of existing private facilities.

    b. California Code of Regulations, title 14, section 15302, which exempts the "...replacement or reconstruction of existing structures and facilities where the new structure will be located on the same site as the structure replaced and will have substantially the same purpose and capacity as the structure replaced..." The Dairy General Order will likely require covered dairies to replace or reconstruct portions of their waste management systems to ensure compliance with the Order's requirements.

    c. California Code of Regulations, title 14, section 15304 exempts "... minor public or private alterations in the condition of land, water, and/or vegetation which do not involve removal of healthy, mature, scenic trees except for forestry and agricultural purposes..." The Dairy General Order will require covered dairies to make improvements to their waste management systems that will result in only minor alterations to land, water, and/or vegetation.

## DAIRY IMPACTS ON WATER QUALITY

21. Groundwater monitoring shows that many dairies in the Region have impacted groundwater quality. A University of California study of five dairies in a high-risk groundwater area in the Region during the 1990s found elevated salts and nitrates beneath the production area, wastewater retention ponds and land application areas. Data included in the first annual monitoring report of the Central Valley Dairy Representative Monitoring Program (CVDRMP) reported that groundwater beneath some dairies that have begun implementation of practices required by the 2007 General Order continue to have elevated levels of salts and nitrates beneath the production area, wastewater retention ponds and land application areas. Representative monitoring programs (RMP) began monitoring groundwater in 2012, and some provisions of the 2007 General Order were only fully implemented by 2012, therefore, monitoring results may not be fully reflective of the effectiveness of current practices. Prior to the issuance of the 2007 General

Order, the Central Valley Water Board requested monitoring at 80 dairies with poor waste management practices in the Tulare Lake Basin. This monitoring has also shown groundwater impacts under many of the dairies, including where groundwater is as deep as 120 feet and in areas underlain by fine-grained sediments.

22. Groundwater monitoring is the most direct way to determine if management practices at a dairy are protective of groundwater, Monitoring and Reporting Program R5-2013-0122 (MRP), which is attached to and made part of this Order, requires groundwater monitoring to determine if a dairy is in compliance with the groundwater limitations of this Order.

23. Under the MRP, Dischargers have the option of either implementing individual groundwater monitoring or participating in a Representative Monitoring Program (RMP) to identify whether or not their specific management practices are resulting in adverse impacts to groundwater (i.e., whether the discharge is in compliance with the groundwater limitations of this Order). Extensive long-term monitoring is needed to document which dairy waste management practices are protective of groundwater, and what effect these management practices will have on groundwater under a variety of different site conditions.

   a. Dischargers implementing individual monitoring must submit the following reports to the Board's Executive Officer:

      *Annual Reports*: Dischargers who have elected to perform individual groundwater monitoring must submit annual groundwater monitoring reports to the Executive Officer. These annual reports provide a summary of the analytical data collected to date and an evaluation of the groundwater monitoring program's adequacy to assess compliance with the Order, including whether the data provided are representative of conditions upgradient and downgradient of the wastewater management area, production area, and land application area of the dairy facility.

      *Summary Report*: In addition to submittal of annual reports, the MRP also requires that Dischargers conducting individual groundwater monitoring submit a summary report six (6) years after initiating sampling. The summary report must provide a detailed assessment of the monitoring data, and must include an evaluation of whether site activities associated with operation of the wastewater retention ponds, production area, or land application areas have impacted groundwater quality. The summary report must include a discussion on implementation of changes in management practices and/or activities that are being taken and an evaluation of progress in complying with Groundwater Limitation F.1 of the Order.

   b. Dischargers participating in an RMP must collectively submit the following reports to the Board's Executive Officer:

*Annual Representative Monitoring Reports*: The RMP must submit Annual Representative Monitoring Reports (ARMR), which must describe the monitoring activities (including a tabulated summary of groundwater analytical data) conducted by the RMP, and which must identify the number and location of installed monitoring wells and other types of monitoring devices. Within each ARMR, the RMP must evaluate the groundwater monitoring data to determine whether groundwater is being impacted by activities at facilities being monitored by the RMP. The submittal must include a description of the methods used in evaluating the groundwater monitoring data.

*Summary Representative Monitoring Report*: Six (6) years following submittal of the first ARMR, the RMP must submit a Summary Representative Monitoring Report (SRMR) to the Board's Executive Officer. The SRMR is to identify management practices that are protective of groundwater quality for the range of conditions found at participating facilities. Based on information supplied in the SRMR, if management practices are found not to be protective of groundwater quality, the SRMR must propose solutions and upgrades that will result in compliance.
*Individual Annual Monitoring Reports*: Dischargers who have participated in the RMP must submit Annual Monitoring Reports following the Executive Officer's approval of the SRMR, which must document what they are doing to upgrade management practices that have been found not to be protective of groundwater. These reports are due every July 1 following Executive Officer approval of the SRMR. The first annual report must identify alternative management practices the Discharger intends to implement at its dairy facility along with a schedule for implementation. With each subsequent Annual Monitoring Report, the Discharger must provide an update on their implementation of additional or alternative management practices.

24. The Central Valley Water Board has documented many discharges of waste from existing milk cow dairies to surface water and has taken appropriate enforcement actions in such cases. This Order prohibits discharges of: waste and/or storm water to surface water from the production area; wastewater to surface waters from cropland; and storm water to surface water from a land application area where manure or process wastewater has been applied unless the land application area has been managed consistent with a certified Nutrient Management Plan. When such discharges do occur, this Order requires the Discharger to monitor these discharges.

25. The milk cow dairies at which this Order is directed were in existence prior to October 2005 and many were constructed several decades ago. The waste management systems at these existing dairies are commonly not capable of preventing all adverse impacts to waters of the state either because of their

outdated design or need for maintenance or both. Historic operation of these dairies has often resulted in adverse effects on the water quality. Groundwater data are needed to determine the existence and magnitude of these impacts. If data document impacts, continued operation of dairies without waste management improvements will perpetuate the ongoing adverse water quality effects caused by the generation and disposal of dairy waste. This Order includes time schedules for compliance for dairy operators to implement improvements if groundwater data indicate that certain types of facilities/practices are not protective of groundwater quality.

## ***STATE ANTI-DEGRADATION POLICY*** **(RESOLUTION 68-16)**

26. The State Anti-Degradation Policy prohibits the Central Valley Water Board from authorizing the degradation of high-quality groundwater unless it has been shown that:

    a. The degradation is consistent with the maximum benefit to the people of the state.

    b. The degradation will not unreasonably affect present and anticipated future beneficial uses.

    c. The degradation does not result in water quality less than that prescribed in state and regional policies, including violation of one or more water quality objectives, and

    d. The discharger employs best practicable treatment or control (BPTC) to minimize degradation.

27. This Order places restrictions on the discharge of wastes from dairy facilities that are intended to prevent pollution and nuisance conditions from occurring or persisting. Though the Board recognizes that degradation of high-quality groundwater will still occur pursuant to this Order, the implementation of nutrient management plans, waste management plans, enhanced management practices within the production area, and improved containment features for new and expanding dairy wastewater retention ponds will limit the amount of degradation that will occur under this Order. Degradation will be limited so that discharges from dairy facilities will not cause long-term impacts to beneficial uses. Where immediate compliance with water quality objectives cannot be achieved, this Order includes a time schedule for compliance for the implementation or modification of waste management practices.

28. Consistent with the *State Anti-Degradation Policy*, this Order establishes requirements and standards that will result in the implementation of BPTC measures to limit the degradation caused by dairy discharges. The following is a general description of what the Board considers to be BPTC for specified areas of a dairy operation:

a. Production Areas (including milk barns, wash/sprinkler pens, feed and non-liquid manure storage areas, and corrals): surface water discharges from the production area are prohibited, and the production areas shall be managed to limit the extent to which wastewater can infiltrate into the underlying materials.

b. Land Application Areas: Dischargers must prepare and implement Nutrient Management Plans (NMPs). Discharges from the land application areas must not cause or contribute to an exceedance of any applicable water quality objective or federal water quality criteria.

c. Existing Wastewater Retention Ponds: Existing wastewater retention ponds must be in compliance with design standards specified in Title 27. However, these design standards have not been found to be protective of groundwater under all conditions, and the immediate replacement of these wastewater retention ponds is not a practicable option for many dairies. Therefore, though compliance with Title 27 design standards was once considered to be BPTC, the Board now considers BPTC for existing ponds to be an iterative process whereby the ponds are evaluated (either under an individual monitoring program or under the RMP) to determine whether or not they are protective of the underlying groundwater, and upgraded or replaced on a time schedule that is as short as practicable if they are found not to be protective. This Order contains a time schedule to bring any deficient management practices (including wastewater retention ponds) into compliance.

d. New and Expanded Wastewater Retention Ponds: This Order establishes requirements for new and expanded wastewater retention ponds that are more stringent than the requirements in Title 27 in order to provide groundwater protection. New and expanded wastewater retention ponds must meet a strict performance standard that only allows for a very conservative pond design unless there has been a demonstration that an alternative design meets the e strict performance standard.

29. This Order also contains closure requirements that specify that the Discharger must maintain coverage under this Order or a subsequent revision to this Order until all manure, process wastewater, and animal waste impacted soil (including soil within the pond(s)), is disposed of or utilized in a manner which does not pose a threat to surface water or groundwater quality or create a condition of nuisance.

30. This Order will assure that pollution or nuisance will not occur outside of the time schedule for improvements set by this Order. This Order addresses impacts from future discharges of waste, but does not address the cleanup of surface and groundwater that has been polluted due to historic dairy operations. Any required cleanup would be handled under separate authority under the Water Code.

31. The Central Valley Water Board recognizes that there is often site-specific, crop-specific, and regional variability which affects the selection of appropriate

management measures, as well as the design constraints and pollution control effectiveness of various practices. In compliance with Water Code section 13360, dairy owners/operators have the flexibility to choose management practices that best achieve a management measure's performance expectations given their own unique circumstances. It is expected that this will be an iterative process whereby the effectiveness of any set of practices in minimizing degradation will be periodically reevaluated as necessary for and/or as more recent and detailed water quality data become available.

32. To assess compliance with the *State Anti-Degradation Policy*, this Order requires Dischargers to monitor discharges to surface waters and groundwater. The requirements to monitor first encountered groundwater (the point in the aquifer where typically detection of changes to groundwater quality, caused by the facility, would be first detected) are met when the Dischargers perform individual groundwater monitoring or participate in an RMP. The purpose of monitoring is to confirm that the discharges are effectively controlled by management practices and to evaluate compliance with this Order.

33. When the Board prescribes waste discharge requirements that will result in the degradation of high-quality waters, the *State Anti-Degradation Policy* requires that the Board first make a determination that the authorized degradation is consistent with the maximum benefit to the people of the State. Consistent with the evaluation contained in the Information Sheet and considering the economic significance of the Central Valley dairy industry and the important role Central Valley dairies play in providing adequate milk supplies to the nation, the Central Valley Water Board finds that maintaining the Central Valley dairy industry is consistent with the maximum benefit to the people of the state. To maintain the industry and to prevent the loss of jobs and the impacts to the local economy that might otherwise occur, some degradation to high quality waters must be allowed. However, this degradation will be limited by this Order so that there will not be long-term impacts to beneficial uses, thereby allowing the full utilization of the aquifer.

## ENVIRONMENTAL STEWARDSHIP PROGRAMS

34. Environmental stewardship programs, such as the California Dairy Quality Assurance Program, and local ordinances can greatly assist the Central Valley Water Board efforts to assure compliance with this Order. Since its inception in 1998, the California Dairy Quality Assurance Program's efforts have resulted in dairy operators having a greater understanding of the need for water quality protection. Local ordinances in several counties throughout the Region have also increased dairy operators' understanding of the needs for water quality protection. Dairies that are certified under a quality assurance program approved by the State Water Board or under a County regulatory program approved by the Central Valley Water Board receive a 50 percent reduction in their annual fee.

35. Participation in an Environmental Stewardship Program or operation of a dairy in a county that has a local ordinance regulating dairies may assist an existing dairy facility in meeting the requirements of this Order but these programs are not a substitute for regulation under this Order.

## GENERAL FINDINGS

36. This Order does not authorize violation of any federal, state, or local law or regulation.

37. As stated in Water Code section 13263(g), the discharge of waste into waters of the state is a privilege, not a right, and this Order does not create a vested right to continue the discharge of waste. Failure to prevent conditions that create or threaten to create pollution or nuisance will be sufficient reason to modify, revoke, or enforce this Order, as well as prohibit further discharge.

38. In compliance with Water Code section 106.3, it is the policy of the State of California that every human being has the right to safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes. This order promotes that policy by requiring discharges to meet maximum contaminant levels designed to protect human health and ensure that water is safe for domestic use.

39. This Order is <u>not</u> a National Pollutant Discharge Elimination System Permit issued pursuant to the Federal Clean Water Act. Coverage under this Order does not exempt a facility from the Clean Water Act. Any facility required to obtain such a permit must notify the Central Valley Water Board.

40. The Findings of this Order, supplemental information and details in the attached Information Sheet, and the administrative record of the Central Valley Water Board relevant to milk cow dairies, were considered in establishing the conditions of discharge.

41. In 2006, the Central Valley Water Board, the State Water Board, and Regional stakeholders began a joint effort to address salinity and nitrate problems in the region and adopt long-term solutions that will lead to enhanced water quality and economic sustainability. Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS) is a collaborative basin planning effort aimed at developing and implementing a comprehensive salinity and nitrate management program. The CV-SALTS effort might effect changes to the Basin Plans that would necessitate the re-opening of this Order.

42. The Central Valley Water Board recognizes that the 2007 General Order imposed new and more stringent requirements on existing milk cow dairies. This Order is

intended to enhance the requirements imposed under the 2007 General Order. However, some revisions to this Order may be necessary in the future to address issues that are not presently foreseen. The Executive Officer will provide annual updates to the Central Valley Water Board on the overall compliance with the Order and make recommendations for revisions to the Order if necessary.

43. The Central Valley Water Board has notified interested agencies and persons of its intent to issue this Order for discharges of wastes from existing milk cow dairies, and has provided them with an opportunity for a public hearing and an opportunity to submit comments.

44. The Central Valley Water Board, in a public meeting, heard and considered all comments pertaining to the proposal to regulate discharges of wastes from existing milk cow dairies under this Order.

IT IS HEREBY ORDERED that, pursuant to Water Code sections 13260, 13263, and 13267 and in order to meet the provisions contained in Division 7 of the California Water Code and regulations and policies adopted thereunder; all Dischargers specified by the Central Valley Water Board and all Dischargers that were formerly regulated under the original version of Order R5-2007-0035 adopted in May 2007, their agents, successors, and assigns shall comply with the following:

## A. PROHIBITIONS

1. The discharge of hazardous wastes, as that term is defined in California Code of Regulations, title 22, section 66261.1 *et seq.*, is prohibited.

2. Except when authorized by a National Pollutant Discharge Elimination System (NPDES) permit, the direct or indirect discharge of waste and/or storm water from the production area to surface waters is prohibited[1].

3. The discharge of waste from existing milk cow dairies to surface waters which causes or contributes to an exceedance of any applicable water quality objective in the Basin Plans or any applicable state or federal water quality criteria, or a violation of any applicable state or federal policies or regulations is prohibited.

4. The collection, treatment, storage, discharge or disposal of wastes at an existing milk cow dairy shall not result in the creation of a condition of pollution or nuisance[2].

[1] Discharges of pollutants from the production area to waters of the United States may not lawfully occur except in compliance with a National Pollutant Discharge Elimination System (NPDES) permit. NPDES permit coverage is not provided by this Order, but must be obtained separately.

[2] Except in circumstances where a Discharger is making improvements to waste management practices that have

5. The disposal of waste not generated by on-site animal production activities is prohibited except where a ROWD for the disposal has been submitted to the Executive Officer and the Central Valley Water Board has issued or waived WDRs for that discharge.

6. The disposal of dead animals in any liquid manure or wastewater retention ponds is prohibited. The disposal of dead animals at a dairy facility is prohibited except when federal, state or local officials declare a State of Emergency, and where all other options for disposal have been pursued and failed, and the onsite disposal complies with all state and local policies for disposal of dead animals[3].

7. All animals shall be prohibited from entering any surface water within the animal confinement area. (Title 27, § 22561.)

8. The application of waste to lands not owned, leased, or controlled by the Discharger without written permission from the landowner or in a manner not approved by the Executive Officer, is prohibited.

9. The land application of manure or process wastewater to cropland for other than nutrient recycling is prohibited.

10. The discharge of wastewater to surface waters from cropland is prohibited. Irrigation supply water that comes into contact or is blended with waste or wastewater shall be considered wastewater under this prohibition.

11. The application of process wastewater to a land application area before, during, or after a storm event that would result in runoff of the applied water is prohibited.

12. The discharge of storm water to surface water from a land application area where manure or process wastewater has been applied is prohibited unless the land application area has been managed consistent with a certified Nutrient Management Plan.

13. The use of manure to construct containment structures or to repair, replace, improve, or raise existing containment structures is prohibited.

14. The direct discharge of wastewater into groundwater via backflow through water supply or irrigation supply wells is prohibited.

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been found not to be protective of the underlying groundwater under a time schedule that is as short as practicable.

[3] In an emergency, guidance is provided by the Conditional Waiver of Waste Discharge Requirements for Disaster-Related Wastes during a State of Emergency within the Central Valley Order 2013-0026.

15. Under this General Order, the expansion of the existing milk cow dairy beyond the level as defined under the term "Expansion" is prohibited[4].

## B. GENERAL SPECIFICATIONS

1. The existing milk cow dairy shall have facilities that are designed, constructed, operated, and maintained to retain all facility process wastewater generated during the storage period (maximum period of time anticipated between land application of process wastewater), together with all precipitation on and drainage through manured areas, up to and including during a 25-year, 24-hour storm (see item II of Attachment B, which is attached to and made part of this Order).

2. In the Sacramento and San Joaquin River Basins, wastewater retention ponds and manured areas at existing milk cow dairies in operation on or before 27 November 1984 shall be protected from inundation or washout by overflow from any stream channel during 20-year peak stream flows. Existing milk cow dairies that were in operation on or before 27 November 1984 and that are protected against 100-year peak stream flows must continue to provide such protection. Existing milk cow dairies that were built or expanded after 27 November 1984 shall be protected against 100-year peak stream flows. (Title 27, §22562(c).)

3. In the Tulare Lake Basin, existing milk cow dairies in operation on or before 25 July 1975 shall be protected from inundation or washout from overflow from any stream channel during 20-year peak stream flows and existing milk cow dairies constructed after 25 July 1975 shall be protected from 100-year peak stream flows. Existing milk cow dairies that were expanded after 8 December 1984 shall be protected from 100-year peak stream flows.

4. Dischargers who are subject to this Order shall implement water quality management practices, as necessary, to protect water quality and to achieve compliance with applicable water quality objectives on a schedule that is as short as practicable as described in the Time Schedule for Compliance (section M of this Order). The proposed time schedule must be supported with appropriate technical or economic justification as to why the proposed schedule is as short as practicable.

5. If groundwater monitoring demonstrates that discharge(s) from a dairy have caused an exceedance of the groundwater limitations set forth in this Order,

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[4] Dischargers must submit a ROWD, document compliance with CEQA, and obtain coverage under individual waste discharge requirements before any material facility expansion. "Expansion" is defined in Attachment E.

the Executive Officer may issue an order to the owner/operator of the monitored dairy to identify and implement management practices that are protective of groundwater quality on a schedule that is as short as practicable.

6. All precipitation and surface drainage from outside of the existing milk cow dairy (i.e., "run on") shall be diverted away from any manured areas unless such drainage is fully contained. (Title 27, § 22562(b).)

7. Manure and process wastewater shall not be applied closer than 100 feet to any down gradient surface waters, open tile line intake structures, sinkholes, agricultural or domestic well heads, or other conduits to surface waters, unless a 35-foot wide vegetated buffer or physical barrier is substituted for the 100-foot setback or alternative conservation practices or field-specific conditions will provide pollutant reductions equivalent or better than the reductions achieved by the 100-foot setback.

## C. POND SPECIFICATIONS

1. The level of waste in the process wastewater retention ponds (ponds) shall be kept a minimum of two (2) feet from the top of each aboveground embankment and a minimum of one (1) foot from the ground surface of each belowground pond. Less freeboard may be approved by the Executive Officer when a Civil Engineer registered in California, or other person as may be permitted under the provisions of the California Business and Professions Code to assume responsible charge of such work, demonstrates that the structural integrity of the pond will be maintained with the proposed freeboard.

2. Ponds shall be managed and maintained to prevent breeding of mosquitoes and other vectors. In particular,

   a. Small coves and irregularities shall not be allowed around the perimeter of the water surface;

   b. Weeds shall be minimized through control of water depth, harvesting, or other appropriate method;

   c. Dead algae, vegetation, and debris shall not accumulate on the water surface; and

   d. Management shall be in accordance with the requirements of the Mosquito Abatement District.

3. Ponds designated to contain the 25-year, 24-hour storm event runoff must have a depth marker that clearly indicates the minimum capacity necessary to

contain the runoff and direct precipitation from a 25-year, 24-hour storm event.

4. Existing Ponds[5]

a. Dischargers conducting groundwater monitoring pursuant to an Individual Monitoring Program shall maintain and operate existing ponds in such a manner so as to constitute best practical treatment or control (BPTC) or best efforts for existing ponds, which is further discussed in the Information Sheet at page 10 (Best Practicable Treatment or Control Measures for Existing Dairy Ponds). Such operations shall be maintained throughout the development of the Summary Report that is required by Monitoring and Reporting Program R5-2013-0122, Attachment A, Section II.12. The Summary Report is due within six years of initiating individual groundwater sampling activities or at an earlier date if required by the Executive Officer.

   If the monitoring data in the Summary Report indicate that Groundwater Limitation F.1 of this Order is violated, Dischargers are required to implement management practices/activities (BPTC for high quality waters or best efforts for waters that are not high quality) that will bring the facility into compliance with Groundwater Limitation F.1on a time schedule that is as short as practicable.

b. Dischargers enrolled under the Representative Monitoring Program (RMP) shall maintain and operate existing ponds in such a manner so as to constitute best practical treatment or control or best efforts as (defined/discussed) in the Information Sheet throughout the development of the Summary Representative Monitoring Report (SRMR), which is due to the Central Valley Water Board on 1 April 2019.

c. Dischargers enrolled under the RMP shall implement the recommended management practices that are applicable to Existing Ponds in accordance with the SRMR and its schedule as approved by the Central Valley Water Board Executive Officer.

   If the SRMR indicates that the Dischargers Existing Ponds may have discharges that violate Groundwater Limitation F.1, of this Order or that such discharges from Existing Ponds may cause degradation to high quality waters, Dischargers are required to implement the approved SRMR's identified management practices/activities for Existing Ponds

[5] Existing Ponds are defined to mean those ponds in operation as of 3 May 2007 when the Board issued the 2007 General Order and are not new ponds that are designed to meet the Tier 1 or Tier 2 requirements set forth in Provision C.5 of this Order.

that will bring the facility into compliance with Groundwater Limitation F.1. Such practices are considered to constitute best practical treatment or control or best efforts and are designed to achieve compliance with Groundwater Limitation F.1 on a time schedule that is as short as practicable.

5. New and Reconstructed Ponds

a. New ponds installed in order to comply with the requirements of this Order (i.e., to increase the storage capacity to meet the existing facility conditions, not related to an expansion) or existing ponds reconstructed for the same purpose shall be designed and constructed to comply with the groundwater limitations in this Order.

b. New and reconstructed pond designs must be reviewed and approved by the Executive Officer prior to construction. This Order provides a tiered approach to pond design requirements to provide an option that will significantly reduce the time required for approval by the Executive Officer as defined below:

i. <u>Tier 1</u>: A pond designed to consist of a double liner constructed with 60- mil high density polyethylene or material of equivalent durability with a leachate collection and removal system (constructed in accordance with Section 20340 of title 27) between the two liners will be considered to be consistent with Resolution 68-16. Review for ponds designed to this standard will be conducted in less than 30 days of receipt of a complete design plan package submitted to the Board.

ii. <u>Tier 2</u>: A pond designed in accordance with California Natural Resource Conservation Service (NRCS) Conservation Practice Standard 313 (as described in the Information Sheet) or equivalent and which the Discharger must demonstrate through submittal of technical reports that the alternative design is protective of groundwater quality as required in Pond Specification 5. C. below.

c. Prior to the enlargement of an existing pond (settling, storage, or retention) or the construction of any such new pond not associated with an expansion, the Discharger shall submit to the Executive Officer:

i. For Tier 1 and 2 pond designs, a design report prepared by, or under the direct supervision of, and certified by, a Civil Engineer who is registered pursuant to California law or other person as may be permitted under the provisions of the California

Business and Professions Code to assume responsible charge of such work. The design report shall include the following, as specified in Section II.B of Attachment B to this Order:

1. Design calculations demonstrating that adequate containment will be achieved,

2. Details on the liner and leachate collection and removal system (if appropriate) materials,

3. A schedule for construction and certification of completion to comply with the Schedule of Tasks J.1 of this Order,

4. A construction quality assurance plan describing testing and observations needed to document construction of the pond in accordance with the design and Sections 20323 and 20324 of title 27, and

5. An operations and maintenance plan for the pond.

ii. For Tier 2 pond design, the design report shall also include a technical report and groundwater model that demonstrates the proposed pond is in compliance with the groundwater limitations in this Order, including calculations that demonstrate the amount and quality of seepage from the proposed pond and its effect on groundwater quality, and include proposed groundwater monitoring to evaluate the impact of pond seepage on groundwater quality.

Enlargement of any existing pond or construction of any new pond shall not begin until the Executive Officer notifies the Discharger in writing that the design report is acceptable.

d. Prior to the placement of waste in any enlarged existing pond or any such newly constructed pond, the Discharger shall submit a post construction report prepared by, or under the direct supervision of, and certified by, a Civil Engineer who is registered pursuant to California law or other person as may be permitted under the provisions of the California Business and Professions Code to assume responsible charge of such work.

Waste shall not be placed into the pond until the Executive Officer notifies the Discharger in writing that the post construction report is acceptable. The post construction report shall include: (1) verification that the pond meets the requirements of this Order as specified in Pond Specification C.5.b including documentation of the results of the construction quality assurance testing and observations; (2) certification that the pond was constructed as designed; and (3) as-built diagrams.

## D. PRODUCTION AREA SPECIFICATIONS

The Production area includes, but is not limited to, barns, milk houses, corrals, milk parlors, manure and feed storage areas, process water conveyances and any other area of the dairy facility that is not the land application area or the ponds.

1. All dirt or unpaved corrals shall be graded to promote drainage. Cow washing areas shall be paved (concrete or equivalent) and sloped to a drain. Water troughs, permanent feed racks, and mangers shall have paved access, and water troughs shall have a drain to carry water away from the corrals. (Cal Code Regs., title 3, § 646.1.)

2. All milk rooms and milk barns shall be floored with concrete or other low permeability suitable material and be properly drained. (Cal Code Regs., title 3, §§ 648(c) & 649(a).) All drainage that comes in contact with waste (as defined in Finding 13) shall be directed to the wastewater retention ponds.

3. All drainage that has contacted feed is a waste in accordance with Finding 13 and shall be directed to the wastewater retention ponds.

4. All roofs, buildings, and non-manured areas located in the production area of the existing milk cow dairy shall be constructed or otherwise designed so that clean rainwater is diverted away from manured areas and waste containment facilities, unless such drainage is fully contained in the wastewater retention ponds. (Title 27, § 22562(b).)

5. Roof drainage from barns, milk houses, or shelters shall not drain into the corrals unless the corrals are properly graded and drained. (Cal Code Regs., title 3, § 661.)

6. The animal confinement area (including corrals), and manure and feed storage areas shall be designed and maintained to convey all water that has contacted animal wastes or feed to the wastewater retention ponds and to minimize standing water as of 72 hours after the last rainfall and the infiltration of water into the underlying soils.

7. For Dischargers conducting individual groundwater monitoring, if the monitoring data in the Summary Report indicate that the Dischargers Production Area may have discharges that violate Groundwater Limitation F.1 of this Order or that such discharges may cause degradation to high quality waters, the Dischargers are required to implement management practices/activities (BPTC for high quality waters or best efforts for waters that

are not high quality) that will bring the facility into compliance with Groundwater Limitation F.1on a time schedule that is as short as practicable.

8. Dischargers enrolled under the RMP shall implement the recommended management practices that are applicable to Production Areas in accordance with the SRMR and its approved time schedule.

   If the SRMR indicates that the Dischargers Production Area may have discharges that violate Groundwater Limitation F.1 of this Order or that such discharges may cause degradation to high quality waters, the Dischargers are required to implement the approved SRMR's identified management practices/activities for Production Areas that will bring the facility into compliance with Groundwater Limitation F.1. Such practices are considered to constitute best practical treatment or control or best efforts and are designed to achieve compliance with Groundwater Limitation F.1 on a time schedule that is as short as practicable.

## E. LAND APPLICATION SPECIFICATIONS

1. Wastes and land application areas shall be managed to prevent contamination of crops grown for human consumption. The term "crops grown for human consumption" refers only to crops that will not undergo subsequent processing which adequately removes potential microbial danger to consumers.

2. Land application of all waste from the facility to areas under the Discharger's control shall be conducted in accordance with a certified Nutrient Management Plan (required in Required Reports and Notices J.1.c below) consistent with the technical standards for nutrient management as specified in Attachment C. The Nutrient Management Plan shall be modified within 90 days if monitoring shows that discharge from the land application fails to comply with the groundwater limitations of this Order or surface water quality objectives or criteria. The modifications must be designed to bring Dischargers into compliance with this Order.

3. No later than 31 December 2007, the Discharger shall have a written agreement with each third party that receives process wastewater from the Discharger for its own use. Each written agreement shall be included in the Discharger's Existing Conditions Report, Nutrient Management Plan, and Annual Report. The written agreement(s) shall be effective until the third party is covered under waste discharge requirements or a waiver of waste discharge requirements that are adopted by the Central Valley Water Board. The written agreement shall:

   a. Clearly identify:

i. The Discharger and dairy facility from which the process wastewater originates,

ii. The third party that will control the application of the process wastewater to cropland,

iii. The Assessor's Parcel Number(s) and the acreage(s) of the cropland where the process wastewater will be applied, and

iv. The types of crops to be fertilized with the process wastewater.

b. Include an agreement by the third party to:

i. Use the process wastewater at agronomic rates appropriate for the crops to be grown, and

ii. Prevent the runoff to surface waters of wastewater, storm water or irrigation supply water that has come into contact with manure or is blended with wastewater.

c. Include a certification statement, as specified in General Reporting Requirements C.7 of the Standard Provision and Reporting Requirements (which is attached to and made part of this Order), which is signed by both the Discharger and third party.

4. Land application of wastes for nutrient recycling from existing milk cow dairies shall not cause the underlying groundwater to contain any waste constituent, degradation product, or any constituent of soil mobilized by the interactions between applied wastes and soil or soil biota, to exceed the groundwater limitations set forth in this Order.

5. The application of animal waste and other materials containing nutrients to any cropland under control of the Discharger shall meet the following conditions:

a. The application is in accordance with a certified Nutrient Management Plan developed and implemented in accordance with Required Reports and Notices J.1.c and Attachment C of this Order; and

b. Records are prepared and maintained as specified in the Record-Keeping Requirements of Monitoring and Reporting Program R5-2013-0122.

6. The application of waste to cropland shall be at rates that preclude development of vectors or other nuisance conditions and meet the conditions of the certified Nutrient Management Plan.

7. Land application areas that receive dry manure shall be managed through implementation of erosion control measures to minimize erosion and must be consistent with a certified Nutrient Management Plan.

8. All process wastewater applied to land application areas must infiltrate completely within 72 hours after application.

9. Process wastewater shall not be applied to land application areas during periods when the soil is at or above field moisture capacity unless consistent with a certified Nutrient Management Plan (see Attachment C).

10. If the monitoring data in the Summary Report indicate that the Dischargers Land Application Area may have discharges that violate Groundwater Limitation F.1 of this Order, or that such discharges may cause degradation to high quality waters, the Dischargers are required to implement management practices/activities (BPTC for high quality waters or best efforts for waters that are not high quality) that will bring the facility into compliance with Groundwater Limitation F.1on a time schedule that is as short as practicable.

11. Dischargers enrolled under the RMP shall implement the recommended management practices that are applicable to Land Application Areas in accordance with the SRMR and its approved time schedule.

    If the SRMR indicates that the Dischargers Land Application Areas may have discharges that violate Groundwater Limitation F.1 of this Order or that such discharges from Land Application Areas may cause degradation to high quality waters, Dischargers are required to implement the approved SRMR's identified management practices/activities for Land Application Areas that will bring the facility into compliance with Groundwater Limitation F.1. Such practices are considered to constitute best practical treatment or control or best efforts and are designed to achieve compliance with Groundwater Limitation F.1 on a time schedule that is as short as practicable.

## F. GROUNDWATER LIMITATIONS[6]

1. Discharge of waste at existing milk cow dairies shall not cause the underlying groundwater to exceed water quality objectives, unreasonably affect beneficial uses, or cause a condition of pollution or nuisance.[7] The appropriate water quality objectives are summarized in the Information Sheet, which is attached to and part of this Order, and can be found in the Central Valley Water Board's Water Quality Control Plan for the Sacramento and San Joaquin River Basins (4th Ed.) and the Water Quality Control Plan for the Tulare Lake Basin (2nd Ed.).

## G. PROVISIONS

1. The Discharger shall comply with the *Standard Provisions and Reporting Requirements for Waste Discharge Requirements General Order R5-2013-0122 for Existing Milk Cow Dairies* (Standard Provisions) dated 3 May 2007, which is attached to and made part of this Order.

2. The Discharger shall comply with all applicable provisions of the California Water Code, Title 27, and the applicable Water Quality Control Plans.

3. The Discharger shall comply with the attached Monitoring and Reporting Program R5-2013-0122 which is part of this Order, and future revisions thereto or with an individual monitoring and reporting program, as specified by the Central Valley Water Board or the Executive Officer.

4. The Discharger shall submit a complete ROWD in accordance with the Water Code section 13260 at least 140 days prior to any material change or proposed change in the character, location, or volume of the discharge, including any expansion of the facility or development of any treatment technology, or construction of an anaerobic digester.

5. If the Preliminary Dairy Facility Assessment[8] indicates that facility improvements are necessary (see Required Reports and Notices J.1.d), the Discharger shall make continual facility improvements while completing implementation of the Waste Management Plan and/or Nutrient Management Plan.

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[6] These limitations are effective immediately except where Dischargers are in compliance with Provision M of this Order and the requirements of Sections II or III of the Monitoring and Reporting Program R5-2013-0122, Attachment A, and such Dischargers are implementing management practices/activities on a time schedule that is as short as practicable. For Dischargers participating in the RMP, the implementation of management practices/activities must be implemented on a time schedule that is as short as practicable and that is consistent with any time schedule or schedule that is included in the SRMR that is approved by the Executive Officer.

[7] Except in circumstances where a Discharger is making improvements to waste management practices that have been found not to be protective of the underlying groundwater under a time schedule that is as short as practicable.

[8] The Preliminary Dairy Facility Assessment is required as part of the Existing Conditions Report (Attachment A).

6. This Order does not apply to facilities where wastes such as, but not limited to, whey, cannery wastes, septage, municipal or industrial sludge, municipal or industrial biosolids, ash or similar types of waste are generated onsite or are proposed to be brought onto the dairy or associated croplands for the purpose of nutrient recycling or disposal. The Discharger shall submit a complete ROWD and receive WDRs or a waste-specific waiver of WDRs from the Central Valley Water Board prior to receiving such waste.

7. If site conditions threaten to violate Prohibition A.2 or Prohibition A.4, the Discharger shall take immediate action to preclude the violation, documenting the condition and all corrective actions. Records of such actions shall be kept and maintained as required in Monitoring and Reporting Program R5-2013-0122. Alterations of the Waste Management Plan (see Required Reports and Notices J.1.a) for the production area to avoid a recurrence shall be submitted as a modification to the Waste Management Plan.

8. If a discharge of waste creates, or threatens to create, significant objectionable odors or nuisance odor and vector conditions, enforcement and/or revocation of coverage under this Order may result.

9. The Discharger shall comply with all requirements of this Order and all terms, conditions, and limitations specified by the Executive Officer.

10. Any instance of noncompliance with this Order constitutes a violation of the Water Code and its regulations. Such noncompliance is grounds for enforcement action, and/or termination of the authorization to discharge.

11. The Discharger must maintain coverage under this Order or a subsequent revision to this Order until all manure, process wastewater, and animal waste impacted soil, including soil within the pond(s), is disposed of or utilized in a manner which does not pose a threat to surface water or groundwater quality or create a condition of nuisance. At least 90 days before desiring to terminate coverage under this Order, the Discharger shall submit to the Executive Officer a closure plan that ensures protection of surface water and groundwater. No more than 30 days after completion of site closure, the Discharger shall submit a closure report which documents that all closure activities were completed as proposed and approved in the closure plan. Coverage under this Order will not be terminated until cleanup is complete.

12. This Order shall become effective upon adoption by the Central Valley Water Board.

13. The Discharger must comply with all conditions of this Order, including timely submittal of technical and monitoring reports as directed by the Executive

Officer. Accordingly, the Discharger shall submit to the Central Valley Water Board on or before each report due date the specified document or, if an action is specified, a written report detailing evidence of compliance with the task. If noncompliance is being reported, the reasons for such noncompliance shall be stated, plus an estimate of the date when the Discharger will be in compliance. The Discharger shall notify the Central Valley Water Board by letter when it returns to compliance with the time schedule. Violations may result in enforcement action, including Central Valley Water Board or court orders requiring corrective action or imposing civil monetary liability, or in terminating the applicability of this Order to a specific facility or Discharger.

14. Technical reports (Monitoring Well Installation and Sampling Plan, Monitoring Well Installation Completion Report, Groundwater Monitoring Report, Waste Management Plan Certification, and portions of the Waste Management Plan) required by this Order must be certified by an appropriately licensed professional as required in this Order and its Attachments (see Schedule of Tasks L.1 below). If the Executive Officer provides comments on any technical report, the Discharger will be required to address those comments.

15. The Discharger shall maintain a copy of this Order at the site so as to be available at all times to site-operating personnel. The Discharger, landowner and his/her designee shall be familiar with the content of this Order.

## H. EFFECTIVE DATE OF COVERAGE UNDER THIS ORDER

1. Coverage under this Order is effective upon notification by the Executive Officer that this Order applies to the Discharger.

## I. PERMIT REOPENING, REVISION, REVOCATION, AND RE-ISSUANCE

1. If more stringent applicable water quality standards are adopted in the Basin Plans, the Central Valley Water Board may revise and modify this Order in accordance with such standards.

2. This Order may be reopened to address any changes in state plans, policies, or regulations that would affect the water quality requirements for the discharges and as authorized by state law. This includes regulatory changes that may be brought about by the CV-SALTS planning efforts.

3. The Central Valley Water Board or the Executive Officer may revoke coverage under this Order at any time and require the Discharger to submit a ROWD and obtain individual waste discharge requirements.

## J. REQUIRED REPORTS AND NOTICES

1. Dischargers must submit the following in accordance with the Schedule of Tasks L.1:

   a. **Existing Conditions Report**: The Discharger shall submit an Existing Conditions Report for the dairy facility, prepared in accordance with Attachment A. The Existing Conditions Report shall provide additional information on existing conditions at the dairy that was not provided in the ROWD submitted in response to the 2005 ROWD Request Letter. The Existing Conditions Report requires the Discharger to complete a Preliminary Dairy Facility Assessment. The Preliminary Dairy Facility Assessment is available on the Central Valley Water Board's web site at http://www.waterboards.ca.gov/centralvalley/available_documents/index.html#confined and must be completed electronically. The Discharger shall include a copy of the results of the Preliminary Dairy Facility Assessment in the Existing Conditions Report.

   b. **Waste Management Plan:** The Discharger shall submit a Waste Management Plan for the production area of the dairy facility, prepared in accordance with Attachment B. The Waste Management Plan shall provide an evaluation of the existing milk cow dairy's design, construction, operation, and maintenance for flood protection and waste containment and whether the facility complies with Prohibition A.14, General Specifications B.1-B.3, Pond Specifications C.1 through C.3, and Production Area Specifications D.1, D.4, and D.5. If the design, construction, operation, and/or maintenance of the dairy facility do not comply with these specifications and prohibition, the Waste Management Plan must propose modifications and a schedule for modifications that will bring the dairy facility into compliance. Certification that the modifications have been implemented shall be submitted in accordance with the Schedule of Tasks L.1.

   c. **Nutrient Management Plan:** A Discharger who applies manure, bedding, or process wastewater to land for nutrient recycling must develop and implement management practices that control nutrient losses and describe these in a Nutrient Management Plan. The Nutrient Management Plan must be certified as specified in Attachment C, maintained at the dairy, submitted to the Executive Officer upon request and must ultimately provide for protection of both surface water and groundwater. Certification that the Nutrient Management Plan has been completed shall be in accordance with the Schedule of Tasks L.1, shall incorporate the elements specified in Attachment C based on a field-specific assessment of the potential for pollutant transport to surface water and groundwater, and shall be submitted to the Executive Officer. The Nutrient Management

Plan shall be updated as specified in the Technical Standards for Nutrient Management in Attachment C or if the Executive Officer requests that additional information be included. Groundwater monitoring will be used to determine if implementation of the Nutrient Management Plan is protective of groundwater quality.

d. **Proposed Interim Facility Modifications**: A Discharger whose Preliminary Dairy Facility Assessment (see Required Reports and Notices J.1.a above) shows that the Whole Farm Nitrogen Balance[9] is greater than 1.65 and/or that the existing retention pond(s) total storage capacity is less than the total storage capacity required shall submit Proposed Interim Facility Modifications as Necessary to Balance Nitrogen and/or Proposed Interim Facility Modifications as Necessary to Improve Storage Capacity, respectively. Such Dischargers shall also submit Documentation of Interim Facility Modifications Completion as Necessary for Storage Capacity and to Balance N.

e. **Salinity Report**: The Discharger shall submit a report that identifies sources of salt in waste generated at the dairy, evaluates measures that can be taken to minimize salt in the dairy waste, and certifies that they will implement the approved measures identified to minimize salt in the dairy waste. If a third party (for example, the California Dairy Quality Assurance Program) produces an industry-wide report that is acceptable to the Executive Officer, the Discharger may refer to that report rather than generating his own report, but must certify that the appropriate measures will be implemented to reduce salt in his dairy waste.

2. Reporting Provisions:

a. All ROWDs, applications, annual reports, or information submitted to the Central Valley Water Board shall be signed and certified in accordance with C. 7 and C.8 of the Standard Provisions.

b. The Discharger shall submit all reports as specified in the attached Monitoring and Reporting Program R5-2013-0122.

c. Any Discharger authorized to discharge waste under this Order shall furnish, within a reasonable time, any information the Central Valley Water Board may request, to determine whether cause exists for modifying, revoking, and reissuing, or terminating their authorization for coverage under this Order. The Discharger shall, upon request, also furnish to the

[9] The Whole Farm Nitrogen Balance is to be determined as the ratio of (total nitrogen in storage – total nitrogen exported + nitrogen imported + irrigation nitrogen + atmospheric nitrogen)/(total nitrogen removed by crops) as reported in the Preliminary Dairy Facility Assessment in the Existing Conditions Report (Attachment A).

Central Valley Water Board copies of records required to be kept by this Order.

d. All reports prepared and submitted to the Executive Officer in accordance with the terms of this Order shall be available for public inspection at the offices of the Central Valley Water Board.

## K. RECORD-KEEPING REQUIREMENTS

1. The Discharger shall create, maintain for five years, and make available to the Central Valley Water Board upon request by the Executive Officer any reports or records required by this Order including those required under Monitoring and Reporting Program R5-2013-0122.

## L. SCHEDULE OF TASKS

1. Dischargers are required to develop and implement a Waste Management Plan and Nutrient Management Plan, submit an Existing Conditions Report, a Salinity Report, a Proposed Interim Facility Modifications, a Preliminary Infrastructure Needs Checklist, and Annual Reports according to the schedule shown in Table 1. All elements of the Waste Management Plan shall be submitted to the Executive Officer by the deadlines specified in Table 1 and signed and certified by the Discharger as required in Required Reports and Notices J.2.a above and the additional professional specified in Table 1.

   Dischargers must submit a statement of completion to the Executive Officer for each of the elements of the Nutrient Management Plan by the deadlines specified in Table 1. All statements must be signed and certified by the Discharger as required in Required Reports and Notices J.2.a above and the additional professional specified in Table 1.

2. If changes are made to the required submittals through Central Valley Water Board or Executive Officer review, those changes shall be implemented.

3. Any Discharger may be requested to complete the Nutrient Management Plan and/or Waste Management Plan prior to the due date identified in Table 1 if the Executive Officer has determined the facility presents a significant risk to groundwater or surface water.

## M. Time Schedule for Compliance

Dischargers conducting an Individual Monitoring Program shall submit a summary report within six (6) years of initiating sampling activities. The summary report must include identification of management practices that need to be implemented to achieve compliance with applicable water quality objectives, including the groundwater limitations of the Order. Required Annual Reports presented after the submittal of the summary report, must include a discussion on implementation of changes in management practices and/or activities that are being taken and an evaluation of progress in complying with the Groundwater Limitations F.1. of the Order. Implementation of the identified management practices must be as soon as practicable, supported with appropriate technical or economic justification and in no case may time schedules extend beyond 10 years from the date that the summary report is approved by the Executive Officer.

For Dischargers participating in a representative monitoring program that is required to submit a Summary Representative Monitoring Report (SRMR) (See Monitoring and Reporting Program R5-2013-0122, Provision III.10), the following time schedule shall apply to allow Dischargers sufficient time to implement identified management practices to achieve compliance with Groundwater Limitations described in Section F.1. of this Order. The Central Valley Water Board may modify these schedules based on evidence that meeting the compliance date is technically or economically infeasible, or when evidence shows that compliance by an earlier date is feasible. Any applicable time schedules for compliance established in the Basin Plans supersede the schedules given below (e.g., time schedules for compliance with salinity standards that may be established in future Basin Plan amendments through the CV-SALTS process).

a. The SRMR must be submitted no later than six (6) years following submittal of the first Annual Representative Monitoring Report (ARMR) (e.g., the CVDRMP submitted its first ARMR on April 1, 2013, thus the CVDRMP's SRMR must be submitted by April 1, 2019).

b. The SRMR must identify management practices that are protective of groundwater quality for the range of conditions found at facilities participating in the representative monitoring program, and must identify in the SRMR time schedules that are as short as practicable for implementation of the identified management practices. Within 18 months of submittal of the SRMR and no later than July 1, 2020, all member dairies of the RMP for which the SRMR was submitted must submit a letter of intent to comply with applicable management practices identified in the SRMR. Time schedules in the SRMR for implementation of the identified management practices must be as soon as practicable, supported with appropriate technical or economic justification and in no case may time schedules beyond 10 years from the date that the SRMR is approved by the Executive Officer.

If, in the opinion of the Executive Officer, the Discharger fails to comply with the provisions of this Order, the Executive Officer may refer this matter to the Attorney General for judicial enforcement, may issue a complaint for administrative civil liability, or may take other enforcement actions. Failure to comply with this Order may result in the assessment of Administrative Civil Liability of up to $10,000 per violation, per day, depending on the violation, pursuant to the Water Code, including sections 13268, 13350 and 13385. The Central Valley Water Board reserves its right to take any enforcement actions authorized by law.

Any person aggrieved by this action of the Central Valley Water Board may petition the State Water Board to review the action in accordance with Water Code section 13320 and California Code of Regulations, title 23, sections 2050 and following. The State Water Board must receive the petition by 5:00 p.m., 30 days after the date of this Order, except that if the thirtieth day following the date of this Order falls on a Saturday, Sunday, or state holiday, the petition must be received by the State Water Board by 5:00 p.m. on the next business day. Copies of the law and regulations applicable to filing petitions may be found on the Internet at:

http://www.waterboards.ca.gov/public_notices/petitions/water_quality

or will be provided upon request.

I, PAMELA C. CREEDON, Executive Officer, do hereby certify that the foregoing is a full, true, and correct copy of an Order adopted by the California Regional Water Quality Control Board, Central Valley Region, on 3 October 2013.

Original signed by

PAMELA C. CREEDON, Executive Officer

Table 1. Schedule for Submittal of Existing Conditions Report, Waste Management Plan, Nutrient M
Salinity Report, Preliminary Infrastructure Needs Checklist, and Annual Reports

| Due Date | Submittal Due | Contents of Submittal |
|---|---|---|
| **31 December 2007** | **Existing Conditions Report** (Attachment A) | Preliminary Dairy Facility Assessment, maps, etc. |
| **1 July 2008** | **Annual Report** | Per Monitoring and Reporting Program No.R5-2013-0122, including Annual Dairy Facility Assessment with proposed interim facility modifications considered to be implemented. |
| **1 July 2008** | Statement of Completion of the Following Items in Attachment C (Nutrient Management Plan):* | |
| | Items I.A.1, I.B, I.C, I.D | Land Application Area Information. |
| | Item II | Sampling and Analysis Plan. |
| | Item IV | Setbacks, Buffers, and Other Alternatives to Protect Surface Water. |
| | Item VI | Record-Keeping Requirements. |
| **1 July 2008** | The following items in Attachment B (Waste Management Plan): | |
| | Items I.A, I.B, I.C, I.D, I.E, I.F.1a, I.F.2a, I.F.3, I.F.4, I.F.5 | Facility Description. |
| | Item V | Operation and Maintenance Plan. |

Table 1. Schedule for Submittal of Existing Conditions Report, Waste Management Plan, Nutrient M
Salinity Report, Preliminary Infrastructure Needs Checklist, and Annual Reports

| Due Date | Submittal Due | Contents of Submittal |
|---|---|---|
| **1 July 2008** | Identification of Backflow Problems | Identify backflow problems with proposed remediation and schedule. |
| | Proposed Interim Facility Modifications as Necessary to Improve Storage Capacity | Proposed interim facility modifications (e.g., recycling flush water, diverting roof runoff, resizing nozzles, removing pond solids, etc.) that can be completed within the next 12 months to decrease storage capacity needs or increase existing storage capacity, with schedule to implement proposed modifications within 12 months. |
| | Proposed Interim Facility Modifications as Necessary to Balance Nitrogen | Proposed interim facility modifications (e.g., acquiring more cropland, exporting more wastes, reducing herd size, etc.) that can be completed within 12 months to balance the nitrogen generated and imported with the nitrogen removed by crops and exported, with schedule to implement proposed modifications within 12 months. |
| **31 December 2008** | Statement of Completion of Item V of Attachment C (Nutrient Management Plan)* | Field Risk Assessment – Evaluate the effectiveness of management practices to control waste discharges from land application areas. |
| | Preliminary Infrastructure Needs Checklist | Identification of infrastructure changes needed to properly manage wastes (e.g., piping, pumps, meters, etc.). |

Table 1. Schedule for Submittal of Existing Conditions Report, Waste Management Plan, Nutrient M
Salinity Report, Preliminary Infrastructure Needs Checklist, and Annual Reports

| Due Date | Submittal Due | Contents of Submittal |
|---|---|---|
| **1 July 2009** | **Annual Report** | Per Monitoring and Reporting Program No. R5-2013-0122 including Annual Dairy Facility Assessment with modifications implemented to date. |
| **1 July 2009** | Documentation of Interim Facility Modifications Completion for Storage Capacity and to Balance Nitrogen | Document all interim modifications completed and identify those that were proposed but not completed. |
| **1 July 2009** | **Nutrient Management Plan**<br><br>Retrofitting Plan with Schedule | Retrofitting needed to improve nitrogen balance (may include piping, meters, pumps, etc.). |
| | Statement of Completion of the Following Items in Attachment C (Nutrient Management Plan)*: | |
| | Item I.A.2 | Land Application Area Information |
| | Item III | Nutrient Budget |
| **1 July 2009** | **Waste Management Plan** (with Retrofitting Plan/Schedule) Including the Following Items in Attachment B (Waste Management Plan): | Retrofitting needed to improve storage capacity, flood protection, or design of production area- may include design/construction of new pond, berms for flood protection, grading for drainage, etc. |
| | Items I.F.1.b, I.F.2.b | Facility Description |

Table 1. Schedule for Submittal of Existing Conditions Report, Waste Management Plan, Nutrient M
Salinity Report, Preliminary Infrastructure Needs Checklist, and Annual Reports

| Due Date | Submittal Due | Contents of Submittal |
|---|---|---|
| **1 July 2009** | Item II<br>Item III<br>Item IV<br>Item VI | Storage Capacity<br>Flood Protection<br>Production Area Design/Construction<br>Documentation there are no cross connections. |
| **1 July 2009** | **Salinity Report** | Identification of salt sources at dairy, evaluation of measures to minimize salt in the dairy waste, and commitment to implement measures identified to minimize salt in the dairy waste. |
| **1 July 2010** | **Annual Report** | Per Monitoring and Reporting Program No. R5-2013-0122 including Annual Dairy Facility Assessment with facility modifications implemented to date. |
| **1 July 2010** | Status on facility retrofitting completed or in progress | Status on facility retrofitting completion as proposed (1 July 2009) for the Nutrient Management Plan and Waste Management Plan. |
| **1 July 2011** | **Annual Report** | Per Monitoring and Reporting Program No. R5-2013-0122 including Annual Dairy Facility Assessment with facility modifications implemented to date. |

Table 1. Schedule for Submittal of Existing Conditions Report, Waste Management Plan, Nutrient M
Salinity Report, Preliminary Infrastructure Needs Checklist, and Annual Reports

| Due Date | Submittal Due | Contents of Submittal |
|---|---|---|
| 1 July 2011 | Certification of Facility Retrofitting Completion<br><br>For Nutrient Management Plan | Certify completion of retrofitting proposed (1 July 2009) to improve nitrogen balance. |
| | The Following Items in Attachment B (Waste Management Plan):<br><br>Item II.C | Certification of completion of modifications made to meet storage capacity requirements. |
| 1 July 2011 | Item III.D<br><br>Item IV.C | Certification of completion of modifications made to meet flood protection requirements.<br><br>Certification of modifications made to meet construction criteria for corrals, pens, animal housing area, and manure and feed storage areas. |
| 1 July 2012 | **Annual Report** | Per Monitoring and Reporting Program No. R5-2013-0122 including Annual Dairy Facility Assessment with facility modifications implemented to date. |
| 1 July 2012 | Certification of Nutrient Management Plan implementation | Certification that the Nutrient Management Plan has been completely implemented. |

* The Discharger must certify in a statement that these items have been completed and certified by the appropriate professional as s be maintained at the dairy, made available to Central Valley Water Board staff during their inspections of the dairy, and submitted to t requested by the Executive Officer.

** A trained professional could be a person certified by the American Backflow Prevention Association, an inspector for a state or loca has experience and/or training in backflow prevention, or a consultant with such experience and/or training.

*** A California Registered Professional is not required to demonstrate the facility has adequate flood protection if the Discharger pro map that shows the facility is outside of the relevant flood zone (see item III of Attachment B).

# CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
# CENTRAL VALLEY REGION

## MONITORING AND REPORTING PROGRAM ORDER NO. R5-2013-0122

## GENERAL ORDER
## FOR
## EXISTING MILK COW DAIRIES

This Monitoring and Reporting Program (MRP) is issued pursuant to California Water Code (CWC) Section 13267. The Discharger shall not implement any changes to this MRP unless a revised MRP is issued by the California Regional Water Quality Control Board, Central Valley Region (Central Valley Water Board) or the Executive Officer.

This MRP includes Monitoring, Record-Keeping, and Reporting requirements. Monitoring requirements include monitoring of discharges of manure and/or process wastewater, storm water, and tailwater from the production area and land application areas, and groundwater.

Monitoring requirements also include monitoring of nutrients applied to, and removed from, land application areas in order for the Discharger to develop and implement a Nutrient Management Plan that will minimize leaching of nutrients and salts to groundwater and transport of these constituents to surface water.

In addition, monitoring requirements include periodic visual inspections of the dairy to ensure the dairy is being operated and maintained to ensure continued compliance with the Order.

This MRP requires the Discharger to keep and maintain records for five years of the monitoring activities for the production and land application areas and to prepare and submit reports containing the results of specified monitoring as indicated below.

All monitoring must begin immediately. Note that some types of events require that a report be submitted to the Central Valley Water Board within 24 hours (see section C).

Dischargers must follow sampling and analytical procedures approved by the Executive Officer. Approved procedures will be posted on the Central Valley Water Board's web site and copies may be obtained by contacting staff. A Discharger may submit alternative procedures for consideration, but must receive written approval from the Executive Officer before using them. If monitoring consistently shows no significant variation of a constituent concentration or parameter, the Discharger may request the MRP be revised to reduce monitoring frequency. The proposal must include adequate technical justification for reduction in monitoring frequency.

The Discharger shall conduct monitoring, record-keeping, and reporting as specified below.

## A. MONITORING REQUIREMENTS

### Visual Inspections

The Discharger shall conduct and record the inspections specified in Table 1 below and maintain records of the results on-site for a period of five years.

| Table 1. INSPECTIONS |
|---|
| ***Production Area***<br>Weekly during the wet season (1 October to 30 April) and monthly between 1 May and 30 September:<br>Inspect all waste storage areas and note any conditions or changes that could result in discharges to surface water and/or from property under control of the Discharger.<br><br>Note whether freeboard within each liquid storage structure is less than, equal to, or greater than the minimum required (two feet for above ground ponds and one foot for below ground ponds).<br><br>During and after each significant storm event[1]:<br>Visual inspections of storm water containment structures for discharge, freeboard, berm integrity, cracking, slumping, erosion, excess vegetation, animal burrows, and seepage.<br><br>Monthly on the 1st day of each month:<br>Photograph each pond showing the height of wastewater relative to the depth marker and the current freeboard on that date. All photos shall be dated and maintained as part of the discharger's record. |
| ***Land Application Areas***<br>Prior to each wastewater application:<br>Inspect the land application area and note the condition of land application berms including rodent holes, piping, and bank erosion. Verify that any field valves are correctly set to preclude off-property or accidental discharges of wastewater.<br><br>Daily when process wastewater is being applied:<br>Inspect the land application area and note the condition of land application berms including rodent holes, piping, and bank erosion; the presence (or lack) of field saturation, ponding, erosion, runoff (including tailwater discharges from the end of fields, pipes, or other conveyances), and nuisance conditions; and the conditions of any vegetated buffers or alternative conservation practices. |

[1] A significant storm event is defined as a storm event that results in continuous runoff of storm water for a minimum of one hour, or intermittent runoff for a minimum of three hours in a 12-hour period.

### Nutrient Monitoring

The Discharger shall monitor process wastewater, manure, and plant tissue produced at the facility, soil in each land application area, and irrigation water used on each land application area for the constituents and at the frequency as specified in Table 2 below. This information is for use in conducting nutrient management on the individual land application areas and at the facility on the whole. It must be used to develop and implement the Nutrient Management Plan. The Discharger is encouraged to collect and use additional data, as necessary, to refine nutrient management.

| Table 2. NUTRIENT MONITORING |
| --- |
| ***Process Wastewater***<br>Each application:<br>Record the volume (gallons or acre-inches) and date of process wastewater application to each land application area.<br><br>Quarterly during one application event:<br>Field measurement of electrical conductivity.<br><br>Laboratory analyses for nitrate-nitrogen (only when retention pond is aerated), un-ionized ammonia-nitrogen, total Kjeldahl nitrogen, total phosphorus, total potassium, and total dissolved solids.<br><br>Once every two years (biennially):<br>Laboratory analyses for general minerals (calcium, magnesium, sodium, bicarbonate, carbonate, sulfate, and chloride).<br><br>Annually<br>Laboratory analyses of liquid process wastewater, prior to blending with irrigation water, for pH, total dissolved solids, electrical conductivity, nitrate-nitrogen, ammonium-nitrogen, total Kjeldahl nitrogen, total phosphorus, and total potassium. |
| ***Manure***<br>Once every two years (biennially):<br>Laboratory analyses for general minerals (calcium, magnesium, sodium, sulfur, chloride) and fixed solids (ash).<br><br>Twice per year:<br>Laboratory analyses for total nitrogen, total phosphorus, total potassium, and percent moisture.<br><br>Each application to each land application area:<br>Record the percent moisture and total weight (tons) applied.<br><br>Each offsite export of manure:<br>Record the percent moisture and total weight (tons) exported.<br><br>Laboratory analyses for percent moisture.<br><br>Annually:<br>Record the total dry weight (tons) of manure applied annually to each land application area and the total dry weight (tons) of manure exported offsite. |
| ***Plant Tissue***<br>At harvest:<br>Record the percent moisture and total weight (tons) of harvested material removed from each land application area.<br><br>Laboratory analyses for total nitrogen, total phosphorus, total potassium (expressed on a dry weight basis), fixed solids (ash), and percent moisture.<br><br>The following test is only required if the Discharger wants to add fertilizer in excess of 1.4 times the nitrogen expected to be removed by the harvested portion of the crop (see Attachment C of Order No. R5-2013-0122 for details): Mid-season, if necessary to assess the need for additional nitrogen fertilizer during the growing season.<br><br>Laboratory analyses for total nitrogen, expressed on a dry weight basis. |

| Table 2. NUTRIENT MONITORING |
|---|
| ***Soil***<br>Once every 5 years from each land application area (may be distributed over a 5-year period by sampling 20% of the land application areas annually):<br>Laboratory analyses for soluble phosphorus<br><br>***The following soil tests are recommended but not required:***<br><br>Spring pre-plant for each crop:<br>Laboratory analyses for:<br>0 to 1 foot depth: Nitrate-nitrogen and organic matter.<br>1 to 2 feet depth: Nitrate-nitrogen.<br><br>Fall pre-plant for each crop:<br>Laboratory analyses at depths below ground surface of:<br>0 to 1 foot: Electrical conductivity, nitrate-nitrogen, soluble phosphorus, potassium and organic matter.<br>1 to 2 feet: Nitrate-nitrogen. |
| ***Irrigation Water***[1]<br>Each irrigation event for each land application area:<br>Record volume (gallons or acre-inches)[2] and source (well or canal) of irrigation water applied and dates applied.<br><br>One irrigation event during each irrigation season during actual irrigation events:<br>For each irrigation water source (well and canal):<br>Electrical conductivity, total dissolved solids, and total nitrogen.[3]<br>Data collected to satisfy the groundwater monitoring requirements (below) can be used to satisfy this requirement. |

[1] The Discharger shall monitor irrigation water (from each water well source and canal) that is used on all land application areas.
[2] Initial volume measurements may be the total volume for all land application areas.
[3] In lieu of sampling the irrigation water, the Discharger may provide equivalent data from the local irrigation district.

## Monitoring of Surface Runoff

The Discharger shall monitor any discharges of manure and/or process wastewater, storm water, and tailwater from the production area and land application area for the constituents and at the frequencies specified in Table 3 below.

| Table 3. DISCHARGE MONITORING |
|---|
| ***Discharges (Including Off-Property Discharges) of Manure or Process Wastewater, from the Production Area or Land Application Area***<br><br>Daily during each discharge:<br>Record date, time, approximate volume (gallons) or weight (tons), duration, location, source, and ultimate destination of the discharge.<br><br>Field measurements of the discharge for electrical conductivity, temperature, and pH. |

| Table 3. DISCHARGE MONITORING |
|---|
| Laboratory analyses of the discharge for nitrate-nitrogen, total ammonia-nitrogen, un-ionized ammonia-nitrogen, total Kjeldahl nitrogen, total phosphorus, potassium, total dissolved solids, $BOD_5$[1], total suspended solids, and total and fecal coliform.<br><br>Daily during each discharge to surface water:<br>For surface water upstream[2] and downstream[3] of the discharge:<br>Field measurements for electrical conductivity, temperature, dissolved oxygen, and pH.<br><br>Laboratory analyses for nitrate-nitrogen, total ammonia-nitrogen, un-ionized ammonia-nitrogen, total Kjeldahl nitrogen, total phosphorus, potassium, total dissolved solids, total suspended solids, and total and fecal coliform. |
| ***Storm Water Discharges to Surface Water from the Production Area***[4]<br>Daily during each discharge to surface water:<br>Record date, time, approximate volume, duration, location, source, and ultimate destination of the discharge.<br><br>For (1) the discharge and surface water (2) upstream and (3) downstream of the discharge:<br>Field measurements of electrical conductivity, dissolved oxygen, temperature, pH, total ammonia-nitrogen, and unionized ammonia-nitrogen.<br><br>Laboratory analyses for nitrate-nitrogen, turbidity, total phosphorus, and total and fecal coliform. |
| ***Storm Water Discharges to Surface Water from Each Land Application Area***[4]<br>First storm event of the wet season[5] and during the peak storm season (typically February)[6] each year from one third of the land application areas[7] with the land application areas sampled rotated each year[8]:<br>Record date, time, approximate volume, duration, location, and ultimate destination of the discharge.<br><br>Field measurements of the discharge for electrical conductivity, temperature, pH, total ammonia-nitrogen, and un-ionized ammonia-nitrogen.<br><br>Laboratory analyses of the discharge for nitrate-nitrogen, total phosphorus, turbidity, and total and fecal coliform. |
| ***Tailwater Discharges to Surface Water from Land Application Areas***[9]<br>Each discharge from each land application area where irrigation has occurred less than 60 days after application of manure and/or process wastewater:<br>Record date, time, approximate volume (gallons), duration, location, and ultimate destination of the discharge.<br><br>Field measurements of discharge for electrical conductivity, temperature, pH, total ammonia-nitrogen, and un-ionized ammonia-nitrogen.<br><br>First discharge of the year from any land application area where irrigation has occurred less than 60 days after application of manure and/or process wastewater:<br>Laboratory analyses for nitrate-nitrogen, total phosphorus, and total and fecal coliform. |

[1] Five-day biochemical oxygen demand.
[2] Upstream samples shall be taken just far enough upstream so as not to be influenced by the discharge.
[3] Downstream samples shall be taken just far enough downstream where the discharge is blended with the receiving water but not influenced by dilution flows or other discharges.

[4] Sample locations must be chosen such that the samples are representative of the quality and quantity of storm water discharged.
[5] This sample shall be taken from the first storm event of the season that produces significant storm water discharge such as would occur during continuous storm water runoff for a minimum of one hour, or intermittent storm water runoff for a minimum of three hours in a 12-hour period.
[6] This sample shall be taken during a storm event that produces significant storm water discharge and that is preceded by at least three days of dry weather. The sample shall be taken during the first hour of the discharge.
[7] One land application area shall be sampled for Dischargers that have one to three land application areas, two land application areas shall be sampled for Dischargers that have four to six land application areas, etc.
[8] The Discharger may propose in the annual storm water report to reduce the constituents and/or sampling frequency of storm water discharges to surface water from any land application area based on the previous year's data (see Storm Water Reporting section below).
[9] Tailwater samples shall be collected at the point of discharge to surface water.

1. If conditions are not safe for sampling, the Discharger must provide documentation of why samples could not be collected and analyzed. For example, the Discharger may be unable to collect samples during dangerous weather conditions (such as local flooding, high winds, tornados, electrical storms, etc.). However, once the dangerous conditions have passed, the Discharger shall collect a sample of the discharge or, if the discharge has ceased, from the waste management unit from which the discharge occurred.

2. Discharge and surface water sample analyses shall be conducted by a laboratory certified for such analyses by the California Department of Health Services. These laboratory analyses shall be conducted in accordance with the Title 40 Code of Federal Regulations Part 136 (*Guidelines Establishing Test Procedures for the Analysis of Pollutants*) or other test methods approved by the Executive Officer.

3. All discharges shall be reported as specified in the Reporting Requirements (Priority Reporting of Significant Events and Annual Reporting) below, as appropriate.

4. The rationale for all discharge sampling locations shall be included in the Annual Report (in the Storm Water Report for storm water discharges from land application areas).

5. Parties interested in coordinating or combining surface water monitoring conducted by an individual dairy or group of dairies with monitoring conducted pursuant to the Conditional Waiver of Waste Discharge Requirements for Discharges from Irrigated Lands (Order No. R5-2006-0053 for Coalition Group or Order No. R5-2006-0054 for Individual Discharger, or updates thereto) may propose an alternative monitoring program for the Executive Officer's consideration. The alternative program shall not begin until the Discharger receives written approval from the Executive Officer.

## Groundwater Monitoring

The Discharger shall sample each domestic and agricultural supply well and subsurface (tile) drainage systems present in the production and/or land application areas to characterize existing groundwater quality. This monitoring shall be conducted at the frequency and for the parameters specified in Table 4 below. The frequency of monitoring the domestic and agricultural supply wells for ammonium nitrogen and total dissolved solids may be reduced to every five years after two years of data are provided to the Executive Officer.

| Table 4. GROUNDWATER MONITORING |
|---|
| ***Domestic and Agricultural Supply Wells***<br>Annually:<br>Field measurements of electrical conductivity and ammonium nitrogen[1].<br>Laboratory analyses of nitrate-nitrogen.<br><br>Every five years (may be distributed over a 5-year period by sampling 20% of the wells annually):<br>Laboratory analyses for general minerals (calcium, magnesium, sodium, bicarbonate, carbonate, sulfate, chloride, and total dissolved solids).<br><br>***Subsurface (Tile) Drainage System***<br>Annually:<br>Field measurements of electrical conductivity and ammonium nitrogen[1].<br>Laboratory analyses of nitrate-nitrogen, total phosphorus, and total dissolved solids. |

[1] If field measurement indicates the presence of ammonium nitrogen, the discharger shall collect a sample for laboratory analysis of ammonium nitrogen.

1. Groundwater samples from domestic wells shall be collected from the tap nearest to the pressure tank (and before the pressure tank if possible) after water has been pumped from this tap for 10 to 20 minutes. If the sample cannot be collected prior to a pressure tank, the well must be purged at least twice the volume of the pressure tank. Groundwater samples from agricultural supply wells shall be collected after the pump has run for a minimum of 30 minutes or after at least three well volumes have been purged from the well. Samples from subsurface (tile) drains shall be collected at the discharge point into a canal or drain.

2. Additional groundwater monitoring requirements are specified in Attachment A to this Order.

## General Monitoring Requirements

1. The Discharger shall comply with the additional groundwater monitoring requirements specified in Attachment A to this Order either through individual groundwater monitoring or by participation in a Representative Monitoring Program as laid out in Attachment.

2. The Discharger shall comply with all the "Requirements Specifically for Monitoring Programs and Monitoring Reports" as specified in the Standard Provisions and Reporting Requirements.

3. Approved sampling procedures are listed on the Central Valley Water Board's web site at http://www.waterboards.ca.gov/centralvalley/available_documents/index.html#confined. When special procedures appear to be necessary at an individual dairy, the Discharger may request approval of alternative sampling procedures for nutrient management. The Executive Officer will review such requests and if adequate justification is provided, may approve the requested alternative sampling procedures.

4. The Discharger shall use clean sample containers and sample handling, storage, and preservation methods that are accepted or recommended by the selected analytical laboratory or, as appropriate, in accordance with approved United States Environmental Protection Agency analytical methods.

5. All samples collected shall be representative of the volume and nature of the material being sampled.

6. All sample containers shall be labeled and records maintained to show the time and date of collection as well as the person collecting the sample and the sample location.

7. All samples collected for laboratory analyses shall be preserved and submitted to the laboratory within the required holding time appropriate for the analytical method used and the constituents analyzed.

8. All samples submitted to a laboratory for analyses shall be identified in a properly completed and signed Chain of Custody form.

9. Field test instruments used for temperature, pH, electrical conductivity, ammonia nitrogen, un-ionized ammonia nitrogen, and dissolved oxygen may be used provided:

   a. The operator is trained in the proper use and maintenance of the instruments;

   b. The instruments are field calibrated prior to each monitoring event; and

   c. Instruments are serviced and/or calibrated by the manufacturer at the recommended frequency.

## B. RECORD-KEEPING REQUIREMENTS

Dischargers shall maintain on-site for a period of five years from the date they are created all information as follows (Owners must maintain their own copies of this information):

1. All information necessary to document implementation and management of the Nutrient Management Plan, including the information described in Items 2 through 6 below;

2. All records for the production area including:

   a. Records documenting the inspections required under the Monitoring Requirements above;

   b. Records documenting any corrective actions taken to correct deficiencies noted as a result of the inspections required in the Monitoring Requirements above. Deficiencies not corrected in 30 days must be accompanied by an explanation of the factors preventing immediate correction;

   c. Records of the date, time, and estimated volume of any overflow or bypass of the wastewater storage or conveyance structures;

   d. Records of mortality management and practices;

   e. Steps and dates when action is taken to correct unauthorized releases as reported in accordance with Priority Reporting of Significant Events below; and

   f. Records of monitoring activities and laboratory analyses conducted as required in Standard Provisions and Reporting Requirements D.5.

3. All records for the land application area including:

   a. Expected and actual crop yields;

   b. Identification of crop, acreage, and dates of planting and harvest for each field;

   c. Dates, locations, and approximate weight and moisture content of manure applied to each field;

   d. Dates, locations, and volume of process wastewater applied to each field;

   e. Whether precipitation occurred, or standing water was present, at the time of manure and process wastewater applications and for 24 hours prior to and following applications;

   f. Dates, locations, and test methods for soil, manure, process wastewater, irrigation water, and plant tissue sampling;

g. Results from manure, process wastewater, irrigation water, soil, plant tissue, discharge (including tailwater), and storm water sampling;

h. Explanation for the basis for determining manure or process wastewater application rates, as provided in the Technical Standards for Nutrient Management established by the Order (Attachment C of Order No. R5-2013-0122);

i. Calculations showing the total nitrogen, total phosphorus, and potassium to be applied to each field, including sources other than manure or process wastewater (Nutrient Budget);

j. Total amount of nitrogen, phosphorus, and potassium actually applied to each field, including documentation of calculations for the total amount applied (Nutrient Application Calculations);

k. The method(s) used to apply manure and/or process wastewater;

l. Records documenting any corrective actions taken to correct deficiencies noted as a result of the inspections required in the Monitoring Requirements above. Deficiencies not corrected in 30 days must be accompanied by an explanation of the factors preventing immediate correction; and

m. Records of monitoring activities and laboratory analyses conducted as required in Standard Provisions and Reporting Requirements D.5.

4. A copy of the Discharger's site-specific Nutrient Management Plan;

5. Tracking Manifest forms (Attachment D of Order No. R5-2013-0122) for off-site exports of manure or process wastewater which includes information on the manure hauler, destination of the manure, dates hauled, amount hauled, and certification; and

6. All analyses of manure, process wastewater, irrigation water, soil, plant tissue, discharges (including tailwater discharges), surface water, storm water, subsurface (tile) drainage, and groundwater.

## C. REPORTING REQUIREMENTS

### Priority Reporting of Significant Events (Prompt Action Required)

The Discharger shall report any noncompliance that endangers human health or the environment or any noncompliance with Prohibitions A.1 through A.5 and A.8 through A.12 in the Order, **within 24 hours** of becoming aware of its occurrence. The incident shall be reported to the Central Valley Water Board office, local environmental health department, and to the California Emergency Management Agency (CalEMA). During non-business hours, the Discharger shall leave a message on the Central Valley Water Board's voice mail. The message shall include the time, date, place, and nature of the noncompliance, the name and number of the reporting person, and shall be recorded in writing by the Discharger. CalEMA is operational 24 hours a day. A written report shall be submitted to the Central Valley Water Board office **within two weeks** of the Discharger becoming aware of the incident. The report shall contain a description of the noncompliance, its causes, duration, and the actual or anticipated time for achieving compliance. The report shall include complete details of the steps that the Discharger has taken or intends to take, in order to prevent recurrence. All intentional or accidental spills shall be reported as required by this provision. The written submission shall contain:

1. The approximate date, time, and location of the noncompliance including a description of the ultimate destination of any unauthorized discharge and the flow path of such discharge to a receiving water body;

2. A description of the noncompliance and its cause;

3. The flow rate, volume, and duration of any discharge involved in the noncompliance;

4. The amount of precipitation (in inches) the day of any discharge and for each of the seven days preceding the discharge;

5. A description (location; date and time collected; field measurements of pH, temperature, dissolved oxygen and electrical conductivity; sample identification; date submitted to laboratory; analyses requested) of noncompliance discharge samples and/or surface water samples taken to comply with the Monitoring Requirements above for *Discharges (Including Off-Property Discharges) of Manure or Process Wastewater or Other Dairy Waste from the Production Area or Land Application Area* and *Storm Water Discharges to Surface Water from the Production Area*;

6. The period of noncompliance, including dates and times, and if the noncompliance has not been corrected, the anticipated time it is expected to continue;

7. A time schedule and a plan to implement corrective actions necessary to prevent the recurrence of such noncompliance; and

8. The laboratory analyses of the noncompliance discharge sample and/or upstream and downstream surface water samples shall be submitted to the Central Valley Water Board office within 45 days of the discharge.

## Annual Reporting

An annual monitoring report is due by **1 July of each year**. It will consist of a General Section, Groundwater Reporting Section, and a Storm Water Reporting Section, as described below.

### General Section

The General section of the annual report shall be completed on an annual report form provided by the Executive Officer (available on the Central Valley Water Board website at http://www.waterboards.ca.gov/centralvalley/available_documents/index.html#confined) and shall include all the information as specified below. This section of the annual report shall cover information on crops harvested during the previous calendar year, whether or not the crop was planted prior to this period.

1. Identification of the beginning and end dates of the annual reporting period;

2. Maximum and average number and type of animals, whether in open confinement or housed under roof during the reporting period;

3. Estimated amount of total manure (tons) and process wastewater (gallons or acre-inches) generated by the facility during the annual reporting period; a calculation of the total nitrogen, total phosphorus, total potassium, and total salt content measured as fixed solids of the solid waste; and total dissolved solids of the liquid waste;

4. Estimated amount of total manure (tons) and process wastewater (gallons or acre-inches) applied to each land application area during the annual reporting period and a calculation of the total nitrogen, total phosphorus, total potassium, and total salt content measured as fixed solids (ash) of the solid waste and total dissolved solids of the liquid waste;

5. Quantify the ratio of total nitrogen applied to land application areas and total nitrogen removed by crop harvest (nitrogen uptake).

6. Estimated amount of total manure (tons) and process wastewater (gallons or acre-inches) transferred to other persons by the facility during the annual reporting period; a calculation of the total nitrogen, total phosphorus, total potassium, and total salt content measured as fixed solids of the solid waste; and total dissolved solids of the liquid waste;

7. Total number of acres and the Assessor Parcel Numbers for all land application areas that were not used for application of manure or process wastewater during the reporting period;

8. Total number of acres and the Assessor Parcel Numbers of properties that were used for land application of manure and process wastewater during the annual reporting period;

9. Summary of all manure and process wastewater discharges from the production area to surface water or to land areas (land application areas or otherwise) when not in accordance with the facility's Nutrient Management Plan that occurred during the annual reporting period, including date, time, location, and approximate volume; a map showing discharge and sample locations; rationale for sample locations; and method of measuring discharge flows;

10. Summary of all storm water discharges from the production area to surface water during the annual reporting period, including the date, time, approximate volume, duration, and location; a map showing the discharge and sample locations; rationale for sample locations; and method of measuring discharge flows;

11. Summary of all discharges from the land application area to surface water that have occurred during the annual reporting period, including the date, time, approximate volume, location, and source of discharge (i.e., tailwater, process wastewater, or blended process wastewater); a map showing the discharge and sample locations; rationale for sample locations; and method of measuring discharge flows;

12. A statement indicating if the Nutrient Management Plan has been updated and whether the current version of the facility's Nutrient Management Plan was developed or approved by a certified nutrient management specialist as specified in Attachment C of Order No. R5-2013-0122;

13. Copies of all manure/process wastewater tracking manifests for the reporting period;

14. A statement indicating if there were any changes to third party agreements to receive manure or process wastewater. If there were any changes, submit copies of all new or revised written agreements with each third party that receives solid manure or process wastewater from the Discharger for its own use;

15. Copies of laboratory analyses of all discharges (manure, process wastewater, or tailwater), surface water (upstream and downstream of a discharge), and storm water, including Chain of Custody forms and laboratory quality assurance/quality control (QA/QC) results;

16. Tabulated analytical data for samples of manure, process wastewater, irrigation water, soil, and plant tissue. The data shall be tabulated to clearly

show sample dates, constituents analyzed, constituent concentrations, and detection limits;

17. Results of the Record-Keeping Requirements for the production and land application areas specified in Record-Keeping Requirements B.2.b, B.2.c, B.3.a, B.3.b, B.3.c, B.3.d, B.3.e, B.3.j, and B.3.l above.

**Groundwater Reporting Section**

Groundwater monitoring results shall be included with the annual reports.

1. Dischargers that monitor supply wells and subsurface (tile) drainage systems only shall submit information on the location of sample collection and all field and laboratory data, including all laboratory analyses (including Chain of Custody forms and laboratory QA/QC results).

2. Dischargers that have monitoring well systems shall include all laboratory analyses (including Chain of Custody forms and laboratory QA/QC results) and tabular and graphical summaries of the monitoring data. Data shall be tabulated to clearly show the sample dates, constituents analyzed, constituent concentrations, detection limits, depth to groundwater, and groundwater elevations. Graphical summaries of groundwater gradients and flow directions shall also be included. Each groundwater monitoring report shall include a summary data table of all historical and current groundwater elevations and analytical results. The groundwater monitoring reports shall be certified by a California registered professional as specified in General Reporting Requirements C.9 of the Standard Provisions and Reporting Requirements of Order No. R5-2013-0122.

**Storm Water Reporting Section**

Storm water monitoring results will be included in the annual report. The report shall include a map showing all sample locations for all land application areas, rationale for all sampling locations, a discussion of how storm water flow measurements were made, the results (including the laboratory analyses, Chain of Custody forms, and laboratory QA/QC results) of all samples of storm water, and any modifications made to the facility or sampling plan in response to pollutants detected in storm water. The annual report must also include documentation if no significant discharge of storm water occurred from the land application area(s) or if it was not possible to collect any of the required samples or perform visual observations due to adverse climatic conditions.

If the storm water monitoring for any land application area indicates pollutants have not been detected in storm water samples, the Discharger may propose to the Executive Officer to reduce the constituents and/or sampling frequency for that area.

## General Reporting Requirements

1. The results of any monitoring conducted more frequently than required at the locations specified herein shall be reported to the Central Valley Water Board.

2. Laboratory analyses for manure, process wastewater, and soil shall be submitted to the Central Valley Water Board upon request by the Executive Officer.

3. Each report shall be signed by the Discharger or a duly authorized representative as specified in the General Reporting Requirements C.7 of the Standard Provisions and Reporting Requirements of Order No. R5-2013-0122, and shall contain the following statement:

   *"I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment."*

4. For facilities in Fresno, Kern, Kings, Madera, Mariposa, and Tulare counties, submit reports to:

   California Regional Water Quality Control Board
   Central Valley Region
   1685 E Street
   Fresno, CA 93706
   Attention: Confined Animal Regulatory Unit

   For facilities in Butte, Lassen, Modoc, Plumas, Tehama, and Shasta counties, submit reports to:

   California Regional Water Quality Control Board
   Central Valley Region
   415 Knollcrest Drive, Suite 100
   Redding, CA 96002
   Attention: Confined Animal Regulatory Unit

   For facilities in all other counties, submit reports to:

   California Regional Water Quality Control Board
   Central Valley Region
   11020 Sun Center Drive #200
   Rancho Cordova, CA 95670
   Attention: Confined Animal Regulatory Unit

ORDERED BY:

PAMELA C. CREEDON, Executive Officer

Date

3 October 2013

# MONITORING AND REPORTING PROGRAM NO. R5-2013-0122
# ATTACHMENT A

## Groundwater Monitoring,
## Monitoring Well Installation And Sampling Plan
## And
## Monitoring Well Installation Completion Report
## For
## Existing Milk Cow Dairies

## I. Groundwater Monitoring

The provisions of Attachment A are set out pursuant to the Executive Officer's authority under California Water Code (CWC) Section 13267 to order Dischargers to implement monitoring and reporting programs. The purpose of groundwater monitoring required by these provisions is to confirm that management practices being employed for the wastewater retention system, land application areas, and animal confinement areas, are protective of groundwater quality and comply with Groundwater Limitation F.1 of the Waste Discharge Requirements General Order for New or Expanded Milk Cow Dairy Facilities (Order).

As an alternative to installing monitoring wells on an individual basis as set out in Section II, Dischargers subject to Order No. R5-2013-0122 (Order) may participate in a Representative Monitoring Program that meets the requirements set forth in Section III below. Dischargers choosing to participate in a Representative Monitoring Program must notify the California Regional Water Quality Control Board, Central Valley Region (Central Valley Water Board). Notification to the Central Valley Water Board[1] must include identification of the Representative Monitoring Program that the Discharger intends to join. Dischargers choosing not to participate in a Representative Monitoring Program or those failing to notify the Central Valley Water Board of their decision to participate in a Representative Monitoring Program, will continue to be subject to the groundwater monitoring requirements of the Order and Monitoring and Reporting Program No. R5-2013-0122 (MRP). If necessary, the Executive Officer will prioritize these groundwater monitoring requirements based on the factors in Table 5 below.

A Representative Monitoring Program is not a Discharger. New or expanded dairy owners and operators are Dischargers and are responsible and liable for individual compliance and for determining if they are in compliance with the terms the Order. As set forth in Section III below, an eligible Representative Monitoring Program will convey information related to a Discharger's participation in the Representative Monitoring Program, conduct representative monitoring pursuant to an approved monitoring plan, and prepare and submit any required plans and monitoring reports. However, member Dischargers will be responsible for failure on the part of the Representative Monitoring Program to comply with the MRP.

1 In lieu of individual discharger notifications to the Central Valley Water Board, a Representative Monitoring Program may provide to the Central Valley Water Board a list of participants that have signed up and met the initial requirements for participation in that Representative Monitoring Program.

If a Discharger participating in a Representative Monitoring Program wishes to terminate participation in the Program, the Discharger shall submit a Notice of Termination to the Executive Officer and the administrator of the Representative Monitoring Program. Administrators of a Representative Monitoring Program shall also notify the Executive Officer of a participant's failure to participate in their Representative Monitoring Program. A Representative Monitoring Program shall inform the Executive Officer of the participant's failure to participate within 45 days, which may result in the Executive Officer issuing a Notice of Termination to the Discharger stating that the Discharger is no longer able to participate in a Representative Monitoring Program as an alternative to individual groundwater monitoring. Termination from participation in a Representative Monitoring Program will occur on the date specified in the Notice of Termination, unless otherwise specified. Dischargers who voluntarily terminate their participation in a Representative Monitoring Program, receive a Notice of Termination from a Representative Monitoring Program, or receive a Notice of Termination from the Executive Officer, shall be individually subject to the groundwater monitoring requirements of the Order and MRP.

Pursuant to the CWC Section 13267, the Executive Officer may, at any time, order implementation of individual groundwater monitoring at an expanded or new dairy facility, even if the Discharger participates in a Representative Monitoring Program. Such order may occur, for instance, if violations of the Order are documented and/or the facility is found to be in an area where site conditions and characteristics pose a high risk to groundwater quality. In the event the Executive Officer orders implementation of individual groundwater monitoring to a participant of a Representative Monitoring Program, such an order shall constitute a Notice of Termination to the participant and the Discharger shall no longer be eligible to participate in a Representative Monitoring Program to comply with the groundwater monitoring requirements of the MRP.

## II. Individual Monitoring Program Requirements

1. The Discharger shall install sufficient monitoring wells to:

    a. Characterize groundwater flow direction and gradient beneath the site;

    b. Characterize natural background (unaffected by the Discharger or others) groundwater quality upgradient of the facility; and

    c. Characterize groundwater quality downgradient of the corrals, downgradient of the retention ponds, and downgradient of the land application areas.

2. It may be necessary to install more than one upgradient monitoring well (i.e., for the production area and the land application area). The Executive Officer may order more extensive monitoring based on site-specific conditions.

| TABLE 5. GROUNDWATER MONITORING FACTORS FOR RANKING PRIORITY | | | |
|---|---|---|---|
| **FACTOR** | **SITE CONDITION** | **POINTS** | **SCORE** |
| Highest nitrate concentration (nitrate-nitrogen in mg/L) in any existing domestic well, agricultural supply well, or subsurface (tile) drainage system at the dairy or associated land application area. | < 10 | 0 | |
| | 10 to 20 | 10 | |
| | > 20 | 20 | |
| Location of production area or land application area relative to a Department of Pesticide Groundwater Protection Area (GWPA). | Outside GWPA | 0 | |
| | In GWPA | 20 | |
| Distance (feet) of production area or land application area from an artificial recharge area as identified in the California Department of Water Resources Bulletin 118 or by the Executive Officer. | > 1,500 | 0 | |
| | 601 to 1,500 | 10 | |
| | 0 to 600 | 20 | |
| Nitrate concentration (nitrate-nitrogen in mg/L) in domestic well on property adjacent to the dairy production area or land application area (detected two or more times). | < 10 or unknown | 0 | |
| | 10 or greater | 20 | |
| Distance (feet) from dairy production area or land application area and the nearest off-property domestic well. | > 600 | 0 | |
| | 301 to 600 | 10 | |
| | 0 to 300 | 20 | |
| Distance (feet) from dairy production area or land application area and the nearest off-property municipal well. | > 1,500 | 0 | |
| | 601 to 1,500 | 10 | |
| | 0 to 600 | 20 | |
| Number if crops grown per year per field. | 1 | 5 | |
| | 2 | 10 | |
| | 3 | 15 | |
| Whole Farm Nitrogen Balance. | < 1.65 | 0 | |
| | 1.65 to 3 | 10 | |
| | > 3 | 20 | |

Total Score: __________

3. Prior to installation of monitoring wells, the Discharger shall submit to the Executive Officer a Monitoring Well Installation and Sampling Plan (MWISP) (see below) and schedule prepared by, or under the direct supervision of, and certified by, a California registered civil engineer or a California registered geologist with experience in hydrogeology. Installation of monitoring wells shall not begin until the Executive Officer notifies the Discharger in writing that the MWISP is acceptable.

4. All monitoring wells shall be constructed in a manner that maintains the integrity of the monitoring well borehole and prevents the well (including the annular space outside of the well casing) from acting as a conduit for pollutant/contaminant transport. Each monitoring well shall be appropriately designed and constructed to enable collection of representative samples of the first encountered groundwater.

5. The construction and destruction of monitoring wells and supply wells shall be in accordance with the standards under *Water Wells* and *Monitoring Wells* in the *California Well Standards Bulletin 74-90 (June 1991)* and *Bulletin 74-81 (December 1981),* adopted by the Department of Water Resources (DWR). Should any county or local agency adopt more stringent standards than that adopted by the DWR, then these local standards shall supercede the Well Standard of DWR, and the Discharger shall comply with the more stringent standards. More stringent practices shall be implemented if needed to prevent the well from acting as a conduit for the vertical migration of waste constituents.

6. The horizontal and vertical position of each monitoring well shall be determined by a registered land surveyor or other qualified professional. The horizontal position of each monitoring well shall be measured with one-foot lateral accuracy using the North American Datum 1983 (NAD83 datum). The vertical elevations of each monitoring well shall be referenced to the North American Vertical Datum 1988 (NAVD88 datum) to an absolute accuracy of at least 0.5 feet and a relative accuracy between monitoring wells of 0.01 feet.

7. Within 45 days after completion of any monitoring well, the Discharger shall submit to the Executive Officer a Monitoring Well Installation Completion Report (MWICR) (see below) prepared by, or under the direct supervision of, and certified by, a California registered civil engineer or a California registered geologist with experience in hydrogeology.

8. The Discharger shall sample monitoring wells for the constituents and at the frequency as specified in Table 6 below. Groundwater monitoring shall include monitoring during periods of the expected highest and lowest water table levels.

| Table 6. ADDITIONAL GROUNDWATER MONITORING |
|---|
| ***Monitoring Wells***<br>Quarterly[1]:<br>Measurement of the depth to groundwater from a surveyed reference point to the nearest 0.01 foot in each monitoring well.<br><br>Semi-annually:<br>Field measurements of electrical conductivity, temperature, and pH.<br><br>Laboratory analyses for nitrate and ammonia.<br><br>Within six months of well construction and every two years thereafter:<br>Laboratory analyses for general minerals (calcium, magnesium, sodium, potassium, bicarbonate, carbonate, sulfate, and chloride). |

[1] After two years of quarterly depth to groundwater measurements, the discharger may request reduction of frequency of depth to groundwater measurements to semi-annually upon demonstration there are no seasonal impacts to groundwater levels.

9. Groundwater samples from monitoring wells shall be collected as specified in the approved Monitoring Well Installation and Sampling Plan (MWISP).

10. The Discharger shall submit to the Executive officer an annual assessment of the groundwater monitoring data due 1 July of each year. The annual assessment may be attached to the annual report required in Section C of the MRP. The annual assessment shall include a tabulated summary of all analytical data collected to date including analytical lab reports for data collected during the past year. The assessment shall include an evaluation of the groundwater monitoring program's adequacy to assess compliance with the Order, including whether the data provided is representative of conditions upgradient and downgradient wastewater management area, production area and land application area of the dairy facility. The assessment shall also include and evaluation of the groundwater monitoring data collected to date with a description of the statistical or non-statistical methods used. The assessment must use methods approved by the Executive Officer. If the Discharger determines that the analytical methods required by this MRP are insufficient to identify whether site activities are impacting groundwater quality, the annual assessment must address Item II.11 below and employ the needed analyses during future monitoring events.

11. If the monitoring parameters required by this MRP are insufficient to identify whether site activities are impacting groundwater quality, the Discharger must employ all reasonable chemical analyses to differentiate the source of the particular constituent. This includes, but is not limited to, analyses for a wider array of constituents and chemical isotopes.

12. Within six years of initiating sampling activities, the Discharger shall submit to the Executive Officer a summary report presenting a detailed assessment of the monitoring data to evaluate whether site activities associated with operation of the wastewater retention system, corrals, or land application areas have impacted groundwater quality. This summary report can be required at an earlier date if evaluation by the Discharger or Central Valley Water Board staff indicates that the

assessment can be completed at an earlier date. This summary report shall also include detailed descriptions of management practices employed at the wastewater retention system, animal confinement areas, and land application areas along with the design standards of the wastewater retention system. The summary report must include an adequate technical justification for the conclusions incorporating available data and reasonable interpretations of geologic and engineering principles to identify management practices protective of groundwater quality. The summary report is subject to approval by the Executive Officer. If monitoring data indicate that Groundwater Limitation F.1 of the Order has been violated, this assessment shall include a description of changes in management practices and/or activities that will be undertaken to bring the facility into compliance. Annual reports required in Section C of the MRP submitted after this summary report must include a discussion and schedule for implementation of changes in management practices and/or activities that are being taken and an evaluation of progress in complying with Groundwater Limitation F.1 of the Order.

13. At any time during the term of this permit, the Central Valley Water Board may notify the Discharger to submit assessments of groundwater monitoring data (including the annual reports and the summary report) electronically. Data shall be submitted in a digital format acceptable to the Executive Officer.

## III. Representative Monitoring Program Requirements

To establish a Representative Monitoring Program in lieu of individual groundwater monitoring, the Representative Monitoring Program must have Executive Officer approval of a submitted Monitoring and Reporting Workplan. The Monitoring and Reporting Workplan shall include sufficient information for the Executive Officer to evaluate the adequacy of the proposed groundwater monitoring program to serve as an alternative to the installation of individual groundwater monitoring wells at dairies. The Monitoring and Reporting Workplan must explain how data collected at facilities that are monitored will be used to assess impacts to groundwater at facilities that are not part of the Representative Monitoring Program's network of monitoring wells. This information is needed to demonstrate whether collected facility monitoring data will allow identification of practices that are protective of water quality at all facilities represented by the Representative Monitoring Program, including those for which on-site data are not collected. The Monitoring and Reporting Workplan must additionally propose constituents the Representative Monitoring Program will monitor and the frequency of monitoring for each constituent identified. The Monitoring and Reporting Workplan must propose a list of constituents that is sufficient to identify whether activities at facilities being monitored are impacting groundwater quality. The list of constituents may necessarily be greater than the constituents required to be monitored at sites under individual orders (as listed in Table 6), as failure to determine whether groundwater has been impacted at a monitored facility will impair the ability to extrapolate findings to facilities where monitoring does not occur. At a minimum the baseline constituents shall include those required of individual groundwater monitoring systems.

1. Once the Monitoring and Reporting Workplan is approved, the Representative Monitoring Program shall begin the process of installing monitoring wells as prescribed in paragraphs 3-7 below.

2. Prior to installation of monitoring wells, the Representative Monitoring Program shall submit to the Executive Officer a MWISP (see below) and schedule prepared by, or under the direct supervision of, and certified by, a California registered civil engineer or a California registered geologist with experience in hydrogeology. Installation of monitoring wells shall not begin until the Executive Officer notifies the Representative Monitoring Program in writing that the MWISP is acceptable. The MWISP must be submitted within 60 days of Executive Officer approval of the Monitoring and Reporting Workplan.

3. All monitoring wells shall be constructed in a manner that maintains the integrity of the monitoring well borehole and prevents the well (including the annular space outside of the well casing) from acting as a conduit for pollutant/contaminant transport. Each monitoring well shall be appropriately designed and constructed to enable collection of representative samples of the first encountered groundwater.

4. The construction and destruction of monitoring wells and supply wells shall be in accordance with the standards under *Water Wells* and *Monitoring Wells* in the *California Well Standards Bulletin 74-90 (June 1991)* and *Bulletin 74-81 (December 1981),* adopted by the Department of Water Resources (DWR). Should any county or local agency adopt more stringent standards than that adopted by the DWR, then these local standards shall supersede the Well Standard of DWR, and the Representative Monitoring Program shall comply with the more stringent standards. More stringent practices shall be implemented if needed to prevent the well from acting as a conduit for the vertical migration of waste constituents.

5. The horizontal and vertical position of each monitoring well shall be determined by a registered land surveyor or other qualified professional. The horizontal position of each monitoring well shall be measured with one-foot lateral accuracy using the North American Datum 1983 (NAD83 datum). The vertical elevations of each monitoring well shall be referenced to the North American Vertical Datum 1988 (NAVD88 datum) to an absolute accuracy of at least 0.5 feet and a relative accuracy between monitoring wells of 0.01 feet.

6. Within 45 days after completion of any monitoring well network, the Representative Monitoring Program shall submit to the Executive Officer a MWICR (see below) prepared by, or under the direct supervision of, and certified by, a California registered civil engineer or a California registered geologist with experience in hydrogeology. In cases where monitoring wells are completed in phases or completion of the network is delayed for any reason, monitoring well construction data are to be submitted within 180 days of well completion, even if this requires submittal of multiple reports.

7. Once the groundwater monitoring network is installed pursuant to an approved Monitoring and Reporting Workplan and paragraphs 3-6 above, the Representative Monitoring Program shall sample monitoring wells for the constituents and at the frequencies as specified in the approved Monitoring and Reporting Workplan. Groundwater monitoring shall include monitoring during periods of the expected highest and lowest water table levels. In cases where the monitoring wells are completed in phases or completion of the monitoring well network is delayed for any reason, collection and analysis of groundwater samples from each well is to commence within 180 days of completion of that well.

8. Groundwater samples from monitoring wells shall be collected as specified in an approved MWISP.

9. The Representative Monitoring Program shall submit to the Executive Officer an Annual Representative Monitoring Report (ARMR). The ARMR shall be due by 1 April of each year and shall include all data (including analytical reports) collected during the previous calendar year. The ARMR shall also contain a tabulated summary of data collected to date by the Representative Monitoring Program. The ARMR shall describe the monitoring activities conducted by the Representative Monitoring Program, and identify the number and location of installed monitoring wells and other types of monitoring devices. Within each ARMR, the Representative Monitoring Program shall evaluate the groundwater monitoring data to determine whether groundwater is being impacted by activities at facilities being monitored by the Representative Monitoring Program. The submittal shall include a description of the methods used in evaluating the groundwater monitoring data. Each ARMR shall include an evaluation of whether the representative monitoring program is on track to provide the data needed to complete the summary report (detailed in Item III.10 below). If the evaluation concludes that information needed to complete the summary report may not be available by the required deadline, the ARMR shall include measures that will be taken to bring the program back on track.

   The ARMR shall include an evaluation of data collected to date and an assessment of whether monitored dairies are implementing management practices that are protective of groundwater quality. If the management practices being implemented at a dairy being monitored are found to not be protective of groundwater quality, the Executive Officer may issue an order to the owner/operator of the monitored dairy to identify and implement management practices that are protective of groundwater quality prior to submittal of the report described in Item III.10 below.

10. No later than six (6) years following submittal of the first ARMR, the Representative Monitoring Program shall submit a Summary Representative Monitoring Report (SRMR) identifying management practices that are protective of groundwater quality for the range of conditions found at facilities covered by

the Representative Monitoring Program. The identification of management practices for the range of conditions must be of sufficient specificity to allow participants covered by the Representative Monitoring Program and the Central Valley Water Board to identify which practices at monitored facilities are appropriate for facilities with a corresponding range of site conditions, and generally where such facilities may be located within the Central Valley (e.g., the summary report may need to include maps of the Central Valley that identify the types of management practices that should be implemented in certain areas based on specified site conditions). The summary report must include an adequate technical justification for the conclusions incorporating available data and reasonable interpretations of geologic and engineering principles to identify management practices protective of groundwater quality. The summary report is subject to approval by the Executive Officer.

11. Assessments of groundwater monitoring data (including the annual reports and the summary report) are to be submitted electronically. Data shall be submitted in an electronic format acceptable to the Executive Officer.

12. On July 1 following Executive Officer approval of the SRMR, each Discharger that is a participant covered by a Representative Monitoring Program shall include in their annual report required in Section C of the MRP a description of management practices currently being implemented at their wastewater retention system(s), land application area(s), and animal confinement area(s). If these management practices are not confirmed to be protective of groundwater quality based on information contained in the SRMR, and therefore are not confirmed to be sufficient to ensure compliance of the facility with Groundwater Limitation F.1 of the Order the Discharger's annual report shall identify which alternative management practices the participant intends to implement at its dairy facility and a schedule for their implementation (based on the findings of the SRMR). Management practices deemed to be protective of groundwater quality are subject to approval by the Executive Officer. With each annual report submitted after the first report following Executive Officer approval of the SRMR, each participant shall include within his or her annual report an update with respect to implementation of the additional or alternative management practices being employed by the Discharger to protect groundwater quality.

13. Within three months of joining a Representative Monitoring Program, each Discharger that is a participant covered by a Representative Monitoring Program shall submit to the Central Valley Water Board a letter stating that they are voluntarily joining the Representative Monitoring Program, they are aware of the conditions and requirements to be a member of the Program, they intend to fully comply with the monitoring and reporting program and intent of the Program, and they are fully aware failure to comply with the Program may result in their removal from the Program and that they may be subject to enforcement by the Central Valley Water Board.

## IV. Monitoring Well Installation and Sampling Plan (MWISP) (Applicable to both Individual and Representative Monitoring Program Requirements)

At a minimum, the MWISP must contain all of the information listed below.

1. General Information:

   a. Topographic map showing any existing nearby (about 2,000 feet) domestic, irrigation, and municipal supply wells and monitoring wells known to the Discharger, utilities, surface water bodies, drainage courses and their tributaries/destinations, and other major physical and man-made features, as appropriate.

   b. Site plan showing proposed well locations, other existing wells, unused and/or abandoned wells, major physical site structures (such as corrals, freestall barns, milking barns, feed storage areas, etc.), waste handling facilities (including solid separation basins, retention ponds, manure storage areas), irrigated cropland and pasture, and on-site surface water features.

   c. Rationale for the number of proposed monitoring wells, their locations and depths, and identification of anticipated depth to groundwater. In the case of a Representative Monitoring Program, this information must include an explanation of how the location, number, and depths of wells proposed will result in the collection of data that can be used to assess groundwater at sites with a variety of conditions that have joined the Representative Monitoring Program but are not being monitored as part of the monitoring network.

   d. Local permitting information (as required for drilling, well seals, boring/well abandonment).

   e. Drilling details, including methods and types of equipment for drilling and logging activities. Equipment decontamination procedures (as appropriate) should be described.

   f. Health and Safety Plan.

2. Proposed Drilling Details:

   a. Drilling techniques.

   b. Well logging method.

3. Proposed Monitoring Well Design - all proposed well construction information must be displayed on a construction diagram or schematic to accurately identify the following:

    a. Well depth.

    b. Borehole depth and diameter.

    c. Well construction materials.

    d. Casing material and diameter - include conductor casing, if appropriate.

    e. Location and length of perforation interval, size of perforations, and rationale.

    f. Location and thickness of filter pack, type and size of filter pack material, and rationale.

    g. Location and thickness of bentonite seal.

    h. Location, thickness, and type of annular seal.

    i. Surface seal depth and material.

    j. Type of well cap(s).

    k. Type of well surface completion.

    l. Well protection devices (such as below-grade water-tight vaults, locking steel monument, bollards, etc.).

4. Proposed Monitoring Well Development:

    a. Schedule for development (not less than 48 hours or more than 10 days after well completion).

    b. Method of development.

    c. Method of determining when development is complete.

    d. Parameters to be monitored during development.

    e. Method for storage and disposal of development water.

5. Proposed Surveying:

    a. How horizontal and vertical position of each monitoring well will be determined.

b. The accuracy of horizontal and vertical measurements to be obtained.

c. The California licensed professional (licensed land surveyor or civil engineer) to perform the survey.

6. Proposed Groundwater Monitoring:

a. Schedule (at least 48 hours after well development).

b. Depth to groundwater measuring equipment (e.g., electric sounder or chalked tape capable of ±0.01-foot measurements).

c. Well purging method, equipment, and amount of purge water.

d. Sample collection (e.g., bottles and preservation methods), handling procedures, and holding times.

e. Quality assurance/quality control (QA/QC) procedures (as appropriate).

f. Analytical procedures.

g. Equipment decontamination procedures (as appropriate).

7. Proposed Schedule:

a. Fieldwork.

b. Laboratory analyses.

c. Report submittal.

## V. Monitoring Well Installation Completion Report (MWICR)

At a minimum, the MWICR shall summarize the field activities as described below.

1. General Information:

a. Brief overview of field activities including well installation summary (such as number, depths), and description and resolution of difficulties encountered during field program.

b. Topographic map showing any existing nearby domestic, irrigation, and municipal supply wells and monitoring wells, utilities, surface water bodies, drainage courses and their tributaries/destinations, and other major physical and man-made features.

c. Site plan showing monitoring well locations, other existing wells, unused and/or abandoned wells, major physical site structures (such as corrals, freestall barns, milking barns, feed storage areas, etc.), waste handling facilities (including solid separation basins, retention ponds, manure storage areas), land application area(s), and on-site surface water features.

d. Period of field activities and milestone events (e.g., distinguish between dates of well installation, development, and sampling).

2. Monitoring Well Construction:

a. Number and depths of monitoring wells installed.

b. Monitoring well identification (i.e., numbers).

c. Date(s) of drilling and well installation.

d. Description of monitoring well locations including field-implemented changes (from proposed locations) due to physical obstacles or safety hazards.

e. Description of drilling and construction, including equipment, methods, and difficulties encountered (such as hole collapse, lost circulation, need for fishing).

f. Name of drilling company, driller, and logger (site geologist to be identified).

g. As-builts for each monitoring well with the following details:

i. Well identification.

ii. Total borehole and well depth.

iii. Date of installation.

iv. Boring diameter.

v. Casing material and diameter (include conductor casing, if appropriate).

vi. Location and thickness of slotted casing, perforation size.

vii. Location, thickness, type, and size of filter pack.

viii. Location and thickness of bentonite seal.

ix. Location, thickness, and type of annular seal.

x. Depth of surface seal.

xi. Type of well cap.

xii. Type of surface completion.

xiii. Depth to water (note any rises in water level from initial measurement) and date of measurement.

xiv. Well protection device (such as below-grade water-tight vaults, stovepipe, bollards, etc).

h. All depth to groundwater measurements during field program.

i. Field notes from drilling and installation activities (e.g., all subcontractor dailies, as appropriate).

j. Construction summary table of pertinent information such as date of installation, well depth, casing diameter, screen interval, bentonite seal interval, and well elevation.

3. Monitoring Well Development:

a. Date(s) and time of development.

b. Name of developer.

c. Method of development.

d. Methods used to identify completion of development.

e. Development log: volume of water purged and measurements of temperature, pH, and electrical conductivity during and after development.

f. Disposition of development water.

g. Field notes (such a bailing to dryness, recovery time, number of development cycles).

4. Monitoring Well Survey:

a. Identify coordinate system or reference points used.

b. Description of measuring points (e.g., ground surface, top of casing, etc.).

c. Horizontal and vertical coordinates of well casing with cap removed (measuring point to nearest ± 0.01 foot).

d. Name, license number, and signature of California licensed professional who conducted survey.

e. Surveyor's field notes.

f. Tabulated survey data.

# CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
# CENTRAL VALLEY REGION

STANDARD PROVISIONS AND REPORTING REQUIREMENTS
FOR

WASTE DISCHARGE REQUIREMENTS GENERAL ORDER NO. R5-2013-0122
FOR
EXISTING MILK COW DAIRIES
3 May 2007

## A. Introduction:

1. These Standard Provisions and Reporting Requirements (SPRR) are applicable to existing milk cow dairies that are regulated pursuant to the provisions of Title 27 California Code of Regulations (CCR) Division 2, Subdivision 1, Chapter 7, Subchapter 2, Sections 22560 et seq.

2. Any violation of the Order constitutes a violation of the California Water Code and, therefore, may result in enforcement action.

3. If there is any conflicting or contradictory language between the Order, the Monitoring and Reporting Program (MRP) associated with the Order, or the SPRR, then language in the Order shall govern over the MRP and the SPRR, and language in the MRP shall govern over the SPRR.

## B. Standard Provisions:

1. The requirements prescribed in the Order do not authorize the commission of any act causing injury to the property of another, or protect the Discharger from liabilities under federal, state, or local laws.

2. The Discharger shall comply with all federal, state, county, and local laws and regulations pertaining to the discharge of wastes from the facility that are at least as stringent as the requirements of the Order.

3. All discharges from the facility must comply with the lawful requirements of municipalities, counties, drainage districts, and other local agencies regarding discharges of storm water to storm drain systems or to other courses under their jurisdiction that are at least as stringent as the requirements of the Order.

4. The Order does not convey any property rights or exclusive privileges.

5. The provisions of the Order are severable. If any provision of the Order is held invalid, the remainder of the Order shall not be affected.

6. The Discharger shall take all reasonable steps to minimize any adverse impact to the waters of the State resulting from noncompliance with the Order. Such steps

shall include accelerated or additional monitoring as necessary to determine the nature and impact of the noncompliance.

7. The fact that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the Order shall not be a defense for violations of the Order by the Discharger.

8. The filing of a request by the Discharger for modification, revocation and reissuance, or termination of the Order, or notification of planned changes or anticipated noncompliance, does not stay any condition of the Order.

9. The Order is not transferable to any person except after notice to the Central Valley Water Board. The Central Valley Water Board may modify or revoke and reissue the Order to change the name of the Discharger and incorporate such other requirements as may be necessary under the California Water Code.

10. The Discharger shall provide to the Executive Officer, within a reasonable time, any information which the Executive Officer may request to determine whether cause exists for modifying, revoking, and reissuing, or terminating the Discharger's coverage under the Order or to determine compliance with the Order. The Discharger shall also provide to the Executive Officer upon request, copies of records required by the Order to be kept.

11. After notice and opportunity for a hearing, the Order may be terminated or modified for cause, including but not limited to:

    a. Violation of any term or condition contained in the Order;

    b. Obtaining the Order by misrepresentation, or failure to disclose fully all relevant facts;

    c. A change in any condition that results in either a temporary or permanent need to reduce or eliminate the authorized discharge; or

    d. A material change in the character, location, or volume of discharge.

12. The Order may be modified if new state statutes or regulations are promulgated, and if more stringent applicable water quality standards are approved pursuant to Title 27 of the CCR, or as adopted into the Central Valley Water Board *Water Quality Control Plans* (Basin Plans) *for the Sacramento River and San Joaquin River Basins (4th Ed), and for the Tulare Lake Basin (2nd Ed.).* The Order may also be modified for incorporation of land application plans, and/or changes in the waste application to cropland.

13. The Central Valley Water Board may review and revise the Order at any time upon application of any affected person or by motion of the Regional Board.

14. The Discharger shall ensure compliance with existing and/or future promulgated standards that apply to the discharge.

15. The Discharger shall permit representatives of the Central Valley Water Board and the State Water Resources Control Board (State Water Board), upon presentations of credentials at reasonable hours, to:

    a. Enter premises where wastes are treated, stored, or disposed and where any records required by the Order are kept;

    b. Copy any records required to be kept under terms and conditions of the Order;

    c. Inspect facilities, equipment (monitoring and control), practices, or operations regulated or required by the Order; and

    d. Sample, photograph, and/or video tape any discharge, waste, waste management unit, or monitoring device.

16. The Discharger shall properly operate and maintain in good working order any facility, unit, system, or monitoring device installed to achieve compliance with the Order. Proper operation and maintenance includes best practicable treatment and controls, and the appropriate quality assurance procedures.

17. Animal waste storage areas and containment structures shall be designed, constructed, and maintained to limit, to the greatest extent possible, infiltration, inundation, erosion, slope failure, washout, overtopping, by-pass, and overflow.

18. Setbacks or separation distances contained under Water Wells, Section 8, Part II, in the *California Well Standards, Supplemental Bulletin 74-90 (June 1991)*, and *Bulletin 94-81 (December 1981)*, California Department of Water Resources (DWR), shall be maintained for the installation of all monitoring wells and groundwater supply wells at existing dairies. A setback of 100 feet is required between supply wells and animal enclosures in the production area. A minimum setback of 100 feet, or other control structures (such as housing, berming, grading), shall be required for the protection of existing wells or new wells installed in the cropland. If a county or local agency adopts more stringent setback standards than that adopted by the DWR, then these local standards shall carry precedence over the Well Standards of DWR, and the Discharger shall comply with the more stringent standards.

19. Following any storm event that causes the freeboard of any wastewater holding pond to be less than one (1) foot for below-grade ponds, or two (2) feet for above-grade ponds, the Discharger shall take action as soon as possible to provide the appropriate freeboard in the wastewater holding pond.

20. For any electrically operated equipment at the facility, the failure of which would cause loss of control or containment of waste materials, or violation of this Order, the Discharger shall employ safeguards to prevent loss of control over wastes or violation of this Order. Such safeguards may include alternate power sources, standby generators, standby pumps, additional storage capacity, modified operating procedures, or other means.

## C. General Reporting Requirements:

1. The Discharger shall give at least 60 days advance notice to the Central Valley Water Board of any planned changes in the ownership or control of the facility.

2. In the event of any change in control or ownership of land or waste discharge facilities presently owned or controlled by the Discharger, the Discharger shall notify the succeeding owner or operator of the existence of the Order by letter at least 60 days in advance of such change, a copy of which shall be immediately forwarded to the appropriate Central Valley Water Board office listed below in the General Reporting Requirements C.11.

3. To assume operation under the Order, any succeeding owner or operator must request, in writing, that the Executive Officer transfer coverage under the Order. The Central Valley Water Board will provide a form for this request that will allow the succeeding owner or operator to provide their full legal name, address and telephone number of the persons responsible for contact with the Central Valley Water Board and a responsibility statement and a signed statement in compliance with General Reporting Requirement C.7 below. The form will also include a statement for signature that the new owner or operator assumes full responsibility for compliance with the Order and that the new owner or operator will implement the Waste Management Plan and the NMP prepared by the preceding owner or operator. Transfer of the Order shall be approved or disapproved in writing by the Executive Officer. The succeeding owner or operator is not authorized to discharge under the Order and is subject to enforcement until written approval of the coverage transfer from the Executive Officer.

4. The Executive Officer may require the Discharger to submit technical reports pursuant to the Order and California Water Code Section 13267.

5. The Discharger shall identify any information that may be considered to be confidential under state law and not subject to disclosure under the Public Records Act. The Discharger shall identify the basis for confidentiality. If the Executive Officer cannot identify a reasonable basis for treating the information as confidential, the Executive Officer will notify the Discharger that the information will be placed in the public file unless the Central Valley Water Board receives, within 10 calendar days, a written request from the Discharger to keep the information confidential containing a satisfactory explanation supporting the information's confidentiality.

6. Except for data determined to be exempt from disclosure under the Public Records Act (California Government Code Sections 6275 to 6276), and data determined to be confidential under Section 13267(b)(2) of the California Water Code, all reports prepared in accordance with the Order and submitted to the Executive Officer shall be available for public inspection at the offices of the Central Valley Water Board. Data on waste discharges, water quality, meteorology, geology, and hydrogeology shall not be considered confidential.

7. All technical reports and monitoring program reports shall be accompanied by a cover letter with the certification specified in C.8 below and be signed by a person identified below:

   a. For a sole proprietorship: by the proprietor;

   b. For a partnership: by a general partner;

   c. For a corporation: by a principal executive officer of at least the level of senior vice-president; or

   d. A duly authorized representative if:

      (1) The authorization is made in writing by a person described in Subsection a, b, or c of this provision;

      (2) The authorization specifies either an individual or a position having responsibility for the overall operation of the facility, such as the position of manager. A duly authorized representative may thus be either a named individual or an individual occupying a named position; and

      (3) The written authorization is submitted to the Central Valley Water Board.

8. Each person, as specified in C.7 above, signing a report required by the Order or other information requested by the Central Valley Water Board shall make the following certification:

   *"I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment."*

9. In addition to Item C.7 above, all technical reports required in the Order that involve planning, investigation, evaluation, or design, or other work requiring interpretation and proper application of engineering or geologic sciences, shall be prepared by, or

under the direction of, and signed by persons registered to practice in California pursuant to California Business and Professions Code, Sections 6735, 7835, and 7835.1 or federal officers and employees who are exempt from these Sections by California Business and Professions Code, Section 6739 or 7836. To demonstrate compliance with Title 16 CCR, Sections 415 and 3065, all technical reports must contain a statement of the qualifications of the responsible registered professional(s). As required by these laws, completed technical reports must bear the signature(s) and seal(s) of the registered professional(s) in a manner such that all work can be clearly attributed to the professional responsible for the work.

10. The Discharger shall file a Report of Waste Discharge with the Central Valley Water Board at least 140 days before making any material change in the character, location, or volume of the discharge. A material change includes, but is not limited to, the following:

    a. The addition of a new wastewater that results in a change in the character of the waste;

    b. Significantly changing the disposal or waste application method or location;

    c. Significantly changing the method of treatment;

    d. Increasing the discharge flow beyond that specified in the Order; and/or

    e. Expanding existing herd size beyond 15 percent.

11. All reports shall be submitted to the following address:

    For facilities in Fresno, Kern, Kings, Madera, Mariposa, and Tulare counties, submit reports to:

    California Regional Water Quality Control Board
    Central Valley Region
    1685 E Street
    Fresno, CA 93706
    Attention: Confined Animal Regulatory Unit

    For facilities in Butte, Lassen, Modoc, Plumas, Tehama, and Shasta counties, submit reports to:

    California Regional Water Quality Control Board
    Central Valley Region
    415 Knollcrest Drive, Suite 100
    Redding, CA 96002
    Attention: Confined Animal Regulatory Unit

For facilities in all other counties, submit reports to:

California Regional Water Quality Control Board
Central Valley Region
11020 Sun Center Drive #200
Rancho Cordova, CA 95670
Attention: Confined Animal Regulatory Unit

**D. Requirements Specifically for Monitoring Programs and Monitoring Reports:**

1. The Discharger shall file self-monitoring reports and/or technical reports in accordance with the detailed specifications contained in the MRP attached to the Order.

2. The Discharger shall maintain a written monitoring program sufficient to assure compliance with the terms of the Order. Anyone performing monitoring on behalf of the Discharger shall be familiar with the written program.

3. The monitoring program shall include observation practices, sampling procedures, and analytical methods designed to ensure that monitoring results provide a reliable indication of water quality at all monitoring points.

4. All instruments and devices used by the Discharger for the monitoring program shall be properly maintained and shall be calibrated as recommended by the manufacturer and at least once annually to ensure their continued accuracy.

5. The Discharger shall retain records of all monitoring information, including all calibration and maintenance records, copies of all reports required by the Order, and records of all data used to complete the reports. Records shall be maintained for a minimum of five years from the date of sample, measurement, report, or application. Records shall also be maintained after facility operations cease if wastes that pose a threat to water quality remain at the site. This five-year period may be extended during the course of any unresolved litigation regarding the discharge or when requested in writing by the Central Valley Water Board Executive Officer.

   a. Records of on-site monitoring activities shall include the:

      (1) Date that observations were recorded, measurements were made, or samples were collected;

      (2) Name and signature of the individual(s) who made the observations, made and recorded the measurements, or conducted the sampling;

      (3) Location of measurements or sample collection;

(4) Procedures used for measurements or sample collection;

(5) Unique identifying number assigned to each sample; and

(6) Method of sample preservation utilized.

b. Records of laboratory analyses shall include the:

(1) Results for the analyses performed on the samples that were submitted;

(2) Chain-of-custody forms used for sample transport and submission;

(3) Form that records the date that samples were received by the laboratory and specifies the analytical tests requested;

(4) Name, address, and phone number of the laboratory which performed the analysis;

(5) Analytical methods used;

(6) Date(s) analyses were performed;

(7) Identity of individual(s) who performed the analyses or the lab manager; and

(8) Results for the quality control/quality assurance (QA/QC) program for the analyses performed.

## E. Enforcement

1. California Water Code Section 13350 provides that any person who violates WDRs or a provision of the California Water Code is subject to civil liability of up to $5,000 per day or $15,000 per day of violation, or when the violation involves the discharge of pollutants, is subject to civil liability of up to $10 per gallon, or $20 per gallon; or some combination thereof, depending on the violation, or upon the combination of violations. In addition, there are a number of other enforcement provisions that may apply to violation of the Order.

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION

Order R5-2013-0122

INFORMATION SHEET
REISSUED WASTE DISCHARGE REQUIREMENTS GENERAL ORDER
FOR
EXISTING MILK COW DAIRIES

## INTRODUCTION

This Information Sheet provides information to supplement, clarify, and elaborate upon the findings and requirements contained in the reissued Waste Discharge Requirements General Order for Milk Cow Dairies R5-2013-0122 (the "Dairy General Order"). This Information Sheet is considered a part of the Dairy General Order.

The Dairy General Order will serve as general Waste Discharge Requirements (WDRs) for discharges of waste from existing milk cow dairies. The Dairy General Order is not a National Pollutant Discharge Elimination System (NPDES) permit, and does not authorize discharges to surface waters that would otherwise require a NPDES permit.

All dairies receiving coverage under the Dairy General Order are required to:

- Monitor wastewater, soil, crops, manure, surface water discharges, and storm water discharges;
- Monitor surface water and groundwater in accordance with a monitoring and reporting program (regulated dairies have the option to join a Representative Groundwater Monitoring Program (RMP) in lieu of individual monitoring of first encountered groundwater);
- Implement a Waste Management Plan for the dairy production area;
- Implement a Nutrient Management Plan (NMP) for all land application areas;
- Retain records for the production area and the land application areas;
- Submit annual monitoring reports; and
- Improve or replace management practices that are found not to be protective of water quality.

## BACKGROUND

Pursuant to Water Code section 13260, any person discharging or proposing to discharge wastes that could affect the quality of the waters of the state is obliged to file a report of that discharge with the appropriate regional water board (this report is referred to as a "Report of Waste Discharge" or "ROWD"). The regional water boards have the authority to waive this requirement pursuant to Water Code section 13269. In 1982, the California Regional Water

Quality Control Board, Central Valley Region (Central Valley Water Board or Board) adopted Resolution No. 82-036, which waived the ROWD requirement for most dairies in the Central Valley Region. This waiver remained in place until statutory changes to Water Code section 13269 resulted in the automatic expiration of all existing waivers on 1 January 2003.

Knowing that the existing waiver was due to expire, the Central Valley Water Board adopted Resolution R5-2002-0205 on 6 December 2002. This resolution stated that all dairies would be expected to obtain regulatory coverage under either:

- Individual or general waste discharge requirements prescribed by the Board pursuant to Water Code section 13263;
- A conditional waiver that the Board would adopt pursuant to Water Code section 13269; or
- Individual or general National Pollutant Discharge Elimination System (NPDES) permits, which would be issued by the Board pursuant to Federal law.

The Board rescinded Resolution R5-2002-0205 on 13 March 2003 because it had failed to issue general waste discharge requirements or a general NPDES permit, and thus dairy operators could not apply for regulatory coverage under either one of those permitting schemes before the deadlines in the resolution expired.

The Central Valley Water Board spent the next couple of years developing a regulatory strategy for addressing dairy wastes. On 8 August 2005, in furtherance of this strategy, the Board issued certified letters to the owners and operators of all known operating dairy facilities. These letters requested that the owners and operators submit a ROWD for each dairy (i.e., multiple RWODs if they owned or operated more than one dairy) to the Central Valley Water Board by 17 October 2005 (this correspondence is referred to as the "ROWD Request Letter"). On 3 May 2007, the Central Valley Water Board issued General Order R5-2013-0122 (the "2007 General Order"). The 2007 General Order regulated "existing milk cow dairies," defined as those dairies that were operating as of 17 October 2005 and that had filed a ROWD in response to the ROWD Request Letter.

Following the issuance of the 2007 General Order, the Asociación de Gente Unida por el Agua (a coalition of community residents and non-profit organizations) and the Environmental Law Foundation (collectively referred to as the "Petitioners") petitioned the 2007 General Order to the State Water Resources Control Board (State Water Board). The State Water Board dismissed the petition, concluding that it failed to raise substantial issues. The Petitioners then filed a petition for writ of mandate in the Sacramento County Superior Court (the "Superior Court"), arguing that the Central Valley Water Board failed to comply with the requirements of State Water Board Resolution 68-16, the Statement of Policy with Respect to Maintaining High Quality of Waters in California (*State Anti-Degradation Policy*) when it issued the 2007 General Order. The Superior Court denied the petition, and the Petitioners subsequently filed an appeal in the Third District Court of Appeal (the "Appellate Court"). The Appellate Court reversed the Superior Court's decision, and found that the Board's 2007 General Order did not comply with the requirements of the *State Anti-Degradation Policy*. (*Asociación de Gente Unida por el Agua* *v. Central Valley Regional Water Quality Control Bd.* (hereafter *AGUA*) (2012) 210 Cal.App.4th 1255.)

Responding to the reversal, the Superior Court issued a Writ of Mandate that compels the Central Valley Water Board to, "[s]et aside the [2007 General Order] and reissue the permit only after application of, and compliance with, the State's anti-degradation policy ... as interpreted by the Court of Appeal in its opinion." The reissued Dairy General Order is intended to set aside and replace the 2007 General Order in compliance with the Superior Court's writ of mandate.

When the Board issued the 2007 General Order, it also issued a companion Monitoring and Reporting Program (MRP) pursuant to Water Code section 13267. This MRP included monitoring, record-keeping, and reporting requirements that were applicable to all dairies regulated by the 2007 General Order. However, due to resource constraints, the dairy industry and the Central Valley Water Board acknowledged that it would be infeasible for all the dairies to immediately implement individual monitoring programs: the dairies lacked the financial resources to install multiple monitoring wells at each facility, there were not enough consultants available to develop groundwater monitoring programs and install multiple monitoring wells at each dairy facility, and the Central Valley Water Board lacked the staff to analyze thousands of individual groundwater monitoring reports.

In order to efficiently assess the water quality impacts associated with various waste management practices employed at the dairies, the Central Valley Water Board proposed two parallel approaches to monitoring: 1) the dairies that elected to conduct their own monitoring could continue to do so under their individual monitoring programs, and 2) the dairies that would prefer to pool their resources could enroll in a RMP. After soliciting public comments on revisions to the MRP that would add an RMP option, the Board's Executive Officer issued the revised version of the MRP (the "Revised MRP") on 23 February 2011.

Under the RMP approach, individual dairies have the option of joining together to collectively monitor different waste management practices in a variety of geologic settings in lieu of developing individual monitoring programs. The collective monitoring effort is being used to develop a suite of effective management practices, and substantially decreases the expense and unnecessary duplication of implementing individual monitoring programs. Dairies utilizing management practices that are found not to be protective of groundwater quality will be required to improve upon those management practices. In accordance with the terms of the Revised MRP, the Board's Executive Officer approved a Monitoring and Reporting Workplan for the Central Valley Dairy Representative Monitoring Program (CVDRMP), which is discussed in greater detail under the section entitled *How Will the Board Evaluate the Effectiveness of Management Practices?*, which is presented later on in this Information Sheet.

## DAIRIES REGULATED BY THE DAIRY GENERAL ORDER

There were approximately 1,600 dairy operations that received regulatory coverage under the 2007 General Order. Since then, the number of dairy operations within the Central Valley Region has declined significantly, largely due to economic reasons. Since 2007, revenues from milk produced by dairies have not kept up with the rising cost of doing business. Increased charges for producing and purchasing cattle feed and depressed milk prices have been the dominant factors in this decline, although regulatory compliance costs have also been a factor. The Board estimates that at this time about 1,300 dairy operations are covered by the 2007 General Order and will be subject to the reissued Dairy General Order.

The herd sizes at these dairy operations vary as operators strive to maintain a consistent milk production. Maintaining consistent milk production requires a dairy operator to manage the herd by continually producing calves, some of which eventually replace the dairy's producing herd over time, while excess stock are marketed for beef production or herd replacement elsewhere. Professionals at the University of California Davis estimate that the normal variation in California dairy herd sizes ranges from about 10 to 15 percent.

For the purposes of this Order, existing herd size is defined as the maximum number of mature dairy cows reported in the ROWDs that were submitted in response to the ROWD Request Letter, plus or minus 15 percent (to account for the normal variation in herd sizes). An increase in the number of mature dairy cows of more than 15 percent is considered an expansion, and the expanded dairy will be required to file a new ROWD to obtain regulatory coverage under a different General Order or an individual order.

As stated above, neither the 2007 General Order nor this Order purports to be a NPDES permit. Dairies that have a discharge requiring coverage under a NPDES permit must obtain coverage under Revised Order R5-2010-118, Revised Waste Discharge Requirements/NPDES Permit CAG015001 (as revised by Order R5-2011-0091). As Order R5-20011-0091 simply modifies Order R5-2010-0118, R5-2011-0091 does not exist as a separate order and the Expiration Date of Order R5-2010-0118 has not changed.

For a variety of reasons, the Central Valley Water Board may also determine that an individual dairy facility is not appropriately regulated under the Dairy General Order, and may require such a facility to be regulated under individual WDRs.

## RATIONALE FOR ISSUING A GENERAL ORDER

The Central Valley Water Board has the authority to regulate waste discharges that could affect the quality of the waters of the state under Division 7 of the Water Code. The Board regulates most discharges by prescribing waste discharge requirements (including both waste discharge requirements issued under state law and waste discharge requirements issued under the federal Clean Water Act) or by issuing conditional waivers. All confined animal facilities (as defined in Cal. Code Regs., tit. 27, § 20164), including dairies, are subject to the Board's regulatory authority.

Water Code section 13263(i) describes the criteria that the Board uses to determine whether a group of facilities should be regulated under a general order (as opposed to individual orders). These criteria include:

- The discharges are produced by the same or similar types of operations,

- The discharges involve the same or similar types of wastes,
- The discharges require the same or similar treatment standards, and
- The discharges are more appropriately regulated under general WDRs rather than individual WDRs.

Dairy facilities are appropriately regulated by a general order because they: (a) involve similar types of operations, where animals are confined and where their wastes are managed by onsite storage, land application, or removal offsite; (b) the discharges from these facilities, which are primarily composed of animal waste, are similar; (c) the dairies are subject to regulations that impose the same or similar treatment standards; (d) discharges of dairy wastes have the same potential to impact waters of the state; and, (e) given the large number of facilities and their similarities, the dairies are more appropriately regulated under a general order.

## APPLICABLE REGULATIONS, PLANS, AND POLICIES

### *Water Quality Control Plans*

The Central Valley Water Board has adopted Water Quality Control Plans (Basin Plans) for the Sacramento River and San Joaquin River Basins ($4^{th}$ ed.) and for the Tulare Lake Basin ($2^{nd}$ ed.). These two Basin Plans designate the beneficial uses of groundwater and surface waters of the Central Valley Region, specify water quality objectives to protect those uses, and include implementation programs for achieving water quality objectives. The Basin Plans also incorporate, by reference, plans and policies of the State Water Board, including the *State Anti-Degradation Policy* and State Water Board Resolution 88-63 (*Sources of Drinking Water Policy*). The Dairy General Order contains requirements necessary to bring the discharges of waste from the dairies into compliance with the Basin Plans, including requirements to meet the water quality objectives and protect beneficial uses specified in the Basin Plans, and other applicable plans and policies.

### *Beneficial Uses of Surface Water and Groundwater*

The State Water Board adopted statewide standard definitions for beneficial uses of surface and ground waters. These standard definitions were used to identify the existing and potential future beneficial uses contained in the Basin Plans. Consideration also was given to the practicability of restoring uses which may have been lost because of water quality.

<u>Surface Waters</u>: Pursuant to Chapter II of the Basin Plans, the beneficial uses of surface water may include: municipal and domestic supply; agricultural supply; industrial process supply; industrial service supply; hydro-power generation; water contact recreation; non-contact water recreation; warm freshwater habitat; cold freshwater habitat; migration of aquatic organisms; spawning reproduction and/or early development; wildlife habitat; navigation; rare, threatened, or endangered species; groundwater recharge; freshwater replenishment; aquaculture; and preservation of biological habitats of special significance. The Sacramento River and San Joaquin River Basins Plan includes four additional beneficial use designations not specified in the Tulare Lake Basin Plan (agricultural stock watering, commercial and sport fishing, estuarine

habitat, and shellfish harvesting). Both Basin Plans contain a Table that lists the surface water bodies and the beneficial uses. Where water bodies are not specifically listed, the Basin Plans designate beneficial uses based on the waters to which they are tributary.

The beneficial uses are protected in the Dairy General Order by, among other requirements, a prohibition on the direct or indirect discharge of waste and/or storm water from the production area to surface waters, a prohibition on the discharge of wastewater to surface waters from cropland, a prohibition on any discharge of storm water to surface water from the land application areas unless the land application area has been managed consistent with a certified Nutrient Management Plan, and a prohibition on the discharge of waste from existing milk cow dairies to surface waters that causes or contributes to an exceedance of any applicable water quality objective or any applicable state or federal water quality criterion.

Ground waters: Chapter II of the Sacramento River and San Joaquin River Basin Plan states:

> "Unless otherwise designated by the Regional Water Board, all groundwaters in the Region are considered as suitable or potentially suitable, at a minimum, for municipal and domestic water supply, agricultural supply, industrial service supply, and industrial process supply."

Chapter II of the Tulare Lake Basin Plan designates the beneficial uses of groundwater to include municipal and domestic supply, agricultural supply, industrial service supply, industrial process supply, water contact recreation, and wildlife habitat. The Tulare Lake Basin Plan includes a Table that lists the designated beneficial uses of groundwater within the Basin.

These beneficial uses are protected in this Order by, among other requirements, the specification that the discharge of waste at an existing milk cow dairy shall not cause a violation of water quality objectives or cause pollution or nuisance. Degradation of groundwater is allowed provided it is in accordance with this Dairy General Order.

***Water Quality Objectives***

Pursuant to Water Code section 13263(a), WDRs must implement the Basin Plans, and the Board must consider the beneficial uses of water, the water quality objectives reasonably required to protect those beneficial uses, other waste discharges, and the need to prevent nuisance conditions. Water quality objectives are the limits or levels of water quality constituents or characteristics that are established for the reasonable protection of beneficial uses of water or the prevention of nuisance within a specific area. (Wat. Code, § 13050(h).) Water quality objectives apply to all waters within a surface water or groundwater resource for which beneficial uses have been designated. Water quality objectives are listed separately for surface water and groundwater in Chapter III of the Basin Plans and are either numeric or narrative. The water quality objectives are implemented in WDRs consistent with the Basin Plans' *Policy for Application of Water Quality Objectives*, which specifies that the Central Valley Water Board "will, on a case-by-case basis, adopt numerical limitations in orders which will implement the narrative objectives." To derive numeric limits from narrative water quality objectives, the Board considers relevant numerical criteria and guidelines developed and/or published by other agencies and organizations.

The primary waste constituents of concern (COC's) due to discharges of waste from dairies with respect to surface waters are: nitrogen in its various forms (ammonia and un-ionized ammonia, nitrate, nitrite, and total Kjeldahl nitrogen), phosphorus, potassium, salts (as measured by total dissolved solids and electrical conductivity), total suspended solids, and pathogens. In addition, dairy operators typically use chemicals such as cleaning products to disinfect their milking equipment, footbaths to maintain the health of their herd, and pesticides in the production area and land application areas. Some portion of some of these chemicals may be commingled with process wastewater before it is stored in the retention pond.

The COC's due to discharges of waste from dairies with respect to groundwater are: nitrogen in its various forms (ammonia and un-ionized ammonia, nitrate, nitrite, and total Kjeldahl nitrogen), salts, and general minerals (calcium, magnesium, sodium, potassium, bicarbonate, carbonate, sulfate, and chloride). The discharge of waste from dairies must not cause surface water or groundwater to exceed the applicable water quality objectives for those constituents. If compliance cannot be immediately achieved, the Board may set a compliance time schedule for the discharger to achieve compliance with the water quality objectives. Under the Basin Plans, this time schedule must be "as short as practicable."

*Water Quality Objectives and Federal Criteria for Surface Water*[1]

Water quality objectives that apply to surface water include, but are not limited to, (1) numeric objectives, including the bacteria objective, the chemical constituents objective (includes listed chemicals and state drinking water standards, i.e., maximum contaminant levels (MCLs) promulgated in Cal. Code Regs., tit. 22, §§ 64431 and 64444 and are applicable through the Basin Plans to waters designated as municipal and domestic supply), dissolved oxygen objectives, pH objectives, and the salinity objectives; and (2) narrative objectives, including the biostimulatory substances objective, the chemical constituents objective, and the toxicity objective. The Basin Plans also contain numeric water quality objectives that apply to specifically identified water bodies, including for example, electrical conductivity objectives for the Delta.

Federal water quality criteria that apply to surface water are contained in federal regulations referred to as the California Toxics Rule and the National Toxics Rule. (See 40 C.F.R. §§ 131.36 and 131.38.)

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[1] The Dairy General Order prohibits the direct or indirect discharge of waste and/or storm water from the production area to surface waters, the discharge of wastewater to surface waters from cropland, and the discharge of storm water to surface water from the land application areas where manure or process wastewater has been applied unless the land application area has been managed consistent with a certified Nutrient Management Plan.

*Water Quality Objectives for Groundwater*

Water quality objectives that apply to groundwater include, but are not limited to, (1) numeric objectives, including the bacteria objective and the chemical constituents objective (includes state MCLs promulgated in Cal. Code Regs., tit. 22, §§ 64431 and 64444 and are applicable through the Basin Plans to municipal and domestic supply), and (2) narrative objectives including the chemical constituents, taste and odor, and toxicity objectives. The Tulare Lake Basin Plan also includes numeric salinity limits for groundwater.

## ***State Water Board Resolution 88-63*** (The Sources of Drinking Water Policy)

The *Sources of Drinking Water Policy* states that all surface waters and groundwaters of the state are considered to be suitable, or potentially suitable, for municipal or domestic water supply, except where the groundwater meets one or more of the criteria specified in the Basin Plan, including:

a. The TDS exceeds 3,000 milligrams per liter (mg/L) (5,000 micromhos per centimeter (umhos/cm) electrical conductivity) and the aquifer cannot reasonably be expected by the Regional Board to supply a public water system;

b. There is contamination, either by natural processes or by human activity (unrelated to a specific pollution incident), that cannot reasonably be treated for domestic use using either Best Management Practices or best economically achievable treatment practices; or

c. The water source does not provide sufficient water to supply a single well capable of producing an average, sustained yield of 200 gallons per day.

d. The aquifer is regulated as a geothermal energy producing source or has been exempted administratively pursuant to 40 CFR, Section 146.4. for the purpose of underground injection of fluids associated with the production of hydrocarbon or geothermal energy, provided that these fluids do not constitute a hazardous waste under 40 CFR, Section 261.3.

Both Basin Plans include criteria for granting exceptions to municipal and domestic supply designations based on the *Sources of Drinking Water Policy*. The Tulare Lake Basin Plan also includes criteria for granting exceptions to the designation of beneficial uses for agricultural supply and industrial supply. The Tulare Lake Basin Plan specifies exceptions to the designated beneficial uses for some groundwater within the Tulare Lake Basin. Exceptions to the *Sources of Drinking Water Policy* are not self-implementing, but must be established in an amendment to the Basin Plan.

## ***Title 27 of the California Code of Regulations***

Title 27 of the California Code of Regulations prescribes minimum standards for animal waste at confined animal facilities. For surface water protection, Title 27 includes requirements for the design of containment facilities for both storm water and process wastewater and for adequate flood protection. For groundwater protection, the minimum standards in Title 27 require existing milk cow dairies to minimize percolation of wastewater to groundwater in disposal fields, apply manure and wastewater to disposal fields at reasonable agronomic rates, and minimize infiltration of water into underlying soils in manured areas. Furthermore, retention ponds must be located in, or lined with, soils of at least 10 percent clay and no more than 10 percent gravel. (Cal. Code. Regs., tit. 27, § 22562(d).)

However, it is Central Valley Water Board staff's understanding that the retention pond standard was developed based on the assumption that manure solids contained within the wastewater would effectively reduce the permeability of the soils lining the wastewater ponds. This reduced permeability would result in a lowering of the pond leaching rate to a level thought to be protective of groundwater quality. An October 2003 report (the "Task 2 Report") by Brown, Vence, and Associates (BVA) confirmed that the "...current Title 27 requirements are insufficient to prevent groundwater contamination from confined animal facilities, particularly in vulnerable geologic environments." Adverse impacts have been detected in areas where groundwater is as deep as 120 feet below ground surface, and in some areas underlain by fine-grained sediments. Factors that appear to affect a clay-lined pond's ability to be protective of groundwater quality vary significantly from site to site due to native soil conditions, pond construction, pond age, manure properties, climate, pond operation, pond maintenance and depth to groundwater. Potential controlling factors appear to include: the inherent structure of the underlying soil, the moisture content of the unsaturated portion of the aquifer (vadose zone), the presence or absence of macropores or preferential pathways within the vadose zone (desiccation cracking, earthworm channels, development of root holes), and the oxidation reduction conditions present within the vadose zone and within the aquifer itself.

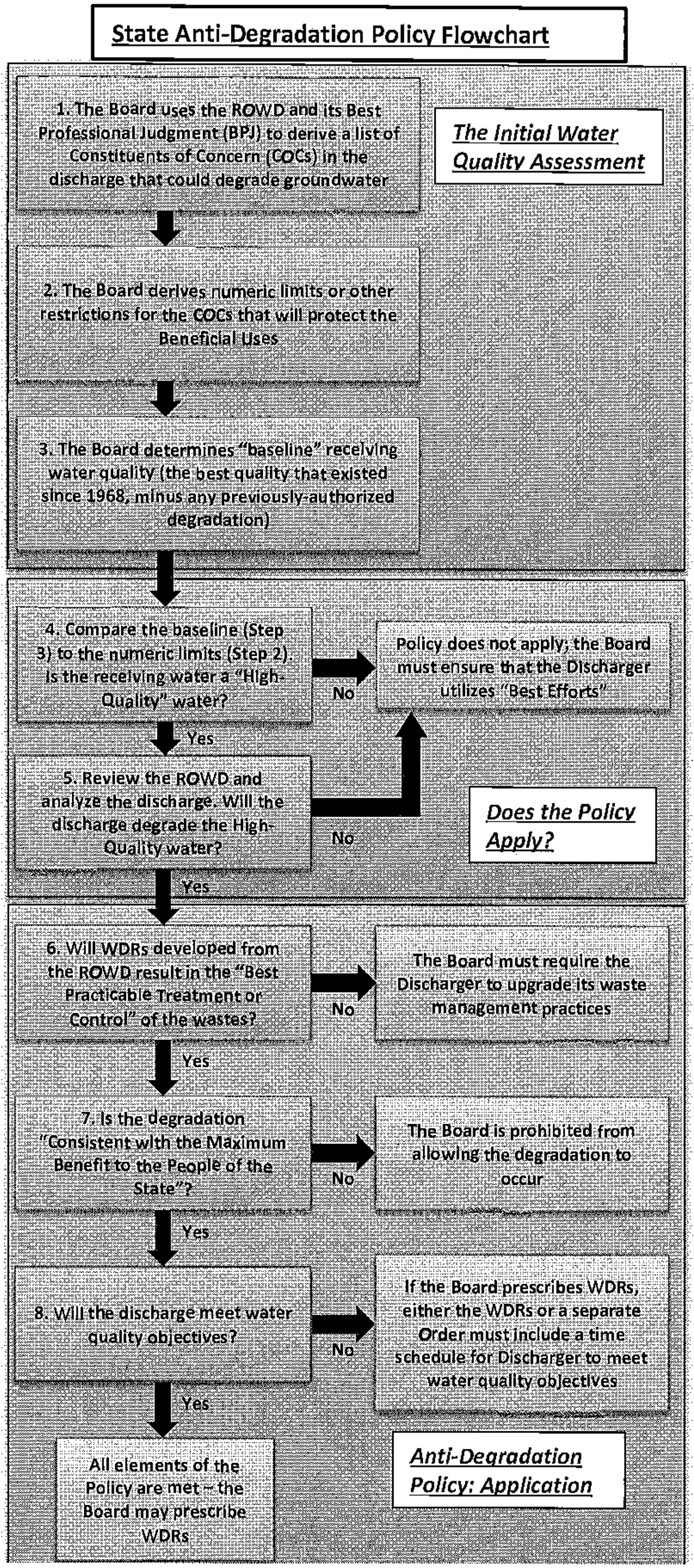
### *Resolution 68-16* (State Anti-Degradation Policy)

The *State Anti-Degradation Policy*, adopted by the State Water Board in October 1968, limits the Board's discretion to authorize the degradation of high-quality waters. This policy has been incorporated into the Board's Basin Plans. High-quality waters are those waters where water quality is more than sufficient to support beneficial uses designated in the Board's Basin Plan. Whether or not a water is a high-quality water is established on a constituent-by-constituent basis, which means that an aquifer can be considered a high-quality water with respect to one constituent, but not for others. (State Water Board Order WQ 91-10.)

The following provisions of the *State Anti-Degradation Policy* are directly applicable to the discharges regulated by the Dairy General Order:

1. Whenever the existing quality of water is better than the quality established in policies as of the date on which such policies become effective, such existing high quality will be maintained until it has been demonstrated to the State that any change will be consistent with maximum benefit to the people of the State, will not unreasonably affect present and anticipated beneficial use of such water, and will not result in water quality less than that prescribed in the policies.
2. Any activity which produces or may produce a waste or increased volume or concentration of waste and which discharges or proposes to discharge to existing high quality waters will be required to meet waste discharge requirements which will result in the best practicable treatment or control of the discharge necessary to assure that (a) a pollution or nuisance will not occur and

(b) the highest water quality consistent with maximum benefit to the people of the State will be maintained.




Generally speaking, these provisions require that the Board adopt standards and requirements to ensure the discharger controls the discharge by employing "best practicable treatment or control" methodologies to limit the extent of the degradation, and that the Board carefully consider whether the permitted degradation inheres to the maximum benefit to the people of the State when the Board prescribes waste discharge requirements that will result in the degradation of high-quality waters. The *State Anti-Degradation Policy* also requires that the Board prohibit waste discharges from resulting in water pollution or nuisance, though this is a requirement that also exists outside the context of the *State Anti-Degradation Policy*. (*see* Wat. Code, § 13263.)

The State Water Board has provided only limited guidance regarding the *State Anti-Degradation Policy*. The State Water Board's Administrative Procedures Update 90-004 provides guidance for implementing *State Anti-Degradation Policy* and the Clean Water Act's anti-degradation provisions (40 C.F.R. § 131.12.) in the context of NPDES permitting. Although APU 90-004 is not directly applicable to the Dairy General Order because nonpoint discharges from agriculture are exempt from NPDES permitting requirements, the Appellate Court found this document informative in interpreting the *State Anti-Degradation Policy*. The following analysis adheres to existing guidance and the Appellate Court's decision in the *AGUA* case.

As recounted in the *AGUA* litigation, the Board erred when it issued the 2007 General Order because it failed to comply with the *State Anti-Degradation Policy*. The reissued Dairy General Order contains revisions designed to comply with the *AGUA* decision, which interpreted the requirements of the *State Anti-Degradation Policy*. The flow chart on this page describes the process that the Board generally uses to apply the *State Anti-Degradation Policy*, and the following discussion elaborates on how these requirements are applied in the context of the Dairy General Order.

The following sections describe the step-by-step approach for applying the Anti-Degradation Policy, followed by the direct application of this policy to the Dairy Genearl Order.

*The Initial Water Quality Assessment*

Step 1: Due to the constituent-by-constituent nature of an anti-degradation analysis, the Board must first compile a list the waste constituents present in the discharge that could degrade groundwater. These constituents are referred to as "constituents of concern," or COCs. The Board uses its best professional judgment to determine this suite of COCs, which is usually extrapolated from the ROWD that was submitted by the discharger.

Step 2: Once the Board has compiled the list of COCs, it then references numeric limits or other restrictions that would protect the beneficial uses associated with the receiving water. Some constituents, such as those constituents that have Maximum Contaminant Levels established in Title 22 of the California Code of Regulations, have numeric water quality objectives associated with them, while others have only narrative water quality objectives associated with them. For constituents that have only narrative water quality objectives associated with them, the Board derives numeric limits by considering relevant numerical criteria and guidelines developed and/or published by other agencies and organizations. (e.g., State Water Board, California Department of Health Services, California Office of Environmental Health Hazard Assessment, California Department of Toxic Substances Control, University of California Cooperative Extension, California Department of Fish and Game, U. S. EPA, U. S. Food and Drug Administration, National Academy of Sciences, U. S. Fish and Wildlife Service, Food and Agricultural Organization of the United Nations).

Step 3: The Board then makes a good-faith effort to determine best water quality that has existed since 1968, the year in which the anti-degradation policy was promulgated (often data from 1968 or earlier are unavailable). The Board then determines whether any subsequent lowering of water quality was due to a regulatory action taken by the Board. The best quality that has existed since 1968, minus any authorized degradation, becomes the "baseline" water quality[2].

*Determining Whether the Anti-Degradation Policy is Triggered*

Step 4: The Board compares the numeric limits derived in Step 2 with the baseline water quality derived in Step 3. For each constituent, if the baseline water quality is better than the derived

[2] Water quality control policies adopted subsequent to 1968 may alter the calculation of this baseline.

limits (i.e., the quality needed to support all of the beneficial uses), then the water is considered a "high-quality water." If the receiving water is not a high-quality water for all of the COCs, then the *State Anti-Degradation Policy* does not apply.

Step 5: The Board determines whether the discharge will degrade the receiving water. The Board makes this determination by comparing the information contained in the discharger's ROWD or other applicable information with the baseline water quality. If the discharge will not degrade the receiving water, then the *State Anti-Degradation Policy* does not apply. *Application of the State Anti-Degradation Policy's Requirements*

Step 6: If the discharge will degrade a high-quality water, then the *State Anti-Degradation Policy* requires the Board to prescribe requirements that will result in the best practicable treatment or control (BPTC) of the wastes in the discharge. BPTC is an evolving concept that takes into account changes in the technological feasibility of deploying new or improved treatment or control methodologies, new scientific insights regarding the effect of pollutants, and the economic realities that regulated industries face. Because this concept evolves over time, standard industry practices that are considered BPTC today may not be considered BPTC in the future. And though "practicality" limits the extent to which a discharger must implement expensive treatment or control measures, the Board must ultimately ensure that discharges do not cause pollution or nuisance, thereby protecting those who rely on the quality of groundwater and surface waters.

Neither the Water Code nor the *State Anti-Degradation Policy* defines the term "best practicable treatment or control." However, the State Water Board has stated that "one factor to be considered in determining BPTC would be the water quality achieved by other similarly situated dischargers, and the methods used to achieve that water quality." (See Order WQ 2000-07, at pp. 10-11). Furthermore, in a "Questions and Answers" document for Resolution 68-16 (the Questions and Answers Document), BPTC is interpreted to include:

> "[A] comparison of the proposed method to existing proven technology; evaluation of performance data (through treatability studies); comparison of alternative methods of treatment or control, and consideration of methods currently used by the discharger or similarly situated dischargers."

Though the Board is prohibited from specifying the design, location, type of construction, or particular manner in which a discharger may comply with a requirement, order, or decree (Wat. Code § 13360.), the Board can still compare the treatment or control practices that a discharger has described in its ROWD to the treatment or control practices employed by similarly-situated dischargers in order to make a BPTC determination. (State Water Board Order WQ 2000-7.) Furthermore, "practicability" dictates that the Board consider the costs associated with the treatment or control measures that are proposed in the ROWD.

Step 7: The *State Anti-Degradation Policy* also requires that the Board consider whether the degradation authorized in a permit is "consistent with the maximum benefit to people of the state." For discharges subject to the federal Clean Water Act, it is only after "intergovernmental coordination and public participation" and a determination that "allowing lower water quality is necessary to accommodate important economic or social development in the area in which the waters are located" that the Board can allow for degradation. (40 C.F.R. § 131.12.)

As described in the Question and Answers Document mentioned above, some of the factors that the Board considers in determining whether degradation is consistent with the maximum benefit to people of the State include: economic and social costs, tangible and intangible, of the proposed discharge, as well as the environmental aspects of the proposed discharge, including benefits to be achieved by enhanced pollution controls. USEPA guidance clarifies that the federal anti-degradation provision,

> "... is not a 'no growth' rule and was never designed or intended to be such. It is a policy that allows public decisions to be made on important environmental actions. Where the state intends to provide for development, it may decide under this section, after satisfying the requirements for intergovernmental coordination and public participation, that some lowering of water quality in "high quality waters" is necessary to accommodate important economic or social development" (EPA Handbook for Developing Watershed Plans to Restore and Protect Our Waters, Chapter 4).

APU 90-004 requires the Board to consider both the costs to the discharger and the costs imposed upon the affected public in the NPDES context, and states that "[c]ost savings to the discharger, standing alone, absent a demonstration of how these savings are necessary to accommodate 'important social and economic development' are not adequate justification' for allowing degradation."

It is, however, important to keep the "maximum benefit to people of the state" requirement in context. Neither the *State Anti-Degradation Policy* nor the Water Code allows unreasonable affects to beneficial uses. Therefore, such unreasonable effects (such as the unmitigated pollution of a drinking water source) are not the focus of the Board's inquiry, because they are legally prohibited. Instead, the *State Anti-Degradation Policy* requires the Board to consider the costs that may be imposed on other dischargers as a result of the degradation that the Board is allowing to occur. For example, if the Board allows a discharger to operate a sub-standard facility that degrades a high-quality groundwater, dischargers situated downstream (for surface waters) or downgradient (for groundwaters) from that discharge would be discharging to a receiving water that lacks any capacity to assimilate additional waste loads. This may impose higher treatment costs on the downstream/downgradient discharger.

Ultimately, the Board may allow degradation to occur following a demonstration that the degradation is consistent with the maximum benefit to the people of the state; the *State Anti-Degradation Policy* is not a no-growth or no-degradation policy. However, the Board must justify why this degradation is beneficial not only to the discharger, but to others reliant on the water quality of the receiving water body.

Step 8: the Board must ensure that discharges will not unreasonably affect present and anticipated beneficial use of such water, will not result in water quality less than that prescribed in relevant policies, and will not cause pollution or nuisance. The Water Code defines "pollution" to mean an alteration of the quality of the waters of the state by waste to a degree which unreasonably affects either the waters for beneficial uses or the facilities which serve these beneficial uses, i.e., violation of water quality objectives. (Wat. Code, § 13050(1).) The term nuisance is defined as anything that is, (1) injurious to health, indecent or offensive to the senses, or an obstruction to the free use of property so as to interfere with the comfortable enjoyment of life or property; (2) affects an entire community or considerable number of persons; and (3) occurs during, or as a result of, the treatment or disposal of wastes. (Wat. Code, § 13050(m).) To constitute a nuisance, all three factors must be met.

The Board ensures that this component of the *State Anti-Degradation Policy* is met by requiring a discharger to comply with water quality objectives designed to protect all designated beneficial uses, thereby protecting those who rely on the quality of groundwater and surface waters.

### *The* State Anti-Degradation Policy *as Applied to the Dairy General Order*

Steps 1-5 (Applied): Although background water quality varies significantly in those areas covered by the Dairy General Order, most receiving waters are considered high-quality waters for one or more constituents of concern, and wastes from dairy facilities will degrade these waters. As the court concluded, "it is certain that the water quality of [at least some of] the existing groundwater is better than the water quality objective, making the groundwater high quality water for antidegradation purposes. Water can be considered high quality for purposes of the antidegradation policy if it is determined to be so for any one constituent, because the determination is made on a constituent by constituent basis." (*AGUA* at 1271.) Furthermore, evidence in the Administrative Record indicates that wastes discharged from the regulated dairies will degrade this high-quality water, thereby triggering the *State Anti-Degradation Policy*.

Step 6 (Applied): Given that the *State Anti-Degradation Policy* applies, the Board must ensure that the Dairy General Order requires regulated dairies to implement BPTC measures to minimize the amount of degradation that will occur.

Generally speaking, the waste management practices employed by dairies can be broken down into three distinct areas: production areas (including milk barns, feed storage areas, and corral areas), wastewater ponds, and land application areas. The following is a discussion of what the Board considers to be BPTC for each of these three components of the regulated dairy operations.

#### Best Practicable Treatment or Control Measures for the Production Area

The Dairy General Order considers the term "Production Area" to include milk barns, wash/sprinkler pens, feed and non-liquid manure storage areas, and corrals (i.e., animal confinement areas). For these areas, the most effective way to reduce or eliminate water quality impacts is to restrict the infiltration of waste in these areas. Title 3 of the California Code of Regulations (Title 3), sections 645 et seq., set specifications for milk dairy buildings, including:

- § 646.1 (Corrals, Ramps, and Surroundings). This section requires that dirt or unpaved corrals be graded to promote drainage and that cow washing areas shall be paved (concrete or equivalent) and sloped to a drain. Water troughs, permanent feed racks, and mangers shall have paved access, and water troughs shall have a drain to carry water away from the corrals;

- § 648(c) Requires that milk rooms be floored with concrete or other suitable material and be provided with a vented, trapped drain and §649(a) requires that milk barns be floored with concrete or other suitable material and be sloped to drain; and
- § 661 Requires that roof drainage from barns, milk houses, or shelters shall not drain into a corral unless the corrals are paved and properly drained.

In addition to the requirements of Title 3, the Dairy General Order requires that milk barns, including their related sprinkler pens and gutters be designed and maintained to convey all water that has contacted animal wastes or feed directly to the wastewater retention system, and that all production area structures must be constructed or otherwise designed so that clean rainwater is diverted away from manured areas, feed storage areas, and waste containment facilities, unless drainage is fully contained in the wastewater retention system. Dairy operators must design and maintain the animal confinement area (including corrals), and manure and feed storage areas in a manner that limits infiltration so that wastes, nutrients, and contaminants generated are directed to the manure retention pond(s). The Dairy General Order prohibits standing water in these areas as of 72 hours after the last rainfall (*see* Production Area Specification D-6 of the reissued Dairy General Order).

<u>Best Practicable Treatment or Control Measures for Land Application Areas</u>

Normal commercial farming practices, including the application of dairy wastes to cropland as fertilizer, can contribute salts, nutrients, pesticides, trace elements, sediments, and other by-products that can affect the quality of surface water and groundwater. Evaporation and crop transpiration remove water from soils, which can result in an accumulation of salts in the root zone. Additional amounts of water are often applied to leach the salts below the root zones. These leached salts can cause impacts to groundwater or surface waters. Even using the most efficient irrigation systems and appropriate fertilizer application rates and timing to correspond to crop needs, irrigation of cropland may degrade high-quality groundwater. In addition, in land applications areas where groundwater is shallow, some Dischargers have installed subsurface (tile) drainage systems to maintain the groundwater level below the crop's root zone. Drainage from these systems, which may include constituents originating from the dairies, may be discharged directly to surface water bodies or to drainage ditches that discharge to surface water bodies. Some of these systems discharge to evaporation basins that are subject to waste discharge requirements.

With respect to salts and nutrients, the key to limiting degradation and ensuring compliance with water quality objectives at the dairies' land application areas is an effective Nutrient Management Plan, which specifies the volume and composition of the wastewater that can be applied to land application areas without causing adverse groundwater impacts. The Board considers an effective Nutrient Management Plan to be BPTC for the land application areas. The majority of the dairies covered under the 2007 General Order had been operating for many years without a Nutrient Management Plan. In response, the Board required each dairy operator to develop and implement a Nutrient Management Plan, and the reissued Dairy General Order will continue this requirement.

Unlike most other groundwater-related components of a dairy's waste management strategy, Nutrient Management Plans have received a significant amount of attention from the USEPA. This is because precipitation-related discharges from land application areas are considered agricultural storm water discharges, and are therefore not subject to the federal Clean Water Act's CAFO regulations. However, this exemption applies only when the "…manure, litter, or process wastewater [at the land application area] has been applied in accordance with site specific nutrient management practices that ensure appropriate agricultural utilization of the nutrients in the manure, litter, or process wastewater…" (40 C.F.R. §122.23.) Therefore, the USEPA has taken a close interest in the "site specific nutrient management practices" for application of waste from large concentrated animal feeding operations to land application areas. The Dairy General Order mandates that dairies employ the management practices required by Title 40 Code of Federal Regulations Section 122.42(e)(1)(vi)-(ix).

Because the Dairy General Order requires compliance with the federal CAFO regulatory requirements, precipitation-related discharges from land application areas at facilities operating in compliance with this Order are considered agricultural storm water discharges. And since they are consistent with USEPA's "best practicable control technology," the technical standards for nutrient management represent BPTC for the purposes of compliance with the *State Anti-Degradation Policy*. In addition, the Dairy General Order requires dairies who utilize tile drain systems to identify their location and discharge point(s) and to monitor discharges from these systems. The Dairy General Order also specifies well and surface water setbacks and requires certification of backflow prevention for all irrigation wells (Standard Provisions 18 and Attachment B. VI [*Waste Management Plan for the Production Area for Existing Milk Cow Dairies*]). Additionally, the Dairy General Order's Land Application Specifications contains additional requirements regarding waste infiltration and soil moisture capacity limits for waste application.

<u>Pond Requirements: Generally</u>

The Dairy General Order includes requirements that all ponds must be verified by an engineer to have adequate capacity and structural integrity to hold generated process water and precipitation. All ponds must be managed and maintained to prevent breeding of mosquitoes and other vectors. Ponds shall not have small coves and irregularities around the perimeter of the water surface. Weeds shall be minimized in all ponds through control of water depth, harvesting, or other appropriate method, and dead algae, vegetation, and debris shall not be allowed to accumulate on the water surface. These measures are required elements of a BPTC program for all ponds, whether they are already existing ponds or whether they are new or expanded ponds.

<u>Best Practicable Treatment or Control Measures for New or Expanded Ponds</u>

Three counties in the Central Valley Region, many other states, and the Natural Resources Conservation Service have pond design requirements that are more stringent than is required by Title 27 (see Table 1 at the end of this Information Sheet). For new or expanded ponds, the Board considers these more stringent design standards to be BPTC.

Kings County and Merced County require pond liners to have a maximum seepage rate of $1 \times 10^{-6}$ centimeters per second (cm/sec). Four of the top ten milk producing states (Wisconsin, Pennsylvania, Michigan, and Washington) require ponds to be designed to comply with the state's Natural Resources Conservation Service Practice Standard 313 (CPS 313). These states' CPS 313s have pond liner requirements that range from in-place soils (two to three feet thick with more than 50 percent fines or maximum permeability of $1 \times 10^{-6}$ cm/sec), or a liner of one foot thick compacted clay with maximum permeability of $1 \times 10^{-7}$ or maximum seepage rate of $1 \times 10^{-6}$ if manure sealing cannot be credited or $1 \times 10^{-5}$ cm/sec if manure sealing can be credited, minimum thickness of one foot) concrete, geomembranes, or geosynthetic clay liners[3].

One state (Idaho) requires pond liners to comply with NRCS Agricultural Waste Management Field Handbook Appendix 10D, which recommends either: two feet of in-place soils with maximum permeability of $1 \times 10^{-6}$ cm/sec or a liner of compacted clay (minimum one foot thick with allowable seepage rate of $1 \times 10^{-5}$ cm/sec if manure sealing credit allowed or $1 \times 10^{-6}$ cm/sec if manure sealing credit not allowed), concrete, geomembrane, or geosynthetic clay. New Mexico and Texas require pond liners have a maximum permeability of $1 \times 10^{-7}$ cm/sec and Minnesota requires pond liners with a maximum seepage rate of $5 \times 10^{-7}$ cm/sec.

California CPS 313 requires pond liners have a maximum target seepage rate of $1 \times 10^{-6}$ cm/sec, except where aquifer vulnerability or risk is high in which case a synthetic liner or other alternative liner is required (see Table 1 of this Information Sheet).

While these pond design requirements provide more groundwater protection than the Title 27 requirements, there are no known studies that fully evaluate the ability of any of these county, state, or NRCS pond liner requirements to protect groundwater quality. It would be difficult to determine if any proposed pond design would be protective of groundwater quality without an evaluation of information on depth to groundwater, existing groundwater quality beneath the facility, nature of the geologic material between the bottom of the retention pond and the first encountered groundwater, nature of the leachate from the retention pond, and proximity to existing supply wells. Proposed pond designs that do not include such an evaluation should be very conservative to assure protection of groundwater under any likely conditions. The most conservative pond design would include a double lined pond with a leachate collection and removal system between two geosynthetic liners. Such pond designs are currently being approved by the Central Valley Water Board at classified waste management units regulated under Title 27 of the California Code of Regulations (i.e., landfills and Class II surface impoundments) and a limited number of wastewater retention ponds at dairies.

The Dairy General Order provides a two-tiered approach that will allow the Discharger two options for retention pond design. Tier 1 includes a retention pond designed to consist of a double liner constructed with 60-mil high density polyethylene or material of equivalent durability with a leachate collection and removal system (constructed in accordance with Cal. Code

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[3] National Resources Conservation Service, Agricultural Waste Management Field Handbook, Appendix 10D – Geotechnical, Design, and Construction Guidelines.

Regs., tit. 27, § 20340) between the two liners. Review for retention ponds designed to this standard will be conducted in less than 30 days of receipt of a complete design plan package submitted to the Board. Tier 2 includes a retention pond designed in accordance with California Natural Resource Conservation Service (NRCS) Conservation Practice Standard 313 or equivalent and which the Discharger must demonstrate through submittal of technical reports that the alternative design is protective of groundwater quality.

Best Practicable Treatment or Control Measures for Existing Dairy Ponds

Existing dairy ponds were built to contain and store the large quantities of dairy cow wastes prior to discharge to land application areas. These ponds present a difficult challenge for the dairies that may be causing unacceptable groundwater impacts. This is because requiring the immediate retrofitting of existing ponds to meet Tier 1 or Tier 2 requirements (the Dairy General Order's requirements for new or expanded ponds) would be beyond practicable economic limits for most dairies (See Memorandum from John Schaap and Steve Bommelje, Provost & Pritchard to Theresa A. Dunham, Somach Simmons & Dunn (August 5, 2013), *Costs to Retrofit Existing Dairies That Do Not Have Tier 1 or Tier 2 Lagoons* (Provost & Pritchard 2013); see also Memorandum from Annie AcMoody, Western United Dairymen to Theresa A. Dunham, Somach Simmons & Dunn (August 6, 2013), *Financial Impact to Retrofit Existing Dairies That Do Not Have Tier 1 or Tier 2 Lagoons* (AcMoody 2013).) Specifically, the range of costs to retrofit lagoons range from an estimated low of $180,000 for a single liner at a 300 milk cow dairy to almost $1.4 million for a double liner at a 3000 milk cow dairy. (See Provost & Pritchard 2013, p. 3.) Considering the net loss in dairy operation revenues over the past five years and the likelihood of an inability to obtain financing, it would be near impossible for most dairy operations retrofit dairy lagoons and remain in operation. (AcMoody 2013, p. 4.) If forced to retrofit such lagoons, many dairy operations would likely go out of business. The widespread closure of dairies in the Central Valley would have regional and state economic impacts.

Considering the wide-spread economic impacts that would occur with respect to requiring application of Tier 1 or Tier 2 requirements to existing ponds, the Central Valley Water Board finds that BPTC for existing ponds constitutes an iterative process of evaluation that includes groundwater monitoring individually or through the RMP, assessment of data collected, evaluation of Existing Pond conditions and their impact on groundwater quality, and case studies that evaluate potential changes in management practices and/or activities that may be necessary to further protect groundwater quality from existing ponds.

The Board will use the SRMR (for dairies represented in the RMP) or individual Summary Monitoring Reports (SMRs), for dairies that are in an individual monitoring program, to determine whether upgrades to existing ponds will be required. Facilities where data demonstrate that an existing pond is resulting in degradation beyond what is authorized under this order will be required to upgrade facilities on a time schedule that is as short as practicable. Substituting alternative management practices for the existing ponds (such as reducing the water level in the ponds, dry-scrape, or other methods) would also be acceptable, provided those management practices are found to be protective of groundwater quality for the conditions present where they would be implemented. Regulated dairies that are found not to be protective of underlying groundwater must upgrade their management practices on a time schedule that is as short as practicable, supported with appropriate technical or economic justification, but in no case may time schedules extend beyond 10 years from the date that the Summary Report or SRMR is approved by the Executive Officer.

Step 7 (Applied): In the case of the dairies regulated by the Dairy General Order, allowing the maximum extent of degradation allowed by law (i.e., degradation up to the water quality objectives that are protective of the designated beneficial uses) would allow the Board to focus its efforts on ensuring that the discharges do not impact sensitive populations that rely on the quality of the receiving waters. In other words, while the focus of the *State Anti-Degradation Policy* is on justifying degradation that will ultimately result in water quality somewhere between the "best water quality that has existed since 1968" and a numeric limit that is protective of all beneficial uses, the Board and the dairy industry acknowledge that their primary task lies in preventing pollution and protecting sensitive uses.

The Board acknowledges that significant degradation at dairies has occurred throughout the Central Valley Region due to historic practices. In issuing the Dairy General Order, the Board will allow the maximum extent of degradation allowed by law to occur. The Dairy General Order is structured in such a way as to compel the dairy industry to focus their available resources on meeting water quality objectives, thereby protecting communities that are dependent on groundwater. As the dairy industry develops more effective management practices in the coming years, the Board may re-evaluate this goal, and may impose more stringent requirements that reflect the availability of better practicable management practices.

Step 8 (Applied): Although dairy waste materials provide nutrients to crops, they can create pollution or nuisance conditions if improperly managed or cause pollution of surface water and/or groundwater if site conditions are not taken into account in preparing a nutrient utilization and management strategy.

While the Board recognizes that it may be impracticable for the dairy industry to make dramatic changes to its waste management practices overnight, or even in a few years, those dairies whose practices are found to not be protective of the underlying groundwater through required individual or representative monitoring must upgrade their operations to ensure compliance with water quality objectives on a time schedule that is as short as practicable.

Allowing regulated dairies to degrade high quality waters is consistent with maximum benefit to people of the State as long as that degradation does not result in detrimental impacts to beneficial uses over the long term. California's dairy industry, built on the foundation of 1,563 family-owned dairies statewide[4], is important to the economic well-being of the Central Valley. Dairy farms generate jobs in a variety of sectors, from employees on the farm, providers of farm and veterinary services, other farmers who grow feed, processors of milk and dairy products, and in transportation of feed, milk and dairy products, and many others. According to a

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[4] Source for this an all data on number of dairies, cows and farm gate value of milk: CDFA.ca.gov/dairy/dairystatsannual.html

California Milk Advisory Board analysis[5], California's dairy industry is responsible for creating a total of 443,574 jobs and $63 billion in economic activity. The same report estimated that a typical dairy cow generates $34,000 in economic activity annually and a herd of 100 cows creates about 25 jobs.

The economic value of the dairy industry is particularly important within the Central Valley, where 89 percent of the state's cows and 81 percent of the state's dairy farms are located, as well as a significant fraction of the state's 117 dairy processing plants. Moreover, the jobs generated in the Central Valley are of even greater importance given routine double-digit unemployment rates in many rural counties and a high reliance on a healthy agricultural sector. Furthermore, California dairy farms are a significant producer of the nation's milk supply. In 2012, California dairy farms produced about 41.7 million pounds of milk, which is about a fifth of the nation's milk supply. As such, California dairies play an important role in food and nutrition security for California and the nation.

Considering the economic significance of the Central Valley dairy industry as well as the important role Central Valley dairies play in providing adequate milk supplies to the nation, the Central Valley Water Board finds that maintaining the Central Valley dairy industry is to the benefit of the people of the state.

*Verifying that the State Anti-Degradation Policy is Satisfied*

Although not an explicit provision of the *State Anti-Degradation Policy*, the Appellate Court determined that the Dairy General Order does not comply with the *State Anti-Degradation Policy* without a monitoring program sufficient to determine whether the discharges are in compliance with the *State Anti-Degradation Policy*.

The primary method used to determine if water quality objectives and the requirements of the *State Anti-Degradation Policy* are being met is surface water and groundwater quality monitoring. The Dairy General Order prohibits discharges of storm water from the production area to surface water and any discharge of storm water to surface water from the land application areas being used for nutrient utilization unless that discharge is from land that has been managed consistent with a certified Nutrient Management Plan. Should discharges of manure, process wastewater, or storm water occur from the production area, the Dairy General Order requires discharge monitoring and chemical analysis to determine if an exceedance of a water quality objective has occurred. The Dairy General Order also requires monitoring of the first storm water discharge of the year to surface waters from land application areas on a rotating basis (1/3 of the fields per year); and tailwater discharges to surface waters from the land application areas if they have occurred less than 60 days following an application of manure and/or process wastewater. Likewise, the Dairy General Order requires individual or

[5] http://www.californiadairypressroom.com/node/289, study by J/D/G Consulting using economic output multipliers developed by the U.S. Department of Commerce, Bureau of Economic Analysis. Based on 2008 data (size of the California dairy industry in number of cows has declined about 3.4 percent since 2008 but the economic impact of the industry is expected to be roughly similar today as to 2008 due to slightly higher overall levels of milk production).

representative groundwater monitoring of natural background water quality and the water quality downgradient of the waste management units (production area, corrals, and land application areas).

Monitoring and Reporting Program R5-2013-0122 (MRP) requires dairy operators to sample domestic and irrigation supply wells on their property, and to either monitor first-encountered groundwater at their facility or participate in an approved representative groundwater monitoring program. The purpose of requiring monitoring of water supply wells includes identifying the quality and trends of water being used at the dairy and the amount of nutrients contained in irrigation water so it can be accounted for in the development of the required nutrient management plan. The purpose of requiring monitoring of first-encountered groundwater is to evaluate current management practices in order to determine whether such practices are protective of groundwater quality at the most vulnerable point. Groundwater monitoring at existing dairies is necessary to: determine background groundwater quality, determine existing groundwater conditions near retention ponds, production areas, and land application areas, determine whether improved management practices need to be implemented, and confirm that any improved management practices will have the desired result on groundwater quality.

This Order requires the Discharger to report any noncompliance that endangers human health or the environment or any noncompliance with the Prohibitions contained in the Order within 24 hours of becoming aware of its occurrence. The Dairy General Order also requires the Discharger to submit annual monitoring reports which contain the analytical results of laboratory data, including all laboratory analyses (including Chain of Custody forms and laboratory QA/QC results) for surface and groundwater monitoring. Additionally, an annual assessment of groundwater monitoring is required. The assessment must include an evaluation of the groundwater monitoring program's adequacy to assess compliance with the Order, including whether the data provided are representative of conditions upgradient and downgradient of the wastewater management area, production area, and land application area of the dairy facility.

Similar to the individual groundwater monitoring program, the representative groundwater monitoring program is required to submit annual monitoring reports and an evaluation of data collected to date and an assessment of whether participating dairies are implementing management practices that minimize degradation of high quality groundwaters and are protective of beneficial uses.

The Central Valley Water Board recognizes that monitoring the effectiveness of the dairies' waste management practices and their effect on groundwater is needed to verify that water quality is adequately protected and the intent of the anti-degradation policy is met. Accordingly, the Dairy Order, in conjunction with the MRP, requires additional groundwater monitoring that must be conducted on an individual dairy basis or through Representative Monitoring Programs (RMPs). Under the terms of the Dairy Order and MRP, all dairies subject to the terms of the Dairy Order must either conduct their own groundwater monitoring or actively participate in a RMP. Currently, most dairies subject to the Dairy Order (more than 98 percent) are members of an RMP.

Both the individual groundwater monitoring provisions and the RMP's monitoring requirements are designed to measure water quality data over time in first-encountered groundwater. An RMP is further required to conduct such monitoring on a variety of dairy farms that represent the overall range of conditions on dairies within the Central Valley. This means for a RMP that a variety of physical site conditions must be monitored, such as varying soil types and depth to groundwater. Varying management conditions must also be measured, such as different types of crops, irrigation methods, waste storage structures and animal housing.

It is recognized that in many cases, a single set of groundwater monitoring data, or even monitoring data over a period of months or years, may not be sufficient to determine the effectiveness of existing management practices. Evaluating groundwater results over an extended period of time, in conjunction with gathering data regarding existing surface practices, is necessary to determine whether water quality is being protected or is being unreasonably impacted.

***Waters that are Not High Quality: The "Best Efforts" Approach***

When a receiving water body quality exceeds or just meets the applicable water quality objective due to naturally-occurring conditions or due to prior Board-authorized activities, it is not considered a high-quality water, and it is not subject to the requirements of the *State Anti-Degradation Policy*. However, where a groundwater constituent exceeds or just meets the applicable water quality objective, the Board must set limitations no higher than the objectives set forth in the Basin Plan. This rule may be relaxed if the Board can show that "a higher discharge limitation is appropriate due to system mixing or removal of the constituent through percolation through the ground to the aquifer." (State Water Board Order No. WQ 81-5.) However, the Board should set limitations that are more stringent than applicable water quality objectives if the more stringent limitations can be met through the use of "best efforts." (State Water Board Order No. WQ 81-5.)(*City of Lompoc*) The "best efforts" approach involves the establishment of requirements that require the implementation of reasonable control measures. Factors which are to be analyzed under the "best efforts" approach include the water quality achieved by other similarly situated dischargers, the good faith efforts of the discharger to limit the discharge of the constituent, and the measures necessary to achieve compliance. (*City of Lompoc*, at p. 7.) The State Water Board has applied the "best efforts" factors in interpreting BPTC. (see State Water Board Order Nos. WQ 79-14 and WQ 2000-07.)

In summary, the Board may establish requirements more stringent than applicable water quality objectives even outside the context of the *State Anti-Degradation Policy*. The "best efforts" approach must be taken where a water body is not "high quality" and the antidegradation policies are accordingly not triggered.

***California Environmental Quality Act***

The Central Valley Water Board adopted a Negative Declaration in 1982 concurrent with the adoption of Resolution 82-036, which waived waste discharge requirements for milk cow dairies. The adoption of the Dairy General Order, which prescribes regulatory requirements for existing facilities in order to ensure the protection of groundwater resources, is exempt from the requirements of the California Environmental Quality Act (CEQA)(Pub. Resources Code, § 21000 et seq.) based on the following three categorical exemptions:

- California Code of Regulations, title 14, section 15301 exempts the "operation, repair, maintenance, [and] permitting ... of existing public or private structures, facilities, mechanical equipment, or topographical features" from environmental review. Eligibility under the Dairy General Order is limited to milk cow dairies that were existing facilities as of 17 October 2005, and the Order does not authorize the expansion of these facilities. The restoration of, or improvements to, dairy waste management systems to ensure proper function in compliance with this Order will involve minor alterations of existing private facilities.
- California Code of Regulations, title 14, section 15302 exempts the "...replacement or reconstruction of existing structures and facilities where the new structure will be located on the same site as the structure replaced and will have substantially the same purpose and capacity as the structure replaced..." The Dairy General Order will likely require covered dairies to replace or reconstruct waste management systems to ensure compliance with the Order's requirements.
- California Code of Regulations, title 14, section 15302 exempts "... minor public or private alterations in the condition of land, water, and/or vegetation which do not involve removal of healthy, mature, scenic trees except for forestry and agricultural purposes..." The Dairy General Order will require covered dairies to make improvements to their waste management systems that will result in only minor alterations to land, water, and/or vegetation.

The majority of the approximately 1,600 dairies covered under the initial Dairy General Order operated under a waiver program that was in effect from 1982 to December 2002. Approximately 86 of those existing facilities were operating under either an individual WDR Order or a 1996 General WDR Order. This Dairy General Order imposes significantly more stringent requirements compared to the previous WDRs or the waiver of WDRs.

The Dairy General Order reduces impacts to surface water by prohibiting discharges of: (1) waste and/or storm water to surface water from the production area, (2) wastewater to surface waters from cropland, and (3) storm water to surface water from the land application area where manure or process wastewater has been applied, unless the land application has been managed consistent with a certified Nutrient Management Plan.

This General Order reduces impacts to groundwater by requiring Dischargers to: (1) develop and implement Nutrient Management Plans that will control nutrient losses from land application areas; (2) implement remedial measures when groundwater monitoring demonstrates that an existing pond has adversely impacted groundwater quality; (3) design and construct new ponds and reconstructed existing ponds to comply with the groundwater limitations and specifications in the Dairy General Order; (4) document that no cross connections exist that would allow the backflow of wastewater into a water supply well; and (5) submit an Operation and Maintenance Plan to ensure that (a) procedures have been established for solids removal from retention ponds to prevent pond liner damage and (b) corrals and/or pens, animal housing areas, and manure and feed storage areas are maintained to collect and divert process wastewater and runoff to the retention pond and to minimize infiltration of wastewater and leachate from these areas to the underlying soils.

In the MRP, the Board is requiring the monitoring of discharges, surface water, groundwater, storm water, tile drainage water, and tailwater to determine compliance with the Dairy General Order.

### *Central Valley Salinity Alternatives for Long-Term Sustainability*

The Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS) initiative has the goal of developing sustainable solutions to the increasing salt and nitrate concentrations that threaten achievement of water quality objectives in Central Valley surface waters and groundwater. The Dairy General Order requires actions that will reduce nitrate discharges and should result in practices that reduce salt loading. The Central Valley Water Board intends to coordinate all such actions with the CV-SALTS initiative. CV-SALTS may identify additional actions that need to be taken by existing milk cow dairies and others to address these constituents. The Dairy General Order can be amended in the future to implement any policies or requirements established by the Central Valley Water Board as a result of the CV-SALTS process.

## REQUIREMENTS AND ENFORCEMENT OF THE DAIRY GENERAL ORDER

### *What are Dairy Wastes, and what are their Potential Impacts to Water Quality?*

For the purposes of this General Order, dairy waste includes, but is not limited to, manure, leachate, process wastewater and any water, precipitation or rainfall runoff that came into contact with raw materials, products, or byproducts such as manure, compost piles, feed, silage, milk, or bedding.

Waste generated at dairies is stored in solid form in piles or in liquid form in waste retention ponds. The wastes are then applied to cropland or transported off-site for utilization on cropland as a nutrient source. These nutrient-laden materials are applied to soils of varying character and drainage characteristics, varying proximity to surface drainages and waterways, and different character of geology and depth to groundwater. Because of the site variability, this General Order requires the development of a Nutrient Management Plan that is field specific to ensure that optimum nutrient utilization takes place. Although the waste materials provide nutrients to crops, they can create nuisance conditions if improperly managed or cause pollution of surface water and/or groundwater if site conditions are not taken into account in preparing a nutrient utilization and management strategy. This General Order regulates the management of dairy wastes onsite and requires nutrient monitoring, discharge monitoring, groundwater monitoring (individual or representative) and continuous tracking of materials being taken off-site for utilization.

Manure from dairies contains high concentrations of salts (total dissolved solids, including constituents such as sodium and chloride) derived primarily from the feed and water sources used in the dairy production activities. Some dairies also use water softening devices for milk barn cleaning and other activities and the concentrated brines or reject water is usually sent to the retention pond, thus increasing the salt concentrations further.

Manure from dairies contains nutrients (including nitrogen, ammonia, phosphorus and potassium compounds) that can be used in crop production. A review of dairy manure by a University of California Committee of Experts on Dairy Manure Management (UCCE) indicates that dairy cows in the Central Valley Region excrete approximately one (1) pound (lb.) of nitrogen per head per day and approximately 1.29 lbs. of inorganic salts (including only $Na^+$, $K^+$, and $Cl^-$) per head per day. Thus, a 1,000-cow dairy generates approximately 365,000 lbs. of nitrogen and 470,000 lbs. of inorganic salts ($Na^+$, $K^+$, and $Cl^-$) per year that must be managed to prevent impacts to water quality.

The application of dairy waste to cropland provides some challenges due to the complexity of nitrogen in the soil-crop system. Soil nitrogen occurs primarily in three different forms - organic nitrogen, ammonium, and nitrate. Sources of organic nitrogen in soil include crop residue, the soil organic matter pool, and dairy waste applications. Organic nitrogen will mineralize to ammonium over time (one to seven years according to the UCCE Review). Thus, organic nitrogen provides a steady, relatively slow release of plant available and leachable nitrogen. Applying manure with high organic nitrogen content may not meet a crop's nitrogen need during the most rapid growth stage, while exceeding the crop nitrogen uptake during the remainder of the crop's growing season, when the nitrogen may be subject to leaching.

Ammonium nitrogen is immediately available to the plant, but also sorbs to soil particles. Ammonium nitrogen that is unused by the plant remains in the soil and is converted to nitrate typically within days to weeks under oxidizing conditions which are present in much of the Central Valley. Nitrate is also immediately available to the plant, but unlike organic nitrogen and ammonium nitrogen it does not adsorb to soil particles, rather it is in a dissolved form and moves readily with soil water.

The application of manure or process wastewater to a land application area results in the discharge of salts and nitrogen compounds. Oxidation of nitrogen compounds by nitrifying bacteria (i.e., ammonia and organic nitrogen compounds) to nitrites and nitrates has the potential to degrade the quality of surface water and groundwater in the Central Valley Region, if not properly managed. Runoff from manured land application areas poses a threat to surface water quality. A similar threat to groundwater exists if the wastes are applied to the land application area at rates that exceed crop needs. The UCCE review of dairy waste states that based on field experiments and computer models, the appropriate nitrogen loading rate that minimizes nitrogen leaching and maximizes nitrogen harvest is between 140 to 165% of the nitrogen harvested. This is a slightly higher loading rate than what is allowed under New Mexico regulations, which require "...the total nitrogen in effluent that is applied to a crop that is harvested shall not exceed by more than 25 percent the maximum amount of nitrogen reasonably expected to be taken up by the crop..." (20.6.2.3109 NMAC). New Mexico does not allow adjustment of the nitrogen content to account for volatilization or mineralization processes.

Surface water can also be degraded and polluted by both the type and high concentrations of pollutants in dairy cow manure and manure wastewater. Ammonia in the waste is highly toxic to aquatic life and can suppress dissolved oxygen concentrations. In addition, nitrogen and phosphorus compounds in the waste can cause excessive algal growth in surface waters, resulting in lower oxygen levels and which in turn causes fish and other organisms to die. The presence of pathogens in the waste can create a public health threat through human contact with affected waters.

Prior to the issuance of the 2007 General Order, the Central Valley Water Board had documented many discharges of waste from existing milk cow dairies to surface water. Between 2004 and 2007, approximately 70 Dischargers had received Notices of Violation from the Central Valley Water Board for such discharges. The Notices of Violation required immediate cleanup of the discharge and either remediation of the cause of the discharge or a plan with an implementation schedule for such remediation. Additional formal enforcement can be taken based on a case-by-case evaluation of the circumstances. Such enforcement could include the issuance of Administrative Civil Liability by the Board or referral to prosecutors for civil or criminal action.

This General Order includes prohibitions, specifications, and provisions for the existing ponds and new ponds, the production area and land application areas that are consistent with state regulations. Consistent with Title 27, this General Order prohibits the direct or indirect discharge of waste from the production area to surface water. This General Order also prohibits discharges of: (1) wastewater to surface waters from cropland, and (2) waste to surface waters that causes pollution or nuisance, or that causes or contributes to exceedances of any water quality objective in the Basin Plans or water quality criteria set forth in the California Toxics Rule and the National Toxics Rule.

Storm water may contain pollutants from dairy wastes if the storm water is allowed to contact manured areas or commingle with wastewater from the dairy. This General Order prohibits discharges of storm water from the production area to surface water and any discharge of storm water to surface water from the land application areas being used for nutrient utilization unless that discharge is from land that has been managed consistent with a certified Nutrient Management Plan.

***How Will the Board Regulate the Discharge of These Wastes?***

Prohibitions: The Dairy General Order includes a number of prohibitions to protect surface and groundwater quality, and to ensure that waste discharges not regulated by this Order are prohibited unless otherwise regulated by another Order of the Central Valley Water Board.

General Specifications: The Dairy General Order includes a number of General Specifications that require dairy facilities regulated under this Order to: maintain and retain process wastewater together with all precipitation and drainage through manured areas up to including a 25-year, 24-hour storm; protect ponds and manured areas from inundation or washout by overflow from any stream channel at least during 20-year peak stream flows, and for many facilities be protected against 100-year peak stream flows; direct all precipitation and surface drainage from outside of the dairy away from manured areas unless such drainage is fully contained; not apply manure and process wastewater closer than 100 feet to vulnerable pathways (e.g., down gradient surface waters, well heads) unless there are sufficient vegetated buffers or physical barriers; and, not use unlined ditches, swales or earthen-berm channels to store process wastewater, manure or tailwater.

Pond Specifications: The Dairy General Order includes requirements that all ponds must be verified by an engineer to have adequate capacity and structural integrity to hold generated process water and precipitation. Specifically, the level of waste in retention ponds shall be kept a minimum of two feet from the top of each aboveground embankment and a minimum of one foot from the ground surface of each belowground pond. All ponds must be managed and maintained to prevent breeding of mosquitoes and other vectors. Ponds shall not have small coves and irregularities around the perimeter of the water surface. Weeds shall be minimized in all ponds through control of water depth, harvesting, or other appropriate method, and dead algae, vegetation, and debris shall not be allowed to accumulate on the water surface.

*New or Reconstructed Pond Specifications*: New or Reconstructed Ponds must be designed to meet specified Tier or 1 or Tier 2 standards and design for such New or Expanded Ponds must be approved by the Executive Officer. Tier 1 standards consist of a double liner constructed with 60-mil high density polyethylene or material of equivalent durability with a leachate collection and removal system. Tier 2 standards are consistent with Natural Resource Conservation Service Practice Standard 313 or equivalent and the Discharger has demonstrated through submittal of technical reports that the alternative design will comply with the groundwater limitations of this Order.

*Existing Pond Specifications:* In addition to the general pond specifications, ponds in existence as of 3 May 2007 must be evaluated to determine whether they are protective of underlying groundwater. This will be accomplished through compliance with an individual monitoring program or by participation in the Representative Monitoring Program. When existing ponds are found not to be sufficiently protective of underlying groundwater, a dairy must upgrade the pond in accordance with the time schedule for compliance detailed in section M. of the reissued Dairy General Order. Alternatively, if groundwater monitoring demonstrates that a discharge of waste threatens to exceed a water quality objective, the Executive Officer may issue an order to the owner/operator of the monitored dairy to identify and implement management practices that are protective of groundwater quality on a schedule that is as short as practicable (reissued Dairy General Order, General Specification B.5).

Production Area Specifications: The production area includes the barns, corrals, milk parlors, manure and feed storage areas, process water conveyance facilities and any other area of the dairy facility that is not the land application area or retention ponds. The General Order includes a number of requirements that apply to the production area, including: roofs, buildings, and non-manured areas within the production area shall be constructed and/or designed so that clean rainwater is diverted away from manured areas and waste containment facilities; drainage from the roofs of barns, milk houses, or shelters shall not drain into corrals unless the corrals are properly graded and drained; all portions of the production area shall be designed and maintained to convey all water that has contacted animal wastes or feed to the wastewater retention system and shall be designed and maintained to minimize standing water. Standing water is not to be present as of 72 hours after the last rainfall. Dischargers shall implement any newly identified management practices/activities from the Summary Representative Monitoring Report which are applicable for their facility on a time schedule that is as short as practicable but cannot exceed 10 years.

*Land Application Area Specifications*: This General Order includes land application specifications that require Dischargers to develop and implement a Nutrient Management Plan (NMP) that provides protection of both surface water and groundwater. The contents of the NMP and technical standards for nutrient management are specified in Attachment C to this General Order. The land application specifications also require Dischargers to have a written agreement with each third party that receives process wastewater from the Discharger for its own use. The written agreement will be effective until the third party is covered under waste discharge requirements or a waiver of waste discharge requirements that are adopted by the Central Valley Water Board and that are specific to the application of the Discharger's process wastewater to land under the third party's control.

The written agreement must identify the Discharger, the third party, the Assessor's Parcel Number and acreage of the cropland where the process wastewater will be applied, and the types of crops to be fertilized with the process wastewater. The written agreement must also include an agreement by the third party to: (1) use the process wastewater at agronomic rates appropriate for the crop(s) grown, and (2) prevent the runoff to surface waters of wastewater, storm water or irrigation supply water that has come into contact with manure or is blended with wastewater.

The technical standards for nutrient management require Dischargers to monitor soil, manure, process wastewater, irrigation water, and plant tissue. The results of this monitoring are to be used in the development and implementation of the NMP. The Dairy General Order also requires Dischargers to create and maintain specific records to document implementation and management of the minimum elements of the NMP, records for the land application area, a copy of the Discharger's NMP, and records on manure, bedding, and process wastewater transferred to other persons.

If existing management practices implemented in the land application area(s) are found not to be sufficiently protective of underlying groundwater, a dairy must change its management practices in accordance with the time schedule for compliance detailed in section M. of the reissued Dairy General Order. Alternatively, if groundwater monitoring demonstrates that a discharge of waste threatens to exceed a water quality objective, the Executive Officer may issue an order to the owner/operator of the monitored dairy to identify and implement management practices that are protective of groundwater quality on a schedule that is as short as practicable (Reissued Dairy General Order, General Specification B.5)

*Closure Provisions:* This General Order includes a provision that the Discharger must maintain coverage under this Order or a subsequent revision to this Order until all manure, process wastewater, and animal waste impacted soil, including soil within the pond(s), is disposed of or utilized in a manner which does not pose a threat to surface water or groundwater quality or create a condition of nuisance. These closure requirements ensure compliance with the provisions of the *State Anti-Degradation Policy*.

Receiving Water Limitations: This Order includes Groundwater Limitations that require the discharge of waste at existing milk cow dairies not cause the underlying groundwater to exceed water quality objectives, unreasonably affect beneficial uses, or cause a condition of pollution or nuisance.

These limitations are effective immediately except where Dischargers are in compliance with the requirements of Sections II or III of the Monitoring and Reporting Program R5-2013-0122, Attachment A, and such Dischargers are implementing management practices/activities on a time schedule that is as short as practicable. For Dischargers participating in the RMP, management practices/activities must be implemented on a time schedule that is as short as practicable and that is consistent with the Time Schedule for Compliance (section M.) contained in the reissued Dairy General Order.

***How Will the Board Evaluate the Effectiveness of Management Practices?***

This Dairy General Order includes a provision that requires compliance with the MRP, and future revisions thereto, or with an individual monitoring and reporting program, as specified by the Central Valley Water Board or the Executive Officer. The MRP requires:

- periodic inspections of the production area and land application areas
- monitoring of manure, process wastewater, crops, and soil
- recording of operation and maintenance activities
- groundwater monitoring
- storm water monitoring
- tile drainage water monitoring
- monitoring of surface water and discharges to surface water
- annual reporting
- annual reporting of groundwater monitoring
- annual storm water reporting
- noncompliance reporting
- discharge reporting

Specifically, the Dairy General Order requires Dischargers to monitor, either individually or through the RMP, first encountered groundwater upgradient and downgradient of the production area, retention ponds, and land application areas. The purpose of the groundwater monitoring program is to determine whether management practices being employed at the dairies do not cause receiving waters to exceed applicable groundwater objectives and confirm compliance with the requirements of this order.

The Dairy Order contains significant requirements for dairies that are designed to be protective of surface and groundwater quality while also being practicable and economically feasible. These include implementation of nutrient management plans prepared by certified specialists (including testing and measurement of manure, irrigation water, soil and plant tissue to track nutrient flow), and implementation of waste management plans prepared by professional engineers. The Dairy Order practices and design and maintenance standards include measures that apply to all areas of the dairy farm, including the crop production areas, existing manure retention ponds and animal housing areas, including all barns and corrals.

These practices (with the exception of certain pond standards that apply only to new or reconstructed ponds) are already in place, were developed over time with expert input from dairy professionals, the United States Department of Agriculture Natural Resources Conservation Service and the University of California[6] and are expected to reduce impacts to water quality from the operation of dairy facilities. However, the Regional Board recognizes that monitoring the effectiveness of these practices is needed to verify that they protect water quality adequately and under a variety of conditions. Accordingly, the Dairy Order in conjunction with the MRP requires additional groundwater monitoring that must be conducted on an individual dairy basis or through Representative Monitoring Programs (RMPs). All dairies subject to the Dairy Order must either conduct their own groundwater monitoring or actively participate in a RMP. Currently, most dairies subject to the Dairy Order (more than 98 percent) are members of an RMP.

_Individual Groundwater Monitoring:_ The individual groundwater monitoring program requires the Discharger to submit a Monitoring Well Installation and Sampling Plan (MWISP) which details the installation of a sufficient monitoring well network to characterize groundwater flow direction and gradient beneath the site; natural background (unaffected by the Discharger or others) groundwater quality upgradient of the facility; and groundwater quality downgradient of the production area, retention ponds, and the land application areas.

Under the individual groundwater monitoring program, the Discharger is required to submit to the Executive officer an annual assessment of the groundwater monitoring data which includes analytical lab reports for data collected during the past year and a tabulated summary of all analytical data collected to date. The annual assessment requires an evaluation of the groundwater monitoring program's adequacy to assess compliance with the Order, including whether the data provided are representative of conditions upgradient and downgradient of the wastewater management area, production area, and land application area of the dairy facility. If the monitoring parameters used to evaluate groundwater quality are found to be insufficient to identify whether site activities are impacting groundwater quality, the Discharger must employ all reasonable chemical analyses to differentiate the source of the particular constituent. This

[6] See "Managing Dairy Manure in the Central Valley of California," published by the University of California Committee of Experts on Dairy Manure Management, 2005.

includes, but is not limited to, analyses for a wider array of constituents and chemical isotopes. Within six years of initiating sampling, or at an earlier date if required by the Executive Officer, a Discharger conducting individual sampling is required to submit a summary report that presents a detailed assessment of the monitoring data to evaluate if site activities associated with the operation have impacted groundwater quality. The Summary Report is subject to Executive Officer approval and must include a description of changes in management practices or activities if the data indicate that Groundwater Limitation D.1 of the Order has been violated.

*Representative Monitoring Program:* As an alternative to installing monitoring wells on an individual basis, dischargers may participate in a Representative Monitoring Program. The Representative Monitoring Program is a data collection and analysis effort that will develop a knowledge base from a subset of Central Valley dairy farms that will support conclusions with respect to existing management practices and their ability to be protective of groundwater quality that are applicable to non-monitored dairies covered under the Dairy General Order.

It is recognized that a single set of monitoring data, or even monitoring data over a short period of months or years, may not be sufficient to determine the effectiveness of existing practices. In many cases, because of time lags of weeks, months or even years between surface practices and resulting effects in groundwater, the effects of improved management practices will not be reflected immediately in monitoring wells. Evaluating these results over time and in conjunction with data regarding surface practices and other data is necessary to determine whether water quality is being protected or is being unreasonably impacted. In order to provide time for the development of this knowledge base, a period of six years has been allotted for the installation of groundwater monitoring wells, collection and chemical analysis of the groundwater samples, and assembly of an adequate data set for statistical evaluation of the data. The completed knowledge base will be utilized to identify management practices for the various management units (i.e., production areas, land application areas and wastewater ponds) that are protective of groundwater quality for the range of conditions found at facilities covered by the Representative Monitoring Program.

Dischargers choosing to participate in a Representative Monitoring Program must notify the Central Valley Water Board. Notification to the Central Valley Water Board must include identification of the Representative Monitoring Program that the Discharger intends to join. Dischargers choosing not to participate in a Representative Monitoring Program will continue to be subject to individual groundwater monitoring program requirements.

Representative Monitoring Programs are required to submit a monitoring and reporting workplan for Executive Officer approval. The workplan must explain how data collected at facilities that are monitored will be used to assess impacts to groundwater at facilities that are not part of the Representative Monitoring Program's network of monitoring wells. This information is needed to demonstrate that data collected at the representative facilities allows for identification of practices that are protective of water quality at all facilities represented by the Representative Monitoring Program, including those for which on-site data are not collected. The Monitoring and Reporting Workplan must additionally propose constituents the Representative Monitoring Program will monitor and the frequency of monitoring for each constituent identified. The

Monitoring and Reporting Workplan must propose a list of constituents that is sufficient to identify whether activities at facilities being monitored are impacting groundwater quality, and by extension if other "represented" facilities may also be impacting groundwater quality due to similar management units and site conditions.

To date, the Central Valley Diary Representative Monitoring Program (CVDRMP) submitted a Phase 1 workplan to establish a Representative Monitoring Program. On 9 September 2012, the Executive Officer conditionally approved the first phase of the CVDRMP Monitoring and Reporting Workplan and Monitoring Well Installation and Sampling Plan for Existing Milk Cow Dairies. The workplan prepared by the CVDRMP consisted of 18 dairies and 126 dedicated monitoring well sites. Of these well sites, CVDRMP constructed 108 as nested wells (i.e., two wells in one borehole) with the remaining 18 well sites being pre-existing, single-well facilities, for a total of 234 wells.

On 6 June 2012 the CVDRMP submitted a Phase II workplan (approved by the Executive Office on 27 August 2012) which expanded the program's monitoring efforts to incorporate 24 additional dairies, including several dairies with numerous pre-existing monitoring wells that have been subject to academic research for many years. CVDRMP now collects data from monitoring wells at 42 Central Valley dairies from Tehama County in the north to Kern County in the south, with 440 wells at 274 well sites.

As part of its Representative Monitoring Program, CVDRMP will examine conditions in first encountered groundwater beneath a select number of Central Valley dairies over time. The Representative Monitoring Program will extrapolate monitoring results from dairy farms monitored under the program to non-monitored member dairy farms to evaluate dairy operations and management practices for specific waste management units (land application areas, production areas, and wastewater ponds), to facilitate the evaluation of cause and effect relationships between subsurface loading of nutrients and salts, and to establish current groundwater quality conditions. For example, dairy management practices on coarse-grained/sandy soils over shallow groundwater that result in groundwater quality improvements beneath cropped manure application fields that are part of the Representative Monitoring Program are expected to produce similar results beneath non-monitored fields of similar soil types, in areas of similar precipitation patterns, and similar application practices. The same rationale applies to the production area and the liquid manure (i.e., wastewater) storage ponds. Representative monitoring is designed to identify a causal link between groundwater chemical characteristics and dairy management practices specific to management units. This includes the identification of groundwater chemical changes in response to changing management practices.

The Representative Monitoring Program is required to submit (on behalf of its member Dischargers) to the Executive Officer an Annual Representative Monitoring Report (ARMR) which describes the monitoring activities (including a tabulated summary of groundwater analytical data) conducted by the Representative Monitoring Program, and identifies the number and location of installed monitoring wells and other types of monitoring devices. Within each ARMR, the Representative Monitoring Program must evaluate the groundwater monitoring data to determine whether groundwater is being impacted by activities at facilities being monitored by the Representative Monitoring Program. The submittal must include a description of the methods used in evaluating the groundwater monitoring data.

No later than six (6) years following submittal of the first ARMR, the Representative Monitoring Program must produce a Summary Representative Monitoring Report (SRMR) identifying management practices for the various management units (i.e., production areas, land application areas and wastewater ponds) that are protective of groundwater quality for the range of conditions found at facilities covered by the Representative Monitoring Program. The identification of management practices for the range of conditions must be of sufficient specificity to allow participants covered by the Representative Monitoring Program and the Central Valley Water Board to identify which practices at monitored facilities are appropriate for facilities with a corresponding range of site conditions, and generally where such facilities may be located within the Central Valley (e.g., the summary report may need to include maps of the Central Valley that identify the types of management practices that should be implemented in certain areas based on specified site conditions). The summary report must include adequate technical justification for the conclusions incorporating available data and reasonable interpretations of geologic and engineering principles to identify management practices protective of groundwater quality. Further, the SRMR must include a proposed schedule for implementation of management practices that are protective of groundwater quality that is as short as practicable.

Each ARMR must include an evaluation of whether the representative monitoring program is on track to provide the data needed to complete the SRMR. If the evaluation concludes that information needed to complete the summary report may not be available by the required deadline, the ARMR shall include measures that will be taken to bring the program back on track. The ARMR shall include an evaluation of data collected to date and an assessment of whether monitored dairies are implementing management practices that are protective of groundwater quality. If the management practices being implemented at a dairy being monitored are found to not be protective of groundwater quality, the Executive Officer can issue an order to the owner/operator of the monitored dairy to identify and implement management practices that are protective of groundwater quality prior to submittal of the report.

Both the individual groundwater monitoring provisions and the RMP monitoring requirements are designed to measure water quality data in first-encountered groundwater. A RMP is further required to conduct such monitoring on a variety of dairy farms that represent the overall range of conditions on dairies within the Central Valley. This means for a RMP that a variety of physical site conditions must be monitored, such as varying soil types and depth to groundwater. Varying management practices must also be measured, such as different types of crops, irrigation methods, waste storage structures, and animal housing.

In cases where water quality is not being sufficiently protected, additional time is needed to identify additional practices for the various dairy facility areas that both improve water quality protection, and are feasible and practicable for dairy operators to implement. This is a chief goal of the RMP process and work is actively underway, to be completed no later than 2019, to identify and verify additional practices where necessary to protect beneficial uses of groundwater. This process includes ongoing monitoring and analysis, field studies of management alternatives, and more intensive evaluation of existing practices, including existing manure storage ponds and nutrient management plans.

Considering the need to evaluate the effectiveness of current practices that are being implemented to comply with the Dairy Order, the Regional Board finds that it is not possible in all circumstances for dairy facilities to immediately comply with groundwater limitations. Accordingly, the Dairy Order provides dischargers with an appropriate amount of time to comply with such limitations. The time being provided is consistent with the time frames established in the MRP with respect implementation of RMPs.

*Individual Monitoring Orders:* The Executive Officer has issued orders to each dairy that require the dairies to either submit individual groundwater monitoring and sampling plans or join a representative groundwater monitoring program. Submitted groundwater monitoring and sampling plans must include a schedule to install groundwater monitoring wells into first encountered groundwater, to collect representative groundwater samples from the wells and have these samples analyzed by a State-certified laboratory for selected constituents, and to report the results back to the Board. The first phase of orders were issued to those dairies where nitrate-nitrogen was detected at 10 milligrams per liter or more in any one domestic well, agricultural well, or subsurface (tile) drainage system in the vicinity of the dairy. The Executive Officer further prioritized the orders based on factors such as: proximity to a municipal or domestic supply well, artificial recharge area, or Department of Pesticide Regulation Groundwater Protection Area; nitrate concentrations in neighboring domestic wells; number of crops grown per year; whether or not the NMP was completed by 1July 2009; and any other pertinent site-specific conditions. A summary of how the Executive Officer determined priorities for installation of monitoring wells is provided in Table 5 of Attachment A to the MRP.

***What Has Been Done Under the 2007 General Order?***

The 2007 General Order established a schedule for Dischargers to develop and implement their Waste Management Plan (WMP) and NMP and required them to make interim facility modifications as necessary to protect surface water and groundwater, improve storage capacity, and improve the facility's nitrogen balance before all infrastructure changes are completed. The 2007 General Order required that all Dischargers submit:

- By 31 December 2007
  - Existing Conditions Report (Attachment A).
- By 1 July 2008
  - Annual Report including Annual Dairy Facility Assessment (an update to the Preliminary Dairy Facility Assessment of Attachment A) with interim facility modifications considered to be implemented.
  - Statement of Completion of the following items in Attachment C (Nutrient Management Plan):

    - Items I.A.1, I.B, I.C. and I.D. (Land Application information), II (Sampling and Analysis Proposal), IV (Setbacks, Buffers, and Other Alternatives to Protect Surface Water), and VI (Record-Keeping Requirements).
  - The following items in Attachment B (Waste management Plan):
    - Items I.A. I.B, I.C, I.D, I.**E**, I.F.1.a, I.F.2.a, I.F.3, I.F.4, and I.F.5 (Facility Description) and V (Operation and Maintenance Plan).
    - Identification of Backflow Problems.
  - Proposed interim facility modifications to improve storage capacity and balance nitrogen.
- By 31 December 2008
  - Statement of Completion of item V (Field Risk Assessment) of Attachment C.
  - Preliminary Infrastructure Needs Checklist.
- By 1 July 2009
  - Annual Report including Annual Dairy Facility Assessment with modifications implemented to date.
  - Documentation of interim facility modifications completion for storage capacity and to balance nitrogen.
  - Nutrient Management Plan – Retrofitting Plan to improve nitrogen balance with schedule.
  - Statement of Completion of items I.A.2 (Land Application Information) and III (Nutrient Budget) of Attachment C.
  - Waste Management Plan with Retrofitting Plan and Schedule
  - Items I.F.1.b and I.F.2.b (Facility Description), II (Storage Capacity), III (Flood Protection), IV (Production Area Design and Construction), and VI (Documentation there are no cross-connections) of Attachment B.
  - Salinity Report.
- By 1 July 2010
  - Annual Report including the Annual Dairy Facility Assessment with facility modifications implemented to date.
  - Status on facility retrofitting completed or in progress.
- By 1 July 2011
  - Annual Report including the Annual Dairy Facility Assessment with facility modifications implemented to date.
  - Certification of facility retrofitting completion including:

- Retrofitting to improve nitrogen balance.
- Items II.C (certification of completion of modifications for storage capacity needs), III.D (certification of completion of modifications for flood protection needs), and IV.C (certification of modifications for production area construction criteria) of Attachment B.

- By 1 July 2012
  - Annual Report including the Annual Dairy Facility Assessment with facility modifications implemented to date.
  - Certification that the Nutrient Management Plan has been completely implemented.

***How Will This Order Be Enforced?***

The State Water Board's Water Quality Enforcement Policy (Enforcement Policy) establishes a process for using progressive levels of enforcement, as necessary, to achieve compliance. It is the goal of the Central Valley Water Board to enforce this order in a fair, firm, and consistent manner. Violations of this order will be evaluated on a case-by-case basis with appropriate enforcement actions taken based on the severity of the infraction and may include issuance of administrative civil liabilities. Progressive enforcement is an escalating series of actions that allows for the efficient and effective use of enforcement resources to: 1) assist cooperative dischargers in achieving compliance; 2) compel compliance for repeat violations and recalcitrant violators; and 3) provide a disincentive for noncompliance. Progressive enforcement actions may begin with informal enforcement actions such as a verbal, written, or electronic communication between the Central Valley Water Board and a Discharger. The purpose of an informal enforcement action is to quickly bring the violation to the discharger's attention and to give the discharger an opportunity to return to compliance as soon as possible. The highest level of informal enforcement is a Notice of Violation.

The Enforcement Policy recommends formal enforcement actions for the highest priority violations, chronic violations, and/or threatened violations. Violations of the Dairy General Order that will be considered as high priority violations include, but are not limited to:

1. Any discharge of waste and/or storm water from the production area to surface waters.
2. The application of waste to lands not owned, leased, or controlled by the Discharger without written permission from the landowner.
3. The discharge of wastewater to surface water from cropland.
4. Failure to submit notification of a discharge to surface water in violation of the Dairy General Order.
5. Falsifying information or intentionally withholding information required by applicable laws, regulations or an enforcement order.

6. Failure to submit a Design Report for any new or enlarged existing settling, storage, or retention pond prior to construction and/or Post Construction Report for such construction.
7. Failure to pay annual fee, penalties, or liabilities.
8. Failure to monitor as required.
9. Failure to submit required reports on time.

To date, the Executive Officer has initiated and taken a significant number of enforcement actions against Dischargers for failure to comply with the terms of the 2007 General Order. Such actions have included, but are not limited to issuance of: 770 Notices of Violation; 94 Water Code 13267 investigations; 71 Selective Enforcement Letters; 67 Administrative Civil Liability complaints (Wat. Code, §§ 13385 and 13323.); and 12 Expedited Payment Letters.

Table 1. Regional, State, and National Pond Liner Design Requirements

| Central Valley Water Board | Pond Liner Design Requirements |
|---|---|
| Waste Discharge Requirements General Order No. R5-2013-0122 | **Tier 1 or Tier 2 option:**<br>Tier 1: A pond designed to consist of a double liner constructed with 60-mil high de or material of equivalent durability with a leachate collection and removal system (cc accordance with Section 20340 of Title 27) between the two liners will be acceptabl demonstration that the pond design is protective of groundwater quality.<br><br>Tier 2: A pond designed in accordance with California Natural Resource Conservati Conservation Practice Standard 313 or equivalent and which the Discharger can de submittal of technical reports that the alternative design is protective of groundwater in General Specification B. 8 of the General Order. |
| **Central Valley Counties** | **Pond Liner Design Requirements** |
| Kings County | The specific discharge (seepage rate) of process water through the soils lining the b the manure separation pits and lagoons shall not be greater than 1 x $10^{-6}$ centimete (cm/sec). |
| Merced County | Liner shall be designed and constructed with a seepage rate of 1 x $10^{-6}$ cm/sec or le for manure sealing) and a minimum thickness of one foot. |
| Solano County | Large dairies (700 or more mature dairy cows):<br>Liner placed atop bedrock or foundation materials comprised of (from bottom to top)<br>(1) Two feet of compacted clay with permeability less than or equal to 1 x $10^{-7}$ cm/<br>(2) 60 mil high-density polyethylene geomembrane with a permeability less than o 1 x $10^{-13}$ cm/sec,<br>(3) Geomembrane filter fabric, and<br>(4) 24-inch thick soil operations layer.<br><br>Medium sized dairies (200 to 699 mature dairy cows):<br>Liner of compacted clay that is a minimum of one foot thick, with maximum permeab cm/sec.<br><br>Small dairies (14 to 199 mature dairy cows):<br>No pond liner requirements. |

Table 1. Regional, State, and National Pond Liner Design Requirements

| Top 10 Milk Producing States (in order of highest to lowest milk production) | Pond Liner Design Requirements |
|---|---|
| California | Title 27 of the California Code of Regulations:<br>10% clay and no greater than 10% gravel. |
| Wisconsin | Wisconsin Natural Resources Conservation Service (NRCS) Practice Standard 313:<br>In-place soils (more than 50 percent fines and three feet thick), clay (maximum perm cm/sec), geomembrane (60 mil high density polyethylene or 60 mil linear low densit geosynthetic clay liner, or concrete . |
| New York | No pond liner design requirements. |
| Pennsylvania | Pennsylvania NRCS Conservation Practice Standard 313:<br>In place soils with acceptable permeability (see Appendix 10D below) or lined (soil li seepage rate of 1 x $10^{-5}$ cm/sec, flexible membrane, bentonite, soil dispersant, or co |
| Minnesota | Any material that meets maximum seepage rate of 500 gallons per acre per day (5.( |
| Idaho | NRCS Agricultural Waste Management Field Handbook Appendix 10D (see below). |
| New Mexico | Case-by-case but compacted clay or synthetic is standard, maximum permeability o |
| Michigan | Michigan NRCS Conservation Practice Standard 313:<br>In soils with acceptable permeability (per Appendix 10D (see below) or lined (with o earth with maximum seepage rate of 1 x $10^{-5}$ cm/sec and a minimum one foot comp layer, flexible membrane, bentonite, or concrete). |
| Washington | Washington NRCS Conservation Practice Standard 313:<br>Maximum soil permeability of 1 x $10^{-6}$ cm/sec or a compacted clay liner, amended so required meeting requirements of NRCS Conservation Practice Standards 521A thr |
| Texas | When no site specific assessment completed, one and a half foot of compacted clay permeability of 1 x $10^{-7}$ cm/sec. Otherwise, "designed and constructed in accordan standards of NRCS, ASAE, ASCE, or ASTM that are in effect at time of construction |

Table 1. Regional, State, and National Pond Liner Design Requirements

| Natural Resources Conservation Service (NRCS) | Pond Liner Design Requirements |
|---|---|
| NRCS Agricultural Waste Management Field Handbook Appendix 10D – Geotechnical, Design, and Construction Guidelines | In-place soils at least two feet thick and maximum permeability of 1 x $10^{-6}$ cm/sec.<br><br>Consider liner if: aquifer is unconfined and shallow and/or aquifer is a vital water sup by less than two feet soil over bedrock, coarse-grained soils with less than 20 perce fines, or soils with flocculated clays or highly plastic clays with blocky structure.<br><br>Acceptable liners:<br>Compacted clay liner (allowable seepage rate of 1 x $10^{-6}$ cm/sec if manure sealing c or 1 x $10^{-5}$ cm/sec if manure sealing can be credited, minimum thickness of one foot geomembranes, or geosynthetic clay liners. |
| California NRCS Conservation Practice Standard 313 | Target maximum seepage rate of 1 x $10^{-6}$ cm/sec for all vulnerability/risk categories,<br>(1) Synthetic liner required when aquifer vulnerability and risk are high (i.e., groun to 20 feet of the pond bottom or coarse soils are present <u>and</u> the pond is withir domestic supply well), or<br>(2) Other storage alternatives required when the aquifer vulnerability and risk are groundwater is within five feet of the pond bottom or the pond is less than 600 improperly abandoned well <u>and</u> the pond is less than 1,500 feet from a public s than 100 feet from a domestic supply well). |

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# MEMORANDUM

To: Theresa A. Dunham; Somach, Simmons & Dunn

From: John Schaap, Steve Bommelje

Subject: Costs to Retrofit Existing Dairies That Do Not Have Tier 1 or Tier 2 Lagoons.

Date: August 5, 2013

This memo estimates the costs to retrofit existing dairies that have do not have Tier 1 or Tier 2 lagoons for a range of dairy sizes. It also discusses other cost drivers that could impact retrofit projects.

## Qualifications

John Schaap graduated from California Polytechnic State University, San Luis Obispo, California with a B.S. in Agricultural Engineering. He also holds an M.S. in Biological and Agricultural Engineering from the University of California, Davis, California.

Mr. Schaap is a registered agricultural and civil engineer in the State of California (license numbers AG 563 and C 61754). He has been in private practice as a consulting agricultural and civil engineer since January 2001, and has specialized full-time in dairy related matters in the San Joaquin Valley since that time. Mr. Schaap is a principal engineer with Provost and Pritchard Consulting Group (P&P).

Provost and Prichard Consulting Group has been meeting agricultural design and consulting needs in Central California since 1968. We have offices in Fresno, Bakersfield, Visalia, Clovis, Modesto, and Los Banos. Our staff includes licensed agricultural and civil engineers, as well as licensed geologists and other technical staff experienced in dairy work.

P&P acquired the dairy design firms of Valley Management Systems, Inc. (VMS) and EJS & Associates, Inc. in 2004, enfolding key personnel into the company to strengthen our dairy business. Since then, our firm has been at the forefront in assisting dairy clients achieve compliance with new or changing regulatory requirements, for both new and existing facilities.

Within approximately the last 10 years, P&P has designed and assisted in the certification of over 50 dairy lagoons in the Central Valley. These have included approximately 27 sites with lagoons meeting the 10% clay soil requirement, 7 sites that followed the NRCS Appendix 10D compacted clay liner guidelines, 10 sites with single liners, mostly using high density polyethylene (HDPE) material; and 8 sites with double HDPE liners with leachate collection and recovery systems (LCRS). Our firm has many more dairy liner projects that are currently in the design stage. The above projects do not include other similar wastewater impoundments that have been engineered for food processors, wastewater treatment plants, or other similar facilities, going back further in P&P's history. In the last ten years, approximately 14 of our technical staff have worked on lagoon projects.

**Cost Estimates**

We have prepared a range of cost estimates for retrofitting or rebuilding dairy lagoons with new liners. See Table 1. The estimates are for four sizes of dairies within a range typically found in the Central Valley: 300 milk cows (MC), 750 MC, 1,500 MC, and 3,000 MC. For each herd size we have calculated costs for four possible scenarios. These scenarios represent the four possible combinations of the following variables:

1) Liner design: single (Tier 2) or double (Tier 1) liner;
2) Lagoon location: new location or build within the current footprint of an existing lagoon location.

In order to keep the analysis consistent through the range of herd sizes, some baseline assumptions were used in sizing lagoons. These include the following:

- Weather conditions found in the Tulare and Kings County area;
- A 5:1 rectangular shape with a total depth of 20 feet;
- A constant rate of dairy barn water generation of 50 gallons per milk cow per day;
- 120 day winter storage period from November 1 to March 1; and,
- Overall storage capacity ratio (actual/required) between 100% and 105%.

Cost estimates assume a completely below ground lagoon with more than 5 feet of clearance to highest anticipated groundwater. Costs for design, earthwork, lining, and construction quality assurance and reporting are included.

Option of Single or Double HDPE Liner Design

The Dairy General Order stipulates that all new or modified lagoons meet the conditions described as a Tier 1 or Tier 2 lagoon. The Tier 1 lagoon is a 60-mil HDPE double liner with a leachate collection and recovery system. The Tier 2 option does not specify the liner material needed; however, it requires groundwater modeling as part of the design, and proposed ongoing monitoring that demonstrates protection of ground water. At this time, when the conditions are such that a single liner is possible, we have found it necessary to design a liner consisting of one layer of 60-mil HDPE over a one-foot thick soil layer with low permeability. Thus, for the Tier 2 case, this is what we have used as the basis of our estimate.

HDPE liner material with proper care and maintenance should have a service life of 20 to 30 years. We have not calculated a life cycle cost, but simply a single installation cost. Dairy facilities can have a useful life that exceeds the liner life, and thus a liner may need to be reinstalled at least once over the useful life of a dairy.

Option of New Location or Existing Location

The existing location option assumes that the size of the current lagoon is adequate, requiring only the excavation of several feet of organic laden soil, and contouring of the side slopes. An existing location requires the removal of liquid and solid manure prior to any construction work. Costs were included for that effort.

The new location option includes estimates for full excavation (assuming stockpiling nearby) and a location within close proximity in order to connect to the existing wastewater system. Here, the cleanout of manure from the old lagoon could be performed at any time but will at some point need to be performed to close the lagoon. If the old lagoon was allowed to dry, the cleanout costs could be reduced by handling the manure in a dry state. So we have included the "liquid and wet solid" cleanout cost in parentheses in Table 1 to provide an understanding of the range of costs that could be expected to clean the old lagoon to close the project.

Table 1. Costs to retrofit lagoons based on dairy size and retrofit type.

| | Existing Location* | New Location | Wet Cleanout** |
|---|---|---|---|
| 300 MC, 2.1 ac lagoon | | | |
| Single | $198,000 | $180,000 | (+$37,000) |
| Double | $270,000 | $252,000 | (+$37,000) |
| 750 MC, 3.4 ac lagoon | | | |
| Single | $300,000 | $275,000 | (+$78,000) |
| Double | $425,000 | $399,000 | (+$78,000) |
| 1,500 MC, 6.0 ac lagoon | | | |
| Single | $521,000 | $482,000 | (+$171,000) |
| Double | $753,000 | $714,000 | (+$171,000) |
| 3,000 MC, 10.7 ac lagoon | | | |
| Single | $948,000 | $887,000 | (+$357,000) |
| Double | $1,383,000 | $1,321,000 | (+$357,000) |

* An existing location estimate includes the cleanout of liquid and solid manure from the lagoon before construction can begin.

** A new location estimate does not include any cleanout cost of the old lagoon. This wet cleanout cost could be expected if performed while water is in the old lagoon.

**Issues**

There are many issues that may arise with the retrofitting or replacement of a lagoon. Each dairy has a different set of circumstances that may require additional effort to be expended in locating and designing a lagoon.

<u>Tier I Lagoon (Double Liner) vs. Tier 2 Lagoon (Single Liner)</u>

From the estimated costs shown in Table 1, a single liner appears to be a more cost-effective option. However, to obtain approval for a single liner, the design must show that groundwater will not be impacted via a model, and a monitoring system must be installed and maintained.

Groundwater models that are currently used to predict the performance of a liner are simplified models that are highly conservative. Conditions contributing to passing the modeling are low nitrate levels in background groundwater samples, high velocity groundwater flow beneath the site, low permeability soils, and minimal defects in the post-construction liner.

Currently, we are finding that most sites do not pass the simplified model and a single liner is thus not an eligible option. If a detailed modeling effort were performed, the modeling cost could equal the cost of the extra liner layer in question, without a guarantee of positive results. Thus, detailed modeling is generally not pursued at this time.

A single liner requires some type of accompanying groundwater monitoring, as noted above. Monitoring wells focused around the subject lagoon (outside of the representative monitoring program) are the typical monitoring system proposed. When depth to first encountered water is great, the cost for installing monitoring wells increases and other groundwater quality influences can possibly be mixed in the samples taken, obscuring the conclusions that can be drawn.

In Table 1 above the single liner option includes costs for installing lagoons, but does not include costs for monitoring. These can include the installation of monitoring wells, sampling and laboratory analysis on an ongoing basis, data assessment and analysis, and technical reports. These costs are not insignificant and can cost tens of thousands of dollars for well installation and hundreds to thousands of dollars per year in ongoing costs.

New Location vs. Existing Location

To rebuild a lagoon in the current location, provisions must be made to divert and contain the daily barn water generation (and any rainfall runoff) temporarily during the construction period. In many cases this may not be feasible, leading to the only other option, to build in a new location.

To compact the soil for structural support and installation of the HDPE liner, the side slopes must typically be 2:1 (horizontal: vertical) or flatter, depending on soil properties. Typical existing lagoon slopes are 1.5:1 or steeper. Therefore a larger lagoon footprint is likely to be needed to maintain the storage volume. In addition, the retrofit will need to provide 5 to 6 feet of additional room around the lagoon perimeter for an anchor trench to hold the liner material. Many lagoons are positioned near other structures on the dairy and this additional space may not be available.

Relocating the lagoon to a new area may require county permit changes if the location is outside of the established footprint of the dairy. Such changes are likely to trigger the need to comply with the California Environment Quality Act (CEQA), which could require the preparation of a mitigated negative declaration or an Environmental Impact Report (EIR). Other land use permits may also be triggered. Additional costs to comply with local land use permitting processes (including CEQA compliance) could possibly ranging between $30,000 to $100,000 or more.

The estimates in Table 1 indicate approximately how many acres the new lagoon is expected to occupy. In some cases, locating the new lagoon near the existing lagoon is infeasible and additional costs may be incurred to route the wastewater to a more distant location. In some cases, significant infrastructure, such as a pump station, may be required.

Highest Anticipated Groundwater

In shallow groundwater areas, this can be a significant issue complicating lagoon design. In other areas where the groundwater has deepened, but historically has been within 5 feet of the invert, it can present a physical or regulatory risk.

In order to quantify the highest anticipated groundwater to plan lagoon construction, areas with shallow groundwater require study on factors influencing the groundwater level, including influences from irrigations, ditches, or rainfall. This could require a complete year of study, periodically recording depth to groundwater in the intended site area, followed by a report from a geologist documenting the findings and recommendations. Conclusions may dictate reducing lagoon depth, building an above ground lagoon, and/or artificially controlling the water table with a tile drainage system.

Above Ground Lagoon

The above ground lagoon can be a good option for a new lagoon, from the perspective of minimizing the volume of soil that must be moved. However, in many areas, these are required due to high groundwater conditions.

Depending on the available soils, embankment height may be limited by engineering constraints. If below grade depth is limited, a deep lagoon (and efficient use of liner area) may not be possible at all. For a given storage volume, decreasing the depth of the lagoon will require increasing the footprint and corresponding liner costs. Thus, the cost for an above ground lagoon could be higher than identified in Table 1, as a function of the depth of the lagoon. There could be a decrease in earthwork costs, as less total volume of earth may need to be moved to provide the same storage volume; however, this is offset by the increased cost of placement of compacted fill in above ground embankments.

Using the 750 milk cow dairy case as an example, an above ground lagoon with only 12 feet of total depth increases the foot print by 1.2 acres and adds an additional cost of approximately $34,000 to the single liner and $83,000 for the double liner installation.

Manure and Sand Separation

New lagoons lined with thin layers of synthetic material are vulnerable to damage from lagoon cleaning equipment. A small hole in the liner can allow wastewater to get underneath. The wastewater naturally produces carbon dioxide and methane, byproducts of anaerobic digestion. The trapped gases under the liner can accumulate (if not vented) and eventually tend to float the liner to the surface, introducing stresses in the liner, leading to more liner damage, more wastewater under the liner, and yet more trapped gases. Thus, a minor nick or puncture of a 60 mil layer can lead to a major incident, requiring the replacement of the entire liner. Costs could approach what is estimated in Table 1 for an existing lagoon relining operation. Accordingly, it is very important to minimize liner exposure to equipment and to reduce cleanings as much as possible.

Manure solids separation systems are common on dairies. Some systems still allow a significant amount of solids into the lagoon because of various issues. Good solids separation can be an important factor enhancing the useful life of a liner. Thus, when installing a lined lagoon it is important to consider or reconsider manure separation. Adding a new screen separator and concrete drying pad can cost from $180,000 for a smaller dairy to $400,000 or more for a larger dairy. These costs are not included in Table 1 but may be necessary on many dairies to properly maintain and operate lagoons with synthetic liners.

Sand or dirt removal is also an important consideration. Sand can be introduced to the manure stream from bedding, feed, track-in from corrals, or other sources. Sand settling lanes or traps are a good solution, but must be considered during design to account for location, elevation, and gravity flow constraints.

Increased Rainfall and Storage Period

The estimates in Table 1 considered the weather conditions representative within Kings and Tulare Counties. Other areas to the north have more rainfall and may require a longer storage period, both of which require additional storage volume. Providing greater storage volume results in increased costs over what was estimated in Table 1.

Using the 750 milk cow dairy again, changing the rainfall numbers to what is expected in the northern Sacramento Valley near Orland, the 750 milk cow dairy needs an additional 1.7 acres and costs are increased by roughly 50%. Adding an additional month of storage adds approximately another 7% to the cost.

## Conclusion

The estimated costs provided in Table 1 are based on the minimum anticipated cost for the construction of an HDPE lined lagoon for a range of dairy sizes. These estimates are conservative (at an estimated higher cost) based on standardized assumptions that were outlined. However, when compared to each unique dairy situation additional cost drivers can easily increase the overall cost. These additional costs outlined in the Issues section can include location, groundwater conditions, manure and sand separation systems, higher rainfall areas than the south valley, and the length of the storage period.

WESTERN UNITED DAIRYMEN

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**MEMORANDUM**

To: Theresa A. Dunham; Somach, Simmons & Dunn

From: Annie AcMoody

Subject: Financial Impact to Retrofit Dairies that Do Not Have Tier 1 or Tier 2 Lagoons

Date: August 6, 2013

This memo estimates the financial impact to retrofit existing dairies that do not have Tier 1 or Tier 2 lagoons for a range of dairy sizes.

**Scope/methodology**

No two California dairies are exactly alike; dairy operators have different resources and production facilities. Therefore, this report provides a range of financial impacts. The estimated costs to retrofit dairy lagoons were based on an analysis provided by Provost and Pritchard (P&P). See memorandum from P&P dated August 5, 2013.

Specific farm financial information was compiled using California Department of Food and Agriculture (CDFA) data. The Cost of Production Unit, within the Dairy Marketing Branch of the CDFA, compiles cost of producing milk on a quarterly basis and publishes yearly averages for each of the production regions in California. More specifically for this analysis, a sample of dairies within California's Central Valley was used for each of the size categories analyzed by P&P.

Assumptions regarding the financing of the projects were made after interviewing personnel from three different lending institutions.

Due to market place volatility, it is extremely difficult to forecast dairy margins with any accuracy. One more reliable way is to look at past recent market conditions. The last five years presented an array of market conditions and provide insight on the financial situation faced by California dairy farmers. Assuming upcoming years are filled with similar extremely variable conditions, allows for an analysis of different scenarios.

**Qualifications**

Annie AcMoody graduated from Universite Laval, Quebec, Canada with a B.S in Agricultural Economics and Management. She also holds an M.S. in Agricultural Economics from Purdue University, West Lafayette, Indiana. Mrs. AcMoody has been the director of economic analysis for Western United Dairymen (WUD) since 2010. She has been an agricultural economist focusing on dairy economics issues in the state of California since 2007. More specifically, prior to working at WUD, she was an economist at the California Department of Food and Agriculture's Dairy Marketing Branch. In that role, she frequently analyzed the financial health of the California dairy industry, both from the dairy producers' and manufacturers' perspectives.

**Dairy production in California**

Milk and associated dairy products (cheese, dry milk powder, butter, ice cream, etc.) are California's top grossing agricultural products. Based on a study commissioned by the California Milk Advisory Board, California's dairy industry supported 450,000 jobs and generated $63 billion in economic impact statewide in 2008. Nationally, California's production is significant: in 2012, California led the nation in milk production, producing 21% of the U.S.'s milk supply.

In recent years, milk price volatility has become a part of dairy operators' reality. The large variation in estimated margins over the past five years is a clear illustration of that. 2009 was especially negative as dairy operators in California were faced with historically low prices for milk and unusually high cost of production. Costs of production have remained high, fueled notably by high feed costs that remain supported by the government's ethanol policies. The margins outlined in this document do not include the cost of compliance with environmental regulations, which are becoming an increasingly larger part of the cost of producing milk in California. Each year, dairies have been forced out of business. The net loss of dairy operations over the past five years totaled 387 farms. This data does not include the number of farmers forced out of business and whose dairies were acquired by another dairy operation that managed to stay in business.

California dairies are complex and advanced operations. Nearly all California dairies are family run, and the farmers strive for production efficiencies through the use of advanced technologies in genetics, nutrition, reproduction, animal housing, and animal welfare.

Data

1) Cost of production

   To calculate the impact of retrofitting dairy lagoons, data from the CDFA Cost of production studies were used. Those studies are conducted quarterly. CDFA staff goes to dairies and gather actual financial information. A sample representing approximately 10% of the dairy farms in California is analyzed each year to provide a representative picture of the financial health of the state's dairy operations (cost of production studies can be found at: http://cdfa.ca.gov/dairy/dairycop_annual.html). In this financial impact study, data from that sample was analyzed. More specifically, dairies representative of the sizes used in the P&P study were studied (300 cows, 750 cows, 1,500 cows and 3,000 cows).

   CDFA releases a cost of production that includes allowances (return on investment and return on management). Because the return on investment is an allowance that can be foregone if the dairy operation is in a dire situation, it was not included in the cost of production number for the purpose of this analysis.

   The cost of retrofitting dairy lagoons was analyzed under four different scenarios. Because the "new location" without assuming a wet clean-up cost was the cheaper option, it was used for a low end estimate. Utilization of both single and double liners was analyzed. The "new location" with wet clean-up cost is the most expensive option; therefore it was used as the most expensive end of the range for analysis purposes. Both single and double liners were also analyzed. From these four scenarios, specific yearly costs to the dairy were calculated using financing assumptions (repayment estimates included in Appendix A).

2) Revenue

Dairy operations' revenues come from the milk check they receive each month. In California, there is a milk pricing system that guarantees a minimum price processors are required to pay. However, each dairy ends up getting a different price due to different milk components, premiums, marketing costs, etc. Therefore, the mailbox price, which represents the net price received by a dairy, was used to determine the dairy revenue for each farm in the sample.

3) Financing

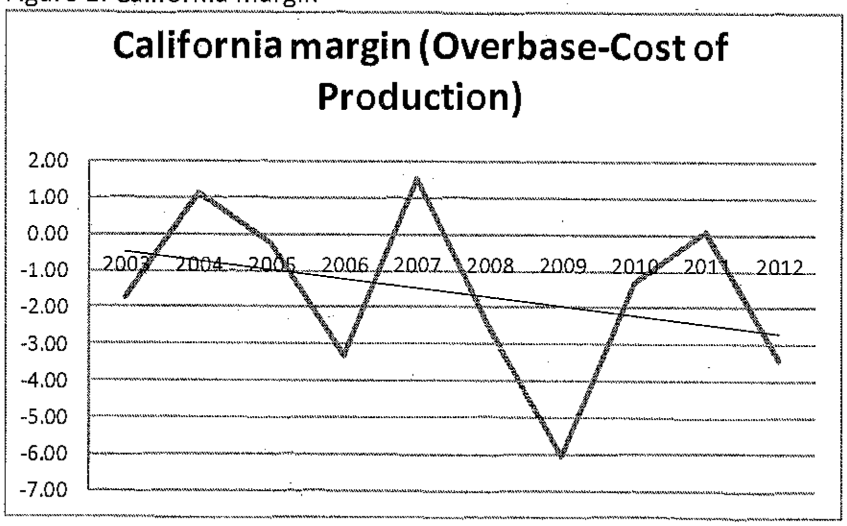
Because the cost of retrofitting dairy lagoons is significant, dairies would have to secure financing to pay for the project. The lack of available credit for dairy operations has been a popular topic in recent years and will be discussed in the Impact section further. For the sake of this study, it was assumed the dairy operation was able to secure a loan. But it is debatable whether a dairy would be able to secure a loan to proceed with the project because retrofitting a dairy lagoon does not create new value on the farm. Therefore, collateral, free of liens, would need to be available. Although some banks would rather lend on a shorter time frame, a twenty year loan seems to be a conservative option, lower yearly cost option and was used as an assumption. The current going interest rate for those terms is 6%.

**Impact to dairies**

1) Financial impact

Over the last decade, dairies have had to weather various pricing conditions, with some positive and some negative margin years. However, the overall trend is one of declining margins. A quick glance at the overbase price (minimum milk price paid producers) minus the cost of production (including allowances) illustrates that point (see Figure 1).

Figure 1: California margin




The bottom line experienced by dairies of the sizes outlined in the P&P memorandum did not exhibit a different trend during the past five years. 2008 and 2009 were not profitable years and forced dairies to dig into their equity to stay afloat (2008 for the 1,500 cow herd sample was an exception). 2010 and 2011 were profitable years while 2012 was not. Table 1 illustrates the net revenue per cow for each herd size.

Table 1: Net Revenue per Cow

| Herd Size | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|
| 300 | $ (89.74) | $ (891.12) | $ 52.11 | $ 396.30 | $ (321.12) |
| 750 | $ (33.26) | $ (745.69) | $ 175.36 | $ 364.25 | $ (309.39) |
| 1500 | $ 98.59 | $ (840.59) | $ 195.37 | $ 622.35 | $ (117.88) |
| 3000 | $ (51.19) | $ (747.42) | $ 265.71 | $ 746.33 | $ (139.97) |

Overall, for the past five years, dairy operations have fallen behind as the average net revenue per cow was negative for all herd sizes but one (see Table 2).

Table 2: Net revenue per cow, five year average

| Average net revenue per cow | | | | |
|---|---|---|---|---|
| Herd size | 300 | 750 | 1500 | 3000 |
| Past five year | $ (170.71) | $ (109.75) | $ (8.43) | $ 14.69 |

Looking at this data clearly explains the declining trend in the number of dairy operations in California. Left with no financial room to maneuver, adding on the cost of retrofitting dairy lagoons would prove impossible for most operations. The negative margins resulting are evidence of how much more economically fragile dairy operations would be if the costs of retrofitting lagoons were to be imposed on them. In no analyzed scenarios were dairies profitable with the added costs. Figure 2 illustrates that point. Table 3 after shows a more detailed analysis for each year and herd size.

Figure 2: Average net revenue per cow

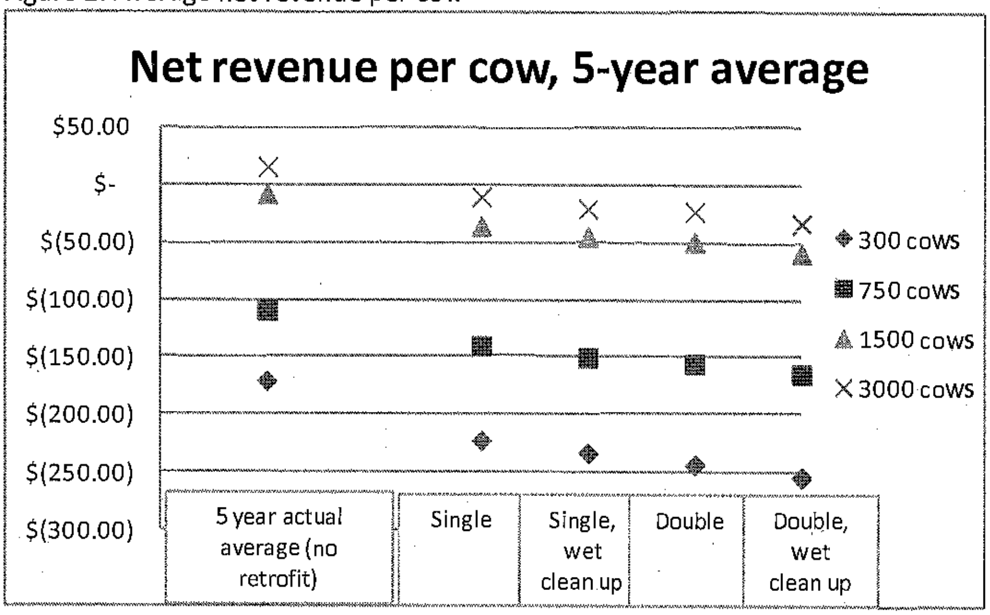


Table 3: Yearly margins by herd size based on four different costs scenarios

| 300 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|
| Single liner | $ (141.32) | $ (942.70) | $ 0.52 | $ 344.72 | $(372.71) |
| Single, wet clean up | $ (151.92) | $ (953.30) | $ (10.08) | $ 334.11 | $(383.31) |
| Double liner | $ (161.95) | $ (963.33) | $ (20.11) | $ 324.08 | $(393.34) |
| Double, wet clean up | $ (172.55) | $ (973.94) | $ (30.71) | $ 313.48 | $(403.94) |
| | | | | | |
| 750 | 2008 | 2009 | 2010 | 2011 | 2012 |
| Single liner | $ (64.79) | $ (777.21) | $ 143.83 | $ 332.72 | $(340.91) |
| Single, wet clean up | $ (73.73) | $ (786.16) | $ 134.89 | $ 323.78 | $(349.85) |
| Double liner | $ (79.00) | $ (791.43) | $ 129.62 | $ 318.51 | $(355.13) |
| Double, wet clean up | $ (87.94) | $ (800.37) | $ 120.68 | $ 309.57 | $(364.07) |
| | | | | | |
| 1500 | 2008 | 2009 | 2010 | 2011 | 2012 |
| Single liner | $ 70.96 | $ (868.22) | $ 167.75 | $ 594.72 | $(145.51) |
| Single, wet clean up | $ 61.16 | $ (878.02) | $ 157.95 | $ 584.92 | $(155.31) |
| Double liner | $ 57.67 | $ (881.52) | $ 154.45 | $ 581.42 | $(158.81) |
| Double, wet clean up | $ 47.87 | $ (891.32) | $ 144.65 | $ 571.62 | $(168.61) |
| | | | | | |
| 3000 | 2008 | 2009 | 2010 | 2011 | 2012 |
| Single liner | $ (76.60) | $ (772.84) | $ 240.29 | $ 720.91 | $(165.39) |
| Single, wet clean up | $ (86.83) | $ (783.07) | $ 230.06 | $ 710.68 | $(175.62) |
| Double liner | $ (89.04) | $ (785.27) | $ 227.86 | $ 708.47 | $(177.82) |
| Double, wet clean up | $ (99.27) | $ (795.51) | $ 217.63 | $ 698.24 | $(188.06) |

2) **Availability of credit**

In conversations with lenders, the financing of the retrofitting projects would be difficult for most operations. To qualify for a real estate secured term loan covering the capital expenses amortized over 20 years, the loan would need to be secured by a 1st priority lien with a maximum debt against the appraised value of the real estate of 65%; this may cover 100% of the expenses or only a portion depending on the available lendable equity of the property. The borrower would need to have a debt-service coverage ratio (for all debt) of 1.25x.

If the dairy lagoon is retrofitted, the value of the dairy would most likely not change, i.e. the dairy's value would not increase because the retrofit was performed. Further, to obtain credit, the dairy likely needs to be free and clear of liens to have equity available. Due to the low profitability in the dairy industry over the past 5 years (as outlined in the previous section), facility values have been discounted heavily. One positive that the aforementioned analysis does not take into account is that farm-land values have appreciated greatly. However, this appreciation may not be sustainable and that appreciation is typically for a highest and best use of something other than growing forage crops to feed cows. It is generally tied to permanent plantings with most of the influence coming from nuts such as almonds, walnuts and pistachios.

**Conclusion**

A dairy lagoon retrofit would increase the overhead and breakeven cost to the operation. This increased cost of production, because it is not revenue generating, cannot be passed on to the processor or consumer so it reduces the profitability of the dairy. Ultimately, these costs could be the final add-on that may put a dairy operation out of business. Further, a large percentage of dairy operations would not be eligible for financing to complete a retrofit due to the lack of repayment capacity and because the operation is already likely over leveraged with existing debt.

Appendix A

TERMS OF LOAN

| | |
|---|---|
| Life of loan (years) | 20 |
| Payments per year | 12 |
| Annual interest rate | 6.00% |

| 300 MC | New location, no clean up cost, Single liner | New location, wet clean up cost, Single liner | New location, no clean up cost, Double liner | New location, wet clean up cost Double liner |
|---|---|---|---|---|
| PRINCIPAL | $ 180,000.00 | $ 217,000.00 | $ 252,000.00 | $ 289,000.00 |
| Monthly Payment | $ 1,289.58 | $ 1,554.66 | $ 1,805.41 | $ 2,070.49 |
| 750 MC | | | | |
| PRINCIPAL | $ 275,000.00 | $ 353,000.00 | $ 399,000.00 | $ 477,000.00 |
| Monthly Payment | $ 1,970.19 | $ 2,529.00 | $ 2,858.56 | $ 3,417.38 |
| 1500 MC | | | | |
| PRINCIPAL | $ 482,000.00 | $ 653,000.00 | $ 714,000.00 | $ 885,000.00 |
| Monthly Payment | $ 3,453.20 | $ 4,678.29 | $ 5,115.32 | $ 6,340.41 |
| 3000 MC | | | | |
| PRINCIPAL | $ 887,000.00 | $ 1,244,000.00 | $ 1,321,000.00 | $ 1,678,000.00 |
| Monthly Payment | $ 6,354.74 | $ 8,912.40 | $ 9,464.05 | $ 12,021.71 |

# ATTACHMENT A

## Existing Conditions Report
## For
## Existing Milk Cow Dairies

## DAIRY FACILITY INFORMATION

A. NAME OF DAIRY OR BUSINESS OPERATING THE DAIRY: ______________________________

PHYSICAL ADDRESS OF DAIRY:

______________________________________________________________
Number and Street City County Zip Code

STREET AND NEAREST CROSS STREET (IF NO ADDRESS): ______________________________

COUNTY ASSESSOR PARCEL NUMBER(S) FOR DAIRY FACILITY: ______________________________

COUNTY ASSESSOR PARCEL NUMBER(S) FOR EACH LAND APPLICATION AREA (WHERE MANURE AND/OR PROCESS WASTEWATER IS APPLIED UNDER CONTROL OF THE OWNER OR OPERATOR WHETHER IT IS OWNED, RENTED, OR LEASED):

______________________________________________________________

______________________________________________________________

______________________________________________________________

B. OPERATOR NAME: ______________________ TELEPHONE NO. ______________

MAILING ADDRESS OF OPERATOR OF DAIRY: ______________________________
Number And Street City Zip Code

C. NAME OF LEGAL OWNER OF THE DAIRY PROPERTY: ______________________________

MAILING ADDRESS OF LEGAL OWNER:

______________________________________________________________
Number and Street City Zip Code

CONTACT PERSON: ______________________ TELEPHONE NO. ______________

D. PERSON TO RECEIVE REGIONAL BOARD CORRESPONDENCE (CHECK): _____OWNER _____OPERATOR ____BOTH

## DAIRY FACILITY ASSESSMENT

A. WASTE MANAGEMENT PLAN AND NUTRIENT MANAGEMENT PLAN:

HAVE YOU COMPLETED A WASTE MANAGEMENT PLAN AND NUTRIENT MANAGEMENT PLAN IN ACCORDANCE WITH THE REQUIREMENTS OF THE WASTE DISCHARGE REQUIREMENTS GENERAL ORDER NO.R5-2013-0122?
_____YES ______NO

IF YES, PLEASE ATTACH A COPY OF THE WASTE MANAGEMENT PLAN AND NUTRIENT MANAGEMENT PLAN TO THIS REPORT.

IF NO, PLEASE COMPLETE A PRELIMINARY FACILITY ASSESSMENT OF YOUR DAIRY AS DESCRIBED IN B BELOW.

B. PRELIMINARY DAIRY FACILITY ASSESSMENT:
IF YOU HAVE NOT COMPLETED A WASTE MANAGEMENT PLAN AND NUTRIENT MANAGEMENT PLAN AS DESCRIBED IN A, ABOVE, PLEASE COMPLETE AND ATTACH A PRELIMINARY DAIRY FACILITY ASSESSMENT[1] FOR YOUR DAIRY. THE PRELIMINARY DAIRY FACILITY ASSESSMENT IS AVAILABLE ELECTRONICALLY ON THE CENTRAL VALLEY

---

[1] THE PRELIMINARY DAIRY FACILITY ASSESSMENT IS ONLY INTENDED TO PROVIDE A PRELIMINARY ASSESSMENT OF YOUR DAIRY FACILITY'S ABILITY TO STORE WASTEWATER GENERATED AT YOUR DAIRY AND THE ABILITY OF YOUR CROPLAND TO UTILIZE THE NUTRIENTS GENERATED AT YOUR DAIRY. IT WILL PROVIDE: (1) A PRELIMINARY ESTIMATE OF YOUR DAIRY'S WASTEWATER STORAGE NEEDS VERSUS THE EXISTING WASTEWATER STORAGE CAPACITY; AND

WATER BOARD WEBSITE AT http://www.waterboards.ca.gov/centralvalley/available_documents/index.html#confined. THE ASSESSMENT MUST BE COMPLETED ELECTRONICALLY AND A COPY OF THE RESULTS ATTACHED TO THIS EXISTING CONDITIONS REPORT THAT YOU SUBMIT TO THE EXECUTIVE OFFICER.

## ADDITIONAL DAIRY FACILITY INFORMATION

A. REPORT OF WASTE DISCHARGE SUBMITTED:

IS ALL OF THE INFORMATION YOU PROVIDED IN THE REPORT OF WASTE DISCHARGE THAT WAS DUE ON 17 OCTOBER 2005 STILL CORRECT? _____YES _____NO

IF NO, PLEASE ATTACH A COPY OF YOUR REPORT OF WASTE DISCHARGE WITH THE CORRECTED INFORMATION AND YOUR CORRECTIONS INITIALED AND DATED.

B. GROUNDWATER MONITORING:

ARE THERE ANY GROUNDWATER MONITORING WELLS AT YOUR DAIRY? ______YES _____NO

HAS A MONITORING WELL INSTALLATION AND SAMPLING PLAN BEEN SUBMITTED TO THE CENTRAL VALLEY WATER BOARD? ______YES ______NO

IS GROUNDWATER MONITORING BEING CONDUCTED AT YOUR DAIRY? ______YES _____NO

C. SUBSURFACE (TILE) DRAINAGE:

DO ANY OF YOUR LAND APPLICATION AREAS HAVE A SUBSURFACE (TILE) DRAINAGE SYSTEM? ______YES ______NO

IF YES, PLEASE INDICATE BELOW THE ASSESSOR PARCEL NUMBER FOR EACH LAND APPLICATION AREA THAT HAS A SUBSURFACE (TILE) DRAINAGE SYSTEM AND THE POINT OF DISCHARGE (E.G., DRAINAGE DITCH, CREEK, STREAM, EVAPORATION BASIN):

| ASSESSOR PARCEL NUMBER(S) | POINT OF DISCHARGE |
|---|---|
| ______________________ | ______________________ |
| ______________________ | ______________________ |
| ______________________ | ______________________ |

D. THIRD PARTY USE OF PROCESS WASTEWATER:

DO YOU PROVIDE PROCESS WASTEWATER TO A THIRD PARTY FOR THEIR OWN USE?

______YES _____NO

IF YES, YOU MUST ATTACH TO THIS REPORT A COPY OF A WRITTEN AGREEMENT WITH EACH SUCH THIRD PARTY. THE WRITTEN AGREEMENT MUST COMPLY WITH LAND APPLICATION SPECIFICATION C.2 OF WASTE DISCHARGE REQUIREMENTS GENERAL ORDER NO. R5-2013-0122.

E. ANAEROBIC DIGESTERS:

DOES YOUR DAIRY TREAT PROCESS WASTEWATER IN AN ANAEROBIC DIGESTER? _____YES _____NO

F. MORTALITY:

INDICATE HOW MORTALITY IS HANDLED:

RENDERING SERVICE________ BURIAL________ OTHER (DESCRIBE)______________________________

(2) A PRELIMINARY ESTIMATE OF THE NITROGEN AND PHOSPHORUS GENERATED AT, AND IMPORTED TO, YOUR DAIRY, THE NITROGEN AND PHOSPHORUS REMOVED BY CROPS GROWN AT YOUR DAIRY, AND THE NITROGEN AND PHOSPHORUS EXPORTED FROM YOUR DAIRY. THE PRELIMINARY FACILITY ASSESSMENT IS NOT A SUBSTITUTE FOR A WASTE MANAGEMENT PLAN OR NUTRIENT MANAGEMENT PLAN AND SHOULD NOT BE USED FOR DESIGN PURPOSES. THE PRELIMINARY DAIRY FACILITY ASSESSMENT WAS DEVELOPED BY THE MERCED COUNTY ENVIRONMENTAL HEALTH DEPARTMENT IN COOPERATION WITH THE CENTRAL VALLEY WATER BOARD, THE UNIVERSITY OF CALIFORNIA, WESTERN UNITED DAIRYMEN, THE CALIFORNIA DAIRY CAMPAIGN, AND THE MILK PRODUCER'S COUNCIL.

G. CHEMICAL USE:

INDICATE ALL CHEMICALS USED AT THE FACILITY THAT ARE STORED IN THE WASTE STORAGE SYSTEM OR THAT COULD BE DISCHARGED TO SURFACE WATER OR GROUNDWATER AND THE APPROXIMATE AMOUNTS USED ANNUALLY (ATTACH ADDITIONAL SHEETS AS NECESSARY):

| | TYPE | APPROXIMATE ANNUAL AMOUNT USED |
|---|---|---|
| SOAPS | ____________ | ____________ |
| DISINFECTANTS | ____________ | ____________ |
| PESTICIDES | ____________ | ____________ |
| FOOTBATHS | ____________ | ____________ |
| OTHER | ____________ | ____________ |

H. SITE MAP:

PROVIDE A SITE MAP (AERIAL OR TOPOGRAPHIC) OF YOUR DAIRY WHICH SHOWS THE FOLLOWING IN SUFFICIENT DETAIL: DAIRY FACILITY PROPERTY BOUNDARIES; LOCATIONS OF ALL MONITORING, DOMESTIC, AND IRRIGATION WELLS; PROCESS WASTEWATER RETENTION PONDS; MILKING PARLOR; ANIMAL HOUSING; CORRALS; AND ALL LAND APPLICATION AREAS WITH IDENTIFICATION OF LAND USED FOR APPLICATION OF MANURE AND/OR PROCESS WASTEWATER.

## CALIFORNIA ENVIRONMENTAL QUALITY ACT (CEQA) COMPLIANCE

A. WAS YOUR DAIRY OPERATING AT ITS CURRENT LOCATION AS OF 17 OCTOBER 2005? _____ YES _____NO

IF YES, HAS YOUR DAIRY EXPANDED BY MORE THAN 15% SINCE 17 OCTOBER 2005? _____YES _____ NO

IF YES (I.E., YOUR DAIRY DID EXPAND BY MORE THAN 15%), DID YOU SUBMIT A REPORT OF WASTE DISCHARGE (ROWD) TO THE CENTRAL VALLEY WATER BOARD FOR THE EXPANSION? _____YES _____NO

## CERTIFICATION

"I CERTIFY UNDER PENALTY OF LAW THAT I HAVE PERSONALLY EXAMINED AND AM FAMILIAR WITH THE INFORMATION SUBMITTED IN THIS DOCUMENT AND ALL ATTACHMENTS AND THAT, BASED ON MY INQUIRY OF THOSE INDIVIDUALS IMMEDIATELY RESPONSIBLE FOR OBTAINING THE INFORMATION, I BELIEVE THAT THE INFORMATION IS TRUE, ACCURATE, AND COMPLETE. I AM AWARE THAT THERE ARE SIGNIFICANT PENALTIES FOR SUBMITTING FALSE INFORMATION, INCLUDING THE POSSIBILITY OF FINE AND IMPRISONMENT. IN ADDITION, I CERTIFY THAT THE PROVISIONS OF WASTE DISCHARGE REQUIREMENTS GENERAL ORDER NO. R5-2013-0122, INCLUDING THE DEVELOPMENT AND IMPLEMENTATION OF A NUTRIENT MANAGEMENT PLAN AND WASTE MANAGEMENT PLAN, WILL BE COMPLIED WITH."

| | |
|---|---|
| SIGNATURE OF OWNER OF FACILITY | SIGNATURE OF OPERATOR OF FACILITY |
| PRINT OR TYPE NAME | PRINT OR TYPE NAME |
| TITLE AND DATE | TITLE AND DATE |

**ATTACHMENT B**

**Waste Management Plan for the Production Area For Existing Milk Cow Dairies**

A Waste Management Plan (WMP) for the production area is required for all existing milk cow dairies subject to Waste Discharge Requirements General Order No. R5-2013-0122 and shall address all of the items below. The portions of the WMP that are related to facility and design specifications (items II and III) must be prepared by, or under the responsible charge of, and certified by a civil engineer who is registered pursuant to California law or other person as may be permitted under the provisions of the California Business and Professions Code to assume responsible charge of such work.

The purpose of the WMP is to ensure that the production area of the dairy facility is designed, constructed, operated and maintained so that dairy wastes generated at the dairy are managed in compliance with Waste Discharge Requirements General Order No. R5-2013-0122 in order to prevent adverse impacts to groundwater and surface water quality.

I. A description of the facility that includes:

A. The name of the facility and the county in which it is located;

B. The address, Assessor's Parcel Number, and Township, Range, Section(s), and Baseline Meridian of the property;

C. The name(s), address(es), and telephone number(s) of the property owner(s), facility operator(s), and the contact person for the facility;

D. Present and maximum animal population as indicated below (this information is in the Report of Waste Discharge submitted in response to the Central Valley Water Board's 8 August 2005 request);

| Type of Animals | Present Number of Animals | Maximum Number of Animals in Past 12 months | Breed of Animals |
|---|---|---|---|
| Milking Cows | | | |
| Dry Cows | | | |
| Heifers: 15 – 24 months | | | |

| Type of Animals | Present Number of Animals | Maximum Number of Animals in Past 12 months | Breed of Animals |
|---|---|---|---|
| Heifers: 7 to 14 months | | | |
| Heifers: 4 to 6 months | | | |
| Calves: up to 3 months | | | |
| Other types of commercial animals | | | |

E. Total volume (gallons) of process wastewater (e.g., milk barn washwater, fresh (not recycled) corral flush water, etc.) generated daily and how this volume was determined; and

F. A Site Map (or Maps) of appropriate scale to show property boundaries and the following in sufficient detail:

1. The location of the features of the production area including:

   a. Structures used for animal housing, milk parlor, and other buildings; corrals and ponds; solids separation facilities (settling basins or mechanical separators); other areas where animal wastes are deposited or stored; feed storage areas; drainage flow directions and nearby surface waters; all water supply wells (domestic, irrigation, and barn wells) and groundwater monitoring wells; and

   b. Process wastewater conveyance structures, discharge points, and discharge/mixing points with irrigation water supplies; pumping facilities and flow meter locations; upstream diversion structures, drainage ditches and canals, culverts, drainage controls (berms/levees, etc.), and drainage easements; and any additional components of the waste handling and storage system.

2. The location and features of all land application areas (land under the Discharger's control, whether it is owned, rented, or leased, to which manure or process wastewater from the production area is or may be applied for nutrient recycling) including:

a. A field identification system (Assessor's Parcel Number; field by name or number; total acreage of each field; crops grown; indication if each field is owned, leased, or used pursuant to a formal agreement); indication what type of waste is applied (solid manure only, wastewater only, or both solid manure and wastewater); drainage flow direction in each field, nearby surface waters, and storm water discharge points; tailwater and storm water drainage controls; subsurface (tile) drainage systems (including discharge points and lateral extent); irrigation supply wells and groundwater monitoring wells; sampling locations for discharges of storm water and tailwater to surface water from the field; and

b. Process wastewater conveyance structures, discharge points and discharge.mixing points with irrigation water supplies; pumping facilities; flow meter locations; drainage ditches and canals, culverts, drainage controls (berms, levees, etc.), and drainage easements.

3. The location of all cropland that is part of the dairy but is not used for dairy waste application including the Assessor's Parcel Number, total acreage, crops grown, and information on who owns or leases the field. The Waste Management Plan shall indicate if such cropland is covered under the Conditional Waiver of Waste Discharge Requirements for Discharges from Irrigated Lands (Order No. R5-2006-0053 for Coalition Group or Order No. R5-2006-0054 for Individual Discharger, or updates thereto);

4. The location of all off-property domestic wells within 600 feet of the production area or land application area(s) associated with the dairy and the location of all municipal supply wells within 1,500 feet of the production area or land application area(s) associated with the dairy; and

5. A map scale, vicinity map, north arrow, and the date the map was prepared. The map shall be drawn on a published base map (e.g., a topographic map or aerial photo) using an appropriate scale that shows sufficient details of all facilities.

II. An engineering report demonstrating that the existing facility has adequate containment capacity. The report shall include calculations showing if the existing containment structures are able to retain all facility process wastewater generated, together with all precipitation on and drainage through manured areas, up to and including during a 25-year, 24-hour storm.

A. The determination of the necessary storage volume shall reflect:

1. The maximum period of time, as defined in the Nutrient Management Plan (item III.B of Attachment C), anticipated between land application events (storage period), which shall consider application of process wastewater or manure to the land application area as allowed by Waste Discharge Requirements General Order No. R5-2013-0122 using proper timing and rate of applications;

2. Manure, process wastewater, and other wastes accumulated during the storage period;

3. Normal precipitation, or normal precipitation times a factor of one and a half, less evaporation on the surface area during the entire storage period. If normal precipitation is used in the calculation of necessary storage volume, the Waste Management Plan shall include a Contingency Plan as specified in II.C below;

4. Normal runoff (runoff from normal precipitation), or runoff due to normal precipitation times a factor of one and a half, from the production area during the storage period. If normal runoff is used in the calculation of necessary storage volume, the Waste Management Plan shall include a Contingency Plan as specified in II.C below;

5. 25-year, 24-hour precipitation on the surface (at the required design storage volume level) of the facility;

6. 25-year, 24-hour runoff from the facility's drainage area;

7. Residual solids after liquids have been removed; and

8. Necessary freeboard (one foot of freeboard for belowground retention ponds and two feet of freeboard for aboveground retention ponds).

B. If the existing facility's storage capacity is inadequate, the WMP shall include proposed modifications or improvements. Any proposed modifications or improvements must be: prepared by, or under the responsible charge of, and certified by a civil engineer who is registered pursuant to California law or other person as may be permitted under the provisions of the California Business and Professions Code to assume responsible charge of such work; and include:

1. Design calculations demonstrating that adequate containment will be achieved;

2. Details on the liner and leachate collection and removal system (if appropriate) materials;

3. A schedule for construction and certification of completion to comply with the Schedule of Tasks J.1 of Waste Discharge Requirements General Order No. R5-2013-0122;

4. A construction quality assurance plan describing testing and observations need to document construction of the pond in accordance with the design and Sections 20323 and 20324 of Title 27; and

5. An operation and maintenance plan for the pond.

C. Contingency Plan: If the necessary storage volume calculated in II.A or II.B above is based on normal precipitation and/or runoff rather than precipitation or runoff from normal precipitation times a factor of one and a half (see II.A.3 and II.A.4 above), then the engineering report shall include a Contingency Plan that includes a plan on how the excess precipitation and/or runoff that is generated during higher than normal precipitation will be managed. If the Contingency Plan includes plans to discharge the excess runoff and/or precipitation to land without being in conformance with the NMP, then the Contingency Plan shall include a Monitoring Well Installation and Sampling Plan (MWISP) with a schedule for implementation that proposes monitoring wells to determine the impacts of such disposal on groundwater quality.

III. An engineering report showing if the facility has adequate flood protection. If the Discharger can provide to the Executive Officer an appropriate published flood zone map that shows the facility is outside the relevant flood zone, an engineering report showing adequate flood protection is not required for that facility. The engineering report shall include a map and cross-sections to scale, calculations, and specifications as necessary. The engineering report shall also describe the size, elevation, and location of all facilities present to protect the facility from inundation or washout as follows:

A. For facilities in the Sacramento River and San Joaquin River Basins showing if:

1. The ponds and manured areas at facilities in operation on or before November 27, 1984 are protected from inundation or washout by overflow from any stream channel during 20-year peak storm flow; or

2. Existing facilities in operation on or before November 27, 1984 that are protected against 100-year peak storm flows will continue such protection; or

3. Facilities, or portions thereof, which began operation after November 27, 1984, are protected against 100-year peak storm flows.

B. For facilities in the Tulare Lake Basin showing if the facility is protected from overflow from stream channels during 20-year peak stream flows for facilities that existed as of 25 July 1975 and protected from 100-year peak stream flows for facilities constructed after 25 July 1975. Facilities expanded after 8 December 1984 must be protected from 100-year peak stream flows.

C. If the facility's flood protection does not meet these minimum requirements, the WMP shall include proposed modifications or improvements with the corresponding design to achieve the necessary flood protection and a schedule for construction and certification of completion to comply with the Schedule of Tasks J.1 of Waste Discharge Requirements General Order No. R5-2013-0122.

IV. A report assessing if the animal confinement areas, animal housing, and manure and feed storage areas are designed and constructed properly.

A. The report shall assess if the following design and construction criteria are met:

1. Corrals and/or pens are designed and constructed to collect and divert all process wastewater to the retention pond;

2. The animal housing area (i.e., barn, shed, milk parlor, etc.) is designed and constructed to divert all water that has contacted animal wastes to the retention pond; and

3. Manure and feed storage areas are designed and constructed to collect and divert runoff and leachate from these areas to the retention pond.

B. If the facility does not meet the above design and construction criteria, the WMP shall include proposed modifications or improvements to achieve the criteria and a schedule for construction and certification of completion to comply with the Schedule of Tasks J.1 of Waste Discharge Requirements General Order No. R5-2013-0122.

V. An operation and maintenance plan to ensure that:

A. All precipitation and surface drainage from outside manured areas, including that collected from roofed areas, is diverted away from manured areas, unless such drainage is fully contained and is included in the storage requirement calculations required in item II, above;

B. Ponds are managed to maintain the required freeboard and to prevent odors, breeding of mosquitoes, damage from burrowing animals, damage from equipment during removal of solids, embankment settlement, erosion, seepage, excess weeds, algae, and vegetation;

C. Holding ponds provide necessary storage volume prior to winter storms (by November 1st at the latest), maintain capacity considering buildup of solids, and comply with the minimum freeboard required in Waste Discharge Requirements General Order No. R5-2013-0122;

D. There is no discharge of waste or storm water to surface waters from the production area;

E. Procedures have been established for removal of solids from any lined pond to prevent damage to the pond liner;

F. Corrals and/or pens are maintained to collect and divert all process wastewater to the retention pond and to prevent ponding of water and to minimize infiltration of water into the underlying soils;

G. The animal housing area (e.g., barn, shed, milk parlor, etc.) is maintained to collect and divert all water that has contacted animal wastes to the retention pond and to minimize the infiltration of water into the underlying soils;

H. Manure and feed storage areas are maintained to ensure that runoff and leachate from these areas are collected and diverted to the retention pond and to minimize infiltration of leachate from these areas to the underlying soils;

I. All dead animals are disposed of properly;

J. Chemicals and other contaminants handled at the facility are not disposed of in any manure or process wastewater, or storm water storage or treatment system unless specifically designed to treat such chemicals and other contaminants;

K. All animals are prevented from entering any surface water within the confined area; and

L. Salt in animal rations is limited to the amount required to maintain animal health and optimum production.

VI. Documentation from a trained professional (i.e., a person certified by the American Backflow Prevention Association, an inspector from a state or local governmental agency who has experience and/or training in backflow prevention, or a consultant with such experience and/or training) that there are no cross-connections that would allow the backflow of wastewater into a water supply well, irrigation well, or surface water as identified on the Site Map required in I.F above.

VII. The certification required in Required Reports and Notices H.2.a of Waste Discharge Requirements General Order No. R5-2013-0122.

# ATTACHMENT C

## Contents Of A Nutrient Management Plan And Technical Standards For Nutrient Management For Existing Milk Cow Dairies

Waste Discharge Requirements General Order R5-2013-0122 (Order) requires owners and operators of existing milk cow dairies (Dischargers) who apply manure, bedding, or process wastewater to land for nutrient recycling to develop and implement management practices that control nutrient losses and that are described in a Nutrient Management Plan (NMP). The purpose of the NMP is to budget and manage the nutrients applied to the land application area(s) considering all sources of nutrients, crop requirements, soil types, climate, and local conditions in order to prevent adverse impacts to surface water and groundwater quality. The NMP must take the site-specific conditions into consideration in identifying steps that will minimize nutrient movement through surface runoff or leaching past the root zone.

The NMP must contain, at a minimum, all of the elements listed below under Contents of a Nutrient Management Plan and must be in conformance with the applicable Technical Standards for Nutrient Management (Technical Standards), also listed below. Note that the NMP must be updated in response to changing conditions, monitoring results and other factors.

A specialist who is certified in developing nutrient management plans shall develop the NMP. A certified specialist is a Professional Soil Scientist, Professional Agronomist, or Crop Advisor certified by the American Society of Agronomy or a Technical Service Provider certified in nutrient management in California by the Natural Resources Conservation Service (NRCS). The Executive Officer may approve alternative proposed specialists. Only NMPs prepared and signed by these parties will be considered certified.

The NMP is linked to other sections of the WDRs. The Monitoring and Reporting Program specifies minimum amounts of monitoring that must be conducted at the dairy. As indicated below, this information must be used to make management decisions related to nutrient management. Likewise, the timing and amounts of wastewater applications to crops must be known to correctly calculate the amount of storage needed in holding ponds.

Wastes and land application areas shall be managed to prevent contamination of crops grown for human consumption. The term "crops grown for human consumption" refers only to crops that will not undergo subsequent processing which adequately removes potential microbial danger to consumers.

## Contents of a Nutrient Management Plan

**Dairy Facility Assessment**
The NMP will include the initial Preliminary Dairy Facility Assessment (Attachment A) and the annual updates as required by Monitoring and Reporting Program R5-2013-0122. Copies of these assessments shall be maintained for 10 years.

The NMP shall identify the name and address of the dairy, the dairy operator, and legal owner of the dairy property as reported in the Report of Waste Discharge and shall contain all of the following elements to demonstrate that the Discharger can control nutrient losses that may impact surface water or groundwater quality and comply with the requirements of the Order and the Technical Standards for Nutrient Management (Technical Standards).

I. Land Application Area Information

A. Identify each land application area (under the Discharger's control, whether it is owned, rented, or leased, to which manure or process wastewater from the production area is or may be applied for nutrient recycling) on a single published base map (topographic map or aerial photo) at an appropriate scale which includes:

1. A field identification system (Assessor's Parcel Number; land application area by name or number; total acreage of each land application area; crops grown; indication if each land application area is owned, rented, or leased by the Discharger; indication what type of waste is applied (solid manure only, wastewater only, or both solid manure and wastewater); drainage flow direction in each field, nearby surface waters, and storm water discharge points; tailwater and storm water drainage controls; subsurface (tile) drainage systems (including discharge points and lateral extent); irrigation supply wells and groundwater monitoring wells; sampling locations for discharges of storm water and tailwater to surface water from the field; and

2. Process wastewater conveyance structures, discharge points and discharge mixing points with irrigation water supplies; pumping facilities; flow meter locations; drainage ditches and canals, culverts, drainage controls (berms, levees, etc.), and drainage easements.

B. Provide the following information for land application area identified in I.A above:

1. Field's common name (name used when keeping records of waste applications).

2. Assessor's Parcel Number.

3. Total acreage.

4. Crops grown and crop rotation.

5. Information on who owns and/or leases the field.

6. Proposed sampling locations for discharges of storm water and tailwater to surface water.

C. Provide copies of written agreements with third parties that receive process wastewater for their own use from the Discharger's dairy (Technical Standards V.A.1 and V.A.3 below).

D. Identify each field under the control of the Discharger and within five miles of the dairy where neither process wastewater nor manure is applied. Each field shall be identified on a single published base map at an appropriate scale by the following:

1. Assessor's Parcel Number.

2. Total acreage.

3. Information on who owns or leases the field.

Note: The NMP must be updated and the Central Valley Water Board notified in writing before waste is applied to the lands identified in Section D.

II. Sampling and Analysis (see Technical Standard I below)

Identify the sampling methods, sampling frequency, and analyses to be conducted for soil, manure, process wastewater, irrigation water, and plant tissue analysis (Technical Standard I below).

III. Nutrient Budget (see Technical Standard V below)

The Discharger shall develop a nutrient budget for each land application area. The nutrient budget shall establish planned rates of nutrient applications for each crop based on soil test results, manure and process wastewater analyses, irrigation water analyses, crop nutrient requirements and patterns, seasonal and climatic conditions, the use and timing of irrigation water, and the nutrient application restrictions listed in Technical Standards V.A through V.D below. The Nutrient Budget shall include the following:

A. The rate of application of manure and process wastewater for each crop in each land application area (also considering sources of nutrients other than manure or process wastewater) to meet each crop's needs without exceeding the application rates specified in Technical Standard V.B below. The basis for the application rates must be provided.

B. The timing of applications for each crop in each land application area and the basis for the timing (Technical Standard V.C below). The maximum period of time anticipated between land application events (storage period) based on proper timing and compliance with Technical Standard V.C. below. This will be used in the Waste Management Plan (item II.A of Attachment B) to determine the storage capacity needs.

C. The method of manure and process wastewater application for each crop in each land application area (Technical Standard V.D below).

D. If phosphorus and/or potassium applications exceed the amount of these elements removed from the land application area in the harvested portion of the crop, the soil and crop tissue analyses shall be reviewed by an agronomist at least every five years. If this review determines that the buildup of phosphorus or potassium threatens to reduce the long-term productivity of the soil or the yield, quality or use of the crops grown, application rates will be adjusted downward to prevent or correct the problem.

IV. Setbacks, Buffers, and Other Alternatives to Protect Surface Water (see Technical Standard VII below)

A. Identify all potential surface waters or conduits to surface water that are within 100 feet of any land application area.

B. For each land application area that is within 100 feet of a surface water or a conduit to surface water, identify the setback, vegetated buffer, or other alternative practice that will be implemented to protect surface water (Technical Standard VII below).

V. Field Risk Assessment (see Technical Standard VIII below)

Evaluate the effectiveness of management practices used to control the discharge of waste constituents from land application areas by assessing the water quality monitoring results of discharges of manure, process wastewater, tailwater, subsurface (tile) drainage, or storm water from the land application areas.

VI. Record-Keeping (see Technical Standard IX below)

Identify the records that will be maintained for each land application area identified in I.A above.

VII. Nutrient Management Plan Review (see Technical Standard X below)

A. Identify the schedule for review and revisions to the NMP.

B. Identify the person who will conduct the NMP review and revisions.

## Technical Standards for Nutrient Management

The Discharger shall comply with the following Technical Standards for Nutrient Management in the development and implementation of the Nutrient Management Plan (NMP).

I. Sampling and Analysis

Soil, manure, process wastewater, irrigation water, and plant tissue shall be monitored, sampled, and analyzed as required in Monitoring and Reporting Program R5-2013-0122, and any future revisions thereto. The results of these analyses shall be used during the development and implementation of the NMP.

II. Crop Requirements

A. Realistic yield goals for each crop in each land application area shall be established. For new crops or varieties, industry yield recommendations may be used until documented yield information is available.

B. Each crop's nutrient requirements for nitrogen, phosphorus, and potassium shall be determined based on recommendations from the University of California, *Western Fertilizer Handbook* (9th Edition), or from historic crop nutrient removal.

III. Available Nutrients

A. All sources of nutrients (nitrogen, phosphorus, and potassium) available for each crop in each land application area shall be identified prior to land applications. Potential nutrient sources include, but are not limited to, manure, process wastewater, irrigation water, commercial fertilizers, soil, and previous crops.

B. Nutrient values of soil, manure, process wastewater, and irrigation water shall be determined based on laboratory analysis. "Book values" for manure and process wastewater may be used for planning of waste applications during the first two years during initial development of the NMP if necessary. Acceptable book values are those values recognized by American Society of Agricultural and Biological Engineers (ASABE), the Natural Resources Conservation Service (NRCS), and/or the University of California that accurately estimate the nutrient content of the material. The nutrient content of commercial fertilizers shall be derived from California Department of Food and Agriculture published values.

C. Nutrient credit from previous legume crops shall be determined by methods acceptable to the University of California Cooperative Extension, the NRCS, or a specialist certified in developing nutrient management plans.

IV. Overall Nutrient Balance

If the NMP shows that the nutrients generated by the dairy exceed the amount needed for crop production in the land application area, the Discharger must implement management practices (such as offsite removal of the excess nutrients, treatment, or storage) that will prevent impacts to surface water or groundwater quality due to excess nutrients.

V. Nutrient Budget

The NMP shall include a nutrient budget which includes planned rates of nutrient applications for each crop that do not exceed the crop's requirements for total nitrogen considering the stage of crop growth and that also considers all nutrient sources, climatic conditions, the irrigation schedule, and the application limitations in A through D below.

A. General Standards for Nutrient Applications

1. Prohibition A.8 of the Order: "*The application of waste to lands not owned, leased, or controlled by the Discharger without written permission from the landowner or in a manner not approved by the Executive Officer, is prohibited.*"

2. Prohibition A. 9 of the Order: "*The land application of manure or process wastewater to cropland for other than nutrient recycling is prohibited.*"

3. Land Application Specification E.3 of the Order: "*No later than 31 December 2007, The Discharger shall have a written agreement with each third party that receives process wastewater from the Discharger for its own use. Each written agreement shall be included in the Discharger's Existing Conditions Report, Nutrient Management Plan, and Annual Report. The written agreement(s) shall be effective until the third party is covered under waste discharge requirements or a waiver of waste discharge*

*requirements that are adopted by the Central Valley Water Board. The written agreement shall:*

a. *Clearly identify:*
   ii. *The Discharger and dairy facility from which the process wastewater originates;*

   iii. *The third party that will control the application of process wastewater to cropland;*

   iv. *The Assessor's Parcel Number(s) and the acreage(s) of the cropland where the process wastewater will be applied; and*

   v. *The types of crops to be fertilized with the process wastewater.*

b. *Include an agreement by the third party to:*
   ii. *Use the process wastewater at agronomic rates appropriate for the crops to be grown; and*

   iii. *Prevent the runoff to surface waters of wastewater, storm water or irrigation supply water that has come into contact with manure or is blended with wastewater.*

c. *Include a certification statement, as specified in General Reporting Requirements C.7 of the Standard Provision and Reporting Requirements (which is attached to and made part of this Order), which is signed by both the Discharger and third party."*

4. Land Application Specification E.5 of the Order: "*The application of animal waste and other materials containing nutrients to any cropland under control of the Discharger shall meet the following conditions:*

   a. *The application is in accordance with a certified Nutrient Management Plan developed and implemented in accordance with Required Reports and Notices J.1.c and Attachment C of this Order; and*

   b. *Records are prepared and maintained as specified in the Record-Keeping Requirements of Monitoring and Reporting Program R5-2013-0122."*

5. Land Application Specification E.6 of the Order: "*The application of waste to cropland shall be at rates that preclude development of vectors or other nuisance conditions and meet the conditions of the certified Nutrient Management Plan.*"

6. Land Application Specification E.8 of the Order: "*All process wastewater applied to land application areas must infiltrate completely within 72 hours after application.*"

7. Land Application Specification E.9 of the Order: "*Process wastewater shall not be applied to land application areas during periods when the soil is at or above field moisture capacity unless consistent with a certified Nutrient Management Plan.*"

8. Provision G.6 of the Order: "*This Order does not apply to facilities where wastes such as, but not limited to, whey, cannery wastes, septage, municipal or industrial sludge, municipal or industrial biosolids, ash or similar types of waste are generated onsite or are proposed to be brought onto the dairy or associated cropland for the purpose of nutrient recycling or disposal. The Discharger shall submit a complete Report of Waste Discharge and receive WDRs or a waste-specific waiver of WDRs from the Central Valley Water Board prior to receiving such waste.*"

9. Plans for nutrient management shall specify the form, source, amount, timing, and method of application of nutrients on each land application area to minimize nitrogen and/or phosphorus movement to surface and/or ground waters to the extent necessary to meet the provisions of the Order.

10. Where crop material is not removed from the land application area, waste applications are not allowed. For example, if a pasture is not grazed or mowed (and cuttings removed from the land application area), waste shall not be applied to the pasture.

11. Manure and/or process wastewater will be applied to the land application area for use by the first crop covered by the NMP only to the extent that soil tests indicate a need for nitrogen application.

12. Supplementary commercial fertilizer(s) and/or soil amendments may be added when the application of nutrients contained in manure and/or process wastewater alone is not sufficient to meet

the crop needs, as long as these applications do not exceed provisions of the Order.

13. Nutrient applications to a crop shall not be made prior to the harvest of the previous crop except where the reason for such applications is provided in the NMP.

14. Water applications shall not exceed the amount needed for efficient crop production.

15. Nutrients shall be applied in such a manner as not to degrade the soil's structure, chemical properties, or biological condition.

B. Nutrient Application Rates

1. General

a. Planned rates of nutrient application shall be determined based on soil test results, crop tissue test results, nutrient credits, manure and process wastewater analysis, crop requirements and growth stage, seasonal and climatic conditions, and use and timing of irrigation water. Actual applications of nitrogen to any crop shall be limited to the amounts specified below.

b. Nutrient application rates shall not attempt to approach a site's maximum ability to contain one or more nutrients through soil adsorption. Excess applications or applications that cause soil imbalances should be avoided. Excess manure nutrients generated by the Discharger must be handled by export to a good steward of the manure, or the development of alternative uses.

2. Nitrogen

a. Total nitrogen applications to a land application area prior to and during the growing of a crop will be based on pre-plant or pre-side dress soil analysis to establish residual nitrogen remaining in the field from the previous crop to establish early season nitrogen applications. Pre-plant or side dress nitrogen applications will not exceed the estimated total crop use as established by the nutrient management plan. Except as allowed below, application rates shall not result in total nitrogen applied to the land application areas exceeding

1.4 times the nitrogen that will be removed from the field in the harvested portion of the crop. Additional applications of nitrogen are allowable if the following conditions are met:

i. Plant tissue testing has been conducted and it indicates that additional nitrogen is required to obtain a crop yield typical for the soils and other local conditions;

ii. The amount of additional nitrogen applied is based on the plant tissue testing and is consistent with University of California Cooperative Extension written guidelines or written recommendations from a professional agronomist;

iii. The form, timing, and method of application facilitates timely nitrogen availability to the crop; and

iv. Records are maintained documenting the need for additional applications.

b. If, in calendar year 2012 or later years, application of total nitrogen to a land application area exceeds 1.65 times total nitrogen removed from the land application area through the harvest and removal of the previous crop, the Discharger shall either revise the NMP to immediately prevent such exceedance or submit a report demonstrating that the application rates have not and will not pollute surface or ground water.

3. Phosphorus and Potassium

a. Phosphorus and potassium may be applied in excess of crop uptake rates. If, however, monitoring indicates that levels of these elements are causing adverse impacts, corrective action must be taken. Cessation of applications may be necessary until crop uptake and harvest has reduced the concentration in the soil.

Important Note:
Use of animal manure as a primary source of nitrogen commonly results in applications of phosphorus and potassium at rates that exceed crop needs. Over time, these elements build up in the soils and can cause adverse impacts. For example, phosphorus will leave the land application area in surface runoff and

contribute to excessive algae growth in receiving waters and potassium can build up in crops to the point of limiting their use as animal feed. Application of these nutrients at agronomic levels, along with reasonable erosion control and runoff control measures, will normally prevent such problems.

Nutrients are being evaluated in several Central Valley surface waters. Where these studies show that nutrients are adversely impacting beneficial uses, the Regional Water Board will work with parties in the watershed, including dairies, to reduce discharges of phosphorus, nitrogen and possibly other constituents.

C. Nutrient Application Timing

1. Process wastewater application is not the same as irrigation. Process wastewater application scheduling should be based on the nutrient needs of the crop, the daily water use of the crop, the water holding capacity of the soil, and the lower limit of soil moisture for each crop and soil.

2. Wastewater shall not be applied when soils are saturated. During the rainy season rainfall can exceed crop water demand. However, the application of wastewater is allowable if tests show that there is an agronomic need and current conditions indicate that threat of nitrate leaching is minimal.

3. The timing of nutrient application must correspond as closely as possible with plant nutrient uptake characteristics, while considering cropping system limitations, weather and climatic conditions, and land application area accessibility.

4. Nutrient applications for spring-seeded crops shall be timed to avoid surface runoff and leaching by winter rainfall.

5. Except for orchards and vineyards, nutrients shall not be applied during periods when a crop is dormant.

D. Nutrient Application Methods

1. The Discharger shall apply nutrient materials uniformly to application areas or as prescribed by precision agricultural techniques.

2. Land Application Specification E.7 of the Order: "*Land application areas that receive dry manure shall be managed through implementation of erosion control measures to minimize erosion and must be consistent with a certified Nutrient Management Plan.*"

VI. Wastewater Management on Land Application Areas

Control of water and process wastewater applications and runoff is a part of proper nutrient management since water transports nutrients, salts, and other constituents from cropland to groundwater and surface water. The Discharger shall comply with the following provisions of the Order, which place requirements on applications of manure and process wastewater to, and runoff from, cropland:

A. Prohibition A.3 of the Order: "*The discharge of waste from existing milk cow dairies to surface waters which causes or contributes to an exceedance of any applicable water quality objective in the Basin Plans or any applicable state or federal water quality criteria, or a violation of any applicable state or federal policies or regulations is prohibited.*"

B. Prohibition A.4 of the Order: "*The collection, treatment, storage, discharge or disposal of wastes at an existing milk cow dairy shall not result in the creation of a condition of pollution or nuisance*[1]."

C. Prohibition A.10 of the Order: "*The discharge of wastewater to surface waters from cropland is prohibited. Irrigation supply water that comes into contact or is blended with waste or wastewater shall be considered wastewater under this Prohibition.*"

D. Prohibition A.11 of the Order: "*The application of process wastewater to a land application area before, during, or after a storm event that would result in runoff of the applied water is prohibited.*"

E. Prohibition A.12 of the Order: "*The discharge of storm water to surface water from a land application area where manure or process wastewater has been applied is prohibited unless the land application area has been managed consistent with a certified Nutrient Management Plan.*"

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[1] In an emergency, guidance is provided by the *CAL/EPA Emergency Animal Disease Regulatory Guidance for Disposal and Decontamination* (October 20, 2004).

F. Land Application Specification E.4 of the Order: "*Land application of wastes for nutrient recycling from existing milk cow dairies shall not cause the underlying groundwater to contain any waste constituent, degradation product, or any constituent of soil mobilized by the interactions between applied wastes and soil or soil biota, to exceed the groundwater limitations set forth in this Order.*"

G. Land Application Specification E.8 of the Order: "*All process wastewater applied to land application areas must infiltrate completely within 72 hours after application.*"

H. Land Application Specification E.9 of the Order: "*Process wastewater shall not be applied to land application areas during periods when the soil is at or above field moisture capacity unless consistent with a certified Nutrient Management Plan (see Attachment C).*"

VII. Setbacks and Vegetated Buffer

A. General Specification B.7 of the Order: "*Manure and process wastewater shall not be applied closer than 100 feet to any down gradient surface waters, open tile line intake structures, sinkholes, agricultural or domestic well heads, or other conduits to surface waters, unless a 35-foot wide vegetated buffer or physical barrier is substituted for the 100-foot setback or alternative conservation practices or field-specific conditions will provide pollutant reductions equivalent or better than the reductions achieved by the 100-foot setback.*"

B. A setback is a specified distance from surface waters or potential conduits to surface waters where manure and process wastewater may not be land applied, but where crops may continue to be grown.

C. A vegetated buffer is a narrow, permanent strip of dense perennial vegetation where no crops are grown and which is established parallel to the contours of and perpendicular to the dominant slope of the land application area for the purposes of slowing water runoff, enhancing water infiltration, trapping pollutants bound to sediment, and minimizing the risk of any potential nutrients or pollutants from leaving the land application area and reaching surface waters.

D. The minimum widths of setbacks and vegetated buffers must be doubled around the wellhead of a drinking water supply well constructed in a sole-source aquifer.

E. Practices and management activities for vegetated buffers include the following:

1. Removal of vegetation in vegetated buffers will be in accordance with site production limitations, rate of plant growth, and the physiological needs of the plants.

2. Do not mow below the recommended height for the plant species.

3. Maintain adequate ground cover and plant density to maintain or improve filtering capacity of the vegetation.

4. Maintain adequate ground cover, litter, and canopy to maintain or improve infiltration and soil condition.

5. Periodic rest from mechanical harvesting may be needed to maintain or restore the desired plant community following episodic events such as drought.

6. When weeds are a significant problem, implement pest management to protect the desired plant communities.

7. Prevent channels from forming.

VIII. Field Risk Assessment

The results of the water quality monitoring of discharges of manure, process wastewater, storm water, and tailwater to surface water from each land application area, as required by Monitoring and Reporting Program R5-2013-0122, shall be used by the Discharger to assess the movement of nitrogen and phosphorus from each land application area. The Discharger will follow guidelines provided by the Central Valley Water Board in conducting these assessments.

IX. Record-Keeping

The Discharger shall maintain records for each land application area as required in the Record-Keeping Requirements of Monitoring and Reporting Program R5-2013-0122.

X. Nutrient Management Plan Review

A. Provide the name and contact information (including address and phone number) of the person who created the NMP; the date that the

NMP was drafted; the name, title, and contact information of the person who approved the final NMP; and the date of NMP implementation.

B. The NMP shall be updated when discharges from any land application area exceed water quality objectives, a nutrient source has changed, site-specific information has become available to replace defaults values used in the overall nutrient balance or the nutrient budget, nitrogen application rates in any land application area exceed the rates specified in Technical Standard V.B or the Field Risk Assessment finds that management practices are not effective in minimizing discharges.

C. The NMP shall be updated prior to any anticipated changes that would affect the overall nutrient balance or the nutrient budget such as, but not limited to, a crop rotation change, changes in the available cropland, or the changes in the volume of process wastewater generated.

D. The Discharger shall review the NMP at least once every five years and notify the Regional Board in the annual report of any proposed changes that would affect the NMP.

# ATTACHMENT D

## Manure/Process Wastewater Tracking Manifest
## For
## Existing Milk Cow Dairies

Instructions:

1) Complete one manifest for each hauling event, for each destination. A hauling event may last for several days, as long as the manure is being hauled to the same destination.
2) If there are multiple destinations, **complete a separate form for each destination.**
3) The operator must obtain the signature of the hauler upon completion of each manure-hauling event.
4) The operator shall submit copies of manure/process wastewater tracking manifest(s) with the Annual Monitoring Report for Existing Milk Cow Dairies.

**Operator Information:**

Name of Operator: ______________________________

Name of Dairy Facility: ______________________________

Facility Address: ______________________________
Number and Street    City    Zip Code

Contact Person Name and Phone Number: ______________________________
Name    Phone Number

**Manure/Process Wastewater Hauler Information:**

Name of Hauling Company/Person: ______________________________

Address of Hauling Company /Person: ______________________________
Number and Street    City    Zip Code

Contact Person: ______________________________
Name    Phone Number

**Destination Information:**

Composting Facility / Broker / Farmer / Other (identify) ________________ (please circle one)

Contact information of Composting Facility, Broker, Farmer, or Other (as identified above):

______________________________
Name    Number and Street    City    Zip Code    Phone Number

Manure/Process Wastewater Destination Address or Assessor's Parcel Number:

______________________________
Number and Street    City    Zip Code    Assessor's Parcel Number

Dates Hauled: ______________________________

**Amount Hauled:**

Enter the amount of manure hauled in tons or cubic yards (indicate the units used), the manure solids content (if amount reported in tons) or manure density (if amount reported in cubic yards), and the method used to calculate the amount:

Manure: ___________Tons or Cubic Yards (indicate which units used)
Manure Solids Content (if amount reported in tons): ______________
Manure Density (if amount reported in cubic yards): ______________

Method used to determine amount of manure: ______________________________

______________________________________________________________

Enter the amount of process wastewater hauled in gallons and the method used to determine the amount.

Process Wastewater: ____________ Gallons

Method used to determine volume of process wastewater: ____________________

______________________________________________________________

**Written Agreement:**
Does the Operator have a written agreement (in compliance with Land Application Specification E.3 of Reissued Waste Discharge Requirements General Order No. R5-2013-0122) with any party that receives process wastewater from the Operator for its own use? (please check one)

____ Yes ______ No

If the answer is no, the Operator agrees to have such a written agreement with any such party for any process wastewater transferred after **31 December 2007** to such party.
___________ (Operator shall provide initials here to acknowledge this requirement).

**Certification**:
I declare under the penalty of law that I personally examined and am familiar with the information submitted in this document, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of a fine and imprisonment for knowing violations.

Operator's Signature: ______________________________ Date: ____________

Hauler's Signature: ______________________________ Date: ____________

## ATTACHMENT E

### Definitions For Existing Milk Cow Dairies

1. "Agronomic rates" is defined as the land application of irrigation water and nutrients (which may include animal manure, bedding, or process wastewater) at rates of application in accordance with a plan for nutrient management that will enhance soil productivity and provide the crop or forage growth with needed nutrients for optimum health and growth.

2. "Anaerobic digester" is defined as a basin, pond, or tank designed, constructed, maintained, and operated for the anaerobic treatment of liquid or solid animal waste and which promotes the decomposition of manure or "digestion" of the organics in manure to simple organics and gaseous biogas products.

3. "Aquifer" is defined as ground water that occurs in a saturated geologic unit that contains sufficient permeability and thickness to yield significant quantities of water to wells or springs.

4. "Artificial recharge area" is defined as an area where the addition of water to an aquifer is by human activity, such as putting surface water into dug or constructed spreading basins or injecting water through wells.

5. "Central Valley Water Board" is defined as the California Regional Water Quality Control Board, Central Valley Region.

6. "Certified Nutrient Management Plan" is defined as a nutrient management plan that is prepared and signed by a specialist who is certified in developing nutrient management plans. A certified specialist is: a Professional Soil Scientist, Professional Agronomist, Professional Crop Scientist, or Crop Advisor certified by the American Society of Agronomy; a Technical Service Provider certified in nutrient management in California by the Natural Resources Conservation Service; or other specialist approved by the Executive Officer.

7. "Confined animal facility" is defined in California Code of Regulations, title 27, section 20164 as "*... any place where cattle, calves, sheep, swine, horses, mules, goats, fowl, or other domestic animals are corralled, penned, tethered, or otherwise enclosed or held and where feeding is by means other than grazing.*"

8. "Confined area" is defined as the area where cows are confined within the production area.

9. "Cropland" is defined as the land application area where dry or solid manure and/or process wastewater is recycled for the purpose of beneficially using the nutrient value of the manure and/or process wastewater for crop production.

10. "Degradation" is defined as any measurable adverse change in water quality.

11. "Discharge" is defined as the discharge or release of waste to land, surface water, or ground water.

12. "Discharger" is defined as the property owner and the operator of an existing milk cow dairy subject to Reissued Waste Discharge Requirements General Order R5-2013-0122.

13. "Existing Milk Cow Dairies" means all dairies that were operating as of 17 October 2005, filed a complete Report of Waste Discharge in response to the 2005 Report of Waste Discharge Request Letter, and have not expanded.

14. "Existing herd size" is defined as the maximum number of mature dairy cows reported in the Report of Waste Discharge filed in response to the 2005 Report of Waste Discharge Request Letter, plus or minus 15 percent of that reported number to account for the normal variation in herd sizes.

15. "Expansion" is defined as, but not limited to, any increase in the existing herd size (i.e., by more than 15 percent of the maximum number of mature dairy cows filed in response to the 2005 Report of Waste Discharge Request Letter) or an increase in the storage capacity of the retention ponds or acquisition of more acreage for reuse of nutrients from manure or process wastewater in order to accommodate an expansion of the existing herd size. "Expansion" does not include installation or modification of facilities or equipment to achieve compliance with the requirements of Reissued Waste Discharge Requirements General Order R5-2013-0122 so long as the modification or installation is sized to accommodate only the existing herd size.

16. "Facility" is defined as the property identified as such in Reissued Waste Discharge Requirements General Order R5-2013-0122.

17. "Field moisture capacity" is defined as "the upper limit of storable water in the soil once free drainage has occurred after irrigation or precipitation."

18. "Freeboard" is defined as the elevation difference between the process wastewater (liquid) level in a pond and the lowest point of the pond embankment before it can overflow.

19. "Incorporation into soil" is defined as the complete infiltration of process wastewater into the soil, the disking or rotary tiller mixing of manure into the soil, shank injection of slurries into soil, or other equally effective methods

20. "Irrigation return flow" is defined as surface and subsurface water that leaves a field following application of irrigation water.

21. "Land application area" is defined as land under control of the milk cow dairy owner or operator, whether it is owned, rented, or leased, to which manure or process wastewater from the production area is or may be applied for nutrient recycling.

22. "Manure" is defined as the fecal and urinary excretion of livestock and other commingled materials. Manure may include bedding, compost, and waste feed.

23. "Manured solids" is defined as manure that has a sufficient solids content such that it will stack with little or no seepage.

24. "Mature dairy cow" is defined as a dairy cow that has produced milk at any time during her life.

25. "Normal precipitation" is defined as the long-term average precipitation based on monthly averages over the time that data has been collected at a particular weather station. Normal precipitation is usually taken from data averaged over a 30-year period (e.g. 1971 to 2000) if such data is available.

26. "Nuisance" is defined in Water Code section 13050(m) as "*...anything which meets all of the following requirements:*
    *(1) Is injurious to health, or is indecent or offensive to the senses, or an obstruction to the free use of property, so as to interfere with the comfortable enjoyment of life or property.*
    *(2) Affects at the same time an entire community or neighborhood, or any considerable number of persons, although the extent of the annoyance or damage inflicted upon individuals may be unequal.*
    *(3) Occur during, or as a result of, the treatment or disposal of wastes.*"

27. "Nutrient" is defined as any element taken in by a plant which is essential to its growth and which is used by the plant in elaboration of its food and tissue.

28. "Nutrient recycling" is defined as the application of nutrients at agronomic rates for crop production.

29. "Off-property discharge" is defined as the discharge or release of waste beyond the boundaries of the property of the dairy's production area or the land application area or to water bodies that run through the production area or land application area.

30. "Open tile line intake structure" is defined as an air vent for a subsurface (tile) drain system.

31. "Order" is defined as the Waste Discharge Requirements General Order.

32. "Overflow" is defined as the intentional or unintentional diversion of flow from the collection, treatment, land application, and conveyance systems, including pumping facilities.

33. "Pollutant" is defined in Title 40 Code of Federal Regulations Section 122.2 as "*...dredged spoil, solid waste, incinerator residue, filter backwash, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials (except those regulated under the Atomic Energy Act of 1954, as amended (42 U.S.C. 2011 et seq.)), heat, wrecked or discarded equipment, rock, sand, cellar dirt and industrial, municipal, and agricultural waste discharged into water.*"

34. "Pollution" is defined in Water Code section 13050(l)(1) as *"...an alteration of the quality of the waters of the state by waste to a degree which unreasonably affects either of the following: (A) The waters for beneficial uses. (B) Facilities which serve these beneficial uses."*

35. "Pond" is defined as retention ponds, storage ponds, settling ponds, or any structures used for the treatment, storage, disposal, and recycling of process wastewater. Ponds are differentiated from sumps, which are structures in a conveyance system used for the installation and operation of a pump.

36. "Process wastewater" is defined as water directly or indirectly used in the operation of a milk cow dairy for any or all of the following: spillage or overflow from animal watering systems; washing, cleaning, or flushing pens, barns, manure pits, or other dairy facilities; washing or spray cooling of animals; or dust control...and includes any water or precipitation and precipitation runoff which comes into contact with any raw materials, products, or byproducts including manure, feed, milk, or bedding.

37. "Production area" is defined as that part of a milk cow dairy that includes the , barns, milk houses, corrals, milk parlors, manure and feed storage areas, process water conveyances and any other area of the dairy facility that is not the land application area or the ponds.

38. "Regional Board" is defined as one of the nine California Regional Water Quality Control Boards.

39. "Salt" is defined as the products, other than water, of the reaction of an acid with a base. Salts commonly break up into cations (sodium, calcium, etc.) and anions

(chloride, sulfate, etc.) when dissolved in water. Total dissolved solids is generally measured as an indication of the amount of salts in a water or wastewater.

40. "Salt in animal rations" is defined as the sodium chloride and any added minerals (such as calcium, phosphorus, potassium, sulfur, iron, selenium, copper, zinc, or manganese) in the animal ration.

41. "Significant quantity" is defined as the volume, concentrations, or mass of a pollutant that can cause or threaten to cause pollution, contamination, or nuisance; adversely impact human health or the environment; and/or cause or contribute to a violation of any applicable water quality standards for the receiving water.

42. "Sole-source aquifer" is defined as an aquifer that supplies 50 percent or more of the drinking water of an area.

43. "State" is defined as the State of California.

44. "State Water Board" is defined as the State Water Resources Control Board.

45. "Significant storm event" is defined as a precipitation event that results in continuous runoff of storm water for a minimum of one hour, or intermittent discharge of runoff for a minimum of three hours in a 12-hour period.

46. "Storm water" is defined as storm water runoff, snowmelt runoff, and surface runoff and drainage.

47. "Subsurface (tile) drainage" is defined as water generated by installing and operating drainage systems to lower the water table below irrigated lands. Subsurface drainage systems, deep open drainage ditches, or drainage wells can generate this drainage.

48. "Surface water" is defined as water that includes essentially all surface waters such as navigable waters and their tributaries, interstate waters and their tributaries, intrastate waters, all wetlands and all impoundments of these waters. Surface waters include irrigation and flood control channels.

49. "Tailwater" is defined as the runoff of irrigation water from an irrigated field.

50. "25-year, 24-hour rainfall event" is defined as a precipitation event with a probable recurrence interval of once in twenty five years as defined by the National Weather Service in Technical Paper No. 40, "Rainfall Frequency Atlas of the United States," May, 1961, or equivalent regional or State rainfall probability information developed from this source.

51. "Waste" is defined as set forth in Water Code section 13050(d), and includes manure, leachate, process wastewater and any water, precipitation or rainfall runoff that came into contact with raw materials, products, or byproducts such as manure, compost piles, feed, silage, milk, or bedding.

52. "Waters of the state" is defined in Water Code section 13050 as "...*any surface water or groundwater, including saline waters, within the boundaries of the state.*"

53. "Wet season" is defined as the period of time between 1 October and 31 May of each year.

## ATTACHMENT F

### Acronyms And Abbreviations
### For
### Existing Milk Cow Dairies

| | |
|---|---|
| ASABE | American Society of Agricultural and Biological Engineers |
| Basin Plans | Water Quality Control Plans |
| BMPs | best management practices |
| $BOD_5$ | five-day biochemical oxygen demand |
| BPT | best practicable control technology currently available |
| BPTC | best practicable treatment or control |
| CCR | California Code of Regulations |
| CDQAP | California Dairy Quality Assurance Program |
| Central Valley Water Board | California Regional Water Quality Control Board, Central Valley Region |
| cm/sec | centimeters per second |
| CPS | Conservation Practice Standard |
| DWQ | Division of Water Quality |
| DWR | Department of Water Resources |
| EC | electrical conductivity |
| ESP | Environmental Stewardship Program |
| ETo | Evapotranspiration from a standardized grass surface |
| GWPA | Groundwater Protection Area |
| MCL | maximum contaminant level |
| mg N/L | milligrams nitrogen per liter |
| mg/L | milligrams per liter |
| ml | milliliter |
| MPN | most probable number |
| MRP | Monitoring and Reporting Program |
| MWICR | monitoring well installation completion report |
| MWISP | monitoring well installation and sampling plan |
| NAD83 | North American Datum 1983 |
| NAVD88 | North American Vertical Datum 1988 |
| NMP | nutrient management plan |
| NPDES | National Pollutant Discharge Elimination System |
| NRCS | Natural Resources Conservation Service |
| NTU | nephelometric turbidity unit |
| pH | Logarithm of the reciprocal of hydrogen ion concentration in gram atoms per liter |
| QA/QC | quality assurance/quality control |
| REC-1 | water contact recreation |
| Region | Central Valley Region |
| Regional Board | California Regional Water Quality Control Board |
| ROWD | Report of Waste Discharge |
| SPRR | Standard Provisions and Reporting Requirements |

| | |
|---|---|
| State Water Board | State Water Resources Control Board |
| State Water Board Resolution 68-16 | State Water Resources Control Board Resolution 68-16 (*Statement of Policy with Respect to Maintaining High Quality of Waters in California*) |
| State Water Board Resolution 88-63 | State Water Resources Control Board Resolution 88-63 (*Sources of Drinking Water Policy*) |
| State Water Board Resolution 92-49 | State Water Resources Control Board Resolution 92-49 (*Policies and Procedures for Investigation and Cleanup or Abatement of Discharges Under Water Code Section 13304* or *Cleanup and Abatement Policy*) |
| TDS | total dissolved solids |
| Title 3 | Title 3 of the California Code of Regulations, Division 2, Chapter 1, Article 22 |
| Title 27 | Title 27 of the California Code of Regulations, Division 2, Subdivision 1, Chapter 7, Subchapter 2, Article 1 |
| UCCE | University of California Committee of Experts |
| U.N. | United Nations |
| μmhos/cm | micromhos per centimeter (same as μS/cm) |
| μS/cm | microsiemens per centimeter (same as μmhos/cm) |
| USEPA | United States Environmental Protection Agency |
| WDRs | waste discharge requirements |
| WMP | waste management plan |