

TABLE IV-14.—SUMMARY OF AEROBIC SPORE REMOVAL DATA FROM SOFTENING PLANTS

Plant	Mean log removal of aerobic spores		
	Primary clarifier	Secondary clarifier	Across plant *
St. Louis	1.7	1.1	3.8
Kansas City	2.4	0	3.4
Columbus Plant 1	1.2	1.6	3.1
Columbus Plant 2	1.3	2.4	4.2

* Excludes removal in pre-sedimentation basins; calculated spore removal may underestimate actual removal due to filter effluent levels below quantitation limits.

The City of St. Louis Water Division operates a two-stage lime softening process preceded by presedimentation. Ferric sulfate and polymer coagulants are added at various points in the process. St. Louis collected *Bacillus subtilis* spore samples between June 1998 and September 2000. During this time period, the mean spore concentration entering the softening process (*i.e.*, after presedimentation) was 8,132 cfu/100 mL. The log removal values shown in Table IV-14 are based on average spore concentrations following primary clarification, secondary clarification, and filtration. However, spore levels in some filtered water samples were below the method detection limit, so that the true mean spore removal across the plant may have been higher than indicated by the calculated value.

The Kansas City Water Services Department plant includes two-stage lime softening with pre-sedimentation and sludge recycle. *Bacillus subtilis* spore data were collected from this plant during January through November 2000. The mean spore concentration entering the lime softening process (after presedimentation) was 5,965 cfu/100 mL. Mean spore levels following primary clarification, secondary clarification, and filtration were 21.1, 25.7, and 2.6 cfu/100 mL, respectively. Corresponding log removal values are shown in Table IV-14. Note that the average spore concentration in the effluent of the secondary clarifier was essentially equivalent to the effluent of the primary clarifier, indicating that little removal occurred in the secondary clarifier. This result may have been due to the high removal achieved in the primary clarifier and, consequently, the relatively low concentration of spores entering the second clarifier. As with the St. Louis plant, many of the filtered water observations were below method detection limits, so actual log removal across the plant may have been higher than the calculated value.

The City of Columbus operates two lime softening plants, each of which has two clarification stages. Coagulant is

added prior to the first clarification stage but lime is not added until the second clarifier (*i.e.*, first clarifier is not a softening stage). Between 1997 and 2000, samples for total aerobic spores were collected approximately monthly at each plant from raw water, following each clarification basin, and after filtration. Mean spore concentrations in the raw water sources for the two plants were 10,619 cfu/100 mL (Plant 1) and 22,595 cfu/100 mL (Plant 2). Mean log removals occurring in the two clarification stages and across the plant are shown for each plant in Table IV-14.

These data indicate that two-stage softening plants can remove high levels of *Cryptosporidium*, and, in particular, that a second clarification stage can achieve 0.5 log or greater removal. Three of the four plants that provided data on removal of aerobic spores achieved greater than 1 log reduction in the second clarifier. Kansas City, the one plant which achieved little removal in the second clarifier, achieved a mean 2.4 log removal in the primary clarifier. This was approximately 1 log more reduction than achieved in the primary clarifiers of the other three plants, so that the spore concentration entering the second clarifier in Kansas City may have been too low to serve as an indicator of removal efficiency. Consequently, EPA has concluded that these data support an additional *Cryptosporidium* treatment credit of 0.5 log for a two-stage softening plant.

EPA is proposing as a condition of the 0.5 log additional credit that a coagulant, which could include excess lime and soda ash or precipitation of magnesium hydroxide, be present in both clarifiers. This requirement is necessary to ensure that significant particulate removal occurs in both clarification stages. Logsdon *et al.* (1994) identified effective flocculation as being a key factor for removal of protozoa in softening plants. Among the softening plants that provided data on aerobic spore removal, St. Louis added ferric and polymer coagulants at different points in the process, and the

two Columbus plants added lime to the second clarifier. Consequently, a requirement that plants add a coagulant, which may be lime, in the secondary clarifier is consistent with the data used to support the 0.5 log additional credit.

The Science Advisory Board (SAB) reviewed the proposed *Cryptosporidium* treatment credit for lime softening and supporting information, as presented in the November 2001 pre-proposal draft of the LT2ESWTR (USEPA 2001g). In written comments from a December 2001 meeting of the Drinking Water Committee, the SAB panel concluded that both single- and two-stage softening generally outperform conventional treatment due to the heavy precipitation that occurs. Further, the panel found that 0.5 log of additional *Cryptosporidium* removal is an average value for a two-stage lime softening plant. However, the SAB stated that the additional credit for two-stage softening should be given only if all the water passes through both stages. Today's proposal is consistent with these recommendations by the SAB.

EPA notes that by including a presumptive credit for softening plants, today's proposal differs from the Stage 2 M-DBP Agreement in Principle, which recommends up to 1 log additional *Cryptosporidium* treatment credit for softening plants based on demonstration of performance, but no additional presumptive credit.

c. Request for comment. EPA requests comment on the proposed criteria for awarding credit to lime softening plants. EPA would particularly appreciate comment on the following issues:

- Whether the information and analyses presented in this proposal supports an additional 0.5 log credit for two-stage softening, and the associated criteria necessary for credit.
- Additional information that either support or suggest modifications to the proposed criteria and credit.

8. Combined Filter Performance

a. What is EPA proposing today? This toolbox component will grant additional credit towards *Cryptosporidium*