



27 April 2017

MEMORANDUM

TO: Bobbie Brady, Yakima County; Melanie Redding, Washington Department of Ecology

FROM: Kevin Lindsey, LHg

SUBJECT: Review Comments on the Report Entitled *Estimated Nitrogen Available for Transport in the Lower Yakima Valley Groundwater Management Area*

On behalf of the Yakima County Farm Bureau and Washington Dairy Federation members in the Yakima Valley, EA Engineering, Science, and Technology, Inc. PBC has prepared this memorandum, the purpose of which is to provide comments on the afore named report, which is dated April 2017. Following some general comments, the balance of this memorandum is organized by report chapter.

General comments.

Objective: First, with respect to the reports objective, it is stated that its objective is to describe modeled estimates of nitrogen availability in the Lower Yakima Valley GWMA (LYVGWMA), and not to calculate how much is: (1) transported to groundwater and (2) analyses to account for nitrogen attenuation in the soil and vadose zone. In addition, it is further stated that the results are for overall evaluation of nitrogen throughout the LYVGWMA and not to understand conditions in any specific portion of the project area. These objectives and constraints are a common feature in many of our following comments, and we are paraphrasing them here to (1) make sure we understand them correctly and (2) because there are places in the report where the authors appear to be departing from the stated objective by bringing up such topics as deep soil sampling, denitrification in the soil column, depth to groundwater, etc. If these later topics are relevant to the stated report objective then additional exploration of that relevance is needed, and sections where they are not currently discussed will need to be revised to include them. That being stated, and considering the stated objective, these other topics should be dropped from the report.

Terminology: Throughout the report terms such potential N loading, nitrogen available for transport, nitrogen loading rates, available nitrogen, and loss rate appear to be used interchangeably, although, there are places where that may not be the intent. Recommend that a single term for a specific meaning be selected, defined, and used. A glossary might help with these.

Units: The report uses a mix of English and Metric units interchangeably. Suggest these get standardized throughout, and if Metric is the standard then include the equivalent English units in parentheses. These could be included in a glossary with the appropriate conversion factors.

Executive Summary.

The report adds up potential sources of nitrogen from lagoons, pens, irrigated farms and on-site septic systems (OSS). Based on the different methods used to estimate nitrogen beneath a potential source, it is not clear to us if pen and lagoon sources are counted twice. For example, OSS estimates, which are based on a unit mass are periodically reduced via cleaning/draining of OSSs. Lagoons and



pens though don't get that type of credit. These are treated as constant sources, at least they appear to be, and as such nitrogen removed from them via periodic cleaning/removal is not treated as a credit in the balance. In addition, since that material is then the source for manure used in the irrigated agriculture discussion, is that then not a credit back to the source, which are the pens and lagoons?

A further consideration in this, lagoon nitrogen is calculated via an average concentration while pens and agriculture, and most other aspects of the estimating for that matter, are calculated using mass. Would a mass approach be better for lagoon fluids; it certainly would allow one to accommodate periodic mass removal due to draining? The potential for double counting lagoon nitrate could be tied to the assumption that lagoons are a constant source of nitrogen because that is what the concentration approach seems to require.

Given these executive summary comments we wonder if additional description and discussion should be given to why each method is used in each chapter. This would include discussion of how each nitrogen source is related, or not, and how when one is used to feed another, that potential credit is accommodated, or why it does not need to be considered.

At the bottom of page 27, and continued on page 28, there are recommended practices for the use of pens and lagoons. But, there are no recommended practices for irrigated ag, only suggestions for getting additional data. Also, the RCIM section has no conclusions or recommendations. Each chapter should have dedicated conclusions/recommendations, or they should all be consolidated in the final chapter.

CAFO Chapter.

General comment: There are places in the chapter that the focus appears to be CAFO's in general and other places where it appears to be dairies. The pens section seems to provide a pretty good example of that where it is not always clear to us if the topic at any point in the text is a pen, a Dairy, a beef feedlot, or what. For clarity, it might be better to break the chapter into non-dairy CAFO's and all the physical features associated with those, and dairy CAFO's and all that goes with those.

Pen estimate: The discussion surrounding Table 6 and Figure 4, which focus on deep soil nitrate sampling, is not within the stated scope and objective of the report. Because the focus, in the case of pens, is to estimate nitrogen at the pen floor (compacted manure) soil interface, the diversion to deep soil sampling is distracting. While the topic is deserving of additional discussion, it is out of scope with respect to the stated report objective and constraints. We recommend its removal from the report.

Lagoon estimate: The use of Darcy's law requires that several basic assumptions are met. Two of these, "soil media saturation and flow is continuous and steady", seem problematic. Were these assumptions investigated during report preparation? If so, please explain how these assumptions are accounted for in the report.

We are concerned about these assumptions because normal lagoon operations, which include periodic draining, will lead to extremely variable pressure head and as a result flow. Flow potential will vary from as much as 0 when the lagoon is empty to some other order of magnitude greater value when it is full. In these circumstances, will flow be steady and continuous? With respect to the saturation assumption, and given periodic draining of lagoons, is there documented evidence of liner saturation? Again, please provide that information/data/background studies.



If these two assumptions can't be documented, then we recommend that the Darcy equation be modified to account for unsaturated conditions. Several good references provide some guidance on this, one notable one being *Vadose Zone Hydrology* by Dan Stephens.

Additionally, the normal use of Darcy in saturated flow usually assumes that fluid viscosity is constant essentially because aquifer temperature, and by association viscosity which is temperature dependent, shows little variation in most scenarios. That is however not the case in an evaluation of infiltration. Darcy's law includes viscosity, and in a seasonal infiltration scenario there can be a wide range in viscosity. For example, water viscosity just above freezing is almost 1.7 mPa.s while at 68 degrees it is approximately 1 mPa.s. Such a range will result a significant decrease in hydraulic conductivity. Was this considered by the authors? Please provide additional explanation why viscosity is, or is not, relevant to nitrogen leakage estimates.

The high, medium, low nitrogen estimates were based on ranges in saturated hydraulic conductivity used in the Darcy calculation. Would using the observed, or literature reported, range of lagoon nitrogen concentrations also be a way to get at the range of potential nitrogen values? The report notes the wide range of lagoon values seen in California. Should that also be looked at here, providing additional estimated high end and low end members for potential nitrogen content at base of lagoon liners?

Other comments: Does table 3 on page 13 reflect that the lagoons are not used to capacity during the year? Does table 5 on page 17 account for pen management and periodic cleaning?

On page 17, the report suggests that most cattle on rangeland and pasture are in the GWMA area. Rangeland and pasture cattle are primarily found outside of the GWMA as that is where more of the rangeland and irrigated pasture is located. The GWMA is primarily irrigated row crops, orchards/vineyards, hops and forage crops. Please provide additional information.

The lagoon estimates start with a concentration, then convert it to a mass after the Darcy estimated flow calculation is made. For a more seamless comparison to the other nitrogen sources, and to better accommodate periodic nitrogen removal from lagoons, would it be better to do lagoon estimates as a mass value and not a concentration value? Using the average concentration, and the average lagoon sizes, one should be able to quickly make a lagoon mass estimate, then accommodate its periodic removal and delivery to other activities in the LYVGWMA. Can the authors discuss this further?

Irrigated Agriculture Chapter.

With respect to the negative nitrogen rates assigned to each crop type, the authors may want to provide additional explanation about what it suggests. In particular, that (1) nitrogen mining is part of the normal crop rotation for crops in that category, and that (2) for tree crops one generally expects a very low to negative number to promote fruit growth, not leaf growth.

Table 8 page 30 lists the top 15 crops by acreage in the LYVGWMA area based on 2015 data. It is out of date for some crops. One example is hops which had 5,961 acres in the LYVGWMA. Current 2017 acres are estimated by the WA Hop Commission to be approximately 15,000 acres. These acres could have replaced juice grapes, older varieties of fruit and forage crop land. This demonstrates how the dynamics of production can change in the area fairly rapidly, which is why assumptions of certain practices may or may not be accurate. New hop plantings are almost exclusively irrigated with drip irrigation, likely replacing less efficient irrigation systems, and putting several thousand acres of



irrigated land under the most current irrigation technology available that not only is very efficient for the crop but also addresses any excessive use of water in the sensitive GWMA area. The authors should make sure this variability with the transition to new technology is clearly stated.

Page 34, irrigation water nitrogen is derived from nitrogen concentrations in the Yakima River taken from a 2012 USGS report. As with the cropping comment above, this number may vary year to year depending on actual cropping, runoff, stream flow, and time of year. The authors should consider a brief description of this variability and its potential effects on N estimates.

Page 37 notes that commercial fertilizer is the most common form of nitrogen in the LYVGWMA. Yet, the report treats manure storage in lagoons, pens, and composting areas as a source, but doesn't consider the commercial fertilizer facilities as potential sources. Should commercial fertilizer be listed in its stored form at the delivery sites as a potential source, based on normal field use, one could calculate that as much as 8,000 tons of commercial fertilizer is not accounted for (80,000 acres X 200 lbs. N/ ac = 8,000). Can an explanation for this apparent exclusion be provided, or should these also be considered?

Page 49 has several thoughts on updating or gathering additional data. Since the DOE has recently established a new permit system that addresses some of the nitrogen issues on farmed lands, the report should explain how these new requirements would address concerns that the report has identified.

RCIM Chapter.

Introduction: In the introduction to this chapter we recommend additional discussion of OSSs pertaining to the following:

- They are designed to leach, whereas most other nitrogen sources are not. While leaching is not relevant to the objective (as we've commented on elsewhere on other topics) it might be worth noting that it occurs.
- There are several high-density OSS areas in the LYVGWMA, as defined by EPA. EPA defines these densities as <10, 10 to 40, and >40 per square mile, pertaining to low, medium, and high density, respectively. Designating these domains on Figure 11 would illustrate these EPA criteria which EPA considers to be reflective of the risk to groundwater contamination.
- Comment on the importance of maintenance and increased effluent volumes due to seasonal increase in population.

Methods: In this section, the last few bullets refer to soil type, elevation, and depth to groundwater. How are these relevant to the basic objective of this section which is to estimate nitrogen at the end of the drain field? Suggest the methods focus on how the nitrogen estimate for OSS effluent is determined, and that discussion of soil type, elevation, etc. be removed.

Nitrogen Removal by Denitrification: This section focuses on denitrification in the soil column, following discharge from the OSS system. This discussion, while important and interesting, is not relevant to the stated objective of the report which is to estimate nitrogen at the drain field (OSS) system discharge point. In addition, the use of soil denitrification to estimate total nitrogen at the point of discharge is using a process downstream of the OSS discharge to estimate the nitrogen concentration at the point of discharge. This doesn't make sense given the stated objective.



OSS Pumping: The nitrogen removal discussion via OSS pumping is interesting and useful. Given that, shouldn't a similar logic be applied to the lagoon discussion? Generally, lagoons are pumped dry at least once per year, and using the logic in the ROSS discussion, shouldn't this removal be applied to the lagoon nitrogen estimates as a credit.

Page 50, first bullet lists 6,044 households. When we merged two databases acquired from the County for the LYVGWMA we identified over 6,100 different sites. Can the authors explain the apparent discrepancy?

Atmospheric Deposition

The report should describe that on lands with growing plants, they likely would take up any amount deposited from the atmosphere just as they take up carbon dioxide. Since most of the land has growing plants, the amount that could be available as a source to groundwater is very small and this is not noted as it should be in the assessment.

Conclusions and Recommendations.

Usage Example: Figure 12, and the discussion pertaining to it seem to run counter to one of the report objectives which states that the results are for the overall evaluation of nitrogen throughout the LYVGWMA and not to understand conditions in any specific portion of the project area. Although the graphic and the discussion are interesting, they do seem to be taking one down a road that leads to assessing nitrogen conditions in a specific area, the area seen in the circle. We recommend that this type of discussion be removed from the report given the stated objectives.

Conclusions: There is a summary of the low, medium, and high nitrogen estimates, and in that discussion, the language points to irrigated ag as the largest single potential nitrogen contributor but then tries to minimize that finding with a however statement. The however statement then goes on to point to high, localized, nitrogen estimates associated with CAFO's. We recommend that such qualifying language not be used as it is pitting one potential source against another. So, while it states that irrigated ag covers a big area and its nitrogen estimate is the largest, it is however not as bad as concentrated CAFO's. Just state the estimates without qualification, irrigated ag estimated to do X and CAFO's estimated to do Y. Given that, and while I don't disagree with the basic comment that a focus on concentrated sources could yield important results in a local area, the report's conclusion that the single largest source is all over the region also suggests that some broad-based actions might yield important area wide results.

Many of the conclusions focus on CAFO's, and that may make sense given the report findings. However, given that the Darcy assumptions are not fully validated, validating the use of Darcy without modification for unsaturated conditions and other physical factors should be included in the recommendations also. If the continuous flow assumption and/or the saturated flow assumption prove to be invalid, or only intermittently valid, then liner seepage estimates will need to be reconsidered.

At the end of the report we recommend a final series of observations, something as follows. For each potential source, state the estimated nitrogen range, the constraints on that estimate, and the work needed for each. Examples of this might look something like is bulleted below (these are just offered as points to consider, we did not dig through the report to make sure the comment is completely correct, again, these are examples):



- Irrigated ag: N at the bottom of the root zone estimated to range from ____ to ____ pounds per year from 2015 data. Constraints: will change every year based on crop rotation and the type of irrigation application equipment and management. Crop rotations can serve to mine excess soil nitrogen from fields. Additional work: correlation to deep soil sampling and crop rotation.
- Lagoons: N at the bottom of the liner estimated to range from ____ to ____ pounds per year based on generalizing assumptions such as constant head and liner saturation. Constraints: Darcy assumptions need to be validated. Additional work: validate the assumptions and recalculate the nitrogen estimate.
- And so on and so forth for each....

Each of these are then a simple statement of estimates and findings, without qualification for one being worse than the other. If after that, the authors want to make recommendations for the GWAC, then please do so.

Thank you for the opportunity to review the report. If any of the authors have questions about these comments, they are welcome to contact me at EA's Kennewick office at 509-947-5729. I would be happy to discuss any of this with them.



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