

**APPENDIX D**

**GUIDANCE DOCUMENT**

**TROPICAL WATER QUALITY INDICATOR WORKSHOP**

**Honolulu, Hawaii**  
**March 1–2, 2001**

**I. Funding and Motivation for this Workshop**

This workshop is being funded primarily by USEPA with matching funds from the Hawaii State Department of Health and the Water Resources Research Center of the University of Hawaii. The primary motivation for this workshop is the EPA Action Plan for Beaches and Recreational Waters (EPA/600/-98/079), which describes a potential problem in tropical environments as follows:

“Currently recommended fecal indicators may not be suitable for assessing human health risks in the tropics. Studies have suggested that at tropical locales such as Puerto Rico, Hawaii, and Guam, *E coli* and enterococci can be detected in waters where there is no apparent warm-blooded animal sources of contamination.

Whether or not current indicator bacteria proliferate naturally in soil and water under tropical conditions must be determined. If so, the range of conditions (such as nutrients, temperature, pH and salinity) under which the bacteria proliferate will be characterized and their geographical boundaries defined. If the phenomenon is widespread under tropical conditions, additional research will be conducted to modify approaches for monitoring, or to develop new tropics-specific indicators. Further evaluation of *Clostridium perfringens* and other microbial indicators (including coliphages) that do not flourish naturally in the tropics will be conducted to determine their usefulness as alternative indicators.”

**II. Goal and Implementation Plan for this Workshop**

The goal of this workshop is to address the concerns as described in the EPA Action Plan by evaluating all of the existing data on the use of fecal indicator microorganisms in tropical environments and to provide EPA with a written report of this evaluation.

To ensure proper guidance, a committee comprised of Al Dufour, Steve Schaub, Rick Hoffmann, Fred Genthner, Roger Fujioka, Eugene Akazawa and Gary Toranzos was formed to plan this workshop. This committee determined that the focus of this workshop should be to discuss the scientific issues of establishing and interpreting water quality standards and not to discuss regulatory issues. As a result, the committee determined that only scientists with research or water monitoring experience would be funded to attend this two-day workshop (March 1–2, 2001). The identified objectives of the invited experts were to discuss and deliberate on the relevant scientific issues and to reach a conclusion on five key questions.

During the morning session of each day, speakers will present a review on the relevant data and to allow the experts to question the data. During the afternoon session, each expert will cast a visible hand vote for or against each of the five specific questions as listed in the agenda. After this voting is tallied, a majority and minority opinion of this voting will be recorded. To expedite this process, all experts were sent a packet of documents. The documents are expected to provide the information for the expected presentations and discussions. Experts are expected to be familiar with the contents of these documents before they arrive at the workshop. Only the invited experts will have the authority to take part in the discussions during the workshop and to vote on each of the questions. We have invited another group of people to attend this workshop. This group of people, which we have called “observers”, are generally from organizations with responsibility for implementing water quality standards. Unlike invited experts, observers will need to bear their own expenses to attend this workshop and moreover, will not have the authority to participate in the deliberations of the workshop.

### **III. The Five Basic Questions to be Resolved by the Workshop**

Five specific and related questions on the performance of fecal microbial indicators in tropical locales were developed for the experts to evaluate and to vote on. These five questions were developed in an attempt to characterize the degree to which the existing fecal indicator bacteria may or may not be suitable for application in some tropical locations as compared to temperate locations. The reason for voting on each of these questions is to reach a consensus decision on the various performance characteristics of these microbial fecal indicators in tropical locales. This kind of information is required to address two expected general questions. First, is there convincing evidence that the current EPA indicators and associated protective criteria used in determining the hygienic quality of water don’t work in tropical settings because of environmental persistence or growth of indicators? Second, if the evidence is not yet convincing, are there research needs or database assessments that would allow a future decision to be made on the acceptability of current indicators/criteria?

#### **A. Question One**

Are there sufficient experimental and monitoring data to conclude that the **assumption** used in interpreting water quality standards (*there are no significant environmental sources of fecal coliforms, E. coli, and enterococci*) is not applicable in tropical areas (Hawaii, Guam, Puerto Rico, south Florida) because these bacteria can be recovered in high concentrations from ambient environments (water, soil, plants) in these areas?

Some of the issues related to above questions are listed below:

1. Were studies conducted to validate this assumption under temperate and tropical conditions? Where is the data to support this assumption?
2. If this assumption is valid under temperate conditions, is it reasonable to expect that it may not be valid under tropical conditions?

3. Can the reports of significant environmental sources of fecal indicator bacteria in tropical location but not in temperate location be reasonably explained by the fact that tropical environments are more conducive to the growth of fecal indicator bacteria than temperate environments?
4. If the assumption used in interpreting water quality standards is not valid for a given environment, how does this affect the interpretation of water quality standards for that area?

#### B. Question Two

Are there sufficient experimental and monitoring data to conclude that the EPA **criteria** (*E. coli*, enterococci) used to assess the quality of environmental waters are not reliable in tropical locales (Hawaii, Guam, Puerto Rico, south Florida) because the selected fecal bacteria persist in these ambient environments and represent non-fecal contamination?

Some of the issues related to the above questions are listed below:

1. The EPA criteria were selected based on studies conducted at three coastal beaches (Boston Harbor, New York City, Lake Pontchartrain), which were documented to be contaminated with sewage effluent. Under those conditions the concentrations of enterococci in recreational waters could be correlated to incidences of diarrheal diseases among swimmers. However, EPA conducted another study where the body of water was not contaminated with sewage and the source of enterococci in the water was due to non point source, most likely related to wild animals. In this study, the concentrations of enterococci in the water could not be correlated with incidences of diarrheal diseases among swimmers.
  - a) Did EPA conduct studies to show that the criteria and the methods to measure these criteria are applicable to all US jurisdictions where these standards were planned to be applied, including the tropical locations?
  - b) Is it reasonable to conclude that elevated levels of EPA criteria (enterococci or *E. coli*) at all other beaches represent the same risk of disease as predicted by the standard when the source of the fecal indicator bacteria has not been identified?
  - c) If the source of the EPA criteria (enterococci, *E. coli*) can be shown to be from non-point source rather than sewage, can one reasonably assume the risk of diarrhea diseases as predicted by the water quality standard is not valid?
  - d) In monitoring studies for recreational waters, must one determine the source of the fecal indicator bacteria to determine the risk that it represents?
  - e) Are methods to determine the source of fecal indicator bacteria from a given body of water feasible and reliable?
2. What controls persistence of fecal indicator bacteria under ambient conditions? Based on the known differences between temperate and tropical environments, can one

reasonably predict that these fecal indicator bacteria will persist longer in tropical environments than temperate environments?

3. If the evidence is obvious and convincing to indicate that fecal indicators can persist and grow in natural environments in the tropics, then is there anything left to be done before continuing to use the current indicators/criteria?
4. If the evidence for persistence and regrowth of current fecal indicators were clear and compelling, what plausible reasons would corroborate that these bacteria are able to colonize (persist) and grow in natural environments (soil, water, plants) in the tropics?
5. If there is compelling evidence that the current EPA indicators and associated protective criteria don't work in tropical settings due to environmental regrowth or persistence, then what needs to be done to provide protection to beachgoers in tropical locations?
6. Can analytical methods be modified to differentiate between fecal-borne and environmental forms of the current indicators and/or change the criteria levels to account for regrowth/persistence?
7. Are candidate modifications to the current indicators available and sufficiently evaluated for a variety of tropical climates and settings? If not, what approach is required to satisfy this need?
8. Do methods need to be evaluated to insure they determine the same risk levels as the standard analytical procedures?

### C. Question Three

Are there sufficient experimental and monitoring data to conclude that the EPA-recommended **recreational water quality standards** are not suitable to assess the hygienic quality of environmental waters in Hawaii, Guam, Puerto Rico, and south Florida?

Some of the issues relevant to the above questions are listed below:

1. If the **assumption** used in interpreting recreational water quality standards is not applicable to tropical locales, can the recreational water quality standards be reliable in tropical locales?
2. If the **criteria** used in establishing recreational water quality standards are not reliable in tropical locales, can the recreational water quality standards be reliable in tropical locales?
3. If fecal indicator bacteria are consistently present in streams and soil at concentrations far in excess of recreational water quality standards and there is no evidence of sewage input, is it reasonable to conclude that this source of bacteria is from non-fecal source and therefore the risk established by the recreational water quality standards is not valid?

4. Can the EPA-recommended recreational water quality standards be modified so it can be made reliable in tropical environments?
5. Based on the data, does it appear that a new criteria must be used to establish a reliable and suitable recreational water quality standards for tropical locales?
6. Evaluate whether “add-on” monitoring of additional indicators and respective criteria in addition to the current EPA indicators/criteria will provide increased evidence of fecal contamination?

#### D. Question Four

Are there sufficient experimental and monitoring data to conclude that fecal indicator bacteria (fecal coliforms, *E. coli*, enterococci) can multiply in tropical environments and that bacteria from these sources are indicative of lower health risk than those from fecal sources?

Some of the issues relevant to the above questions are listed below:

1. If conditions (temperature, moisture, pH nutrient level) known to be permissive for the growth of fecal indicator bacteria are provided for in the ambient tropical environment, is it reasonable to conclude that these fecal bacteria can multiply and persist under such conditions?
2. Can experiments conducted under laboratory-controlled conditions be used to predict the behavior of fecal bacteria under ambient conditions? If not what kinds of experiments must be completed to show that fecal bacteria can multiply under ambient conditions?
3. Since most pathogens (viruses, protozoa) cannot be expected to multiply under ambient conditions, what is the health significance of concentrations of fecal bacteria, which have resulted from their multiplication under ambient conditions?

#### E. Question Five

Are there sufficient experimental and monitoring data to conclude that the proposed **alternative criteria** and **recreational water quality standards** for Hawaii and Puerto Rico are more useful than the current EPA criteria and standards?

Some of the issues relevant to the above questions are listed below:

1. Does monitoring data with alternative criteria and recreational water quality standard provide more confidence in determining when a body of water is contaminated with sewage?
2. Have new candidate indicators/criteria levels been evaluated for a variety of tropical climates and settings? If not, what approach is needed to satisfy this need?
3. Do the new indicators/criteria need to be **risk based** as are the current EPA indicators/criteria? If the decision is made to replace the current indicators, can risk based assessments be made without extensive epidemiological studies?

4. Are new indicator analytical methods available and generally accepted, have they been collaboratively tested?