Sent via email

May 4, 2026

State Water Resources Control Board
Attention: Courtney Tyler, Clerk to the Board
1001 I Street, 24th Floor
Sacramento, CA 95814

RE: Agricultural Expert Panel Draft Report Comment Executive Summary

Dear Expert Panelists,

The undersigned organizations appreciate the opportunity to comment on the recently released Draft Report of the Second Statewide Agricultural Expert Panel for the Irrigated Lands Regulatory Program ("Expert Panel or Panel"). We support some aspects of the Draft Report that provide recommendations rooted in science to improve the Irrigated Lands Regulatory Program (ILRP) and to better protect groundwater quality. Specifically, we appreciate that the Draft Report recognizes that there is adequate data to establish numeric metrics in order to manage nitrogen discharges, acknowledges that there is a point where nitrogen application and discharges are excessive, and supports the sustainable nutrient management practices that were featured in Ag Order 4.0.

However, the **available science and ongoing impacts to public health compel more urgent and affirmative action than reflected in the draft report**. Nitrate contamination in the state, particularly in the Central Valley and Central Coast Regions, is widespread and increasing, and the health impacts associated with consuming water with unsafe levels of nitrate are dire. Every year of delay not only means an additional year of residents living with unsafe drinking water, but several additional years of restoration to meet the nitrate MCL and increases the cost manifold.[1]

The undersigned organization reaffirm both the scientific basis and societal need to set final and interim nitrogen application and discharge limits, to ensure the Draft Report avoids the consideration of economics when identifying those limits, to urge the Panel to stay focused on the technical calls of the charge questions and to support its recommendations with data, and to correct programmatic and regulatory misconceptions that have developed throughout the Expert Panel process.

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[1]Central Coast Regional Board, "Order No. R3-2021-0040 - Attachment A", p. 161-163. Available at: https://www.waterboards.ca.gov/centralcoast/water_issues/programs/ilp/docs/ag_order4/2021/ao4_att_a.pdf.

We ask the Expert Panel to revise their Draft Report to consider the following:

Recommendation 1: The Panel Must Avoid Providing Policy Recommendations.
We agree that water quality protective numeric limits may vary between regions.[2] However, the Expert Panel deviates from its charge questions and oversteps its assignment by recommending that numeric limits on discharges should not be precedential.[3] The State Water Board has tasked the Panel to advise on a scientific question, not a legal one. The Board's authority and discretion to make statewide and/or region-specific precedential requirements is determined by a much broader record that is obligated to protect water quality.

Recommendation 2: The Panel Should Revise its Definition of a "Sustainable Irrigated Lands Regulatory Program" to Match the Water Board's

We are concerned that the Panel's understanding of a "sustainable" ILRP skews away from protecting water quality and toward protecting financial interests and maintaining status quo agricultural production. The Panel apparently interprets "sustainable" to mean economic sustainability,[4] whereas we interpret it as a regulatory program that is transparent, accountable, and impactful in reducing pollution; that generates sufficient data and fees to sustain the Water Board's regulatory activities; and that sustains water quality for current and future generations.

Recommendation 3: Recommend Interim Discharge Limits to Ensure Growers Make Progress Towards Final Discharge Limits that are Protective of Groundwater Quality.

The Draft Report concludes that there is enough evidence to improve the existing regulatory framework to include the implementation of interim limits that work towards final limits that meet water quality objectives.[5] However, the Expert Panel leaves the decision to implement interim limits to the Regional Boards, arguing that targets can also be effective to regulate nitrogen discharges[6] and that some regions have limited data to set limits. This is not the case in Regions 3 and 5. These regions have multiple years of nitrogen applied and removed data. Based

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[2] The Report also acknowledges that a lack of data in other regions should not preclude action in regions where such data is available. Furthermore, the Panel agrees that Region 3 and Region 5 have the data needed to set limits.

[3] Lines 687-689 in the Draft Report state, "Based on scientific and technical considerations the Panel recommends that limits are not required statewide or as a precedential tool to be used by Regional Boards." Note that the sentence immediately prior, however, suggests setting targets rather than limits.

[4] Lines 2865-2870 illustrate the panel's interpretation of "sustainable": "Limits 'that are protective of groundwater quality and support a long-term sustainable Irrigated Lands Regulatory Program' require that the need for groundwater protection is balanced with the economic cost to landowners/operators for the proper nutrient management. The Expert Panel was not presented with sufficient evidence to consider economic cost to implement specific practices, let alone specific practices that may successfully protect groundwater quality in the above rigorous manner.

[5] Draft Report at 11: 668-73.

[6] Draft Report at 12.

on the data, the Expert Panel should recommend that Region 3 and Regions 5, at a minimum, establish interim limits.

Recommendation 4: The Panel Should Recommend Limits, Not Targets, for the Central Valley.

The Expert Panel fails to provide evidence which demonstrates that targets alone are effective at reducing nitrogen discharges – let alone reducing excessive nitrogen discharges. Since 2023, growers in the Central Valley have been subject to voluntary nitrogen discharge *targets*, not an enforceable limit. Despite these targets, nitrogen discharges continue excessively. According to the Central Valley's own data, some of the largest polluters discharged 449 lbs of nitrogen per acre.[7] The Panel should recommend that Regions with adequate data and extreme nitrate impacts develop limits on nitrogen discharges.

Recommendation 5: The Expert Panel Must Recommend a Time Schedule that Achieves Compliance, as Required by the Nonpoint Source Policy

The Nonpoint Source Policy requires that a water board, in adopting a program to control nonpoint source pollution, adopt a "specific time schedule, and corresponding quantifiable milestones designed to measure progress toward reaching the specified requirements."[8] However, the Draft Report recommends an approach that would not contain a final time schedule, and therefore does not comply with the Nonpoint Source Policy.[9] The Draft Report appears to recommend only setting an initial limit or target, followed by an iterative review by the Regional Board, and potential setting of additional limits or targets. These are legal requirements that neither the Water Boards nor the Expert Panel are free to ignore. Because it does not comply with the law, the Draft should be revised to remove this recommendation and to require a final schedule.

Recommendation 6: Outreach, Education, and Technical Assistance Must be Coupled with Interim Limits to Ensure that Growers Make Progress Towards Meeting Final Limits that are Protective of Groundwater Quality.

Education and outreach is indeed necessary to help growers implement best management practices. Alone, however, these efforts do not protect water quality, as evidenced by groundwater contamination tests in California from the past two decades. Education and Outreach must be coupled with interim and final limits to make meaningful progress.

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[7] State Water Board, *INMP Summary Report Data Visualization Tool*. Available at: https://app.powerbigov.us/view?r=eyJrIjoiZmE2OGVmZmQtZTk2Ny00YWZjLTgwNTEtMDBlMzc2ZjdjZDY4IiwidCI6ImZlMTg2YTI1LTdkNDktNDFlNi05OTQxLTA1ZDIyODFkMzZjMSJ9
[8] Nonpoint Source Policy at p. 13.
[9] Draft Report at pp. 17-18.

Well-designed environmental regulations induce innovation.[10] Final limits drive innovation and will move the agricultural industry in the direction of protecting water quality. Continuing to recommend education and outreach paired with voluntary targets will result in the status quo and offer no solution to residents living with contaminated groundwater.[11]

Recommendation 7: The Panel Should Recommend that Interim Application Limits are Coupled with Interim Discharge Limits to Ensure that All Growers Make Progress Towards Final Limits that are Protective of Groundwater Quality.

Interim application and discharge limits are essential to ensuring progress toward protection of groundwater quality. While interim limits on A or A_{FER} are blunt instruments, the fact that they are not designed to reach a final limit or operational benchmark does not prevent them from being useful to prevent the highest applications and discharges.[12] The Panel should recommend both types of interim limits to address fertilizer overapplication and to begin reducing nitrate discharges toward a final limit which achieves safe drinking water levels for nitrate.

Recommendation 8: The Panel Should Recommend Improvements in Data Transparency, Quality Assurance, and Verification to Develop Nitrogen Limits that are Protective of Groundwater Quality.

The existing system of data collection limits accountability and slows scientific progress. Transparency in data reporting is a foundation of almost every existing regulatory pollution control program, and it is unprecedented for a regulated entity to be able to hide the raw data on pollution from the regulating entity. Such lack of transparency undermines public trust and accountability. The Central Coast region shows that more transparent systems are feasible, with field-level reporting, standardized formats, and tools that allow both regulators and the public to explore trends, and can be independently verified by third party scientists.

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[10] Zhang, W., Zhu, B., Li, Y. et al. Revisiting the Porter hypothesis: a multi-country meta-analysis of the relationship between environmental regulation and green innovation. Humanit Soc Sci Commun 11, 232 (2024). https://doi.org/10.1057/s41599-024-02671-9

[11] We are also uncomfortable with the suggestion that taxpayers bear a significant portion of the cost of outreach, education, and technical assistance for growers. (See Draft Report at 15.) Nitrogen discharge attributable to irrigated agriculture is the cause of significant groundwater contamination, and low-income communities bear the brunt of that pollution. The industry–particularly the large farms that control 63% of the irrigated acreage in California–should bear the primary financial responsibility for learning how to avoid discharge in the future, not taxpayers. (See Draft Report at 5.)

[12] The Panel also notes that Ag Order 4.0 only set A limits for six crops. (Draft Report at 31: 1510.) It is important to note two responses. First, these crops are the six most common crops in the Central Coast, representing 75% of the total. (Ag Order 4.0, Att. A, at p. 143.) Thus, the work to develop these A limits is already done for the vast majority of one of the major agricultural areas of the state. Second, it is also important to point out that Ag Order 4.0 sets backup A limits of 500 lbs/acre/crop initially, followed by 480 lbs/acre/crop after several years. We are not aware of any research demonstrating crop need at those levels of application, yet some growers do report N application above those levels. An A limit set at these levels would reduce discharges associated with those excessive applications while being eminently achievable by the vast majority of growers.

At the very least, the Panel should reconsider the assumption that anonymous data would be higher quality. And it should consider that fully transparent data reporting will, by requiring growers to put their name on it, incentivize growers to report more fairly and accurately. Without access to consistent data on nitrate discharge, acreage and location, third-party scientists cannot verify conditions over time, audit calculations, or identify pollution hotspots at a meaningful scale. Without acreage data, regulators and third parties cannot assess whether limits are working, because the total amount of N applied cannot be calculated.

Recommendation 9: The Panel Should Include a Balanced Discussion of the CV-SWAT and N Balance Approaches.

As the draft report has stated, all models are wrong, but some are useful. The N balance approach's usefulness lies in its transparency, ease of calculation, and use of easily available farm data, which should be represented clearly in the report. On the other hand, one of the main issues with the CV-SWAT model is its transparency and trust associated with the data used and model outputs. The way the CV-SWAT model is set up limits public transparency, because the field-level data–including acreage and location–used to run the CV-SWAT model is not publicly available, precluding independent model verification runs. The N balance approach to calculate nitrogen leaching is based on clear scientific support and experience from across the globe and should be clearly articulated.

Recommendation 10: The Panel Should Cite Literature Regarding Advancements in Nitrogen Science

Question 3 asks the Panel to consider whether advancements in research have occurred since the 2014 release of the first Expert Panel's report. However, this section does not cite any studies, papers or books.[13] The failure to cite research makes evaluating the Panel's response to this question difficult to evaluate.

Recommendation 11: Verification of Nitrogen Discharges Should Include Vadose Zone Studies

The Draft Report recommends comparing fertilizer sales to reported values on INMP forms and comparing N levels at wells over time to calculated A-R values two ways to verify whether program metrics are accurately estimating nitrogen discharge.[14] The Panel should also consider whether use of lysimeters, soil core samples, or other direct measurements of nitrogen at the bottom of the root zone and/or in the vadose zone can be effective checks on the performance of the regulatory metrics.

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[13] Draft Report, at pp. 18-21.
[14] Draft Report at 30.

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RE: Comments on Second Statewide Agricultural Expert Panel Draft Report

Dear Expert Panelists,

The undersigned organizations appreciate the opportunity to comment on the recently released Draft Report of the Second Statewide Agricultural Expert Panel for the Irrigated Lands Regulatory Program ("Expert Panel or Panel"). We support some aspects of the Draft Report that provide recommendations rooted in science to improve the Irrigated Lands Regulatory Program (ILRP) and to better protect groundwater quality. Specifically, we appreciate that the Draft Report recognizes that there is adequate data to establish numeric metrics in order to manage nitrogen discharges, acknowledges that there is a point where nitrogen application and discharges are excessive, and supports the sustainable nutrient management practices that were featured in Agriculture Order 4.0 (Ag Order 4.0).

However, the available science and ongoing impacts to public health compel more urgent and affirmative action than reflected in the draft report. Nitrate contamination in the state, particularly in the Central Valley and Central Coast Regions, is widespread and increasing, and the health impacts associated with consuming water with unsafe levels of nitrate are dire. According to recent data, average domestic well levels in the Central Coast and Central Valley regions test at 19.8 and 9.6 mg/L, respectively.[1] Furthermore, it is important to remember that part of the issue that precipitated the Central Coast Regional Board's imposition of nitrogen application and discharge limits was that as domestic well nitrate levels in many sub-basins were rising, agricultural operations' practices were not changing.[2] Current projections to 2050 illustrate that demands for nitrogen fertilizers will continue to increase, requiring urgent action to reduce environmental harms and protect public health.[3] Every year of delay not only means an additional year of residents living with unsafe drinking water, but several additional years of restoration to meet the nitrate MCL which increases the cost manifold.[4]

The undersigned organizations reaffirm both the scientific basis and societal need to set final and interim nitrogen application and discharge limits, to ensure the Draft Report avoids the consideration of economics when identifying those limits, to urge the Panel to stay focused on the technical calls of the charge questions and to support its recommendations with data, and to correct programmatic and regulatory misconceptions that have developed throughout the Expert Panel process.

Given that the Draft Report is very similar to previous versions, our prior comment letters submitted on September 29, 2025, October 10, 2025, October 30, 2025, and January 29, 2026, remain largely unaddressed and are attached and incorporated herein by reference. Additionally, we ask the Expert Panel to revise their Draft Report to consider the following:

1. **The Panel Must Avoid Providing Policy Recommendations.**
2. **The Panel Should Revise its Definition of a "Sustainable Irrigated Lands Regulatory Program" to Match the Water Board's.**

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[1] Drs. Dialesandro, J. and Stewart, Frey, I. analyzed public data shared with the Groundwater Ambient Monitoring and Assessment Program. The data covered well monitoring results from 2010 to 2025. Their analysis further found that the same data revealed that the average nitrate level in on-farm wells in the Central Coast Region is 21.6 mg/L.

[2] *See* Order No. R3-2021-0040, *General Waste Discharge Requirements for Discharges from Irrigated Lands, Attachment A, Findings*, California Water Quality Control Board, Central Coast Region, p. 2-3. *See also id*. at p. 140-141, stating that 15, 22, 19, 23 and 17 percent of wells showed increasing nitrate concentration trends in the Forebay, Eastside, Upper Valley, 180/400 foot, and Santa Maria sub-basins, respectively.

[3] Woodward EE, Edwards TM, Givens CE, Kolpin DW, Hladik ML,"Widespread use of the nitrification inhibitor nitrapyrin: assessing benefits and costs to agriculture, ecosystems, and environmental Health," Environ Sci Technol. 2021 Feb 2;55(3):1345-1353. Available at: https://pubmed.ncbi.nlm.nih.gov/33433195/.

[4] Central Coast Regional Board, "Order No. R3-2021-0040 - Attachment A", p. 161-163. Available at: https://www.waterboards.ca.gov/centralcoast/water_issues/programs/ilp/docs/ag_order4/2021/ao4_att_a.pdf.

3. **Recommend Interim Discharge Limits to Ensure Growers Make Progress Towards Final Discharge Limits that are Protective of Groundwater Quality.**
4. **The Panel Should Recommend Limits, Not Targets, for the Central Valley.**
5. **The Expert Panel Must Recommend a Time Schedule that Achieves Compliance, as Required by the Nonpoint Source Policy.**
6. **Outreach, Education, and Technical Assistance Must be Coupled with Interim Limits to Ensure that Growers Make Progress Towards Meeting Final Limits that are Protective of Groundwater Quality.**
7. **The Panel Should Recommend that Interim Application Limits are Coupled with Interim Discharge Limits to Ensure that All Growers Make Progress Towards Final Limits that are Protective of Groundwater Quality.**
8. **The Panel Should Recommend Improvements in Data Transparency, Quality Assurance, and Verification to Develop Nitrogen Limits that are Protective of Groundwater Quality.**
9. **The Panel Should Include a Balanced Discussion of the CV-SWAT and N Balance Approaches.**
10. **The Panel Must Cite Literature Regarding Advancements in Nitrogen Science in Order.**
11. **The Verification of Nitrogen Discharges Should Include Vadose Zone Studies.**

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I. The Draft Report Demonstrates that Existing Data Can Form the Basis for a Nitrate Regulatory Program with Numeric Standards.

In Question 1, the State Board asked the Expert Panel to review the data and the science and give its opinion on a question with potentially profound consequences for nitrogen regulation in California: does the data support a discharge limit based on nitrogen applied and removed metrics? And the Draft Report – well-supported by the information that it analyzes – answers with a resounding "yes."

Before discussing why the Expert Panel's conclusion is correct, it is important to consider the context for Question 1. The State Board convened this Expert Panel to answer the fundamental question left unanswered by several decades of attempted and failed regulatory proceedings: are numeric estimates of nitrogen applied and removed from irrigated lands generated by self-reported data sufficiently reliable to create a regulatory program that protects water quality?

Previous efforts to control nitrate discharge had focused largely on incentivizing improved nitrogen management practices. The assumption was that improving management practices would drive down excess nitrogen application, and, in turn, discharge. But extensive experience in the Central Coast and Central Valley demonstrate that this approach does not improve water quality.[5] Confronted with this fact, the Central Coast Regional Board updated its regulatory program to include numeric limits on nitrogen applications and discharges in Ag Order 4.0, acknowledging that numeric limits have dramatically improved water quality in other parts of the world.[6] Unfortunately, the State Water Board remanded the numeric limits in Ag Order 4.0 before they could make a demonstrable impact. The State Board determined, among other things, that the "the science supporting our irrigated lands regulatory program is, as thoroughly explained in Order WQ 2018-0002 (ESJ Order), still evolving and we have not yet identified a metric that directly correlates to ongoing practices ceasing to cause or contribute to exceedances of nitrate water quality objective in groundwater that can be used as a regulatory tool."[7] The State Board decided that a second Expert Panel should weigh in on whether A and R data could be used to regulate nitrogen discharges and protect water quality.

The State Water Board, at the behest of the state legislature, convened its first Agricultural Expert Panel in 2014 to recommend improvements to the Irrigated Lands Regulatory Program to better account for pollution to groundwater.[8] The first panel ultimately recommended that growers simply report their nitrogen use efficiency ratios (nitrogen applied (A)/nitrogen removed (R)).[9] In 2018, the State Board endorsed the use of both A/R and A-R as metrics to measure growers' progress towards reducing nitrogen discharge, but again stopped short of setting numeric limits based on A/R, stating that "it is premature at this point to project the manner in which the multi-year A/R ratio target values might serve as regulatory tools."[10] The Board stated that use of the A/R metric as a regulatory limit would likely await "convening an expert panel that can help evaluate and consider the appropriate use of the acceptable ranges for multi-year A/R ratio target values in irrigated lands regulatory programs statewide."[11]

To date, the State Water Board has stopped short of issuing or approving the use of numeric limits as a regulatory tool. As extensively demonstrated throughout the record before this Panel,

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[5] As early as 1988, the State Board recommended consideration of limiting nitrogen fertilizer application. (State Board, Nitrate in Drinking Water, Report to the Legislature, Report No. 88-11WQ (1988), at p. 49, available at https://ucanr.edu/sites/default/files/2012-03/138960.pdf (accessed May 1, 2026).

[6] Central Coast Regional Water Board, *Order No. R3-2021-0040*, Agriculture Order 4.0, Attachment A. Available at: https://www.waterboards.ca.gov/centralcoast/water_issues/programs/ilp/docs/ag_order4/2021/ao4_att_a.pdf.
Daniel Rath, *Scientific Literature Review for Questions Posed to the Upcoming Second Statewide Agricultural Expert Panel*. Available at:
https://www.nrdc.org/sites/default/files/2025-08/scientific-literature-review-of-nitrogen-related-limits.pdf.

[7] State Board, WQ Order 2023-0081 (2023 State Board Order) at p. 24.

[8] See SBX2 1 (2007), § 5. Available at https://www.leginfo.ca.gov/pub/07-08/bill/sen/sb_0001-0050/sbx2_1_bill_20080930_chaptered.html; Wat. Code § 83002.5.

[9] R. Burt et al., Conclusions of the Agricultural Expert Panel (2014) at p. 24, 38.

[10] State Board, *Order WQ 2018-0002*, In the Matter of Review of Waste Discharge Requirements General Order No. R5-2012-0116 for Growers Within the Eastern San Joaquin River Watershed that are Members of the Third-Party Group (ESJ Order), at p. 74.

[11] *Ibid.*

nitrate pollution attributable to irrigated agriculture is the primary cause of groundwater contamination statewide, but particularly in the Central Valley (Region 5) and Central Coast (Region 3).[12] California has known about the harms of nitrogen pollution since the 1960s, and yet, the State and Regional Boards have failed to take meaningful regulatory action to stop this pollution at the source.

We provide this history to show that the Second Agricultural Expert Panel's answer to Question 1 represents not only this Panel's considered judgment, but also the culmination of decades of regulatory processes. By answering Question 1 in the affirmative – which the Draft Report does – the Expert Panel acknowledges that more aggressive regulatory action is appropriate to reduce nitrogen pollution and protect water quality.

The Expert Panel makes two things abundantly clear: 1) That sufficient data exists to develop nitrogen-related discharge limits that are ultimately protective of groundwater quality, and 2) That meeting those water quality protective limits is possible. As discussed in Recommendation 8 (*infra*), publicly available data shows that some growers are already meeting the 50 lbs/acre/year nitrogen discharge limit protective of groundwater quality in the Central Coast.

II. The Draft Report Highlights Recommendations That Can Improve the ILRP

We would like to thank the Panel for the significant amount of work they have put into this process throughout the past several months. We acknowledge the immense amount of effort and time that went into preparation for and attendance at multiple Panel meetings and drafting the Draft Report.

We fully support several recommendations in the Draft Report, including this non-exhaustive list:

A. The acknowledgement that A-R is an appropriate metric "to evaluate and quantify N discharges to groundwater for regulatory purposes" and the recognition that limits for A-R (or other nitrate discharge equivalent metrics) can be made now.[13]
B. The recommendation to use soil nitrate testing as a best management practice.[14]
C. The endorsement of the discount factors that were initially included in Ag 4.0.[15]
D. The need for continued development of R values.[16]

[12] Thomas Harter et al., *Addressing Nitrate in California's Drinking Water With a Focus on Tulare Lake Basin and Salinas Valley Groundwater*, p. 3. Available at: https://ucanr.edu/sites/default/files/2012-03/138956.pdf
[13] Draft Report at 17: 898-900.
[14] *Id.* at 20: 1022-1029.
[15] *Id.* at 32: 1555-1566.
[16] *Id.* at 15: 836-842.

E. The acknowledgment that there are both N application levels and N discharges that are excessive at a certain point.[17]

F. The recommendation that growers document how their reported A and R values were determined.[18]

   a. Similarly, the recommendation that requires standardized documentation showing how growers calculated and measured their reported N applied, the proportion of N mineralized from organic fertilizer and compost, and harvested product.[19]

   b. The recommendation to develop a "comprehensive comparison and assessment of fertilizer sales (for synthetic commercial fertilizer reported to CDFA) in California against ILRP-reported statewide fertilizer application rates" to provide verification of ILRP data.[20]

G. The recommendation to evaluate and implement buffer zones surrounding community wells.[21]

H. The consideration of financial incentives to lower discharge, including adjustment of fees based on A-R values.[22]

I. Recommending that nitrogen applied is used as a metric to assess nitrogen discharge "in situations where N removal coefficients or reliable yield estimates are not available…"[23]

J. Highlighting that "unreasonably low values for metrics, especially when computed over a three-year period, should be treated as potentially erroneous and require similar follow-up as outliers at the high end of A and R related metrics. This should not be limited to statistical outliers at the low end, but to all fields/properties with unreasonably low three-year average A/R or A-R values."[24]

K. The recommendation that the State Board, "in collaboration with CDFA, the Farm Bureau and third parties develop a standardized table of commodity names, crop type names, crop groups and crop group names," in light of the difficulty that non-standardized terms has caused for attempts at data analysis across coalitions.[25]

L. The recognition that "small acreage farms are unlikely to demonstrate a reduced water quality impact based on acreage alone."[26]

M. The recommendation to standardize reporting and documentation requirements.[27]

III. RECOMMENDATIONS FOR IMPROVING THE DRAFT REPORT

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[17] *Id.* at 13: 745.
[18] *Id.* at 14: 794-97.
[19] *Id.* at 28: 1363-67.
[20] *Id.* at 28: 1384-87.
[21] *Id.* at pp. 16, l. 849-51, p. 62, l. 2686.
[22] *Id.* at pp. 16, l. 859-70, p. 63 l. 2701-11.
[23] *Id.* at 22: 1126-28.
[24] *Id.* at 25: 1248-52.
[25] *Id.* at 27: 1326-28.
[26] *Id.* at 45: 1992-94.
[27] *Id.* at 28.

The Expert Panel's Draft Report must be improved in the following ways to protect clean water for people and communities in a manner that complies with existing law.

Recommendation 1: The Panel Must Avoid Providing Policy Recommendations.

A final discharge limit should be based on N discharge values that are protective of water quality. As the Panel writes, these discharge values are the amount of N discharged from an acre of irrigated lands that, for given local precipitation and hydrogeological conditions, will not cause or contribute to a violation of the 10 mg/L N MCL. The Panel has identified this as 31 lbs/acre in the Central Valley and 50 lbs/acre on the Central Coast. We agree that water quality protective numeric limits may vary between regions.[28] However, the Expert Panel deviates from its charge questions and oversteps its assignment by recommending that numeric limits on discharges should not be precedential.[29] The State Water Board has tasked the Panel to advise on a scientific question, not a legal one. The Board's authority and discretion to make statewide and/or region-specific precedential requirements is determined by a much broader record that is obligated to protect water quality.

Recommendation 2: The Panel Should Revise its Definition of a "Sustainable Irrigated Lands Regulatory Program" to Match the Water Board's.

It appears from the Panel's discussions and the Draft Report that there are different understandings of what it means for the ILRP to be "sustainable." The Panel apparently interprets "sustainable" to mean economic sustainability,[30] whereas we interpret it as a regulatory program that is transparent, accountable, and impactful in reducing pollution; that generates sufficient data and fees to sustain the water board's regulatory activities; and that sustains water quality for current and future generations. We are concerned that the Panel's understanding of a "sustainable" ILRP skews away from protecting water quality and toward protecting financial interests and maintaining status quo agricultural production. According to the Central Valley Water Board, the goal of the ILRP "is to protect the quality of surface and groundwater for the benefit of present and future generations." Further, the Sustainable Groundwater Management Act, Wat Code section 10720 et seq., provides a definition of "sustainability" more in line with

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[28] The Report also acknowledges that a lack of data in other regions should not preclude action in regions where such data is available. Furthermore, the Panel agrees that Region 3 and Region 5 have the data needed to set limits.

[29] Lines 687-689 in the Draft Report state, "Based on scientific and technical considerations the Panel recommends that limits are not required statewide or as a precedential tool to be used by Regional Boards." Note that the sentence immediately prior, however, suggests setting targets rather than limits.

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our understanding of the term.[31] In the context of the ILRP's goal, we believe it more likely that "sustainable" as used in Charge Questions 1 and 2 refers to regulatory sustainability over a precious, shared natural resource. Ultimately, the Water Board directed the Expert Panel to not consider economics.[32]

Relatedly, the Panel's discussion of economic sustainability and agronomic feasibility is based on current agricultural practices and farming systems. The Panel, unfortunately, overlooks that farming systems and agricultural operations can – and must – adapt for 21st century conditions. Many farmers across California are already using innovative techniques and organic, sustainable, and regenerative farming practices to grow food and limit pollution. Despite some panelists expressing concern that a forward-looking approach is a policy determination outside of the Panel's scope,[33] the Panel has been presented with scientific evidence demonstrating how regulation drives change.[34] There is ample evidence that pushing an industry to meet regulatory requirements can drive investment and innovation, including in California (e.g. California's Renewable Portfolio Standard, AB 32, and Clean Cars Rules).[35] The Water Boards' own data shows that it is already possible for growers to meet drinking water limits, particularly if growers adopt several or all of the practices recommended in the Draft Report.[36]

Under existing ILRP regulations, farmers using sustainable farming practices are penalized for stewarding the land. These farmers are competing in the same regulatory landscape as their polluting counterparts, creating a competitive disadvantage. Without clear enforceable limits, early adopters of nitrogen-reducing practices are subsidizing the inaction of those who choose not to do the same. Clear, enforceable limits create a level playing field that rewards farmers for using sustainable farming practices that reduce nitrogen pollution.

As previously discussed, reaching final discharge values protective of water quality is both possible and already happening, so the Panel should not adopt its impossibility as a central

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[31] *See* Water Code § 10721(u)-(x).

[32] *See*, e.g. *See* State Water Resources Control Board, *Response to General Comments on the Second Statewide Agriculture Expert Panel* (October 24, 2024) at 3, 14 ("This Panel is charged with providing recommendations based on science, rather than the economic impact of its recommendations."). Available at: https://www.waterboards.ca.gov/water_issues/programs/agriculture/docs/generalresponses.pdf; October 31, 2025 State Water Board Expert Panel Plenary Meeting, Presentation by Karen Mogus, clarifying the Expert Panel's role.

[33] January 14, 2026 Agricultural Expert Panel Working Group Meeting #8 at 6:05:09. Available at: https://www.youtube.com/watch?v=Pe1xgJ9RjS8

[34] *See,* e.g. August 14, 2025 Agricultural Expert Panel Plenary Meeting, Presentation by Dr. Daniel Rath, Dr. Jake Dialesandro, and Dr. Iris Stewart-Frey, "Comparing nitrogen regulation globally and in California: water quality impacts and structure."

[35] *See* Recommendation 6, *infra.*

[36] *See* Central Coast Irrigated Lands Regulatory Program Dashboard for Grower Reporting and Water Quality. Available at: https://app.powerbigov.us/view?r=eyJrIjoiMzYxYzk1ZWUtNmZlMi00YjNkLTlkNjUtZDMwZTgxNGMxYzg5IiwidCI6ImZlMTg2YTI1LTdkNDktNDFlNi05OTQxLTA1ZDIyODFkMzZjMSJ9; August 14, 2025 Agricultural Expert Panel Plenary Meeting, Presentation by Dr. Iris Stewart-Frey and Dr. Jake Dialesandro, "Analysis of Central Valley and Central Coast agricultural fertilizer and shallow groundwater nitrate data."

premise. Sustainability is forward-looking; accordingly, the Panel's recommendations should be as well.

Recommendation 3: Recommend Interim Discharge Limits to Ensure Growers Make Progress Towards Final Discharge Limits that are Protective of Groundwater Quality.

In WQ Order 2023-0081 (2023 State Board Order), the State Board determined that the Central Coast Regional Board's use of interim limits on nitrogen discharge went against the State Board's precedential requirements in the ESJ Order.[37] The State Board concluded that an Expert Panel must be convened in order to proceed with a new regulatory approach, such as using interim limits to regulate nitrogen discharges.[38] The Draft Report concludes that there is enough evidence to improve the existing regulatory framework to include the implementation of interim limits that work towards final limits that meet water quality objectives.[39] The State Board must act quickly to reinforce the Panel's recommendation to include interim limits to regulate nitrogen discharges under the Irrigated Lands Regulatory Program.

Although this is a strong recommendation, the Expert Panel leaves the decision to implement interim limits to the Regional Boards, arguing that targets can also be effective to regulate nitrogen discharges.[40] Yet the Panel fails to substantiate the efficacy of targets in protecting water quality with evidence.

The Panel's first reason is that data is not available for all crops and all agricultural systems.[41] It is true that there may be some regions or crops that have limited data to set interim limits now. For example, the Panel identifies that there is limited R coefficient data for niche crops and crops grown in container nurseries.[42] But these barriers are not common in Region 3 and Region 5. Region 3 and Region 5 have sufficient nitrogen applied and nitrogen removed data to set interim limits and make progress towards meeting final limits. Specifically, Region 3 has collected 11 years of nitrogen applied data and three years of nitrogen removed data. Region 5 has almost seven years of A, R, A/R, and A-R data.[43] Furthermore, farming operations in Region 3 and Region 5 rely largely on commonly grown crops that have been sufficiently studied which reduces the uncertainty associated with niche crops and alternative growing systems. The Panel doesn't identify any barriers which prevent Region 3 and Region 5 from establishing interim limits in their regions and indeed recommends that the Regional Boards in these regions move ahead with data-based actions to control discharge. As stated above in Recommendation I, the

[37] 2023 State Board Order, at p. 15-19. This determination is the subject of active litigation in Sacramento Superior Court. A trial court decision is expected in the fall of 2026.
[38] *Id.*
[39] *Id.* at 11: 668-73.
[40] *Id.* at 12.
[41] *Id.* at 12: 693-99.
[42] *Id.* at 12: 692-695.
[43] 2023 State Board Order at p. 19.

Panel is charged to provide recommendations based on data and scientific research. Based on the data, the Expert Panel should recommend that Region 3 and Regions 5, at a minimum, establish interim limits.

Second, the Panel asserts that targets "can also help the agricultural industry make improvements in reducing N loading despite the lack of penalties."[44] But this is a reason to include targets as a first step, not to fail to include limits as a backstop.

Third, the Panel states that Ag Order 4.0 contained a mechanism to revisit and adjust targets and limits.[45] Again, this is not a reason to reject limits; as noted below, the Nonpoint Source Policy contemplates adjusting time schedules if a Regional Board determines that a program is not working properly.

Fourth, the Panel refers to "scientific and technical considerations" for recommending that limits not be required as statewide precedent.[46] But the Panel does not cite any studies or evidence for these "scientific and technical considerations."

The Panel asserts that the data shows that "there is a point at which N discharges to groundwater are excessive" referring to either nitrogen discharge measured by A-R at the 80th or 90th percentile.[47] Additionally, the Panel acknowledges that excessive nitrogen discharges have greatly impacted drinking water in Region 3 and Region 5.[48] It is not clear why this level of discharge should not serve as an initial limit. The Panel points to no evidence showing that discharge at these rates is agronomically necessary. And indeed, it acknowledges that discharge at the 80th percentile is "agronomically achievable."[49] It is unreasonable to allow A-R amounts that are both known to cause discharges and are agronomically unnecessary. Yet choosing to include only targets, but not limits, would allow exactly that outcome: without a binding limit, the Boards have no authority to bring enforcement actions or otherwise halt a discharger who simply decides not to abide by a target. Nonbinding targets are not a sufficient approach for other areas of the law, whether they involve point sources of water pollution or speed limits, and they are not sufficient here. The Panel nowhere appears to acknowledge that in a regime with targets and no limits, some growers (hopefully, but not certainly, a small percentage) will ignore those targets and continue business as usual.[50] If the ILRP is to function to reduce and ultimately eliminate nitrogen discharge, enforceable limits will be necessary. The Panel should revise its

[44] Draft Report at 12: 679.
[45] *Id*. at 12: 684.
[46] *Id.* at 12: 687-89.
[47] *Id.* at 13:745-754. It is unclear from the Draft Report why A-R levels set at the mean or median would not also provide an "agronomically feasible" benchmark.
[48] *Id.* at 13: 733-36.
[49] *Id.* at 13: 756.
[50] Nor does the Panel acknowledge that if growers derive an economic advantage from over-applying nitrogen–and the rates of over-application imply that that at least some growers believe this–then failing to impose limits punishes good actors by placing them at a disadvantage as compared to those who refuse to abide by the non-binding targets.

answer to Question 1 to strongly recommend interim limits where appropriate and supported by the evidence.

Recommendation 4: The Panel Should Recommend Limits, Not Targets, for the Central Valley.

In the Draft Report, the Panel recommends that the Regional Boards can choose to either adopt interim limits or interim targets. Furthermore, the Panel states that it supports both the Central Valley's process of developing targets and the Central Coast's process of developing limits.[51] However, the Expert Panel fails to provide evidence which demonstrates that targets alone are effective at reducing nitrogen discharges – let alone reducing excessive nitrogen discharges.

The data shows that targets have been unsuccessful in protecting water quality and reducing excessive nitrogen discharges in the Central Valley. In 2023, the Central Valley Regional Board conditionally approved discharge targets. Despite these targets, nitrogen discharges continue excessively. According to the Central Valley's own data, some of the largest polluters discharged 449 lbs of nitrogen per acre.[52] These discharges exceed the operational benchmark in the Central Valley by more than ten times, leaving communities and ecosystems to pay the price.[53] Targets are insufficient for protecting water quality. The Panel should recommend that Regions with adequate data and extreme nitrate impacts develop limits on nitrogen discharges.

Recommendation 5: The Expert Panel Must Recommend a Time Schedule that Achieves Compliance, as Required by the Nonpoint Source Policy

The Draft Report recommends an approach that would not contain a final time schedule, and therefore does not comply with the Nonpoint Source Policy.[54] The Nonpoint Source Policy is binding on the State and Regional Boards. (E.g., *Monterey Coastkeeper v. State Water Resources Control Bd.* (2018) 28 Cal.App.5th 342, 145-46.) It requires that a water board, in adopting a program to control nonpoint source pollution (whether a WDR, a waiver of WDRs, a basin prohibition, or some combination of these), adopt a "specific time schedule, and corresponding quantifiable milestones designed to measure progress toward reaching the specified requirements."[55] This schedule "may not be longer than that which is reasonably necessary to

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[51] Draft Report at 13: 741-743.

[52] State Water Board, *INMP Summary Report Data Visualization Tool*. Available at: https://app.powerbigov.us/view?r=eyJrIjoiZmE2OGVmZmQtZTk2Ny00YWZjLTgwNTEtMDBlMzc2ZjdjZDY4IiwidCI6ImZlMTg2YTI1LTdkNDktNDFlNi05OTQxLTA1ZDIyODFkMzZjMSJ9

[53] Stewart, Iris T., John Dialesandro, Samantha Lei, and Lilah Foster. 2025. "Toward the Human Right to Water for Vulnerable Communities: The Effectiveness of Stakeholder Processes to Control Regional Shallow Groundwater Contamination by Nitrates." Water Resources Research 61 (10): e2025WR040896. https://doi.org/10.1029/2025WR040896.

[54] Draft Report at 17-18.

[55] Nonpoint Source Policy at p. 13.

achieve an NPS implementation program's water quality objectives."[56] This language is clear that a schedule must reach all the way to compliance; it cannot stop after only designating the first step. In *Monterey Coastkeeper*, the Court of Appeal struck down the Central Coast's waiver of WDRs that was modified by the State Board to not require a final time schedule, but to only require iteratively improving management practices.[57]

The State Board interpreted the Nonpoint Source Policy as requiring final time schedules in its 2023 Order which remanded portions of Ag Order 4.0 to the Central Coast Regional Board. In that Order, the State Board noted that certain aspects of Ag Order 4.0 did not contain "final time" schedules; the schedules for participants in the third party alternative program stopped in 2028 at discharge levels well short of compliance.[58] The State Board noted that in order to comply with the Nonpoint Source Policy, final compliance schedules were necessary and remanded them in part on that basis.

The Draft Report recommends an approach to setting interim limits and targets that is not compliant with the Nonpoint Source Policy.[59] The Draft Report appears to recommend only setting an initial limit or target, followed by an iterative review by the Regional Board, and potential setting of additional limits or targets. This approach is very similar to those approaches rejected by the Court of Appeal in *Monterey Coastkeeper* and the 2023 State Board Order: it fails to set a final compliance schedule. Instead, the Draft's approach merely recommends setting the first milestone, and stopping there. This is not a final schedule for ceasing to cause or contribute to water quality violations. And it certainly does not set a schedule that is no longer than reasonably necessary to achieve compliance. These are legal requirements that neither the Water Boards nor the Expert Panel are free to ignore. Because it does not comply with the law, the Draft should be revised to remove this recommendation and to require a final schedule.

The Draft's approach has other flaws: it recommends only setting further, tighter milestones if the previous milestone was "agronomically achievable."[60] Nowhere in the Draft Report, however, does the Panel define "agronomically achievable."

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[56] *Ibid.*

[57] *Monterey Coastkeeper*, supra, 28 Cal.App.5th 369-70 ["the NPS Policy expressly requires time schedules and quantifiable milestones; the purpose is to assure that the water quality objectives are eventually met."].

[58] See 2023 State Board Order at p. 23-24; Ag Order 4.0 at Table C.1-3, p. 52. The State Board acknowledged the "apparent tension between requiring the establishment of final compliance dates for achieving nitrate water quality objectives and rejecting the General WDRs' use of enforceable limits on nitrogen application and A-R difference." (2023 State Board Order at p. 24.) We believe that while the State Board's requirement of final schedules was appropriate, its removal of the enforceable aspects of Ag Order 4.0's time schedules both violated the law and was unsupported by the record before the State Board at the time.

[59] State Board, *Policy for the Implementation and Enforcement of the Nonpoint Source Pollution Control Program* (2004), at p. 13 (Nonpoint Source Policy).

[60] Draft Report at 17:905-15; 13:758.

This focus potentially incentivizes foot-dragging. Under the Draft's logic, the slower growers are to implement new practices and move towards meeting the milestone, the less likely it will be that the Regional Board sets a further, more aggressive target. The Nonpoint Source Policy's logic relies on setting a full schedule, with milestones along the way, to move dischargers towards compliance.

This is not to say that the schedule, once set, is carved in stone. The Nonpoint Source Policy recognizes that "If the [regional board] later determines that additional time is necessary to complete the program, it may make further amendments to the time schedule or issue an enforcement order that contains a compliance schedule."[61] But the Policy is clear that setting the full schedule is a required first step. Only then, if the schedule is shown to not be working, can it later be amended. But the burden must be on the Board to determine that the schedule is not working, not – as the Draft proposes – for the burden to be on the Board to demonstrate that schedule *is* working before moving to the next milestone.[62] Such a system is ripe for abuse and fails to comply with the policy.

The Draft Report must be modified to discuss setting a final compliance schedule.

Recommendation 6: Outreach, Education, and Technical Assistance Must be Coupled with Interim Limits to Ensure that Growers Make Progress Towards Meeting Final Limits that are Protective of Groundwater Quality.

Research shows that regulation drives change.[63] The Porter Hypothesis posits that well-designed environmental regulations induce innovation.[64] A recent meta analysis of the Porter Hypothesis has further demonstrated that "command and control regulation," or the use of law and regulations to curb pollution, is the most consistent and effective in driving innovation.[65] In the

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[61] State Board, *Nonpoint Source Policy*, at p. 13.
[62] For these reasons, the Draft reverses the process in Ag Order 4.0. That Order set a final compliance schedule for individual dischargers, but contained a procedure to reevaluate the program in 2027-28 based on "discharger reported nitrogen applied and removed data, new science, and management practice implementation and assessment before becoming effective." See Ag Order 4.0 at Table C.1-3, p. 52 and table C.2-1, p. 54; see also Ag Order 4.0 Att. A at p. 89 ["If prior to 2027 or anytime thereafter an expert panel finds that another regulatory method would be more protective of water quality, or if the more protective regulatory methods are identified through other sources, the Central Coast Water Board will review the requirements of this Order and will make modifications as appropriate."]. This language establishes a time schedule, but allows for later modificaiton–the opposite approach from only setting an initial milestone with the remaining schedule development deferred until later.
[63] For example, since their adoption in 1974 and 1980, the Corporate Average Fuel Economy (CAFE) standards for fuel efficiency have nearly doubled the fuel efficiency of passenger cars 2024 Transportation Statistics Annual Report ("[the] first standards [were] set in 1978 when new passenger cars averaged 19.9 miles per gallon (MPG) on federal tests and 16.9 in actual use . . . In 2023, new cars averaged 46.1 MPG on the federal test and 34.9 MPG on the road . . ."), available at: https://www.bts.gov/product/transportation-statistics-annual-report.
[64] Zhang, W., Zhu, B., Li, Y. et al. Revisiting the Porter hypothesis: a multi-country meta-analysis of the relationship between environmental regulation and green innovation. Humanit Soc Sci Commun 11, 232 (2024). https://doi.org/10.1057/s41599-024-02671-9
[65] *Id.*

context of air pollution, Shi et al. take the Porter Hypothesis a step further, arguing "environmental degradation not only suppresses economic productivity but also erodes the core drivers of long-term innovation capacity."[66] Put simply, ongoing pollution inhibits long-term innovation. Science-based limits on nitrogen pollution will drive innovations in the agricultural industry while giving farmers the flexibility to experiment with what's appropriate on their land to meet the limits.

The Draft Report suggests relying on enforcing "best management practices" in lieu of numeric limits.[67] This approach does not ensure accountability for nitrogen pollution reductions.[68] While such practices may help some dischargers reduce pollution, compliance with waste discharge requirements must be based on measurable results, not practices alone.[69] Growers are already required to implement some best management practices, including sediment and erosion control measures, water quality management practices, and irrigation and nitrogen management plans. Unfortunately, the Central Valley Regional Board has failed to measure and verify reductions in nitrogen pollution and improvements in water quality as a result of these best management practices, underscoring why best management practices alone cannot be relied upon to meet water quality objectives.[70]

Education and outreach is indeed necessary to help growers implement best management practices. Alone, however, these efforts do not protect water quality, as evidenced by groundwater contamination tests in California from the past two decades. Outreach and education have been relied on for decades across the country, with poor results, including worsening water quality in California, Oregon, Minnesota, Washington, and Iowa.[71] Conditions worsened in these states, to the point that communities and nonprofits petitioned the EPA over

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[66] Shi, J.; Farooq, U.; Tabash, M.I.; Riyadh, H.A.; Almajali, T.A. Air Pollution and the Innovation Gap: A Challenge for Sustainable Growth in Emerging and Growth Leading Economies (EAGLE). *Sustainability* **2025**, *17*, 4423. https://doi.org/10.3390/su17104423

[67] Draft Report at 12:698-99.

[68] Ag Order 4.0, Attachment A, at p. 1-2 ["The previous agricultural orders relied on a management practice implementation approach without clear and enforceable requirements (i.e., numeric limits and time schedules) or monitoring and reporting necessary to drive the development and implementation of effective management practices or evaluate their effectiveness with respect to reducing pollutant loading, achieving water quality objectives and protecting beneficial uses….Although the previous orders increased awareness of the pollutant loading and associated water quality problems caused by agricultural activities, they have not resulted in improved water quality or beneficial use protection."].

[69] Nonpoint Source Policy at p. 12 [" [Management practice] implementation never may be a substitute for meeting water quality requirements….".].

[70] *Environmental Law Foundation v. State Water Resources Control Bd.* (2023) 89 Cal.App.5th 451, 465.

[71] We are also uncomfortable with the suggestion that taxpayers bear a significant portion of the cost of outreach, education, and technical assistance for growers. (See Draft Report at 15.) Nitrogen discharge attributable to irrigated agriculture is the cause of significant groundwater contamination, and low-income communities bear the brunt of that pollution. The industry–particularly the large farms that control 63% of the irrigated acreage in California–should bear the primary financial responsibility for learning how to avoid discharge in the future, not taxpayers. (See Draft Report at 5.)

nitrogen contamination in drinking water.[72] Continuing to rely on education, outreach, and voluntary targets preserves the status quo and offers no meaningful relief to residents with contaminated groundwater. Interim and final numeric limits deliver progress and results to people, communities, ecosystems, and regulators, as demonstrated by other countries that have improved water quality after issuing numeric limits on nitrogen.

The science is clear: numeric limits reduce nitrogen pollution and protect clean water. California declared a Human Right to Water in 2012, yet too many communities still do not have access to clean and safe drinking water. Numeric limits on nitrogen applications and discharge will help California deliver on its commitment in a timely manner.

Recommendation 7: The Panel Should Recommend that Interim Application Limits are Coupled with Interim Discharge Limits to Ensure that All Growers Make Progress Towards Final Limits that are Protective of Groundwater Quality.

As discussed above in Recommendation 3, interim limits can ensure that all growers make progress toward final limits that are protective of groundwater quality. "Interim limits" encompass both application limits and discharge limits: both are essential for making progress. Increasingly protective nitrogen-related limits can be set now using A-R data. The Panel should recommend using existing nitrogen application data to set interim application limits to immediately target outliers and reduce nitrogen pollution from the most egregious overappliers.

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[72] Monterey Waterkeeper, et al., "Title IV Complaint and Petition for Rulemaking for Promulgation Central Coast Region Water Quality Standards," March 26, 2024. Available at: https://www.epa.gov/system/files/documents/2024-04/05no-24-r9-complaint_redacted.pdf; Food and Water Watch et al., "Petition for Emergency Action Pursuant to the Safe Drinking Water Act § 1431, 42 U.S.C. § 300i, to Protect Citizens of the Lower Umatilla Basin in Oregon from Imminent and Substantial Endangerment to Public Health Caused by Nitrate Contamination of Public Water Systems and Underground Sources of Drinking Water," January 16, 2020. Available at: https://www.epa.gov/system/files/documents/2022-12/Lower-Umatilla-Groundwater-SWDA-Petition-2020.pdf; Minnesota Center For Environmental Advocacy et al., "Petition for Emergency Action Pursuant to the Safe Drinking Water Act, 42 U.S.C. § 300i, to Protect the Citizens of the Karst Region of Minnesota from Imminent and Substantial Endangerment to Public Health Caused by Nitrate Contamination of Underground Sources of Drinking Water," April 24, 2023. Available at: https://www.mncenter.org/sites/default/files/permalinks/42423-emergency-sdwa-petition-to-epa-with-exhibits.pdf; Center For Food Safety et al., "Petition for Emergency Action under Section 1431 of the Safe Drinking Water Act to Protect Residents of the Lower Yakima Valley, Washington, from Imminent and Substantial Endangerment to Public Health Caused by Nitrate Contamination of Drinking Water Sources," October 26, 2021. Available at: https://www.centerforfoodsafety.org/files/20211026-petition-for-emergency-action-under-section-1431-of-the-sdwa_00006.pdf.; Iowa Environmental Council et al., "Petition for Emergency Action Pursuant to the Safe Drinking Water Act, 42 U.S.C. § 300i, to Protect the Citizens of the Karst Region of Iowa from Imminent and Substantial Endangerment to Public Health Caused by Nitrate Contamination of Underground Sources of Drinking Water," 2024. Available at: https://www.iaenvironment.org/webres/File/IA_SDWA_Petition_Complete.pdf.; Allamakee County Protectors — Education Campaign et al., "Coalition Letter to EPA: Use of Safe Drinking Water Act in Areas of High Nitrate Contamination," WaterWatch, October 29, 2024. Available at: https://waterwatch.org/coalition-letter-to-epa-regarding-utilization-of-federal-safe-drinking-water-act-in-areas-of-high-nitrate-contamination/.

Limits on nitrogen overapplication, whether expressed as limits on fertilizer nitrogen applied (A_{FER}) or total nitrogen applied (A), serve two critical functions. First, they can immediately reduce the highest rates of overapplication and subsequent pollution where there is no R data collected. Second, application limits affirm that rates above that limit are unjustifiable. In other words, application limits act as a backstop for A-R or model-based limits. [73]

The Panel's Draft Report should explore all scientifically supported options to inform the Boards' decision-making. Question 6 asks whether A_{FER}-based interim limits, such as those proposed by the Central Coast Regional Board in Ag Order 4.0, are an appropriate tool for protecting groundwater.[74] Although the Draft Report acknowledges that A_{FER}-based interim limits could reduce excessive fertilizer nitrogen application, it dismisses them as potentially redundant and focuses primarily on regulatory clarity rather than evaluating whether and how A_{FER} limits, alone or combined with A limits, would advance groundwater protection–an issue squarely within the Panel's technical expertise in Question 6.

Interim application and discharge limits are essential for ensuring progress toward groundwater protection. The Panel should recommend both types of interim limits to ensure progress towards clean water for people and ecosystems.

Recommendation 8: The Panel Should Recommend Improvements in Data Transparency, Quality Assurance, and Verification to Develop Nitrogen Limits that are Protective of Groundwater Quality.

Any successful results-driven regulatory program requires transparency and accountability, including making underlying reported data publicly accessible and available.[75] Unfortunately, data transparency is a major issue with the current Central Valley program, where raw data is hidden from the public and the regulatory agency. Such lack of transparency undermines public trust and accountability. Key data, like field-level acreage and location, are removed by

[73] For this reason, we find the Panels' concern that including an A metric could confuse growers to be unpersuasive. (See Draft Report at 31: 1505-1509.) When preparing an INMP, it is a simple check to compare total A to the A limit, and then compare A-R to any applicable A-R limit and ensure that both numbers in the INMP are below the applicable limit.

[74] The Panel also notes that Ag Order 4.0 only set A limits for six crops. (Draft Report at 31: 1510.) It is important to note two responses. First, these crops are the six most common crops in the Central Coast, representing 75% of the total acreage. (Ag Order 4.0, Att. A, at p. 143.) Thus, the work to develop these A limits is already done for the vast majority of one of the major agricultural areas of the state. Second, it is also important to point out that Ag Order 4.0 sets backup A limits of 500 lbs/acre/crop initially, followed by 480 lbs/acre/crop after several years. We are not aware of any research demonstrating crop need at those levels of application, yet some growers do report N application above those levels. An A limit set at these levels would reduce discharges associated with those excessive applications while being eminently achievable by the vast majority of growers.

[75] The Nonpoint Source Policy, for instance, requires that "An NPS control implementation program shall include sufficient feedback mechanisms so that the RWQCB, dischargers, and the public can determine whether the program is achieving its stated purpose(s), or whether additional or different MPs or other actions are required." (Nonpoint Source Policy, at p. 13.)

coalitions before shared with the Regional Board. Without acreage data, it is not possible to calculate nitrogen loading and the effect it has on groundwater contamination and has the following two effects: (1) Withholding this data makes it impossible to independently verify which areas or operations are improving, or not, over time - a key charge of the State Board. (2) In addition, data transparency is key to enable regulators to craft targeted and effective regulations. For example, without the Tule Basin acreage data, the regulators and the public would not know that around only 10% of growers are responsible for ~60% of the discharge.[76] This kind of information would allow regulators to target regulations to achieve the largest reductions in pollution and improvements in water quality.

There are many areas where nitrogen pollution continues to worsen and harm people and ecosystems in the Central Valley (Region 5) and in the Central Coast (Region 3). Also there is a statistically significant, positive relationship between nitrogen discharge (A-Rlbs/acre) and nitrate concentrations in groundwater wells. There are 18% of ranch acres on the Central Coast already meeting a nitrate discharge target of 50lbs/acre.[77] Discharge rates protective of groundwater quality are achievable.

The Draft assumes that the anonymity provided to growers' nitrogen data incentivizes higher quality reporting.[78] However, this assumption is unsupported by the evidence. Furthermore, in its 2018 ESJ Precedential Order, the State Board also stated that dischargers do not have an inherent right to privacy for their field-level data.[79]

The statewide ILRP has conducted a natural experiment: Growers in Region 5 report A and R data anonymously and without location or acreage, while Region 3 publicly reports all grower data. If anonymity improved data quality, Region 5's data would be stronger, but the Panel cites no evidence to support this. Instead, the Draft Report's examples of poor data quality comes from Region 5's Kern Coalition with similar issues identified across other Central Valley coalitions.[80] At a minimum, the evidence undermines the assumption that anonymous data are higher quality and suggests that transparent reporting may improve accuracy by holding growers accountable.

Better examples already exist: The Central Coast region shows that more transparent systems are feasible and effective. Their field-level reporting, standardized formats, and tools that allow

[76] Drs. Dialesandro, J. and Stewart, Frey, I., *Analysis of Central Valley and Central Coast Agricultural Fertilizer and Shallow Groundwater Nitrate Data*, Slides 19-22, August, 14, 2025.

[77] Central Coast Regional Water Board. *Irrigation and Nutrient Summary Report.* Available at: https://app.powerbigov.us/view?r=eyJrIjoiMzYxYzk1ZWUtNmZlMi00YjNkLTlkNjUtZDMwZTgxNGMxYzg5IiwidCI6ImZlMTg2YTI1LTdkNDktNDFlNi05OTQxLTA1ZDIyODFkMzZjMSJ9

[78] See Draft Report at 25.

[79] ESJ Order, at p. 22, n. 65 ["To the extent we recognize the incentive privacy provides growers to join coalitions, nothing in this order should be construed as recognizing any right to privacy of the specific field-level data and regional water boards retain flexibility provided by this order."].

[80] Draft Report at 25: 1245-47

both regulators and the public to explore trends, which can be independently verified by third party scientists.

Agricultural coalitions have withheld field-level data citing privacy concerns. And yet - there has been no evidence that uninvited visits to farms will increase with non-anonymized data. In addition, names and addresses of farm owners are already public via enrollment in the program and coalition membership lists. Furthermore, there has been no evidence of adverse consequences of making acreage public in Region 3. Finally, there has also been no evidence of negative consequences with other regulatory programs which require non-anonymized reporting, e.g., National Pollutant Discharge Elimination System (NPDES) permits.

Based on this evidence we ask that the Draft Report acknowledge that the data is Region 5 is limited without information on acreage, location, or soil type, and recommend that it be made available.

Data quality must be improved: Across the Region 5 coalitions, datasets are released with different naming conventions, unclear units (e.g., total pounds vs. pounds per acre), and large unexplained outliers, including values that are likely errors but are not flagged or corrected. With readily available electronic reporting tools, consistent units and naming conventions should be the baseline; failure to ensure this level of data quality is unreasonable and should be highlighted in the Draft Report. For example, some coalitions omit nitrogen applied in irrigation water, despite its inclusion in individual INMP reports.

Current quality control for data collection and verification is unclear: There is little transparency about how data is cleaned, validated, or corrected before release, raising concerns about reliability. Verified data must be released in a timely manner to address the issue at stake: nitrate concentrations above safe and legal limits that have gone unchecked for decades. The Draft Report should recommend standard and procedures of quality control

Significant data gaps exist and need to be filled: Spatial coverage of sampling data is often sparse and temporal variability is poorly captured. Many wells have only been sampled once every few years, when there is evidence that nitrate varies on interannual time scales. More widespread and more frequent sampling is needed to characterize spatial and temporal variability as well as local and regional trends. This is needed to protect communities from harmful contaminants in their water AND for the State Board to assess whether and where nitrate contamination is improving. If we do not insist on better spatial and temporal coverage in monitoring, we will be here in 10 years again discussing what we do not know, and we will significantly curtail our ability to target priority areas.

The quality of the analysis hinges on the quality of the data collected and released: Data gaps need to be filled and reported data needs to be independently verified and released to increase the accuracy of the analysis. Without access to consistent data on nitrate discharge, acreage and location, third-party scientists cannot verify conditions over time, audit calculations, or identify pollution hotspots at a meaningful scale. Without acreage data, regulators and third parties cannot assess whether limits are working, because the total amount of N applied cannot be calculated.

The Draft Report already recognizes that while most farms are small, most acreage–and therefore much of the nitrate discharge–comes from large operations. This is important information.[81] Current data reporting limits accountability and scientific analysis. State Board staff were unable to draw clear conclusions without acreage data. The Expert Panel should recommend making verified data available to the public. California has sufficient information to set science-based application and discharge limits. Without acreage data, nitrogen loading and groundwater impacts cannot be assessed.

Recommendation 9: The Panel Should Include a Balanced Discussion of the CV-SWAT and N Balance Approaches.

We request that the Recommendations provide more information on the benefits of the N balance approach alongside the CV-SWAT model approach, particularly in Section 6.4. There is a significant amount of research on the suitability of the N balance approach to estimate nitrogen leaching from agricultural land both in California and globally.[82] The N balance approach's strengths lie specifically in its transparency, ease of calculation, and use of easily available farm data, which should be represented clearly in the Draft Report.

To provide some specific examples, the N balance approach has been proposed as an evidence-based foundation for food supply chain companies to mitigate and track NO_3 pollution, and is one of the primary methods used to track nitrogen pollution in the EU.[83] Its value as a

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[81] Draft Report at 5: 470-76 states that small farms account for 3.3% of irrigated acreage, while large farms manage 69.9% of acreage

[82] Duda, Robert, Robert Zdechlik, and Jarosław Kania. 2023. "Groundwater Nitrate Pollution Risk Assessment Based on the Potential Impact of Land Use, Nitrogen Balance, and Vulnerability." *Environmental Science and Pollution Research* 30 (58): 122508–23. https://doi.org/10.1007/s11356-023-30850-9.; McLellan, Eileen L., Kenneth G. Cassman, Alison J. Eagle, et al. 2018. "The Nitrogen Balancing Act: Tracking the Environmental Performance of Food Production." *BioScience* 68 (3): 194–203. https://doi.org/10.1093/biosci/bix164.; White, Kathryn E., Eric B. Brennan, Michel A. Cavigelli, and Richard F. Smith. 2022. "Winter Cover Crops Increased Nitrogen Availability and Efficient Use during Eight Years of Intensive Organic Vegetable Production." *PLOS ONE* 17 (4): e0267757. https://doi.org/10.1371/journal.pone.0267757.

[83] Tamagno, Santiago, Alison J. Eagle, Eileen L. McLellan, et al. 2022. "Quantifying N Leaching Losses as a Function of N Balance: A Path to Sustainable Food Supply Chains." *Agriculture, Ecosystems & Environment* 324 (February): 107714. https://doi.org/10.1016/j.agee.2021.107714.; Jordan-Meille, Lionel, Pascal Denoroy, Klaus Dittert, et al. 2023. "Comparison of Nitrogen Fertilisation Recommendations of West European Countries." *European Journal of Soil Science* 74 (6): e13436. https://doi.org/10.1111/ejss.13436.; https://library.edf.org/AssetLink/v86j02bt52us3rw4pl6640c6k7203plc.pdf

regulatory tool lies precisely in its ability to translate environmental targets into actionable goals for farmers. Given that the central theme of the recent Regulatory Alignment Study is the importance of consistent and transparent data governance, the advantage that use of the N balance approach provides in meeting that goal should not be discounted. [84]

The benefits of the N balance approach weighed against the benefits of the CV-SWAT model is also a valuable area for the Expert Panel to provide recommendations. As has been mentioned several times in the expert panel process, and in the Draft Report, the SWAT model is an open-source, internationally used model for runoff, non-point source pollution, and other complex hydrological processes under changing environments whose various components have been verified and are well supported. The CV-SWAT model is a version of this model modified for use in the California Central Valley.

However, the way the CV-SWAT model is used in the Central Valley raises problems for its use as a regulatory tool. One of the main issues with the CV-SWAT model is its transparency and trust associated with the data used and model outputs. The way the CV-SWAT model is set up limits public transparency, because the field-level data–including acreage and location–used to run the CV-SWAT model is not publicly available, precluding independent model verification runs. Model runs used to determine whether farmers are reaching a limit protective of groundwater quality should be able to be independently verified by scientists with the relevant expertise, and the underlying datasets driving that model need to be available to the public.

Other concerns highlighted by Central Coast stakeholders about how data is used in the CV-SWAT model include lack of clarity around how fertilizer application rates reported in the INMPs are entered into the model, lack of clarity about how grower reported N removal values are used, and lack of clarity about how crops not already included in the crop library are treated. Additionally, its dependence on a root zone library and groundwater hydrologic models that are based primarily on Central Valley data and modeling makes it difficult to extend to the Central Coast.

Further, the application of the CV-SWAT model to generate Groundwater Protection Values and Targets relies on numerous assumptions that raise questions about the accuracy and reliability of those targets.[85] For instance, the GWP Targets use 2019 cropping patterns for annual crops to generate average recharge rates for townships, rather than relying on each year's INMP reports to

[84] California Department of Food and Agriculture, *Regulatory Alignment Study Draft Final Recommendations and Implementation Next Step*s. Available at: https://www.cdfa.ca.gov/RegulatoryAlignment/docs/Regulatory_Alignment_Study_Draft_Final_Recommendations_and_Implementation_Steps.pdf

[85] See Formation Environmental, LLC, Groundwater Protection Targets (December 15, 2022) (GWP Targets) available on request at https://www.waterboards.ca.gov/centralvalley/water_issues/irrigated_lands/water_quality/coalitions_submittals/ (accessed May 4, 2026).

recalculate those figures.[86] Where growers reported utilizing residual soil nitrogen to grow crops (i.e., applying no nitrogen), the coalitions nonetheless assumed that some nitrogen was applied.[87] Where reported nitrogen exceeded 500 lbs/acre, the coalitions ignored those figures and assumed that the average nitrogen for that crop was applied.[88] Where the N applied was insufficient to reach reported crop yield (according to the model's assumptions about the N required to reach that yield), the coalitions assumed N was added at the 90th percentile rate.[89] Some of these assumptions affected hundreds of townships and model-reported values for tens- or hundreds of thousands of acres.[90] The use of such assumptions and adjustments highlight the potential pitfalls of a numeric model approach, as compared to the N balance approach.

As the Draft Report has stated, all models are wrong, but some are useful. The N balance approach's usefulness lies in its transparency, ease of calculation and robust agreement with N leaching estimates, and is directly relevant to the task set to the Water Boards and supported by the regulatory alignment study. Estimating potential N leaching from agricultural land is both meant to determine what leaching reductions need to be made, and to communicate to affected communities that progress is being made - which means that transparency is a primary goal alongside accuracy. Region 3's use of a consistent, transparent, and externally verifiable method to calculate nitrogen leaching is based on clear scientific support and experience from across the globe and should be clearly articulated alongside Region 5's approach.

Recommendation 10: The Panel Should Cite Literature Regarding Advancements in Nitrogen Science

Question 3 asks the Panel to consider whether advancements in research have occurred since the 2014 release of the first Expert Panel's Draft Report. However, this section does not cite any studies, papers or books.[91] The failure to cite research makes evaluating the Panel's response to this question difficult to evaluate.

Recommendation 11: Verification of Nitrogen Discharges Should Include Vadose Zone Studies

The Draft Report recommends two ways to verify whether program metrics–whether based on A-R or numerical models–are accurately estimating nitrogen discharge. These are calculations of fertilizer sales as compared to reported values on INMP forms, and measurement of N levels at

[86] *Id.* at p. 18.
[87] MLJ Environmental, Formation Environmental, Groundwater Protection Values for Crop Years 2020, 2021, and 2022 (2025), at p. 13.
[88] *Id.* at pp. 13-14.
[89] *Ibid.*
[90] *Ibid.*
[91] Draft Report, at 18-21.

wells over time as compared to calculated A-R values.[92] Both of these methodologies have some promise. The second one–comparing N concentrations in shallow wells to reported A-R discharge—however, likely involves too much time lag to be useful regulatorily. The Panel should consider whether use of lysimeters, soil core samples, or other direct measurements of nitrogen at the bottom of the root zone and/or in the vadose zone can be effective checks on the performance of the regulatory metrics. Such studies could also evaluate the effectiveness of management practices such as cover cropping and high-carbon amendments, as well as help calibrate the discount factors appropriate for those measures.[93]

***

Thank you for the opportunity to comment on the Draft Report. We look forward to working with the Expert Panel and State Board to better protect drinking water.

Sincerely,

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[92] Draft Report at p. 30.
[93] *See* Draft Report at p. 34-38.

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Attachment A - Comment Letter sent to Second Agricultural Expert Panel on September 29, 2025

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September 29, 2025

Via E-mail

E. Joaquin Esquivel - Chair
Dorene D'Adamo – Vice Chair
Laurel Firestone
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State Water Resources Control Board
1001 "I" Street, 24th Floor
Sacramento, CA 95812

Re: State Water Resources Control Board's Legal Authority to Request Additional Data from Central Valley Coalitions and the Need for Acreage Data to Answer Questions Posed to the Second Agricultural Expert Panel

Dear Chair Esquivel and Members of the Board:

The undersigned groups write for two reasons: First, we address the State Water Resources Control Board (State Board)'s authority to request and acquire additional data from Third-Party Coalitions (Coalitions) regulated by the Central Valley Regional Water Board pursuant to the 2018 Eastern San Joaquin Order[1] (ESJ Order). Second, we request that the State Board exercise that authority and require that the Coalitions provide acreage and soil-type data tied to the anonymous field-level A and R data reported under the ESJ Order. Specifically, we request that the State Board direct that the Coalitions amend their submissions to the Central Valley Board to add fields to Tables 1, 2, and 3 required by the ESJ Order that specify the acreage and soil type for each field reported in those tables.[2]

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[1] State Board, Order No. WQ-2018-0002, In the Matter of Review of Waste Discharge Requirements General Order No. R5-2012-0116 for Growers Within the Eastern San Joaquin River Watershed that are Members of the Third-Party Group Issued by the California Regional Water Quality Control Board, Central Valley Region SWRCB/OCC FILES A-2239(a)-(c) (2018).

[2] In the alternative, we request that the Regional Boad direct the Coalitions to provide the acreage information described in this letter directly to members of the Expert Panel, so that they can analyze the data themselves.

Background

Under the ESJ Order, the Coalitions currently submit certain information to the Central Valley Board anonymously and without location information or acreage data for specific fields. (See ESJ Order at pp. 47-52.) Growers report some field-level data, including management practices and nitrogen applied (A) and removed (R) directly to the Coalitions via their Irrigation and Nutrient Management Plan Summary Reports. But the Coalitions report that data to the Central Valley Regional Board—and thus to the public—using anonymous identifiers.

Using these identifiers, the Coalitions disaggregate the nitrogen A and R and management practice data from the physical locations of the fields. Growers provide data sorted by anonymous grower in one set of tables (Tables 1 and 2), and a separate table provides data by anonymous field (Table 3).[3] This disaggregation means that A/R—which is a unitless ratio—is reported on a per-field basis, and A-R is reported in terms of pounds per acre. Neither the anonymous grower identifiers nor the anonymous field identifiers contain acreage data or soil type data. As a result of the lack of acreage data, the required reported datasets do not provide information on the magnitude of nitrogen discharge from each field: this calculation would require multiplying A-R per acre by the acreage of the field. And the lack of soil type data prevents researchers and stakeholders from understanding how management practices impact both the amount of nitrogen that has the potential to leach and groundwater percolation rates.

Soil type data, like acreage data, is not required to be included in the publicly available tables required by the ESJ Order. However, the Coalitions are currently required to include soil type mapping in their Groundwater Quality Management Plans. (ESJ Order, MRP-1 at p. 3.) As a result, it should be possible to assign a soil type to each field based on the field's APN.

In August 2025, the State Board convened the Second Agricultural Expert Panel (Expert Panel) and asked it to review a set of questions relating to the management and regulation of nitrogen pollution in California's irrigated lands programs.[4] As discussed below, acreage and soil type data is likely necessary to answer most of the questions.

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[3] A fourth table—Table 4—does not provide any information on individual growers, but rather aggregates A and R data at the township level and reports aggregated totals for each 36-square-mile township.

[4] State Board, Questions for the Second Statewide Agricultural Expert Panel (Oct. 24, 2024) (Expert Panel Questions), available at https://www.waterboards.ca.gov/water_issues/programs /agriculture/docs/panelquestions.pdf (accessed July 22, 2025).

The State Board Has the Authority to Request Additional Data from the Coalitions

The State Board has clear authority to obtain and analyze additional data from growers and the Coalitions, including information that is currently submitted anonymously.

The ESJ Order affirms the Board's authority to request non-anonymized acreage and location data from the Coalitions. In the ESJ Order, the Board stated that the decision to require only anonymized data was not permanent, and that future information and regulatory needs could cause it to revisit that decision over time. (ESJ Order at p. 48.) Specifically, the State Board reserved for itself the right to "require disclosure of name and location data in the future." (*Ibid.*) Further, the Central Valley Board may "at any time request the names and locations corresponding to the anonymous identifiers."[5] (*Id.* at p. 50.) The ESJ Order goes on to state that the "Central Valley Water Board also has the discretion to direct the Third Party to segregate the anonymous data into smaller geographic subsets where warranted. . . [and] environmental groups and others are free to request that the Central Valley Water Board obtain this type of targeted data from the Third Party."[6] (*Ibid.*) The ESJ Order also provides that the management practice data currently reported to the Central Valley Water Board in Table 1 without any geographic information could be associated with an APN-based identifier in the future. (ESJ Order at p. 30, fn. 87.) Together, these provisions make abundantly clear that the Boards have full authority at any time to de-anonymize the data that is currently anonymous, and to obtain location, soil type, and acreage information that is currently not provided to the Regional Board or the public.[7]

Further, in justifying its requirement that Coalitions report anonymized field-level data to the regional board, the Board rejected the argument that AR data constitutes proprietary business information. (ESJ Order at pg. 46.) It also rejected the argument that growers have any "right to privacy" regarding field-level data required to be reported to

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[5] While the ESJ Order refers to the Central Valley Board's power to request additional data, that power also resides in the State Board. The State Board may review a regional board's "failure to act" at any time under Water Code section 13320, and may direct that regional board to act—or take the action itself—if the regional board's inaction was "inappropriate or improper". It is worth noting that the Central Valley Board is required to report biannually on the adequacy of the anonymous data provisions, something which it does not appear to have done since 2022. (ESJ Order at p. 74.)

[6] This authority could be used to provide acreage information by buckets—in increments of 25 acres, for example—as discussed further below.

[7] It is important to note that through this letter, the undersigned are *not* requesting full de-anonymization at this time, only acreage information sufficient to perform the analyses described later in this letter and to address the factual questions raised by the State Board's questions to the Expert Panel.

the Coalitions. (*Id.* at p. 22, fn. 65.) As result, nothing in the ESJ Order prevents the Board from requesting that the Coalitions provide un-anonymized or location-specific data.

Nor does *Environmental Law Foundation v. State Water Resources Control Bd.* (2023) 89 Cal.App.5th 451 (*ELF*) pose any such barrier. In *ELF*, the Court of Appeal upheld the State Board's power to use anonymized and aggregated data in the context of the ESJ Order but did not prevent the Boards' acquiring or disclosing such data at a future point. (See *ELF*, *supra*, 89 Cal.App.5th at 474.) The court found that while the Board exercised reasonable discretion in determining that anonymized and aggregated data in management plans and summary reports sufficiently complied with the Nonpoint Source Policy, that conclusion was limited to a holding that anonymization was sufficient "at least for present purposes." (*Id.* at 477-78.) The court specifically noted language in the ESJ Order reserving the right of the Board to request more specific data in the future and reasoned that the Board "could reasonably exercise discretion to require 'more granular' feedback" at a later point. (*Id*. at 480, 482.) Nothing in *ELF*, therefore, indicated that the Board could not use its reserved authority to request further data, including non-anonymized data, in the future.

In addition to the authority that the State Board retained to modify the anonymity provisions in the ESJ Order, the State and Regional Boards also have authority under Water Code sections 13260, 13263, and 13267 to obtain additional data and information. Section 13267, in particular, allows for the State Board to perform investigations and request further data from dischargers if necessary. Further, the State Board may use its authority to review regional board actions and inactions under section 13320 and may assume the powers of the regional board to direct further action. These provisions provide additional authority, beyond the ESJ Order itself, to require soil type and acreage data to be made available to the second Statewide Agriculture Expert Panel (Expert Panel) and the public.

As we explain below, acreage and soil type data in particular are vital to approaching the next phases of the program and can be shared without compromising anonymity.

Acreage Data Is Necessary for Meaningful Analysis of A and R Data, Including for Answering the Questions to the Expert Panel

In October 2024, the State Board posed nine questions to the Expert Panel. As the Expert Panel has begun its deliberation, it is more and more crucial that public data be available so that the panel can succeed in answering the State Board's questions and ultimately so that the Board moves forward with its legally mandated duty to adopt waste discharge requirements for nitrate pollution that have a high likelihood of success, among other requirements.

In particular, acreage and soil type information will likely be necessary to answer at least questions 1, 2, 3 5, 6, 7, 8, and 9.

A. Acreage Data Allows Analysis of the Distribution of Growers' Contribution to Pollution

In general, without acreage information, it is impossible to assess the impact of nitrogen discharges from any given operation on water quality. For example, an A-R balance of 150 lbs. per acre over five acres has vastly different implications for nitrogen pollution reduction than 150 lbs. per acre over 200 acres: the first situation has a surplus application totaling 750 lbs. of nitrogen, while the second has a surplus of 30,000 lbs. Thus the lack of acreage data hinders the ability to assess the impact on water quality and potential leaching into groundwater of growers with high rates of discharge as compared to those with low discharge rates: without knowing acreage, the data does not reveal which operations discharge large or small total amounts of nitrogen into groundwater. Per-acre-only data simply doesn't give information to understand which particular growers or fields are worth prioritizing for additional outreach and assistance.[8]

But beyond prioritizing individual operations, the lack of acreage data severely impedes the assessment of different potential regulatory schemes, and such assessment is the point of the Expert Panel. If a small number of "bad apples" are causing the majority of the impact, a regulatory program could look very different than one to control pollution where the median grower is discharging at a level causing significant impacts.

An example illustrates this point. In the Central Coast, growers report their data directly to the regional board, meaning that acreage data is freely available. And the

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[8] As a related point, acreage data for applied nitrate and surplus removal reported at the township level—as in Table 4—is too coarse and imprecise to effectively evaluate groundwater impacts. Each township encompasses a 36-square-mile area (6 miles by 6 miles), which can contain a wide range of soil types, cropping patterns, irrigation methods, and management practices. The publicly available township-level data in Table 4 does not include soil type, irrigation method, or management practices. (ESJ Order at pp. 49, 85.) Because nitrate discharges can vary dramatically within even small geographic areas, aggregating data across such a broad unit masks critical spatial variability. Without more precise geographic information—such as parcel-level or field-level data—it's not possible to accurately identify where high nitrogen applications or surpluses are occurring within the township. As a result, it's impossible to link the reported nitrogen use to specific groundwater wells or vulnerable zones, making it ineffective for assessing localized groundwater contamination risks or informing targeted management and regulatory decisions. This point is not merely abstract: in the analyses that some of the undersigned groups are preparing to present to the Expert Panel, researchers have been unable to use the public data to draw adequate conclusions—conclusions that could be made with acreage data and finer location data. Nor does it allow the kind of prioritization and assessment of the impacts of different tiers of operations on nitrogen pollution.

Central Coast Regional Board has prepared a dashboard allowing analysis of that data.[9] Figure 1 below, as reproduced from that dashboard, shows a histogram of A-R data for 2023 and 2024:

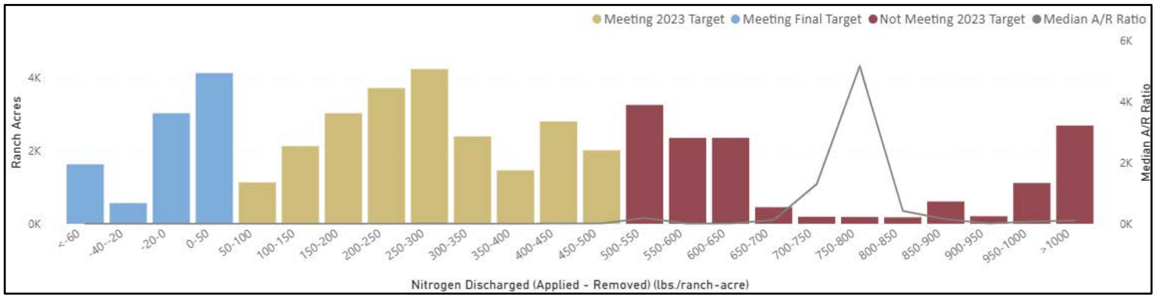

Figure 1

This figure suggests that while a healthy minority of growers are meeting the final discharge target of 50 lbs. per acre, the majority of growers are not, with a larger minority failing to meet even the 2023 target of 500 lbs. per acre. The median A-R is 202 lbs. per acre, per the dashboard; that figure is approximately four times the amount that the Central Coast Regional Board found would be unlikely to cause or contribute to water quality exceedances.[10]

Acreage data for each operation is necessary to perform this analysis; without it, it is impossible to sort each operation's contribution to total nitrogen discharge. Because the public does not have access to acreage data for the Central Valley, it is impossible to analyze whether similar dynamics exist there. It is not hard to imagine a basin where even though median discharge into the basin is close to the operational benchmark, a small minority of high dischargers generate significant pollution. In that scenario, a limit set at or close to the median could significantly reduce the pollution issue while requiring no changes for most growers.

B. Acreage and Soil Type Data Will Be Necessary to Answer the Questions Posed to the Expert Panel

The questions directed to the Expert Panel also require acreage and soil type data to answer.

[9] Irrigated Lands Program Dashboard for Grower Reporting and Water Quality (last updated May 1, 2025), https://app.powerbigov.us/view?r=eyJrIjoiMzYxYzk1ZWUtNmZlMi00YjNkLTlkNjUtZDM wZTgxNGMxYzg5IiwidCI6ImZlMTg2YTI1LTdkNDktNDFlNi05OTQxLTA1ZDIyODFkMzZjMSJ9.

[10] Central Coast Regional Board, Order No. R3-2021-0040, attach. A at pp. 149-50.

1. Question 1

Question 1 asks, among other things, what "additional data should be collected and/or what additional research needs to be conducted to further support the development of nitrogen-related limits that are protective of groundwater quality and support a long-term sustainable Irrigated Lands Regulatory Program?" Soil type data is available through the GQMPs, as discussed above, but is not publicly associated with the field-level data. As nitrogen leaching rates, volatilization rates, and management practices all likely depend on soil type, this data should be shared with the Expert Panel now to help the panelists address this question.[11]

2. Question 2

Question 2 asks whether limits can be set that make progress towards being protective of water quality. To effectively answer Question 2 and estimate the potential impacts of limits, including interim limits, the Expert Panel needs to know the nitrogen (N) discharges associated with growers and individual fields, an overview of the number of acres meeting discharge targets within each coalition, and how those acres meeting discharge targets change from year to year. Acreage data is vital for answering Question 2. Additionally, it is necessary to know acreage data to calculate median discharges. In the Central Coast, where the median grower's discharge is well above what the regional board has calculated is necessary to be protective, a limit set at the median grower's discharge would result in median discharges approximately four times what is needed to avoid MCL exceedances.[12]

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[11] Soil type is also associated with nitrous oxide emissions from agricultural lands and thus will be important to support ongoing efforts to address air pollution from irrigated agriculture. (See, e.g., N. Adotey, et al., University of Tennessee Extension, Institute of Agriculture, Soil Properties that Affect Ammonia Volatilization Loss from Urea Ammonium Nitrate, available at https://utia.tennessee.edu/publications/wp-content/uploads/sites/269/2025/05/W1322.pdf (accessed September 24, 2025).

[12] The 2012 UC Davis Nitrate Report determined that, in the Central Valley, discharge exceeding 31 lbs./acre would have the potential to cause exceedances of the MCL. (Center for Watershed Sciences, UC Davis, Addressing Nitrate in California's Drinking Water (2012), at p. 17 (UC Davis Report), available at https://ucanr.edu/sites/default/files/2012-03/138956.pdf (accessed July 23, 2025); UC Davis Report, Technical Report 2, pp. 8-9, available at https://ucanr.edu/sites/default/files/2012-10/139110.pdf (accessed July 23, 2025); see Central Coast Regional Board, Order No. R3-2021-0040, attach. A at pp. 149-50.) In the Central Coast, with additional rainfall as compared to the Central Valley, the Central Coast Regional Board calculated that that benchmark value should be 50 lbs. per acre. (Order No. R3-2021-0040, attach. A, at pp 149-50.) The median A-R figure for the 2023-2024 Central Coast data was approximately 202 lbs. per acre, roughly four times this benchmark.

Acreage data is therefore vital to understand how limits set at different levels will affect water quality and will affect growers economically. Without acreage data, the Expert Panel is flying blind in answering Question 2.

3. Question 3

Question 3 asks for a review of the 2014 Agricultural Expert Panel's recommendations in light of current knowledge. That panel recommended that reporting units for A/R data be grouped by soil type, among other factors.[13] However, even though the State Board chose to use field-level data instead of "reporting units," it never incorporated soil type reporting into its program. As a result, now is the time to incorporate the 2014 panel's recommendations to include soil type reporting.

4. Question 5

Similarly, Question 5 asks, among other things, whether the INMP data is "effective for the Water Board to assess reductions in nitrogen discharges to groundwater and improvements in management practices, both on an individual grower basis and an overall basis[.]" It further asks whether the data is "capable of being used to confirm that follow up actions are being appropriately prioritized (e.g., by distinguishing between overapplication on large farms vs. overapplication on small farms)[.]" As discussed above, the lack of acreage data is a serious impediment to answering these questions. On an individual basis, it is simply not possible to assess reductions in nitrogen discharges without knowing the magnitude of those discharges, which cannot be done without acreage data. And equally axiomatically, the data is not capable of determining the difference between applications on large and small farms without knowing the size of those farms. Additionally, the Expert Panel cannot measure potential improvements to groundwater quality without knowing soil type because soil type informs groundwater percolation and nitrogen volatilization rates.

5. Questions 6, 7, and 8

Question 6 asks whether setting limits on fertilizer nitrogen based on percentile groupings of growers, as was done in Ag Order 4.0 in the Central Coast, was an appropriate metric. Evaluating a percentile approach is similarly impossible without knowing the size of fields and their contributions to discharge at each percentile.

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[13] Irrigation and Training Research Center, Conclusions of the Agricultural Expert Panel (2014), at p. 37, available at https://www.waterboards.ca.gov/water_issues/programs/agriculture/docs/ILRP_expert_panel_final_report.pdf (accessed July 29, 2025).

Question 7 asks for input on several issues surrounding Ag Order 4.0's discount factors for potentially protective management practices, including organic fertilizer, scavenged nitrogen, and treatment. The question asks, among other things, whether these discount factors allow a "full accounting" of the nitrogen with potential to discharge to groundwater, and whether including those discounting factors will allow "valid and comparable A/R and A-R values between different growers." The same defect as above prevents assessing these questions. A "full accounting" of nitrogen impacts requires knowing how much is being discharged, and as discussed above, without acreage data this figure cannot be calculated. Similarly, knowing whether the discount factors will result in "valid and comparable A/R and A-R values between different growers" requires knowing acreage for each grower so that any comparison is apples-to-apples. While some management practice data is gathered in the Central Valley, it is not associated with acreage, thus making judgments about those management practices' extent impossible.[14]

Last, Question 8 asks whether data exists to analyze the relative impacts of "small and/or small diversified farms." Acreage data is self-evidently necessary to answer this question, as without it, it is impossible to know whether any given farm is small or large.

Two Potential Workarounds Could Preserve Grower Anonymity While Providing Useful Data

We are sensitive to the growers' desire for anonymity. This letter is not an attempt to relitigate the *ELF* case by requesting broad de-anonymization. We acknowledge that there is a concern that members of the public might be able to cross-reference acreage data to the field data in the membership list and thereby unmask growers' actual names.[15] If this concern is the barrier to requesting acreage data, however, we would propose two workarounds that could alleviate this concern.

First, acreage could be rounded to a significant digit where such cross-referencing would not yield reliable results. Second, the acreage data could be provided in "buckets" of 25 acres: for example, a field could be coded as being 0-25 acres, 25-50 acres, etc.[16]

Both of these methods would likely preserve anonymity by preventing cross-referencing, but would give the public and the Boards some ability to estimate the relative impacts of different sizes of operations.

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[14] Table 4, which includes aggregated A and R data by 36-square-mile township, does not include management practice data, as discussed above. (ESJ Order at pp. 49, 85.)

[15] At least one State Board staff member raised this concern during the 2018 ESJ Order hearings.

[16] The maximum aggregated field size that can be reported under the ESJ Order is 640 acres. (ESJ Order at pp. 30-31, fn. 88.)

Of course, either option would require some additional work on the part of the Coalitions, could introduce the possibility of inadvertent data errors, and would reduce the precision of any calculations based on the approximate acre figures. As a result, we believe that simply providing the acreage data information is the most straightforward solution.

Conclusion

Many of the questions put to the expert panel ask it to evaluate whether current data exists, or to analyze whether new data needs to be gathered to answer them. But there is no need for the expert panelists to answer these questions in the abstract: where acreage or soil type data is the missing piece, the data is available, and the State Board can obtain it right now. The undersigned groups have scientists and data experts available to perform analyses similar to the ones published in the Central Coast's dashboard on a short turnaround. The math is not difficult. If the State Board fails to direct disclosure of critical acreage data, the Expert Panel may be constrained from fully investigating and answering the questions before it, potentially leading to more delay in addressing the nitrogen pollution crisis.

For the foregoing reasons, we respectfully request that the State Board direct the Coalitions to provide the acreage and soil type data described above.

Sincerely,

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cc: Erica Kalve, State Water Resources Control Board
Karen Mogus, State Water Resources Control Board
Patrick Pulupa, California Regional Water Quality Control Board, Central Valley Region

Attachment B - Comment Letter sent to Second Agricultural Expert Panel on October 10, 2025

State Water Resources Control Board
1001 I St, Sacramento, CA 95814
Chair Joaquin Esquivel, Members of the Board, and Ms. Karen Mogus

October 10, 2025

[*Sent via email]*

RE: Regional Data Gaps Do Not Warrant Delay in Setting Limits on Nitrogen Application and Discharge in the Central Coast and Central Valley Regions

The undersigned organizations write to urge the State Water Resources Control Board (State Board) to set limits on nitrogen application and nitrogen discharge. At the meetings of the Second Agricultural Expert Panel (Expert Panel) to date, it has been suggested that the State Board should await further data collection from *all* regions before setting enforceable numeric limits on nitrogen use or discharge in *any* region. We strenuously oppose this approach. There are clear, documented, ongoing exceedances of water quality objectives in the Central Coast and

Central Valley regions, and the State and regional boards have clear legal obligations to address those exceedances through waste discharge requirements or other appropriate regulatory tools. There is no legal support for failing to address pollution in one region simply because another region has a less-developed regulatory program.

1. **The State Board and Regional Boards have the responsibility to protect groundwater quality and implement each and every basin plan**

The State Board has the authority to protect groundwater quality[1] and each regional board has the obligation to protect groundwater quality within its own region in order to comply with the Porter-Cologne Water Quality Act and the Human Right to Water Act.[2] Each regional board has an obligation to adopt basin plans that contain water quality objectives calculated to protect beneficial uses.[3] Each regional board has adopted a basin plan that incorporates the maximum contaminant level (MCL) of 10 mg/L for nitrate as a water quality objective, and the State Board has approved each of those plans. To protect water quality, each regional board must ensure that water quality programs have a high likelihood of achieving water quality objectives, contain a timeline with quantifiable milestones to meet water quality objectives,[4] use best practicable treatment and control, and ensure that any degradation is consistent with the maximum benefit to the people of the State, among other requirements.[5] The State Board and each regional board have the authority to ensure that the Irrigated Lands Regulatory Program meets these requirements by establishing enforceable limits on nitrogen application and discharge.

To comply with state law, the State Board cannot delay implementation of effective control measures for pollution in certain regions on the basis that other regions have delayed their data collection and regulatory development. Such a policy would be in direct conflict with the unambiguous legal requirements to implement the basin plans for each region and to adopt waste discharge requirements that implement those basin plans and state water policies.[6] As discussed below, such a delay would further hinder implementation in the two regions–the Central Coast and Central Valley–with the best-documented and most acute contamination while the state gathers evidence on the other regions. Thus, we ask the State Water Board to reiterate to the Expert Panel that the possibility of insufficient data in one region does not constrain setting limits in regions where the pollution is well-documented.

[1] Wat. Code §§ 106.3, 13000 et seq.
[2] State Water Board. *Resolution 2016-0010*
[3] Wat. Code §§ 13240, 13241.
[4] *Nonpoint Source Policy,* pgs. 11-12
[5] *Anti-degradation Policy*
[6] Wat. Code §§ 13240, 13242, 13247, 13263; see, e.g., *State Water Resources Control Board Cases* (2006) 136 Cal.App.4th 674, 725-34 [compliance with water quality objectives contained in basin plans is mandatory when boards engage in permitting activities].

2. **There is clear, documented, ongoing nitrogen pollution and drinking water contamination in the Central Coast and Central Valley regions**

The Central Coast region (Region 3) has collected two years of nitrogen-applied and nitrogen-removed data to demonstrate that high levels of nitrogen discharge continue to cause exceedances of nitrate water quality objectives in the groundwater.[7] The data shows that the median nitrogen discharge on the Central Coast from 2023 to 2024 was 215 lbs/acre.[8] This discharge rate well exceeds the final discharge limit of 50 lb/acre that Ag Order 4.0 initially set — indicating that growers on the Central Coast typically discharge 165 lbs/acre of nitrogen more than what is necessary to prevent exceeding water quality objectives.[9] In 2021, Region 3 documented that these discharges caused 64% of on-farm domestic wells in the Salinas Valley Forebay sub-basin to exceed the nitrate MCL of 10 mg/L. The mean nitrate concentration of the contaminated domestic wells in this sub-basin was 25.7 mg/L.[10] However, domestic wells that exceed the nitrate MCL extend beyond the Forebay sub-basin. Nitrate concentrations are also increasing in the Santa Maria sub-basin and the majority of the Salinas Valley sub-basins.[11] There is sufficient evidence showing that ongoing exceedances continue to cause water quality impacts on the Central Coast. The Central Coast Regional Board must set numeric limits on nitrogen application and discharge to prevent further impacts.

The Central Valley Region (Region 5) has compiled the most data of all of the regional Irrigated Lands Regulatory Programs — with at least seven years of nitrogen-applied and nitrogen-removed data. This data demonstrates that current discharges in the Central Valley contribute to exceedances of water quality objectives. Since January 2023, 44% of shallow domestic wells in the Central Valley have tested at or above the nitrate MCL.[12] Region 5 has collected seven years of discharge data which demonstrates that discharges have led to drinking water impacts. Region 5 needs limits on nitrogen application and discharge to protect groundwater quality.

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[7] The Central Coast Regional Board has at least 7 years of fertilizer application data from 55 percent of irrigated acres throughout the Central Coast region. See State of California Regional Water Quality Control Board Central Coast Region, Staff Report for Regular Meeting of October 12-14, 2022. Available at: https://www.waterboards.ca.gov/centralcoast/board_info/agendas/2022/oct/item3_stfrpt.pdf. Additionally, Ag Order 4.0 expanded fertilizer application reporting requirements to all irrigated acres in the Central Coast beginning in 2024 (reporting on TNA data from 2023). This means that the Central Coast Regional Board has access to at least 2 years of application data (2023 -2024) on all growers in the Central Coast, at least 7 years of data for 55 percent of growers, and at least 10 years of data for 27 percent of growers. See Ag Order 4.0, Attachment B, p. 34.

[8] Central Coast Regional Water Board. *Irrigation and Nutrient Summary Report.* Available at: https://app.powerbigov.us/view?r=eyJrIjoiMzYxYzk1ZWUtNmZlMi00YjNkLTlkNjUtZDMwZTgxNGMxYzg5IiwidCI6ImZlMTg2YTI1LTdkNDktNDFlNi05OTQxLTA1ZDIyODFkMzZjMSJ9

[9] Central Coast Regional Water Board. *Order No. R3-2021-0040 - Attachment A*, p. 149-150.

[10] *Id.* P. 139

[11] *Id.* P. 140-141.

[12] Water and Climate Justice Lab, Santa Clara University, Follow-Up Analysis of Central Valley (Region 5) Agricultural Fertilizer and Shallow Groundwater Nitrate Data, Oct. 1, 2025.

3. Data gaps in some regions must not prevent the Board and regional boards from establishing nitrogen application and discharge limits for the Central Coast and Central Valley regions

All regional boards were directed by the East San Joaquin Order (Order) to update their Irrigated Lands Regulatory Programs to include the Order's precedential reporting requirements within five years of approval of the Order.[13] Consequently, some regional boards lack complete nitrogen-applied and nitrogen-removed data. Well-testing and groundwater trend monitoring is not as advanced in other regions, in part because irrigated agriculture does not exist on the same scale, and nitrate contamination is somewhat less widespread. However, data collection delays in some regions do not constrain the responsibility of the State Board and regional boards to set limits on nitrogen application and discharge in the Central Coast and Central Valley, where such violations are well-documented, and where the cause–discharge stemming from overapplication of nitrogen to fertilizer to irrigated lands–is clear.

As stated above, each regional board has the responsibility to protect groundwater quality and ensure that water quality programs meet the requirements of the Anti-degradation Policy and Nonpoint Source Policy. The State Board and regional boards must use best practicable treatment and control when implementing the Irrigated Lands Regulatory Program — regardless of other regional boards' delay in collecting data. Ultimately, the State Board and all regional boards must establish limits on nitrogen application and discharge to implement best practicable treatment and control and protect water quality.[14] Delays in data collection in some regions do not excuse inaction in regions that have well documented discharge data and water quality impacts.

Conclusion

Further delay in regulating nitrogen contamination is unjustifiable, particularly in regions with well-documented data and severely nitrate-impacted communities. We urge the State Board to establish limits on nitrogen application and discharge in regions that have adequate data.

Sincerely,

Kjia Rivers
Senior Policy Advocate
Community Water Center

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[13] State Water Board. WQ Order 2018-0002, p. 9

[14] Region 3 stated in Ag Order 4.0 that total nitrogen applied data from 2014 through 2019 have not changed significantly in response to reporting requirements alone. Central Coast Regional Water Board. *Order No. R3-2021-0040 - Attachment A*, p. 144.

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Elias Rodriguez
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cc: Ngodoo Atume
Dr. Michael Cahn
Dr. Ruth Dalquist-Willard
Dr. Daniel Geisseler (Chair)
Dr. Thomas Harter

Dr. Ali Montazar
Richard Smith
Dr. Hannah Waterhouse

Attachment C - Comment Letter sent to Second Agricultural Expert Panel on October 30, 2025

October 30, 2025

Sent Via e-mail

Second Statewide Agricultural Expert Panel
State Water Resources Control Board
1001 I St., Sacramento, CA 95814

RE: Comments on October 13, 2025 and October 22, 2025 Public Working Group Meetings & Charge Questions 1 and 2

Dear Expert Panelists:

The undersigned groups write to provide recommendations related to Charge Questions 1 and 2 posed to the Second Statewide Agricultural Expert Panel for the Irrigated Lands Regulatory Program ("Expert Panel"). Specifically, we provide recommendations regarding how to set final limits along with increasingly protective interim limits for nitrogen application and discharge.

We have listened to the discussions on October 13, 2025 and October 22, 2025 with interest, and are generally encouraged by the Expert Panel's conversation and appreciative of the views expressed by each of the Panelists. We write now to reaffirm the need to set both final and interim limits[1] and to provide feedback on some points Panelists have made thus far.

Before turning to specific recommendations, we first note again that the Panel is not charged with consideration of economics or public policy in making its recommendations to the State Water Board. This was by design.[2] The State Water Resources Control Board will factor economic considerations into its final determination.[3] It would be improper and outside the scope of the Expert Panel process to factor economics or opinions regarding the role of enforcement versus other regulatory tools into the Expert Panel's recommendations.[4]

Consistent with the proper scope of the Expert Panel, the rest of our recommendations relate to the specific language in Charge Questions 1 and 2. The state of groundwater contamination in the Central Coast and Central Valley Regions is such that enforceable limits are necessary to

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[1] The charge questions were developed through a rigorous public feedback process that, among other things, ultimately arrived at using the term "limits," rather than "targets." Indeed, the term "targets" does not appear in the Charge Questions at all. *See* State Water Resources Control Board, Questions for the Second Statewide Agricultural Expert Panel (October 24, 2024), available at https://waterboards.ca.gov/water_issues/programs/agriculture/docs/panelquestions.pdf. The term "targets"–meaning non-binding metrics the violation of which would not lead to enforcement–was contained in both the 2018 ESJ Order as well as the 2021 Central Coast Regional Water Board's (Region 3) Order R3-2021-0040, available at https://www.waterboards.ca.gov/centralcoast/board_decisions/adopted_orders/2021/ao4_order.pdf. The decision to exclude "targets" from consideration by this panel was one made deliberately: the next step for the ILRP is to move towards enforceable regulatory programs that lead to achievement of water quality objectives on a fixed time schedule in conformance with the law.

[2] *See* State Water Resources Control Board, Response to General Comments on the Second Statewide Agriculture Expert Panel (October 24, 2024) at 3, 14, available at https://www.waterboards.ca.gov/water_issues/programs/agriculture/docs/generalresponses.pdf.

[3] Wat. Code §§ 13241 and 13263. *See also* Wat. Code § 13320. Further, while additional education and outreach is undoubtedly a critical component of the Expert Panel's recommendations, it alone has not led to a demonstrable improvement in nitrogen discharge or groundwater quality. *See* Central Coast Regional Water Board. *Order No. R3-2021-0040, Attachment A*, p. 144, stating that total applied nitrogen has not changed significantly between 2014 and 2019 in response to reporting requirements alone.

[4] To further clarify the role of the Expert Panel, we understand that the State Water Board intends to provide a presentation on this point at the October 31, 2025 Expert Panel meeting.

meet California's legal requirements for groundwater quality.[5] Our specific recommendations regarding setting interim and final limits are as follows.

Charge Question 1: Sufficient data and scientific research exists to establish nitrogen-related limits, targeting the highest dischargers first and allowing lower priority Regions to come into compliance over time.

Throughout the Expert Panel's discussion to date, it has become abundantly clear that sufficient data exists to inform development of nitrogen-related limits. As a result, and to reduce nitrogen waste discharge resulting from the over-application of synthetic fertilizer nitrogen as soon as possible, we urge the Expert Panel to answer Charge Question 1 in the affirmative, with the caveat that the limits should be field-level rather than crop-based. Consistent with many of the points made by Expert Panelists, the final discharge limit should not be crop-specific because nitrogen management practices that are protective of groundwater quality are not crop-specific. Regardless of the cropping system, there is an amount of nitrogen discharge that will not cause or contribute to degradation of water quality.[6]

Recognizing the diversity and scale of agricultural operations in California, we understand the need for flexibility in implementing final discharge limits; however, we underscore that there is no justification for further delay in setting enforceable limits where significant data has already been collected, particularly in Regions 3 and 5. Focusing efforts on the regions and discharges that are severely impacted by nitrate contamination and well understood will naturally provide additional time for less nitrate-impacted regions to collect data and implement monitoring programs to ultimately reach the nitrogen discharge limits. A framework of interim and final limits could be implemented according to time schedules,[7] allowing growers to adjust their irrigation and fertilization practices to achieve compliance over time. Moreover, combining alternative compliance pathways that incentivize the use of irrigation water nitrogen[8] or

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[5] Wat. Code §§ 106.3, 13000 et seq.

[6] The 2012 UC Davis Nitrate Report determined that nitrogen discharge in excess of 31 pounds of nitrogen per acre per year would have the potential to cause exceedances of the MCL in basins with a recharge rate equal to or less than 1 AF/ac. Report for the State Water Resources Control Board Report to the Legislature, *Addressing Nitrate in California's Drinking Water*, Jan. 2012. Available at: https://ucanr.edu/sites/default/files/2012-03/138956.pdf. *See also* Central Coast Regional Water Board. *Order No. R3-2021-0040*, *Attachment A*, p. 149-150. Available at: https://www.waterboards.ca.gov/centralcoast/water_issues/programs/ilp/docs/ag_order4/2021/ao4_att_a.pdf.

[7] Wat. Code § 13263(c). *See also* Central Coast Regional Water Board. *Order No. R3-2021-0040,* p. 54.

[8] In panel discussions to date, it has been mentioned that growers are not accounting for nitrate present in irrigation water when calculating their nitrogen applied (A) values. While a handful of growers may not be including this data, growers are required to account for the excess nitrogen in irrigation water per the precedential requirements of the ESJ order; "[t]he nitrogen applied includes all nitrogen proactively added to a field from any source such as organic amendments, synthetic fertilizers, manure, and *irrigation water* . . . The requirement for calculation of annual and multi-year A/R ratio and A-R difference parameters for

regenerative agriculture practices like cover cropping and composting with interim and final limits will ensure adequate flexibility across Regions and agricultural operations.

Charge Question 2: Increasingly protective interim nitrogen-related limits can be established now, building on the approaches included in the 2021 Central Coast Order.

Increasingly protective interim limits prioritizing the highest applications and discharges are necessary to protect groundwater quality. In Order R3-2021-0040, General Waste Discharge Requirements for Discharges from Irrigated lands (2021 Central Coast Order), the Central Coast Regional Water Quality Control Board (Central Coast Board) set enforceable nitrogen discharge and fertilizer application limits. The Expert Panel should review and consider this framework in answering Charge Question 2. Specifically, using data collected via the region's Total Nitrogen Applied Form between 2014 and 2019, the Central Coast Board set a nitrogen application limit of the 90th percentile of growers of past fertilizer nitrogen (AFER) application values by 2023 and the 85th percentile by 2025.[9] This method addresses the highest percentile dischargers first and scales the percentile value down over time in 2-10 year increments.[10]

While we are generally in alignment with the multiple Expert Panel members who have suggested a similar strategy to setting increasingly protective interim limits, we urge the Expert Panel to adjust the percentiles used by the Central Coast Regional Board, recognizing the time that has elapsed since the 2021 Order and considering the additional data that has been collected since then. We note that the agricultural coalitions in the Central Valley Region have proposed acceptable A/R ranges with the upper range set at the 75th percentile, and have also indicated an intent to use these acceptable ranges to identify outliers.[11] Without endorsing the Central Valley Region's approach, which is not itself protective of groundwater quality, we provide this discussion to note that the approach recommended by the Expert Panel should not be weaker than the outlier provisions in the Central Valley. Rather, if the Expert Panel does recommend a percentile-based approach to interim limits, it should be stronger than the Central Valley Region's approach.

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each grower by field shall be precedential for irrigated lands regulatory programs statewide . ..” (emphasis added). State Water Board. ORDER WQ 2018-0002 (ESJ Order), pp. 38, 40. Available at https://www.waterboards.ca.gov/board_decisions/adopted_orders/water_quality/2018/wqo2018_0002_with_data_fig1_2_appendix_a.pdf

[9] Central Coast Regional Water Board. *Order No. R3-2021-0040*, p. 54.

[10] *Id.*

[11] *See* State Water Board. ORDER WQ 2018-0002, at p. 52. Available at https://www.waterboards.ca.gov/board_decisions/adopted_orders/water_quality/2018/wqo2018_0002_with_data_fig1_2_appendix_a.pdf; *see also* Crop-Specific Multi-Year Acceptable Ranges of Applied Nitrogen Relative to Nitrogen Removed (October 2024) at p. 6, available at https://kingsriverwqc.org/wp-content/uploads/2025/03/20241007_aracceptableranges_report-1.pdf; East San Joaquin Water Quality Coalition, 2020 Member Annual Report at p. 13, available at https://www.esjcoalition.org/pdf/2020ESJAnnual.pdf (accessed October 27, 2025) (describing outlier calculation methodology).

Conclusion

Enforceable final and interim nitrogen application and discharge limits are necessary to achieve California's groundwater quality requirements, and an approach for setting these limits has already been established.[12] Accordingly, we urge the Expert Panel to recommend final and increasingly protective interim limits on nitrogen application and discharge that builds upon and strengthens the Central Coast Board's approach.

Sincerely,

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Legal Advocate
Leadership Counsel for Justice & Accountability

Madi Richards
Policy Manager
California Coastkeeper Alliance

Natalie R. Herendeen
Executive Director | Attorney
Monterey Waterkeeper

Elias Rodriguez
On behalf of the Comité de Salinas
California Rural Legal Assistance, Inc.

Rosa Carrillo
San Jerardo Housing Cooperative

Horacio Amezquita

Kjia Rivers
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Community Water Center

[12] *See* Central Coast Regional Water Board. *Order No. R3-2021-0040*.

Iris Stewart-Frey
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Nathaniel Kane
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Chris Shutes
Executive Director
California Sportfishing Protection Alliance

cc: Karen Mogus
Chief Deputy Director
State Water Resources Control Board

Attachment D - Comment Letter sent to Second Agricultural Expert Panel on January 29, 2026

Members of the Second State Wide Agricultural Expert Panel

January 29, 2026

[Sent via email]

RE: Draft Final Expert Panel Recommendations Report_v2

Dear Expert Panel Members:

The undersigned organizations write to provide revisions for the Expert Panel's consideration for responses to Charge Questions One and Two found in the "Draft Final Expert Panel Recommendations Report_v2". Substantive edits have been provided in blue, while edits for clarity and consistency have been provided in green.

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4. Responses to Charge Questions

This section includes the responses of the Expert Panel to the questions posed by the Water Board. Drafts of the questions were written and revised by teams of two Panel members. Revisions were based on discussions of the Panel at public meetings and comments submitted by individual Panel members. Unless otherwise stated, the recommendations reflect the opinion of the entire Expert Panel. The questions are included in the responses. They can also be found in Appendix B.

Targets vs. Limits

Several charge questions refer to limits. The following definitions were provided by Karen Mogus, Chief Deputy Director, State Water Resources Control Board ("State Water Board") at the Expert Panel meeting on 10/31/2025: A "target" is a non-enforceable standard, that is subject to limited follow-up such as requiring additional education or increased monitoring and reporting.

A "limit" is an enforceable standard that is subject to progressive enforcement actions, beginning with informal enforcement actions like oral or written contact by Water Board staff and potentially escalating to an issuance of a Notice of Violation (NOV). Formal enforcement actions are statute-based actions to address a violation or threatened violation of water quality laws, regulations, policies, plans, or orders, and include Notices to Comply, Technical/Monitoring Report Orders, Cleanup and Abatement Orders (CAOs), Time Schedule orders under Section 13300 or 13303, Cease and Desist Orders (CDOs), the modification or rescission of a permit, and the imposition of Administrative Civil Liability (ACL). ~~such as issuing a cease and desist order (CDO), establishing a time schedule order (TSO) for compliance, and imposing administrative civil liability (ACL).~~

4.1. Response to Question 1

Lead Authors

Richard Smith and Hannah Waterhouse

Question

Is there enough data and scientific research to set crop-specific nitrogen-related limits (e.g., A/R, A-R, or other limits) that are protective of groundwater quality and support a long-term sustainable Irrigated Lands Regulatory Program? What metrics and methodology would be used for developing those limits and what would the limits be? What additional data should be collected and/or what additional research needs to be conducted to further support the development of nitrogen-related limits that are protective of groundwater quality and support a long-term sustainable Irrigated Lands Regulatory Program?

Background, Terminology and Concepts

- ~~Question 1 referred to the development of limits, but in this response, we will also utilize the concept of targets.~~ The panel understands that ~~policymakers in the regulatory arena~~ regulators may ~~either~~ choose enforceable limits as a "stick" and/or develop compliance pathways that rely on "targets" as a "carrot" in lieu of, or in combination with, enforcement limits. Limits ~~can provide~~ are an effective regulatory ~~clout~~ tool, either on their own or in combination with other regulatory tools, because they carry the threat of penalties in cases of non-compliance. For example, The European Union and regions of New Zealand reduced nitrogen discharges by 33% and 32% percent respectively after establishing limits.[1] ~~But the panel also heard testimony about examples of the effective use of targets in helping the agricultural industry make improvements in reducing N loading despite the lack of penalties. Targets used in conjunction with educational efforts can play an important role in the regulatory framework. The panel further understands that in the future, when greater information or improved practices exist,~~ With the information we have today, the panel understands that limits, which are protective of safe drinking water standards and groundwater quality, can be established and implemented. These limits may need to undergo ~~But even regulations with limits, as in Ag Order 4.0, may explicitly stipulate~~ review and be ~~assessment of limits and interim targets and allow them to be~~ adjusted ~~as needed~~ based on progress over time towards reducing N leaching to groundwater.

- The panel ~~also~~ recognizes that there is enough data to set initial limits on the upper range (e.g., ~~80th~~ 75th percentile) of currently applied N loading (~~or other metrics such as current A/R or~~ ie. A-R), ~~may be appropriate to consider in the regulatory framework~~. ~~Targets/limits~~ The approach to setting limits may need to be adjusted based ~~addressed~~ on ~~a local/~~regional differences ~~basis~~. The diversity of agricultural production systems in the state makes it ~~impossible~~ difficult to impose a one-size-fits-all approach to the regulatory process. For instance, few removal coefficients are available for plants grown in container nurseries and many niche specialty crops. In addition, multi-year production of potted plants complicates yearly development and evaluation of A-R values. These types of complications need a thorough evaluation to determine the appropriate regulatory avenues which may include the enforcement of recommended practices that are recognized for reducing nitrate leaching in these production systems.
- However, these limitations should not preclude action being taken on systems where specific metrics can be applied, like for annual cropping systems in the Central Valley (Region 5) and seasonal vegetable cropping systems in the Central Coast (Region 3). Other areas may have little risk of groundwater contamination of nitrate due to impermeable clay layers, or high-water tables that are tile drained, but would still benefit from reporting A, R and ~~or~~ discharge of N to understand impacts of N management on surface water. Another example

[1] Daniel Rath, Ph.D. *Literature Review of Questions Assigned to the Expert Advisory Panel 2025*, p. 10-11.

involves the applicability of N discharge targets in areas where agricultural activities do not pose a risk to drinking water quality.

- There is sufficient scientific literature and monitoring data to support the development of crop-specific, nitrogen-related limits that are protective of groundwater, particularly when using adaptive approaches. Methods would rely on field-scale nitrogen mass balance metrics (A-R), combined with crop uptake coefficients, and groundwater vulnerability assessments, with progressively more stringent limits for exceedances or high-risk conditions (see below). Long-term sustainability would require expanded monitoring of nitrate in shallow groundwater, improved tracking of fertilizer and irrigation practices at the field level, and adaptive limits.
- ~~The panel agreed that implementation of diverse metrics such as those used in Regions 3 and 5 are appropriate. and should be left to the discretion of the Regional Boards to decide.~~
- The panel recognizes that despite regional differences in agricultural production systems across the state, some consistency in management and reporting obligations and regulatory requirements is necessary to track statewide progress in reducing N loading and continue improving the ILRP.

Response and Recommendations

Question 1a: Is there enough data and scientific research to set crop-specific nitrogen-related limits (e.g., A/R, A-R, or other limits) that are protective of groundwater quality and support a long-term sustainable Irrigated Lands Regulatory Program?

In some regions sufficient data and analytical tools are available to set long term crop-specific ~~targets~~ limits for nitrate discharge from agricultural land that is protective of water quality. Other regions may need more time to collect and analyze data to assess ground water risks from nitrate; however, this should not preclude these regions from collecting data on applied N and implementing ~~targets~~ limits.

1. ~~Targets and~~ Limits ~~may~~ refer to the A-R metric (lbs N/acre/year)~~, the A/R metric (unitless), or the A metric (lbs N/acre/year)~~ and may be applied to a specific crop, a specific multi-cropping system, or to a specific land area. ~~These reporting criteria should be left at the discretion of the Regional Water Quality Control Boards.~~ For cropping systems where only one crop is produced per year, crop-specific ~~targets/~~limits are reasonable. In cropping systems with more than one crop per season the ~~target/~~limit would need to be applied by accounting for N applied and N removed of all crops grown on the land during the year. It is recommended that ~~any of these metrics~~ A-R, for regulatory purposes, be used

only on appropriate rolling three-year (crop, multi-cropping system, or land-based) averages to account for various disruptions and issues that occur in agricultural production systems (See Additional Considerations 1).

2. The operational benchmark defined in the 2012 UC Davis Nitrate Report (Harter et al., 2012) could be used as is the lower target final limit that must be met to protect groundwater from nitrate contamination. The operational benchmark acts as a reference point above which N leaching to groundwater has the potential to cause exceedances of the Maximum Contaminant Level (MCL) of 10.0 ppm nitrate-N (See Additional Considerations 2). For the Central Valley, the UC Davis Nitrate Report determined that N discharge more than 31 lb N/acre/year would have the potential of causing or contributing to exceedances of the to exceed the MCL of nitrate. Accounting for additional recharge due to rainfall, the Central Coast Water Board determined that this benchmark would be 50 lb N/acre/year on the Central Coast. This These loading levels of loading used here are the ultimate benchmark for agricultural operations to safeguard groundwater quality.
3. There is ample evidence of exceedances of drinking water standards for nitrate in groundwater in some regions of the state. Nitrate monitoring of wells in Regions 3 and 5 show has determined that a significant number of wells exceed the drinking water MCL for nitrate-N of 10 ppm and many more approach MCL levels. Nitrate levels vary in time and space, thus wells where nitrate levels approach the MCL must be frequently monitored. Additional report data show increases in nitrate concentrations for wells that were already exceeding the safe drinking water threshold for nitrate. In other regions nitrate contamination may not yet be a concern for their groundwater aquifers, but is a concern for surface water quality. this is not the case. However, nitrate contamination of surface water and other contaminants may be of concern, and should be taken into consideration.
4. Each region should have a process to collect applied N data and collect and/or develop removed N data in space and time. This data can be used to assess levels of N loading in their area (See Additional Considerations 3).
5. We agree there is a point at which N applications may beare excessive. For instance, growers in the currently highest 80th or 90th 75th percentile of either the “A-R”, “A/R”, “A” or equivalent (e.g., CV-SWAT derived) metrics may should be subject to initial limits that will be scaled down over time. This group of growers consistently apply applies more N than 80 to 90 75 percent of the agricultural industry to of which they are a part in their region. With limits set at the 75th percentile, Tthese growers have a specific number to achieve and can seek assistance from technical advisors and extension agents on how best to achieve these numeric reductions that have been shown to work for other growers, including may need technical assistance to implementing best

management practices (BMPs) such as testing for residual soil nitrates and adjusting fertilizer rates accordingly, use of efficient irrigation practices, and utilization of crop fertilization guidelines provided by the CDFA FREP program.

6. ~~In addition, targets may~~ Additional interim limits for below the 75th percentile should be set to reduce nitrate discharge to levels closer to the operational benchmark that protects groundwater quality. ~~The targets need to be set based on levels that~~ Interim limits below the 75th percentile of growers are achievable by the industry, as seen in A-R distributions in Region 3 and will lead to improved water quality. However, compliance with these limits need not be achieved immediately. ~~Focused research can also be used to help determine the agronomic feasibility of proposed targets. An iterative 3–5-year process can determine if the industry, making a concerted effort to utilize BMPs, can meet the targets.~~ The Regional Water Quality Control Boards ("Regional Water Boards") should establish time schedules detailing when growers must comply with these interim limits beyond the 75th percentile. ~~After 3-5 years the process~~ These time schedules can be evaluated every 5 years to determine ~~why or why not growers were able to meet the target~~ if they need to be adjusted. ~~The evaluation process should consider environmental, socioeconomic (land tenure, market requirements), and agronomic considerations of achieving the target. The target discharge levels should be further reduced in a reasonable fashion over time in a 3–5-year cycle as the industry innovates to become more efficient in managing N~~
7. The ultimate requirement ~~goal~~ for the agricultural industry is to achieve nitrate loading that ~~is protective of water quality and as close as agronomically feasible to~~ meets the operational benchmarks identified in #2 above. ~~Through this iterative evaluation process the regional boards will determine whether the industry can ultimately achieve the operational benchmark level.~~ This approach of developing a time schedule is exemplified by the system ~~of targets/limits~~ laid out in Ag Order 4.0 by the Central Coast Regional Water Board. ~~This system is intended to be reviewed as appropriate as the process in Region 5 where targets are intended to be updated every five years.~~
8. ~~In some regions, soil-crop, vadose zone, and hydrogeological models can be used to estimate the factors that affect nitrate leaching to groundwater, including natural recharge from clean water, aquifer geology, denitrification processes, and mix of crop types at a landscape scale on current and future nitrate risk to groundwater. The models can be applied to different size areas – from farm to watershed scale. Some level of field validation should also be conducted to assure that the employed simulation models provide accurate estimates of nitrate loading to groundwater.~~
9. Transparency, including for a progressive enforcement policy, needs to be considered and effectively communicated to affected parties (See Additional

Considerations 4).~~ Anonymized, d~~ Data transparency ~~could help~~, as seen in the Central Coast where farm level data is publicly available, is critical to ensure accountability. We recommend that all regions ensure that farm level data, including acreage, is publicly available to ensure data transparency~~, as has been done on the Central Coast where farm level data is one step removed, however each region should develop their own data privacy and transparency models~~.

Question 1b. What metrics and methodology would be used for developing those limits and what would the limits be?

The expert panel concludes that the best approach to setting limits/targets would be the use of Applied (A) minus removed (R) N ~~any reasonable methodology (~~mass balances ~~or more complex simulation models)~~ for estimating potential nitrate discharge to groundwater. The A-R ~~Applied (A) minus removed (R) N data~~ difference value provides quantifiable data on nitrate discharge and potential nitrate leaching losses. ~~h~~Hydrogeological information and/or soil-water transport models can ~~be used to~~ also evaluate potential and future impacts of nitrate discharge from agriculture on groundwater nitrate concentration while accounting for other processes such as denitrification, aquifer recharge, and in-well (and aquifer) mixing of water from various sources prior to extraction and use as drinking water. However, the complexity of these models reduces transparency for affected parties, including growers.

10. Regions 3 and 5 have collected data on applied N and harvest yields through their yearly INMP and applied N reports. In addition, crop removal coefficients (conversion factors to obtain removed N from yield data) have been developed for most ~~of the~~ major California commodities, although they are lacking for many small-acreage or niche crops. Hence, the difference between applied N (from various sources) and removed N (from harvest) can be reasonably calculated for most commodities and assessed by growers and regulators in these regions.
11. Acreage data is necessary to assess the impact of nitrogen discharges from any given operation on water quality. For example, an A-R balance of 150 lbs. per acre over five acres has vastly different implications for nitrogen pollution reduction than 150 lbs. per acre over 200 acres: the first situation has a surplus application totaling 750 lbs. of nitrogen, while the second has a surplus of 30,000 lbs. Although growers in Region 5 submit acreage data to the Coalitions, this data isn't publicly available. Access to acreage data, like that provided in Region 3, will help the Regional Water Boards understand how much nitrogen discharges will be reduced by setting limits on various percentiles of growers. We recommend that acreage data for all regions is made publicly available.
12. Using the above-mentioned data, regulators and water quality coalitions can assess A-R data ~~, A/R, and applied N data~~ and identify outliers based on ~~80 to 90th~~ the 75th percentile~~s~~ of ~~any one of these metrics~~ the A-R metric. This is a

first step in regulatory action that can address the growers that are farthest from the operational benchmark ~~desired water quality goals~~. In regions where methodologies for calculating N removed have ~~has~~ not been developed growers should report total applied N.

13. As A and R data may be used to inform ~~targets and~~ limits, it is important that growers also document how their reported A and R values were determined through ~~(~~fertilizer records, fertilizer sales receipts, product sale records, etc~~)~~ so that the quality of the data can be evaluated by third party coalitions and regional water ~~quality control~~ boards.
14. Region 5 is currently using the model CV-SWAT to determine nitrate leaching from the root zone based on grower's reported A and R, and the CV-NPSAT framework to assess impacts of N discharge on groundwater nitrate concentrations at a township scale. Through this process Region 5 estimates as best as possible N discharge to groundwater, then Coalitions go back to their members with the INMP summary report to work on improvements. ~~This use of computer modeling is very appropriate and may be chosen as an approach by other regions, but~~ Because the CV-SWAT and CV-NPSAT modeling, inputs and outputs (known as groundwater protection formulas, values, and targets) are simultaneously undergoing peer review as the instant recommendations are being developed, we cannot endorse the use of these models as a method for developing enforceable limits at this time.~~it is recognized~~ The Panel also recognizes that this approach may not be appropriate for all regions.
15. Region 3, Ag Order 4.0 laid out a schedule of targets and limits specifically for various alternative "A-R" related metrics. This approach builds incentives into their A-R formula that directly reward desirable growers' performance. This approach is also an appropriate model for reducing nitrate loading in an effective and reasonable manner (Answer 1a. bullet 6). The ultimate goal in the approaches taken by both regions is to protect water quality and~~, if possible,~~ achieve the operational benchmark.
16. In addition to interim and final limits, ~~Fee~~ fee structures for participation in the IRLP process can be devised to reward growers who ~~that~~ achieve good water quality requirements ~~goals~~ or make progress toward meeting the operational benchmark (See Additional Considerations 5). Best management practices should be incentivized to encourage their widespread adoption (See Additional Considerations 6).
17. Funding for increased research on new and useful best management practices (BMPs) as well as technical assistance and education to help growers adopt BMPs will be needed to reach compliance with whatever ~~targets~~ limits are set.

1c. What additional data should be collected and/or what additional research needs to be conducted to further support the development of nitrogen-related limits that are protective of groundwater quality and support a long-term sustainable Irrigated Lands Regulatory Program?

Development of R values for all commodities ~~needs to continue to be~~ must remain a priority. The expert panel agrees that ~~targets~~ limits for A-R ~~(or other nitrate discharge equivalent metrics)~~ can be determined and implemented ~~made~~ now and provides a roadmap for reducing nitrate discharges in regions where groundwater exceeds the MCL for nitrate or is at risk for nitrate contamination. Given the complexities of characterizing removal from agricultural systems such as container nurseries, small diverse growing operations, and substrate produced crops, research is needed to characterize how to evaluate the risk of nitrate leaching posed by these systems. All forms of research on improving N use efficiency in crop production is needed to help move agricultural production in all regions closer to the operational benchmark for nitrate discharge.

18. A thorough evaluation of the unique cropping systems of each region of the state needs to be conducted to evaluate to what extent they pose a N leaching risk.
19. An effort should be undertaken to develop N removed data for crops that do not have existing data. Ultimately, each crop system should move towards developing the means to estimate A-R data. In the interim, values for similar crops can be used in lieu of a specific coefficient. For some commodities (e.g. cut flowers with a large number of varieties and types), removal coefficients of representative commodities may be used in lieu of specific coefficients. Establishment of removal coefficients may include research trials in addition to literature reviews from regions with similar soils and climates. Evaluation of practice based enforcement for container nurseries should be explored and evaluated.
20. Funding for research from State Agencies such as CDFA should be solicited to fund continued development and demonstration of best management practices, development of agronomic practices, and technology that can help growers reduce nitrate loading in agricultural regions that have the greatest risk of causing nitrate contamination of underlying groundwater. Areas of research include continued evaluations of cover crops and other end-of-growing season practices that reduce the load of residual soil nitrate during winter fallow (e.g. high carbon amendments), and expanding/optimizing the role of rotational cash crops in utilizing residual soil nitrate (scavenging cash crops) and thereby reducing nitrate leaching, improved irrigation efficiency technologies that reduce the risk of deep percolation of water during the growing season, evaluating N fertilizer technologies that improve N use efficiency, stimulation of microbial N

fixing in plants, breeding efforts to improve N use efficiency of crops, characterizing levels of nitrate leaching in organic production systems, levels of leaching in small scale and diversified production systems, denitrification rates across different climate, soils, management systems, high carbon amendments, etc.

21. Specific cropping systems that need research include: nursery systems (many regions), diverse orchard/nursery operations (Regions 8 and 9), small diversified organic or conventional operations (many regions), cut flower operations, etc. Research needs to include evaluating which crops/operations pose a risk of nitrate leaching and if there is a need for them to be subject to ILRP regulations. In container nursery operations, there is a need to evaluate the amount of N removed in container stock and how to evaluate sites with non-permeable surfaces. Research to determine average values and ranges for N applied in diversified systems such as mixed vegetable production could provide an alternate method of identifying outliers in systems where calculating N removed is difficult.
22. Identify and designate nitrate vulnerability zones as seen in the case of the EU nitrate directive and in the CV-SALTS program and evaluate the feasibility of implementing ~~look at implementation of~~ buffer zones.
23. Frequent (seasonal) monitoring of well nitrate levels and well depths in all regions of interest.
24. Research into effective verification and auditing processes should be conducted to ensure reductions in A-R are validated and enduring.
25. Research to ~~support the use~~ verify the groundwater protection formulas, values, and targets developed using the ~~of~~ CV-SWAT and CV-NPSAT models in the Central Valley Region. ~~(or similar soil-crop models) and groundwater models elsewhere (outside of the Central Valley).~~
26. Research on whether risk of N leaching is lower in regenerative and organic farming systems.
27. Research into the socioeconomic (e.g. land tenure) and market driven factors that allow operations to meet the operational benchmark currently. Given farmers are operating in a large socio-ecological system, other actors (e.g. wholesale buyers) could be considered when creating a regulatory program that supports limits “that are protective of groundwater quality and support a long-term sustainable Irrigated Lands Regulatory Program.”

Additional Considerations

1. Rolling three-year averages
    - In the development of three-year averages, removed N is calculated by multiplying yield by ~~with~~ a removal coefficient. While coefficients for many

crops are based on recent data from California and can be considered representative, they can vary considerably from one field to another. Therefore, the A-R values calculated for individual fields are estimates and not exact values. All of the fields need to be included with limited a minimum number of exceptions when calculating rolling three-year averages. The approach currently used by some Central Valley coalitions to calculate three-year averages for the identification of outliers does not meet this criterion: Only fields where the same crop has been grown for three consecutive years by the same grower are included in the calculation. Fields with a rotation of annual crops and fields that were managed by different growers during the three-year period are excluded. This approach would not be appropriate to calculate three-year average A-R values that are subsequently compared to limits targets.

2. How groundwater recharge rates correspond with limits Does the committee have sufficient information to set specific limits/targets?
    - The panel was not presented with (and is not aware of) has sufficient research and data that suggests there currently exists a metric relevant to groundwater quality goals for which region-, sub-region (area), or crop-specific limits can be set "that are protective of groundwater quality and support a long-term sustainable Irrigated Lands Regulatory Program". A sustainable Irrigated Lands Regulatory Program requires that metrics are established to ensure a high likelihood of compliance with water quality objectives. The Panel recognizes that limits are needed in order to achieve a sustainable Irrigated Lands Regulatory Program. The following points provide a rationale for this finding further detail on how final limits may be established:
    - Where the source area of a well is exclusively irrigated agricultural land, and assuming groundwater recharge is 1 ac·ft/ac per year, the loss of 27 lb N/ac per year of nitrate-N in that 1 ac·ft of recharge is exactly equal to the MCL (10 mg nitrate-N per liter). In practice, the value used in the Central Valley is 31 lb N/acre/year (based on levels of recharge and denitrification) and on the Central Coast 50 lb N/acre/year (based on greater levels of groundwater recharge).
    - In the absence of denitrification, the proper "limit" limit for nitrate-N discharge from the root-zone that is protective of groundwater quality (i.e., assures that the drinking water in the well meets the MCL) is 27 lb/ac/year with a groundwater recharge of 1 ac·ft/ac per year, averaged over a 3-year moving average period and averaged over the source area of that well.
    - In areas with less recharge, the source area is proportionally larger and the nitrate-N loss that leads to MCL exceedance in recharge is

proportionally smaller, e.g., for 6 inches of recharge, the MCL is reached with 14 lb N/acre/year in nitrate-N losses. The proper ~~"limit"~~ limit would be even smaller.

- To the degree that well source areas are not entirely in irrigated land production and especially if ~~some parts of~~ the source area contains a nearby stream, significant dilution of the nitrate signal from the irrigated lands within the source area will occur, allowing for a higher limit than 27 lb N/acre/year to be protective of groundwater quality.
- To the degree that denitrification occurs between the source area and the well, a limit that is higher than 27 lb N/acre/year will be protective of groundwater quality.
- Hence, the ~~theoretically~~ appropriate limits for nitrate-N discharge to protect groundwater quality~~, without considering supporting a long-term sustainable IRLP,~~ are on the order of a few tens of lb/acre/year, absent~~without~~ significant denitrification and stream water recharge.
- The panel understands that the State Water Board is charged with consideration of economic impacts associated with setting regulatory limits. As the panel lacks economic expertise, no attempt to weigh economic impacts has been made here. Nor does the panel have expertise in the public health costs of not meeting regulatory limits of nitrate contamination.
- ~~For many crops (not all) such a limit would be difficult and costly to achieve, based on the testimony heard by the panel.~~
- ~~Limits "that are protective of groundwater quality and support a long-term sustainable Irrigated Lands Regulatory Program" require that the need for groundwater protection is balanced with the economic cost to landowners/operators for the proper nutrient management. The Expert Panel was not presented with sufficient evidence to consider economic cost to implement specific practices, let alone specific practices that may successfully protect groundwater quality in the above rigorous manner~~
- ~~The Expert Panel therefore considers only targets, not limits, that are useful to move toward lower nitrate discharge into groundwater. However, limits could be considered for those farmers in the 80th to 90th percentile of A (or A/R, A-R, or other appropriate metrics).~~

3. The spatial scale at which limits/targets are best applied
    - The primary responsible party is the landowner, or where farmed land is leased, and ~~/~~operator. Current ILRP programs define both the landowner and the operator as "dischargers" subject to permit requirements. (Ag Order 1.0 at p. 7; ESJ WDRs at p. 1.)

- The source area of wells impacted by nitrate in irrigated areas of the Central Coast is typically on the order of 1-2 acres per gpm (gallons per minute) pumped, where the pump rate represents the annual average (e.g., a well that pumps 1,000 gpm for six months but nothing otherwise has a nominal annual average pumping rate of 500 gpm). For domestic wells (average pumping rate: 1gpm), the source area will be small (1-2 acres), for wells pumping 300 – 500 gpm (annual average), the source area will encompass 300 - 1000 acres. The presence of losing streams in the source area of a well may significantly reduce the size of the source area, with the stream being a major source ~~then~~ of the well water.
- Travel time to the well will vary – less for water recharged in the proximal part of the source area, more for water recharged in the distal part of the source area. Based on Visser et al.(Report to CC RWB, 2020), the average travel time in most wells subject to nitrate pollution is less than 40 years.
- Nitrate loading from across the source area will be mixed in the extraction well: Within each well, water of younger and older ages is mixing, typically ranging from less than half of the mean age to more than twice the mean age measured in a well (e.g., Henri and Harter, 2019).
- ~~Given the above information, it is reasonable to set the minimum area over which the nitrate discharge relevant information is evaluated for purposes of evaluating target compliance is at least 10 acres (quarter-quarter-quarter section, for domestic wells) but can be larger. This is relevant especially to small, diversified farms. From a hydrogeological (well) perspective, a full understanding of the total N fluxes at the 10-acre scale (over the course of the moving three-year window) is sufficient to assess the risk for groundwater contamination. It does not have to be assessed at each 1 acre or smaller parcel.~~
- ~~The maximum area over which metrics are developed for compliance with targets can reasonably be several square miles to sub-regional, e.g., the township (approximately 36 square miles) in the Central Valley ILRP, if there are sufficient provisions that a target will protect most wells in that subregion or township.~~

4. ~~Anonymization~~ Data Transparency
    - ~~For purposes of achieving water quality goals, some anonymization and data privacy is reasonable. For example, the APN and field and crop level A and R related data together with the township summary, where the latter includes the crop-specific acreages, provides sufficient information to~~ Data transparency must be prioritized for each region. Although the Panel has enough information to understand that the Regional Water Boards can set

limits on nitrogen discharges, there are many data gaps which limit the ability to assess individual grower performance and growers' progress complying with limits ~~improvements and overall range of N budgets by crops and townships~~. For example, individual growers' acreage and soil type data for the Central Valley isn't publicly available. Individual growers' soil type data will allow the Water Boards to better understand nitrogen leaching rates, volatilization rates, and the implementation of management practices. Individual acreage data allows for the Regional and State Water Boards and affected parties to understand nitrogen (N) discharges associated with growers and individual fields, an overview of the number of acres meeting discharge targets within each coalition, and the yearly variability of acres meeting discharge targets. The Panel recommends that the State Water Board require that each region makes this data publicly available. In addition, frequent (seasonal) monitoring of well nitrate concentrations and well depth will help to understand the progress. Currently, most wells are monitored very infrequently (on the order of once per decade).

- ~~Each region can develop their own data privacy and transparency framework so long as the amount of N loading for a region can be calculated by the regulating body and affected stakeholders~~.

5. Fee adjustment incentives
    - Currently, the fees paid by growers to their coalition are based on ~~the~~ acreage. Acreage-based fees should remain and ~~The fees~~ could be adjusted to reflect A-R values: Growers with low A-R values would pay less per acre while growers with A-R values that ~~are above~~ exceed the operational benchmark and that are high compared to the A-R values of other growers who grow the same crop in the region would pay a higher fee per acre. Such a fee structure would reward growers who already achieve low A-R values, while it would provide a financial incentive for growers with high A-R values to improve N management in their crops.
6. Incentivization of practices to improve water quality
    - Small-scale diversified farms using crop rotation with multiple crops may have overlapping crops from one calendar year to the next but can also implement practices to increase N removal such as winter cover cropping in plots being fallowed, crop rotations, and riparian buffer plantings. Incentives could focus on reducing N applied and/or increasing N removal.
    - In Region 3, where cool season vegetables are produced 2-3 times per season, achieving an A-R metric near the target that protects groundwater from nitrate (~50 N/acre/year) is more difficult given current technology and production practices. ~~Development of interim targets in this region~~

needs to be carefully thought through to balance the economic and environmental realities. Practices such as judicious use of soil nitrate testing during the cropping season to guide fertilizer applications, accounting for nitrate-N in irrigation water to reduce fertilizer applications accordingly and efficiently irrigating to reduce nitrate leaching during the growing season will help reduce N applications on the A side of the A-R metric. Use of practices such as cover crops and high carbon amendments should be incentivized to reduce N losses during the winter.

4.2. Response to Question 2

Lead Authors: Hannah Waterhouse and Richard Smith

Question

Based on the data and scientific research that is currently available, what series of increasingly protective interim nitrogen-related limits can be set now to ensure that all growers make progress towards nitrogen-related limits that are protective of groundwater quality and support a long-term sustainable Irrigated Lands Regulatory Program?

Response and Recommendations

The expert panel concludes that the data and scientific research that is currently available supports the conclusion agrees that targets increasingly protective interim nitrogen-related limits can be set now utilizing for A-R (or other nitrate discharge equivalent metrics) can be made now and provides a roadmap time schedule for reducing in order to reduce nitrate discharges in regions where groundwater exceeds the MCL for Nitrate or is at risk for nitrate contamination. The interim targets limits do not necessarily need to achieve the 10 ppm Nitrate-N MCL in the short term, but should achieve safe drinking water levels in the long term. However, an iterative process that ratchets down water quality targets In other words, interim limits can be developed in order to bring discharges closer to the operational water quality objective in a steady and measured way that is environmentally beneficial and agronomically feasible would be the desired path forward.

1. A-R data or A data collected by regulators or water quality coalitions in each region provides the baseline data from which achievable targets interim limits and firm upper limits that can be established. The development of targets interim limits for growers below the 75th percentile may be assisted by specific research projects that verify that established targets are agronomically feasible analyzing crop specific A-R distributions in the region.

2. ~~Targets~~ Limits within a region may need to vary by crop types and cropping systems (vegetable cropping systems, agronomic crops, tree crops, vineyards, berry production)
3. Initially, limits ~~may be considered~~ should be developed to address operations that exceed the ~~highest 80 – 90th~~ 75th percentile of A-R, at a minimum ~~a selected metric (A-R, A/R, A, or others)~~. ~~Targets~~ Additional interim limits ~~can~~ should be utilized to bring the industry closer to the operational benchmark over time. (See answer 1a, bullet 6).
4. The State Water Board or the Regional Water Boards may develop time schedules that require growers to meet interim limits.
5. An ongoing and extensive education effort should be conducted to help growers utilize best management practices (BMPs) to comply with interim limits ~~in ratcheting down the values of the selected metric~~. Incentives can be offered by the Regional Boards/Coalitions and consequences can result from continued exceedances (See 6). Educational outreach to work with growers on BMP to improve N use efficiency should be made a priority to assist growers in making rapid progress to improving water quality.
6. Research should be incentivized that develops new technology for improving N use efficiency by crops, developing technologies and practices that increase N removal, and can contribute to reducing A-R values in challenging cropping systems. New technologies may include: N fertilizer technologies (controlled release fertilizers and nitrification inhibitors), technologies to increase immobilization during the winter fallow, more N efficient crop varieties, etc.
7. In regions where growers generally produce one crop per year and/or permanent crops (e.g. Region 5), it may be easier to achieve A-R values close to the operational benchmark compared to regions where multiple crops are grown per field per season. If growers can verify that they are achieving discharge values close to protective water quality targets, incentives should be developed that help these growers continue progress in reducing their A-R levels. Growers that can consistently achieve A-R values less than protective water quality limits either through the crop types that they grow (alfalfa) or practices implemented should receive some relief from regulatory reporting (eg. Financial incentives See appendix 5)
8. ~~Educational outreach to work with growers on BMP to improve N use efficiency should be made a priority to assist growers in making rapid progress to improving water quality.~~

* * * * *

Thank you for your consideration of these proposed revisions and we look forward to providing additional feedback to the Expert Panel's Final Draft Report.

Sincerely,

Kjia Rivers
Senior Policy Advocate
Community Water Center

Corinne Gibson
Staff Attorney
Leadership Counsel for Justice and Accountability

Jake Dialesandro
Lecturer Santa Clara University Department of Environmental Studies and Science
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San Jerardo Cooperative

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Senior Policy Analyst
Natural Resources Defense Council

Bianca Lopez

Co-Found/Project Director
Valley Improvement Projects

Attachment E - MLJ Environmental, Formation Environmental, Groundwater Protection Values for Crop Years 2020, 2021, and 2022 (2025)

Buena Vista Coalition
Cawelo Water District Coalition
East San Joaquin Water Quality Coalition
Grassland Drainage Area Coalition
Kaweah Basin Water Quality Association
Kern River Watershed Coalition Authority
Kings River Watershed Coalition Authority
Sacramento Valley Water Quality Coalition
San Joaquin County & Delta Water Quality Coalition
Tule Basin Water Quality Coalition
Westlands Water Quality Coalition
Westside San Joaquin River Watershed Coalition
Westside Water Quality Coalition

December 15, 2022

Via Email Only

Patrick Pulupa, Executive Officer
California Regional Water Quality Control Board
Central Valley Region
11020 Sun Center Drive, Suite #200 Rancho
Cordova, CA 95670
Patrick.Pulupa@waterboards.ca.gov

Dear Patrick:

The thirteen above listed irrigated agricultural coalitions hereby jointly submit Revised Groundwater Protection Targets (GWP Targets) as an update to the originally submitted GWP Targets that were timely submitted on July 19, 2022. The GWP Targets were updated based on comments received from Central Valley Regional Water Quality Control Board (Central Valley Water Board) staff and members of the public including Environmental Justice advocates.

We look forward to working with you and your staff during the additional public review and comment period associated with this submittal. For ease in coordination purposes, please contact Tess Dunham at (916) 718-5774, or tdunham@kscsacramento.com if you or your staff have questions regarding this submittal. Ms. Dunham will be sure to direct the question to the appropriate Coalition team member or consultant.

The authorized individuals identified below make the following certification statement in conjunction with this submittal:

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with the system designed to assure that qualified personal or represented Members properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant *penalties for knowingly submitting false information, including the possibility of fine and imprisonment for violations.*

Sincerely,

Tim Ashlock, PE
Buena Vista Coalition

David Halopoff, ILRP Coordinator
Cawelo Water District Coalition

Parry Klassen, Executive Director
East San Joaquin Water Quality Coalition

Joseph McGahan, Coordinator
Grassland Drainage Area Coalition

Donald Ikemiya, Executive Director
Kaweah Basin Water Quality Association

Nicole Bell, Manager
Kern River Watershed Coalition Authority

Debra Dunn, Coordinator
Kings River Watershed Coalition Authority

David Guy, President
Northern California Water Association for
Sacramento Valley Water Quality Coalition

Michael Wackman, Executive Director
San Joaquin County & Delta Water Quality Coalition

David DeGroot, Technical Lead
Tule Basin Water Quality Coalition

Russ Freeman, PE
Westlands Water Quality Coalition

Joseph McGahan, Coordinator
Westside San Joaquin River Watershed Coalition

Mark Gilkey, Executive Director
Westside Water Quality Coalition

cc: Irrigated Lands Regulatory Program, irrlands@waterboards.ca.gov
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Groundwater Protection Targets

Prepared for:

Buena Vista Coalition
Cawelo Water District Coalition
East San Joaquin Water Quality Coalition
Grassland Drainage Area Coalition
Kaweah Basin Water Quality Association
Kern River Watershed Coalition Authority
Kings River Watershed Coalition Authority
Sacramento Valley Water Quality Coalition
San Joaquin County and Delta Water Quality Coalition
Tule Basin Water Quality Coalition
Westlands Water Quality Coalition
Westside San Joaquin River Watershed Coalition
Westside Water Quality Coalition

Prepared by:
Formation Environmental, LLC

FORMATION
ENVIRONMENTAL

JULY 19, 2022
Revised December 15, 2022

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Figures

LIST OF ABBREVIATIONS

A-R	Nitrogen Applied Minus Nitrogen Removed or Sequestered
C2VSimFG	Fine Grid California Central Valley Groundwater-Surface Water Simulation Model
CalEPA	California Environmental Protection Agency
CDP	Census Designated Place
CVDRMP	Central Valley Dairy Representative Monitoring Program
CVGMC	Central Valley Groundwater Monitoring Collaborative
CV-SALTS	Central Valley Salinity Alternatives for Long-term Sustainability
CV-SWAT	Central Valley Soil and Water Assessment Tool
DAC	Disadvantaged Community
GAR	Groundwater Assessment Report
GNLM-CV	Groundwater Nitrate Loading Model for the Central Valley
GQMP	Groundwater Quality Management Plan
GSP	Groundwater Sustainability Plan
GWP	Groundwater Protection
HVA	High Vulnerability Area
INMP	Irrigation and Nitrogen Management Plan
lb/ac or lbs/ac	Pounds per Acre
LTILRP	Long-term Irrigated Lands Regulatory Program
mg	milligrams
mg/L	milligrams per liter
MHI	Median Household Income
MPEP	Management Practices Evaluation Program
N	Nitrogen
NMP	Nitrogen Management Plan
CV-NPSAT	Non-Point Source Assessment Tool
NRCS	National Resources Conservation Services

NRE	Nitrogen Removal Efficiency
SGMA	Sustainable Groundwater Management Act
TDS	Total Dissolved Solids
UC	University of California
USGS	United States Geological Survey

EXECUTIVE SUMMARY

Waste Discharge Requirement General Orders that apply to members of third-party groups (often referred to as the Long-term Irrigated Lands Regulatory Program, or LTILRP) require third-parties (referred to as Coalitions) on behalf of their members to submit Groundwater Protection (GWP) Formula, Values and Targets for high-priority townships to the Executive Officer of the Central Valley Regional Water Quality Control Board (Central Valley Water Board). The Coalitions subject to the GWP Formula, Values and Targets requirements include the following:

- Buena Vista Coalition
- Cawelo Water District Coalition
- East San Joaquin Water Quality Coalition
- Grassland Drainage Area Coalition
- Kaweah Basin Water Quality Association
- Kern River Watershed Coalition Authority
- Kings River Watershed Coalition Authority
- Sacramento Valley Water Quality Coalition
- San Joaquin County and Delta Water Quality Coalition
- Tule Basin Water Quality Coalition
- Westlands Water Quality Coalition
- Westside San Joaquin River Watershed Coalition
- Westside Water Quality Coalition

The thirteen Coalitions subject to these requirements have worked collectively and developed a single GWP Formula to generate GWP Values for all high-priority townships (i.e., GWP Townships), and submitted a GWP Values Report to the Central Valley Water Board on July 19, 2021. An addendum to the July 19, 2021, GWP Values Report was then submitted on December 14, 2021, to include additional Sacramento Valley Townships (collectively hereafter referred to as the GWP Values Report). The GWP Values Report documented the GWP Values for 399 GWP Townships. The GWP Values reflect how total applied nitrogen (N), total removed N, irrigation and precipitation, and the suite of the Central Valley Soil and Water Assessment Tool (CV-SWAT) root zone processes influence the potential average concentration of nitrate-N in water leached below the root zone. The GWP Values represent current estimates of nitrate-N load immediately below the root zone for the GWP Townships, based on 2019 grower-reported management data. GWP Values are expressed as the mass of nitrate-N at the bottom of the root-zone in total pounds (lbs) and average pounds per acre (lbs/ac) for each GWP Township. The GWP Values may be subject to additional post root zone attenuation processes below the bottom of the root zone.

GWP Targets are required for each GWP Township for which a GWP Value has been computed. The purpose of the GWP Targets is to set a desired target intended to achieve compliance with receiving water limitations for groundwater. Receiving water limitations are limitations on growers that state that wastes discharged from member operations "… shall not cause or contribute to an exceedance of applicable water quality objectives in surface water, unreasonably affect applicable beneficial uses, or cause or contribute to a condition of pollution or nuisance." (See, e.g., State Board Order WQ 2018-0002, Appendix A, p. 19.) The receiving water limitation for nitrate (as N) is the state's drinking water standard that is set at 10 mg/L-N, and the time to meet the limit is subject to time schedules of differing lengths for each of the thirteen Coalitions. While GWP Targets are required to be developed, they currently exist as un-enforceable targets.

GWP Targets were timely submitted by the thirteen Coalitions for GWP Townships on July 19, 2022. Based on questions posed by Central Valley Water Board staff and public comments received from several environmental justice organizations, the GWP Targets Report and its supporting documentation have been revised. This Revised GWP Targets Report reflects the changes made based on the comments received.

In this Report, the Coalitions propose GWP Targets, that are consistent with the LTILRP Orders. However, as this Report documents, there is tremendous uncertainty with this initial set of GWP Targets because of the complexity and uncertainties associated with groundwater conditions in the Central Valley. First, groundwater quality in the Central Valley aquifer system is impacted by numerous complex, dynamic, and interrelated processes, all subject to varying degrees of understanding and uncertainty. To develop GWP Targets that are reflective of these interrelated processes, it is necessary to characterize the fate of groundwater quality under current and alternative scenarios of groundwater recharge and nitrate-N loading. This requires accurate estimates of water budget components and nitrate-N mass loading, as well as the physical and chemical characteristics of the aquifer, N transformations (e.g., denitrification), and groundwater flow and mixing. Without robust estimates of these key surface and subsurface processes, it is challenging to estimate: 1) the relative influence of various discharge sources in different areas on underlying water quality, 2) the impacts of current conditions on future water quality, and 3) the changes in surface processes (i.e., load reduction, increased recharge) required to improve or protect water quality.

Second, for a variety of reasons, robust data and information to develop GWP Targets that are reflective of these complex processes are not currently available. Importantly, this includes estimates of actual nitrate-N loadings from other sources (besides irrigated agriculture [i.e., GWP Values]) and locally refined estimates of water budget components, both of which affect the amount of nitrate-N concentration entering the aquifer. Other nitrate-N loads are uncertain because they have not been quantified with as much rigor as the GWP Values. The best available estimates are from the Groundwater Nitrate Loading Model for the Central Valley (GNLM-CV) (Harter et al., 2017). GNLM-CV is based on comprehensive mass balance accounting of major nitrate-N sources and sinks (e.g., fertilizer sales, crop N removal, dairy waste, urban sources, etc.) throughout the Central Valley. Although it contains spatially explicit nitrate-N loading estimates, the high-level estimates of nitrate-N for certain land uses and locations are based upon various sets of assumptions that in some cases have not been further evaluated to determine their level of accuracy. Furthermore, uncertainties exist regarding regional hydrology, and currently available data may not reflect future hydrologic conditions for various parts of the Central Valley. For a number of reasons, regional hydrology is expected to change in terms of 1) the amount of groundwater pumped to support irrigated agriculture (which may diminish irrigated agricultural acreage) and/or 2) the amount of aquifer recharge (which may increase in some areas to balance withdrawals).

Understanding this current lack of data and information is important as it explains the uncertainty associated with developing GWP Targets that are designed to achieve compliance with receiving water limitations. Nevertheless, this Report puts forward GWP Targets to comply with the terms of the LTILRP Orders (i.e., are designed to achieve compliance with receiving water limitations). Per the LTILRP Orders, GWP Targets must be updated at least once every five years. The Coalitions intend to further develop and improve on the accuracy of these GWP Targets (over the next five years). Further, there are significant unknowns regarding irrigated agriculture's ability (and the time necessary) to meet the GWP Targets for many townships. Because of this significant concern with the GWP Targets, the Coalitions have developed milestones as interim performance goals to ensure that irrigated agriculture is taking positive steps toward reducing the amount of nitrate-N that may leach from below the root zone.

GWP Targets for Complying with Receiving Water Limitations (GWP Targets)

As required by the General Orders, the Coalitions have identified GWP Targets that are intended to achieve compliance with receiving water limits, after considering other relevant post-root-zone processes, for GWP Townships. The assessment framework for developing GWP Targets entails using CV-SWAT and other surface loading information in conjunction with a groundwater model capable of simulating the fate and transport of nitrate-N (i.e., the Non-Point Source Assessment Tool [CV-NPSAT]). The combined modeling tool framework facilitates consideration and incorporation of hydrologic conditions, other nitrate-N and water sources, and post-root-zone processes. There are a small number of GWP Townships located in the Sacramento Valley for which GWP Targets are not provided due to an apparent overestimation of nitrate-N concentrations compared to actual known groundwater monitoring results, which may be due to the highly conservative approach for reflecting attenuation below the root zone.

The GWP Targets are loading targets (i.e., average lb N/ac at the bottom of the root zone) to comply with receiving water limitations after considering other relevant post-root-zone processes (Figure ES-1). The assessment framework for developing GWP Targets includes the following:

Step 1. **Incorporate recharge into assessment framework using CV-NPSAT**. In its current form, CV-SWAT does not consider recharge from natural streams/rivers, canals, or recharge basins/projects, which realistically impacts groundwater quality. As such, comprehensive recharge estimates from the Department of Water Resources (DWR) 1.01 version of the Fine Grid California Central Valley Groundwater-Surface Water Simulation Model Fine (C2VSimFG) are incorporated into the assessment framework through CV-NPSAT. This step includes leveraging the CV-SWAT percolation information to spatially distribute C2VSimFG groundwater recharge appropriately across the landscape for use in CV-NPSAT.

Step 2. **Estimate all Nitrate-N loads**. This step includes development of a nitrate-N loading map that considers nitrate-N loading from irrigated agriculture on high vulnerability area (HVA) lands (i.e., GWP Values), as well as other sources. Although uncertainty exists with estimates of nitrate-N loads from other sources, preliminary estimates are incorporated into the spatially comprehensive assessment framework for dairy, irrigated agriculture outside of HVA lands, and urban lands.

Step 3. **Account for Post-root-zone Processes**. Based on available data and studies, the assessment framework currently considers denitrification in the saturated zone through a post-processing step under certain specified conditions. For the vadose zone, the assessment framework currently does not account for nitrate-N attenuation that may occur. Because denitrification and other attenuating factors are not considered in the vadose zone for these initial GWP Targets and are conservatively represented in the saturated zone, the initial GWP Targets are themselves conservative. Notably, the Coalitions intend to further evaluate potential attenuation that may occur in the vadose zone for future consideration when developing subsequent GWP Targets.

Step 4. **Update CV-NPSAT to Finalize the Linked Modeling Tool**. This step includes updating CV-NPSAT with the results from Steps 1 through 3 (above) to connect surface loading to the groundwater processes simulated in CV-NPSAT.

Step 5. **Calculate GWP Targets**. The GWP Targets were calculated through determining the GWP Township load reduction required to achieve the receiving water limitations for groundwater using modeled predictions of future water quality based on current nitrate-N loading and hydrology.

Uncertainty in predicted water quality (i.e., CV-NPSAT results) is due to uncertainty in the model inputs (particularly regional hydrology and other nitrate-N loads) and underrepresentation of denitrification in certain regions (particularly in the Sacramento Valley). In addition, there are special circumstances for some GWP Townships with a paucity of domestic wells because CV-NPSAT requires a minimum number of wells across a suitably large extent to develop and interpret meaningful results of constituent fate. These sources of uncertainty and special circumstances will be further considered in future refinements to the GWP Targets assessment framework, and hence future GWP Targets.

Once approved by the Central Valley Water Board's Executive Officer, GWP Targets must be incorporated into Groundwater Quality Management Plans (GQMPs) as performance goals. It is anticipated that Coalitions will conduct outreach and education to their members to explain the intent and purposes of the GWP Targets and encourage implementation of management practices that move townships towards meeting GWP Targets. However, GWP Targets themselves are not enforceable, regulatory standards.

Milestones as Interim Performance Goals

Although not required by the General Orders, the Coalitions propose to include township-based milestones for inclusion in Groundwater Quality Management Plans as interim performance goals to manage toward over the next five-year interval. The milestones are set at a level to optimize near-term nitrate-N load reduction based on evaluation of grower-reported management information. The milestones reflect area-weighted-average nitrate-N loading (lb/ac) at the bottom of the root zone that may be achieved through successful adoption and/or refinement of management practices (where needed) (Figure ES-2). The steps used to compute township-based milestones for GWP Townships are summarized as follows:

Step 1. Identify GWP Townships for milestones. Milestones are provided for all GWP Townships estimated to discharge more than 10 mg nitrate-N/L at the bottom of the root zone, as identified in the GWP Values Report (Central Valley Coalitions 2021). If a GWP Township is estimated to discharge less than 10 mg nitrate-N/L, then the no milestone is necessary and the GWP Target for that township is essentially status quo to maintain current loading levels. Furthermore, milestones are only provided for GWP Townships where an interim performance goal towards the GWP Target is applicable. In other words, for some GWP Townships, an interim goal is not necessary and the GWP Target (rather than a milestone) will be incorporated into the GQMPs for the next five-year period.

Step 2. Develop Crop-specific A-R Thresholds to Calculate Milestones. To identify areas for adoption and/or refinement of management practices, crop-specific A-R thresholds were developed based on evaluation of the distribution of four years (2017-2020) of grower-reported Irrigation and Nitrogen Management Plan (INMP)/Nitrogen Management Plan (NMP) Summary Report data.

Step 3. Estimate Potential Load Reductions Associated with Achieving the A-R Thresholds. The potential nitrate-N load reductions associated with achieving the crop-specific A-R thresholds across all parcels enrolled in the ILRP were estimated using the Root-zone Library developed for the GWP Values (Central Valley Coalitions 2021).

Step 4. Calculate Milestone. Nitrate-N loading estimates were aggregated to the township scale in the same manner that GWP Values were computed. The aggregated township loading estimates comprised of alternative nitrate-N loading scenarios (where needed) are the milestones, expressed as the acre-weighted average lb/ac nitrate-N loading at the bottom of the root zone.

FUTURE GWP TARGETS

The GWP Target assessment framework focuses on as many of the major factors and processes related to nitrate-N fate and transport as practicable. Currently, the GWP Target assessment framework concentrates on two influential determinants of the fate of applied N: 1) processes on and in the crop root zone, considering the effects of irrigation and fertilizer management, crop and soil type, topography, and climate, and 2) transport of nitrate-N to wells once it enters the aquifer. There are additional processes that can be locally important to nitrate-N fate that will be considered in future refinements to the GWP Targets assessment framework, and hence future GWP Targets. This includes integration of refined model inputs related to estimates of other nitrate-N loads and regional hydrology based on ongoing work to improve understanding of the Central Valley aquifer. In addition, the Coalitions in conjunction with UC Davis (where applicable), the Central Valley Water Board, and other stakeholders will refine the existing model tools, identify additional data and information to incorporate, and develop additional modeling tools, as appropriate. This includes work to incorporate post-root-zone denitrification. The GWP Targets will be reviewed and revised as necessary every five years.

FIGURE ES-1. DISTRIBUTION OF GWP TARGETS TO COMPLY WITH RECEIVING WATER LIMITATIONS

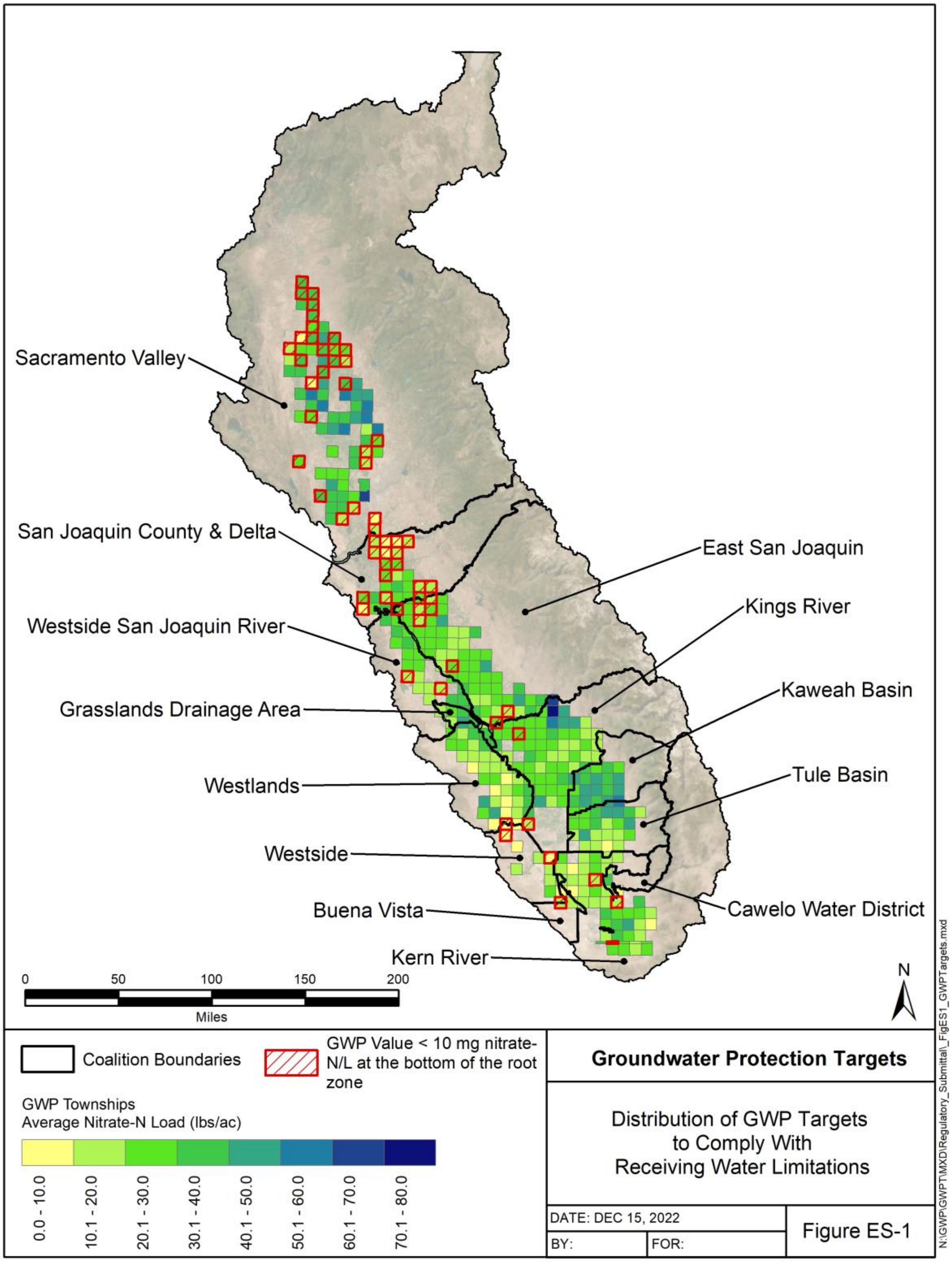
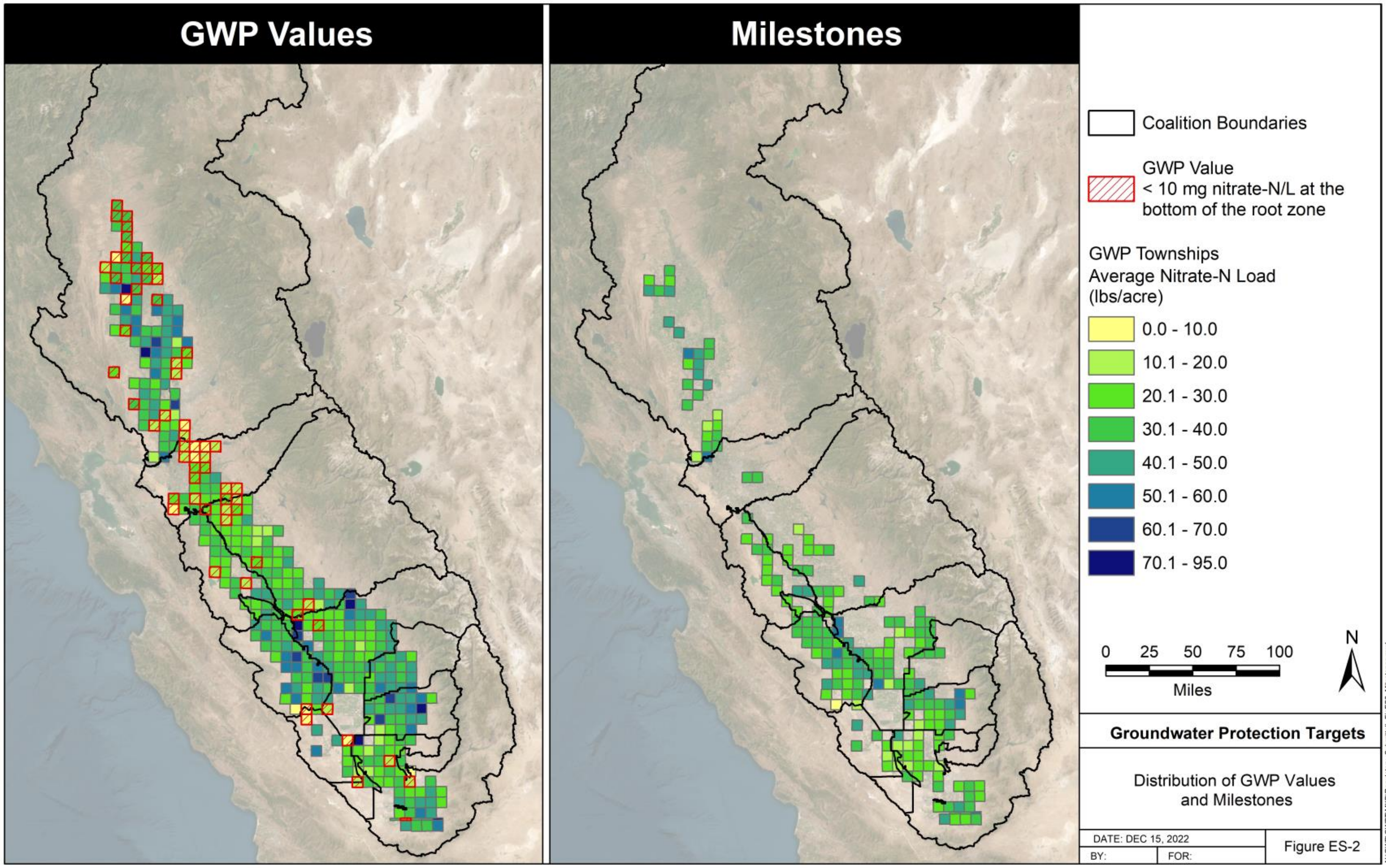


FIGURE ES-2. DISTRIBUTION OF GWP VALUES AND MILESTONES



1 INTRODUCTION

This Report provides the Groundwater Protection (GWP) Targets for high-priority townships[1] (i.e., GWP Townships) for the participating third-party agricultural Coalitions [2] that are assisting in the implementation of the Central Valley Long-term Irrigated Lands Regulatory Program (LTILRP). The Coalitions were required to submit GWP Targets for those townships in which a GWP Value was submitted, and subsequently approved by the Executive Officer of the Central Valley Regional Water Quality Control Board (Central Valley Water Board). The Coalitions timely submitted GWP Targets on July 19, 2022. After receiving comments and input from the Central Valley Water Board and other stakeholders, the Coalitions prepared this revised Report. This Report includes the following information:

- Section 1, Introduction, describes the General Order requirements for the GWP Targets, the third-parties (i.e., water quality Coalitions) participating in this approach, a summary of the approach to develop the GWP Targets, and an overview of the use and applicability of the GWP Targets.
- Section 2, GWP Targets for Complying with Receiving Water Limitations, details the assessment framework for developing the GWP Targets, including uncertainty and the unique circumstances for calculating GWP Targets for certain areas and GWP Townships. This section also identifies the GWP Targets, including maps and tabular summaries.
- Section 3, Milestones as Interim Performance Goals, describes the context for the milestones as well as the methods to identify the township-based milestones.
- Section 4, Future Refinements to GWP Target Assessment Framework, describes the approach for additional studies and efforts related to addressing current levels of uncertainty in the GWP Targets, and identifies potential model improvements for the first five-year update.
- Section 5, Conclusions, summarizes the various conclusions regarding the development of GWP Targets now and into the future.
- Section 6, References, includes the cited materials herein.

1.1 GENERAL ORDER REQUIREMENTS

In 2018, the State Water Board adopted new requirements for irrigated lands programs statewide. Relevant here are the new requirements for the development of a GWP Formula to generate township-specific GWP Values, and subsequently GWP Targets, for GWP Townships. The Central Valley Water Quality Coalitions developed a single GWP Formula to generate GWP Values for all GWP Townships and submitted a GWP Values Report to the Central Valley Water Board on July 19, 2021. An addendum to the

[1] High-priority areas are those areas where the Executive Officer determines that irrigated agriculture may be causing or contributing to exceedances of water quality objectives or a trend of degradation that may threaten applicable beneficial uses (Order WQ 2018-0002, p. 66).

[2] Reference to all Coalitions for this submittal does not include the California Rice Commission on behalf of rice growers in the Sacramento Valley. Per State Water Board Order WQ 2018-0002, the GWP provisions are not applicable to rice growers in the Sacramento Valley.

July 19, 2021, GWP Values Report was then submitted on December 14, 2021, to include additional Sacramento Valley Townships (collectively hereafter referred to as the GWP Values Report). The GWP Values Report documented the calculated GWP Values for 399 GWP Townships. The GWP Values are township-level estimates of existing nitrate-N-loading numbers at the root zone from irrigated agriculture parcels that are subject to Irrigation and Nitrogen Management Plan summary reporting requirements.[3] The GWP Values reflect how total applied nitrogen (N), total removed N, irrigation and precipitation, and the suite of the Central Valley Soil and Water Assessment Tool (CV-SWAT) root zone processes influence the potential average concentration of nitrate-N in water leached just below the root zone.

The LTILRP General Orders require the development of GWP Targets for each GWP Township for which a GWP Value has been computed. The purpose of the GWP Targets is to set a desired target that is intended to achieve compliance with receiving water limitations for groundwater. The GWP Values have been used in this Report, along with the additional data and tools, to develop GWP Targets (Section 2). The GWP Targets must be reviewed, and revised as necessary, once every five years and need to be informed by Coalition Groundwater Quality Assessment Report Updates (GAR Updates), the Management Practices Evaluation Program (MPEP), the groundwater trend monitoring program, and the Central Valley Groundwater Monitoring Collaborative (CVGMC) Five-Year Assessment Report. Once approved by the Central Valley Water Board's Executive Officer, GWP Targets need to be incorporated into Groundwater Quality Management Plans (GQMPs) as performance goals.

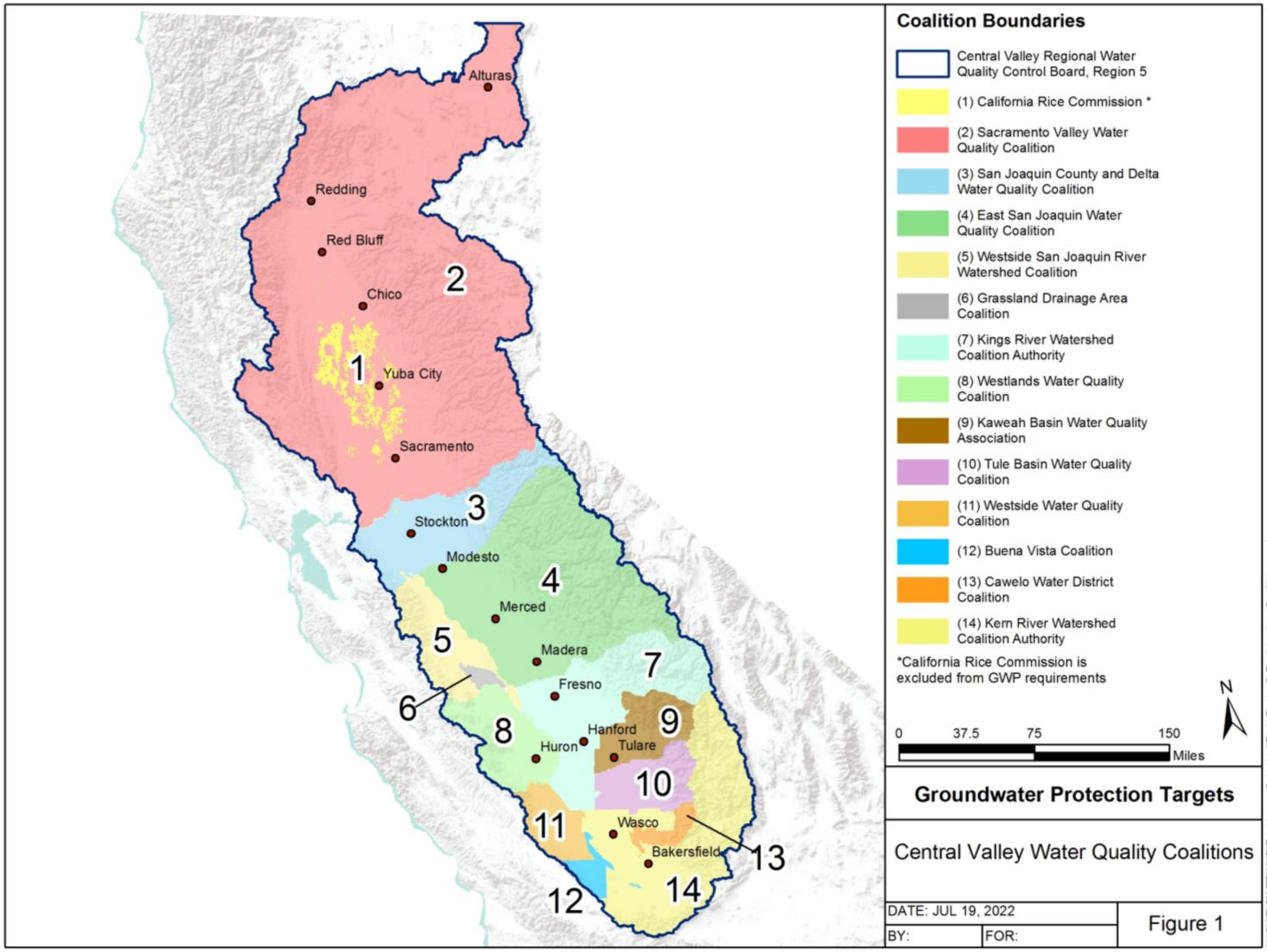
1.2 Coalitions

Thirteen water quality Coalitions participated in developing and implementing the GWP Formula to compute GWP Values, and subsequent to approval of GWP Values, to develop GWP Targets. This includes all Coalitions except for the California Rice Commission. The California Rice Commission is not subject to this requirement. Figure 1 shows the participating Coalitions, which are also listed below.

- Buena Vista Coalition
- Cawelo Water District Coalition
- East San Joaquin Water Quality Coalition
- Grassland Drainage Area Coalition
- Kaweah Basin Water Quality Association
- Kern River Watershed Coalition Authority
- Kings River Watershed Coalition Authority
- Sacramento Valley Water Quality Coalition
- San Joaquin County and Delta Water Quality Coalition
- Tule Basin Water Quality Coalition
- Westlands Water Quality Coalition
- Westside San Joaquin River Watershed Coalition
- Westside Water Quality Coalition

[3] Under the ILRP Orders, only irrigated agricultural parcels within High Vulnerability Groundwater Areas are required to submit Irrigation and Nitrogen Management Plan Summary Reports.

FIGURE 1. MAP OF CENTRAL VALLEY WATER QUALITY COALITIONS



1.3 SUMMARY APPROACH TO GWP TARGETS

The Coalitions have developed an approach for development and application of GWP Targets, as required by the General Orders.

- **GWP Targets for Complying with Receiving Water Limitations (GWP Targets).** As required by the LTILRP Orders, the Coalitions identify GWP Targets that are intended to achieve compliance with receiving water limits, after considering other relevant post-root-zone processes, for GWP Townships. The assessment framework for developing GWP Targets entails using CV-SWAT and other surface loading information in conjunction with a groundwater model capable of simulating fate and transport of nitrate-N (i.e., Non-Point Source Assessment Tool [CV-NPSAT]). The combined modeling tool framework facilitates consideration and incorporation of hydrologic conditions, other nitrate-N and water sources, and post-root-zone processes.

- **Milestones as Interim Performance Goals.** Due to a high level of uncertainty associated with GWP Targets designed to achieve receiving water limits, the Coalitions propose township-based milestones to manage toward over the next five-year interval. The milestones are set at a level to optimize near-term nitrate-N load reduction using a statistical approach that considers crop-specific N management metrics. Evaluation of grower-reported management information was used to develop the milestones. The milestones reflect area-weighted-average nitrate-N loading (lb/ac) at the bottom of the root zone that may be achieved through successful refinement of management practices by farming operations (where needed). The milestones are intended to be included in Groundwater Quality Management Plans, and the use of milestones is consistent with Key Element #3 of the State's Policy for Implementation and Enforcement of the Nonpoint Source Pollution Control Program (NPS Policy).

- **Future GWP Targets.** Future GWP Targets are expected to integrate refined model inputs related to regional hydrology and estimations of other nitrate-N loads based on the ongoing work (described below) to improve understanding of the Central Valley aquifer. In addition, the Coalitions in conjunction with UC Davis (where applicable), the Central Valley Water Board, and other stakeholders will refine the existing model tools, identify additional data and information to incorporate, and develop additional modeling tools, as appropriate. This includes work to incorporate post-root-zone denitrification, and potentially, additional evaluation and refinement of local water budget components. The GWP Targets will be reviewed and revised as necessary every five years.

The Coalitions propose including milestones because of the complexity and uncertainties associated with groundwater conditions in the Central Valley. First, groundwater quality in the Central Valley aquifer system is impacted by numerous complex, dynamic, and interrelated processes, all subject to varying degrees of understanding and uncertainty. To develop GWP Targets that are reflective of these interrelated processes, it is necessary to characterize the fate of groundwater quality under current and alternative scenarios of groundwater recharge and nitrate-N loading. This requires accurate estimates of water budget components and nitrate-N mass loading, as well as the physical and chemical characteristics of the aquifer, N transformations (e.g., denitrification), and groundwater flow and mixing. Without robust estimates of these key surface and subsurface processes, it is challenging to estimate: 1) the relative influence of various discharge sources in different areas on underlying water quality, 2) the impacts of current conditions on future water quality, and 3) the changes in surface processes (i.e., load reduction, increased recharge) required to improve or protect water quality.

Second, for a variety of reasons, robust data and information to develop GWP Targets that are reflective of these complex processes are not currently available. For example, actual nitrate-N loadings from other sources besides irrigated agriculture have not been quantified with as much rigor as the GWP Values. In 2012, researchers at the University of California (UC), Davis developed nitrate-N loading estimates for the Tulare Lake Basin and Salinas Valley (Harter et al. 2012), which were then updated and expanded to create the Groundwater Nitrate Loading Model for the Central Valley (GNLM-CV) (Harter et al. 2017). GNLM-CV is based on comprehensive mass balance accounting of major nitrate-N sources and sinks (e.g., fertilizer sales, crop N removal, dairy waste, urban sources, etc.) throughout the Central Valley and contains spatially explicit nitrate-N loading estimates. While informative, GNLM-CV contains generalized estimates of nitrate-N for certain land uses and locations based upon various sets of assumptions that in some cases have not been further evaluated to determine their level of accuracy. Irrigated agriculture is just one potential source of nitrate-N, and information on other nitrate-N loads is needed to accurately determine the influence that irrigated agriculture may have on groundwater quality.

In another example, robust data and information on regional groundwater is not yet available as a result of the Sustainable Groundwater Management Act (SGMA). SGMA requires Groundwater Sustainability Agencies (GSAs) to develop Groundwater Sustainability Plans (GSPs) for many groundwater basins throughout California. Under SGMA, GSPs are required to identify and achieve groundwater sustainability goals based upon local information and analysis. Further, GSPs for critically over-drafted basins were required by January 31, 2020, and the remaining high- and medium- priority basins were required by January 31, 2022. Upon submittal, GSPs were subject to public review and review by the Department of Water Resources (DWR) within two years of submittal. DWR's reviews of GSPs for critically over-drafted basins were completed on or before January 2022, while the remaining GSPs are still under review. DWR's reviews resulted in requests for further updates and information to a number of the GSPs. Updated GSPs are in the process of being reviewed and approved by DWR.

Understanding this current lack of data and information is important as it explains the uncertainty associated with developing GWP Targets that are designed to achieve compliance with receiving water limitations. Although this Report puts forward GWP Targets to comply with the terms of the LTILRP Orders, the accuracy of these GWP Targets (even as estimates) are significantly hampered by this lack of current data and information. Further, there are significant unknowns regarding irrigated agriculture's ability (and the time necessary) to meet the GWP Targets for many GWP Townships. Because of this significant concern with the GWP Targets, the Coalitions have developed milestones to ensure that irrigated agriculture is taking positive steps forward towards reducing the amount of N that may leach from below the root zone. The milestones are intended to assist Coalitions and growers in working towards meeting GWP Targets that ultimately result in compliance with receiving water limitations, which upon meeting the receiving water limit means that irrigated agriculture in those GWP Townships are no longer causing or contributing to an exceedance of the nitrate drinking water objective.

The use and application of milestones in GQMPs is appropriate for several reasons. First, GQMPs are the vehicle used for incorporating schedules and milestones towards meeting receiving water limitations. The milestones proposed here in this Report are just one step towards meeting GWP Targets, which reflect what may be necessary for meeting receiving water limitations. Second, there is considerable uncertainty with the GWP Targets at this time. Looking ahead five years (2027), it is anticipated that significant new data and information will be available regarding the Central Valley aquifer system and sources of nitrate-N loading that will improve development of future GWP Targets. For example, SGMA-based GSPs for critically over-drafted basins should be approved and implemented, resulting in improved local estimates of current and future water use and recharge dynamics. Second, Nitrate Control Program Management Zone Implementation Plans for Priority 1 and Priority 2 areas should be available and approved by the Central Valley Water Board, which will require the determination (or refinement) of nitrate-N loading estimates from various point and non-point sources. Irrigated agriculture is just one potential source of nitrate-N in any given township or groundwater basin. Information on other nitrate-N loads (e.g., septic, urban, dairy, industrial, etc.), hydrologic conditions (natural and/or managed recharge), and information on vadose and saturated zone conditions and processes is needed to accurately determine the influence that irrigated agriculture may have on groundwater quality. Third, groundwater modeling and N transport tools like CV-NPSAT should be further refined and updated.

Moreover, future Central Valley conditions are unclear with respect to land use and regional hydrology due to anticipated requirements under SGMA, as well as climate change. For example, it is anticipated that implementation of the GSPs under SGMA may result in 1) fallowing and/or retirement of agricultural lands in portions of the Central Valley (which in turn would alter nitrate-N loading, recharge patterns, and other water budget components), 2) more concerted efforts for managed aquifer recharge when conditions are suitable, and 3) reduced groundwater pumping, which may impact processes such as "pump and fertilize," which has the potential to remove nitrate-N mass from the aquifer over time.

Given that significant types of information necessary to develop GWP Targets are likely to change in the next five years and beyond, and the significant, ongoing work to improve understanding of Central Valley aquifers, the inclusion of milestones in the GQMPs is appropriate.

1.4 Use and Applicability of GWP Targets

The LTILRP General Orders require the development of GQMPs, when triggered. GQMPs are generally triggered when there are exceedances of applicable water quality objectives or there are high-vulnerability groundwater areas. Such plans are required by an applicable Water Quality Control Plan (Basin Plan) or as determined by the Executive Officer of the Central Valley Water Board. In lieu of submitting GQMPs for certain specified areas, Coalitions may choose to develop and submit a single Comprehensive GQMP that covers the extent of the Coalition's boundaries. Regardless, all GQMPs must meet the requirements as specified in the LTILRP General Orders. All thirteen Coalitions submitting this Report have existing, approved GQMPs.

GQMPs must incorporate a Management Plan Strategy that includes, in relevant part, 1) actions to meet receiving water limitations, 2) actions to educate growers about source of water quality exceedances to promote prevention, protection, and remediation efforts that can maintain and improve water quality, 3) strategies to implement management plan tasks (including identifying management practices that are technically feasible, economically feasible, and proven to be effective at protecting water quality), 4) a specific schedule and milestones for implementation of management practices and tasks, and 5) measurable performance goals aligned with elements of the management plan strategy. Performance goals include specific targets that identify expected progress, and performance goals must include any developed GWP Targets.

Annually, Coalitions must prepare and submit a Management Plan Progress Report. The timing for submittal varies with each LTILRP Order. As part of the Management Plan Progress Report, Coalitions must identify any recommended changes to the Management Plan. Proposed changes to Management Plans must be approved by the Executive Officer prior to implementation. GWP Values were included in GQMPs upon submittal of the GWP Values Report in 2021.

To incorporate GWP Targets and milestones into the appropriate GQMPs, and include strategies related to achieving applicable milestones and GWP Targets, the Coalitions intend to recommend changes to their GQMPs as part of their annual Management Plan Progress Reports after the GWP Targets have been approved. Once the proposed recommended changes to the GQMPS are submitted, the Coalitions will then wait to receive Central Valley Water Board approval prior to implementation. In accordance with the LTILRP General Orders, the Coalitions will provide GWP Target Summary Comparisons to GWP Values once the GWP Targets have been approved by the Central Valley Water Board’s Executive Officer. The GWP Targets will be reviewed, and updated, if necessary, five years from the Central Valley Water Board’s Executive Officer approval of the GWP Targets themselves.

2 GWP TARGETS FOR COMPLYING WITH RECEIVING WATER LIMITATIONS

The GWP Targets are expressed as loading targets for GWP Townships (i.e., average lb N/ac at the bottom of the root zone). The assessment framework entails using CV-SWAT and other surface loading information in conjunction with a groundwater model (CV-NPSAT). The linked modeling tool framework facilitates consideration and incorporation of hydrologic conditions and processes, other nitrate-N and water sources, and post-root-zone processes. The following sections provide background information on the essential components of the assessment framework, including selection of CV-NPSAT, as well as the methods to determine the GWP Targets.

2.1 BACKGROUND

The approach for development of GWP Targets requires comprehensive watershed information to account for surface, vadose zone, and groundwater processes known to influence regional water quality. Further, these processes need to be considered in concert to enable the assessment of potential impacts of irrigated agriculture on groundwater quality in terms of both current loading as well as under future load reduction scenarios. To address these essential components and enable a holistic assessment of potential impacts from irrigated agriculture, the modeling tool framework must consider the following key elements:

- Detailed surface nitrate-N loading from irrigated agriculture (i.e., GWP Values), as well as contributions of nitrate-N from sources outside of irrigated agriculture (e.g., dairy, urban) in GWP Townships.

- Regional recharge from water sources beyond the root zone of irrigated agriculture. This includes potential recharge from streams and rivers, canal seepage, recharge projects, and percolation from natural lands. Recharge is a key hydrologic process that can affect the concentration of nitrate-N in percolation reaching groundwater and thus affect nitrate-N concentrations in aquifers. As such, accurately reflecting recharge rates and their spatial distribution is essential for understanding the potential impacts of surface nitrate-N loading on underlying groundwater quality.

- Representation of post-root zone attenuation processes, including N transformations (i.e., denitrification) in the vadose zone and saturated zone. Denitrification can occur, if conditions are suitable, in the vadose zone and in the saturated zone. Denitrification rates are affected by a suite of physiochemical factors including sediment texture, moisture content, reduction-oxidation conditions, concentrations of reduced carbon species, and other electron donors, among others.

- Accounting of groundwater flow and transport processes in the aquifer and well structures, including well and aquifer hydraulics and preferential flow paths.

Given these key elements, the CV-NPSAT was selected as the best available groundwater modeling and transport tool for the development of the GWP Targets. CV-NPSAT was developed by UC Davis (Kourakos and Harter 2011, Kourakos et al. 2012, Kourakos and Harter 2014a, Kourakos and Harter 2014b, and

Harter et al. 2020) with funding from the California State Water Resources Control Board and National Resources Conservation Services (NRCS). CV-NPSAT is based on a streamline modeling concept that simulates non-point source pollution transport through groundwater to wells (Martin and Wegner 1979). CV-NPSAT considers the effects of groundwater travel time, mixing/dilution within the aquifer and within the well, well location and screen depth, among other factors, and predicts the effects of surface nitrate-N loading on future produced water quality across a distribution of virtual wells (i.e., municipal, production, domestic) within a minimum spatial unit of interest (e.g., township). CV-NPSAT is intended to be used by stakeholders, decision-makers, and land managers to understand the potential effects of future management practices on water quality (Boyle et al. 2013). The tool is not intended to be used to evaluate water quality at the individual well level, nor at an exceedingly small scale (i.e., smaller than a township) due to the resolution of the regional input data from underlying groundwater models. As such, a minimum number of wells across a suitably large extent is required to develop and interpret meaningful results of constituent fate.

There are two versions of CV-NPSAT based on existing, calibrated Central Valley groundwater models. This includes: 1) the California Department of Water Resources (DWR) 1.01 version of the Fine Grid California Central Valley Groundwater-Surface Water Simulation Model Fine (C2VSimFG Version 1.01, last updated April 28, 2021), and 2) the United States Geological Survey (USGS) Central Valley Hydrologic Model (CVHM) (Faunt 2009). DWR's C2VSimFG version was selected for the development of GWP Targets because the water budgets in C2VSimFG were updated through 2015. In addition, C2VSimFG has a finer modeling resolution in certain locations, meaning that the proportion of recharge from irrigated agriculture as compared to other sources (e.g., streams/rivers) can be more accurately apportioned. Nonetheless, these are regional-scale models developed to reflect broad hydrological processes and contain inherent uncertainty in local hydrology. For comparison, USGS's CVHM version that was available during the preparation of this Report only has information up to 2003. An update to (CVHM2) is in development and expected to be released soon.

CV-NPSAT contains virtual well datasets that reflect actual wells completed in shallower and deeper portions of the aquifer. This includes a dataset comprised of virtual domestic wells (shallow aquifer) and virtual municipal/irrigation wells (deep aquifer). Virtual domestic wells simulated in CV-NPSAT are based on the dataset prepared by Pauloo et al. (2019). This dataset reflects approximately 95,000 DWR Well Completion Reports from the California Open Data Portal (data.ca.gov), providing general well location and depth data. However, the location accuracy of most wells is one square mile (one section), so wells were randomly scattered within a half mile radius (i.e., randomly placed within the section). Each record contains information on the completion depth which is directly used in CV-NPSAT. However, screen interval data were not reported for all wells. To address this, linear models were developed for each C2VSimFG subregion using well data that contains both well depth and screen interval to interpolate screen intervals to the remaining wells. Additionally, standard deviations were used to somewhat randomize the interpolated screen intervals, thus avoiding a perfect linear correlation between well depth and screen interval. It is unknown what fraction of domestic wells from the dataset have failed and/or are no longer in production. Therefore, it is possible that some included in the dataset are no longer used, however, given that CV-NPSAT results are to be statistically interpreted at the township scale, not the individual well, this is not necessarily a limitation.

Although CV-NPSAT will benefit from future improvements to the underlying hydrology used to construct the tool (i.e., local refinement relative to C2VSimFG), it is nonetheless the best available groundwater modeling tool for development of the GWP Targets at this time. The methodology to calculate the GWP Targets includes five key steps to assess the potential impacts of irrigated agriculture on water quality. Steps 1-4 include linking the nitrate-N loads developed from CV-SWAT (i.e., GWP Values) and estimated from other sources to the hydrology and virtual domestic wells simulated by CV-NPSAT. Step 5 includes calculating the GWP Targets by determining the load reduction required to achieve receiving water limits in GWP Townships using modeled predictions of future water quality based on current nitrate-N loading and hydrology. Methods to calculate the GWP Targets using the linked modeling tool are described in the following section.

2.2 Assessment Framework

The GWP Targets assessment framework consists of five steps, as illustrated in Figure 2. The assessment framework, particularly Steps 1 and 4, was implemented in collaboration with CV-NPSAT developers from UC Davis. The steps include:

Step 1. Incorporate Recharge into Assessment Framework for GWP Targets. In its current form, CV-SWAT does not consider recharge from natural streams/rivers, canals, or recharge basins/projects, which realistically impacts groundwater quality. Recharge from C2VSimFG is incorporated into the assessment framework through CV-NPSAT. CV-NPSAT is based on a constant or "steady state" groundwater flow field. Groundwater system "stresses" (e.g., recharge, well pumping, stream recharge/discharge) represented in CV-NPSAT are spatially distributed but are temporally averaged based on C2VSim's calibrated period (1985-2015).

Redistributing the steady-state recharge volumes from C2VSimFG is important for ensuring that spatial characteristics (climate, soil, land use) and natural features (streams, rivers, etc.) are adequately represented in CV-NPSAT. The steady-state recharge distribution directly affects the simulated produced water concentrations in virtual wells. CV-SWAT simulations used to create the GWP Root-zone Library and GWP Values consider the major factors known to influence percolation from the root zone, including crop-specific irrigation and transpiration, evaporation, climate, and soil type. Furthermore, CV-SWAT hydrologic response units (HRUs) are delineated at a significantly finer spatial scale than modeling units in C2VSimFG, meaning that more discrete spatial differences are accounted for in CV-SWAT. CV-NPSAT developers leveraged the CV-SWAT percolation information to spatially distribute C2VSimFG recharge appropriately across the landscape. Therefore, this step includes using information from CV-SWAT to redistribute steady-state recharge for irrigated agricultural and natural lands in CV-NPSAT. Specifically, this includes the following:

- **Step 1a: Determine Recharge Patterns for Irrigated Agricultural Lands.** Land-use patterns within the Central Valley are dynamic and change as a function of agronomic, economic, and environmental factors. It is important to develop a representative recharge pattern that is consistent with current land and water use information such that future predictions of water quality modeled in CV-NPSAT are informed and reflective of today's conditions. Land use information for characterizing current conditions include 2019 INMP/NMP data used for calculating GWP Values as well as crop maps developed by DWR for years 2016 and 2018 to supply information for irrigated agriculture on non-HVA lands as well as other land uses.

  Fields planted with annual crops may undergo rotations, while perennial crops remain static for longer periods of time. Therefore, the locations of perennial crops were held constant based on the most recent land use information (2019 INMP/NMP and 2018 DWR data). Fields with annual crops required additional analysis to avoid mischaracterizations of local recharge estimates by considering the variety of annual crops and potential rotations (including fallowing) that occur in any given field. To assess annual cropping distributions within townships, current land use information was used to assign the relative proportion of various annual crops within each Central Valley Township. The relative proportion of each crop in each township was used to scale average crop *x* HRU recharge estimates to generate an average recharge volume for fields planted to annuals that is reflective of local cropping patterns.

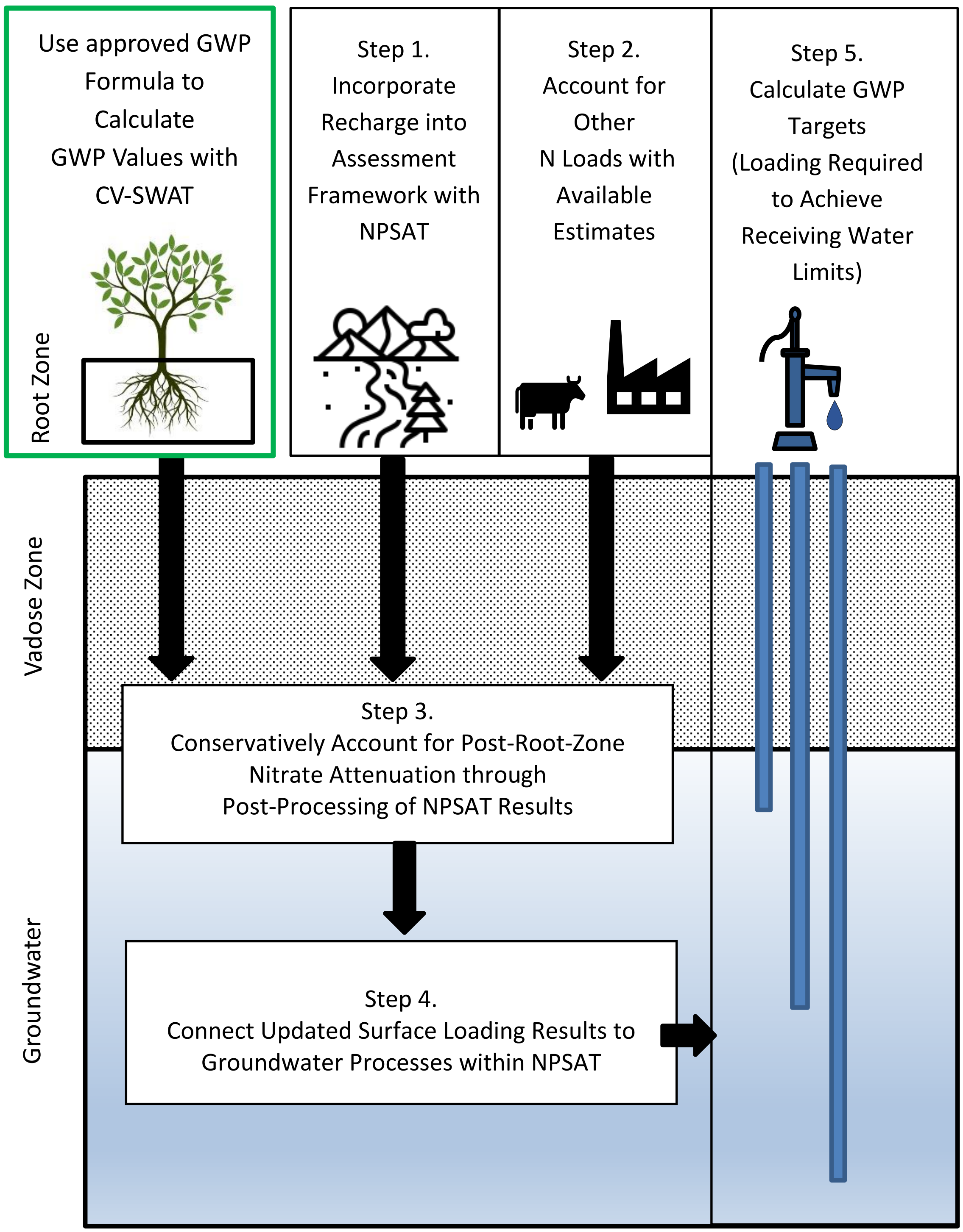
  It should be noted that the agricultural landscape in the Central Valley will likely continue to evolve in the near future as annual crop land may be converted to perennial crops, or some acreage may be intermittently or permanently land fallowed. As such, the redistribution of recharge will need to be revisited in future GWP Target calculations to account for differences in agricultural land and water uses that may affect groundwater model predictions.

- **Step 1b: Determine Recharge Patterns for Other Lands.** Some fields in certain areas of the Central Valley have been taken out of agricultural production, which affects their annual recharge contribution. An analysis was conducted to identify these fallowed fields, as compared to those previously identified during specific periods of land use classification that may in fact not be permanently fallowed (i.e., DWR crop mapping). This analysis involved evaluation of recent historical annual actual evapotranspiration information (Paul et al. 2018) determined from remote sensing techniques for fields classified as fallow in the 2016 and/or 2018 DWR crop maps. Recharge for fields determined to be out of agricultural production were calculated from a CV-SWAT run with idle land use to account for any potential recharge due to precipitation. Other land uses such as grasslands, woodlands, non-irrigated pasture, and urban were simulated with CV-SWAT to determine their contribution to recharge.

- **Step 1c: Consider Recharge from Water Features.** Recharge estimates exist for water features (e.g., streams/rivers/etc.) in C2VSimFG. This information was preserved (recharge locations and volumes) and used to account for recharge from these sources.

FIGURE 2. OVERVIEW OF ASSESSMENT FRAMEWORK USED TO DETERMINE GWP TARGETS

The root-zone-based GWP Values were calculated using the approved GWP Formula for irrigated agriculture in GWP Townships (green box). The GWP Targets were determined with other scientifically supported variables that influence the potential average concentration of nitrate-N in water expected to reach groundwater (black boxes).



Step 2. Estimate All Nitrate-N Loads. Prior to updates for use in the GWP process, CV-NPSAT contained two datasets of spatially explicit nitrate-N loading estimates, namely GNLM-CV (Harter et al. 2017) and 4 generic CV-SWAT simulations developed under the SSJV MPEP (MPEP Team 2019). However, the determination of GWP Targets requires the most up to date and accurate nitrate-N loading information to better evaluate the impacts of surface processes on underlying groundwater quality. As such, the Coalitions have developed a new nitrate-N loading map for integration in the GWP Targets assessment framework that considers nitrate-N loading from irrigated agriculture on HVA lands (i.e., GWP Values), as well as other sources. Although uncertainty still exists with estimates of nitrate-N loads from other sources, preliminary estimates are incorporated into this spatially comprehensive assessment framework for dairy, irrigated agriculture outside of HVA lands, and urban lands. These estimates provide one bookend scenario to be evaluated in determination of the GWP Targets (Step 5). The following methods and data sources were used to estimate nitrate-N loads for use in CV-NPSAT:

- **Step 2a: Irrigated Agriculture on HVA Lands.** The GWP Values represent nitrate-N loads from irrigated agriculture in GWP Townships (Central Valley Coalitions 2021). The GWP Values were computed at the parcel/subparcel scale and were considered for calculation of the GWP Targets.

- **Step 2b: Dairy Lands.** Estimated nitrate-N loads from Dairy land were generated in collaboration with the Central Valley Dairy Representative Monitoring Program (CVDRMP). CV-SWAT simulations were carried out to model root zone processes and nitrate-N discharges from lands receiving manure applications. Similar to irrigated agriculture, the relationship between applied N and yield are important for assessing discharges from dairy lands. Currently, it is difficult to determine how individual fields receiving land applications of manure are managed, so generic but representative practices were assumed. Assumptions included the following: 1) corn-wheat silage rotations modeled with yields based on CVDRMP input, 2) solid and liquid manure, as well as mineral fertilizer applications based on input from the CVDRMP and its advisors, and 3) total N application rates (manure + mineral) were assumed to meet the Dairy Order requirement of an A/R at 1.4. CVDRMP provided parcels/fields enrolled in the program to properly assign the leaching estimates to the landscape.

- **Step 2c: Irrigated Agriculture Outside of HVA Lands.** Estimates of loading rates from irrigated agriculture outside of HVAs (where GWP Values do not exist) were obtained from the Root-zone Library in conjunction with the most current DWR land use maps available (2016, 2018). The land use maps provided specific or approximate land use classes for specific locations and the Root-zone Library provided average loading estimates for specific crops based on the associated Coalition INMP/NMP Summary Report average applied N and yield information. Fields under annual crops were averaged based on the crop mix in the township in a similar fashion to Step 1. As such, these approximated nitrate-N loads incorporate local land use, management, soil, and climate information.

- **Step 2d: Urban Areas.** Although estimates of nitrate-N loading from urban areas (e.g., golf courses, residential areas, wastewater treatment plants, etc.) are available in GNLM-CV, estimates for these areas were set to discharge at 10 mg nitrate-N/L (see Section 2.3 for additional explanation).

Step 3. Account for Post-root-zone Processes. The GWP Target assessment framework includes a conservative approach to accounting for the post-root-zone processes that support nitrate-N attenuation. Currently, CV-NPSAT does not consider denitrification in either the vadose zone or saturated zone. However, there are numerous California-specific studies and literature (referenced below) that call out certain conditions that are favorable for such post-root-zone process that attenuate nitrate-N. Based on available data and studies, the GWP Targets assessment framework currently considers denitrification in the saturated zone under certain specified conditions through a post-processing step. For the vadose zone, the assessment framework currently does not account for nitrate-N attenuation that may occur. Notably, however, future refinement of the assessment framework will consider post-root-zone attenuation processes, including denitrification in the vadose zone, and refine representation of these processes in the saturated zone (Section 4). Because denitrification and other attenuating factors are not considered in the vadose zone, and these are conservatively represented in the saturated zone, the GWP Targets are themselves conservative.

For the saturated zone, estimated rates of denitrification from literature (Green et al. 2016) were applied to areas on the landscape with conditions suitable for denitrification to occur (Rosecrans et al., 2017). This included the following:

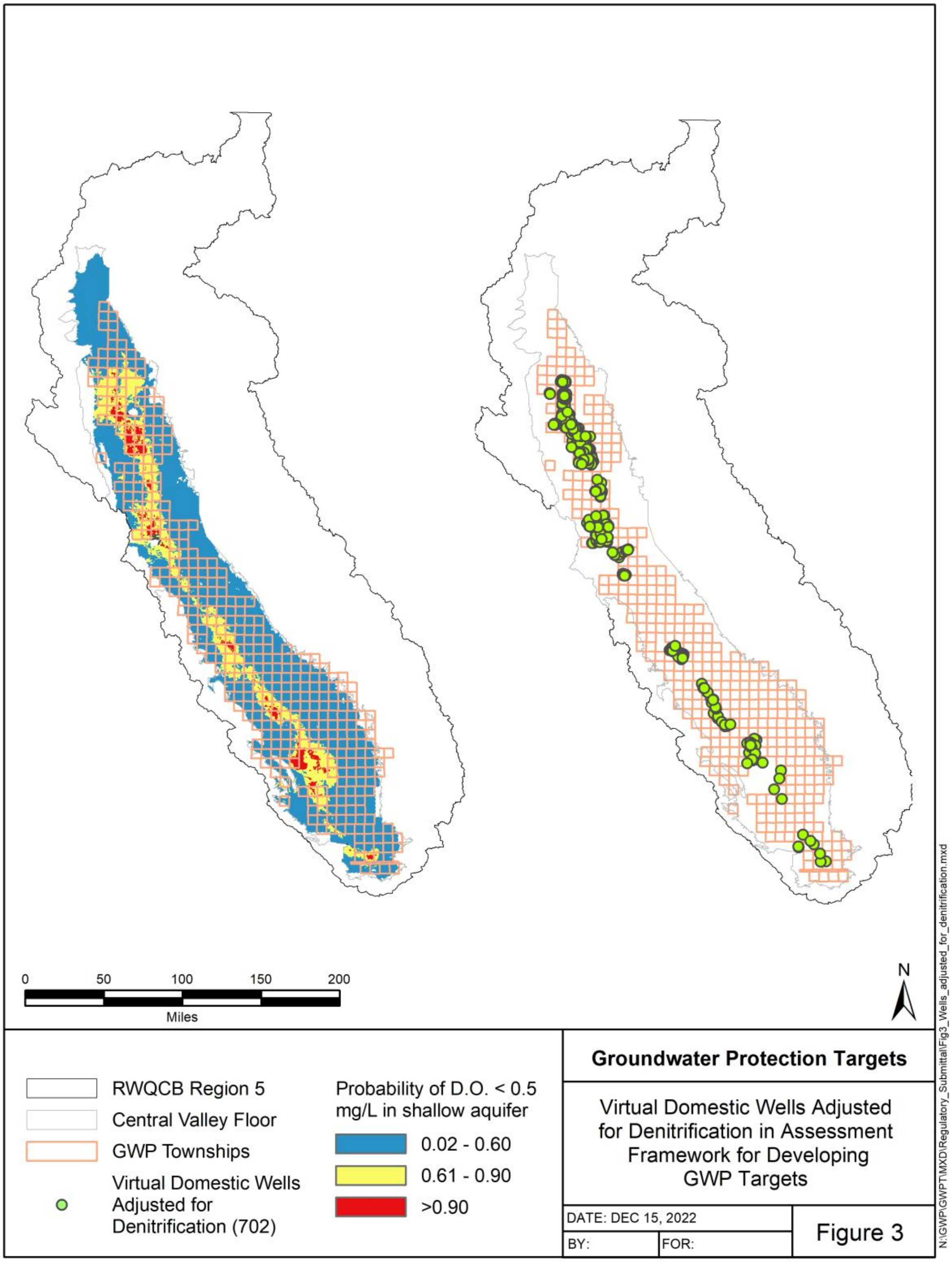
- **Step 3a: Isolate Regions with Suitable Conditions for Denitrification.** In the Central Valley, studies have identified where dissolved oxygen concentrations are likely sufficiently low to enable denitrification to proceed (Rosecrans et al. 2017). These regions are associated with the valley troughs, areas with shallow water tables, historical groundwater discharge to rivers, and where shallow modern groundwater interacts with surface soils higher in carbon (Landon et al. 2011, Chapelle et al. 2013). Rosecrans et al. (2017) provide predicted probabilities of redox conditions in groundwater (dissolved oxygen and manganese concentrations) across the Central Valley. Prediction grids of dissolved oxygen <0.5 mg/L for the upper aquifer associated with domestic wells were evaluated to isolate areas with > 90% probability of dissolved oxygen <0.5 mg/L. This conservative threshold was used for determining areas with suitable redox conditions for denitrification. For reference, Ransom et al. 2017 found that a threshold of roughly 60% tended to correspond with lower nitrate-N concentrations. These locations were used in post-processing of CV-NPSAT results to account for denitrification.

- **Step 3b: Determine Groundwater Residence Time.** Under conditions that promote denitrification, the residence time of water and its dissolved constituents (i.e., nitrate-N and electron sources) will directly determine the magnitude of denitrification (Tesoriero et al. 2000). California studies have examined the age of groundwater and the relationship with denitrification. In general, as groundwater age increases it becomes more anoxic with increased denitrification potential (Landon et al. 2011, Green et al. 2016, McMahon et al. 2011). Groundwater residence time (i.e., travel times in the saturated zone prior to interception from a well) is directly simulated in CV-NPSAT. The flow-weighted average travel times in the saturated zone were computed for all domestic wells in CV-NPSAT, and the median travel times were determined for the Sacramento Valley watershed and San Joaquin watershed (14.4 and 13.8 years, respectively). These median groundwater residence times were used in post-processing of CV-NPSAT results to account for denitrification.

- **Step 3c: Determine Losses of Nitrate-N Through Denitrification from Published Literature.** A median denitrification estimate of 0.32 mg/L/year from Green et al. (2016) is used as the estimated rate of denitrification in areas with suitable conditions. When combined with the median travel time, the resulting denitrification computed for wells affected by this process was 4.6 and 4.4 mg/L for the Sacramento and San Joaquin Valleys, respectively.

- **Step 3d: Adjust CV-NPSAT Concentration Predictions.** Denitrification losses from Step 3c were applied to the predicted well concentrations as a post-processing step. The concentration predictions were adjusted in wells located within, or with source areas within, areas identified in Step 3a. Of the approximately 95,000 domestic wells reflected in CV-NPSAT, the number of well concentrations adjusted for denitrification was 531 and 171 for the Sacramento and San Joaquin Valleys, respectively, located across 61 GWP Townships (Figure 3). The adjusted CV-NPSAT results in these areas, along with the remaining non-adjusted CV-NPSAT results, were used to determine the GWP Targets in Step 5.

FIGURE 3. VIRTUAL DOMESTIC WELLS ADJUSTED FOR DENITRIFICATION IN ASSESSMENT FRAMEWORK FOR DEVELOPING GWP TARGETS



Step 4. Update CV-NPSAT to Finalize the Linked Modeling Tool. This step includes updating CV-NPSAT with the results from Steps 1 through 3 (above) to connect surface loading to the groundwater processes simulated in CV-NPSAT.

Step 5. Calculate GWP Targets. The GWP Targets were calculated through determining the GWP Township load reduction required to comply with receiving water limitations for groundwater using modeled predictions of future water quality based on current nitrate-N loading and hydrology. GWP Targets are conservative because they focus on protecting shallow domestic wells.

As described in Step 1, water budget information is based on C2VSimFG. Recharge volumes from C2VSimFG are used, along with nitrate-N loading estimates from Step 2, to compute the nitrate-N concentration entering the aquifer in CV-NPSAT. Rapid travel times through the vadose zone were assumed because 1) current nitrate-N mass is conserved in the vadose zone, and 2) the assessment framework is not trying to accurately access the timeframe for improvements to water quality. Rather, CV-NPSAT is run for a sufficient period of time into the future (i.e., multiple decades) such that steady-state well concentrations are achieved across the Central Valley, meaning the concentrations no longer change with more time. When this occurs, nitrate-N concentrations represent the effect of current management practices on future water quality.

As described in Section 2.1, CV-NPSAT requires a minimum number of wells across a suitably large extent to develop and interpret meaningful results. In other words, CV-NPSAT results do not accurately reflect concentrations for individual wells. Rather, the distribution of water quality results across a population of wells in CV-NPSAT are used to determine GWP Targets. Uncertainty in the characteristics of these predicted distributions (i.e., CV-NPSAT results) arises from uncertainty in underlying groundwater model assumptions (e.g., aquifer physical properties), as well as in the model inputs for regional hydrology and other nitrate-N loads and underrepresentation of denitrification in certain regions. Section 2.3.1 provides more information regarding these sources of uncertainty.

The methods used to interpret CV-NPSAT results and determine GWP Targets are based upon professional judgement and the current state of knowledge regarding appropriate use of CV-NPSAT output. As such, while these methods provide reasonable and scientifically defensible GWP Targets, it is possible that new methods and statistics may be identified and utilized for future GWP Target updates. In addition to this and as further discussed in Section 4, it is anticipated that future refinements to CV-NPSAT and a stronger understanding of its use, key data inputs (e.g., regional recharge), and representation of post root zone attenuation will lead to overall improvements in the assessment framework and accuracy/certainty of GWP Targets. The remaining paragraphs provide additional information regarding the relationship between virtual wells simulated in CV-NPSAT and GWP Townships, as well as how other nitrate-N loads were incorporated into the assessment framework for calculation of GWP Targets.

Relationships Between Virtual Wells and GWP Townships

Relationships were established between virtual well source areas and townships, so that the impacts of a given township's load are assessed across all wells impacted by activities in that township, even if a given well(s) is outside of the township boundary. However, not all GWP Townships include an adequate quantity of domestic wells necessary for statistically valid water quality predictions in CV-NPSAT (see Sections 2.1 and 2.3.2 for additional explanation). A threshold of at least 20 wells impacted by a township was identified as being the minimum number of wells necessary to support valid, representative CV-NPSAT results based upon current understanding and professional judgement. This 20 well threshold will continue to be evaluated during future refinements to the assessment framework (Section 4).

There are 104 GWP Townships which impact 20 or fewer wells (Figure 4, Figure 5). In total, these 104 GWP Townships include 721 wells, or approximately 0.08% of all shallow domestic wells. It is necessary to consider additional wells in relation to these GWP Townships in order to compute GWP Targets. To achieve this, the GWP Township boundaries were incrementally buffered outward in each direction in 1-mile intervals until at least 20 domestic wells were captured within the buffered township boundary. The recharge, N loading, and virtual domestic wells associated with these buffered townships were used to calculate GWP Targets for these GWP Townships. To assess whether the buffering approach significantly alters the aquifer characteristics of a given township, the underlying aquifer properties from C2VSimFG were compared for the original and buffered GWP Township boundaries. The results of this comparison are illustrated in Figure 6 and demonstrate consistency in these properties across original and buffered township boundaries.

Incorporation of Other N Loads

Due to uncertainty regarding estimates of other nitrate-N loads (Step 2), and to better ascertain irrigated agriculture's impact on groundwater quality, two bookends were used to generate an average value of other nitrate-N loads for use in determination of the GWP Targets. In both bookends, GWP Targets are based on estimated loading levels that are predicted to result in virtual domestic wells producing groundwater that meets the 10 mg nitrate-N/L water quality standard. As previously described, CV-NPSAT results represent predicted water quality across a broad population of virtual domestic wells and are not intended to represent water quality at the individual virtual domestic well level. Because of CV-NPSAT's limitations in this regard at this juncture, it is appropriate to estimate loading levels (and set GWP Targets) based on CV-NPSAT results indicating that the vast majority (at least the 85^{th} percentile) of virtual domestic wells in the given township produce groundwater that meets the 10 mg/L standard. This threshold was selected as an indicator of compliance based upon professional judgement regarding the ability of CV-NPSAT to accurately predict water quality across a population of wells.

The bookends for other nitrate-N loads in model simulations include the following:

- **Bookend 1: Assume 10 mg Nitrate-N/L for All Other N Loads to Isolate Impact of Irrigated Agriculture on HVA Lands.** This bookend assumes that sources of all other nitrate-N loads are at 10 mg nitrate-N/L. This is not reflective of reality because, undoubtedly, other discharges vary from above to below 10 mg nitrate-N/L. The purpose of this bookend is to ascertain whether irrigated agriculture (i.e., GWP Values) is causing or contributing to an exceedance of the receiving water limit. Under this scenario, CV-NPSAT predicted concentrations above 10 mg nitrate-N/L are assumed to be a result of irrigated agriculture. Nitrate-N loads from irrigated agriculture (GWP Values) were iteratively reduced by 10% to determine the loading levels required to comply with the water quality standard. However, this scenario exaggerates the assimilative capacity available for loads from irrigated agriculture, thus, certain areas result in GWP Targets that may not be restrictive enough to protect water quality.

- **Bookend 2: Assume Best Available Estimates for All Other Nitrate-N Loads to Incorporate Contributions from Other Dischargers.** This bookend assumes the best available estimates for all other nitrate-N loads (Step 2). The purpose of this bookend is to avoid placing the entire burden of complying with receiving water limits on irrigated agriculture alone. Current loading estimates were simulated from 1945 until 2020 to ensure there were no artifacts of historical loading assumptions on future water quality predictions. Nitrate-N loads from irrigated agriculture (GWP Values) and from other sources were iteratively reduced by 10% to determine the loading levels required to comply with the water quality standard. Although this bookend provides a more realistic assessment of the potential impact of current loading from irrigated agriculture on future water quality compared to Bookend 1, this bookend is less capable of ascertaining instances where current irrigated agriculture is, in part, responsible for causing or contributing water quality exceedance.[4] Furthermore, where other nitrate-N discharges are an important factor and contribute significant nitrate-N to groundwater, GWP Targets for these townships may be more restrictive on irrigated agricultural than is appropriate.

[4] Notably, GWP Targets apply to current sources of irrigated agriculture that are subject to the ILRP Orders. GWP Targets are not designed to address legacy sources of nitrate that may already be contained within the system.

FIGURE 4. GWP TOWNSHIPS WITH FEWER THAN 20 DOMESTIC WELLS IN THE SACRAMENTO AND SAN JOAQUIN VALLEYS

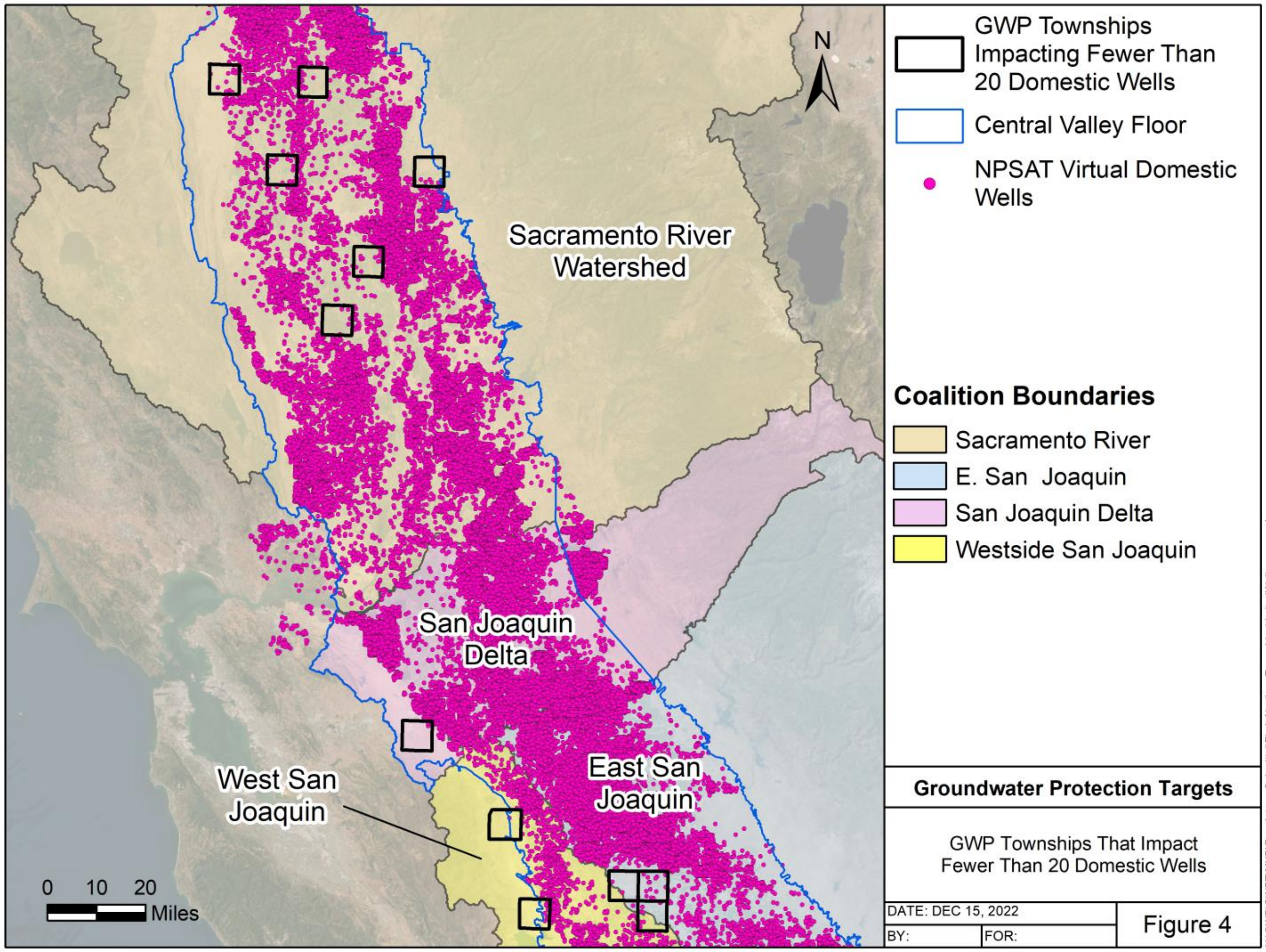


FIGURE 5. GWP TOWNSHIPS WITH FEWER THAN 20 DOMESTIC WELLS IN THE SOUTHERN SAN JOAQUIN VALLEY

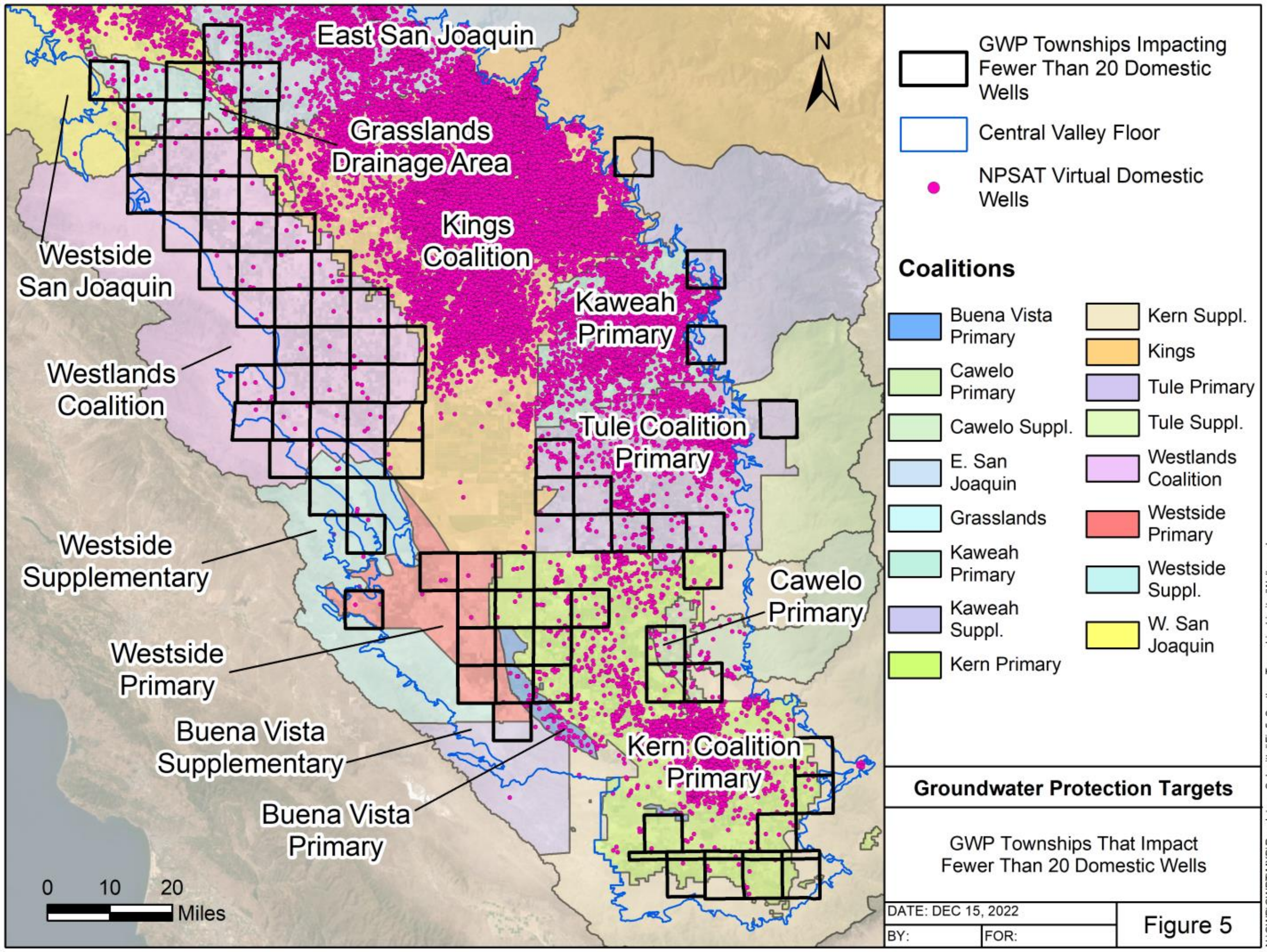
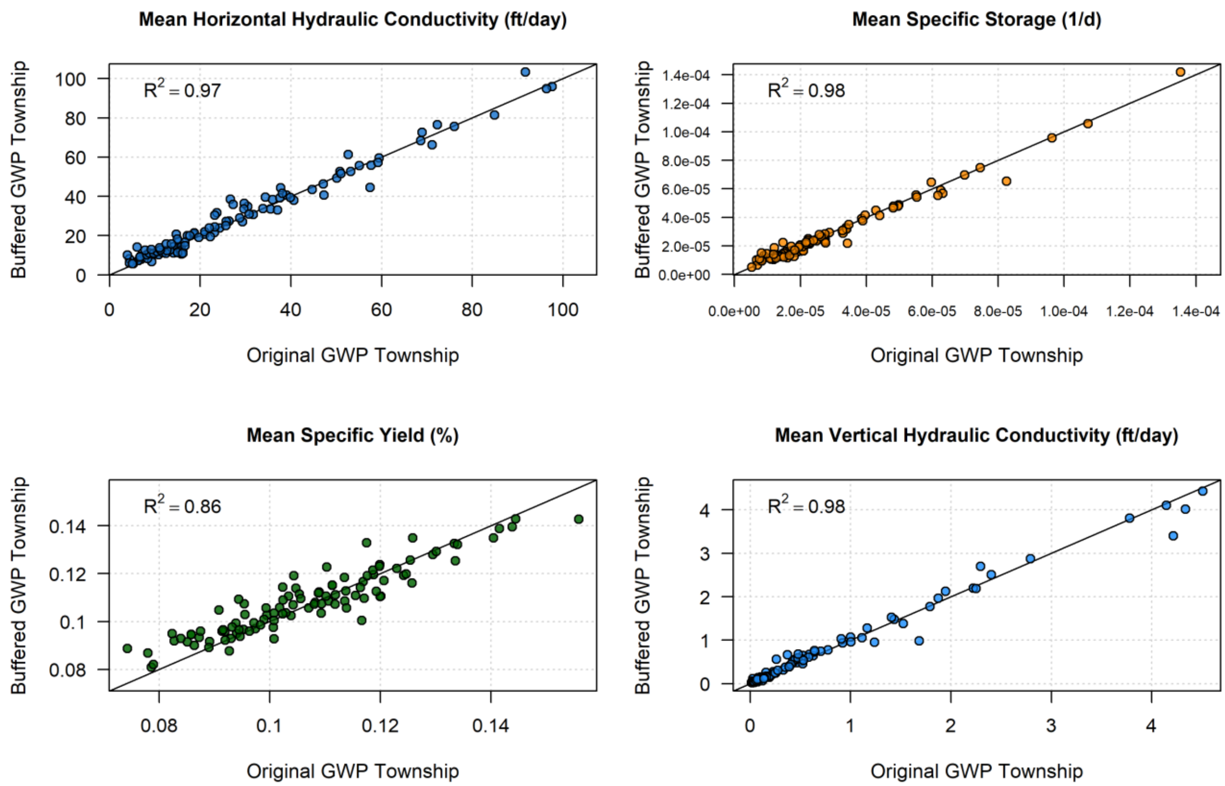


FIGURE 6. COMPARISON OF MEAN C2VSIMFG AQUIFER PROPERTIES WITHIN GWP TOWNSHIP ORIGINAL AND BUFFERED BOUNDARIES (EACH POINT REPRESENTS ONE GWP TOWNSHIP)



2.3 UNCERTAINTY AND SPECIAL CIRCUMSTANCES

Uncertainty in predicted water quality (i.e., CV-NPSAT results) is due to uncertainty in the model inputs (particularly regional hydrology and other nitrate-N loads) and underrepresentation of denitrification in certain regions (particularly in the Sacramento Valley). In addition, there are special circumstances for some townships with a paucity of domestic wells because CV-NPSAT requires a minimum number of wells across a suitably large extent to develop and interpret meaningful results of nitrate-N concentration. Each of these additional and significant factors is described below.

2.3.1 UNCERTAINTY IN MODEL INPUTS

Regional Hydrology. As described in Section 2.2, the assessment framework uses the long-term average recharge volumes from C2VSim's calibrated period (1985-2015) to compute the nitrate-N concentration entering the aquifer in CV-NPSAT. Although this is the best available approach, uncertainties exist regarding water budget information at the regional scale and available data may not accurately reflect local and/or future hydrologic conditions for various parts of the Central Valley. Notably, changes are anticipated to result from the implementation of GSPs by GSAs in response to SGMA. Regional hydrology is expected to change in terms of 1) the amount of groundwater pumped to support irrigated agriculture (which may diminish irrigated agricultural acreage) and/or 2) the amount of aquifer recharge (which may increase in some areas to balance withdrawals). As part of GSP development, GSAs have prepared local water budget information that may in the future be refined, including (but not limited to) refinements to C2VSimFG. Strategies to meet SGMA requirements will be dynamic and adaptive, and future groundwater pumping and recharge strategies, and where these will occur, are anticipated to evolve as GSPs are implemented.

Regarding future conditions related to regional recharge, the assessment framework reflects CV-NPSAT's current spatial distribution of recharge (i.e., where, and relatively how much), but alters the total volume of recharge while holding the nitrate-N load constant. Regional hydrology may not change in this way, but the assessment framework does not include predictions regarding where land fallowing or additional recharge projects may occur.

Other Nitrate-N Loads. As described in Section 2.2, the assessment framework considers nitrate-N loads from irrigated agriculture on HVA lands (i.e., GWP Values), as well as other sources. Estimates of nitrate-N loads from other sources are somewhat uncertain because they have not been quantified with as much rigor as the GWP Values. For example, uncertainty regarding other nitrate-N loads includes:

- **Dairy Lands.** It is well known that dairy waste management practices vary widely, including manure application method, rate, and timing. This affects nitrate-N concentrations at the bottom of the root zone. Furthermore, various estimates exist for dairy nitrate-N loading to groundwater, with estimates displaying wide ranges both within and across studies (Geisseler 2012, Harter et al. 2017, Miller et al. 2020, Luhdorff and Scalmanini 2020).

- **Irrigated Agriculture Outside of HVA Lands.** Regionally specific management information available from growers farming on HVA lands provides a reasonable basis for management approaches on non-HVA lands, meaning estimates of these nitrate-N loads from non-HVA lands are relatively robust.

- **Urban Areas.** Sources of nitrate-N from this land use class include landscape fertilizers, sewage leakage, septic systems (also present in non-urban settings), and industrial and municipal wastewater treatment facilities. Estimates for these sources in the GNLM-CV dataset have a range (0 – 3,210 lb/ac), though have a median of 18 lb/ac. Loads and recharge are somewhat generalized across urban areas, even though in reality these areas have variable land surface types (e.g., impervious surfaces, vacant land) and irrigated/fertilized areas (e.g., landscaping, turf playfields and golf courses, etc.).

  CV-NPSAT results for townships containing urban areas are strongly affected by assumptions about urban discharges. In general, recharge from these areas is low (approximately 1-2 inches), so an N load of 18 kg/ha equates to a concentration of 20 – 40 mg nitrate-N/L. Moreover, the required load reduction needed to have these discharges meet the 10 mg nitrate-N/L objective is substantial (75 - 87.5%). Therefore, townships that contain a considerable fraction of wells in and/or impacted by urban discharges may have an exceedingly restrictive GWP Target result that may not reflect the true impacts of irrigated agriculture.

2.3.2 Results in Townships with Limited Number of Wells

As described in Section 2.1, CV-NPSAT is designed to characterize the impact of nitrate-N loads on virtual wells that reflect actual wells recorded in DWR's Well Completion Report database. The use of domestic wells to identify GWP Targets is conservative because it focuses on shallow groundwater. However, for some townships, the lack of actual shallow, domestic wells affects the simulation of water quality in virtual domestic wells in CV-NPSAT. In these cases, the statistical representation of nitrate-N concentrations in virtual wells is less reliable due to the small proportion of the aquifer affecting the limited number of wells. While the fate of nitrate-N in groundwater is not well represented in these areas, groundwater impairment (if any) affects few actual domestic wells. As described in Section 2.2, 104 GWP Townships were buffered until they included an adequate number of wells to develop a GWP Target.

Public water supply systems that provide drinking water to Disadvantaged Communities (DACs) within these 104 GWP Townships were identified through data sources maintained by DWR and the California Environmental Protection Agency (CalEPA). DWR has three different levels of DAC analysis: Tract, Block Group, and Census Designated Place (CDP) (DWR 2022). The Tract and Block Group datasets cover the entire state. The Block Groups are congruous subsets of each Tract. The CDPs are isolated areas the Census has determined to be populated places, although the designation does not cover all populated areas. The DWR datasets determine DAC status by comparing the Median Household Income (MHI) of the unit of analysis (Tract, Block Group, or CDP) to the statewide MHI. Analysis units with MHI less than 80% of statewide MHI are considered DACs. The CalEPA dataset uses Tracts as the unit of analysis and its DAC designation criteria includes multiple parameters, including MHI in a similar manner as the DWR criteria (CalEPA, 2022). The CalEPA geographic areas do not align with the DWR Tract-level data. To identify public water systems within these 104 GWP Townships, the CalEPA definition and the DWR Block Group and CDP definitions were used. These three DAC definitions were all clipped to the extents of the 104 GWP Townships.

Of the 104 GWP Townships, 58 from the westside of the San Joaquin Valley and Tulare Lake Basin overlie relatively saline groundwater, making the water (and wells that access it) less desirable. DACs within these GWP Townships rely predominantly on surface water deliveries, and where public supply wells do exist, they are completed below the Corcoran Clay. Communities in these 58 GWP Townships may not rely on shallow groundwater for drinking water for reasons other than nitrate-N contamination. Thus, although GWP Targets have been calculated for these areas, it may be appropriate to further consider and evaluate if the drinking water beneficial use appropriately applies to these areas.

2.3.3 Potential Underrepresentation of Attenuation Mechanisms

Post-root-zone attenuation mechanisms have the potential to transform nitrate-N discharges from the land surface. Denitrification is one of the factors that can contribute to nitrate-N attenuation or transformation in both the vadose zone and the saturated zone. Other potential attenuation mechanisms include volatilization of ammonia, dilution with older groundwater, and complex hydrological processes including mixing with recharge water from streams in the vadose zone and saturated zone (Ransom et al. 2018).

Regarding complex hydrological processes, CV-NPSAT currently relies on the regional groundwater model C2VSimFG, which represents the best information available during the tool's latest update. While this model has been calibrated for the Central Valley, the developers acknowledge that the tool may benefit from local refinement in certain areas if additional data and information are available that were not used for the current version's calibration (DWR 2020). Therefore, there is the potential that local attenuation processes are not accurately reflected in the current assessment framework. Over the next five years, the Coalitions intend to work with the developers of CV-NPSAT and others to update the assessment framework and tools relied on within the framework as new data and information become available to refine water budget components and hydrological processes.

CV-NPSAT currently conserves all nitrate-N delivered from the root zone in both the vadose zone and saturated zone, whereas it is known that in areas with suitable conditions, considerable nitrate-N is converted into gaseous forms through denitrification (e.g., McMahon et al. 2008; Landon et al. 2011, Green et al. 2016). Quantitative work done to determine denitrification rates in the Central Valley has mainly been carried out in a limited geographical area around Modesto and focused only on the saturated zone (Mahon et al. 2008, Landon et al. 2011, Green et al. 2016). Limited work has been done to assess vadose zone denitrification in the Central Valley (Harter et al. 2008, Waterhouse et al. 2021) due to challenges associated with obtaining direct measurements, the spatial variability of the factors that influence the process, and the confounding effects of potential factors influencing well sample measurements (e.g., source areas, effects of mixing, nitrate-N source, isotope signature).

However, the process of denitrification is well understood, as are the environmental factors that influence it (Rivett et al. 2008). Denitrification is a type of chemical reaction known as a reduction/oxidation reaction (redox reaction). A redox reaction describes the transfer of electrons from one constituent (reducing agent) to another constituent known as the oxidizing agent. Microorganisms or abiotic pathways facilitate the transfer of electrons from various sources (organic carbon, reduced metals) to nitrate-N (oxidizing agent), which results in the conversion of nitrate-N to nitrogenous gases (Rivett et al. 2008).

Denitrification occurs on a molecular level in microsites (tiny zones in soil where conditions favor the process) and is affected by a variety of interrelated biogeochemical and hydrogeological factors. In general, denitrification tends to be limited in environments that contain ample oxygen because oxygen is a more efficient oxidizing agent than nitrate-N, meaning it is favored in biotic and abiotic redox reactions. Therefore, factors that create low-oxygen environments in the vadose zone and saturated zone create more suitable conditions for denitrification. The other key requirement for this process to occur is ample reducing agents (organic carbon for microbially mediated denitrification, reduced metals for biotic/abiotic denitrification). Below are bullets describing interrelated regional characteristics that can promote conditions favorable for denitrification:

- **Climate and prolonged periods of wetness.** Climates with precipitation that satisfies a relatively high proportion of potential evapotranspiration tend to have wetter soils and subsoils. Where these conditions are sustained for sufficient periods of time, low-oxygen conditions can occur (Burow et al. 2013).

- **Landscape position.** Low-lying positions receive run-off from upland areas, and poorly drained areas tend to accumulate water, thus promoting low-oxygen conditions (Burow et al. 2013).

- **Soil and subsoil texture.** Finer textured soils and sediments tend to have a large fraction of fine pores that hold onto water more tenaciously, leading to relatively high water holding capacities and low hydraulic conductivities. These properties also favor wetness and retard the diffusion of oxygen (Hillel, 2003).

- **Ample reducing agents.** Electron sources like organic carbon or reduced metals are needed to reduce nitrate-N into gaseous forms (Rivett et al. 2008). Organic carbon can either be transported from overlying soil layers (in dissolved forms) or exist in sediments from previous depositional events (Chapelle et al. 2013). Furthermore, because aerobic microorganisms also use organic carbon for their metabolism, the presence of organic carbon can lead to a depletion of oxygen through respiration. Reduced metals are supplied from sediment parent material which varies spatially. Iron (one of the most common elements in the earth's crust, and thus in sediments and soils) in particular has been shown to facilitate denitrification in subsoils (Waterhouse et al. 2021).

- **Depth to groundwater.** Shallow groundwater fills soil and subsoil pores with water, thus slowing oxygen diffusion (which is 10,000 times faster in gas-filled pores than in water-filled pores). Furthermore, in areas where groundwater is nearer to the land surface, it is also closer to soil layers that contain organic carbon sources that can leach downward (McMahon and Chapelle 2008).

- **Reactive geology.** Certain sediment constituents react with oxygen (e.g., iron sulfide deposits), meaning that oxygen may be depleted in waters that are in prolonged contact with such minerals (Kolbe et al. 2019).

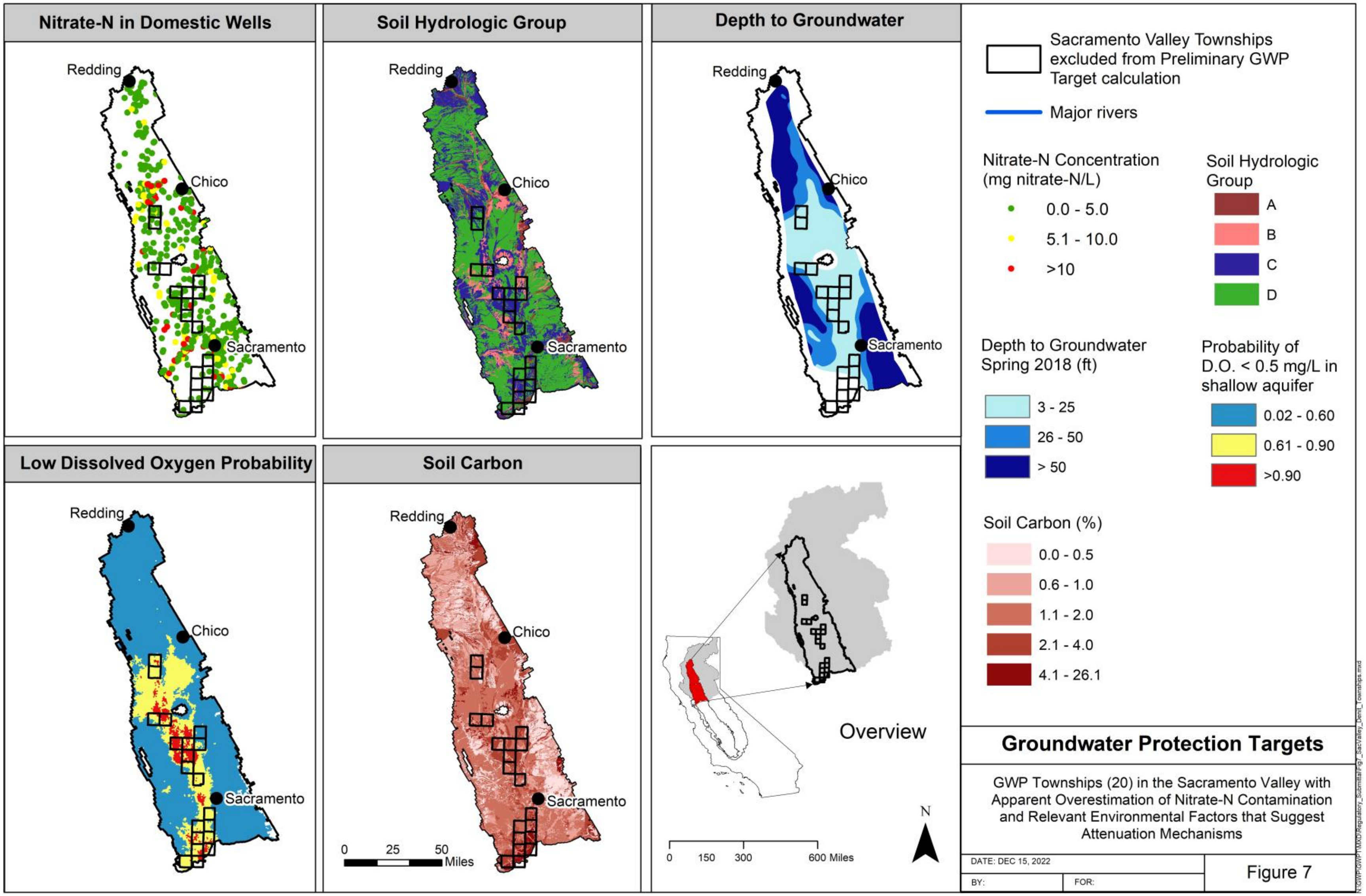
Regional-scale studies have characterized where saturated zone conditions favor denitrification in the Central Valley based on monitoring data and consideration of the factors known to affect denitrification. As mentioned in Section 2.2, favorable conditions for denitrification occur in the valley troughs, areas with shallow water tables, areas with historical groundwater discharge to rivers, and where shallow modern groundwater interacts with surface soils higher in carbon (Landon et al. 2011, Chapelle et al. 2013). In addition, Rosecrans et al. (2017) modeled the likelihood of low dissolved oxygen conditions and elevated concentrations of reduced manganese in the Central Valley (i.e., conditions supporting increased likelihood of widespread denitrification) based on a variety of data inputs, including depth to groundwater (based on CVHM), soil and subsoil texture and drainage/conductivity information, lateral position (distance from streams), land use (including riparian areas), and soil/subsoil minerology. Using these results, Ransom et al. (2017) showed that the probability of reduced conditions in the saturated zone (greater than 60% probability of dissolved oxygen <0.5 mg/L or reduced manganese concentrations > 50 ug/L) was the strongest predictor of nitrate-N concentrations among other considered factors (e.g., historical nitrate-N loading estimates, annual recharge, etc.). Since these reduced conditions are the same conditions that favor higher rates of denitrification, it is reasonably possible that denitrification is the operative mechanism driving this relationship. For comparison, a highly conservative threshold of >90% probability of dissolved oxygen <0.5 mg/L was used in the current assessment framework to isolate regions with suitable conditions for denitrification in the saturated zone.

Therefore, given that denitrification in the current assessment framework is highly conservative in the saturated zone and not considered in the vadose zone, the current assessment framework is not fully accounting for denitrification and its mitigating impact on water quality. Future refinement of the assessment framework will consider denitrification in the vadose zone and refine its representation in the saturated zone (Section 4).

2.3.4 Apparent Overestimations of Nitrate-N Contamination in Portions of Sacramento Valley

Predicted water quality results from CV-NPSAT were compared to other available data and information (e.g., GARs, MPEP, Trend Monitoring Program, GAMA) to determine whether the results appropriately reflect local groundwater conditions. Through this evaluation, it was found that the assessment framework overestimates nitrate-N levels for 20 GWP Townships in the Sacramento Valley, likely due to underrepresentation of post-root zone processes (Figure 7) (Section 2.3.3). Within these GWP Townships, the model results suggest that approximately 15% or more of the wells should exceed the receiving water limitations. However, monitoring data from these same areas show that actual groundwater nitrate-N concentrations are well below receiving water limitations (i.e., less than 5 mg nitrate-N/L)

FIGURE 7. GWP TOWNSHIPS (20) IN SACRAMENTO VALLEY WITH APPARENT OVERESTIMATION OF NITRATE-N CONTAMINATION AND RELEVANT ENVIRONMENTAL FACTORS THAT SUGGEST ATTENUATION MECHANISMS



Upon finding this anomaly, additional analysis was conducted to determine if it is appropriate to compare current water quality conditions (which are a function of historical nitrate-N loading, hydrology, and potential attenuation factors) to future water quality predictions made with CV-NPSAT simulations (which are a function of today's conditions). To ensure that a comparison of current water quality conditions against future simulated conditions was appropriate, additional analysis focused on understanding the stability of regional hydrology over time, as well as the similarity of historical and current estimates of nitrate-N loads. If historical conditions (i.e., historical N loading estimates) are generally comparable to current conditions (i.e., current N loading estimates) in these GWP Townships, then it is reasonable to conclude that there is an apparent overestimation of nitrate-N contamination in portions of the Sacramento Valley. The following outlines the comparison between historical and current conditions.

- **Regional Hydrology is Stable Over Time.** The water budget components in C2VSimFG are relatively stable over time in the Sacramento Valley. For example, across the Sacramento Valley Watershed from the calibrated period of 1985-2015, the coefficient of variation for net deep percolation and recharge is approximately 23%. This suggests that over decadal timescales, regional hydrology can be considered fairly stable based upon C2VSimFG, meaning that differences in nitrate-N loading (if any) may be more important for determining whether there is an apparent overestimation of nitrate-N concentration with the current assessment framework. Notably, however, local-scale hydrological processes may be misrepresented in the current assessment framework due to the limitations associated with C2VSimFG at this time.

- **Historical and Current Estimates of Nitrate-N Loads are Comparable.** As a general benchmark, Ransom et al. (2017) found that nitrate-N loading from the 1970s and total N inputs from the 1990s are strong predictors of current groundwater nitrate-N measurements across the Central Valley. This relationship may differ to some extent in the Sacramento Valley due to the shallower depth to groundwater as compared to the San Joaquin Valley and Tulare Lake Basin.

  Available historical nitrate-N loading estimates include the mass balance-based GNLM-CV (Harter et al. 2017) and statistically inferred loading rates from Ransom et al. (2018). GNLM-CV is based on comprehensive mass balance accounting of major nitrate-N sources and sinks (e.g., fertilizer sales, crop N removal, dairy waste, urban sources, etc.) and relies on regional scale information to define many components of the mass balance. Field-scale management information was not available and was thus not used to develop the GNLM-CV. Further, N inputs greater than agronomic rates were applied to the landscape in various ways to satisfy the mass balance accounting and may not accurately reflect past N management at specific locations or for some sources.

  In comparison, the statistically inferred nitrate-N loading rates (Ransom et al. 2018) are effectively "back calculated" from current water quality data. Current water quality data were related to 1990 land use and loading rates were determined through statistical methods that also considered generalized assumptions around well source area and agricultural recharge volumes. This approach also implemented a nitrate-N attenuation factor to reduce loading estimates for certain geographies to better match observed water quality information. The authors stated that the attenuation could be a function of denitrification and/or travel time. Notably, many of the wells used to infer loading rates by Ransom et al. (2018) are from the San Joaquin Valley, and there are very few wells near these 20 GWP Townships.

When compared to these two approaches, current estimates of nitrate-N loading in the assessment framework (Section 2.2) are generally comparable to GNLM-CV estimates from 1975 (Harter et al., 2017) for these 20 GWP Townships. Specifically, of the 20 GWP Townships, 15 townships are within ± 10 lb/ac nitrate-N loading (township average) and for five townships, the current estimated nitrate-N loading is 10-15 lb/ac greater. GNLM-CV estimates for 1990 were all higher than the current assessment framework.

There is also generally good agreement between N loading estimates from the current assessment framework and the statistically inferred estimates from Ransom et al. (2018). Specifically, of the 20 GWP Townships, 13 townships are within ± 10 lb/ac and the remainder have higher loading estimates in the current assessment framework (four townships between 10 and 20 lb/ac, and three townships between 20 and 30 lb/ac). Notably, the nitrate-N attenuation factor used by Ransom et al. (2018) is larger in magnitude and geography than what is considered by the current assessment framework.

Keeping in mind that estimates of historical nitrate-N loading are found to be a good predictor of current groundwater quality as actually measured, it is reasonable to conclude by extension that the current estimates of nitrate-N loading should be reasonable indicators for future water quality. In the assessment framework, nitrate-N loading generally compares well to two independent estimates of historical loading from unique methodologies for these 20 GWP Townships, meaning that a comparison between current water quality and future predictions is reasonable. Furthermore, it is highly unlikely that all three methodologies systematically over-estimate nitrate-N loading in these townships, meaning that some attenuation mechanisms are likely occurring underneath these GWP Townships to explain one or more factors contributing to the apparent discrepancy between modeled results and current ambient water quality conditions.

The current assessment framework takes a highly conservative approach for reflecting potential denitrification below the root zone. Environmental conditions associated with these 20 GWP Townships include close proximity to a stream/river, a shallow depth to groundwater (DWR, 2021), relatively small differences between precipitation and potential evapotranspiration (Burow et al., 2013), fine textured sediments, and relatively high carbon content in soil layers (Faunt et al., 2010, National Cooperative Soil Survey 2022) (Figure 7). In addition, the majority of these areas are estimated by Rosecrans et al. (2017) to have a high probability of low D.O. concentrations in the upper aquifer, which is highly favorable for denitrification. These factors, which have also been documented by others (e.g., Burow et al. 2013), suggest that denitrification contributes to low nitrate-N in these areas of the Sacramento Valley. Furthermore, data and information from C2VSimFG used in CV-NPSAT are based upon the calibrated regional groundwater model and may be less accurate at the local scale. It is therefore possible that additional hydrologically-based attenuation mechanisms may also be impacting CV-NPSAT predictions in these areas.

In conclusion, water quality monitoring data illustrate nitrate-N concentrations well below the receiving water limitations for 20 GWP Townships in the Sacramento Valley. Comparison between current monitoring data and modeled results is appropriate for the Sacramento Valley because regional hydrology and nitrate-N loading estimates are relatively stable over time based upon available information previously described. Overestimations of nitrate-N concentrations in Sacramento Valley groundwater are likely due to uncertainty associated with the current assessment framework handling of attenuation processes. For this reason, GWP Targets are not provided for these GWP Townships, unless the GWP Value indicates that irrigated lands in the township are discharging at or below 10 mg/L-N. For the 19 GWP Townships for which the GWP Value exceeds 10 mg/L-N, milestones are provided. For the one remaining GWP Township (for which the GWP Value is below 10 mg/L-N), the GWP Target is set at the GWP Value to maintain status quo.

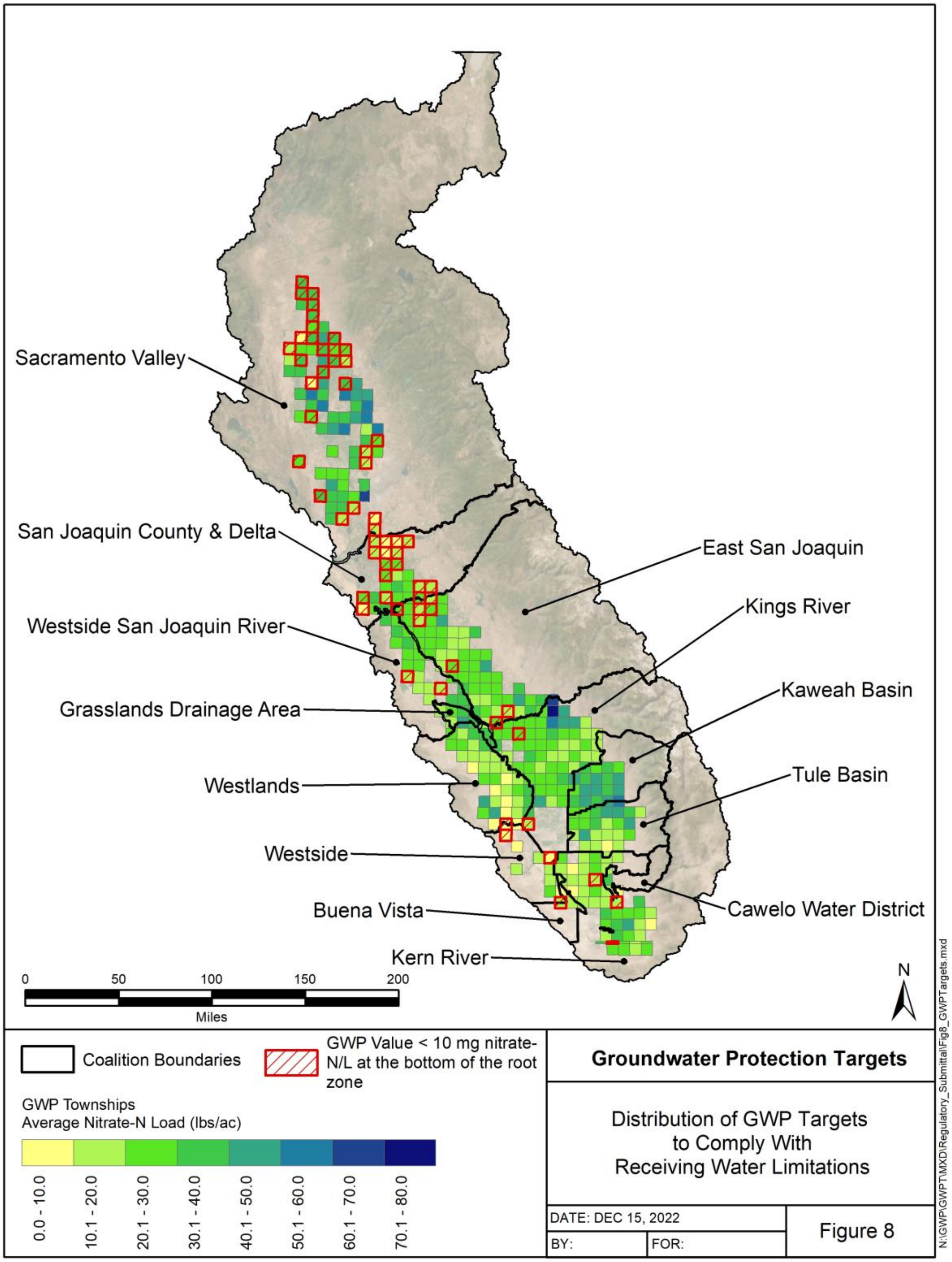
2.4 GWP TARGETS

As described in this Report, the GWP Targets have been developed to comply with the terms of the LTILRP Orders even though the accuracy of these GWP Targets (even as estimates) is significantly hampered by the lack of current data and information needed to inform the assessment framework (i.e., regional hydrology, other nitrate-N loads). Furthermore, the assessment framework currently includes a conservative approach to reflect post-root zone attenuation, meaning that the GWP Targets are conservative.

The GWP Targets reflect the acre-weighted average nitrate-N loading (lbs/ac) at the bottom of the root zone determined through CV-NPSAT simulations to ensure irrigated agriculture is protective of drinking water associated with domestic wells (Section 2.2). As described in Section 2, the GWP Targets are based on the best available information and tools (CV-SWAT, CV-NPSAT/C2VSimFG) and are a function of regional hydrology, nitrate-N discharges to groundwater from irrigated agriculture and other sources, in addition to groundwater flow and mixing processes that transport nitrate-N from the water table to virtual domestic wells. As such, subregional differences in these environmental characteristics and processes can result in varying GWP Targets across GWP Townships.

GWP Targets were computed for 379 GWP Townships where model predictions were deemed adequately reliable (i.e., no apparent overpredictions of nitrate contamination) for the initial determination of GWP Targets. The GWP Targets are displayed graphically in Figure 8, and presented in a tabular format in Appendix 1. As shown in Figure 8, there are 64 GWP Townships with GWP Values at or below 10 mg/L-N (indicated by the red boxes), thus the GWP Target is set at the GWP Value to maintain status quo.

FIGURE 8. DISTRIBUTION OF GWP TARGETS TO COMPLY WITH RECEIVING WATER LIMITATIONS



3 MILESTONES AS INTERIM PERFORMANCE GOALS

As described in Section 1, there is appreciable uncertainty associated with the GWP Targets that are described in Section 2. Considering this uncertainty, the Coalitions have developed milestones designed to improve efficient use of N by growers. The milestones are intended to move growers closer to achieving compliance with receiving water limits, or in other words, no longer cause or contribute to exceedances of the nitrate drinking water objective. The milestones are intended to be incorporated into GQMPs for the next five-year period.

Specifically, the milestones optimize near-term load reduction, where needed, using a statistical approach that considers crop-specific management metrics based on applied and removed N. This includes evaluation of multiple years of grower reported Irrigation and Nitrogen Management Plan (INMP)/Nitrogen Management Plan (NMP) Summary Report information to identify near-term load reduction opportunities. The following sections provide additional context for the development of milestones as well as information on the crop-specific management metrics and the methods used to compute the milestones.

3.1 CONTEXT FOR MILESTONES

The development of appropriate GWP Targets for irrigated agriculture requires an accurate and holistic representation of the Central Valley aquifer system, including adequate characterization of the various key components including 1) estimates of nitrate-N discharges to groundwater across all dischargers, 2) accounting of regional recharge from irrigated root zones and other sources as well as other hydrological processes, 3) post-root-zone attenuation processes, 4) aquifer characteristics and processes, and 5) information on groundwater usage (i.e., well locations and construction information, pumping rates/volumes). As such, uncertainty associated with data and information for any individual component or set of components can lead to additional uncertainty in the determination of irrigated agriculture's impacts to groundwater quality and thus the determination of township-specific GWP Targets. In contrast, the root zone of irrigated agriculture represents the best characterized component of the Central Valley aquifer system due to the detailed CV-SWAT model and site-specific management information provided by growers. Therefore, milestones based upon a detailed analysis of the root zone of irrigated agriculture provide a clear, quantifiable, and more certain near-term milestone that will result in nitrate-N load reduction where needed.

Irrigated agriculture in California's Central Valley is a much more complex enterprise than in other areas of the United States. A large number of diverse crops have significant acreage, with high-value horticultural crops (e.g., fruit and nut trees, vegetables) dominating the agricultural landscape. Growers farm under varying environmental conditions (soil, climate, topography) and implement a wide range of management practices to produce crops. Further, for all major crops that collectively encompass approximately 98% of acreage reported in INMP/NMP summary reports, grower-reported data illustrate a wide range of yields. This range arises from the variety of management practices employed (of which N application is only one component), weather, pest pressure, and market conditions. In such a complex system, it is impossible to define universally appropriate N application rates for any given crop without considering site-specific information and context. While growers' ability to maximize N delivery to their crops (and the subsequent removal of N in harvested material) is subject to varying challenges and constraints (e.g., crop damage, irrigation system, water availability), this does not preclude the identification of parcels that may benefit from improved management practices that can lead to more crop uptake of applied N.

To evaluate the efficiency of N use and the associated potential environmental impacts, various metrics are available. However, for the purpose of determining milestones as presented in this Report, two metrics were identified and evaluated, and the most appropriate metric was selected for this application. The two metrics evaluated were 1) N Removal Efficiency (NRE) and 2) N Applied minus N Removed or Sequestered (A-R). NRE is the fraction of N applied that is removed in harvested material or sequestered in perennial tissue. A-R is the mass balance of N applied minus N removed in harvested material or sequestered in perennial tissue. While related, these metrics are not the same. For example, the A-R mass balance can be variable at a given NRE. Moreover, at a given NRE, the A-R mass balance increases with increasing crop yield. A-R more directly relates to potential groundwater nitrate-N loading because it represents the mass of available nitrate-N that may be available to leach to groundwater. Considering that the purpose of GWP Targets is to ultimately achieve compliance with receiving water limits, which must account for the potential amount of nitrate-N loading to groundwater, A-R was determined to be the most appropriate tool to assess N management of major acreage crops to develop the milestones.

As part of the reporting requirements for the General Orders, growers must report Irrigation and Nitrogen Management Plan (INMP) (formerly Nitrogen Management Plan [NMP]) summary data (e.g., crop type, N applied, yield) to the Coalitions in their INMP and NMP Summary Reports (hereafter referred to as "INMP/NMP Summary Reports"). Coalitions use these data to calculate N removed using crop-specific coefficients (Geisseler 2016, 2021). The INMP/NMP Summary Reports data along with the crop-specific coefficients provide the information necessary to identify opportunities for near-term, technically, and economically feasible load reductions.

Moreover, the Root-zone Library that was developed to calculate GWP Values provides information needed to estimate potential load reductions associated with improved N management. Specifically, as a part of development of the GWP Values, a Root-zone Library was developed using CV-SWAT (Central Valley Coalitions 2021). The Root-zone Library includes unique model runs for Central Valley crops that account for soil and climate conditions, as well as management information from INMP/NMP Summary Reports. Each model run provides a unique estimate of percolation and nitrate-N leaching using CV-SWAT results based on crop, soil, climate, applied N, and yield. As a result, the Root-zone Library can be used to estimate load reductions by selecting an alternative management scenario for a given parcel *x* crop *x* soil *x* climate (relative to a reported INMP/NMP Summary Report) with more efficient use of N and therefore a lower nitrate-N leaching estimate. This alternative scenario is reflective of the implementation of management practices that are known or have been demonstrated to be protective of groundwater quality. In this way, the Root-zone Library provides the basis for quantifying the milestones.

3.2 METHODS

The steps used to compute milestones for GWP Townships are as follows:

Step 1. Identify GWP Townships for milestones. Milestones are provided for GWP Townships where an interim performance goal would move growers closer to achieving compliance with receiving water limits. This includes most GWP Townships estimated to discharge more than 10 mg nitrate-N/L at the bottom of the root zone, as identified in the GWP Values Report (Central Valley Coalitions 2021). If a GWP Township is estimated to discharge less than 10 mg nitrate-N/L, then a milestone is unnecessary and the GWP Target is set at a level that reflects the status quo to maintain current loading levels. Furthermore, milestones are only provided for GWP Townships where an interim performance goal towards the GWP Target is applicable. In other words, for some GWP Townships, an interim goal is not necessary and the GWP Target (rather than a milestone) will be incorporated into the GQMPs for the next five-year period.

Step 2. Develop Crop-specific A-R Thresholds. Crop-specific A-R thresholds were developed based on evaluation of the distribution of four years (2017-2020) of grower-reported INMP/NMP Summary Report data for individual crops across the Central Valley. For crops with more than 10,000 acres of INMP/NMP Summary Report data over the four years, the crop-specific A-R thresholds were determined based on the A-R mass balance achieved by the majority of the reported acreage. Specifically, four years of crop-specific A-R values were sorted from smallest A-R to largest A-R, and the associated acreage from each report was tallied. Only A-R values greater than 0 were included to ensure the milestones are based upon agronomically sustainable systems. From there, the A-R threshold was defined as the A-R that has been achieved by 75% of the total assessed acreage (over four years) for individual crops (Figure 9). For crops with marginal acreage (less than 10,000 acres of INMP/NMP Summary Report data over four years), a NRE of 45% was used for both annuals and perennials based on analysis of INMP/NMP Summary Reports of larger acreage crops. While there is limited information on these crops with marginal acreage, the relative potential impact of nitrate-N leaching on groundwater quality is also limited.

Step 3. Estimate Potential Load Reductions Associated with Achieving the A-R Thresholds. The potential nitrate-N load reductions are relative to the GWP Values computed with the 2019 INMP/NMP Summary Reports and were estimated using the Root-zone Library (Central Valley Coalitions 2021). To compute the potential nitrate load reductions, parcels were identified that reported an A-R in 2019 that exceeded the A-R threshold (Step 2) for the respective crop(s). For these identified parcels, an alternative scenario was selected from the Root-zone Library with the appropriate crop x soil x climate combination that reflects an A-R that is at or just within the appropriate A-R threshold. No assumptions were made regarding improved crop yield (i.e., increases in the “R” term), meaning that selected alternative scenarios contained adjusted N fertilizer rates (“A” term) while the reported yields were held constant. Non-bearing perennial A-R distributions were similar to mature crops and were therefore treated the same as mature trees for the purposes of determining potential load reduction.

Step 4. Calculate Milestone. Once alternative loading scenarios were selected for all parcels above the crop-specific A-R thresholds, nitrate-N loading estimates from these parcels and the unadjusted parcels (i.e., already within the A-R threshold) were aggregated to the township scale in the same manner that GWP Values were computed. The aggregated township loading estimates comprised of alternative nitrate-N loading scenarios (where needed) are the milestones, expressed as the acre-weighted average lb/ac nitrate-N loading at the bottom of the root zone.

In summary, the milestones were determined through a crop-specific assessment of A-R based on multi-year grower-reported INMP/NMP Summary Report data. The milestones reflect the acre-weighted average nitrate-N loading at the bottom of the root zone anticipated if all growers in that township were to meet the A-R associated with 75% of the acres for that crop across the valley (or 45% NRE for marginal crops). The proposed milestones provide for a clear, quantifiable, metric for reduction in nitrate-N load where needed.

3.3 MILESTONES

The milestones reflect acre-weighted average nitrate-N loading (lb/ac) at the bottom of the root zone that may be achieved through successful refinement of management practices (where needed). Milestones were computed for 191 GWP Townships and provide a clear, quantifiable, and more certain interim performance goal for reduction in nitrate-N load where needed. Milestones were not computed for 208 GWP Townships because their GWP Values indicate they are currently discharging at or below 10 mg/L-N (64 GWP Townships) or an interim performance goal is not applicable.

Each GWP Township is comprised of a unique crop mix with individual crops being managed in site-specific ways, meaning that the resulting milestones vary considerably across GWP Townships both in terms of (1) the opportunity for load reduction relative to the GWP Values (i.e., the current state of N below the root zone) and (2) the ultimate targeted nitrate-N load for the township.

The prioritized load reduction for those parcels that are above the A-R threshold as compared to other growers (on a crop-by-crop basis) associated with the milestones will result in the greatest near-term mitigation of nitrate-N discharges possible considering current circumstances and available information. The milestones are summarized below, illustrated graphically in Figure 10, and presented in a tabular format in Appendix 1.

FIGURE 9. THEORETICAL CROP-SPECIFIC DISTRIBUTION OF APPLIED NITROGEN (A) MINUS NITROGEN REMOVED (R) AND THE A-R THRESHOLD ASSOCIATED WITH 75TH PERCENTILE OF REPORTED ACREAGE

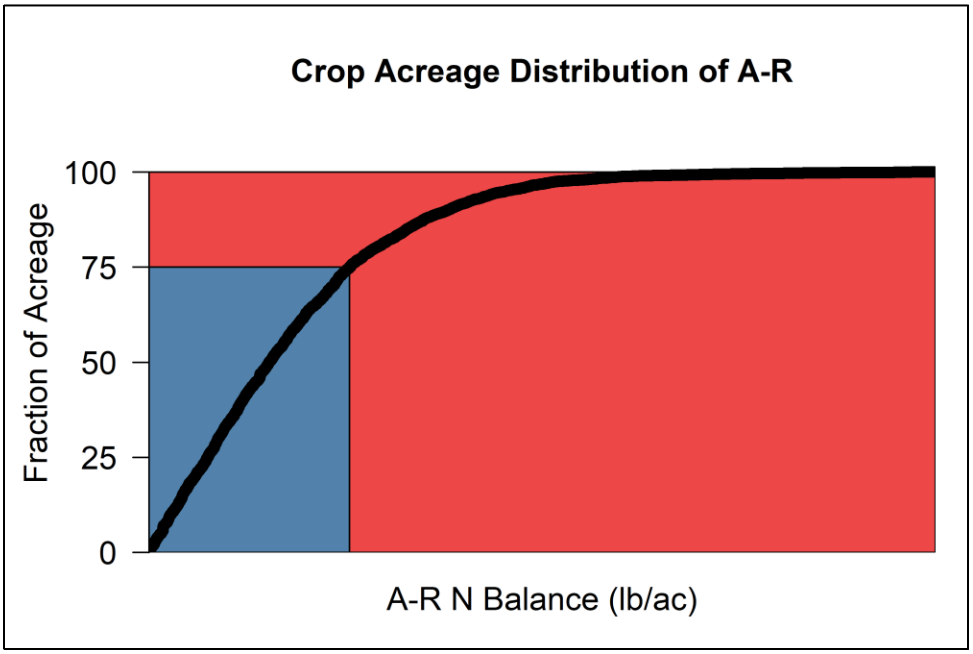
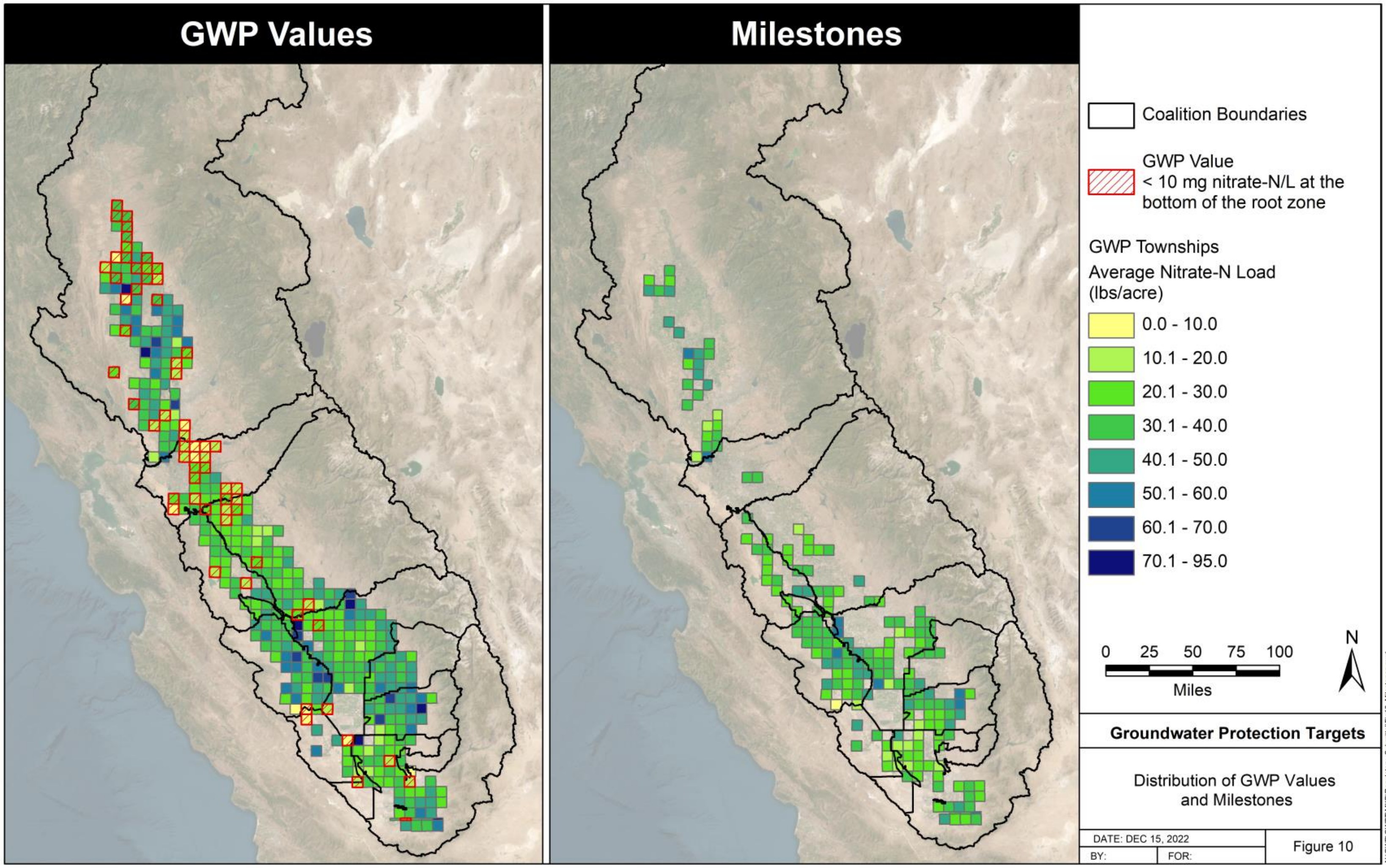


FIGURE 10. DISTRIBUTION OF GWP VALUES AND MILESTONES



4 FUTURE REFINEMENTS TO GWP TARGET ASSESSMENT FRAMEWORK

As described throughout Section 2, the GWP Target assessment framework focuses on as many of the major factors and processes related to nitrate-N fate and transport as practicable. Currently, the GWP Target assessment framework concentrates on two components that are influential determinants of the fate of applied N: 1) processes on and in the crop root zone, considering the effects of irrigation and fertilizer management, crop and soil type, topography, and climate, and 2) transport of nitrate-N to wells once it enters the aquifer.

There are additional processes that can be locally important to nitrate-N fate that will be considered in future refinements to the GWP Targets assessment framework, and hence future GWP Targets. Over the next five years, the Coalitions, in conjunction with UC Davis (where applicable), the Central Valley Water Board, and other stakeholders, will refine existing model tools and methods for interpreting their output, identify additional data and information, and develop additional modeling tools, as appropriate. The Coalitions anticipate that these future refinements include, but are not limited to, the area described below.

Model Inputs. By 2027, it is likely that significant new data, model refinements (regionally and locally), and other information will be available regarding the Central Valley aquifer system that will improve determination of future GWP Targets. For example, GSP implementation has begun in all medium, high, and critically over-drafted basins. GSP implementation will lead to improved local estimates of water use and hydrological dynamics. Second, as required by the Regional Water Board, Nitrate Control Program Management Zone Implementation Plans for Priority 1 and Priority 2 areas should be available and underway. This will require the determination (or refinement) of N load estimates from various point and non-point sources. Third, CV-NPSAT (developed by UC Davis), should be further refined and updated to address some of the uncertainties identified in this Report as well as other potential uncertainties that may be uncovered. These updated data sources will improve model inputs, particularly for regional hydrology and quantification of other N loads.

Denitrification. Various mechanisms and geographic distributions that account for denitrification will be explored for incorporation into the GWP Target assessment framework.

Results in Townships with Limited Number of Domestic Wells. The need to address this aspect of the GWP Target assessment framework could be prioritized by the relative level of potential impact on actual groundwater users in these areas. Since the issue is by definition limited to areas with very few shallow wells, potential impacts on groundwater that is actually used as drinking water may be very limited in some of these areas. Where existing groundwater conditions are known or likely to include poor water quality (e.g., high salinity), a closer look at actual well and human populations to determine whether groundwater, based on other non-nitrate-N issues, is or is likely ever to be used for drinking would be a first step. In areas where groundwater use for drinking is unlikely because it is infeasible or impractical, de-designation of drinking water uses may be appropriate. Where this is not the case, alternative approaches to improving characterization and calculating GWP Targets of these areas would be pursued.

5 Conclusions

As described throughout this Report, groundwater quality in the Central Valley aquifer system is impacted by numerous complex, dynamic, and interrelated processes, all subject to varying degrees of understanding and uncertainty. To develop GWP Targets with any level of certainty, it is necessary to characterize groundwater quality under current and alternative scenarios involving nitrate-N loading associated with agricultural and other land uses. This requires accurate estimates of recharge and nitrate-N loading, as well as the physical and chemical characteristics of the aquifer, post-root zone attenuation factors, and groundwater flow and constituent transport. Without robust estimates of these key surface and subsurface processes, it is challenging to determine GWP Targets with any level of certainty. Understanding this current lack of data and information is important as it explains the level of uncertainty associated with the GWP Targets. However, GWP Targets must be reviewed every five years, and updated if necessary. Future GWP Targets are expected to integrate refined model inputs related to regional hydrology including additional evaluation and refinement of regional and local water budget components in addition to estimations of other nitrate-N loads and post-root-zone processes.

In contrast to the uncertainty of the data and information available to determine the GWP Targets, the root zone of irrigated agriculture represents the best characterized component of the Central Valley aquifer system due to the calibrated, detailed CV-SWAT model and site-specific management information provided by growers. As a result of the data and information available, a detailed analysis of the root zone of irrigated agriculture was possible, resulting in milestones that provide a clear, quantifiable, and more certain metric for reduction in nitrate-N load where needed. The milestones reflect acre-weighted average nitrate-N loading (lb/ac) at the bottom of the root zone that may be achieved through refinement of management practices. The milestones are intended to be incorporated into GQMPs to inform management practices for the next five years, while refinements to the assessment framework for the GWP Targets occur.

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APPENDIX 1 GWP TARGETS AND MILESTONES AS INTERIM PERFORMANCE GOALS

TABLE 1-1. SUMMARY OF GWP TARGETS FOR GWP TOWNSHIPS AND MILESTONES AS INTERIM PERFORMANCE GOALS

			GWP Value		Milestones as Interim Performance Goals	GWP Targets		
MTR	Coalition(s)	Percent High Vulnerability Area	2019 INMP/NMP Acreage	AWA Nitrate-N load (lb/ac) at the Bottom of the Root Zone	AWA Nitrate-N load (lb/ac) at the Bottom of the Root Zone	Buffer Distance Applied To GWP Township To Include 20 or More Virtual Domestic Wells (miles)	Number of Domestic Wells in CV-NPSAT Impacted by GWP Township Load	AWA Nitrate-N load (lb/ac) at the Bottom of the Root Zone
M01N06E	SJCDWQC	73	822	20.4	NA	0	314	20.4
M01N07E	SJCDWQC	96	9302	38.9	35.7	0	328	19.4
M01N08E	SJCDWQC	26	7136	42.5	38.2	0	222	25.5
M01S06E	SJCDWQC	50	2875	26.6	NA	0	438	26.6
M01S07E	SJCDWQC	100	13685	33.7	NA	0	342	33.7
M01S08E	SJCDWQC	72	10831	33.4	NA	0	247	25
M01S09E	SJCDWQC	71	6945	20	NA	0	619	20
M01S10E	ESJWQC, SJCDWQC	48	4728	16.3	NA	0	356	16.3
M02N06E	SJCDWQC	99	2078	25	NA	0	407	25
M02N07E	SJCDWQC	79	10551	22.3	NA	0	512	22.3
M02S04E	SJCDWQC	55	3362	22.7	NA	0	325	22.7
M02S05E	SJCDWQC	70	4229	33.2	NA	0	313	33.2
M02S06E	SJCDWQC	67	8781	19.1	NA	0	268	19.1
M02S07E	ESJWQC, SJCDWQC	100	11519	23.2	NA	0	362	23.2
M02S08E	ESJWQC, SJCDWQC	100	13968	27	NA	0	283	27
M02S09E	ESJWQC, SJCDWQC	99	12350	20.5	NA	0	530	20.5
M02S10E	ESJWQC, SJCDWQC	100	7878	18.7	NA	0	842	18.7
M02S11E	ESJWQC, SJCDWQC	28	5363	25	NA	0	435	25
M03N02E	SVWQC	14	3904	16	16	1	31	NA
M03N03E	SVWQC	26	4071	52.9	52.9	0	29	NA
M03N05E	SJCDWQC	33	3223	20	NA	0	67	20
M03N06E	SJCDWQC	100	11040	9	NA	0	414	9
M03N07E	SJCDWQC	30	4183	13.4	NA	0	388	13.4
M03S04E	SJCDWQC	13	70	9.7	NA	1	30	9.7
M03S05E	SJCDWQC, WSJRWC	91	9239	27.4	NA	0	272	27.4
M03S06E	SJCDWQC, WSJRWC	100	16197	36.1	NA	0	211	32.5
M03S07E	ESJWQC, SJCDWQC, WSJRWC	100	11419	20.5	NA	0	115	20.5
M03S08E	ESJWQC	100	12921	24.3	NA	0	366	24.3
M03S09E	ESJWQC	100	2012	16.8	NA	0	177	16.8
M03S10E	ESJWQC	100	9736	20.4	NA	0	393	20.4
M03S11E	ESJWQC	37	13462	30	NA	0	218	30
M04N03E	SVWQC	34	7062	33	33	0	67	NA
M04N04E	SVWQC	16	4263	34.4	33.2	0	26	NA
M04N05E	SJCDWQC	58	9399	12.1	NA	0	84	12.1

			GWP Value		Milestones as Interim Performance Goals	GWP Targets		
MTR	Coalition(s)	Percent High Vulnerability Area	2019 INMP/NMP Acreage	AWA Nitrate-N load (lb/ac) at the Bottom of the Root Zone	AWA Nitrate-N load (lb/ac) at the Bottom of the Root Zone	Buffer Distance Applied To GWP Township To Include 20 or More Virtual Domestic Wells (miles)	Number of Domestic Wells in CV-NPSAT Impacted by GWP Township Load	AWA Nitrate-N load (lb/ac) at the Bottom of the Root Zone
M04N06E	SJCDWQC	96	14106	9	NA	0	405	9
M04N07E	SJCDWQC	24	3431	9	NA	0	659	9
M04N08E	SJCDWQC	17	2813	11.2	NA	0	188	11.2
M04S06E	SJCDWQC, WSJRWC	84	11502	31.5	NA	0	42	31.5
M04S07E	ESJWQC, WSJRWC	91	13549	35.2	32.3	0	40	26.4
M04S08E	ESJWQC, WSJRWC	99	13640	21.5	NA	0	197	21.5
M04S09E	ESJWQC	100	8045	16.9	NA	0	389	16.9
M04S10E	ESJWQC	100	15014	21.8	NA	0	498	21.8
M04S11E	ESJWQC	61	10942	44.5	NA	0	355	44.5
M05N03E	SVWQC	29	2361	30.8	30	0	53	NA
M05N04E	SVWQC	74	7730	40.6	37.4	0	85	NA
M05N05E	SJCDWQC, SVWQC	73	8112	14.2	NA	0	54	14.2
M05S07E	ESJWQC, WSJRWC	74	10428	33.9	NA	0	96	30.5
M05S08E	ESJWQC, WSJRWC	88	10909	28.4	NA	0	222	28.4
M05S09E	ESJWQC	100	8178	23.4	NA	0	268	23.4
M05S10E	ESJWQC	100	6946	24.5	NA	0	401	24.5
M05S11E	ESJWQC	71	9833	25.1	NA	0	509	23.8
M05S12E	ESJWQC	36	8235	18.7	17.9	0	177	15.9
M05S13E	ESJWQC	52	8812	18.5	NA	0	92	18.5
M05S14E	ESJWQC	24	2215	30.1	NA	0	72	30.1
M06N01E	SVWQC	42	7275	38.7	NA	0	231	38.7
M06N02E	SVWQC	14	2691	12.3	NA	0	63	12.3
M06N03E	SVWQC	33	5403	20.2	19.2	0	71	NA
M06N04E	SVWQC	78	10392	21.8	20.9	0	124	NA
M06N05E	SVWQC	20	2192	2.6	NA	0	115	2.6
M06S07E	WSJRWC	37	1798	28.6	26.4	1	64	24.3
M06S08E	WSJRWC	98	19431	33.6	NA	0	124	33.6
M06S09E	ESJWQC, WSJRWC	100	9245	27.7	26.6	0	112	23.5
M06S10E	ESJWQC	100	7051	24.9	NA	0	378	24.9
M06S11E	ESJWQC	100	9899	21.5	NA	0	357	21.5
M06S12E	ESJWQC	100	11617	17.5	NA	0	477	15.8
M06S13E	ESJWQC	62	8275	33.1	26.7	0	358	19.9
M07N01E	SVWQC	66	10816	32.4	NA	0	267	32.4
M07N02E	SVWQC	94	16849	41.3	NA	0	119	33
M07N03E	SVWQC	39	6369	13.1	NA	0	38	13.1
M07N04E	SVWQC	54	6642	19.5	19.3	0	614	NA

			GWP Value		Milestones as Interim Performance Goals	GWP Targets		
MTR	Coalition(s)	Percent High Vulnerability Area	2019 INMP/NMP Acreage	AWA Nitrate-N load (lb/ac) at the Bottom of the Root Zone	AWA Nitrate-N load (lb/ac) at the Bottom of the Root Zone	Buffer Distance Applied To GWP Township To Include 20 or More Virtual Domestic Wells (miles)	Number of Domestic Wells in CV-NPSAT Impacted by GWP Township Load	AWA Nitrate-N load (lb/ac) at the Bottom of the Root Zone
M07S08E	WSJRWC	88	11997	36	33.5	0	76	27
M07S09E	ESJWQC, WSJRWC	64	5245	33.1	32	0	89	29.8
M07S10E	ESJWQC	82	2939	21.1	NA	0	259	21.1
M07S11E	ESJWQC	93	12174	37	27	0	125	14.8
M07S12E	ESJWQC	99	14591	20.7	NA	0	283	18.6
M07S13E	ESJWQC	98	5770	30.6	28.9	0	856	23
M07S14E	ESJWQC	53	7733	29.4	25.5	0	496	23.5
M07S15E	ESJWQC	58	8601	36.5	32.8	0	64	29.2
M08N01E	SVWQC	66	11740	39.2	36.4	0	197	35.3
M08N01W	SVWQC	22	3228	31.1	NA	0	179	31.1
M08N02E	SVWQC	40	7154	44.3	NA	0	155	39.9
M08N03E	SVWQC	50	5236	28.2	NA	0	77	28.2
M08N04E	SVWQC	34	171	68.2	NA	0	349	68.2
M08S08E	WSJRWC	66	10442	27.1	NA	0	56	27.1
M08S09E	ESJWQC, WSJRWC	27	5760	25.8	23.3	0	79	20.6
M08S11E	ESJWQC, WSJRWC	22	1684	26.8	26.8	1	27	17.4
M08S12E	ESJWQC	39	3105	21.3	NA	1	72	21.3
M08S13E	ESJWQC	77	11073	28.5	NA	0	89	21.4
M08S14E	ESJWQC	82	8482	27.3	NA	0	176	23.2
M08S15E	ESJWQC	14	3180	46.7	NA	0	105	42
M09N01E	SVWQC	11	2831	42.5	NA	0	340	42.5
M09N02E	SVWQC	74	11408	37.1	35.2	0	151	26
M09N04E	SVWQC	35	1582	33	NA	0	161	33
M09S08E	WSJRWC	31	2441	14.4	NA	1	46	14.4
M09S09E	WSJRWC	36	4451	26.2	25.4	0	87	15.7
M09S12E	WSJRWC	35	7733	35.9	32.6	1	28	26.9
M09S13E	ESJWQC, WSJRWC	39	8362	34.4	30.6	0	29	27.5
M09S14E	ESJWQC	93	5245	39.7	NA	0	58	25.8
M09S15E	ESJWQC	73	7411	29.9	NA	0	110	23.9
M09S16E	ESJWQC	14	4683	22.9	NA	0	110	21.8
M10N01E	SVWQC	33	5319	30.7	30.3	0	517	26.1
M10N01W	SVWQC	17	5835	29.8	NA	0	127	29.8
M10N02E	SVWQC	53	8265	28.7	NA	0	260	25.8
M10N03E	SVWQC	52	4735	41.1	40.4	0	55	NA
M10S09E	WSJRWC	46	2960	27.6	26.1	0	64	17.9
M10S10E	WSJRWC	66	10694	36.9	32	0	182	16.6

			GWP Value		Milestones as Interim Performance Goals	GWP Targets		
MTR	Coalition(s)	Percent High Vulnerability Area	2019 INMP/NMP Acreage	AWA Nitrate-N load (lb/ac) at the Bottom of the Root Zone	AWA Nitrate-N load (lb/ac) at the Bottom of the Root Zone	Buffer Distance Applied To GWP Township To Include 20 or More Virtual Domestic Wells (miles)	Number of Domestic Wells in CV-NPSAT Impacted by GWP Township Load	AWA Nitrate-N load (lb/ac) at the Bottom of the Root Zone
M10S11E	WSJRWC	12	1978	14.5	NA	0	54	14.5
M10S13E	ESJWQC, WSJRWC	27	4489	39.8	NA	0	33	35.8
M10S14E	ESJWQC	78	13893	23.6	NA	0	44	21.2
M10S15E	ESJWQC	98	14344	27.2	NA	0	133	21.8
M10S16E	ESJWQC	27	6890	32.3	NA	0	218	29.1
M10S18E	ESJWQC	10	7467	48.4	43.1	0	568	31.5
M11N02E	SVWQC	33	6397	51.3	48.4	0	120	NA
M11N03E	SVWQC	72	7772	36	NA	0	30	36
M11N03W	SVWQC	14	949	25.4	NA	0	103	25.4
M11N04E	SVWQC	47	821	10.9	NA	0	72	10.9
M11S10E	GDAC, WSJRWC	83	9772	31	24.3	0	23	13.9
M11S12E	GDAC, WSJRWC	13	3103	42	40.9	0	85	35.7
M11S13E	ESJWQC, WSJRWC	23	8093	44.3	43.2	0	88	31
M11S14E	ESJWQC, WSJRWC	56	16271	33	30.8	1	38	16.5
M11S15E	ESJWQC	44	8002	37.7	34	0	37	15.1
M11S16E	ESJWQC	95	13169	31	25.2	0	115	20.1
M11S17E	ESJWQC	54	8599	31.6	NA	0	550	26.9
M11S18E	ESJWQC	20	5502	43.7	NA	0	774	43.7
M11S19E	ESJWQC	23	2891	30.6	NA	0	1934	29.1
M11S20E	ESJWQC, KRWQC	24	3650	42.4	NA	0	233	38.2
M11S21E	ESJWQC	34	341	61.8	NA	0	213	61.8
M12N01E	SVWQC	22	3072	28.4	27.9	1	38	25.6
M12N02E	SVWQC	80	9447	45.1	42	0	42	NA
M12N03E	SVWQC	69	5491	34.4	NA	0	24	34.4
M12N04E	SVWQC	33	1592	16.1	NA	0	70	16.1
M12N05E	SVWQC	17	580	20.6	NA	0	74	20.6
M12S11E	GDAC	34	7846	24.9	22.9	2	32	19.9
M12S12E	GDAC	22	7314	22.9	NA	0	30	21.8
M12S13E	GDAC, WSJRWC	13	4530	38.1	NA	1	29	38.1
M12S14E	ESJWQC, WSJRWC	71	9312	39.4	NA	0	42	31.5
M12S15E	ESJWQC, WSJRWC	16	14491	40.3	29.7	1	32	24.2
M12S16E	ESJWQC	12	5364	20.7	NA	0	21	19.7
M12S17E	ESJWQC	63	17860	18.3	NA	0	95	18.3
M12S18E	ESJWQC, KRWQC	66	15692	19.8	NA	0	165	19.8
M12S19E	ESJWQC, KRWQC	58	12571	40.8	35.1	0	342	30.6
M12S20E	ESJWQC, KRWQC	81	3737	34.3	28.6	0	501	27.4

MTR	Coalition(s)	Percent High Vulnerability Area	GWP Value		Milestones as Interim Performance Goals	GWP Targets		
			2019 INMP/NMP Acreage	AWA Nitrate-N load (lb/ac) at the Bottom of the Root Zone	AWA Nitrate-N load (lb/ac) at the Bottom of the Root Zone	Buffer Distance Applied To GWP Township To Include 20 or More Virtual Domestic Wells (miles)	Number of Domestic Wells in CV-NPSAT Impacted by GWP Township Load	AWA Nitrate-N load (lb/ac) at the Bottom of the Root Zone
M12S21E	KRWQC	95	1794	73.1	NA	0	1254	73.1
M12S22E	KRWQC	67	407	45.9	NA	0	814	45.9
M13N01E	SVWQC	33	6070	70.7	55.2	1	24	NA
M13N02E	SVWQC	56	5718	57.8	49.1	1	24	NA
M13N03E	SVWQC	72	7110	50	37.8	0	123	NA
M13N04E	SVWQC	81	7041	34.2	NA	0	125	34.2
M13N05E	SVWQC	44	5918	28.6	NA	0	108	28.6
M13S12E	GDAC, WSC, WSJRWC	53	13405	29.9	26	2	30	17.9
M13S13E	GDAC, WSC	54	10581	47.6	NA	2	24	45.2
M13S14E	ESJWQC, GDAC, WSC, WSJRWC	52	7478	35.7	33.7	0	21	30.3
M13S15E	ESJWQC, GDAC, WSJRWC	38	11748	28.1	26.4	1	25	15.5
M13S16E	ESJWQC, KRWQC	12	12690	20.8	NA	0	29	20.8
M13S17E	ESJWQC, KRWQC	10	12326	29.2	NA	0	168	29.2
M13S18E	ESJWQC, KRWQC	97	15881	25	NA	0	248	25
M13S19E	KRWQC	100	3849	28.8	NA	0	1329	27.4
M13S20E	KRWQC	100	187	20.1	NA	0	566	20.1
M13S21E	KRWQC	100	789	54.6	NA	0	945	54.6
M13S22E	KRWQC	100	5774	46	NA	0	1296	46
M13S23E	KRWQC	75	5729	44.3	NA	0	247	44.3
M13S24E	KRWQC	33	1315	32.9	32.9	0	33	13.2
M14N01E	SVWQC	31	6030	45.9	NA	0	29	45.9
M14N01W	SVWQC	34	6878	39.5	NA	0	32	39.5
M14N02E	SVWQC	11	1680	62.6	NA	1	119	56.3
M14N03E	SVWQC	81	10795	46.8	37.5	0	546	NA
M14N04E	SVWQC	75	2955	15.4	NA	0	305	15.4
M14N05E	SVWQC	37	4701	51.5	NA	0	85	51.5
M14S12E	WSC	41	9139	42.5	35.5	5	23	21.2
M14S13E	WSC	69	20875	37.8	33.2	3	21	18.9
M14S14E	WSC	91	11848	34.5	33.6	2	23	31
M14S15E	WSC, WSJRWC	44	2450	37	NA	0	27	37
M14S16E	KRWQC	56	11064	88.6	52.7	0	63	26.6
M14S17E	KRWQC	25	8857	29	NA	0	189	29
M14S18E	KRWQC	100	17332	25.3	NA	0	215	25.3
M14S19E	KRWQC	100	11444	27.6	NA	0	413	27.6

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M14S20E	KRWQC	100	3668	28.9	NA	0	690	28.9
M14S21E	KRWQC	100	8517	42.9	33.2	0	485	32.2
M14S22E	KRWQC	100	10973	39.7	32.1	0	604	25.8
M14S23E	KRWQC	100	8619	21.8	NA	0	330	21.8
M14S24E	KRWQC	89	6857	46.6	37.9	0	126	18.6
M14S25E	KRWQC	16	1023	41.3	38.1	2	34	16.5
M15N01E	SVWQC	34	4358	31.5	NA	0	120	31.5
M15N01W	SVWQC	53	7934	50.4	43.3	0	54	NA
M15N02E	SVWQC	19	1544	30.8	NA	0	596	30.8
M15N02W	SVWQC	22	1779	21.2	NA	0	24	21.2
M15N03E	SVWQC	71	6100	49.7	NA	0	1531	47.2
M15N03W	SVWQC	20	4095	23.7	NA	0	125	20.1
M15N04E	SVWQC	75	4811	54.6	NA	0	319	54.6
M15S12E	WSC	54	4077	37.2	35.4	9	27	29.8
M15S13E	WSC	92	18110	58.1	39.7	7	28	29
M15S14E	WSC	96	8474	36.9	30.6	4	23	14.8
M15S15E	WSC	87	1698	38.3	38.3	2	25	36.4
M15S16E	KRWQC	35	9212	66.4	54.3	0	54	39.8
M15S18E	KRWQC	42	11428	38.8	NA	0	76	25.2
M15S19E	KRWQC	97	16369	30.7	NA	0	379	29.2
M15S20E	KRWQC	100	14140	23.9	NA	0	851	23.9
M15S21E	KRWQC	100	13037	25	NA	0	429	22.5
M15S22E	KRWQC	100	12967	23.7	19.6	0	379	14.2
M15S23E	KRWQC	100	12564	24.2	20.5	0	538	16.9
M15S24E	KRWQC	100	13603	35.4	30.7	0	393	21.2
M15S25E	KRWQC	51	7251	44.3	37.9	0	48	13.3
M16N01W	SVWQC	49	4567	53.5	NA	0	86	53.5
M16N02W	SVWQC	17	2777	47.5	40.9	0	122	33.2
M16N03E	SVWQC	73	11689	46.5	NA	0	231	39.5
M16N04E	SVWQC	34	993	50.6	NA	0	236	50.6
M16S13E	WSC	44	1527	33.4	31.2	9	21	13.4
M16S14E	WSC	82	12871	39.4	35.9	6	20	15.8
M16S15E	WSC	61	15961	42.3	30.7	4	21	16.9
M16S16E	KRWQC, WSC	76	11454	35.9	29.9	2	37	19.7
M16S17E	KRWQC, WSC	19	7201	57.2	46.3	0	20	20
M16S19E	KRWQC	58	17119	40	NA	0	264	36

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M16S20E	KRWQC	100	17858	22.8	NA	0	252	21.7
M16S21E	KRWQC	100	15974	31.4	21.7	0	238	14.1
M16S22E	KRWQC	100	11359	17.1	NA	0	336	13.7
M16S23E	KRWQC	100	15336	25.2	NA	0	549	22.7
M16S24E	KRWQC	100	13039	35	29.2	0	408	19.2
M16S25E	KBWQA, KRWQC	89	11295	42	36.3	0	188	14.7
M17N01W	SVWQC	33	4454	36.8	NA	0	33	36.8
M17N02E	SVWQC	14	2078	57.3	NA	0	326	57.3
M17N02W	SVWQC	36	3622	56.1	NA	1	48	56.1
M17N03E	SVWQC	53	8965	48.3	NA	0	334	48.3
M17N03W	SVWQC	25	3486	39.1	NA	0	62	39.1
M17N04E	SVWQC	31	1107	47.8	NA	1	30	47.8
M17S14E	WSC	58	1939	26.6	26.6	9	20	9.3
M17S15E	WSC	49	18926	52.5	38.3	5	20	18.4
M17S16E	WSC	76	10922	61.5	50.7	5	25	18.5
M17S17E	KRWQC, WSC	80	14477	36.4	33.3	3	29	14.6
M17S18E	KRWQC, WSC	16	11068	45.8	44.2	0	52	27.5
M17S19E	KRWQC	42	7578	38.9	35.9	0	163	23.3
M17S20E	KRWQC	47	11739	28.6	22.7	0	210	17.2
M17S21E	KRWQC	100	15688	30.8	25	0	233	23.1
M17S22E	KRWQC	100	15954	22.2	NA	0	195	22.2
M17S23E	KRWQC	93	14860	26.4	21.8	0	101	19.8
M17S24E	KBWQA, KRWQC	100	4492	43.2	39	0	139	32.4
M17S25E	KBWQA, KRWQC	100	12004	37.7	33.8	0	252	26.4
M17S26E	KBWQA	69	12956	40.5	35.1	0	48	30.4
M17S27E	KBWQA	25	3241	25	NA	1	69	25
M18N01W	SVWQC	56	7850	41.7	NA	0	59	41.7
M18N02E	SVWQC	11	801	34.3	NA	0	221	34.3
M18N02W	SVWQC	11	952	9.6	NA	0	49	9.6
M18N03E	SVWQC	17	2508	40.8	NA	0	234	40.8
M18S15E	WSC	60	8286	52.6	40.3	7	21	23.7
M18S16E	WSC	71	14785	54.8	42.8	5	20	24.7
M18S17E	WSC	68	20061	35.8	30.1	4	26	8.9
M18S18E	KRWQC, WSC	89	18149	53.9	49.3	2	41	18.9
M18S19E	KRWQC, WSC	25	6756	41.9	39.5	0	128	29.3
M18S20E	KRWQC	41	11885	36.5	31.7	0	259	23.7

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M18S21E	KRWQC	100	10641	36.6	32	0	377	23.8
M18S22E	KRWQC	100	9285	38.7	NA	0	381	32.9
M18S23E	KBWQA, KRWQC	91	4180	45.3	NA	0	125	40.8
M18S24E	KBWQA	86	8324	36.6	NA	0	160	36.6
M18S25E	KBWQA	62	7585	48.2	NA	0	533	48.2
M18S26E	KBWQA	60	12683	36.1	NA	0	277	36.1
M18S27E	KBWQA	62	6913	40.8	NA	0	150	40.8
M19N01W	SVWQC	63	9209	37.7	NA	0	67	37.7
M19N02W	SVWQC	15	1694	94.8	49.7	0	57	NA
M19N03W	SVWQC	36	1639	52.2	37.8	0	138	36.5
M19N04W	SVWQC	14	3719	46.7	42.3	0	42	32.7
M19S16E	WSC	50	15047	32.9	27.2	6	25	9.9
M19S17E	WSC	52	18310	33.5	29.6	5	22	10.1
M19S18E	WSC	89	20758	66.8	49.9	3	20	26.7
M19S19E	KRWQC, WSC	77	9609	61.4	47	1	33	36.8
M19S20E	KRWQC	39	5328	35.6	35.3	0	147	26.7
M19S21E	KRWQC	53	9617	36.2	31	0	244	25.3
M19S22E	KRWQC	100	7544	33.9	NA	0	245	28.8
M19S23E	KBWQA, KRWQC	96	7480	29.1	29	0	85	26.2
M19S24E	KBWQA	80	7398	41.3	NA	0	265	41.3
M19S25E	KBWQA	60	12162	41.7	NA	0	441	41.7
M19S26E	KBWQA	87	12305	32.9	NA	0	262	32.9
M19S27E	KBWQA	37	2257	42.9	NA	1	47	42.9
M20N01E	SVWQC	37	6143	30.3	NA	0	40	30.3
M20N01W	SVWQC	23	7177	40.2	NA	1	49	40.2
M20N02E	SVWQC	14	2227	14.9	NA	0	66	14.9
M20N02W	SVWQC	36	2405	31.9	22.3	0	85	NA
M20N03W	SVWQC	60	10536	30.2	NA	0	159	30.2
M20N04W	SVWQC	39	3497	26.5	24.9	1	61	19.9
M20S15E	WSC	76	4683	52.6	46.8	6	21	42.1
M20S16E	WSC	84	9559	41.5	35.5	3	20	16.6
M20S17E	WSC	51	17941	28.7	25.1	3	25	8.6
M20S18E	WSC	66	19209	44.3	39.2	4	20	13.3
M20S19E	KRWQC, WSC	75	8648	32.6	NA	2	36	32.6
M20S20E	KRWQC	17	6737	56.2	52.8	0	49	45
M20S21E	KRWQC	22	2498	13.6	13.6	0	27	10.2

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M20S22E	KRWQC	100	4678	35.4	31.4	0	47	26.6
M20S23E	KBWQA	100	10516	38.7	36.7	0	125	31
M20S24E	KBWQA	90	10112	57.5	48.3	0	112	43.1
M20S25E	KBWQA, TBWQC	100	5842	40.9	NA	0	220	36.8
M20S26E	KBWQA, TBWQC	100	11783	41.8	NA	0	124	41.8
M20S27E	KBWQA, TBWQC	85	9690	53.6	NA	0	55	50.9
M21N01E	SVWQC	76	15744	26	NA	0	578	26
M21N01W	SVWQC	55	8007	32.3	NA	0	48	32.3
M21N02E	SVWQC	19	2377	21.2	NA	0	741	21.2
M21N02W	SVWQC	56	12995	37.3	30.9	0	109	28
M21N03W	SVWQC	92	14022	33.1	NA	0	204	29.8
M21N04W	SVWQC	11	1805	19.3	NA	0	24	19.3
M21S15E	WSC	29	1211	23.6	23.6	7	20	20.1
M21S16E	WSC	89	7451	50.8	NA	5	22	40.6
M21S17E	WSC	79	9463	28.6	26.3	4	20	5.7
M21S18E	WSC	87	20005	44.7	38.9	6	23	11.2
M21S19E	WSC	41	4815	48	41.5	4	29	33.6
M21S23E	KBWQA, TBWQC	95	4885	33	32.1	0	28	29.7
M21S24E	KBWQA, TBWQC	100	7042	36.7	31.1	0	38	25.7
M21S25E	TBWQC	100	4805	66.7	42.9	0	58	36.7
M21S26E	TBWQC	100	12884	49.2	NA	0	101	44.3
M21S27E	TBWQC	96	6541	47.9	NA	0	413	40.7
M21S28E	TBWQC	33	1566	59.3	51.8	0	270	32.6
M21S29E	TBWQC	25	422	27.6	27	4	114	16.6
M22N01E	SVWQC	53	4360	39.7	NA	0	1385	39.7
M22N01W	SVWQC	28	8425	46.2	NA	0	161	46.2
M22N02W	SVWQC	28	4707	32.3	NA	0	310	32.3
M22N03W	SVWQC	19	1283	9.7	NA	0	1149	9.7
M22S16E	WSC	33	611	7.6	7.6	8	22	4.6
M22S17E	WSC	65	345	2.9	NA	7	23	2.9
M22S18E	WSC	35	4293	20.6	19.3	7	20	8.2
M22S19E	KRWQC	13	1591	19.1	NA	8	27	19.1
M22S23E	TBWQC	76	4393	44.4	43.6	1	29	28.9
M22S24E	TBWQC	100	4020	34.9	31.4	0	39	22.7
M22S25E	TBWQC	100	5661	45.8	39.4	0	88	32.1
M22S26E	TBWQC	100	14351	40.1	32.4	0	52	20

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M22S27E	TBWQC	93	9037	54.4	43.6	0	142	27.2
M22S28E	TBWQC	51	3978	72.5	54.2	0	127	43.5
M23N01W	SVWQC	70	10385	38.9	NA	0	111	38.9
M23N02W	SVWQC	33	6718	23.9	NA	0	224	23.9
M23S17E	WSC	10	343	4.7	NA	11	21	4.7
M23S23E	TBWQC	27	1415	23.8	23.8	3	25	10.7
M23S24E	TBWQC	65	1692	68	NA	2	46	47.6
M23S25E	TBWQC	98	10662	32.8	24.9	0	78	16.4
M23S26E	TBWQC	100	16808	32.6	27.3	0	25	11.4
M23S27E	TBWQC	82	11442	40.7	32.1	0	30	18.3
M23S28E	TBWQC	28	2331	49.4	45.2	0	26	29.6
M24N02W	SVWQC	41	4718	31.2	NA	0	231	31.2
M24S18E	WWQC	34	807	41.1	40.6	10	23	8.2
M24S24E	TBWQC	13	6680	16.4	16.4	2	24	12.3
M24S25E	TBWQC	89	15181	26.5	24.5	1	31	14.6
M24S26E	TBWQC	100	16680	30.3	27	1	27	9.1
M24S27E	KRWCA, TBWQC	45	8310	55.1	46.5	2	29	11
M25N02W	SVWQC	31	4000	30.6	NA	0	504	30.6
M25N03W	SVWQC	34	5665	32.9	NA	0	536	31.3
M25S20E	WWQC	55	18575	42.6	32.2	5	21	10.7
M25S21E	WWQC	97	2746	2.7	NA	3	20	2.7
M25S22E	KRWCA	69	3010	70.4	45.5	2	23	24.6
M25S24E	KRWCA	26	9823	18.9	15.7	0	38	11.3
M25S25E	KRWCA	99	10789	29.9	NA	0	61	28.4
M25S26E	KRWCA, TBWQC	99	18324	32.2	23.6	0	36	12.9
M25S27E	KRWCA, TBWQC	14	6578	39.8	32.4	1	24	11.9
M26N02W	SVWQC	40	3027	39.4	NA	0	395	39.4
M26N03W	SVWQC	31	5472	36.2	NA	0	486	36.2
M26S18E	WWQC	46	5181	50.6	35.4	12	25	10.1
M26S21E	KRWCA, WWQC	84	5412	24	23.1	2	21	15.6
M26S22E	KRWCA	94	2619	21.7	18.2	1	20	16.3
M26S23E	KRWCA	34	11972	19.3	18.6	1	30	7.7
M26S24E	KRWCA	33	16158	33.8	24.7	1	38	15.2
M26S25E	KRWCA	69	19044	26	NA	0	28	20.8
M26S26E	CWDC, KRWCA	66	17810	26.5	23.1	0	32	10.6
M27N03W	SVWQC	39	3978	35.3	NA	0	828	35.3

			GWP Value		Milestones as Interim Performance Goals	GWP Targets		
MTR	Coalition(s)	Percent High Vulnerability Area	2019 INMP/NMP Acreage	AWA Nitrate-N load (lb/ac) at the Bottom of the Root Zone	AWA Nitrate-N load (lb/ac) at the Bottom of the Root Zone	Buffer Distance Applied To GWP Township To Include 20 or More Virtual Domestic Wells (miles)	Number of Domestic Wells in CV-NPSAT Impacted by GWP Township Load	AWA Nitrate-N load (lb/ac) at the Bottom of the Root Zone
M27S21E	WWQC	19	14350	23.1	17.8	4	22	10.4
M27S22E	BVC, KRWCA, WWQC	97	12402	26.2	21.7	4	40	10.5
M27S23E	KRWCA	77	16687	35.8	24.7	1	23	10.7
M27S24E	KRWCA	71	16005	30.8	22.4	0	27	15.4
M27S25E	KRWCA	100	22407	17.8	NA	0	21	17.8
M27S26E	CWDC, KRWCA	46	15770	32.2	NA	1	31	30.6
M28S21E	WWQC	54	10623	32.2	26.5	6	22	24.2
M28S22E	BVC, KRWCA, WWQC	60	15379	16.3	15.3	2	20	2.4
M28S23E	BVC, KRWCA	47	13157	16	15.3	1	24	4
M28S24E	KRWCA	39	13210	25.3	22.3	0	37	15.2
M28S25E	KRWCA	99	17910	35.3	26.9	0	67	24.7
M28S26E	CWDC, KRWCA	89	17369	23	19.2	1	34	17.2
M28S27E	CWDC, KRWCA	11	3333	8.9	NA	1	24	8.9
M29S22E	WWQC	15	3221	14.5	NA	2	20	14.5
M29S23E	BVC, KRWCA	12	6068	39.1	38	0	31	17.6
M29S24E	BVC, KRWCA	28	14162	26.8	25.6	0	37	14.7
M29S25E	KRWCA	49	15836	20.3	NA	0	77	18.3
M29S26E	KRWCA	99	15318	30.1	26.2	0	111	19.6
M29S27E	KRWCA	74	762	16.2	NA	0	342	16.2
M29S29E	KRWCA	34	1905	32.2	NA	0	42	32.2
M30S26E	KRWCA	25	8961	36.9	36.1	0	116	31.4
M30S27E	KRWCA	39	1456	26.2	NA	0	114	26.2
M30S28E	KRWCA	100	2598	23.9	22.7	0	173	21.5
M30S29E	KRWCA	100	16728	47.9	39.1	0	87	28.7
M30S30E	KRWCA	43	8774	28.4	25.3	2	23	17
M31S26E	BVC, KRWCA	13	4969	41.7	NA	0	22	27.1
M31S27E	KRWCA	30	12305	35.4	NA	0	253	35.4
M31S28E	KRWCA	56	12924	47.6	NA	0	160	47.6
M31S29E	KRWCA	97	20637	40.7	35.9	0	31	12.2
M31S30E	KRWCA	55	10129	24.1	22.6	3	26	7.2
M32S26E	KRWCA	17	19666	25.9	24.8	2	38	18.1
M32S27E	KRWCA	76	19575	36.6	32.9	0	20	31.1
M32S28E	KRWCA	68	21082	54.5	44.7	0	20	30
M32S29E	KRWCA	60	23025	45.5	33.6	2	32	13.7
S11N18W	KRWCA	16	6162	50.7	34.6	6	24	20.3
S11N19W	KRWCA	73	25918	32.7	23.1	3	20	19.6

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MTR	Coalition(s)	Percent High Vulnerability Area	2019 INMP/NMP Acreage	AWA Nitrate-N load (lb/ac) at the Bottom of the Root Zone	AWA Nitrate-N load (lb/ac) at the Bottom of the Root Zone	Buffer Distance Applied To GWP Township To Include 20 or More Virtual Domestic Wells (miles)	Number of Domestic Wells in CV-NPSAT Impacted by GWP Township Load	AWA Nitrate-N load (lb/ac) at the Bottom of the Root Zone
S11N20W	KRWCA	54	11238	31.6	30	2	27	20.5
S11N21W	KRWCA	57	12035	41.2	41.1	4	24	24.7
S12N18W	KRWCA	24	4567	73.7	55.1	6	25	22.1
S12N19W	KRWCA	100	6279	42.7	34.2	4	20	19.2
S12N20W	KRWCA	100	4008	38.6	33.1	3	26	21.2
S12N21W	KRWCA	94	4609	15	NA	3	21	15
S12N22W	KRWCA	18	4201	35.4	NA	6	29	30.1