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Los Osos WW System
Supplmental Information

California Regional Water Quality Control Board
Central Coast Region

INTERNAL MEMO

TO: Roger Briggs
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FROM: Jay Cano,
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DATE: October 24, 1994

SUBJECT: Review of Los Osos Nitrate Study

I reviewed the Los Osos Nitrate Study and have many comments. While the Technical Advisory Committee's July 7, 1994 memo (behind inside cover of report), concludes that septic tanks are not the cause of the Los Osos ground water problems, the data do not support that conclusion. The data plainly show that nitrate concentrations in liquid collected below seepage pits/leach field are many times the drinking water limit. The report simply ignores the obvious. Nonetheless, I'll discuss my general comments about the report, then I'll discuss specific comments which the report should have addressed to be complete and accurate.

General Comments

The report's data do not justify the conclusions as described in the July 7, 1994 memo from the TAC to the San Luis Obispo County Board of Supervisors. For example, the answer to the first question in the memo implies that all nitrogen below the seepage pits/leach fields is denitrified to nitrogen gas. However, data in the report (Tables 5 & 6) show nitrate concentrations in samples collected in lysimeters below the leach pits to be many times above the drinking water limit. The conclusions need to accurately characterize the data generated by the study and that is nitrate concentrations below seepage pits and a leach field substantially exceeded drinking water limits.

Also, for measured decreases in nitrate concentration, the report needs to explore other possible explanations besides denitrification. For example, another possible loss of nitrogen that could occur is the dispersion of effluent in soil as a result of capillary action. The result simply would be dilution into the surrounding soil moisture and decreased nitrate concentration. Also, the report does not account for the probable loss of nitrogen drawn away as ammonia from the suction lysimeters particularly at the Bayridge Estates site. Furthermore, the report does not discuss the effect of naturally occurring chloride on the N/Cl ratio which could, and probably does, have an effect on the ratio. The report claims decreases in the N/Cl ratio is solely the result of

denitrification. These are only a few examples of many problems with the report.

One curious point of this report was the conclusions section beginning on page 90 somewhat accurately characterizes the data developed in this study. For example, it states, "The data suggest ... nitrate becomes transformed to nitrogen gas..." It doesn't say the data conclude but merely the data suggest. Also, in response to question No. 3, it says, "The data support denitrification..." Here again, it says the data support, it does not conclude denitrification. In contrast, other portions of the report, without the benefit of additional data, take a giant leap and conclude denitrification occurs. Also, the answer to the third question in the July 7, 1994 memo simply responds with yes, denitrification is occurring.

Regardless of whether denitrification is occurring, the critical point here is that lysimeter moisture at 25 feet below the leach pits still had nitrate concentrations at one to four times the drinking water limit (Tables 5 & 6). Whereas, the data may suggest that denitrification could be occurring, the data do not support that it is occurring. To conclude it is occurring, analyses beyond the scope of this study are needed such as measurement of nitrogen gas created as a result of denitrification and the existence of denitrifying bacteria at depth.

Another interesting point is that the lysimeter nitrate data under the seepage pits at the forty foot depth is consistent with the County's quarterly monitoring well data. In very general terms, well data show nitrate in the range of 10 to 20 ml/l as N whereas the lysimeter data varied from about 10 to 40 mg/l as N. Keep in mind these seepage pits are 40 feet above ground water which is probably one of the most ideal conditions in the Los Osos area. The study's data show that nitrate concentrations increased with decreasing distance to the pit.

In any event, the specific comments below need to be addressed before making the conclusions at stated in the July 7, 1994 memo. Simply put, while the report developed some useful information, it was not enough to make the purported conclusions.

Therefore, based on my review, the data from this study reaffirms that discharges from septic tank systems are impairing the beneficial uses of ground water in the Los Osos area. I can find no compelling reason to recommend the Regional Board reconsider the prohibition zone as specified in the Basin Plan. In fact, based on the data presented in the report, the Board should consider action forthwith to ensure beneficial uses of the ground water basin are protected.

Specific Comments

1. Page 1, Paragraph 1 - Most communities with densities as Los Osos do not use individual septic tank systems for wastewater disposal.

2. Page 1, Paragraph 2 - Discharges from individual septic tank systems in Los Osos were studied and results described in several reports including the "Brown and Caldwell Report."

3. Page 2 - Not all of the Technical Advisory Committee members listed have participated in preparation of the July 7, 1994 memo "From: The Technical Advisory Committee" to the Board of Supervisors. Therefore, the July 7, 1994 memo is misleading because it implies its preparation had participation of all TAC members. The report should clearly state the level to which the various TAC members have participated with preparation of the memo and the report .

4. Page 3, Item (2) - This is a very optimistic objective. How is it possible with the given scope of work? More tests than the study provided are needed to conclude any mechanism of transformation.

5. Page 16, Paragraph 1 - The meaning of this "Deduction" is unclear. The report should explain in more detail.

6. Page 16, Paragraph 3 - The report states that the field monitoring program's instrumentation was designed to monitor nitrogen concentrations and transformations. Considering that the program consisted of sampling liquids from the vadose zone, what instrumentation was used to measure transformations? The report refers to data which indicates possible transformations, but references to actual instrumentation used to measure transformations cannot be found.

7. Page 18, paragraph 2 and Page 19, Table 1 - The report states the lysimeter holes were drilled at an angle so as to get the lysimeters directly under the leach field or seepage pits. Table 1 shows that the Bayridge Estates lysimeters were drilled vertically. The report should correct this inconsistency. If the lysimeters were drilled vertically, beside the leach fields as depicted on Figure 6, results can be expected to be different than results of samples collected directly below a seepage pit.

8. Page 22, Table 2, Soil Coring Data, Native Site - This table shows data taken at five depths at the native site. However, page 18, 6.1. Soil Borings, paragraph 1 states that the soil samples taken from the Ferrel Ave site (native vegetation) were discarded. Where is the Table 2 data from? Discussion of these soil samples occurs in other sections of the report.

9. Page 23, Lysimeter installation, paragraph 5 - As a practical matter, it is likely a suction pump cannot collect a sample from a depth greater than 25 feet. The report should state which samples were collected by suction and which were collected by pressurization. As a matter of interest, the deepest lysimeter at Bayridge was 15 feet indicating all samples were probably collected by suction. Whereas, at the 13th and 14th street sites, samples collected at 25, 30 and 40 feet were probably collected by pressure. The report should discuss how these different sampling techniques could affect results.

10. Page 27, Paragraph 2 - Location of the application site of the bromide tracer solution (Figure 11, Page 21 as referenced in the report) cannot be found.

11. Pages 42 and 43, Table 7 - This table shows water quality data collected at Bayridge Estates. As mentioned in comment No. 7 above, these samples were collected beside the leach field, not under it as was done with the seepage pits. Due to this fact and the on-off nature of these leach fields, it is likely some samples collected contained little or no percolating effluent. This could explain why lysimeter data results are so variable. The report should discuss the effects on data by having the combination of offset lysimeters and the on-off sequencing of the leach fields.

12. Page 46, last paragraph and page 51, paragraph 4 - The 15 foot sampling depth is assumed to be effluent from the pit itself. Water quality characteristics would be much different from a lysimeter sample collected five feet below the pit. The report should make the distinction between pit effluent and lysimeter collections.

13. Page 47, paragraph 3 - Another mechanism besides denitrification could possibly decrease nitrate/chloride ratios. Keep in mind that the ratio depends on two variables - concentration of nitrate and concentration of chloride. A decrease in the ratio would indicate denitrification if the leachate were diluted in a liquid medium devoid of nitrogen and chloride. However, if the diluting medium itself (i.e. surrounding soil as described on page 83, paragraph 2) contains chloride, that chloride would mix with the sample thus causing the ratio to decrease. While some portions of the report suggest the decrease in nitrate/chloride or EC is the result of denitrification, other portions of the report indicate this phenomenon is rock solid evidence that denitrification has occurred. The report should explain in detail how chloride in surrounding soil can affect the nitrate/chloride or EC values.

14. Page 59, paragraph 2 - The report alludes to a possible source of nitrate as simply natural soil nitrogen primarily in the upper horizon. If that were true, high nitrate problems would occur in virtually all ground water, given that nitrogen occurs naturally in almost all surface soils. How much of this nitrate is adsorbed to the soil and actually immobile? To mobilize this nitrate wouldn't the soil need to be saturated thus diluting the soil nitrate? The

arguments put forth in the report need more explanation. Also, the report should go on to explain the lack of high nitrate in ground water to the area east of the densely populated area.

15. Page 59, last paragraph - The report discusses the "tremendous reservoir of nitrate-nitrogen" in the Los Osos basin based on soil samples collected from a native site and park area. As mentioned in comment No. 8 above, the report previously stated the native site soil cores were discarded. This inconsistency should be explained.

16. Page 61, paragraph 2 - The "native" site is in the middle (Ferrel Ave) of Los Osos. The report does not explain how ground water at this location would not be influenced by septic systems.

17. Page 61-62, Gamma Ray Logging - Page 30 of the report states, "The gamma ray log generally has a poor response in such soils" (referring to Los Osos sands). The report over-emphasizes data from the results of this poor technique. With this in mind, the report should put into proper perspective the value of the gamma ray logging information.

18. Page 62, Neutron Logging, first paragraph - How is the statement substantiated that leachate infiltrated vertically downward with little horizontal spreading? The same forces that create the capillary zone as discussed in the paragraph below (page 62) would tend to create horizontal spreading.

19. Page 65, paragraph 2 - The report states that bromide was detected at the 15 foot depth 140 hours after the leach field was started. Table 4, page 29 shows bromide increased substantially at the 15 foot depth on March 8, 1993. Table 10, page 64 shows the leach field was activated the same day, March 8, 1993. How does that translate into bromide reaching the 15 foot depth after 140 hours and the calculated hydraulic conductivity of 1.8 feet per day?

20. Page 65, last paragraph - At the 15 foot depth, nitrate can be expected to be zero because the sample was taken from the pit itself.

21. Page 66, paragraph 2 - The report says that the microbial denitrification process presumably transformed the nitrate-nitrogen into nitrogen gas. If denitrification is occurring, the report should go on to explain to what extent nitrogen is lost to the atmosphere.

22. Page 66, paragraph 4 - The report should explain how the decrease in ratio could or could not be the result of dilution in a medium containing chloride. If the report claims dilution is not likely, it should explain what forces are acting to keep capillary forces from causing leachate to spread horizontally.

23. Page 67, last paragraph - How is the statement that 50 to 60 mg/l of nitrogen lost to the denitrification process justified with the data from this report? To make such a conclusion, the report needs to explain what happens to nitrate in effluent drawn horizontally and away from the lysimeters under the influence of capillary action. Wouldn't this horizontally drawn effluent dilute with the surrounding soil moisture? If not, the report should explain.

24. Page 72, 8.63 Chemical Data for the 14th Street Site, Paragraph 2 and Page 73, last paragraph - The report suggests water from another source is mixing with effluent because of changes in chloride concentration. Changes in chloride concentration simply could be the result of chloride in the soil column. The report should recognize that the moisture collected in the lysimeters is from the unsaturated zone, therefore these minute traces of moisture may vary significantly in concentration with relatively small inputs of salts. Page 83, paragraph 2 explains the possibility of chloride in soil which is more reason to suspect natural chloride in the soil column is causing N/Cl ratios to decrease.

25. Page 73, Paragraph 4 - The report should discuss which samples were collected by vacuum and which by pressure. The different sampling techniques could cause different results.

26. Page 74, paragraph 1 - Soil moisture in lysimeters collected at the 30 and 40 foot levels could simply be moisture primarily from surrounding soils rather than moisture primarily from leachate. Natural soil moisture could explain the relatively high chloride concentrations.

27. Page 74, 8.72 Nitrate-N/Chloride ratios for Bayridge Estates Leach field - This paragraph states that the data "suggests" denitrification is operating. This is a more accurate statement than statements elsewhere in the report stating denitrification *is* occurring.

28. Page 74, last sentence - The drastic change in ratio could also be the result of both nitrification and change in water chemistry.

29. Page 75, 8.75 Nitrogen Transformations at the Bayridge Estates Leach fields, Paragraph 2 - The report should explain how the perched water tables are conducive to biological denitrification given that the neutron logging data supporting perched water was altered due to "slurry installation" (See p. 24, Neutron Logging, Deduction).

30. Page 75, last paragraph - The report entirely misses a possible, if not likely scenario, regarding the fate of nitrogen. Too much credence is given to the accuracy of the data developed at the Bayridge site. The report should recognize that lysimeters were installed beside the leach fields, not directly under them as with the leach pits. Also, given the lysimeter samples were

collected at 15 feet of depth or less, it is likely all samples were collected by vacuum. Therefore a substantial amount of ammonia can be expected to be lost. This is especially true given the relatively high concentrations of ammonia found in the samples although the samples were collected by vacuum. Furthermore, if it takes two days to collect a sample as indicated on page 39, nitrogen in the form of ammonia would be lost with the vacuum. This could still be true given most nitrogen may be in the ammonium form. As ammonia is drawn off the sample, ammonium would convert to ammonia to maintain equilibrium in the sample. Also, keep in mind that evaporation of moisture would have little effect on the concentration of ammonia because of the much higher vapor pressure of ammonia (@ 60° F ammonia vapor pressure is 107.6 psi while water vapor pressure is 0.256 psi). As a result, ammonia would readily volatilize (evaporate) whereas water would remain relatively unaffected.

31. Page 76, Paragraphs 3 and 4 - The report claims absolutely that denitrification is occurring. Before making such a conclusion, other possible phenomenon should be explained. For example, what about loss of total nitrogen due to volatilization of ammonia? What about the possible incomplete nitrification process due to the on-off nature of the leach field operation? Nitrification may not be complete until it reaches the capillary fringe or upper ground water horizon. (Page 74, paragraph 5 indicates a possibility of nitrification in the upper ground water zone). What about the fact the lysimeters are not set directly below the leach fields? The on-off leach field operation is likely to result in leachate passing through different portions of the leach field at different times and at different volumes. It could also result in unpredictable hit-and-miss leachate sample collection. That is, sometimes leachate may migrate laterally to a lysimeter and sometimes it may not regardless of whether a leach field was on or off and regardless of how long it was on or off. The wide variation in data results supports the hit-and-miss possibility. In any event, the report needs more justification for such conclusions.

32. Page 76, last paragraph - It is unclear how the, "data clearly indicate that concentrated nitrate-nitrogen levels in soil water develop at the immediate beginning of a wet dosing period, and then the nitrate declines to less than 1 mg N/L as the infiltration is continued." Only one data set (1-11-93) out of about ten supports that statement.

33. Page 77, last paragraph - The report should explain how dilution in a chloride rich medium could be another "deviation" to the N/Cl ratio.

34. Page 78, General Findings, paragraph 1 - given other possible explanations for changes in N/Cl ratios, the report should explain how denitrification is probable rather than possible.

35. Page 78, General Findings, paragraph 2 - The report states that the reduction of N/Cl ratios supports the concept of denitrification. Is this statement truly the more accurate statement that better characterizes the data?

Also, how can the statement be made that concentrations of nitrate-nitrogen in ground water are higher than the leachate from the unsaturated soil above? It is uncertain when or whether the Bayridge Estates lysimeters collected any leachate. Also, no explanation is made of volatilization of ammonia and the possibility of incomplete nitrification where samples were collected.

36. Page 80, paragraph 2 - The nine-fold difference between lysimeter leachate and ground water has many explanations besides the ground water nitrate coming from another source. Other opinions, not documented in this report, discount this other source as insignificant. Particularly if these opinions are already known to the report's authors, the report should comprehensively discuss these other sources before concluding leachate nitrate is not causing ground water nitrate.

37. Page 80, paragraph 4 - More justification is needed before concluding that nitrate concentration decreased due to denitrification.

Also, the report needs to explain how the, "soil is enhancing the water quality of the leachate with regard to nitrate."

38. Page 82, paragraph 1 - Why couldn't the other sources of nitrate be from septic tank seepage pits in shallow ground water? The data shows nitrate concentrations at five feet below the seepage pit to vary from four to eleven times the drinking water limit. Given the Los Osos area is hilly and the samples collected for this study were from the better operating systems with 40-foot separation to ground water, wouldn't seepage pits in lower lying areas where there is little or no ground water separation contribute substantial amounts of nitrate? To be complete, the report needs to fully explain this possibility.

39. Page 82, paragraph 2 - This report mentions other sources of nitrate that could be contributing to the existing high nitrate problem. Why wouldn't the same denitrification process occur to these sources of nitrate that the report claims is occurring to septic tank leachate? The last sentence on this page states that nitrogen from dying native vegetation would undergo the same transformations identified in the Nitrogen Cycle. How do the ubiquitous denitrifying bacteria selectively choose septic tank leachate nitrogen for denitrification and not nitrogen released from dying native vegetation or any other source?

40. Page 83, paragraphs 4 and 5 - The report needs to fully explain how

denitrification is unequivocally demonstrated. It is not shown how the data lead to this conclusion.

41. Page 85, paragraphs 3 and 4 - The report references nitrification/denitrification studies of effluent moving laterally apparently at relatively shallow depth. How do those studies relate to the Los Osos nitrate study which claims denitrification at depth? The report needs to substantiate the existence of denitrifying bacteria at depth in the Los Osos area.

42. Pages 85 to 86 - The studies referenced indicate the possibility of denitrification but there is no description of the rate of denitrification. The report should define the extent that the denitrification process can keep up with nitrogen leaving the seepage pit/leach field. How do the results of those studies relate to the Los Osos study?

43. Page 89, first paragraph - Nitrate nitrogen was not measured "just below the leach field or leach pit". Those measurements were made in the pit or leach field.

44. Page 90, Conclusions, Answer No. 1 - Given that the conclusion "suggests" nitrogen undergoes nitrification and denitrification, why do other parts of the report conclude nitrification/denitrification? The report should be consistent. Also, the information provided by this study only weakly justifies denitrification. How can it conclude nitrate is converted to nitrogen gas?

45. Page 90, Conclusions, Answer No. 2 - A simple comparison of numbers could possibly support the conclusion. However, actual events could be much more complex than a simple comparison of numbers. The report needs to account for the scenarios described in comment Nos. 30 and 31 above. Also, how can the report support the conclusion, "delivered leachate," when two of three lysimeters collected samples at least 15 feet above ground water?

46. Page 91, Conclusions, Answer No. 3 - Again the report states that the data support denitrification, but do not prove it unequivocally to all concerned. It is not a matter of proof to all concerned but rather a matter of what the data show. More specific testing is needed to conclude denitrification is occurring. While there are indicators of denitrification, the scope of this study was insufficient to conclude it is occurring.

Furthermore, denitrification based on N/Cl and N/EC ratios is hardly evident from Figures 25 and 26 for Bayridge Estates. How can the report claim that the pattern on nitrification and denitrification held true for all three sites at all sampling times?

47. Page 92, first paragraph - Here again the report claims denitrification inconsistent with the report's conclusion.

48. Page 92, second paragraph - Defining "waves" of nitrogen was never an objective of this study given the limited data set.

49. Page 92, Ground water quality, paragraph No. 4 - How can data from this report conclude that this "unknown" source of nitrogen is unrelated to population density?

50. Page 92, Leach field and leach pit systems, paragraph No. 7 - How can this conclusion be made when lysimeters below the leach field/pits found water quality above the drinking water limit? While nitrogen transformations <u>may</u> be occurring, the data show the transformations are not occurring to the extent to adequately protect ground water quality even with a 40 foot separation to ground water. If one considers the number of leach fields/pits that were installed with minimum ground water separation (8 feet), the data show nitrate concentration could range from 50 to 90 mg/l as N.

51. Page 110, paragraph 5 - How "rapidly" can denitrification occur? The report should compare the rate of denitrification with the daily input from a septic tank source.