# UCD's Attempts to Solve the IRA Injection Well Plugging Problem through Addition of Chemicals to the Reinjected Water

June 18, 2003

Susan Timm
CVRWQCB

Dear Susan:

At our recent telephone conference call RPM meeting, mention was made that UCD and the Regional Board staff were discussing monitoring that is to be done should UCD gain approval for adding a polyphosphate to the IRA waters that are reinjected into the groundwater as part of the limited-scope clean-up of the groundwaters polluted by the LEHR site, which is being conducted by UCD in the IRA.

As I mentioned when I first heard of the proposal to air-strip the pumped polluted groundwaters and then reinject them, there could readily be a significant problem with post-reinjection calcium carbonate deposition. As indicated several years ago, the air-stripping of a groundwater that is saturated with respect to calcium carbonate (i.e., associated with a calcareous aquifer system) can readily lead to subsequent calcium carbonate deposition. I urged at that time that this should be investigated and that provisions should be made as part of the IRA to address this potential problem. As with many other aspects of the IRA, UCD ignored these suggestions and has had chronic problems with the IRA in a variety of areas, including reinjection well plugging.

A couple of years ago, when plugging problems began to occur, I again raised the issue of calcium carbonate deposition. This is a well known phenomenon. In 1960 through 1989 when I taught graduate-level aquatic chemistry courses, I used this type of situation as an example of calcium carbonate aquatic chemistry that needs to be considered, and that can readily be addressed through equilibrium calculations. When the plugging problems first began to occur, UCD staff and a consultant claimed that the problem was not calcium carbonate, but something else. It appears now that that claim may have been inappropriate, based on the fact that the UCD staff and consultants are now acknowledging that it is likely calcium carbonate deposition that is leading to the plugging problem. As I have indicated over the years, this is exactly what would be predicted based on calcium carbonate chemistry in this system.

During the past year the RPMs have required that UCD provide information on how this plugging of the injection well due to calcium carbonate deposition can be remediated. The appropriate approach to take is that of adding $CO_2$ back to the water equivalent to that which was removed in air-stripping, to bring the reinjection waters back in equilibrium with the aquifer. Evidently UCD has rejected this approach and is attempting to inject chemicals into the reinjected water that have the potential to interact with aquifer materials, which could cause further pollution of the aquifer.

In connection with EDTA addition, I pointed out that this could readily lead to problems with mobilization of the variety of natural and pollutant constituents in the aquifer. Based on the recent RPM conference call, it appears that UCD has decided to proceed with polyphosphate

addition as a potentially inexpensive method of controlling the post-calcium-carbonate precipitation in the aquifer near the point of reinjection. I have had considerable experience with polyphosphate water quality issues and wish to indicate that this approach may lead to significant water quality problems that need to be thoroughly investigated before the approval of widespread addition of polyphosphate as an additive in the current pilot-scale IRA system or in an expansion of this approach as part of beginning to effectively clean up the polluted groundwaters at the LEHR site.

While teaching in the University of Wisconsin, Madison, graduate program in aquatic chemistry, I had a number of graduate students do their masters theses and PhD dissertations on various aspects of phosphate and polyphosphate chemistry. Further, I was involved in a number of consulting jobs with industry, public utilities and others, on the potential use of polyphosphates. Polyphosphates can be a mixture of compounds of various condensed phosphates, which are developed upon heating orthophosphate, with a removal of water during the heating process. This, depending on conditions, leads to chains and rings of POP compounds.

Polyphosphates have two mechanisms of impact. One is through complexation, where true soluble complexes are formed, and the other is through controlling crystal growth through peptization, where, as the chemical, such as ferric hydroxide or calcium carbonate, starts to precipitate, the addition of polyphosphate will coat the initial crystals and prevent their growth. This prevents the deposition of the precipitates as solids. Condensed phosphates, however, are degradable, where they convert back to orthophosphate through hydrolysis reactions. Upon hydrolysis and the loss of the properties that cause the polyphosphate to inhibit precipitation, either through complexation or control of crystal growth, it is no longer effective, and the precipitates will then form at some location downstream from the point at which these materials were added to the water system.

In surface water systems, this occurs usually at some location where the phosphate that is added is not of major significance, and the precipitates are not of concern with respect to impacting water quality. However, in groundwater systems, the hydrolysis of the polyphosphates can lead to downgradient water quality problems, including plugging. The magnitude of the plugging problem can be much smaller because of the much larger surface area where precipitation occurs, compared to around an injection well screen.

If any polyphosphate or other additive is added to the IRA reinjection water other than $CO_2$, then there will be need to conduct large-scale detailed monitoring to determine if any adverse post-reinjection conditions occur. It is unlikely that the existing monitoring well array associated with the IRA will be adequate for properly sampling for the potential problems before widespread aquifer pollution occurs. The proper monitoring of the system will require a fairly close-based series of wells along the centerline of the reinjection plume, where samples would need to be taken monthly to determine if problems are beginning to be found in the aquifer system.

From my experience, UCD needs to stop trying to continue to manage its wastes and their impacts with a cheaper-than-real-cost approach. If UCD is going to reinject properly treated groundwaters pumped from the LEHR site, they will need to utilize recarbonation, where the air-

stripped $CO_2$ is added back to the system. While this may initially be more expensive, ultimately it can lead to a more reliable approach, with fewer problems.

Previously I have mentioned the activities of the American Society of Civil Engineers Groundwater Recharge Committee, where I have contacted committee members regarding their information on groundwater recharge well plugging issues. I wish to mention that this committee is meeting in Philadelphia in late June and have added to the agenda a discussion of the calcium carbonate plugging issues. I am also asking the committee to address the issue of the addition of polyphosphates to see if any members of the committee have encountered situations where this approach has been used to prevent calcium carbonate precipitation in the aquifer. I will pass on any useful information I obtain from this effort.

If there are questions on these comments, please contact me.

Fred

G. Fred Lee, PhD, DEE