

Alexandria Boehm, PhD
Associate Professor of Environmental Engineering
Stanford University
Stanford, CA
94305

9 September 2010

Dear Ms. Stormo,

Please find attached my peer-review of the staff report. In particular, I address the questions outlined in my charge document. I assert that I have no conflict of interest.

Sincerely,

Alexandria Boehm

Digitally signed by Alexandria Boehm
DN: cn=Alexandria Boehm, o=Stanford
University, ou=Dept Civil and Environmental
Engineering, email=aboehm@stanford.edu, c=US
Date: 2010.09.09 22:47:07 -07'00'

1) Use of the USGS study as the main scientific basis for the proposed Basin Plan Amendment.

The use of the USGS study is sound. The authors of the USGS study have compiled available historical water level and nitrate data and have shown that nitrate levels have increased in specific units of the aquifer since water was imported and used to augment the aquifer. Spikes in nitrate are evident in the portions of the aquifer where water levels have risen due to artificial recharge. Spikes are coincident with the recharge events.

Although it would have been nice to have even more historical water level and nitrate data, they simply do not exist. The available data are sufficient to logically conclude that increases in nitrate were concurrent with the water level increases due to recharge in portions of the aquifer.

The USGS team used multiple lines of evidence to explore whether or not nitrate in the groundwater is from sewage: they used chemical tools (isotopes, organic compounds, chloride), historical data sets, and modeling (including simple models and sophisticated models). The chemical analyses allowed the formulation of mixing diagrams that show the mixing of imported water, septage and naturally occurring groundwater in portions of the aquifer. The presence of caffeine and pharmaceuticals, even at very low levels, suggests that septage is present in the groundwater. The isotopic analysis of nitrate indicated that samples with the highest levels of nitrate were consistent with a septage source. All these techniques are state of the art and standard. There are not additional techniques that are presently in use to identify source of nitrate in groundwater that could have been used.

The USGS report is well written, logical, and scientifically sound. Its use is appropriate as a scientific basis for the amendment.

2) Modeling used in USGS study.

Two types of models were used in the report. Mixing models were used in the form of mixing diagrams to assess what waters compose the high nitrate groundwater, as well as simple mass balance models to test whether mixing of the groundwater with septage would give rise to concentrations observed. Sophisticated numerical models based on mass balance that account for convection, dispersion, etc were used for prediction of water level and nitrate in the future. Below, I will discuss the numerical models and their application as the mixing models are discussed later.

The numerical modeling used in the USGS study is state of the art. Authors used MODFLOW-96 and MOC3D for groundwater flow and solute transport, respectively. The models were used in two ways: first to model historical observations and test the understanding of the mechanism of contamination, and second to predict the effects of new conjunctive uses of the Yucca Valley aquifers on nitrate concentrations and water levels. MODFLOW predicted water level quite well when simulations were compared to measurements in the aquifer. Trends in nitrate and nitrate levels were predicted

reasonably well with MOC3D. Even though there is a paucity of data to compare the models too, the available data are predicted well. The success of the model indicates the conceptual model where the rise in groundwater levels due to recharge entrains septage in the unsaturated zone and causes elevated nitrate is appropriate.

The authors used trial and error to chose some model parameters and openly admit that the result is that the model is probably not the only model that could be developed to predict water level and nitrate concentrations. However, the ability of the model to predict historical water levels and nitrate concentrations given inputs from septage, irrigation, and imported water provides a strong piece of evidence septage is the source of nitrate in the aquifer. When the modeling results are considered in light of the rest of the evidence provided in the USGS report, it strongly supports the idea that septage is the source of nitrate in the aquifer.

3) Adequacy of data used in the USGS study.

The data collected and mined for the USGS study together are adequate in supporting the conclusion that septage is to blame for the high nitrate levels in the aquifer in the Warren Subbasin. The authors used state of the art techniques to measure chemical constituents. They showed anthropogenic chemicals, albeit at low concentrations, in the aquifer. They showed high delta-N15 values consistent with a septage source. The use of organic carbon and fluorescence was inconclusive. It would have been nice if the authors had more delta-N15 data for the septage end-member, but scientists agree that sewage has a high delta-N15 of nitrate, so there is not a huge need to better characterize the end member. Nitrate to chloride ratios also point to septage as a source of pollution. These data, taken together with the time series data on nitrate and groundwater level, and the modeling simulation results, support that septage is a source of nitrate to the aquifer.

4) Relationship of septic tank discharges to ground water recharge efforts used in the USGS study.

The USGS authors present two conceptual models to explain how septage could be causing the high nitrate levels in the groundwater and why the nitrate became elevated when the groundwater rose. They provide sufficient evidence and logic to conclude that the rising groundwater levels due to artificial recharge have entrained nitrate rich septage in the unsaturated zone. They show that assuming reasonable vertical migration speeds of 0.07 to 1 ft/d, it would take the septage 1.2 to 17 years to reach the aquifer. However, high nitrate was not seen in the wells in the subbasin until well after this, which suggests that vertical migration of the septage was not the cause of the high nitrate levels¹. The authors go on to show that given the volume of pore space in the unsaturated zone, the septage discharge to the subbasin could be held up in the unsaturated zone. In addition, the timing of the increase in nitrate was coincident with the commencement of the artificial recharge program. The authors conduct a simple mixing cell model to determine

¹ A comment later in this report refers to a section in the staff report that incorrectly states that nitrate increases due to vertical migration of the septage.

if the nitrate concentrations observed after recharge in the midwest and mideast aquifers began can be explained by mixing of septage already present in the pore spaces in the moisture and water with 10 mg/l nitrate as it rose to fill the unsaturated zone. The simple model predicts nitrate concentrations in the same range as those observed in the field. This simple model, together with the more complex model numerical model supports the conceptual model where the rising water levels, due to artificial recharge, entrain septage already present in the aquifer to create high nitrate concentrations.

5) Groundwater data collected subsequent to the USGS study from 2002-2010.

Data presented in appendix D of groundwater level and nitrate concentrations in the Midwest hydrogeologic unit suggests that nitrate concentrations have become lower in particular wells since the publication of the USGS report. However, nitrate is still higher than 10 mg/L nitrate as nitrate in all wells in 2010 (10 mg/L nitrate as nitrate is the background level in groundwater, and 44 mg nitrate as nitrate is EPA standard). In addition, the staff report mentions on page 26 that in 2009, nitrate at 18.4 mg/L nitrate as N (EPA level is 10 mg/L nitrate as N) was measured in the East unit, which had low nitrate at the time of the USGS report.

The data presented in the USGS report indicates that there is a large amount of septage entering the ground in the subbasin and suggests the unsaturated zone has limited ability to denitrify. I do not think that the limited data provided in appendix D can be used to logically conclude that future groundwater quality threats will not be an issue or to prove that the downward trend will continue and nitrate will decrease to less than 10 mg/L nitrate as nitrate.

Another issue that is not discussed in the USGS is the potential for waterborne pathogens to be present in the groundwater, particularly viruses. If nitrate from septage was found in the groundwater, then there is a possibility that human pathogens could also be present. Granted there are various removal mechanisms for pathogens in the subsurface, but the possibility of their presence does exist. This is something that should be looked into in the near future if possible. The staff report does acknowledge this issue, which is good and appropriate.

6) Staff Report a) Does the Staff Report omit any important issues? b) Is the scientific portion of the proposed rule based upon sound knowledge, methods and practice?

The staff report does not omit any issues. However, I think it would be strengthened with the following considerations:

A) Page 10 of the report, last paragraph. The report claims that the “downward migration of the septic system effluent locally contaminated groundwater with nitrate and pathogens” (quote is not exact). There are two problems with this sentence. The first is that the USGS report actually concluded that the most probably manner in which the groundwater became contaminated was by the water table rising due to infiltration of

State Water Project water which subsequently entrained septage in the unsaturated zone. So the description of the mechanism whereby the groundwater became contaminated is not accurately described in the sentence. Second, no data were provided in my review packet that showed elevated concentrations of pathogens in the groundwater. While I am certain they would likely be found if analyses were done, there is not a scientific basis to state this. I suggest re-phrasing this sentence.

B) Page 18, last paragraph. It would be good to point out that nitrate, besides affecting human health, also can seriously adversely affect ecosystem health. Although Yucca Valley is in the desert and there is minimal exfiltration of groundwater, any above ground septage leakage or groundwater exfiltration into surface waters could lead to eutrophication and possibly changes in vegetation, etc.

C) Page 23, top partial paragraph. It would strengthen the report if the staff explained what lines of evidence were used in the USGS report. I would suggest something along the lines:

“USGS used multiple lines of evidence to show that septage adversely impacts water quality in the Warren Subbasin aquifer. They used historical well data (groundwater level and nitrate), as well as land use information, isotopes of nitrogen, measurements of caffeine and pharmaceuticals, as well as sophisticated, state of the art groundwater flow and solute transport models to show unequivocally that septic effluent has adversely impacted the quality of groundwater in portions of the Warren Subbasin. They also showed that continued and expanded conjunctive use of the aquifers in the future could cause high nitrate concentrations in large portions of the aquifer.”

7) Additional comments on staff report.

I felt the staff report was very well written and highlights the evidence for failing septic tanks in the Yucca Valley area – something that is not covered in the USGS report. This result, in conjunction with all the evidence provided by the USGS, indicates that the proposed amendment to the basin plan is needed and scientifically warranted.

UNIVERSITY OF CALIFORNIA, BERKELEY

BERKELEY • DAVIS • IRVINE • LOS ANGELES • RIVERSIDE • SAN DIEGO • SAN FRANCISCO



SANTA BARBARA • SANTA CRUZ

ENVIRONMENTAL ENGINEERING PROGRAM
DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING
760 DAVIS HALL MC 1710
BERKELEY, CALIFORNIA 94720-1710

PHONE: (510) 642-0948
FAX (510) 642-7483

October 31, 2010

Joan Stormo, Senior Environmental Geologist
Colorado River Basin Regional Water Quality Control Board
73-720 Fred Waring Drive, Suite 100
Palm Desert, CA 92260
Email: jstormo@waterboards.ca.gov

Dear Ms Stormo:

I am pleased to provide the requested review of the staff report in support of a basin plan amendment to prohibit wastewater discharges from septic tank sub-surface disposal systems in the town of Yucca Valley, California.

1. USGS report of 2003. This study is a detailed analysis of exiting groundwater elevation data as well as nitrate levels in well waters within the Warren Subbasin. It is clear from this study that nitrate is coming from septic tank discharges.
2. USGS modeling. The USGS report adopts a number of modeling approaches that support the analysis that septic tank discharges are the main source of nitrate in pumped groundwater. Mixing models are used to compare groundwater nitrate levels with nitrate levels in various source terms including natural recharged groundwater, artificially recharged groundwater, and septic tank discharges. While not strictly predictive, mixing models are very powerful in demonstrating with measurements the dominant source of contamination when there are multiple sources. The use of isotopic analysis for the nitrogen atoms present in the groundwater nitrate provides additional supporting information that the source of the nitrate is septic tank discharges. Computer modeling of groundwater flow and nitrate transport quantify nitrate sources and their transport, but at a much more complex level. The water flow in the subsurface must first be simulated using the commonly accepted MODFLOW package. Water flow predictions from MODFLOW are then used to drive a solute transport, MOC3D, suitable for nitrate transport assuming nitrate is a conservative, nonreactive compound. Flow and transport models require a representation of the subsurface geometry that is only poorly known from well logs and local geologic information, including the presence of faults that can act as barriers to groundwater migration. These uncertainties in the subsurface lead to extensive model calibration to identify appropriate parameter values related to subsurface transport properties and nitrate release rates. Once the model is calibrated then sensitivity studies are undertaken to identify what parameters are critical, and in this case the USGS report provided a detailed analysis of model uncertainty.
3. USGS data adequacy. There is generally never enough data, but professional judgment is required to utilize the available historical data and recently collected data to move forward with more informed decisions. The historical data was adequate and new data collected from existing

wells in the basin was a reasonable approach to undertake groundwater flow and solute transport modeling.

4. Septic tank discharges and groundwater recharge. The multiple models evaluated in the USGS report ranging from mixing models to numerical groundwater and solute transport models support the conceptual model that the increase in nitrate in well water came from a rise in the water table caused by the importation of water into the basin. There is an alternative explanation that was not discussed in the USGS report. Prior to artificial recharge into the basin, the overdrafting of the groundwater basin provided a very thick vadose zone where septic tank nitrogen compounds probably encountered partially oxidizing conditions. Under those conditions ammonia and organic nitrogen can be oxidized to nitrate. If that nitrate is then mixed with high organic content septic tank water, nitrate reduction to nitrogen gas is possible via denitrification. When the artificial recharge was initiated, this possible soil-aquifer treatment system could have been arrested by water flooding. Since denitrification can cause a shift in the isotopic composition of the remaining nitrate, and perhaps there is a detectable shift in the nitrate isotopic composition to support or dismiss this alternative explanation. Nitrogen isotope geochemistry under denitrification conditions is not something I had time to investigate within the time constraints of this review.

5. Groundwater data from 2002 – 2010. Appendix D of the staff report with recent nitrate and groundwater elevation data demonstrate continued high levels of nitrate in the groundwater even though they do not exceed drinking water standards. Levels reported are in the range of 10 to 30 mg/L and that level might represent some steady state value of septic tank discharges and groundwater recharge, but such an analysis does not appear in the staff report and the USGS report does not consider that situation. In the USGS 2003 report, Figure 15 (page 42) shows nitrate concentrations increasing over time in the deepest groundwater sampling interval (YV2-570) over the period of artificial recharge with SWP water. Additionally, groundwater from this deepest sample with the highest nitrate concentrations has a mixing curve of Delta Oxygen-18 water and nitrate in Figure 18 (USGS page 55) that indicates there has been no dilution of that water with imported SWP water. These results suggest that septic tank discharges are possibly denser than ambient groundwater and artificially recharged SWP water causing the waste to sink to the lower levels of the aquifer. Appendix D in the staff report does not include nitrate concentrations in that well in the 2003 to 2010 period to evaluate if deeper groundwater could be a reservoir of nitrate contamination for the whole aquifer.

Bigger Picture:

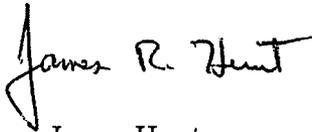
The USGS report and the staff report on the Yucca Valley water supply did not start off with an analysis of the aquifer storage, the town's water pumping, and septic tank discharges to quantify the waste load being added to the subsurface. Under natural conditions the inflow and outflow were estimated by USGS at less than 100 ac-ft/yr, and as a consequence, the water in the basin is old based on radiocarbon dating with estimates of 2000 to 3000 years (page 14). Water pumping prior to the importation of State Water Project water was mining the groundwater aquifer with well pumping far exceeding inflows and septic tank discharges. While there is considerable consumptive use of Yucca Valley water reported for a golf course, there is no consideration of landscape irrigation by households and the corresponding nutrient loads associated with those practices. A Google Earth image of the town of Yucca Valley in February 2009 indicates limited landscaping, but this is the middle of winter. There should be an analysis of actual consumptive use with an overall water balance for the basin. Prior to the importation of SWP water the groundwater aquifer was being used as the sole source of drinking water and the sole recipient of wastewater. That circumstance resulted in the long term buildup of wastewater components in the

groundwater basin and would not be viewed as sustainable either from a water supply or a waste management perspective.

The installation of a sewer during Phase I implementation is justified by the annual rate of failure of septic systems within Yucca Valley. Septic systems for residential development at that density along with commercial establishments exceed waste accommodation rates and the soil's infiltration capacity. Separate from the documents presented for this review was a description of the Water Reclamation Facility being planned for Yucca Valley present on the Hi-Desert Water District website. The proposed plant will utilize secondary treatment with filtration to achieve 10 mg/L BOD (organic matter), 10 mg/L suspended solids, and 8 mg/L total nitrogen. With extended aeration it is likely the wastewater effluent will be nitrified and all the nitrogen will be present as nitrate. Since this effluent will be infiltrated on site, the groundwater basin will again be subject to increased nutrient loading along with the accumulation of salts within the aquifer. While the sewer collection system and treatment plant will be an advance over a poorly functioning diffuse septic system, will the solution being proposed ultimately improve the nitrate loading to the groundwater basin?

I hope these comments are useful to you in your deliberations.

Sincerely,

A handwritten signature in cursive script that reads "James R. Hunt".

James R. Hunt
Lawrence E. Peirano Professor of Environmental Engineering
Co-Director, Berkeley Water Center



California Regional Water Quality Control Board
Colorado River Basin Region



73-720 Fred Waring Drive, Suite 100, Palm Desert, California 92260
(760) 346-7491 • Fax (760) 341-6820
<http://www.waterboards.ca.gov/coloradoriver>

Linda S. Adams
Secretary for
Environmental Protection

Arnold Schwarzenegger
Governor

December 9, 2010

Alexandria B. Boehm, Ph.D.
158 Charles Marx Way
Palo Alto, CA 94304

Dear Dr Boehm:

SUBJECT: RESPONSES TO SCIENTIFIC PEER REVIEW COMMENTS FOR THE STAFF REPORT IN SUPPORT OF A BASIN PLAN AMENDMENT TO CONDITIONALLY PROHIBIT WASTEWATER DISCHARGES FROM SEPTIC TANK SUB-SURFACE DISPOSAL SYSTEMS IN THE TOWN OF YUCCA VALLEY, SAN BERNARDINO COUNTY, CALIFORNIA

Thank you for reviewing and commenting on the subject staff report. This letter provides responses to your comments provided by letter dated September 9, 2010. Your comments are summarized below in the order presented in your letter. Our response to each comment is provided in **bold type**, with text deleted from the staff report indicated by **strikethrough**, and text added to the staff report indicated by **underline**.

1. Use of the USGS study as the main scientific basis for the proposed Basin Plan Amendment.

COMMENT: "The available data are sufficient to logically conclude that increases in nitrate were concurrent with the water level increases due to recharge in portions of the aquifer..... The USGS report is well written, logical, and scientifically sound. Its use is appropriate as a scientific basis for the amendment."

RESPONSE: **Agreed.**

2. Modeling used in USGS study.

COMMENT: "When the modeling results are considered in light of the rest of the evidence provided in the USGS report, it strongly supports the idea that septage is the source of nitrate in the aquifer."

RESPONSE: **Agreed. The evidence is sufficient to conclude septage is the source of nitrate in the aquifer.**

California Environmental Protection Agency

3. Adequacy of data used in the USGS study.

COMMENT: "The data collected and mined for the USGS study together are adequate in supporting the conclusion that septage is to blame for the high nitrate levels in the aquifer in the Warren Subbasin... It would have been nice if the authors had more delta-N15 data for the septage end-member, but scientists agree that sewage has a high delta-N15 of nitrate, so there is not a huge need to better characterize the end member. Nitrate to chloride ratios also point to septage as a source of pollution. These data, taken together with the time series data on nitrate and groundwater level, and the modeling simulation results, support that septage is a source of nitrate to the aquifer."

RESPONSE: **Agreed. Although additional delta-N15 data is preferable, the information available indicates septage is the cause of the high nitrate levels in groundwater from the Warren Subbasin.**

4. Relationship of septic tank discharges to groundwater recharge efforts used in the USGS study.

COMMENT: "The USGS authors present two conceptual models to explain how septage could be causing the high nitrate levels in the groundwater and why the nitrate became elevated when the groundwater rose. They provide sufficient evidence and logic to conclude that the rising groundwater levels due to artificial recharge have entrained nitrate rich septage in the unsaturated zone."

RESPONSE: **Agreed.**

5. Groundwater data collected subsequent to the USGS study from 2002-2010.

COMMENT: "Data presented in appendix D of groundwater level and nitrate concentrations in the Midwest hydrogeologic unit suggests that nitrate concentrations have become lower in particular wells since the publication of the USGS report. However, nitrate is still higher than 10 mg/L nitrate as nitrate in all wells in 2010 (10 mg/L nitrate as nitrate is the background level in groundwater, and 44 mg nitrate as nitrate is EPA standard)... The data presented in the USGS report indicates that there is a large amount of septage entering the ground in the subbasin and suggests the unsaturated zone has limited ability to denitrify. I do not think that the limited data provided in appendix D can be used to logically conclude that future groundwater quality threats will not be an

issue or to prove that the downward trend will continue and nitrate will decrease to less than 10 mg/L nitrate as nitrate..."

RESPONSE: **Agreed. The data does not conclusively indicate that downward trends in nitrate levels will continue, nor indicate that groundwater quality will be protected in the future.**

COMMENT: "Another issue that is not discussed in the USGS is the potential for waterborne pathogens to be present in the groundwater, particularly viruses. If nitrate from septage was found in the groundwater, then there is a possibility that human pathogens could also be present. Granted there are various removal mechanisms for pathogens in the subsurface, but the possibility of their presence does exist. This is something that should be looked into in the near future if possible. The staff report does acknowledge this issue, which is good and appropriate."

RESPONSE: **Agreed. The threat of waterborne human pathogens in groundwater merits further investigation.**

6. Does the Staff Report omit any important issues?

COMMENT: The staff report does not omit any issues. However, I think it would be strengthened with the following considerations:

"Page 10 of the staff report, last paragraph. The report claims that the *downward migration of the septic system effluent locally contaminated groundwater with nitrate and pathogens* (quote is not exact). There are two problems with this sentence. The first is that the USGS report actually concluded that the most probable manner in which the groundwater became contaminated was by the water table rising due to infiltration of State Water Project water which subsequently entrained septage in the unsaturated zone. So the description of the mechanism whereby the groundwater became contaminated is not accurately described in the sentence. Second, no data were provided in my review packet that showed elevated concentrations of pathogens in the groundwater. While I am certain they would likely be found if analyses were done, there is not a scientific basis to state this. I suggest re-phrasing this sentence."

RESPONSE: **Agreed. The statement you refer to in the last paragraph of page 10 of the Staff Report will be revised to read as follows:**

These features, combined with the high density of septic systems found in some areas of Yucca Valley [footnote to be added here—see below] , ~~has facilitated the downward migration of~~ are among the factors that contribute to septic system effluent, locally contaminating groundwater with salts (particularly nitrates) ~~and pathogens associated with domestic waste.~~

[Footnote: Approximately 92% of the Town is zoned for residential and commercial development on one-half acre or smaller lots. The highest density occurs with multi-family zoning, which allows up to ten dwelling units per acre (see Appendix B).]

7. Is the scientific portion of the proposed rule based upon sound knowledge, methods and practice?

COMMENT: "Page 18, last paragraph. It would be good to point out that nitrate, besides affecting human health, also can seriously adversely affect ecosystem health. Although Yucca Valley is in the desert and there is minimal exfiltration of groundwater, any above ground septage leakage or groundwater exfiltration into surface waters could lead to eutrophication and possibly changes in vegetation, etc."

RESPONSE: **Staff allude to ecosystem impacts on page 17, Table 3, in the column labeled "Reason For Concern", where it states "Nitrogen is an aquatic plant nutrient that contributes to eutrophication and loss of dissolved oxygen in surface waters such as lakes." The staff report focuses on groundwater impacts because the Town of Yucca Valley has no perennial surface waters.**

COMMENT: "Page 23, top partial paragraph. It would strengthen the report if the staff explained what lines of evidence were used in the USGS report."

RESPONSE: **Thank you for your suggestion. The following will be added to the end of the paragraph at the top of page 23:**

Septic system density varies widely in Yucca Valley. However a study by USGS, *Evaluation of the Source and Transport of High Nitrate Concentrations in Groundwater, Warren Subbasin, California* (2003), clearly indicates groundwater in Yucca has been degraded by septic system discharges, particularly in areas with high densities of residential lots (i.e. several septic systems per acre). ~~This is due in part to the poor performance of septic systems in high density areas given inadequate soils, and excess loading.~~ USGS used several lines

of evidence to demonstrate adverse impacts to water quality from septage in specific areas of the Warren Subbasin aquifer including: land use information; well data (historical groundwater levels and nitrate concentrations); nitrogen isotopes; caffeine and pharmaceutical analyses, and state of the art groundwater flow and solute transport models. USGS also showed that continued and expanded conjunctive use of the aquifers may cause high nitrate levels in large portions of the aquifer.

8. Additional comments regarding the staff report.

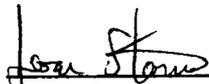
COMMENT: "I felt the staff report was very well written and highlights the evidence for failing septic tanks in the Yucca Valley area – something that is not covered in the USGS report. This result, in conjunction with all the evidence provided by the USGS, indicates that the proposed amendment to the basin plan is needed and scientifically warranted."

RESPONSE: Thank you.

Thank you for reviewing the scientific elements of the proposed Basin Plan Amendment to Conditionally Prohibit Wastewater Discharges from Septic Tank Sub-Surface Disposal Systems in the Town of Yucca Valley, California. Your contribution to this process is greatly appreciated.

If you have further comments or questions, please contact Jon Rokke at (760) 776-8959.

Sincerely,



Joan Stormo
Senior Engineering Geologist, PG, CHG
Colorado River Basin
Regional Water Quality Control Board

JR/tab

File: Yucca Valley Septic Prohibition



Linda S. Adams
Secretary for
Environmental Protection

California Regional Water Quality Control Board Colorado River Basin Region

73-720 Fred Waring Drive, Suite 100, Palm Desert, California 92260
(760) 346-7491 • Fax (760) 341-6820
<http://www.waterboards.ca.gov/coloradoriver>



Arnold Schwarzenegger
Governor

December 10, 2010

James R. Hunt, Ph.D.
Professor of Civil and Environmental Engineering
University of California, Berkeley
625 Davis Hall, MC 1710
Berkeley, CA 94720-1710

Dear Dr Hunt:

SUBJECT: RESPONSES TO SCIENTIFIC PEER REVIEW COMMENTS FOR A STAFF REPORT IN SUPPORT OF A BASIN PLAN AMENDMENT TO CONDITIONALLY PROHIBIT WASTEWATER DISCHARGES FROM SEPTIC TANK SUB-SURFACE DISPOSAL SYSTEMS IN THE TOWN OF YUCCA VALLEY, SAN BERNARDINO COUNTY, CALIFORNIA

Thank you for reviewing and commenting on the subject staff report. This letter provides responses to your comments provided by letter dated October 31, 2010. Your comments are summarized below in the order presented in your letter. Our response to each comment is provided in **bold type**.

COMMENT: "1. USGS report of 2003. This study is a detailed analysis of exiting [*sic*] groundwater elevation data as well as nitrate levels in well waters within the Warren Subbasin. It is clear from this study that nitrate is coming from septic tank discharges."

RESPONSE: **Agreed. The USGS study clearly indicates nitrate levels in groundwater samples from the Warren Subbasin result from septic tank discharges.**

COMMENT: "2. USGS modeling....Flow and transport models require a representation of the subsurface geometry that is only poorly known from well logs and local geologic information, including the presence of faults that can act as barriers to groundwater migration. These uncertainties in the subsurface lead to extensive model calibration to identify appropriate parameter values related to subsurface transport properties and nitrate release rates. Once the model is calibrated then sensitivity studies are undertaken to identify what parameters are critical, and in this case the USGS report provided a detailed analysis of model uncertainty."

California Environmental Protection Agency

RESPONSE: **Agreed. The subject USGS report adequately addresses the uncertainty of their model.**

COMMENT: "3. USGS data adequacy. There is generally never enough data, but professional judgment is required to utilize the available historical data and recently collected data to move forward with more informed decisions. The historical data was adequate and new data collected from existing wells in the basin was a reasonable approach to undertake groundwater flow and solute transport modeling."

RESPONSE: **Agreed. Combining historical data with recent data is reasonable for modeling groundwater flow and transport.**

COMMENT: "4. Septic tank discharges and groundwater recharge. The multiple models evaluated in the USGS report ranging from mixing models to numerical groundwater and solute transport models support the conceptual model that the increase in nitrate in well water came from a rise in the water table caused by the importation of water into the basin. There is an alternative explanation that was not discussed in the USGS report. Prior to artificial recharge into the basin, the overdrafting of the groundwater basin provided a very thick vadose zone where septic tank nitrogen compounds probably encountered partially oxidizing conditions. Under those conditions ammonia and organic nitrogen can be oxidized to nitrate. If that nitrate is then mixed with high organic content septic tank water, nitrate reduction to nitrogen gas is possible via denitrification. When the artificial recharge was initiated, this possible soil-aquifer treatment system could have been arrested by water flooding. Since denitrification can cause a shift in the isotopic composition of the remaining nitrate, and perhaps there is a detectable shift in the nitrate isotopic composition to support or dismiss this alternative explanation. Nitrogen isotope geochemistry under denitrification conditions is not something I had time to investigate within the time constraints of this review."

RESPONSE: **As you indicate, the soil-aquifer treatment system may have been arrested by flooding of the vadose zone during artificial aquifer recharge. However this does not alter your conclusion later in your letter where you state:**

“The installation of a sewer during Phase I implementation is justified by the annual rate of failure of septic systems within Yucca Valley. Septic systems for residential development at that density along with commercial establishments exceed waste accommodation rates and the soil’s infiltration capacity.” (Emphasis added)

Given the above, the situation you describe does not significantly affect the need for the subject Basin Plan Amendment in the Town of Yucca Valley. We will, however, provide your comment(s) to the authors of this USGS report for their consideration and possible investigation.

COMMENT: “5. Groundwater data from 2002 – 2010. Appendix D of the staff report with recent nitrate and groundwater elevation data demonstrate continued high levels of nitrate in the groundwater even though they do not exceed drinking water standards. Levels reported are in the range of 10 to 30 mg/L and that level might represent some steady state value of septic tank discharges and groundwater recharge, but such an analysis does not appear in the staff report and the USGS report does not consider that situation. In the USGS 2003 report, Figure 15 (page 42) shows nitrate concentrations increasing over time in the deepest groundwater sampling interval (YV2-570) over the period of artificial recharge with SWP water. Additionally, groundwater from this deepest sample with the highest nitrate concentrations has a mixing curve of Delta Oxygen-18 water and nitrate in Figure 18 (USGS page 55) that indicates there has been no dilution of that water with imported SWP water. These results suggest that septic tank discharges are possibly denser than ambient groundwater and artificially recharged SWP water causing the waste to sink to the lower levels of the aquifer. Appendix D in the staff report does not include nitrate concentrations in that well in the 2003 to 2010 period to evaluate if deeper groundwater could be a reservoir of nitrate contamination for the whole aquifer.”

RESPONSE: Staff agrees that wastewater discharges may be denser than ambient groundwater or SWP water, and sink to the lower levels of the aquifer. This possibility, while interesting, does not affect the need for the subject Basin Plan Amendment for the Town of Yucca Valley. We will forward your comments to the USGS report authors for their consideration.

Bigger Picture:

COMMENT: "The USGS report and the staff report on the Yucca Valley water supply did not start off with an analysis of the aquifer storage, the town's water pumping, and septic tank discharges to quantify the waste load being added to the subsurface. While there is considerable consumptive use of Yucca Valley water reported for a golf course, there is no consideration of landscape irrigation by households and the corresponding nutrient loads associated with those practices. There should be an analysis of actual consumptive use with an overall water balance for the basin. Prior to the importation of SWP water the groundwater aquifer was being used as the sole source of drinking water and the sole recipient of wastewater. That circumstance resulted in the long term buildup of wastewater components in the groundwater basin and would not be viewed as sustainable either from a water supply or a waste management perspective."

RESPONSE: In addition to being the local water purveyor, the Hi-Desert Water District (HDWD) was designated the Water Master of this "adjudicated basin" in 1977 by court order due to severe overdraft of areal aquifers. In 1991, HDWD adopted the "Warren Valley Basin Management Plan" and began encouraging water conservation through programs such as "Cash for Grass", which advocates replacing lawns with desert landscape. The only golf course in the Town was closed in 2004; this combined with the prevalence of desert landscape has reduced nutrient loading from landscape irrigation to insignificant levels.

COMMENT: "The installation of a sewer during Phase I implementation is justified by the annual rate of failure of septic systems within Yucca Valley. Septic systems for residential development at that density along with commercial establishments exceed waste accommodation rates and the soil's infiltration capacity."

RESPONSE: Agreed.

COMMENT: "Separate from the documents presented for this review was a description of the Water Reclamation Facility being planned for Yucca Valley present on the Hi-Desert Water District website. The proposed plant will utilize secondary treatment with filtration to achieve 10 mg/L

BOD (organic matter), 10 mg/L suspended solids, and 8 mg/L total nitrogen. With extended aeration it is likely the wastewater effluent will be nitrified and all the nitrogen will be present as nitrate. Since this effluent will be infiltrated on site, the groundwater basin will again be subject to increased nutrient loading along with the accumulation of salts within the aquifer. While the sewer collection system and treatment plant will be an advance over a poorly functioning diffuse septic system, will the solution being proposed ultimately improve the nitrate loading to the groundwater basin?"

RESPONSE: Nitrate loading to the groundwater basin from proposed facilities will be assessed by our agency during issuance of Waste Discharge Requirements (WDRs). WDRs protect the quality and beneficial uses of state waters by ensuring sufficient treatment of wastewater before discharge.

Thank you for reviewing the scientific elements of the proposed Basin Plan Amendment to Prohibit Wastewater Discharges from Septic Tank Sub-Surface Disposal Systems in the Town of Yucca Valley, California. Your contribution to this process is greatly appreciated.

If you have further comments or questions, please contact Jon Rokke at (760) 776-8959.

Sincerely,



Joan Stormo
Senior Engineering Geologist, PG, CHG
Colorado River Basin
Regional Water Quality Control Board

JR/tab

File: Yucca Valley Septic Prohibition