Strategies for Managing Total Coliform and \textit{E. coli} in Distribution Systems [Project #3116]

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OBJECTIVES:
The primary objective of this project was to develop a comprehensive, practical guide that utilities can use to manage and respond to total coliform and \textit{E. coli} occurrences in drinking water distribution systems. An additional objective was to evaluate several new coliform monitoring, tracking, and data integration approaches and assess their potential use in drinking water distribution systems.

BACKGROUND:
Total coliform bacteria are common inhabitants of soils, vegetation, and ambient water, but are mostly associated with the digestive tract of animals. Total coliform bacteria may be inactivated or injured by environmental stresses (e.g., lack of nutrients) and water treatment (e.g., chlorine disinfection) in a manner similar to most bacterial pathogens and many viral enteric pathogens. For these reasons, total coliform bacteria are currently used to meet the objectives of the 1989 Total Coliform Rule (TCR). The objectives are to (1) indicate the adequacy of source water treatment, (2) indicate the presence of fecal contamination, and (3) indicate distribution system integrity. Violations of the TCR are the most common type of regulatory non-compliance for community water systems. Additional research and guidance that identifies the linkages between routine activities within the distribution system, adequate treatment, and coliform occurrences is needed and very timely.

APPROACH:
The project objective was accomplished in the following three sequential phases:

- Phase 1—Compile, review, and summarize existing data
- Phase 2—Assess tracking tools
- Phase 3—Develop a Distribution System Microbial Integrity Toolbox (DS MIT) and associated guidance

RESULTS/FINDINGS:

Conclusion with respect to total coliform occurrence
Total coliform occurrences can arise due to a number of situations but can be broadly categorized into three main causes including regrowth, treatment breakthrough, and contamination. Additional problems can arise from improper sample collection techniques or selection of a poor sample faucet.

Conclusion with respect to \textit{E. coli} occurrence
Occurrences of \textit{E. coli} in distribution systems are likely due to a much more limited number of factors specifically related to introduction of contaminants into the system.

Conclusion and research findings with respect to the application of Microbial Source Tracking (MST) tools
to drinking water distribution systems

MST tools, although available, are not simple to implement and require a significant number of samples (at least 20–30 isolates) to attempt to establish a link between a coliform occurrence and its source. For most utilities these advanced tools are not practical unless there were frequent occurrences of coliforms (of the same species and phenotype), there was a serious need to track the origin of the problem, and there was sufficient technical expertise to do (or contract) the analysis. Systems without sufficient technical expertise should contract with a qualified consultant to help them implement and interpret MST results.

Conclusion and research findings with respect to resolving coliform occurrence

Resolving coliform occurrences can be complicated and time consuming. There is no universal strategy that can be applied in distribution systems to resolve total coliform and/or *E. coli* occurrences since each system has its own water chemistry, operational characteristics, and structural characteristics, and there are several potential sources of coliforms.

**IMPACT:**

The reader looking for advice to solve a current coliform problem could consult the guidance manual’s issue papers, utility case study reports, the DS MIT of coliform response strategies, the Mini-Guide, or specific research elements. Management tools for implementation by large, medium, and small utilities have been prepared that address distribution system monitoring, source tracking, treatment options, operational and maintenance practices, and utility responses. Use of this manual and implementation of the associated research findings should result in improved public confidence in our drinking water systems and reduced TCR implementation burden for utilities and regulatory agencies.

**RESEARCH PARTNERS:**

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