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| **Topic or Issue: Tracer Studies**  Participants: Bill Davis (PAI-facilitator), Nancy Feagin (WA-notetaker),  Darlene Galido (AK), Robert Reaves (AR), Mandy Smith (CT), Bob Campbell (IA), Ben Haring (KS), Todd Stephenson (KS), Kaitlyn Bates (MI), Emily Lester (NC), Joseph McNally (NJ), Stephanie Stoner (PA), Candy Thompson (OK), David Dawson (VA), Michele Welsh (OK)  Mark Sceery (EPA R1), Andrea Traviglia (EPA R1), Jason Gambatese (EPA R9) |
| **Topic Description and Objectives:**  The SWTR requires surface water and ground water under the direct influence of surface water systems to achieve 3-log removal/inactivation of *Giardia* and 4-log removal/inactivation of viruses. This is usually achieved through a combination of filtration and disinfection. Disinfection inactivation by chlorine and other chemical disinfectants is a function of contact time. Tracer studies are used to determine contact time for this purpose.  The following was shared during this small group discussion.  **Is there a tracer study topic you are interested in?**  Bob Campbell (Iowa) – I am interested in discussing onsite sampling equipment accuracy and potential discrepancies, also the use of other tracers.  Candy Thompson (Oklahoma) – The State of Oklahoma has funding to put toward tracer studies in the next fiscal year. When using an outside contractor, who is qualified to perform tracer studies and what cri­teria is used to select a contractor?  Nancy Feagin (Washington) – Has anyone else used chlorine as a tracer? And if so, what criteria did you use to decide when it was appropriate?  Darelene Galido (Alaska) – Just learning what I don’t know.  Jason Gambatese (EPA Region 9) Tribal program – What can we do when we have no equipment and no resources?  Emily Lester (North Carolina) – I would just like to use this as an opportunity to learn more about tracer studies.  Joe McNally (New Jersey) – I would like to learn from others. We are looking into requiring tracer studies from some of our water systems.  Michele Welsh (Oklahoma) – I would like to learn more about tracer studies.  Robert Reaves (Arkansas) – I would like to learn more about tracer studies.  Mark Sceery (EPA Region 1) – I would like to learn more about tracer studies.  Mandy Smith (Connecticut) – How do we develop a CT verification project for all surface water plants?  Stephanie (Pennsylvania) **–** I am interested in *Giardia* inactivation, especially after learning that few are doing it correctly. About ten years ago, Pennsylvania did some contract work focusing on tracer studies of small systems. This work led to the development of new regulations two to three years ago. They require systems to calculate *Giardia* log inactivation daily. I am interested in learning how to identify weaknesses in the tracer study process and how to determine when the results are valid; also, data integrity in general.  Todd Stevenson (Kansas) – I would like to learn more about tracer studies.  Andrea (EPA Region 1) – As a consultant, I worked on tracer studies in the past. I would like a refresher on tracer studies, to better support Tribes/States in Region 1.  **When using a third party to do the tracer study, how do you make sure they do them well and who do you chose to do the work?**  Stephanie – Pennsylvania used outside contractors to do this work ten to twelve years ago and started with the smallest systems. There are differences in the quality of work from one contractor to another. The state used three sequential contracts. The studies done in the first year were not as robust as ones done by the company that won the second and third contracts. Generally, it takes more than one day to get an accu­rate result. The contractors wanted to fit the work into one 8-hour day. Tracer studies are a great tool for getting a first look. We never found baffling factors increased due to the tracer study; sometimes the results were shockingly low. The shortest tracer study clear well result was four minutes. This was at a system where the clear well inlet and outlet were right next to each other. They didn’t have to issue a boil water advisory, but they had to make some quick changes to achieve adequate contact time. In the time since we did this work, a lot of systems have made changes to treatment or plant configuration, and the previous studies are no longer valid. It was a good snapshot in time, but now we are finding issues.  Nancy – Washington had a similar project with similar findings. Several systems were not at all what we thought and were assuming in the daily *Giardia* inactivation calculations. In several cases we found almost complete short-circuiting of the clear well/storage tank. There were a lot of things we found that you wouldn’t have found otherwise, because they are hidden from view. We had the contractor do three runs at different flow rates, which took several days to complete. This cost $9,000 to 10,000 per system, and we used SRF set-asides to do the work.  **What flowrates did you specify?**  Nancy – Not sure, maybe average flow, and at least 85% of the plant maximum design flow.  Bill – PAI recently completed a project in Louisiana where they found that they required 90% of peak operating flow and average daily flow. The goal was to have two flow rates. If the plant begins operating at flow rates higher than the tracer study, the plant needs a new tracer study.  **Did you find the baffling factor was affected by flowrate?**  Nancy – Hard to generalize. Our goal was to get a single baffling factor, for ease of reporting. One of the challenges was getting the high flows, especially in winter (low demand). The practicalities of getting that much flow through the system was a challenge. Tank levels had to be low enough to accept the water dur­ing the entire duration. We developed tracer study criteria that we had the contractor follow.  **Any other states have experience using a contractor?**  Dave – We had a system that was under a Consent Order use their own consultant to do a tracer study. We reviewed the study plan before it was completed.  **When you have multiple runs, how do you pick the baffling factor?**  Nancy – We picked the worst case of the runs, with a small safety factor. We have a final report that sums up the findings, I’d be happy to share with anyone who would like to see it.  **How long do you need to run the tracer study to get good results?**  Stephanie – It depends on the situation, the size of the facility you are testing, and monitoring the concen­tration of the tracer, which in their case was salt, as it increases during the test. You can also monitor the decrease in tracer concentration at the end of the test, for a more robust overall test. We only did a single flowrate, but we separated pre- and post- disinfection segments. This added some time and affected the timing. We found the contractor needs to run the post- first, so it doesn’t impact the pre-.  **Was the contractor an engineering firm? Did you have any special criteria you used?**  Stephanie – Pennsylvania used local engineering firms. The first was an individual; the second was one of the bigger engineering firms in the state. We routinely require systems to complete tracer studies for new permits or compliance issues, so engineering firms already know roughly what the state is looking for and what needs to be submitted.  **Any thoughts on onsite sampling equipment, alternative tracers?**  Bob – Systems don’t want to exceed the 2 ppm fluoride standard because of the public notification conse­quences, and they may have 0.5 ppm background levels. The monitoring equipment doesn’t seem to be as accurate as needed to run a tracer study in that range of concentrations.  Nancy – We used potassium chloride and fluoride during our contract. Fluoride gave much more stable results. (Potassium) chloride results bounced around more. We used the step dose, not the slug dose. Some communities are reluctant to use fluoride, and some couldn’t use potassium chloride due to the size of the system and equipment available. In two or three cases, we were able to successfully use chlorine as a tracer. We used it for the finished water only (post-filtration). We had them do a hold test to make sure there wasn’t a significant chlorine demand. This allows you to use existing chemical feed and monitoring equip­ment. We also did a number of lag studies (monitoring the decrease in concentration at the end of the tracer study), which gives you additional data to look at.  Stephanie – The Pennsylvania contractors used salt (sodium chloride) as the tracer and measured conduc­tivity. Typically, we only allow fluoride if the system is already permitted to add it.  **Were there any unintended consequences of doing a tracer study? Did systems have to increase chlorine levels due to the lower baffling factor and then have DBP issues?**  (Jason)  Nancy – A lot of systems in Washington had significantly more contact time than they needed, even with the decreased baffling factor, and they didn’t need to increase chlorine levels as a result of the tracer study. If you do a project like this, think ahead about what you will do if the contact time is much lower than you thought. We were on the cusp of needing a health advisory with one of our systems, but they were able to quickly make repairs and correct the problem. We didn’t see any noticeable change in DBPs.  Stephanie – In Pennsylvania we found the same thing. Although the baffling factors tended to go down, not all of them went down dramatically, in part because they were using estimates to start with. One of our motivations for this project is related to disinfection by-products. Many systems had stopped pre-chlorinating to reduce DBPs, and we were concerned that the systems didn’t have enough post-filtration contact time to meet Pennsylvania’s 1.0-log *Giardia* inactivation requirement (the Federal rule only requires 0.5-log).  **When would you require another tracer study?**  Stephanie – Usually, systems only do tracer studies when their consultant and state staff cannot agree on a conservative estimated baffling factor. Any time there is a change in location or configuration we will want to see a new tracer study.  Nancy – When there is a big change in capacity or a physical change in plant configuration, we would require a tracer study. We used to accept empirical baffling factors from the EPA Guidance Manual, but over time we realized they were not conservative. That was one of the reasons we went ahead with the tracer study project. For example, we have found baffling factors below 0.1 for unbaffled tanks. We don’t require a tracer study for a pipeline.  **Accuracy of analytical equipment?**  Bill – The equipment owner’s manual should give you information on the accuracy of the method.  Robert – For fluoride analysis, AccuVacs are less accurate than SPADNS. Alaska did fluoride data integ­rity work and had good results with a DR890 or DR900 and the SPADNS method.  **Can a system revise their baffling factor using a tracer study if they want?**  David – In Virginia, systems that disagree with the conservative state-assigned baffling factor can do a study to support a higher number.  **When reviewing tracer studies, are there things that have jumped out that are key?**  Nancy – We want to see 95% recovery of the tracer; don’t stop the tracer study too soon.  David – Data integrity; how did the data look, precision, sensitivity. Keeping fluoride tracer below the 2.0 mg/L limit.  Stephanie – Make sure the tracer study mirrors the locations where the chlorine is actually injected and where the residual is monitored. Often the contractor opts for easier or more convenient locations.  Bill – We visited a system where they did a tracer study at two flow rates, and the result showed higher result at the lower flow rate. We would normally expect to see more short-circuiting at a higher flow rate rather than a lower one.  **Did Washington use work from Colorado in the tracer study work?**  Nancy – We previously used a blanket 1.0 baffling factor for any pipe flow. Colorado did some work showing the length to width criteria, where that assumption was no longer valid. So, we adopted that.  **A system wants to pick a new tank; how do you assign the initial baffling factor, and do you go back and adjust it later, after the tank is built?** (Jason)  Nancy – We use an AWARF study by Teefy instead of the EPA Guidance Manual, then we require a tracer study to confirm within six months. The engineer can also use data they may have of tracer studies of sim­ilar tanks they have designed. We would want a larger safety factor when not doing a tracer study right up front.  (Teefy was not the correct author’s name; Nancy put correct reference in the *chat*): Grozes, G. et al, 1999. Improving Clearwell Design for CT Compliance. AWWA Research Foundation. Denver, CO.  **Has anyone else used chlorine as a tracer?**  Bill – We used it at just one plant, and it worked well. It was finished water. We didn’t do a hold study. This system had done their own tracer study. We just wanted to see if they were in the general ballpark. They were within 1%. My takeaway is that, under the right circumstances, chlorine might be a decent tracer to use.  Nancy – We think a chlorine bump test might be a great screening tool to find systems where the contact time is way off. The system could increase their chlorine by some amount, 50 or 100 percent, and you wait to see how long it takes to reach the end of the clear well. We have thought about using that in a more sys­tematic way, but we have not done it yet in Washington.  **What frequency should you test the tracer at? Would more frequent monitoring allow you to spot artifacts in the data, similar to turbidity?** (Robert)  Nancy – You want enough data points near the T10, so you don’t miss it. There is guidance for this in an AWARF report, and we added it to our state tracer study guidance.  (Posted in the *chat*) Teefy, S. 1996. Tracer Studies in Water Treatment Facilities: A Protocol and Case Studies. AWWA Research Foundation. Denver, CO.  (Posted in the *chat*) Appendix B.4 of Washington’s [Water System Design Manual](file:///\\doh\user\fr-kent\nxf0303\Desktop\AWOP%20National%202021%20working%20files\331-123.pdf) (pub 331-123) has a tracer study checklist.  Stephanie – In our first contract, the samples may only have been collected every five minutes, and the later contracts did it at least every minute, if not continuous. This may have been one reason the results weren’t as reliable as the later studies. For conductivity, they could have used a data logger to capture con­tinuous data.  **How to update the tracer study over time?**  Bill emphasized the need to have an idea within your oversight program of how you are going to update the contact time determinations as things change at the water system. Will it be the responsibility of the water system? Or is the state going to go back and do it?  Stephanie – I agree with the need to do updates. In Pennsylvania we wanted to get an idea of what was out there, and we don’t have plans to repeat that work. That is the responsibility of the utility. When a new storage tank or clear well is being designed, we often see designers using unrealistic assumptions. They should be using worst case scenarios for parameters such as pH, temperature, and tank levels. This will give them a buffer in most cases, in case the baffling factor needs to be adjusted in the future.  **How to account for unequal flows into and out of the tank?**  Nancy – That is a difficult and messy situation, but it is common. Ideally, we’re trying to keep the water level constant. I think we use an average volume, but I’m not sure. |
| **Action Steps:** |
| * No further action is identified, but the participants are available for follow-up regarding any clarifica­tions or questions. |