Peer Review of Draft Onsite Wastewater Treatment Systems

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This review was conducted for the California State Water Resources Control Board. All documentation and data provided with the draft regulations were considered in preparing the following comments. The primary focus of the review follows the outline of numbered issues provided to reviewers and identified as "Enclosure 2: Description of the scientific portion of the proposed regulations to be addressed by peer reviewers". Although aware these draft regulations were being promulgated, this reviewer had not previously reviewed earlier drafts or versions of this document. The opinions and conclusions presented here are solely those of the writer.

Issue 1: It is intrinsically logical that Onsite Wastewater Treatment Systems (OWTS) will become increasingly challenged as the volume disposed increases. While a multitude of local factors will affect performance, it makes sense to establish a volume level that will trigger increased oversight. The specified 5,000 gallons-per-day limit appears reasonable based on available data.

Issue 2: It is unclear to me how the 150 mg/L BOD and 150 mg/L TSS will be applied or used. If I am reading this correctly (24910.a), it is assumed that "normal" household septic tank effluent will generally meet these levels and therefore these values represent reasonable design criteria for the dispersal system. Some assumption for design is necessary, and as noted, the BOD value is consistent with the 2002 EPA design criteria (Table 4-3), but the EPA loading designs say nothing about TSS. In paragraph 24910.s it appears that all new or replaced OWTS tanks will be required to have effluent filters. The data in the Crites and Tchobanoglous reference (Table 4-16) show a range of 20-55 mg/L TSS for septic tank effluent with a filter. So I'm not sure where or how the 150 mg/L TSS criteria gets used for design purposes.

Further, the actual values appear in Section 24910.a.3 and refer to "other wastewater", *i.e.* other than household. Who makes the determination of whether the septic tank effluent would be expected to exceed the 150 mg/L BOD and/or 150 mg/L TSS, and as noted, since it appears effluent filters are being required, the TSS seems moot? How does one determine what the "strength" of the waste entering the dispersal system will be for situations other than household waste? Is some kind of documentation required? I can envision certain circumstances, but it appears this requirement needs additional clarification.

Issue 3: The benefits of effluent filters are well documented. For clarification, as I understand the draft regulation, an effluent filter is not considered a Supplemental Treatment Component and does not trigger the mandatory requirement for a service contract. Therefore the servicing and maintenance requirements for effluent filters will be an important item to be documented in the homeowner O&M Manual.

Issue 4: This section presented the greatest technical challenge to me. I recognize the need to find a balance between sound science and practicality, and the following comments are offered in that spirit. My concerns are with multiple aspects of the monitoring requirement, including (1) the purpose or goal, (2) the sampling point, and (3) choice of constituents. While these are related to some extent, I'll address them separately.

(1) The goal of the monitoring seems to be ill defined. Regulatory monitoring is typically conducted for compliance purposes, but in this case there are no stated limits to meet or actions that result from the monitoring requirement. How will these data be used? Who has responsibility? Looking at the bacterial requirement as an example, it specifies testing for total coliform, and if positive, retesting for fecal coliform (I will discuss indicator choice later). If total coliform is positive, and fecal negative, is that end of story? What if both are positive? There does not appear to be any follow through of any kind connected with the testing requirement, other than the data is reported to SWRCB. What value is that unless there is some associated response? I find this a difficult

concept to justify on a scientific or public health basis as currently articulated in the draft regulation.

2. The testing requirement is being applied to those with a septic system and a potable well on the property. The requirement further indicates that a monitoring well located down gradient within 100 feet of the OWTS may be used for sampling, or alternatively, the potable well may be sampled. The discussion information provided correctly concludes that most homeowners would simply sample their well. But if the well is sampled, there is no consideration for the location of the well relative to the OWTS, or time in service of the well and OWTS. Since background data are likely not available, it is unclear how these data will be used to assess the impacts of OWTS. This raises a question of what the value will be of reporting these data to SWRCB.

3. If a testing requirement is going to be included in this regulation, I recommend additional thought be given to the specified constituents. I will start with the microbial testing, since that is my specific area of expertise. USEPA recently promulgated the Groundwater Rule (GWR), which was designed to address groundwater microbial contamination, but applies only to public water supplies. Much research went into developing that regulation. Many technical workshops were held to get the most current scientific input. It too was controversial, and the end result was a compromise that not all in the science community agreed with. Nevertheless, I think it would be of value to incorporate the basic concepts of the groundwater rule into any required monitoring that may result from the draft OWTS regulation.

It is pretty much the consensus of the environmental public heath microbiology community that viruses represent the most significant public health risk associated with groundwater, and a viral indicator would be the preferred predictor of safety. That said, there have been many documented disease outbreaks resulting from bacterial and/or protozoan parasites in well water with serious illness and deaths associated with *E. coli* 0157:H7 infections. Although viruses have been demonstrated to have a much greater potential to migrate through soil, the factors governing virus transport and survival are complex. Somewhat surprisingly, more of the documented groundwater associated disease outbreaks have been caused by bacterial pathogens compared to viruses. There are a number of possible explanations for this. In reality, most groundwater disease outbreaks I have looked at occurred in settings where filtration was compromised, such as karst or fractured rock formations, or well integrity was compromised in some way. Another concern with testing for viral indicators (coliphage) was that the analyses are more expensive than conventional bacterial indicators. The final approach utilized for the GWR was to model it somewhat after the Total Coliform Rule, however, the GWR did maintain the option to be able to use any of three more specific fecal indicators, *E. coli*, enterococci, or coliphage for follow-up determination of fecal contamination if the total coliform test is positive.

I would suggest any required microbial monitoring for the OWTS regulation follow this basic model, and eliminate the use of fecal coliform. Fecal coliform is truly a misnomer and should more correctly be called thermotolerant coliforms. The fecal coliform test is a surrogate for testing for *E. coli*. When the fecal coliform test was originally developed, there were not simple, inexpensive tests available to test specifically for *E. coli*. Now there are, and *E. coli* is a more specific fecal indicator than "fecal coliform". Another advantage of using *E. coli* is that currently available tests are able to test for both total coliform and *E. coli* simultaneously in a single test (e.g. Colilert and m-Coli Blue membrane filter).

Total coliform is a conservative test, but may not be indicative of fecal contamination. Fecal coliform is a better indicator, but one of the common organisms that gives a positive result in the fecal coliform test is *Klebsiella pneumonia*, which is a common soil organism and more importantly, also frequently associated with biofilms. In a research project I'm currently involved with in Southern Cal., we are seeing some wells with biofilm problems where we get positive results for total and fecal coliforms, but none of the more specific fecal indicators, *i.e. E. coli*, enterococci or coliphage, have been detected.

As currently drafted, the OWTS specifies testing for total coliform, and if positive retesting for fecal coliform. If fecal coliform was replaced by *E. coli* in the OWTS Draft, a single test would provide both total coliform and *E. coli* data with the initial test for no additional cost. This represents a lot more value for your dollar, and has the added advantage of being conceptually consistent with the GWR. I personally believe it is also of value from a public perception standpoint if our regulatory structures have some "internal consistency". In this same vein, it would be of value to designate enterococci and coliphage (especially male-specific coliphage) as alternative "fecal" indicators in addition to *E. coli*. I would expect most well owners would not test for these due to additional cost, just as most complying with the GWR will elect to use *E. coli*, but naming them as recognized fecal indictors again maintains consistency with the GWR and provides for more options in those cases where one might want more testing information about the well water quality and potential fecal contamination. In addition, giving these alternative fecal indicators "regulatory" recognition could be of value in situations where surface water contamination has been identified as an issue and septic systems may be part of the problem. I'll outline an approach below of how a microbial monitoring requirement might better be used with the change to *E. coli*.

Regarding the specified chemical constituents, some of the listed chemicals have associated drinking water limits, but others do not. How will the results from these other constituents be used? MBAS is obviously a potential sewage indicator. But it is unclear how the calcium, magnesium, sodium, potassium, carbonate and bicarbonate data will be used. What will be the value of reporting these data to the SWRCB when there is no indicated response associated with the testing?

If a testing requirement is going to be justified, there needs to be provision for some associated response or consequence. That may be as simple as a mandated advisory notice will be issued to the well owner explaining the significance of the results and possible actions. For those chemical constituents with current drinking water limits, the well owner can be advised if any exceed State and Federal safe drinking water limits. In the case of MBAS a well owner can be notified that sewage related chemicals are present in the well water, and the significance of that determination. Again, I'm not clear on how the other unregulated constituents will be used.

For microbial testing, as noted above, I recommend fecal coliform be replaced by *E. coli*. Then if the well owner has a coliform test run, there are three possible results that can come back from that initial test: (1) negative, (2) total coliform positive, but *E. coli* negative, or (3) positive for both total coliform and *E. coli*. If negative, no further action required. When positive for total coliform, but negative for *E. coli*, an advisory notice can be issued to the well owner explaining that the well may have fecal contamination, or may have a biofilm problem. The well owner could be advised to have the well disinfected by a well service company, and/or be provided instructions for how to disinfect the well with chlorine. There's tons of information available on the internet instructing home owners how to disinfect private wells. It would be a simple task to put together and advisory notice. Then following disinfection, the well owner would have a second bacterial test run. Even though the original test was negative for the more specific fecal indicator, biofilms can harbor opportunistic pathogens that may be a problem for immunocompromised individuals.

In those cases where the first test was positive for both total coliform & *E. coli* (#3 above), the well owner should be advised that the well is fecally contaminated and that disinfection of the well may not solve the problem. Further investigation may be required to assess the safety of the well for potable use.

Issue 5: Addressing the issue of brines is logical and warranted. I am a little unclear with the concept of a "regulated" recommendation, and how this will be accomplished. I wonder if it would be more logical to include that item with the required information that needs to be included in an operating manual (24910.j). Unfortunately that does not address existing OWTS. Perhaps a one-time generic guidance document should be prepared and distributed to existing OWTS owners; it could include much of the information specified in the requirement for new systems owner manuals, such as the list of substances that could inhibit operation and substances that could cause pollution. It also might be worthwhile to mention the potential benefits of using water-use reduction devices, i.e. low flow toilets, water saving showerheads, etc.

Issue 6: Determining high groundwater level is important. In those cases where historical records for the area, or other methods are deemed inadequate, there is a provision for determining high groundwater using a piezometer and measuring between November and April. We historically go through wet and dry weather cycles, and water tables can drop dramatically during a prolonged drought period. I'm not sure what the solution is, but it seems drought periods need to be considered, or this method may significantly underestimate the groundwater level.

Issue 7: This section deals with performance requirements for supplemental treatment components, specifically disinfection units that would be required to protect groundwater or surface water when the geological setting is determined to not be capable of providing adequate treatment. As noted previously, there is adequate scientific evidence suggesting that viruses represent the greatest potential health risk related to inadequate filtration due to their potential to migrate further in soil, and their relatively low infectious doses. For testing the safety of wells, the use of coliform monitoring represents a "pragmatic" compromise and is consistent with the final approach used in the Ground Water Rule for public water supplies. However, qualifying or determining the adequacy of a supplemental treatment unit is a different issue. We can use California's wastewater treatment criteria as an example. A disinfection/filtration system must demonstrate the ability to remove 5 logs of virus. This removal demonstration can be based on the use of poliovirus, or male-specific coliphage. The coliphage test, while more expensive than the coliform test, is relatively inexpensive compared to human virus testing and would not represent an unreasonable financial burden for "qualifying" acceptable disinfection equipment. Once the process has been adequately shown to accomplish the requisite virus removal and is an accepted process, coliform can be used for periodic monitoring to demonstrate ongoing performance, as designated in 24913.h.

Given the scientific consensus that viruses represent the greatest potential microbial health risk with groundwater, it is only logical that viruses are included as a target organism to demonstrate the adequacy of a supplemental disinfection process that will be used when it is determined that natural filtration is inadequate. This approach is consistent with California's wastewater treatment requirements.

Issue 8: Using the drinking water limit is logical.

Issue 9: This is a reasonable requirement.

Issue 10: No specific comment. I concur with the premise. The details represent professional judgment.

Issue 11: This specific subject is not one that I have personal expertise with, however, it is apparent that this drives design and will have some site specific consequences. That said, there appears to be some conflict between the EPA references provided. The February 2002 Manual clearly recommends that sidewalls not be included as infiltrative surfaces. The earlier 1980 EPA design manual appears to argue that there are situations where deeper trenches are preferable. I am assuming that there is adequate documentation and experience that the earlier recommendations are no longer considered valid, and the current Manual supercedes the earlier recommendations.

Issue 12: Appears to be standard design criteria; no comment.

Issue 13: I am not a hydrogeologist, but I have been involved in much groundwater recharge research and have worked with research teams that included hydrogeologists. This subject has come up. Obviously water cannot filter through large rocks. What then becomes critical is the nature and make-up of the material between the rocks. The rocks actually create a much more circuitous travel path, and depending on the nature of the material between the rocks, the filtration path may actually be increased relative to vertical travel. Was any thought given to the possibility of some more complete kind of soil assessment that could potentially mitigate the presence of course fragments?

Issue 14: Assuming there are no preferential flow paths, I agree with the premise that most bacterial pathogens (and protozoans) will be removed within 3 feet of effective soil filtration. Effective and reliable removal of viruses is much less certain with this minimum distance of unsaturated soil. There is extensive literature documenting virus transport over greater distances, however, these studies are generally conducted with high doses of virus, so it is difficult to translate the data to risk. It is reasonable to assume that one would normally see at least an order of magnitude reduction in most cases with 3 feet of unsaturated flow, and most likely much greater reduction depending on numerous factors. The two primary factors governing the distance a virus may migrate are inactivation (die-off) and attenuation (adsorption). Many different variables affect the relative contribution of each for removing viruses. Adsorbed viruses also may desorb and migrate under certain conditions, such as heavy rainfall or flooding.

I guess the emphasis is on the word "minimum" here regarding depth of the unsaturated zone, and what level of virus removal one wanted to be assured of. If a multi-log reduction of viruses is to be guaranteed, 3 feet of unsaturated flow may not provide that consistently. Virus inactivation does not cease once in the saturated zone, but it is less effective and the virus removal rate decreases with distance. On the other hand, if one hits fractured rock, little additional virus reduction may occur. The pathogen load in private family septic tanks is quite variable because most individuals are normally not infected. However, when ill, it has been reported that virus concentrations as high as 10^{10} may be present in the waste from a single household, for short periods. Some of that virus load will be removed in the septic tank itself since a large portion of the viruses are associated with solids and will settle out. One study reported that 75% of the virus load will be removed in the septic tank, but with high concentrations entering, there can be short periods when the concentration of viruses reaching the dispersal system will be quite high. With minimal unsaturated flow, the setback and location for potable wells and distance to surface water becomes a greater concern.

There have been numerous efforts to model virus transport in soil. One of interest is Virtus, a model of virus transport in unsaturated soil (Appl. & Environ. Microbiol. 58:5, p. 1609-1616. 1992). While these models are not robust enough for regulatory purposes, they can help give one a sense of virus reduction that may be expected under different conditions, and might be used to develop some general guidelines for relating setbacks to unsaturated soil depths.

To summarize briefly, I am not comfortable that the 3 foot minimum unsaturated depth provides adequate protection for virus contamination, however, that could be mitigated by considering other factors, such as setbacks to surface water and distance and location of potable wells. The documentation presented with the review package does not suggest that the potential for virus migration was fully considered.

Issue 15: I think this is entirely reasonable if the performance criteria for the supplemental treatment include some level of documented virus reduction in addition to bacterial reduction.

Issue 16: I have no experience with the use of engineered fill. I have no conceptual objection to the use of engineered fill; comments for Issue 14 would apply.

Issue 17: Documentation appears to support this approach.

Issue 18: There appears to be an error in this section. The Issue 18 subject line indicates "the proposed regulations would require a minimum of 6 inches of soil over shallow subsurface dispersal systems." In the text below the item 18 subject line, it says the "proposed regulations allow these systems to be placed less than 6 inches below the surface". When I look at the text of the draft regulation, 24914(h) says nothing about depth below the surface. Clearly there should be some minimum depth, but the emitters need to remain in the root zone. As noted in the Beggs *et al.* reference, recommendations range from 4 to 12 inches. The evaluation reported by Beggs *et al.* was conducted with emitters at 6-inch depth. This is a judgment call. Six inches seems very reasonable as a minimum. But it is unclear if some other depth is being proposed, or if a minimum depth requirement was eliminated.

As a personal note, I think this option should be promoted. Philosophically this shifts the OWTS from a disposal method to a reuse option, which is important given the increasing demand on water supplies.

Issue 19: No Comment

Issue 20: Probably represents a reasonable risk of failure, i.e. overflow. Location would be important factor relative to the impact of failure. Were any additional siting requirements considered for the use of seepage pits?

Issue 21: This section focuses on impaired surface water where OWTS may contribute to the impairment, specifically on pathogens and nitrogen. Excess nitrogen can represent a health problem in drinking water, but also contributes to water body impairment as a nutrient at a lower concentration than that which triggers health concerns. There are two main nutrients that contribute to eutrophication: nitrogen and phosphorus. Algal growth, especially blue-green algae (cyanobacteria) is becoming an increasing problem, especially in connection with the toxic blue-greens. Phosphorus, not nitrogen, is generally the primary nutrient driving algal blooms. Numerous TMDLs have been generated for controlling phosphorus, so it would be logical to include phosphorus here along with nitrogen from the perspective of protecting impaired surface water.

Per my discussion for Issue 4, I would suggest fecal coliform be changed to *E. coli* in this section, and that enterococci and coliphage be added as indicators that are also considered indicative of fecal contamination. As noted in much of the above discussion, viruses present the greatest theoretical risk and it is important to include a viral indicator as being a valid indication of fecal contamination from OWTS. This is fully consistent with the

Groundwater Rule. Including these organisms simply indicates that "impairment" could be established by indicators other than coliform.

I realize that fecal coliform is specified as the "pathogen" indicator in Basin Plans. USEPA has established recreational water standards based on enterococci for marine water and *E. coli* or enterococci for fresh water. In September 2002 the CVRWQCB Staff recommended amending that Basin Plan to change the fecal coliform limits to federal *E. coli* limits. To my knowledge, that change was never enacted. Given that we now have two federal regulations (Recreational limits and GWR) based on some combination of *E. coli*, enterococci and coliphage, and both of these are directly related to this issue of impaired surface waters, I think the OWTS regulation should be consistent with current scientific thinking and regulatory requirements. Hopefully the Basin Plans will catch up some day.