Groundwater Disinfection Regulation Workshop

SPONSORED BY

National Water Research Institute

Arnold and Mabel Beckman Center

OF THE NATIONAL ACADEMIES OF

SCIENCES AND ENGINEERING

100 ACADEMY DRIVE

IRVINE, CALIFORNIA 92715

JANUARY 6 - 8, 1997

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FOREWORD

In 1992 the National Water Research Institute (NWRI), in collaboration with the Weston Institute of West Chester, Pennsylvania, sponsored a Nominal Group Technique (NGT) workshop and convened a group of experts representing water utilities, the research community, and federal regulators to address the question: *What are the highest priority research problems needing to be solved in order to allow for the cost-effective implementation of the 1995 Groundwater Disinfection Rule?* The participants identified the issue, **the chemical aspects of transport and fate of pathogens**, as the highest priority research problem.

As a direct result of that workshop, research projects addressing the issue were initiated at the University of California-Irvine, and the University of Colorado. Today a second generation of projects at Texas A&M University and the University of Montana continues to pursue important questions that arose from the initial research. Through a cooperative agreement, the NWRI and its research partner, the U.S. Environmental Protection Agency, have to date invested $532,086 in support of these projects which are critical to achieving the goal of reducing the cost of implementing the Groundwater Disinfection Rule.

In this workshop participants were asked to address a broader question: ***What are the most significant benefits that should be considered in the development of groundwater disinfection regulations?*** The reason for this broader focus is the parallel and ongoing development of both state and federal regulations dealing with the microbial contamination of groundwater. Eighty-seven benefits were identified and presented by the participants whose names are listed as the originators. After consolidation, 28 major benefit areas were distilled from the original 87 and are presented in priority order as ranked by the 24 participants.

This report comprises two parts. Part 1 presents the results of the NGT workshop and is made up of three sections. The first section is an introduction that describes how the workshop was conducted and provides a preliminary analysis of the results. The second section presents each of the eighty-seven responses to the workshop question grouped under 28 major benefit headings that appear in the table of contents. The third section comprises appendices which contain a more detailed analysis of the ranking of the benefits by the participants, including an analysis of the rankings and strength of feeling of seven sub-groups of participants.

Part 2 contains the reports of the Working Groups that prepared a preliminary action plan to begin addressing the ten highest priority benefits. The Working Groups, comprising two or three participants, presented their report and enlisted comments and recommendations from the other participants. Immediately following the ten reports is an appendix that contains copies of the guidance documents used by the Working Groups.

The staff of the Beckman Center provided excellent accommodations and support. The workshop staff also deserves our thanks, including; Lucy Bravo, Dianne DeHavelland, and David Pyle, word processors; Joseph Pezely graphics; Olivia Vela, graphics assistant; Patricia Linsky, editor; and Teresa Taylor, photographer.

We were gratified by the insightful and forthright presentations made by all of the participants. Each person made significant contributions to the productive outcome of this workshop.

RONALD B. LINSKY
Executive Director
National Water Research Institute
Workshop Secretary

WILLIAM S. GAITHER, PH.D., P.E.
Gaither & Associates
Workshop Chair

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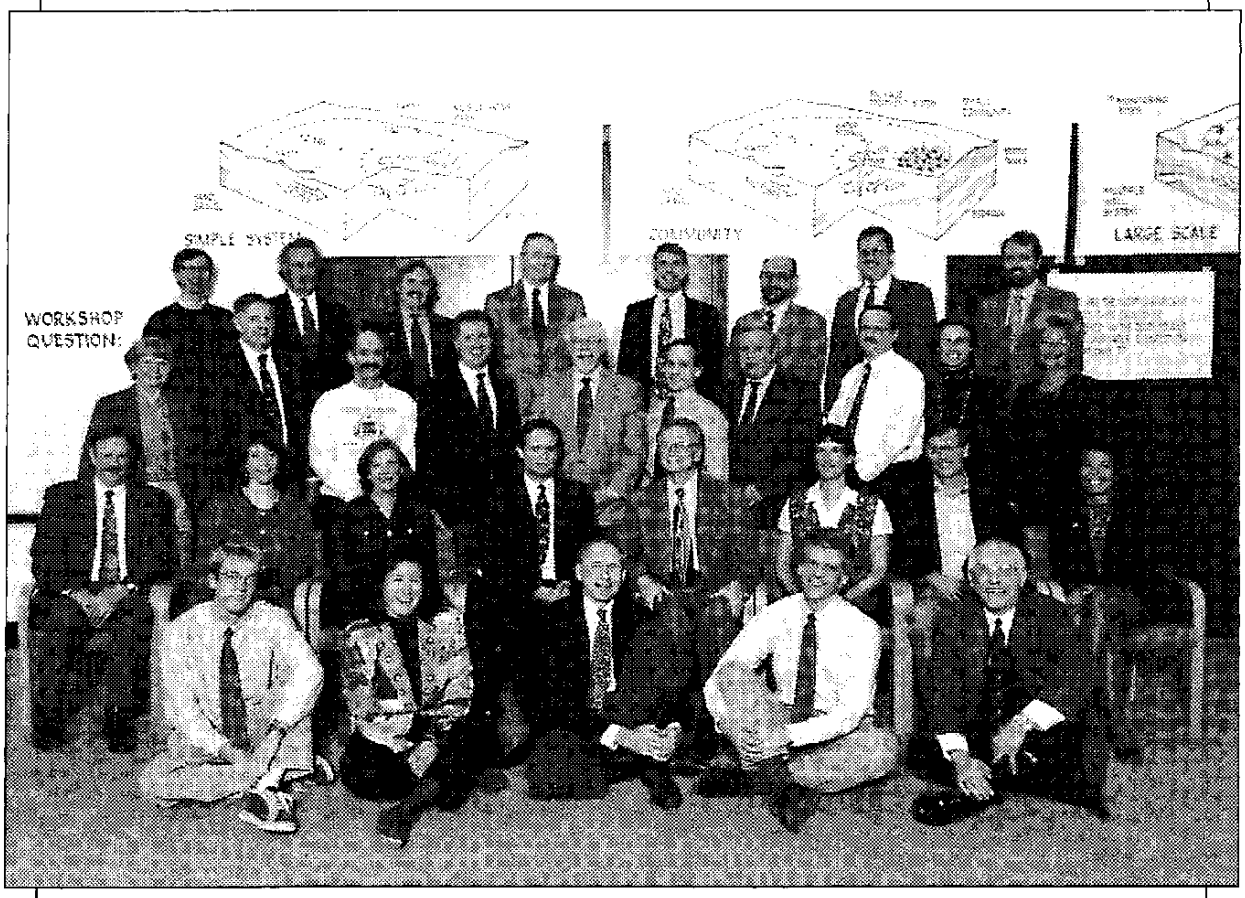
PARTICIPANTS

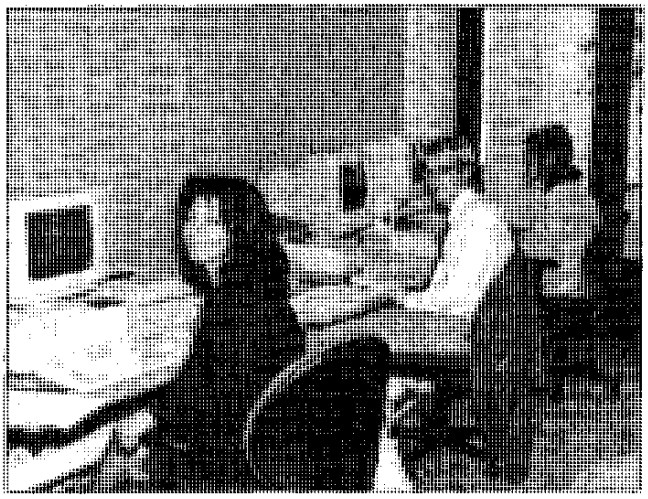


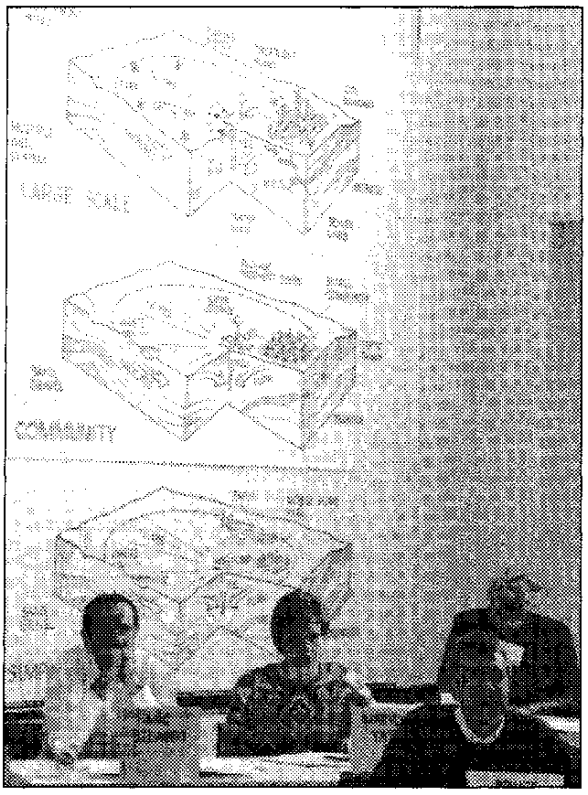
TOP ROW (LEFT TO RIGHT): Roy Herndon, Joe Drago, Bob Raucher, Joe Pezely *(graphics)*, Bruce Macler, Chuck Gerba, Henry Anderson, Jeff Lazo.

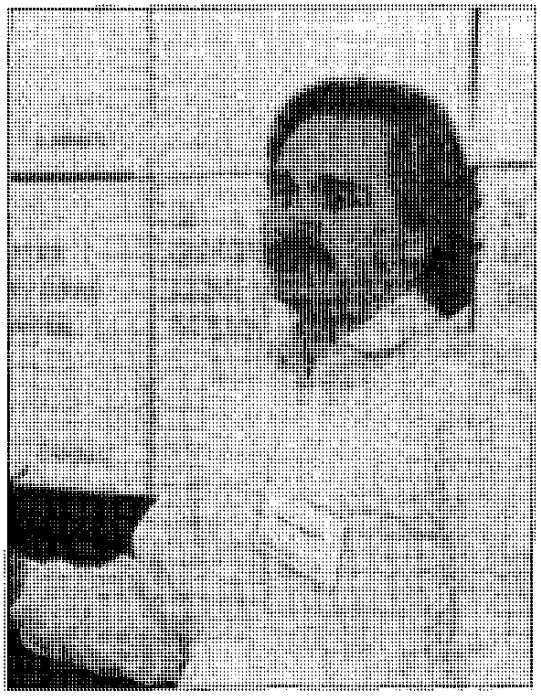
STANDING: Anita Highsmith, Jonathan Bulkley, Mike Barcelona, Chuck Job, Al Dufour, Matt Clark, Roger Selburg, Mic Steward, Marylynn Yates, Patricia Linsky *(Editor)*

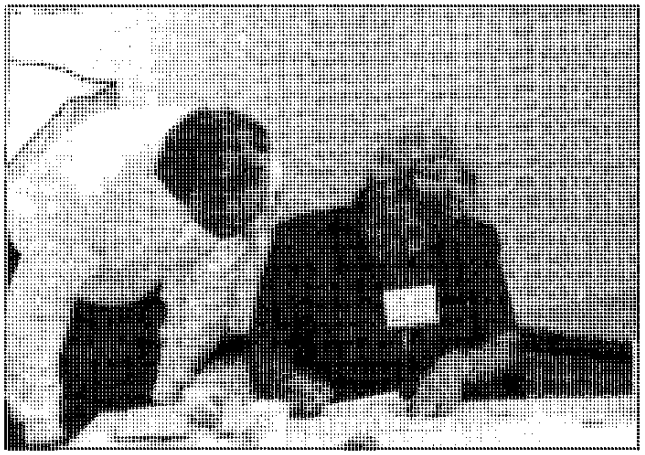
SEATED: Jerry Hansler, Erin Flanagan, Sandi Archibald, Tony Bennett, Bill Mills, Betsy Cantwell, Ken Frederick, Lucy Bravo *(Coordinating Word Processor)*

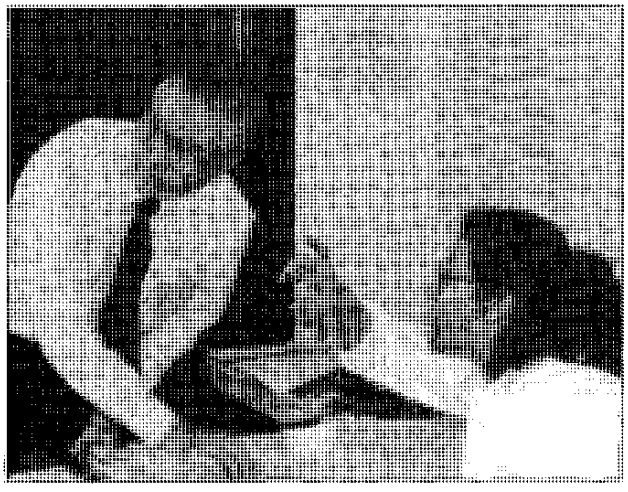
FLOOR: David Pyle *(Word Processor)*, Olivia Vela *(Graphics Assistant)*, Bill Gaither *(Chair)*, Bill Blomquist, Ron Linsky *(Secretary)*

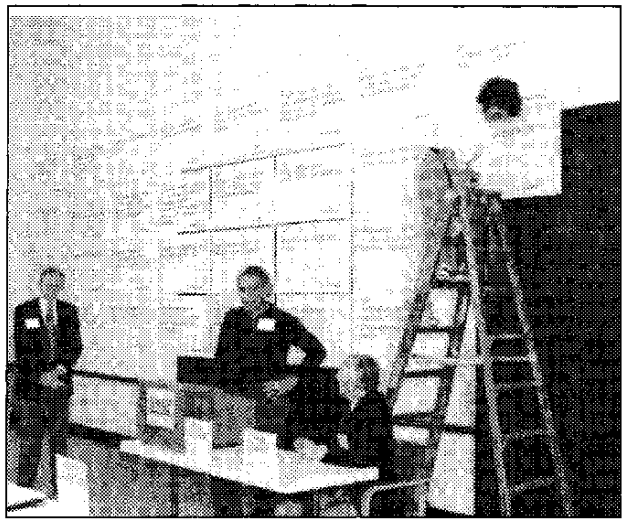












PART 1

NGT Workshop

WORKSHOP ORGANIZATION

Preparations

In early 1996 the National Water Research Institute (NWRI) initiated discussions with representatives of the US EPA's Office of Water. Those discussions focused on incorporating a groundwater resource valuing component within the traditional cost/benefit analysis process. The purpose of the valuing component would be to give new and more sensitive measures of the effects of changes in water quality, water supply, and applicable disinfection technologies. It was also suggested that the valuing component would give the states new tools as they developed their own groundwater regulation strategies.

Inasmuch as the Groundwater Disinfection Rule regulations were under active development by the US EPA, NWRI suggested that a useful focus for a Nominal Group Technique (NGT) workshop would be to address the general question of groundwater disinfection regulation. With the assistance of the US EPA and the Research Advisory Board of the NWRI, forty five individuals who possessed expertise in water utility management, federal regulation, state regulation, public health, economics, microbiology, and engineering were identified and invited. Twenty seven accepted NWRI's invitation and twenty four attended.

Participants arrived at the Arnold and Mabel Beckman Center on Monday afternoon, January 6th. Workshop registration at 3:30 p.m. was followed by a two-hour introductory session that began at 4:00 p.m. Ron Linsky, Executive Director of the NWRI, welcomed the participants and defined the purpose of the workshop. Since the participants comprised a diverse group of disciplines, the introductory session was designed to provide a common frame of reference for the workshop on the following day. Graphical representations of the natural and engineered elements of water supply protection for various sizes of groundwater systems were discussed. Roy Herndon, Manager of the Hydrogeology Department of the Orange County Water District (OCWD), presented an illustrated talk about how the OCWD protects the quality of its groundwater resource. Next, Bill Gaither, the workshop chair, presented examples of benefits and services from a 1996 paper by Bergstrom, Boyle, Job and Kealy (Ref. 1). Copies of the graphical material used in this session are included in Appendix B. Next, the group discussed the workshop question and revised a few words to broaden its applicability.

Following dinner the participants reassembled in the workroom where Bill Gaither briefed the participants on workshop procedures. Workshop Guidelines (Appendix N) and the Final Agenda (Appendix O) were reviewed. Dr. Gaither explained that the process followed was a modified version of the NGT process developed by Professors Delbecq and Van de Ven of the University of Wisconsin in the late 1960s (Ref. 2). After a question-and-answer period participants returned to their hotel to complete any unfinished homework.

Agenda

On Tuesday, January 7th, participants were picked up at their hotel at 7:00 a.m. and bused to the Beckman Center. Breakfast was served at 7:00 a.m. and the workshop began promptly at 8:00 a.m. Work accomplished that day consisted of the following activities:

- **8:00 A.M. – 12:00 P.M.** Identification and Posting of Benefits
- **12:00 P.M. – 12:45 P.M.** Lunch
- **12:45 P.M. – 6:30 P.M.** Consolidation of Benefits into Major Benefit Groups
- **6:30 P.M. – 7:30 P.M.** Dinner
- **7:30 P.M. – 9:30 P.M.** Continued Consolidation of Benefits
- **9:30 P.M. – 9:45 P.M.** Priority Ranking of Major Benefit Areas by Each Participant
- **10:00 P.M.** Participants Returned to Hotel by Bus

Following the workshop adjournment at 9:45 p.m., the workshop staff compiled the results of the rankings that had been completed by each participant during the workshop. The top Ten Priority Issues were posted on the walls of the workroom, and Working Groups were appointed to refine and amplify these issues for presentation the following day.

Benefit Identification and Posting

Participants were seated in alphabetical order starting with Henry Anderson in the front row right facing the lectern and ending with Marylynn Yates in the left rear of the room.

Starting with Anderson, each participant, in turn, was invited to the lectern to present his or her highest priority response to the workshop question which was posted on the front wall of the workroom. Three minutes were allotted for each participant to identify and describe a benefit, to propose how to measure the effects of the benefit, and to suggest an approach to valuing the benefit. Forms used for this purpose are shown in Appendix P.

At the conclusion of each presentation, the speaker was asked by the secretary (Ron Linsky) to repeat the title to ensure that the twenty-word maximum title which would be lettered and posted on the workroom wall would represent, as clearly and succinctly as possible, the intent of the originator.

If the title proposed by the presenter represented clearly the ideas outlined in their oral presentation, the secretary accepted it without comment. If, in the opinion of the secretary, the benefit title did not represent what the presenter had just said, a modified title was proposed by the workshop secretary in the language of the presenter. This title could be accepted or rejected by the presenter.

Questions of clarification to the presenter were allowed from the other participants. Neither challenges nor suggestions to modify the thrust of the oral presentation were allowed by the chair. If a participant had in mind a variation on what a presenter had proposed, the chair encouraged her or him to write that up as a separate benefit description and present it at his or her next turn.

At the conclusion of each three-minute (or less) presentation, the agreed-upon title was lettered by the secretary on a 3″ x 5″ card, numbered, the originator's name noted, and the card taken to Joe Pezely working at the rear of the room. The title was then quickly lettered on a 35″ by 22″ sheet of paper, and posted on the wall of the workroom. The lettering was of sufficient size that the most distant participant could read it with ease. By 12:00 noon., 87 benefits had been presented and posted.

The Benefit was assigned a sequential number, edited, and delivered to the word processing room to be put into the format of this report. A draft write-up was returned to the originator in the workroom for review. Originators were responsible for editing and approving the text of what they had written.

Consolidation

After all identified benefits were posted on the workroom wall, the process of consolidation was started. The purpose of consolidation was to ensure that each benefit would be put into a distinctive cluster of related benefits grouped under one overarching benefit title.

Obviously, there are many ways in which a set of 87 issues can be grouped. The participants were challenged by the task of striking a balance between subsuming too many benefit titles under one heading and "burying" important ideas, versus keeping each idea as a discrete title at the risk of confusing the participants with too many similar options to vote for. The consolidation phase goal was to reduce the total number of benefit ideas remaining on the workroom wall to between one-quarter and one-third of the total number proposed. In this case, 87 ideas were boiled down to 28 discrete major benefit groups, 35 percent of the original number, with several of the 28 standing alone as unique benefits.

Considerable debate and discussion took place during the consolidation phase. To facilitate this process, each participant who originated a benefit was asked to maintain a Consolidation Worksheet (See Appendix Q) throughout the benefit identification phase. When a similar, or complementary, benefit was presented, the originator was responsible for noting its number on the worksheet. The chair alerted each originator at the start of the workshop that they would be called upon in the consolidation phase to lead the discussion of how they would propose to cluster their benefit with other benefits with a similar thrust into a distinct major benefit group.

Each benefit originator was assured by the chair that they would retain the absolute right to either merge their benefit idea into a group of similar benefits, or to insist that their benefit stand alone. Similarly, each originator was assured that they retained the absolute right to title their benefit in the way they thought to be most accurate and to edit their text the same way. Whenever benefits were subsumed under a major benefit group title, the texts of all benefit included under that overarching benefit title were included in their entirety in the final report.

Ranking

The final step in the process was to ask each participant to rank in descending order of priority the top ten benefits from among the 28 remaining on the workroom wall as they saw the benefit being responsive to the workshop question. A sample copy of the Ranking Sheet used is included as Appendix R. Compiling the results of these individual ranking sheets established an order of importance of the 28 benefit titles left on the workroom wall following the consolidation step. That order is how the body of this report is organized.

Text Approval

As noted earlier, as soon as prepared text was entered into the word processors, a draft was returned to the originator for further editing. Some originators continued making improvements and required several drafts before they were satisfied. With each participant's approval in hand at adjournment time, it was possible to begin preparing this report.

PRELIMINARY ANALYSIS OF RESULTS

The results of this workshop were analyzed to determine what differences in priorities existed among the seven sub-groups of participants. This was done by taking the data from the Ranking Sheets (Appendix R) and compiling it with members of the same group. The subgroups into which the participants were divided include (1) utility managers, (2) federal regulators, (3) state regulators, (4) public health officials, (5) economists, (6) microbiologists, and (7) engineers. No category could contain fewer than two individuals or the confidentiality of the ranking process would be compromised. Fortunately, the smallest group in this workshop contained two individuals and the largest group contained six.

Listed below are tables which give titles of the top ten priorities as established by the seven subgroups listed above. The first table gives the ranking of all 24 participants and is in the same order as the table of contents. Subsequent tables represent the priorities of the seven subgroups.

In Appendices D, E, F, G, H, I, J, and K, complete rankings are given for each group. In those appendices three other items of information are given, including: (1) the number of times the issue was picked, (2) the total points received by every issue, and (3) the strength of feeling expressed as a percentage. A more complete explanation of these data, and how they are computed, is given in Appendix C of this report.

Top Ten Benefits Ranked by All Participants (24)

1. Reduced Risk of Waterborne Illness
2. Increased Reliability and Availability of Groundwater Systems
3. Prevent Microbial Contamination of the Source Water
4. Comprehensive Quality Assurance Plan for Assessing the Quality of Drinking Water
5. Close the Information Gap on the Microbial Quality of Drinking Water to Enhance State, Local and Utility Surveillance and Regulatory Programs and to Identify the Impact and Extent of Contamination
6. Reduce Uncertainty about Health-Effects Incidence and Severity through Better Integration of Public Health Disease Surveillance and Regulatory Monitoring
7. Identification of Wells that Pose the Maximum Threat to Public Health
8. Benefits to Future Generations
9. Improved Approaches to Developing Drinking Water Regulations
10. Value of Avoiding Disinfection by Identification of Wells with Adequate Natural Protection

Top Ten Benefits Ranked by Utility Manager Participants (2)

1. Identification of Wells that Pose the Maximum Threat to Public Health
2. Close the Information Gap on the Microbial Quality of Drinking Water to Enhance State, Local and Utility Surveillance and Regulatory Programs and to Identify the Impact and Extent of Contamination
3. Increased Reliability and Availability of Groundwater Systems
4. Value of Improved Management of Small Systems
5. Reduced Risk of Waterborne Illness
6. Value of Avoiding Disinfection by Identification of Wells with Adequate Natural Protection
7. Comprehensive Quality Assurance Plan for Assessing the Quality of Drinking Water
8. Changes in Risk Premia
9. Reduce Uncertainty about Health-Effects Incidence and Severity through Better Integration of Public Health Disease Surveillance and Regulatory Monitoring
10. Improved Implementation of State Programs that Provide Flexible Approaches to Protect Groundwater from Microbial Contamination

Top Ten Benefits Ranked by Federal Regulator Participants (3)

1. Reduced Risk of Waterborne Illness
2. Prevent Microbial Contamination of the Source Water
3. Increased Reliability and Availability of Groundwater Systems
4. Comprehensive Quality Assurance Plan for Assessing the Quality of Drinking Water
5. Improved Implementation of State Programs that Provide Flexible Approaches to Protect Groundwater from Microbial Contamination
6. Benefits to Future Generations
7. Changes in Risk Premia
8. Increased and Improved Public Involvement
9. Close the Information Gap on the Microbial Quality of Drinking Water to Enhance State, Local and Utility Surveillance and Regulatory Programs and to Identify the Impact and Extent of Contamination
10. Increased Public Understanding of and Confidence in Drinking Water Safety

Top Ten Benefits Ranked by State Regulator Participants (3)

1. Reduced Risk of Waterborne Illness
2. Increased Reliability and Availability of Groundwater Systems
3. Prevent Microbial Contamination of the Source Water
4. Value of Avoiding Disinfection by Identification of Wells with Adequate Natural Protection
5. Comprehensive Quality Assurance Plan for Assessing the Quality of Drinking Water
6. Identification of Wells that Pose the Maximum Threat to Public Health
7. Improved Approaches to Developing Drinking Water Regulations
8. Environmental Justice
9. Reduce Uncertainty about Health-Effects Incidence and Severity through Better Integration of Public Health Disease Surveillance and Regulatory Monitoring
10. Improved Implementation of State Programs that Provide Flexible Approaches to Protect Groundwater from Microbial Contamination

Top Ten Benefits Ranked by Public Health Participants (2)

1. Reduced Risk of Waterborne Illness
2. Comprehensive Quality Assurance Plan for Assessing the Quality of Drinking Water
3. Reduce Uncertainty about Health-Effects Incidence and Severity through Better Integration of Public Health Disease Surveillance and Regulatory Monitoring
4. Identification of Wells that Pose the Maximum Threat to Public Health
5. Increased Public Understanding of and Confidence in Drinking Water Safety
6. Value of Avoiding Disinfection by Identification of Wells with Adequate Natural Protection
7. Benefits to Future Generations
8. Provide Incentives to Develop and Adopt New Technologies and Improved Management Practices Designed to Meet Regulations
9. Avoid Switching to Bottled or Other More Expensive Sources of Drinking Water
10. Close the Information Gap on the Microbial Quality of Drinking Water to Enhance State, Local and Utility Surveillance and Regulatory Programs and to Identify the Impact and Extent of Contamination

Top Ten Benefits Ranked by Economist Participants (6)

1. Reduced Risk of Waterborne Illness
2. Benefits to Future Generations
3. Changes in Risk Premia
4. Avoid Switching to Bottled or Other More Expensive Sources of Drinking Water
5. Improved Approaches to Developing Drinking Water Regulations
6. Concomitant Water Quality Benefits
7. Provide Incentives to Develop and Adopt New Technologies and Improved Management Practices Designed to Meet Regulations
8. Reduce Uncertainty about Health-Effects Incidence and Severity through Better Integration of Public Health Disease Surveillance and Regulatory Monitoring
9. Increased Reliability and Availability of Groundwater Systems
10. Identification of Wells that Pose the Maximum Threat to Public Health

Top Ten Benefits Ranked by Microbiologist Participants (4)

1. Reduced Risk of Waterborne Illness
2. Prevent Microbial Contamination of the Source Water
3. Comprehensive Quality Assurance Plan for Assessing the Quality of Drinking Water
4. Increased Reliability and Availability of Groundwater Systems
5. Reduce Uncertainty about Health-Effects Incidence and Severity through Better Integration of Public Health Disease Surveillance and Regulatory Monitoring
6. Value of Avoiding Disinfection by Identification of Wells with Adequate Natural Protection
7. Lower Cost of Disease Prevention Strategies
8. Close the Information Gap on the Microbial Quality of Drinking Water to Enhance State, Local and Utility Surveillance and Regulatory Programs and to Identify the Impact and Extent of Contamination
9. Improved Implementation of State Programs that Provide Flexible Approaches to Protect Groundwater from Microbial Contamination
10. Changes in Risk Premia

Top Ten Benefits Ranked by Engineer Participants (4)

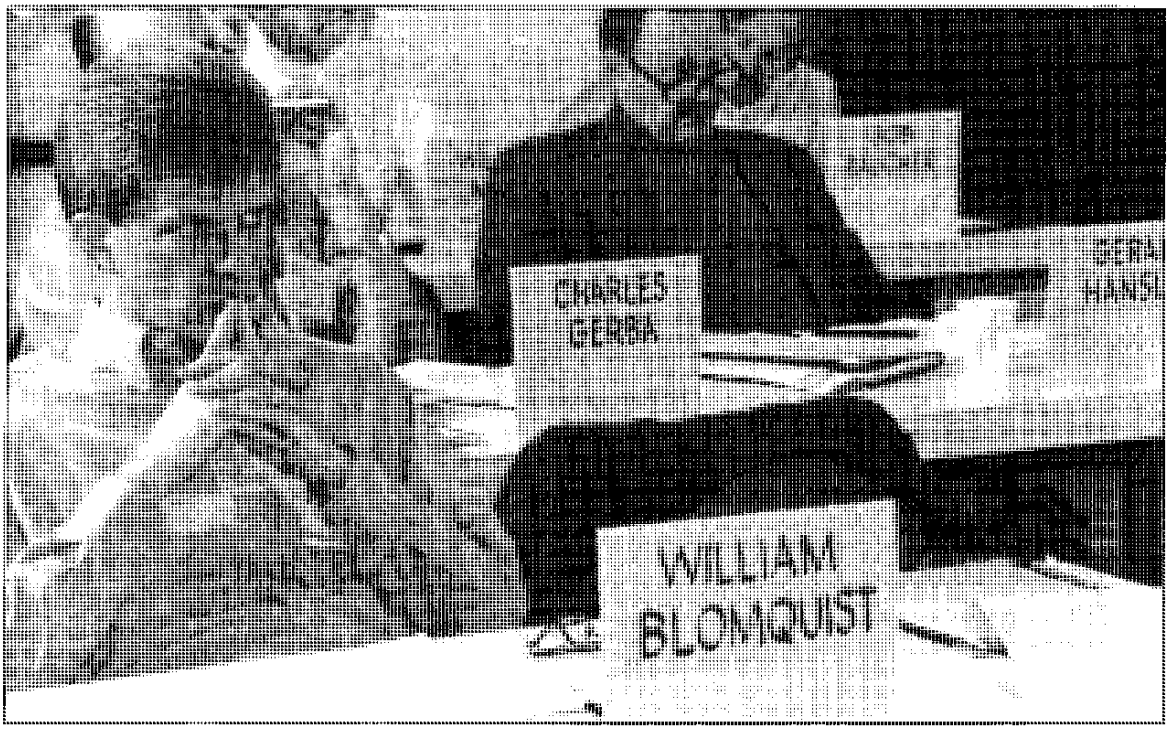
1. Reduced Risk of Waterborne Illness
2. Increased Reliability and Availability of Groundwater Systems
3. Prevent Microbial Contamination of the Source Water
4. Comprehensive Quality Assurance Plan for Assessing the Quality of Drinking Water
5. Close the Information Gap on the Microbial Quality of Drinking Water to Enhance State, Local and Utility Surveillance and Regulatory Programs and to Identify the Impact and Extent of Contamination
6. Improved Approaches to Developing Drinking Water Regulations
7. The Benefits to Future Generations
8. Value of Avoiding Disinfection by Identification of Wells with Adequate Natural Protection
9. Improved Implementation of State Programs that Provide Flexible Approaches to Protect Groundwater from Microbial Contamination
10. Avoid Switching to Bottled or Other More Expensive Sources of Drinking Water

PRIORITY RANKING OF BENEFITS

Notes:

1. The following 28 benefits are presented in descending order of importance as ranked by all (24) participants.

2. Priority benefits often comprise several benefits proposed by individual participants. Wherever that occurs, one lead participant is designated by the chair to compose a new title, a revised benefit description, a recommendation about how to measure the effect(s) of the benefit, and a suggested method to value the benefit. All individual benefits subsumed under the new title are presented alphabetically in order of author name.


CHARLES
GERBA
WILLIAM
BLOMQUIST

PRIORITY RANK 1

Reduced Risk of Waterborne Illness

ORIGINATORS:

Drago on behalf of himself, Blomquist, Bulkley, Clark, Dufour, Frederick, Gerba, Hansler, Job, Raucher, and Stewart

Benefit description:

Risk reduction through control of exposure to pathogenic organisms in groundwater would include reductions in acute, chronic, and recurring morbidity, mortality, and disability in the general population and sensitive subpopulations (e.g., infants, elderly, and immuno-compromised). Resulting benefits would include lower health costs, increased worker productivity and leisure time, and reduced reliance on bottled and boiled water.

How to measure the effect(s) of the benefit:

The major measurement challenge is to develop a baseline correlation between microbial contamination of groundwater and waterborne health effects using the endpoints of morbidity, mortality, and disability for both the general population and sensitive subpopulations. Baseline epidemiological studies (with retrospective followup studies after rule implementation) and probabilistic models are suggested as methods to develop these estimates. These estimates need to indicate the distribution of health impacts according to the duration and severity of illness and age of the affected. Once the occurrence estimates are made, measurements of expected reductions in societal (lost time and wages/productivity) costs, medical treatment expenses, and loss of life would be developed.

How to value the benefit:

Willingness to pay (or accept compensation) is the appropriate valuation concept. Contingent valuation could be used to estimate the willingness to pay for actions that reduce the risk of waterborne illness. Specific values for benefits will vary depending on the type of risk reduction and the affected population. Morbidity and disability can be addressed by contingent valuation to avoid various symptomatic effects. Cost-based measures such as lost wages/productivity and medical treatment expenses can be used as proxy benefit values for the general public (to the extent that reliable willingness to pay estimates are not available), while lost wages/productivity may not be appropriate for sensitive subpopulations. Mortality would be addressed by value(s) of a statistical life saved based on willingness to pay concepts and using quality adjusted life years.

The following benefits were subsumed under the above title:

BENEFIT TITLE: **Fewer incidents of serious illness among infants, elderly, and immuno-compromised populations.**

ORIGINATOR: Blomquist

Benefit description:

Medical care for infants, the elderly, and the immuno-compromised are among the most expensive kinds of medical care, yet these populations are at greatest risk of developing serious (even fatal) illnesses from water contamination. Reducing their exposure would benefit their health and lower health care expenses.

How to measure the effect(s) of the benefit:

- Biological/physiological effects - reduced illness/improved health of these populations.
- Social/economic effects - reduced expenses for medical treatment among these populations; ability to devote those resources to other valued purposes.

How to value the benefit:

Because the members of these populations are least likely to be producing an income through employment, models that monetize the value based on lost wages, etc., are probably not as applicable. We should be able to monetize the savings in medical treatment over time rather directly if there is a valid estimate of the reduction in the number of illnesses likely to occur as a result of the rule's implementation.

BENEFIT TITLE: **Provision of water for human use/consumption which presents a low/acceptable risk for human health problems: death/ illness/disability.**

ORIGINATOR: Bulkley

Benefit description:

Water is essential to life; after.air (oxygen), it is the critical resource which limits human life. Most adults have sufficient body fat to survive a period of days without food; air (minutes); water (1-3 days; function of circumstances).

How to measure the effect(s) of the benefit:

- Reduced incidence of waterborne illness.
- Reduced fatalities from waterborne illness (sensitive populations, overall population).

How to value the benefit:

Multi-step process:

- Estimate expected number of annual fatalities (with and without final Groundwater Protection Rule).
- Estimate expected number of annual non-fatal illness (with and without final Groundwater Protection Rule).
- Estimate expected number of annual person-years lost - death - (with and without final Groundwater Protection Rule).
- Estimate expected number of annual person years lost - illness - (with and without final Groundwater Protection Rule).
- Estimate expected annual cost of medical treatment of illness including long-term disability (with and without final Groundwater Protection Rule).

BENEFIT TITLE: **Avoidance of illness (morbidity) caused by contaminated drinking water.**

ORIGINATOR: Clark

Benefit description:

Reduced (or changed) occurrence of some set of symptoms.

How to measure the effect(s) of the benefit:

Identify cause and effect linkages, probability of occurrence giving presence of organism - duration and severity; age of afflicted; latency in distribution.

How to value the benefit:

- Establish cause and effect linkages - identify distribution of age; duration and severity.
- Valuation - contingent valuation/willingness to pay to avoid each duration and severity of illness.
- Replacement cost.
- Ceiling: POU/POE system

BENEFIT TITLE: **Avoidance of mortality.**

ORIGINATOR: Clark

Benefit description:

Fewer premature deaths.

How to measure the effect(s) of the benefit:

Cause and effect: reduced probability of fatal illness.

- Age of afflicted - Monte Carlo Distribution.
- Delay of onset.
- Net out increase cancer from disinfection.

How to value the benefit:

- Hedonic wage studies.
- Avoidance behavior - bottled water.
- POU/POE cost as maximum potential benefit.

BENEFIT TITLE: **Reduction of waterborne illness.**

ORIGINATOR: Drago

Benefit description:

Benefits include reduction in lost time (productivity) at work and/or leisure opportunities. Benefits would presumably continue to occur over the long term.

How to measure the effect(s) of the benefit:

The benefit could be measured by change in lost work days on wages, in frequency of visits to clinics or doctors, and in medication purchases. Missed leisure opportunities would be more difficult to measure.

How to value the benefit:

- Value of benefit could be based on costs of lost work days or wages, health care visits, and medication. Missed leisure opportunities would be more difficult to quantify.

BENEFIT TITLE: **The most significant benefit that should be considered is a minimal health risk from microbial waterborne pathogens in drinking water consuming populations.**

ORIGINATOR: Dufour

Benefit description:

The benefit is a product, namely drinking water for public consumption, that essentially is free of viable microbial pathogens that may cause infectious disease in those who drink the water. This benefit should be supported by a comprehensive risk assessment.

How to measure the effect(s) of the benefit:

The effects of this benefit would normally be measured by the number of cases of disease prevented. However, since a baseline level of waterborne disease is not available, it is likely that the benefits may be measured by the frequency of waterborne outbreaks of disease that result from a breakdown of any system devised to protect public health.

How to value the benefit:

- Sequential epidemiological studies might be performed before and after implementation of regulations. Such data might be used to conduct a cost/benefit assessment with respect to illness or disease avoided.

BENEFIT TITLE: **Reducing health risks associated with drinking water.**

ORIGINATOR: Frederick

Benefit description:

Improved public health would result in lower health costs, increased worker productivity, increased leisure time, and improved life expectancy. Protecting and restoring public confidence in drinking water quality would reduce reliance on bottled and boiled water, thereby lowering both the financial and labor costs of providing drinking water.

How to measure the effect(s) of the benefit:

The first step is estimating the likely impact of water quality on public health through epidemiological studies or inferences from tests on laboratory animals. Then, the impacts of public health on worker productivity, leisure time, life expectancy, and averting behavior could be estimated through a combination of studies that might involve techniques such as surveys of past behavior associated with morbidity and incidents of contaminated drinking water.

How to value the benefit:

The benefits of good quality drinking water are the avoided costs that would result from the disease and illness associated with contaminated drinking water. These costs include the value of work and leisure times lost as a result of illness (i.e., the marginal value of labor multiplied by the time lost due to illness), the costs of medical care, and the costs of actions such as buying bottled water and boiling tap water taken to avoid contaminated drinking water. These costs might be estimated directly from studies of past experiences of severe illness associated with poor drinking water or indirectly through surveys of the willingness to pay for good-quality, reliable drinking water.

BENEFIT TITLE: **Reduction in enteric illness within a community.**

ORIGINATOR: Gerba

Benefit description:

Reduction in health care provided for short-term (gastroenteritis) and long-term health effects (diabetes, myocarditis). Reduction in waterborne disease outbreaks.

How to measure the effect(s) of the benefit:

- Reduction in enteric illnesses through epidemiological studies.

How to value the benefit:

- Reduction in radical treatment costs and lives saved.

BENEFIT TITLE: **An alternative to bottled water.**

ORIGINATOR: Hansler

Benefit description:

Services provided:

- Obtaining necessary microbial information upon which to consider alternative remedial actions.
- Costing out alternative remedial measures so best decision can be made.
- Utilizing 1 and 2 above to influence owners and public on the necessity of adjusting water prices.
- Causing the improvement of state, local, utility owner water system protection programs.

How to measure the effect(s) of the benefit:

- Increase in number of systems having a profile of microbial surveillance.
- Increase in number of systems where determination of adequacy/inadequacy is made.
- Increase in number of systems which meet national standards for compliance.
- Decreases in reported and estimated drinking water (groundwater) borne disease cases.

How to value the benefit:

- Estimating reduction in:
- Lost work days.
- Lost school days.
- Health and hospital costs.
- Lost leisure days.
- Legal fees and settlement costs due to contaminated water.

BENEFIT TITLE: **Avoidance of infective concentrations of pathogenic microbes in groundwater supplied public water systems.**

ORIGINATOR: Hansler

Benefit description:

Services provided:

- Obtaining necessary microbial information upon which to consider alternative remedial actions.
- Costing out alternative remedial measures so best decision can be made.
- Utilizing 1 and 2 above to influence owners and public on the necessity of adjusting water prices.
- Causing the improvement of state, local, utility owner water system protection programs.

How to measure the effect(s) of the benefit:

- Increase in number of systems having profile of microbial surveillance.
- Increase in number of systems where determination of adequacy/inadequacy is made.
- Increase in number of systems which meet national standards for compliance.
- Decreases in reported and estimated drinking water (groundwater) borne disease cases.

How to value the benefit:

Estimating reduction in:

- Lost work days.
- Lost school days.
- Health and hospital costs.
- Lost leisure days.

BENEFIT TITLE: **Value of reduced recurring health effects.**

ORIGINATOR: Job

Benefit description:

Illness from microbes can recur over and over again, especially in sensitive populations. Benefits from reducing or eliminating illness over time is commensurate with system maintenance costs over time.

How to measure the effect(s) of the benefit:

Identify and measure recurring illnesses, their incidence, frequency, and duration, particularly for sensitive populations.

How to value the benefit:

Identify and measure costs for dealing with recurring illnesses from microbial contaminants and project over time.

BENEFIT TITLE: **Reduce public health risk that consumers of groundwater will incur a waterborne pathogenic disease.**

ORIGINATOR: Raucher

Benefit description:

Reduced number of morbidity and mortality events among those who consume groundwater, and reduced concern for groundwater users.

How to measure the effect(s) of the benefit:

- Quantification of risk reduction requires assessment of illness and mortality incidence (baseline risks, post-regulatory risks).

Challenges in quantification include:

- Significant uncertainties of baseline and post-regulation risk levels.
- Accounting for the manner in which regulations are designed and implemented.
- Possible increased risks due to disinfection by-products.

How to value the benefit:

Willingness to pay for risk reductions is the appropriate conceptual approach. Operationalize via:

New primary research:

- Contingent Valuation Method research
- New primary hedonic research (wage studies, etc.) - Quality Adjusted Life Years for mortality.
- Benefits transfer of existing primary research, especially for mortality risks - additional morbidity research needed on valuation side.

Use of cost-based proxies to supplement willingness to pay:
- Averting costs.
- Cost of illness.
- Etc.

BENEFIT TITLE: **Reduction of waterborne disease.**

ORIGINATOR: Stewart

Benefit description:

Ideally, this rule should focus on implementation of regulations that limit waterborne disease due to contamination of groundwater by microbial agents. The benefits of minimizing waterborne disease include higher standards of public health (i.e., reduced morbidity and mortality in the population) and increased economic benefits associated with reduction of illness in the community.

How to measure the effect(s) of the benefit:

- Epidemiological surveys of illness within the community.
- Development of an econometric model to assess the economic benefit of increased work productivity due to reduction of waterborne illness. Economic benefit should be adjusted to reflect trade-off with cost or use of treatment that may introduce health compromising by-products. Benefit analysis should also be adjusted to distinguish endemic disease associated with other sources of illness (e.g., contaminated food, person-to-person contact, etc.) and waterborne disease.

How to value the benefit:

- Econometric model.
- Societal benefit of greater confidence in drinking water.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PRIORITY RANK 2

Increased Reliability and Availability of Groundwater Systems

ORIGINATORS:

Macler on behalf of himself, Bennett, Cantwell, Herndon, and Highsmith

Benefit description:

Increased reliability and availability (reduced failure) supports reduction of disease outbreaks and endemic illness; increases consumer confidence and perception of safety; reduces losses from failure of water system; reduces contamination from other materials; reduces maintenance and capital costs; and, enhances community protection.

How to measure the effect(s) of the benefit:

- Estimate failure rates with/without different regulatory components.
- Evaluate changes in total coliform risk violations.

How to value the benefit:

- Estimate costs of repair from failure events.
- Estimate transactional costs from failure events.
- Estimate lost economic activity and lost revenue from failure events.
- Estimate costs of (avoiding) disaster activities (boil water notices, emergency activities) from failure events.

The following benefits were subsumed under the above title:

BENEFIT TITLE: **Protection of distribution systems from microbiological contamination.**

ORIGINATOR: Bennett

Benefit description:

- Contamination that occurs after source treatment would be controlled.
- Contamination occurs through cross connections and line breaks/leaks.

How to measure the effect(s) of the benefit:

Reduce the total coliform and *E.coli* violations.

How to value the benefit:

- Cost of notification.
- Avoid moves to bottled water.
- Avoid moves to POU devices.

BENEFIT TITLE: **Infrastructure improvements.**

ORIGINATOR: Cantwell

Benefit description:

Both positive and negative effects on system infrastructure (i.e., materials that make up systems). Effects of lower levels of microbial contaminants or effects of disinfection byproducts on system components and their operational envelopes.

How to measure the effect(s) of the benefit:

Examples: increases or decreases in maintenance costs or capital costs.

How to value the benefit:

The measures above are all in terms of changes in costs. This is by its nature already monetized. You could also value this benefit in terms of the effect of regulation on system availability. (See attached definition of availability, a measure of system down-time.)

Availability: an engineering term and statistical methodology associated with the amount of time a system is functioning as intended. It is measured with statistical distributions for expected down-time due to failures (MTBF, etc.), maintenance activities, and off-nominal events.

BENEFIT TITLE: **Develop minimum federal well construction and siting standards.**

ORIGINATOR: Herndon

Benefit description:

- To the extent that gaps may exist in current federal policies on engineering controls to protect wells from microbial contamination, disinfection regulations should assure baseline standards for well design, construction, and siting.
- Maintains state option for more stringent standards.
- Evaluates existing state and federal well standards in light of microbial contamination.

How to measure the effect(s) of the benefit:

Improvement in well-derived water quality; reduced monitoring requirements; increased well performance.

How to value the benefit:

No recommendation proposed.

BENEFIT TITLE: **Improved methods for determining best management practices during natural and unnatural occurrences.**

ORIGINATOR: Highsmith

Benefit description:

- Benefits large populations by early implementation of Best Management Practices.
- Identifies the need for alternate water sources.
- Reduces possible harmful health effects to population.
- Allows public officials to notify and guide community during emergency situations.

How to measure the effect(s) of the benefit:

- Establish a database for local and state health departments to use during future occurrences.
- Measure methods for handling emergencies.
- Develop new technologies for providing potable water during these times.

How to value the benefit:

- Improved public health and public confidence.
- Development of emergency preparedness guidelines.

BENEFIT TITLE: **Increased reliability and availability of groundwater systems.**

ORIGINATOR: Macler

Benefit description:

Increased reliability (reduced failures) supports reduction of disease outbreaks and endemic illnesses; supports increased consumer confidence/perception of reliability; reduces losses from failures/loss of drinking water; and, reduces contamination from other materials.

How to measure the effect(s) of the benefit:

Estimate failure rates +/– different regulatory components.

How to value the benefit:

- Estimate costs of repair from failure events.
- Estimate costs of lost revenue from failure events.
- Estimate costs of lost economic activity from failure events.
- Estimate costs of avoiding disaster activities from failure events (boil water notices, emergency activities).

PRIORITY RANK 3

Prevent Microbial Contamination of the Source Water

ORIGINATORS:

Flanagan on behalf of herself, Blomquist, Gerba, Highsmith, Job and Yates

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Benefit description:

Implement a microbial source water protection approach to maintain and preserve source water quality; reduce the risk to human health from microbial contamination and disinfection by-products; and, increase the coordination of wastewater and drinking water programs. These activities, in conjunction with an on-going monitoring program, will optimize the utilization of water and land resources and reduce the risk to human health from microbial pathogens.

How to measure the effect(s) of the benefit:

- Routine monitoring with enforceable standards.
- Identify and measure volume/occurrence of all major microbial contaminant sources.
- Reduced contamination of groundwater by pathogenic organisms.
- Identify health effects of microbial and co-occurring contaminants.
- Reduced illness from pathogenic organisms.
- Reduced costs because of coordination between wastewater and drinking water programs; reduced need for treatment of microbial contamination; and, reduced need to develop additional supplies.
- Identify and manage or eliminate sources likely to contribute co-occurring contaminants.

How to value the benefit:

- Evaluate cost of treating for microbial and co-occurring contaminants found in wellhead or source water protection areas.
- Evaluate health effects costs associated with microbial and co-occurring contaminants served by public water systems with wellhead or source water protection programs.
- Evaluate downstream treatment costs and recreation-related health effects costs for wellhead protection areas in zones of groundwater discharge to streams.
- Reduction in medical costs
- Determine replacement costs of storage capacity or stream flow contributed by the aquifer.
- Reduction in water treatment costs.
- Increased property values.

The following benefits were subsumed under the above title:

BENEFIT TITLE: **Preservation of water quality in aquifers for water storage and base streamflow.**

ORIGINATOR: Blomquist

Benefit description:

If the rule reduces contamination of source water resulting from backflow, poor well construction/maintenance or return flows of contaminated groundwater, water quality in aquifers should receive some protection as well. Because aquifers provide water storage capacity and in many circumstances supply some of the base flow of surface streams, preservation of their quality is a potential benefit to be considered when developing regulations.

How to measure the effect(s) of the benefit:

Hydrological and social effects: non-contaminated aquifers will be available for storage of surplus water (i.e., conjunctive use) which is much less costly than the construction, operation, and maintenance of additional surface storage, and those aquifers that provide streamflow or springs will provide greater benefits to human beings and other species for a longer period than if they become contaminated.

How to value the benefit:

There would be several steps:

- First, we will need to estimate the frequency and scale with which poor well construction/maintenance, backflow from distribution systems, or return flows of contaminated water causes groundwater contamination.
- Second, we will need to anticipate what proportion of those incidents could reasonably be expected to be reduced by implementation of this rule.
- Third, answers to the first two points can be used to estimate (a) the amount of needed surface storage that would not be needed with successful implementation of the rule, and (b) the proportion of surface streams fed by groundwater sources that would not become contaminated as a result of successful implementation of the rule. Monetizing the value of (a) is straightforward, and (b) is monetized as valuation of surface used water uses.

BENEFIT TITLE: **Manage potential sources of contamination to prevent microbial contamination.**

ORIGINATOR: Flanagan

Benefit description:

- Source water that does not require disinfection.
- Decrease in the monetary resources needed to disinfect groundwater and address any disinfection by-products.
- Reduction in health care costs and reduced exposure to disinfection by-products. This is a longer term benefit. (Minimum time frame for change - two years).
- Management activities will be more efficient because efforts are targeted in a defined area and focus on the sources of potential microbial contamination.
- Increase in public confidence in the quality of their drinking water supplies.
- Increased knowledge about the community water supply and a greater feeling of personal responsibility to protect it.

How to measure the effect(s) of the benefit:

- Decrease the need for disinfection of the source water.
- Increased public awareness and involvement in groundwater and drinking water issues.
- Decrease in sources that may contribute microbial contamination to source water.

How to value the benefit:

If the source water is contaminated, the change, assuming a decrease, in the cost to disinfect source water.

BENEFIT TITLE: **Reduction of or improvement of waste discharges to the subsurface.**

ORIGINATOR: Gerba

Benefit description:

- Reduction in groundwater contamination.
- Better regulations or control of contaminate sources.

How to measure the effect(s) of the benefit:

Less contamination of groundwater by pathogenic microorganisms.

How to value the benefit:

Less treatment (i.e., disinfection) of groundwater required before USO.

BENEFIT TITLE: **Develop groundwater monitoring systems to target small communities.**

ORIGINATOR: Highsmith

Benefit description:

Benefits primarily small communities of less than 25 persons - such as trailer park septic systems to reduce health effects.

How to measure the effect(s) of the benefit:

Place routine monitoring service in these communities and impose fines for real estate owners failing to meet standards.

How to value the benefit:

- Improved public health.
- Reduced short-/long-term health effects.
- Reduced days absent from normal activities (school, work, etc.).

BENEFIT TITLE: **Limit industrial and agricultural contamination of surface and groundwater.**

ORIGINATOR: Highsmith

Benefit description:

Reduces unknown and undue microbial burden to groundwater caused by industrial and agricultural spillage into surface waters, i.e., animal parts deposit, pesticide/herbicide runoff, etc.

How to measure the effect(s) of the benefit:

- Reduces cost and cleanup effort of treatment system.
- Reduces potential health effects.

How to value the benefit:

- Long-term water protection of surface/groundwater.
- Benefit to property values.

BENEFIT TITLE: **Benefits from wellhead protection affecting co-occurring contaminants.**

ORIGINATOR: Job

Benefit description:

Elimination or improved management of microbial sources of contamination may reduce other co-occurring contaminants, thereby reducing or eliminating the need for their treatment and response to their health effects. This places more control in the community for safe water. Benefits in implementing Best Management Practices will help small unregulated communities to protect drinking water.

How to measure the effect(s) of the benefit:

- Identify contaminants that may co-occur at microbial sources and quantity.
- Identify health effects associated with contaminants co-occurring at microbial sources (e.g., NO3)
- Identify co-occurring contaminants in zones of groundwater discharge to streams and quantify public water systems and recreational uses affected.

How to value the benefit:

- Evaluate cost of treating for co-occurring contaminants, if not already by microbial treatment techniques.
- Evaluate health effects costs associated with contaminants co-occurring with microbes.
- Evaluate downstream treatment costs and recreation-related health effects costs for wellhead protection areas in zones of groundwater discharge to streams.

BENEFIT TITLE: **Improved coordination between waste (water) disposal activities (regulations) and drinking water activities (regulations).**

ORIGINATOR: Yates

Benefit description:

Waste disposal practices are regulated many times without consideration of the potential for microbial contamination of underlying groundwater (e.g., septic tanks are sited based on percolation rates).

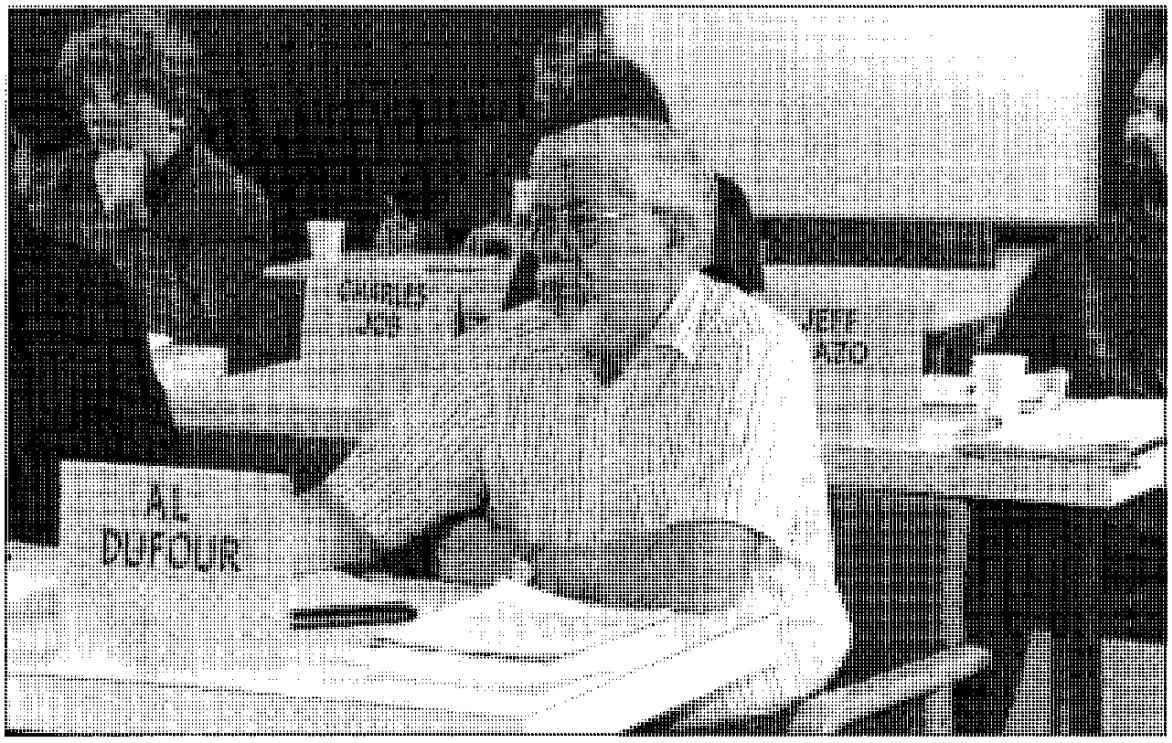
Coordination of wastewater and drinking water activities should result in decreased costs for both activities as a result of preventing contamination of drinking water (and thus lowering cost of treatment), optimized utilization of water and land resources, etc.

How to measure the effect(s) of the benefit:

- The effects can be measured by:
- Fewer contamination events and decreased illness.
- Lower treatment costs because fewer wells would be deemed vulnerable to fecal contamination.
- Decreased exposure to disinfectants and disinfection by-products.

How to value the benefit:

No recommendation proposed.



PRIORITY RANK 4

Comprehensive Quality Assurance Plan for Assessing the Quality of Drinking Water

ORIGINATORS:

Dufour on behalf of himself, Bennett, Highsmith, and Stewart

Benefit description:

Quality assurance for drinking water systems can include monitoring water to ensure the quality of the product or monitoring the treatment process to ensure that it is operating properly. The benefits of quality assurance should apply to all systems. A quality assurance plan includes methods to specifically detect and quantify indicators and pathogens that would present clear evidence of a waterborne hazard. This may require the development of new methods, especially for emerging pathogens.

How to measure the effect(s) of the benefit:

The benefit would result in:

- Increased public confidence in the quality of drinking water.
- Selection or implementation of appropriate treatment regimes to control specific pathogen(s) unique to the system.
- Cost of unnecessary treatment would be avoided.
- False alarms due to non-specific methods would be minimized.

How to value the benefit:

- Cost savings due to more effective monitoring tools.
- Increased lead time in public notification.
- Increased public confidence.

The following benefits were subsumed under the above title:

BENEFIT TITLE: **Development of appropriate indicators of water which does or is likely to contain pathogens.**

ORIGINATOR: Bennett

Benefit description:

Provide accurate measurable indicators of risk in lieu of measuring exposure and/or disease.

How to measure the effect(s) of the benefit:

Drinking water indicator monitoring more closely tracks disease or exposure surveillance.

How to value the benefit:

Cost difference between on-site indicator monitoring compared to total costs of exposure or disease surveillance.

BENEFIT TITLE: **A rational quality assurance system for maintaining the quality of drinking water delivered to the consumer.**

ORIGINATOR: Dufour

Benefit description:

The benefit of a clear, reliable, scientifically-defendable means of measuring the efficiency of the drinking water treatment process or the quality of the product would be an increase in public confidence, greater use by regulatory authorities, and minimal false alarms with respect to the degradation of drinking water quality. Consideration should be given to Hazard Analysis Critical Control Point-type approaches.

How to measure the effect(s) of the benefit:

This benefit would be difficult to measure because it deals with public confidence and regulatory authority acceptance. In theory, the number of false alarms would be minimized.

How to value the benefit:

No recommendation proposed.

BENEFIT TITLE: **Develop groundwater monitoring systems to target small communities.**

ORIGINATOR: Highsmith

Benefit description:

Benefits primarily small communities of less than 25 persons - such as trailer park septic systems to reduce health effects.

How to measure the effect(s) of the benefit:

Place routine monitoring service in these communities and impose fines for real estate owners failing to meet standards.

How to value the benefit:

- Improved public health.
- Reduced short-/long-term health effects.
- Reduced days absent from normal activities (school, work, etc.).

BENEFIT TITLE: **Identification of emerging pathogens in surface and groundwater.**

ORIGINATOR: Highsmith

Benefit description:

Benefits utilities and health officials by recognizing that current indicator(s) systems may not identify emerging pathogens shown to be associated with waterborne disease.

How to measure the effect(s) of the benefit:

- Develop methods to isolate and identify emerging pathogens.
- Develop surrogate methods to identify groups of organisms.
- Develop rapid methods for emerging pathogens that may cause waterborne illness.

How to value the benefit:

Serves to improve public health.

BENEFIT TITLE: **Comprehensive methods to assess groundwater contamination.**

ORIGINATOR: Stewart

Benefit description:

Most regulations establish maximum contaminant levels-exceedance results in public notification and immediate corrective actions. Microbial contaminants, especially pathogens, are often evaluated using indicator organisms (e.g., coliforms). However, these indicators have been periodically shown to be inadequate in predicting the presence (or absence) of pathogens. It would be beneficial to develop a comprehensive plan to assess whether or not groundwater is contaminated with pathogens. This assessment could include: use of indicators (e.g., coliforms), viral surrogates (e.g., coliphage), plus actual pathogen monitoring (e.g., virus), and examination of other factors (e.g., loss of system integrity, proximity to waste discharges, etc.).

Benefit: public notification would not be required unless there was clear evidence of pathogen contamination.

How to measure the effect(s) of the benefit:

- Public confidence would not be eroded by unnecessary public notification - measurement by survey instruments.
- Cost of unnecessary treatment could be avoided.

How to value the benefit:

- Increased public confidence.
- More comprehensive knowledge of groundwater quality to implement cost-effective solutions.

PRIORITY RANK 5

Close the Information Gap on the Microbial Quality of Drinking Water to Enhance State, Local and Utility Surveillance and Regulatory Programs and to Identify the Impact and Extent of Contamination

ORIGINATORS:

Barcelona on behalf of himself, Bulkley, Hansler, and Herndon

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BENEFIT TITLE: **Closing the information gap on the microbial quality of drinking water will enhance state, local and utility surveillance and regulatory programs and identify the impact and extent of contamination.**

Benefit description:

Enhanced surveillance and monitoring programs will provide an improved basis for decision-making on (among other things) where to place available public resources and which remedial options will provide the most benefit to the public. The benefit will accrue particularly for small non-community systems which may have little technical basis for decision-making at the current time. Collateral benefits of more comprehensive information resulting from the rule include: benchmarks for protection against further degradation due to microbial or other constituents, water quantity difficulties, and the generally more efficient use of the resource.

How to measure the effect(s) of the benefit:

- Cost savings in applying disinfection where needed versus treating across the board.
- Determining the increase in valid sanitary surveys.
- Increase in groundwater drinking water systems meeting national standards over time.
- Reduction in contamination occurrences in groundwater systems of varying sizes.

How to value the benefit:

- Avoided costs of providing disinfection systems where they are not needed.
- Avoidance of illness (lost school/work days, health/hospital costs, lost leisure days) due to provision of disinfection where they are needed.

The following benefits were subsumed under the above title:

BENEFIT TITLE: **Closing the information loop on drinking water quality.**

ORIGINATOR: Barcelona

Benefit description:

An overall drinking water quality profile from source to consumer has been lacking due to the welter of regulations which have been applied from the aquifer/resource to the tap. Microbial indicators of water quality can tell us more about the health of the total system than inorganic, organic, or corrosivity indicators utilized previously. More efficient water production and treatment strategies will result.

How to measure the effect(s) of the benefit:

We need to integrate the chemical, physical, and biological indicators of water resource quality and better communicate to the public that their tap is directly subject to limitations in the quality and quantity of the water resource.

How to value the benefit:

We may recognize that our efforts to monitor groundwater microbiology quality indicators can add significant value to the information we already collect.

BENEFIT TITLE: **Upgrading of state, local, and utility surveillance and regulatory programs; obtaining critical microbial information, costing out of remedial measures.**

ORIGINATOR: Hansler

Benefit description:

Services provided:

- Obtaining necessary microbial information upon which to consider alternative remedial actions.
- Costing out alternative remedial measures so best decision can be made.
- Utilizing the above two services to influence owners and the public on the necessity of adjusting water prices.
- Causing the improvement of state, local, utility owner water system protection programs.

How to measure the effect(s) of the benefit:

Effects of the benefits can be measured by:

- Determining the increase in valid sanitary surveys to determine if problems exist.
- The number of groundwater drinking water systems improved to meet national standards over time.
- The percent of reduction in microbial contamination in groundwater/drinking water systems.
- The reduction in waterborne disease incidence by state and county considering the various types of groundwater systems: community, factory, transient, individual.

How to value the benefit:

Estimating reduction in:

- Lost work days
- Lost school days
- Health and hospital costs
- Lost leisure days

BENEFIT TITLE: **Increasing the efficient use of groundwater resources.**

ORIGINATOR: Herndon

Benefit description:

Groundwater disinfection regulations can provide a vehicle to more efficiently utilize groundwater supplies, presuming that they would entail developing a better understanding of the hydrology, quality, and value of the resource. This would be particularly pertinent to the reported 170,000 "non-community" water systems in the nation. Other long-term benefits: protection against water quality degradation due to non-microbial constituents; water shortage protection; and, cost savings from more efficient use of resource.

How to measure the effect(s) of the benefit:

Compare "no-action" alternative or implementation of existing policies to new alternatives and policies developed to evaluate changes in water supply and quality.

How to value the benefit:

Cost savings can be measured through avoided future costs for treatment or developing alternate supplies.

BENEFIT TITLE: **Information on the extent and impact of microbial contamination of groundwater.**

ORIGINATOR: Bulkley

Benefit description:

At present, accurate information on the extent and impact of microbial contamination of groundwater is very limited, especially with the large number of small water supply systems. Solid information obtained through sanitary surveys and coordinated health information will mitigate this present condition.

How to measure the effect(s) of the benefit:

The major measure of the effect of the benefit is that rather than require a uniform provision of disinfection to all systems, it provides the opportunity to target disinfection where problems exist.

How to value the benefit:

The major value of the benefit is in terms of the avoided cost of provision of disinfection systems where they are not needed. Another value is the provision of the disinfection systems where they are needed and the concurrent avoidance of illness among the customers served.

PRIORITY RANK 6

Reduce Uncertainty About Health-Effects Incidence and Severity through Better Integration of Public Health Disease Surveillance and Regulatory Monitoring

ORIGINATORS:

Archibald on behalf of herself, Anderson, and Dufour

Benefit description:

There are costs associated with under (over) estimation of health risks. If health effects are underestimated, there are lost benefits from foregone protection; if risks are overestimated, there are opportunity costs of these regulatory resources in other uses. Currently, the public health disease surveillance and regulatory mechanisms are not linked. These systems can reduce uncertainty if they were responsive to each other. This would help determine the level of disease or illness due to consumption of drinking groundwater. Also, this health information should help with relative risk (e.g., food).

How to measure the effect(s) of the benefit:

- Compare the estimate costs (benefits) of regulation with an assumed or theoretical risk to health versus the costs of regulation to actual or probable health risks.
- Use surveys and epidemiological studies and perhaps restructure sampling techniques.

How to value the benefit:

- How much would be saved (regulatory costs avoided) with better epidemiological studies and/or monitoring to provide information to benefits assessment?
- Avoided costs of unnecessary treatment costs.
- Reduced morbidity and mortality.

The following benefits were subsumed under the above title:

BENEFIT TITLE: **Integration of public health disease surveillance and regulatory monitoring.**

ORIGINATOR: Anderson

Benefit description:

Current systems independent. Need mechanisms for linkage. Systems need to be responsive to each other. Improved laboratory methods; risk model validation; decrease need for special studies/investigation.

How to measure the effect(s) of the benefit:

- Positive predictive value of monitoring results.
- Surveys and epidemiological studies. Results of prospective evaluation trends.
- Structured evaluation of surveillance programs.
- Early recognition of problems. Response plans for outbreaks by water utility.

How to value the benefit:

Better information, avoided costs; coordinated response; reduced severity of outbreaks; increased accountability.

BENEFIT TITLE: **Reduce uncertainty about health effects incidence and severity.**

ORIGINATOR: Archibald

Benefit description:

There are costs associated with under (over) estimation of health risks. If health effects are underestimated, there are lost benefits from foregone protection; if risks are overestimated, there are opportunity costs of these regulatory resources in other uses.

How to measure the effect(s) of the benefit:

Compare the estimate costs (benefits) of regulation with an assumed or theoretical risk to health versus the costs of regulation to actual or probable health risks.

How to value the benefit:

How much would be saved (regulatory costs avoided) with better epidemiological studies and/or monitoring to provide information to benefits assessment?

BENEFIT TITLE: **Attributable risk.**

ORIGINATOR: Dufour

Benefit description:

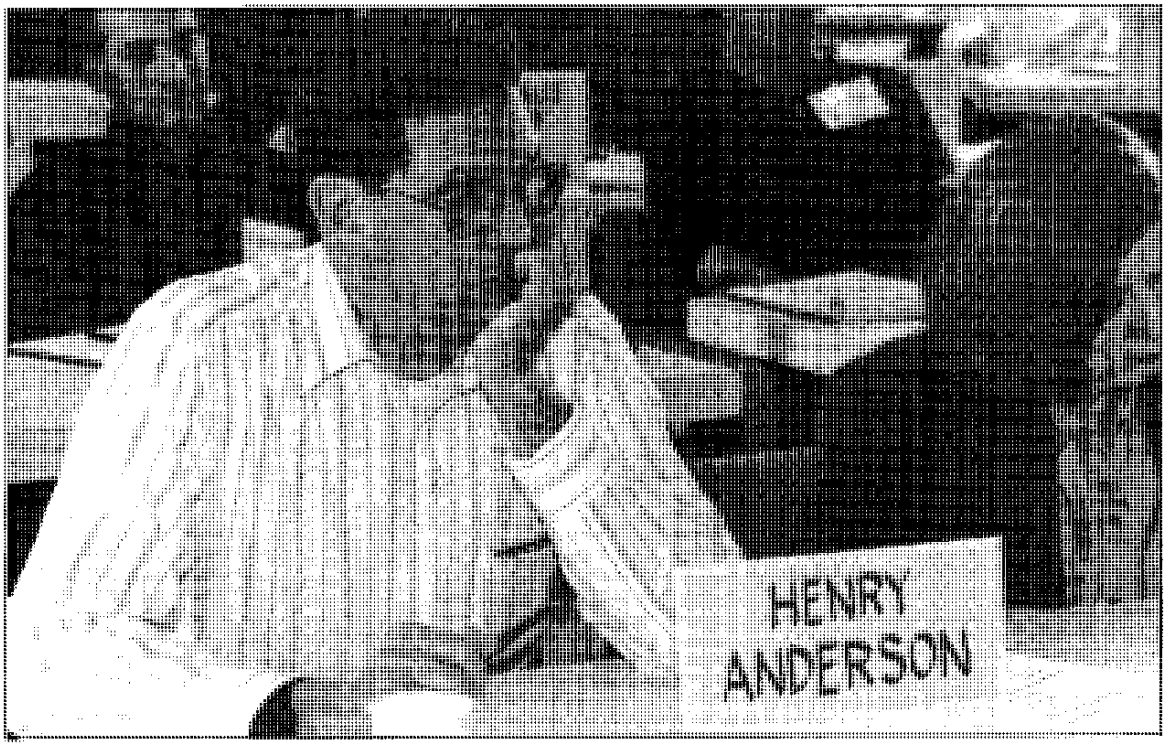
- Determine level of disease or illness due to consumption of drinking groundwater. Compare to risks of other exposures, e.g., food.
- Develop regulations based on contribution of groundwater to overall illness rate.

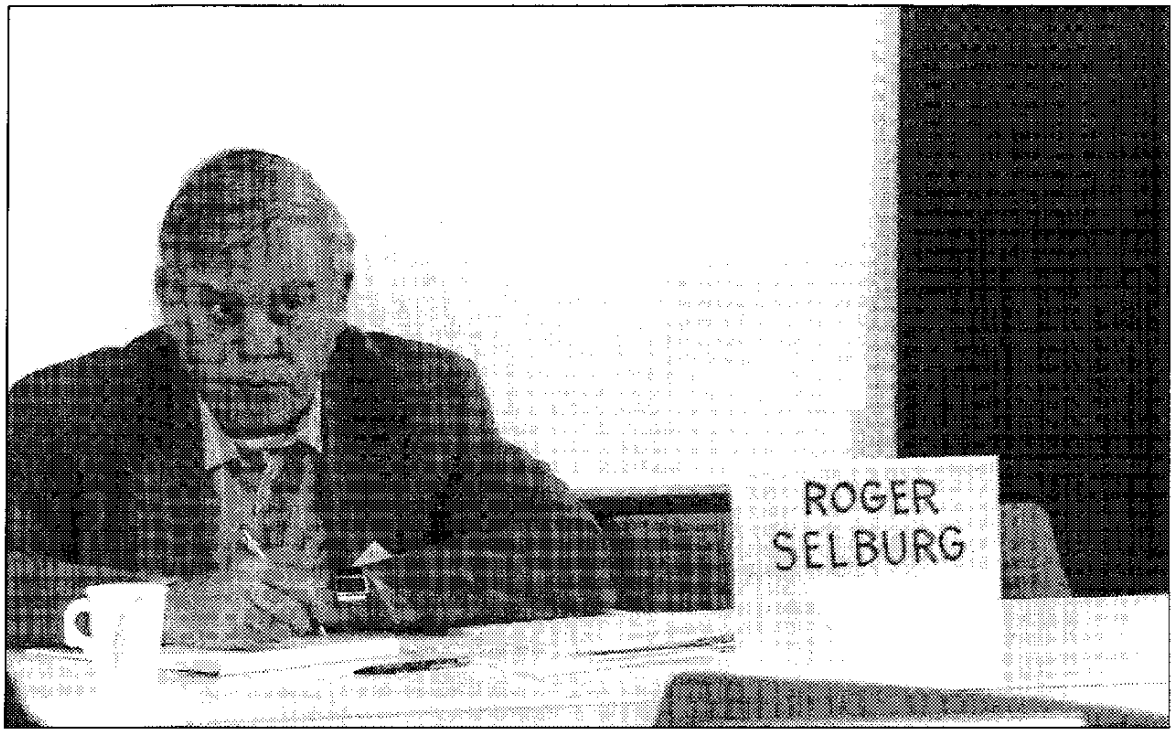
How to measure the effect(s) of the benefit:

This approach will lead to scientifically-defendable regulations and may lead to lower costs in implementing the regulation.

How to value the benefit:

No recommendation proposed.

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PRIORITY RANK 7

Identification of Wells that Pose the Maximum Threat to Public Health

ORIGINATORS:

Mills on behalf of himself and Selburg

The following benefits were subsumed under the above title:

BENEFIT TITLE: **Identification of wells that pose the maximum threat to public health.**

ORIGINATOR: Mills

Benefit description:

- Certain wells, because of hydrogeology, location, etc., are highly vulnerable to microbial contamination.
- Focus on wells with greatest risk of microbial contamination - immediate positive impact on public health.
- Allocate resources for the greatest health benefit.
- Limit disinfection by-products exposure and chlorine-handling hazards to selected few locations.

How to measure the effect(s) of the benefit:

Reduced waterborne disease outbreaks from groundwater sources that pose public health risk from microbial contamination.

How to value the benefit:

Estimation of direct and indirect costs associated with microbial illnesses.

BENEFIT TITLE: **Viral contamination identification and mitigation.**

ORIGINATOR: Selburg

Benefit description:

The most significant benefit of the Groundwater Disinfection Rule is the protection of human health. The 1996 Safe Drinking Water Act calls for the disinfection of groundwater systems, as necessary. The most significant benefit to consider is that the potential health risk due to viral contamination of groundwater systems be evaluated and systems disinfected, where necessary. Stated another way, systems which test positive for fecal contamination should be required to disinfect. This method directs resources toward systems where a significant threat to public health exists and will provide long-term benefits where necessary, as opposed to disinfecting all groundwater systems regardless of the existence of viral contamination.

How to measure the effect(s) of the benefit:

The effect of the benefit may be measured directly by determining the number of groundwater systems which test positive for fecal contamination and would consequently benefit from disinfection.

How to value the benefit:

The benefit of the public not drinking water contaminated with fecal contamination can be calculated using existing USEPA procedures.

PRIORITY RANK 8

Benefits to Future Generations

ORIGINATORS:

Archibald on behalf of herself and Cantwell

Benefit description:

Groundwater benefits extend over time. Regulators and water managers must contend with society's time preferences in regulatory design. Intertemporal benefits must be incorporated in benefit assessment. The services to future generations must be included. This is an issue of intergenerational equity.

How to measure the effect(s) of the benefit:

Traditional benefit-cost criteria address the problem of use rates over time by comparing net benefits received in one period with the net benefits received in another period, relying on present value analysis. The present value of a one-time benefit received a year from now is the estimated net benefit in that year divided by $(1 + r)$ where "r" is the discount rate. The higher the discount rate, the greater the amount of the resource that will be allocated to earlier time periods.

How to value the benefit:

Traditional approaches to valuing future services are being questioned. It may not be just a question of "choosing" the right discount rate. There are new approaches being considered to attaining intergenerational equity in access to non-renewal and renewable resources. One line of thinking is that the benefits should be preserved over time, that is, leave the resource in the same condition (e.g., level and quality) or be able to provide the same service from an alternative. Where populations increase, the problem of maintaining access is made more difficult. A minimal notion of social justice may be to preserve opportunities for future generations. Rule-making should be explicit about the discount rate employed and its impact on future benefits. Perhaps benefits under ranges of discount rates should be presented.

The following benefits were subsumed under the above title:

BENEFIT TITLE: **The benefits to future generations.**

ORIGINATOR: Archibald

Benefit description:

Groundwater benefits extend over time. Regulators and water managers must contend with society's time preferences in regulatory design. Intertemporal benefits must be incorporated in benefit assessment. The services to future generations must be included.

How to measure the effect(s) of the benefit:

Traditional benefit-cost criteria address the problem of use rates over time by comparing net benefits received in one period with the net benefits received in another period, relying on present value analysis. The present value of a one-time benefit received a year from now is the estimated net benefit in that year divided by $(1 + r)$ where "r" is the discount rate. The higher the discount rate, the greater the amount of the resource that will be allocated to earlier time periods.

How to value the benefit:

Traditional approaches to valuing future services are being questioned. It may not be just a question of "choosing" the right discount rate. There are new approaches being considered to attaining intergenerational equity in access to non-renewal and renewable resources. One line of thinking is that the benefits should be preserved over time, that is, leave the resource in the same condition (e.g., level and quality) or be able to provide the same service from an alternative. Where populations increase, the problem of maintaining access is made more difficult. A minimal notion of social justice may be to preserve opportunities for future generations. Rule-making should be explicit about the discount rate employed and its impact on future benefits. Perhaps benefits under ranges of discount rates should be presented.

BENEFIT TITLE: **Intergenerational equity with respect to service and system stewardship.**

ORIGINATOR: Cantwell

Benefit description:

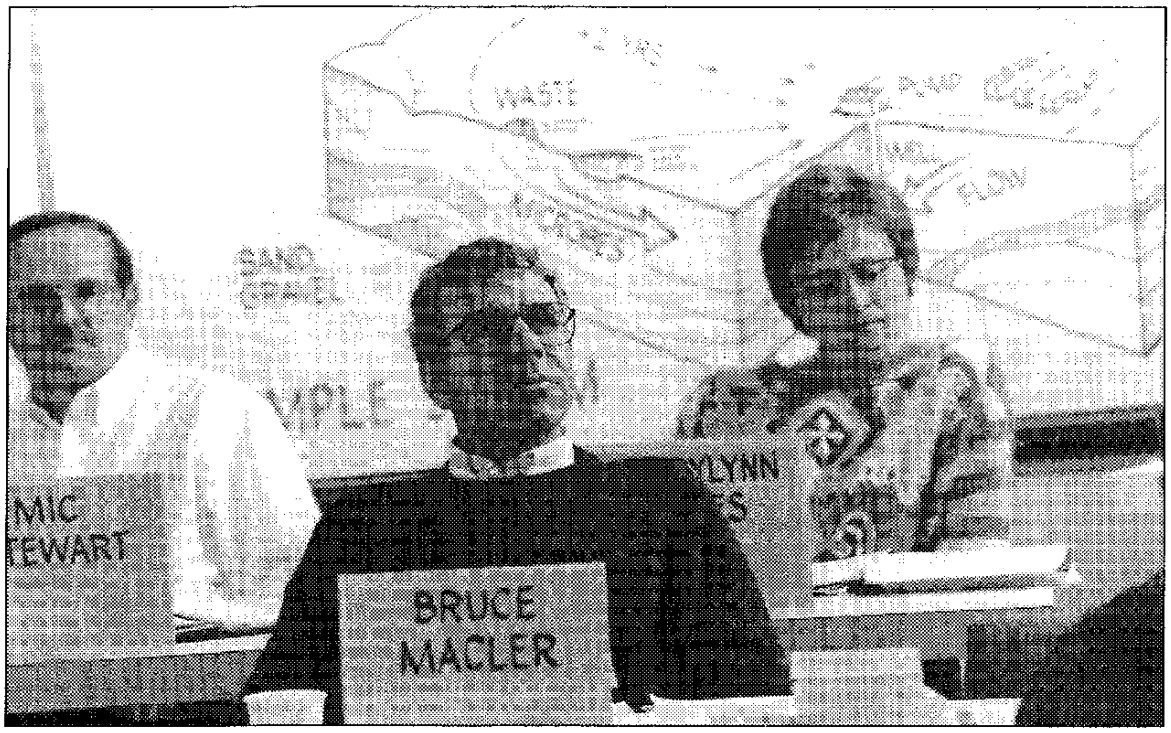
Current improvements to drinking water systems provide services that will cost future generations less (in infrastructure development) than if they had to undertake such developments themselves.

How to measure the effect(s) of the benefit:

Future (discounted) value of physical improvements that regulations might be require now (i.e., costs) versus current value.

How to value the benefit:

No recommendation proposed.


BRUCE
MACLER

PRIORITY RANK 9

Improved Approaches to Developing Drinking Water Regulations

ORIGINATORS:

Macler on behalf of himself, Archibald, Frederick, and Selberg

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Benefit description:

The approaches used to craft a groundwater disinfection regulation could be used to yield substantial improvements to all subsequent drinking water regulations. The ultimate benefits include enhanced public health protection, state and utility acceptance and implementation, and public perception of drinking water safety.

How to measure the effect(s) of the benefit:

Time costs or opportunity costs for regulators and utility managers for alternative regulatory schemes.

How to value the benefit:

- Reduced court cost estimates.
- Transactional cost estimates based on surveys or case studies.

The following benefits were subsumed under the above title:

BENEFIT TITLE: **Minimizing transaction costs in rule making.**

ORIGINATOR: Archibald

Benefit description:

Transactions costs reduce net benefits. They include such costs as reporting costs, negotiating with EPA, legal costs, and testing. These costs can be high, reducing benefits of regulations and providing incentives for non-compliance.

How to measure the effect(s) of the benefit:

Time costs or opportunity costs for regulators, water managers and citizens or advocates can be used to measure the benefit in terms of avoided costs, as can legal costs. These costs can be compared to alternative regulatory schemes (e.g., decentralized options may not always be most efficient if coordination costs are high).

How to value the benefit:

Surveys or case studies could be used to estimate transactions costs. The monetary costs are easy to capture but have not generally been considered in rule making.

BENEFIT TITLE: **The net benefit from different microbial risk goals or levels of protection should be explicitly considered in rule making.**

ORIGINATOR: Archibald

Benefit description:

The marginal cost of reducing risk increases as risks are reduced. Efficiency requires that marginal benefit equals marginal cost. However, we are not making rules under a benefit-cost framework. Benefits will be considered, but we will choose a risk goal (e.g., 1 in 100,000 or 1 in a million) that will have a given level of benefit. Knowledge of net benefits for alternative risk levels would provide information to the policy process on the incremental costs of achieving different risk goals.

How to measure the effect(s) of the benefit:

Regulators and the public would see the tradeoffs explicitly between benefits and costs.

How to value the benefit:

The value to the public of reducing risks could emerge. The regulatory process itself could become more efficient in terms of reducing litigation over a pre-determined risk goal and use of regulatory dollars.

BENEFIT TITLE: **Cost-effectiveness in the use of public and private funds directed to protecting water quality.**

ORIGINATOR: Frederick

Benefit description:

The greatest public health benefits from a given investment of public and private funds would be achieved by equalizing the marginal benefits received per dollar spent in response to regulations. Improved cost-effectiveness is critical for securing public and congressional support of regulations.

How to measure the effect(s) of the benefit:

Cost effectiveness is measured by comparing illnesses and deaths prevented per dollar spent in response to regulations among all groundwater supply systems. The benefits of a cost-effective strategy could be measured by comparing the change in health benefits achieved from a given expenditure with and without an efficient allocation of resources. Alternatively, the benefits might be estimated by comparing the dollars saved for achieving a given level of public health through an efficient (as opposed to an alternative) allocation of resources.

How to value the benefit:

Contingent evaluation might be used to estimate the willingness to pay for the public health improvements associated with an efficient allocation of a given amount of public and private resources. Alternatively, the value of the benefits might be estimated by comparing the dollars saved by achieving a given level of public health through an efficient (as opposed to a more expensive, inefficient) allocation of resources.

BENEFIT TITLE: **Improved approaches to developing drinking water regulations.**

ORIGINATORS: Macler

Benefit description:

The approaches used to craft the Groundwater Disinfection Rule could yield substantial improvements to all drinking water regulations: enhanced public health protection, state and utility acceptance and implementation, public perception of drinking water safety.

How to measure the effect(s) of the benefit:

Survey states and utilities on their experiences with rules developed using these approaches versus other approaches.

How to value the benefit:

- Comparison of estimated costs of different regulatory structures for utilities and states.
- Reduced court costs.

BENEFIT TITLE: **Supportable regulations.**

ORIGINATOR: Selburg

Benefit description:

Research, including field testing, is needed to justify any of the proposed rules. USEPA must be able to show how groundwater contamination will occur and demonstrate the consequences of not following the regulatory requirements. The benefit should be the general support of the regulation by the regulated community rather than the wide-spread resistance demonstrated when the previous groundwater disinfection rule was proposed.

How to measure the effect(s) of the benefit:

The benefit can be estimated by the speed with which the regulation is implemented following promulgation and estimate made as to the number of people protected by the regulation.

How to value the benefit:

The cost savings can be estimated from the cost of defending against a law suit filed to slow or halt the promulgation of the regulation.

PRIORITY RANK 10

Value of Avoiding Disinfection by Identification of Wells with Adequate Natural Protection

ORIGINATORS:

Mills on behalf of himself and Yates

Benefit description:

- Avoiding cancer cases due to unnecessary disinfection and disinfection by-product formation.
- Avoiding illness, injury, and death to disinfection handlers and surrounding public.
- Avoiding treatment costs.
- Avoiding consequences of individuals switching to bottled water as a result of objectionable tastes/odors from disinfection.

How to measure the effect(s) of the benefit:

- Reduced cancer incidence.
- Reduced illness, etc., related to disinfection facilities.
- Avoided disinfection treatment costs.
- Avoided illnesses from bottled water.
- Avoided increases in water costs as a result of switching to bottled water.
- Avoided decreases in water sales by public water utilities as a result of switching to bottled water.

How to value the benefit:

Cost avoidance; enhanced public health benefits, etc.

The following benefits were subsumed under the above title:

BENEFIT TITLE: **Identification of wells with adequate natural protection.**

ORIGINATOR: Mills

Benefit description:

- Many wells constructed in non-vulnerable hydrogeologic settings, distance to sanitary sewers, and have good water quality history are wells that demonstrate adequate natural protection.
- Avoid expenditures where no health benefits are realized.
- Minimize unnecessary exposure from disinfection by-products and chlorine-handling hazards.
- Reserve scarce public resources for wells where impacts on health are identified.

How to measure the effect(s) of the benefit:

- Measure by calculating the treatment cost savings.
- Estimate costs of disinfection by-products exposure, health effects avoidance.
- Estimate costs associated with providing chlorine-hazard prevention.

How to value the benefit:

- Cost avoidance methodology:
- Treatment.
- Cancer occurrence avoidance

BENEFIT TITLE: **Avoiding unnecessary cancer cases.**

ORIGINATOR: Yates

Benefit description:

The purpose of the Groundwater Disinfection Rule is to reduce the level of endemic and epidemic microbial disease without exposing the public to an unnecessary risk from exposure to potential carcinogenic disinfection by-products. In order to calculate the cost that will be incurred to protect the public health, one must determine the value of the cancer cases that will be avoided by the implementation of the Groundwater Disinfection Rule.

How to measure the effect(s) of the benefit:

Calculate the value of the cancer cases that will be avoided by implementation of appropriate "avoidance criteria" in the Groundwater Disinfection Rule.

How to value the benefit:

Calculate the number of cancer cases that would result if all groundwater were required to be disinfected. Calculate the number of cancer cases that will result from the development and implementation of appropriate "avoidance criteria." Determine the difference between those numbers, and determine the value of those cancer cases avoided.

BENEFIT TITLE: **Avoiding switching to bottled water**

ORIGINATOR: Yates

Benefit description:

Implementation of the Groundwater Disinfection Rule will likely result in the disinfection of some groundwater sources that are not currently disinfected. Disinfection can produce tastes and odors that are objectionable to some individuals. These individuals may switch to bottled water, which does not have to meet the same standards as public drinking water. This may result in an increase in microbial illness. It will also result in an increased cost to the consumer. It will also have an impact on public water utilities in the form of decreased water sales.

How to measure the effect(s) of the benefit:

Calculate the value of increased illnesses incurred by individuals who switch to bottled water to avoid objectionable tastes and odors in their water resulting from disinfection. Calculate the impact of the resulting decreased water sales on public water utilities. Calculate the increased cost of bottled water for the consumer relative to tap water.

How to value the benefit:

Calculate the number of individuals who would switch to bottled water as a result of implementation of the Groundwater Disinfection Rule. Calculate the increased number of illnesses that would occur in those individuals. Calculate the value of avoiding that number of illnesses. Calculate the cost to public utilities of decreased water use. Calculate the increased cost of bottled water to the consumer (relative to tap water costs).

BENEFIT TITLE: **Avoiding illness, injury, and death to disinfectant handlers and surrounding public.**

ORIGINATOR: Yates

Benefit description:

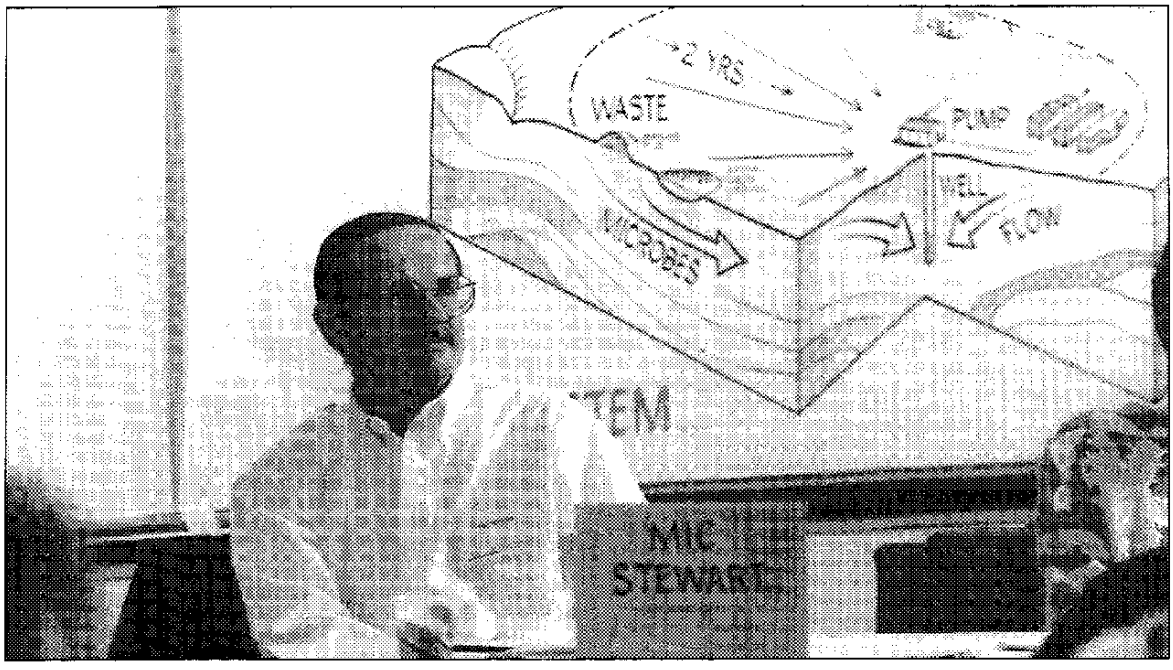
The purpose of the Groundwater Disinfection Rule is to reduce the level of endemic and epidemic microbial disease without exposing the public to an unnecessary risk from exposure to potential carcinogenic byproducts. In order to calculate the cost that will be incurred to protect the public health, one must determine the value of the illnesses, injuries, and deaths to disinfectant handlers and the surrounding public.

How to measure the effect(s) of the benefit:

Calculate the value of the illnesses, injuries, and deaths to disinfectant handlers and the surrounding public that are avoided by requiring only wells vulnerable to fecal contamination to be disinfected.

How to value the benefit:

Calculate the number of illnesses, injuries, and deaths to disinfectant handlers and the surrounding public that would result if all groundwater were required to be disinfected. Calculate the number of illnesses, injuries, and deaths to disinfectant handlers and the surrounding public that will result from the development and implementation of appropriate "avoidance criteria." Determine the difference between those numbers, and determine the value of those illnesses, injuries, and deaths to disinfectant handlers and the surrounding public that are avoided.



PRIORITY RANK 11

Improved Implementation of State Programs that Provide Flexible Approaches to Protect Groundwater from Microbial Contamination

ORIGINATORS:

Flanagan on behalf of herself, Job, Selburg, and Stewart

Benefit description:

Implementation of state programs that allow for greater flexibility in determining if disinfection and/or other technical approaches are required based on local conditions and, if so, which techniques will work and provide incentives to develop innovative approaches to achieving the goals of the state program at the local level.

How to measure the effect(s) of the benefit:

- Action plans are being developed by the water utilities and the state health departments. These action plans will outline appropriate measures based on identified microbial contaminant sources and local conditions. These action plans may benefit from leveraging the information and/or resources of other programs to accomplish mutually-compatible goals (e.g., the Wellhead Protection Program and Drinking Water Program).
- Increase in location-specific approaches to protecting groundwater supplies from microbial contamination.
- Measure changes in water quality.

How to value the benefit:

- The change in costs of microbial contamination/disinfection as compared to a uniform approach.
- Savings to the state and communities based on the ability to design location-specific approaches to groundwater protection as compared to a uniform approach.

The following benefits were subsumed under the above title:

BENEFIT TITLE: **Improved implementation of state regulations to protect groundwater used for drinking water from microbial contamination- particularly in small systems.**

ORIGINATOR: Flanagan

Benefit description:

If implementation of state regulations is improved, there are benefits that can be derived both from preventing microbial contamination in the source water and improved practices in the operation and maintenance of the distribution system. The health benefits include a decrease in microbial illnesses and, assuming a decrease in disinfection is required, a decrease in exposure to disinfection by-products. There is also the increased possibility of system compliance with program requirements thereby increasing the number of systems providing drinking water free of microbial contamination and increased public confidence.

How to measure the effect(s) of the benefit:

- Decrease in microbial waterborne illness in small communities.
- Increased public involvement in issues and activities related to their drinking water and drinking water protection.

How to value the benefit:

- What is the current cost to small communities from microbial illness?
- What is the change in the cost after the improvements to the system?
- Assumption: rules are implementable for small systems.

BENEFIT TITLE: **Value of flexible, targeted disinfection for small, medium and large systems.**

ORIGINATOR: Job

Benefit description:

The range of options for disinfection (including source water protection, monitoring, sanitary survey, distribution system maintenance, and treatment) offers possibilities for the best, most cost-effective approaches to be applied to the specific microbial problems of communities.

How to measure the effect(s) of the benefit:

Evaluate costs for all major options. Compare targeted approaches based on microbial problems and system size to uniform approaches for all systems.

How to value the benefit:

Poll water suppliers on value of flexible, targeted approaches to microbial problems.

BENEFIT TITLE: **Flexible criteria for determining if disinfection is required.**

ORIGINATOR: Selburg

Benefit description:

One of the most significant benefits of the Groundwater Disinfection Rule should be the flexibility in the criteria provided to the states to determine which groundwater systems will be required to disinfect. Hydrogeologic settings which provide natural protection from viral contamination vary greatly throughout the country. There would be great benefit from a Groundwater Disinfection Rule allowing each state flexibility in determining which groundwater systems require disinfection, provided there is adherence to the goals of the Groundwater Disinfection Rule.

How to measure the effect(s) of the benefit:

The effect of the benefit may be measured directly by determining the number of groundwater systems which would not be required to disinfect.

How to value the benefit:

Value could be determined by summing the cost savings to each groundwater system which was not required to install disinfection equipment.

BENEFIT TITLE: **Development of Guidance Manual for innovative solutions to address groundwater contamination.**

ORIGINATOR: Stewart

Benefit description:

- Development of a Guidance Manual would:
- Provide a non-regulated approach for public water systems to implement operational changes to improve groundwater supplies/conveyance systems without penalties for non-compliance.
- Provide greater flexibility for innovative solutions including new technology.
- Provide technical options for addressing groundwater-related problems.
- Outline steps to create an action plan in conjunction with the State Health Department.
- This action plan could be used to identify potential contamination sources and to implement preventative measures using existing and/or innovative technology as appropriate.

How to measure the effect(s) of the benefit:

Improved water quality, decreased microbial contamination level violations.

How to value the benefit:

Value would be a function of increased flexibility (more innovative approaches) to resolve groundwater-related water quality issues. Potentially, these solutions could be used on a national basis by the water industry.

PRIORITY RANK 12

Changes in Risk Premia

ORIGINATORS:

Lazo on behalf of himself and Job

Benefit description:

Individuals experience real welfare costs due to the presence of risk or uncertainty. This cost is measured by the risk premium which is a function of the individual's risk aversion and the individual's perception of risk characteristics, including the probability and severity of adverse events. Groundwater disinfection regulations will affect perceived risk characteristics inducing welfare impacts including changes in the risk premium.

How to measure the effect(s) of the benefit:

Measurement requires identifying changes that the regulation will require or induce. Next, these changes must be related to the effect on individual's perception of risk characteristics. These must then be related to individual's welfare which is a function of these perceptions and the individual's aversion to risk.

How to value the benefit:

- Contingent valuation to elicit values (willingness to pay) to reduce risk combined with methods from cognitive psychology to quantify and characterize perceived risk. Scenarios must be designed to identify risk aversion and risk premium.
- A comprehensive valuation exercise will also address issues of:
- Component values (e.g., health, environmental, aesthetic, economic).
- Market size (aggregation issues).
- Commodity timing (discounting).
- Value decomposition (use value, paternalistic altruism, bequest, existence).

The following benefits were subsumed under the above title:

BENEFIT TITLE: **Changes in perceptions of safety in drinking water from groundwater.**

ORIGINATOR: Lazo

Benefit description:

Individuals experience real changes in welfare based on their perceptions of the safety of drinking water, including the probability and severity of contamination. Implementation of a Groundwater Disinfection Rule may affect perceived risk attributes inducing positive or negative welfare impacts.

How to measure the effect(s) of the benefit:

The factors inducing such welfare changes depend on the nature of the rule, information provided to individuals, risk communication, and how individuals incorporate this into their perceptions. These may be measured using methods to evaluate the effectiveness of risk communication.

How to value the benefit:

Contingent valuation to elicit option prices for changes in risk and uncertainty of drinking water safety.

Develop this using mental models to understand individuals' perceptions and psychometric scales to quantify and characterize risk attributes. A comprehensive valuation exercise will also address issues of:

- Component values (e.g., health, environmental, aesthetic, economic).
- Market size (aggregation issues).
- Commodity timing (discounting).
- Value decomposition (use value, paternalistic altruism, bequest, existence).

BENEFIT TITLE: **Value of risk aversion premium for health-effects avoidance.**

ORIGINATOR: Job

Benefit description:

The higher value associated with potential, recurring, involuntary risk of consuming microbially-contaminated water results in benefits being valued at levels greater than the observed cost of effects avoided. Individuals and elected leaders should define this premium.

How to measure the effect(s) of the benefit:

For each type of risk and by system size, conduct contingent valuation to determine the range of premiums.

How to value the benefit:

- Apply results of contingent valuation to national estimate of effects.
- Estimate ranges of risk premium from other studies and apply this to projection of effects.

PRIORITY RANK 13

Avoid Switching to Bottled or Other More Expensive Sources of Drinking Water

ORIGINATORS:

Archibald and Blomquist

Benefit description:

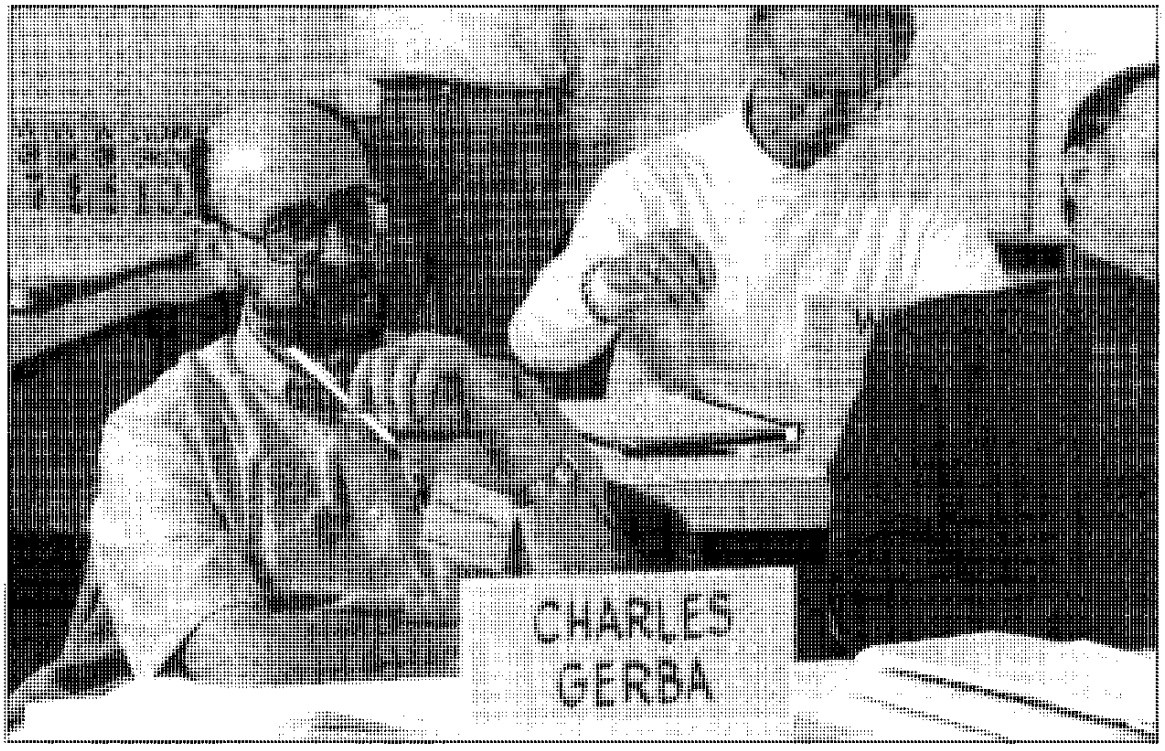
By enhancing or maintaining the quality of drinking water supplied from groundwater sources, the regulations should prevent inefficient switching by water suppliers or consumers to bottled water, point-of-use treatment, or other more expensive supplies.

How to measure the effect(s) of the benefit:

Effects are primarily (perhaps exclusively) financial - cost savings resulting from ability to avoid switching.

How to value the benefit:

- Estimates of anticipated switching frequency without the rule x price differential.
- Estimates of anticipated switching frequency with the rule x price differential.


CHARLES
GERBA

PRIORITY RANK 14

Increased Public Understanding of and Confidence in Drinking Water Safety

ORIGINATORS:

Cantwell on behalf of herself, Anderson, Gerba, and Macler

Benefit description:

Increased communication and public involvement will lead to improved public understanding of and confidence in drinking water safety. Increasing levels of community knowledge are likely to yield decreased incidents of negative publicity. This in turn leads to continued tourism levels in tourist areas.

How to measure the effect(s) of the benefit:

Survey public understanding of drinking water issues (i.e., association between exposure and disease) and correlate with communication of these issues. Public participation could be measured by meeting attendance or written inputs. Decrease in community-originated lawsuits and other "outrage" measures. Tourism dollars gained or lost.

How to value the benefit:

- Determine costs associated with community "outrage" events (like lawsuits).
- Correlate public confidence with reductions in stress.
- Assign qualitative value based on surveys of community satisfaction.

The following benefits were subsumed under the above title:

BENEFIT TITLE: **Increasing public confidence in the safety of groundwater**

ORIGINATOR: Anderson

Benefit description:

- Reduce uncertainty in estimating risk.
- Primary prevention - reduce rates of illness.
- Reduce impact of secondary prevention "boil water orders."
- Increase community knowledge and understanding.

How to measure the effect(s) of the benefit:

- Exposure and disease surveillance.
- Demonstrate association of exposure and disease.

How to value the benefit:

- Value of flexibility of water use.
- Cost of disease prevented.
- Cost of boil water orders.

BENEFIT TITLE: **Increased and improved public involvement.**

ORIGINATOR: Cantwell

Benefit description:

Public perception of the value (to their health) of the Groundwater Disinfection Rule and/or its requirements is more directly in line with the benefits rule developers expect. Costs related to public outrage, unwillingness to pay for changes, and lawsuits should go down.

How to measure the effect(s) of the benefit:

Participation can be measured by things like meeting attendance and written inputs. Measuring improvements in public involvement is more difficult - ties to participation in educational opportunities, maybe? Decreases in community-originated lawsuits and other measures of "outrage."

How to value the benefit:

Decreases in costs associated with community "outrage" events. Measure community evaluation of the process with and without increased involvement.

BENEFIT TITLE: **Avoidance of negative publicity.**

ORIGINATOR: Gerba

Benefit description:

No decrease in tourism. Avoidance of products manufactured or grown in an area of known contamination.

How to measure the effect(s) of the benefit:

Tourism dollars lost. Decrease in product sales.

How to value the benefit:

Economic loss to a community or recreational area.

BENEFIT TITLE: **Increased communications and public understanding of drinking water safety.**

ORIGINATOR: Macler

Benefit description:

Increased communication of drinking water issues can yield reduced stress and improve quality of life.

How to measure the effect(s) of the benefit:

- Surveys of public understanding of drinking water issues.
- Surveys of public concern for drinking water hazards versus other public health issues.

How to value the benefit:

No recommendation proposed.


ANITA
HIGHSMITH

PRIORITY RANK 15

Provide Incentives to Develop and Adopt New Technologies and Improved Management Practices Designed to Meet Regulations

ORIGINATORS:

Frederick on behalf of himself, Cantwell, and Highsmith

Benefit description:

Regulations have the potential to provide either effective incentives or at least no disincentives for researching and developing new technologies and management techniques that can lower the costs of complying with regulatory standards. The potential benefits of incentives for research and development include reduced long-term costs of meeting current standards and the prospect that technological advances might make it feasible to meet higher health standards in the future.

How to measure the effect(s) of the benefit:

Estimate the cost savings and health benefits likely to emerge as a result of new or improved technology and management practices.

How to value the benefit:

Estimate the present value of the anticipated cost savings of meeting the regulations in the future. Future improvements in public health attributed to improved technology and management could be valued as the willingness to pay for the health improvements. Contingent valuation could be used to measure the willingness to pay.

The following benefits were subsumed under the above title:

BENEFIT TITLE: **Stimulating novel technology development.**

ORIGINATOR: Cantwell

Benefit description:

Potential of the regulations to provide effective incentives or no disincentives leading to the research and development of totally new technologies that can lower the cost of control (i.e., real time, species specific, low cost, robust sensors, etc.) and improve the ability of even small systems to comply with regulations.

How to measure the effect(s) of the benefit:

- Time savings to be gained.
- Dollar invested by developers versus dollar potential in the market (What is the market? How stimulate?).
- Reductions in compliance costs.

How to value the benefit:

Develop a means to assign value per potential to significantly reduce operation costs, reductions of risk by virtue of better or more reliable monitoring.

BENEFIT TITLE: **Provide incentives to develop and adopt new technologies and improved management practices designed to meet regulations.**

ORIGINATOR: Frederick

Benefit description:

The benefits include reduced, long-term costs of meeting current standards through the development of new technologies and improved management practices and the prospect that technological advances might make it feasible to meet higher standards in the future.

How to measure the effect(s) of the benefit:

Estimate the cost and health improvements likely to emerge.

How to value the benefit:

Estimate the cost savings over time of meeting the regulations and the change in public health attributed to improved technology and management.

BENEFIT TITLE: **Improved microbiological methods for measuring groundwater quality.**

ORIGINATOR: Highsmith

Benefit description:

- Allow rapid identification of contamination levels and notifications to health officials.
- Understanding significance of particular contaminants.
- Establish databases to monitor endemic and epidemic illnesses.
- Reduced costs to communities.

How to measure the effect(s) of the benefit:

- Improve surveillance during endemic and epidemic studies.
- Evaluate outcome.
- Recognize that indicators vary system to system.
- Set costs for future water delivery.

How to value the benefit:

- Increased lead time in public notification.
- Reduced costs to individuals and community.
- Support for new technologies.


ANITA
HIGHSMITH
JOSEPH
DRAGO

PRIORITY RANK 16

Concomitant Water Quality Benefits

ORIGINATORS:

Drago on behalf of himself and Clark

Benefit description:

Residential, commercial, and industrial customers may benefit from improved disinfection by public water systems. These benefits would include disinfection avoidance or reduction by industries for process water, and by commercial food handlers and food processors. Benefits (good or bad) to residential users may occur due to reductions (or increases) in aesthetic value of water and plumbing maintenance and repairs.

How to measure the effect(s) of the benefit:

Measurement for industries and commercial establishments would be avoidance or reduction of capital and operations and maintenance (O&M) costs for disinfection, and possible avoidance of waterborne illness. Homeowner benefits could be measured by changes in maintenance of plumbing systems and reduction in water quality compliants.

How to value the benefit:

The measured effects of the benefit could be directly monetized.

The following benefits were subsumed under the above title:

BENEFIT TITLE: **Benefits of reduced food handling and processing costs and related disease.**

ORIGINATOR: Clark

Benefit description:

- Industrial (restaurants, food processing) benefits of avoided on-site treatment.
- Lower disease; and/or reduced O&M and capital costs for risk avoidance.

How to measure the effect(s) of the benefit:

Costs of treatment at plant; location decisions. Value of clean water to selecting sites for industry.

How to value the benefit:

- Costs of avoided aversion and remediation (O&M and capital costs) or disease costs (morbidity and mortality).
- Location - benefit to community.

BENEFIT TITLE: **Impacts of water quality changes in distribution systems due to disinfection (good and/or bad).**

ORIGINATOR: Drago

Benefit description:

Implementing disinfection, or modifying disinfection practices, may change or disturb biofilms or coatings on piping and plumbing and/or may oxidize (and precipitate) inorganics such as iron or manganese that may cause aesthetic problems. Problems may be short term, and then level out.

How to measure the effect(s) of the benefit:

Effects are physical, chemical, and/or biological. These could be measured by examining changes in frequency of water quality complaints, changes in bacterial (HPC) levels, and frequency of line flushing, or plumbing repairs.

How to value the benefit:

Value of benefit could be based on changes in costs to maintain distribution system (flush lines, etc.) and to repair or replace plumbing (homeowner cost).

BENEFIT TITLE: **Reduced microbial contamination of industrial process water.**

ORIGINATOR: Drago

Benefit description:

Reduced production costs of manufactured goods.

How to measure the effect(s) of the benefit:

Measure change in operational costs (capital and O&M) to produce industrial process water.

How to value the benefit:

Value same as measure of effect.

PRIORITY RANK 17

Nonuse Values

ORIGINATOR:

Lazo on behalf of himself

Benefit description:

Individuals may derive utility without the direct consumption of a commodity. These values are termed nonuse values. A groundwater disinfection regulation may induce benefit changes such as bequest values (intergenerational, interdependent utility), paternalistic altruism values (commodity specific interdependent utility), or existence values.

How to measure the effect(s) of the benefit:

These benefits do not necessarily generate behavioral changes on the part of individuals and may not be measurable by indirect methods.

How to value the benefit:

Due to the nature of nonuse values they can only be valued by contingent valuation. Identification or decomposition of nonuse values may not be psychologically or methodologically feasible. Nonuse values may be identified as a residual of total value minus use values.

The following benefits were subsumed under the above title:

BENEFIT TITLE: **Bequest values**

ORIGINATOR: Lazo

Benefit description:

Utility derived from intergenerational interdependent utility. Based on current generation's concern that future generations have clean and/or safe drinking water (this is a current period benefit).

How to measure the effect(s) of the benefit:

No recommendation proposed.

How to value the benefit:

Contingent valuation- may not be methodologically feasible to separate from other values. Implies that the only valid approach may be to value the total benefit with a single method. Otherwise, double counting of benefits is likely to occur.

BENEFIT TITLE: **Paternalistic altruism.**

ORIGINATOR: Lazo

Benefit description:

Utility derived from commodity specific interdependent utility. Theoretical derivation indicates non-paternalistic altruism should not be counted while paternalistic altruism should be counted in benefit cost analyses.

How to measure the effect(s) of the benefit:

No recommendation proposed.

How to value the benefit:

- Contingent valuation?
- Again, identification or decomposition may not be psychologically or methodologically feasible.

BENEFIT TITLE: **Existence values.**

ORIGINATOR: Lazo

Benefit description:

Utility derived from knowing groundwater is not contaminated even if no one will ever use it.

How to measure the effect(s) of the benefit:

May only occur with source protection that incidentally protects water which will not be used. If such values are significant, this may move rule making toward prevention rather than disinfection.

How to value the benefit:

Contingent valuation - may not be methodologically feasible to separate from other values.

PRIORITY RANK 18

Environmental Justice

ORIGINATORS:

Raucher on behalf of himself, Bennett, and Blomquist

Benefit description:

Providing a more uniform level of risk protection to groundwater users in small, rural communities relative to larger and/or surface water systems.

How to measure the effect(s) of the benefit:

Compare the distribution of anticipated risk reduction and other benefits and costs of the regulations across water users according to system size, water source, and community income measures.

How to value the benefit:

- Normative, qualitative discussion of how risks were distributed at baseline, and how (presumably) the risks are more equitably (evenly) distributed after the regulation.
- Indicate cost per unit of risk reduction for customers of systems of different size.

The following benefits were subsumed under the above title:

BENEFIT TITLE: **Consistent application of disinfection objectives regardless of drinking water sources.**

ORIGINATOR: Bennett

Benefit description:

Provide microbiologically-safe water at each entry point, then protect distribution systems equally.

How to measure the effect(s) of the benefit:

How do you measure equality? People using different source types are assured of equal health protection. Trust in the water is the same (i.e., no higher rate of use in bottled water or POE/POU devices among users of different sources).

How to value the benefit:

- Avoided costs of POE/POU devices.
- Avoided bottled water costs.

BENEFIT TITLE: **Placing groundwater and surface water supplies under similar regulatory regimes.**

ORIGINATOR: Blomquist

Benefit description:

Environmental equity - providing regulatory protection for those whose drinking water is supplied from groundwater sources that is similar to the protection for those served from surface sources.

Reduction in the temptation for water suppliers to switch from surface to groundwater in order to avoid compliance with the Surface Water Treatment Rule or the Enhanced Surface Water Treatment Rule.

How to measure the effect(s) of the benefit:

Sociological effects - reduced differential in the drinking water protection for residents and customers served from groundwater sources compared with those served from surface water sources.

Health effects - enhanced health from regulatory compliance, or reduced illness from regulatory avoidance.

How to value the benefit:

Health effects are monetizeable from a variety of methods. How to monetize fairness?

BENEFIT TITLE: **Environmental Justice.**

ORIGINATOR: Raucher

Benefit description:

Providing a more uniform level of risk protection to groundwater users in small, rural communities relative to larger and/or surface water systems.

How to measure the effect(s) of the benefit:

Compare the distribution of anticipated risk reduction and other benefits and costs of the regulations across water users according to system size and community income measures.

How to value the benefit:

- Normative, qualitative discussion of how risks were distributed at baseline, and how (presumably) the risks are more equitably (evenly) distributed after the regulation.
- Indicate cost per unit of risk reduction for customers of systems of different size.

PRIORITY RANK 19

Lower Cost of Disease Prevention Strategies

ORIGINATOR:

Gerba on behalf of himself

Benefit description:

Do not need to develop a vaccine for every potential agent transmitted by water. Do not have to develop new antibodies. Prevention of the emergence of waterborne pathogens from developing countries. For example, *hepatitis E* virus is rare in the United States but common in developing countries.

How to measure the effect(s) of the benefit:

- Lower health care and mortality costs.
- Absence of outbreaks from emerging waterborne pathogens.

How to value the benefit:

Avoided deaths from vaccine failure. Cost of medical research to develop new vaccines. Reduced disease surveillance costs.

BENEFIT TITLE: **Lower cost disease prevention strategies.**

ORIGINATOR: Gerba

Benefit description:

Do not need to develop a vaccine for every potential agent transmitted by water. Do not have to develop new antibodies.

How to measure the effect(s) of the benefit:

No recommendation proposed.

How to value the benefit:

Deaths avoided from vaccine failure. Cost of medical research to develop new vaccines.

BENEFIT TITLE: **Prevention of the emergence of new pathogens.**

ORIGINATOR: Gerba

Benefit description:

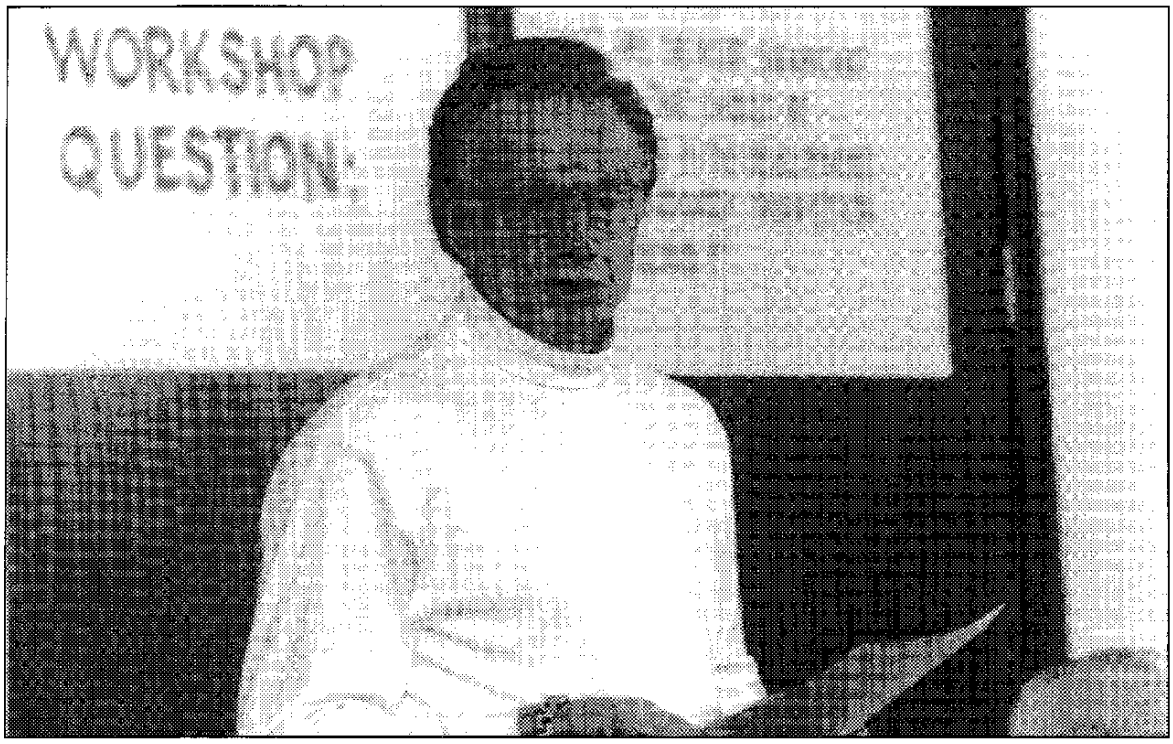
Many waterborne pathogens are rare in the United States (i.e., *hepatitis E* virus), but can be easily imported into the United States by travelers. Importation of pathogens into the United States from the third world is an increasing problem.

How to measure the effect(s) of the benefit:

- Lower health care and mortality costs.
- Costs of investigation and treating rare illnesses.

How to value the benefit:

Health care and mortality costs. Reduce disease surveillance costs.



PRIORITY RANK 20

Value of Improved Management of Small Systems

ORIGINATORS:

Job on behalf of himself, Blomquist, and Mills

Benefit description:

By adopting improved management (including source management, sanitary survey, distribution system maintenance, partnerships in system O&M, and other means), small systems may be able to upgrade, where necessary, the quality of their drinking water from microbial contaminants. Improved management of small systems for microbial contaminants should improve drinking water industry compliance overall and improve its image.

How to measure the effect(s) of the benefit:

Survey small systems' for opportunities to improve management and reduce risk of microbial contamination; estimate costs of avoided health effects and improved management measures for microbial protection.

How to value the benefit:

- Compare costs of small systems improved management and cost of health effects.
- Evaluate quality of life indices through contingent valuation.
- Evaluate non-compliance and reported health effects and identify health improvement opportunities and reduced costs.

The following benefits were subsumed under the above title:

BENEFIT TITLE: **Preservation of small water systems and a diverse water supply industry.**

ORIGINATOR: Blomquist

Benefit description:

Diversity in the ownership, size, and operation of water systems enhances water supply availability and affordability for small communities and for customers and employees of transient non-community water systems. That diversity also provides data for field comparisons of the quality, cost, and reliability of water supply from diverse organizations. Finally, the preservation of small systems as independent water suppliers may enhance community identity and other quality-of-life values.

How to measure the effect(s) of the benefit:

The effects of these benefits have primarily to do with avoidance of the loss or collapse of small water systems that are likely to result from either the liability exposure of continuing to serve contaminated water or from a draconian rule that imposes costs on suppliers that drive out small systems.

How to value the benefit:

- Availability and affordability of water supplied by small community water systems: For any system, avoidance of costs required to connect to the nearest large system.
- Availability and affordability of water supplied by non-community water systems (especially transient): For any system, avoidance of costs required to connect to nearest large system.
- Value of quality-of-life, small community independence, preservation of small entrepreneurial entities: Contingent valuation.

BENEFIT TITLE: **Value of allowing small systems more self control and management.**

ORIGINATOR: Job

Benefit description:

By adopting improved source management and sanitary survey methods, small systems can maintain control of their own health protection from waterborne disease and avoid large system overhead.

How to measure the effect(s) of the benefit:

- Survey interests of and value to small systems for self control and management for health effects protection from microbes.
- Identify and measure costs for small independent systems and recently merged systems.

How to value the benefit:

Evaluate the difference between costs of improved small system management and merged system management from microbial and other contaminants.

BENEFIT TITLE: **Provide incentives for small and non-community systems to consolidate and/or privatize into larger systems.**

ORIGINATOR: Mills

Benefit description:

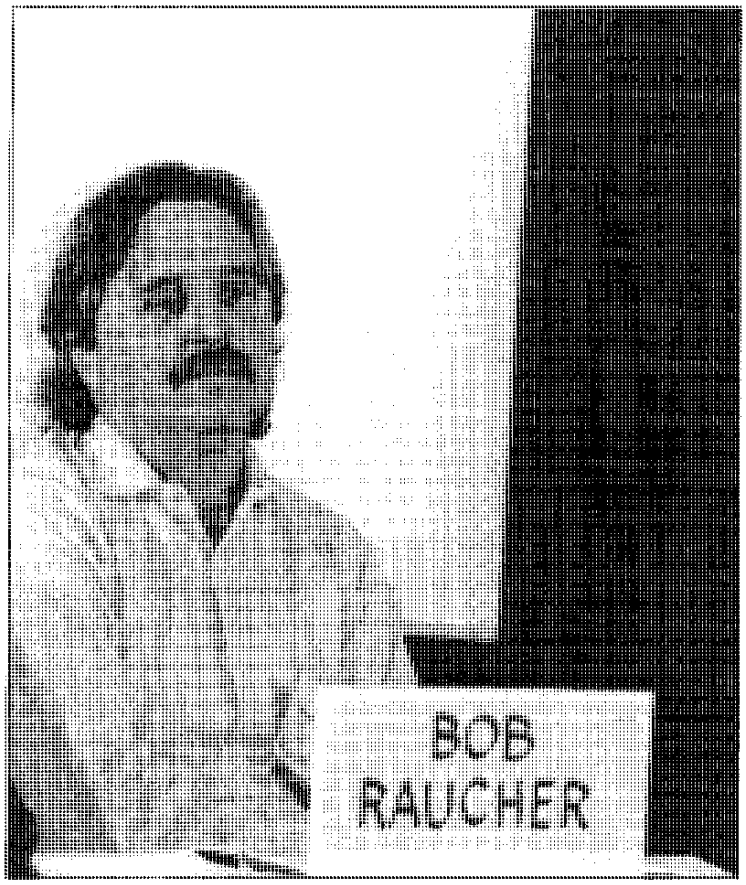
- Reduction of large segment of microbial illness problem.
- Improved water industry image.
- Provide financial resources to monitor and treat.

How to measure the effect(s) of the benefit:

Improved public health statistics.

How to value the benefit:

Methods that quantify improved public health benefits; improved productivity and education opportunities.


BOB
RAUCHER

PRIORITY RANK 21

Promote More Sustainable Levels of Water Consumption by Raising the Price of Water

ORIGINATOR:

Raucher

Benefit description:

Water is underpriced and, therefore, is overconsumed. Actions to raise the price of water will promote conservation and a more prudent and sustainable level of draw down.

How to measure the effect(s) of the benefit:

Using estimated price elasticity of demand to predict reduced use and, hence, increased sustainability of groundwater withdrawals (time frame to depletion and/or diminished groundwater quality). Additional benefits include reduced costs in near term (less pump and treat costs for water suppliers and wastewater treatment plants).

How to value the benefit:

- Cost of providing potable supplies, at the margin, in the future.
- Low and fixed income persons at disadvantage.


CHARLES
JOB
MATTHEW
CLARK

PRIORITY RANK 22

Downstream Recreation in Uncontaminated Water

ORIGINATOR:

Clark

Benefit description:

Ability to fish, swim downstream in uncontaminated waters, disease avoided, or avoidance of economic losses.

How to measure the effect(s) of the benefit:

Linkages between groundwater and downstream surface waters and contamination. Degree of use.

How to value the benefit:

- Contingent valuation and willingness to pay for clean water.
- Averting behavior/use of substitutes.
- Economic losses to fishery; recreation locale.

PRIORITY RANK 23

Increased and Improved Public Involvement

ORIGINATORS:
Macler on behalf of himself and Archibald

The following benefits were subsumed under the above title:

BENEFIT TITLE: **Increased community quality of life.**

ORIGINATOR: Macler

Benefit description:

Improvements to perceived community quality of life from having reliably safe water. Reduced stress, increased civic pride, positive attitude to drinking water.

How to measure the effect(s) of the benefit:

No recommendation proposed.

How to value the benefit:

- Changes in property values.
- Changes in bottled water sales.
- Willingness to pay surveys.

BENEFIT TITLE: **Benefits to private property values.**

ORIGINATOR: Archibald

Benefit description:

Groundwater disinfection regulation could provide a private benefit to property owners in terms of higher property values.

How to measure the effect(s) of the benefit:

Differences in property values for similar property types with different water qualities could be compared.

How to value the benefit:

Market values would be used.

PRIORITY RANK 24

Ecosystem Values

ORIGINATOR:

Lazo

Benefit description:

If there are secondary impacts from regulations which enhance or impair ecological integrity, these should be considered. These include impacts on ecosystem components (e.g., species) or ecosystem functions.

How to measure the effect(s) of the benefit:

Need to develop ecosystem models which can quantify (or perhaps just qualify) impacts on ecosystems from groundwater contamination and from disinfection.

How to value the benefit:

Methods in economics need to be developed or expanded to encompass or consider extrastructure (as opposed to infrastructure) services of the ecosystem.

PRIORITY RANK 25

Local Economic Development

ORIGINATOR:

Job

Benefit description:

Water is a basic community resource important to attracting business and people. Microbially-protected community water supplies may be attractive to economic development interests.

How to measure the effect(s) of the benefit:

Survey business trade groups and recently relocated businesses in small- and medium-size communities on the importance of drinking water quality in location decisions.

How to value the benefit:

Evaluate effects of potential business investments in small- and medium-sized communities.

PRIORITY RANK 26

Use Best Available Sources of Drinking Water

ORIGINATOR:

Gerba

Benefit description:

Lower treatment costs. Greater reliability of treatment processes.

How to measure the effect(s) of the benefit:

Better management of water resources. Lower water treatment costs. Lower frequency of system failure.

How to value the benefit:

Treatment costs. Disease avoided.

PRIORITY RANK 27

Groundwater Disinfection Trust Fund

ORIGINATOR:

Bulkley

Benefit description:

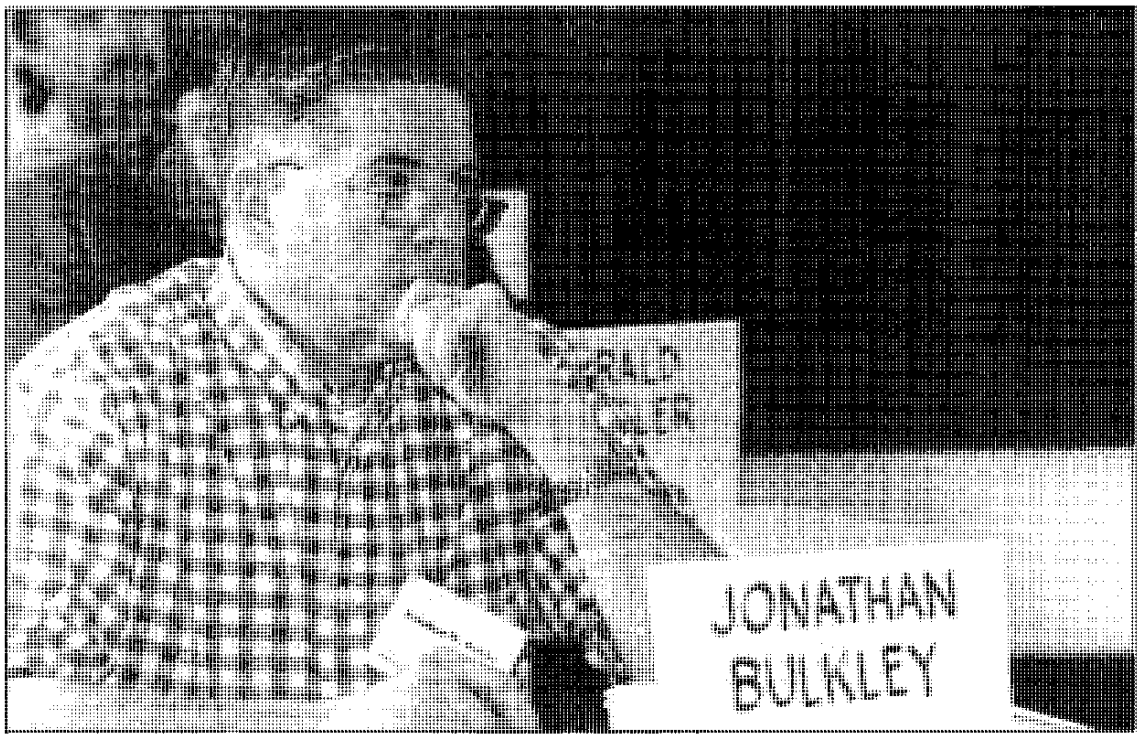
A groundwater disinfection trust fund would be established, through a tax on the withdrawal of groundwater. This trust fund would be used to finance the health surveys and the sanitary surveys to enable responsible state/federal officials to know the extent of the problem.

How to measure the effect(s) of the benefit:

It would provide a reasonable means to finance the monitoring required in order to identify the nature of the problem. The capital costs to correct the problem would be the responsibility of the user of the groundwater.

How to value the benefit:

The value of the trust fund is directly related to the value of more accurate and extensive information on the extent of distribution of microbial contamination in small groundwater systems serving small groups of users.



PRIORITY RANK 28

Enhanced International Leadership in Drinking Water Protection

ORIGINATORS:

Macler on behalf of himself and Lazo

The following benefits were subsumed under the above title:

BENEFIT TITLE: **Enhanced international leadership in drinking water protection.**

ORIGINATOR: Macler

Benefit description:

EPA is generally seen as a leader for drinking water protection. Groundwater disinfection regulations will be useful internationally to focus attention on reducing groundwater-related illness and provide guidance on disinfection approaches.

How to measure the effect(s) of the benefit:

Reduced infant mortality in third world.

How to value the benefit:

Summation of local values of a living child.

BENEFIT TITLE: **Cost savings in regulatory development for other countries.**

ORIGINATOR: Lazo

Benefit description:

Cost savings in rule making for other countries.

How to measure the effect(s) of the benefit:

This is not the measurement of benefits in other countries in the sense of mortality/morbidity effects. To what extent does the United States assist other countries by reducing time of implementation?

How to value the benefit:

Estimate the costs to other countries for developing their own regulatory structure and determine the extent to which they borrow regulations from the United States. Need to distinguish cases where other countries would not have implemented regulations from those where they would have but simplified the rule-creating process.

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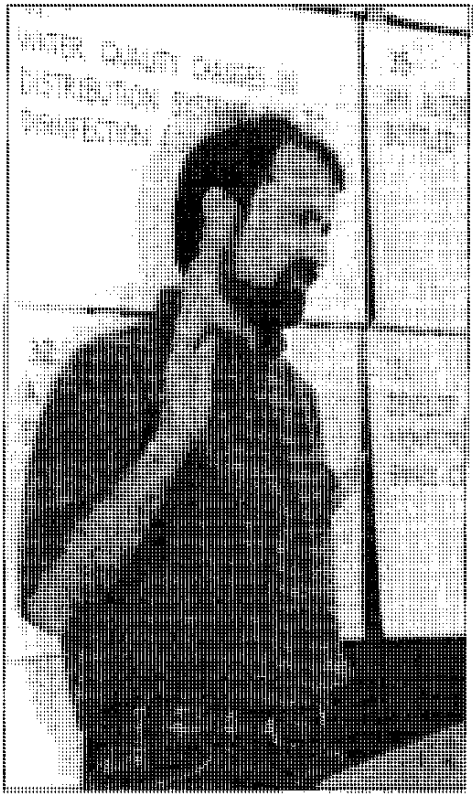
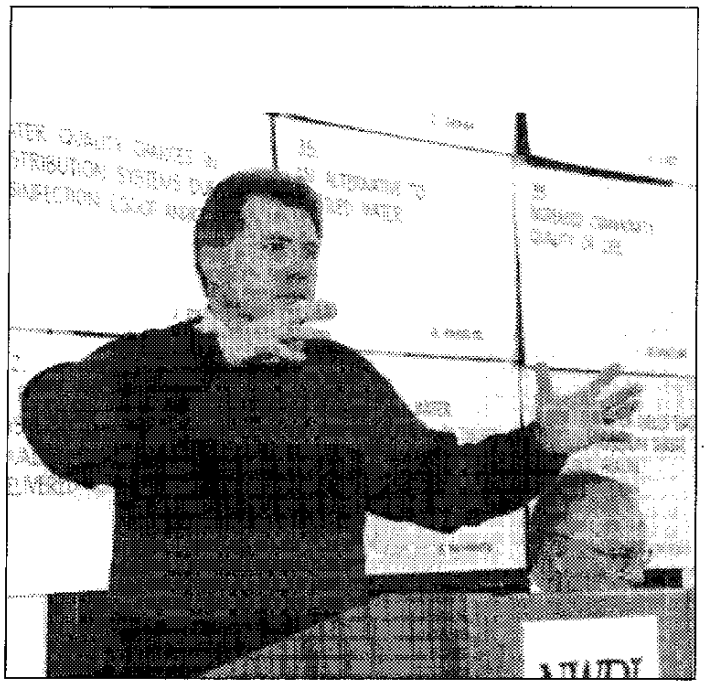
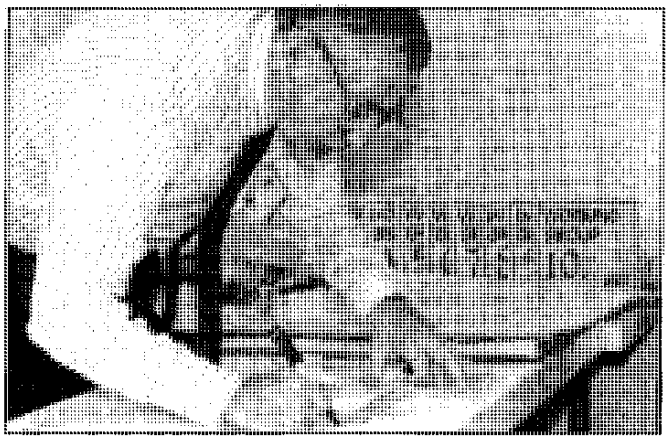
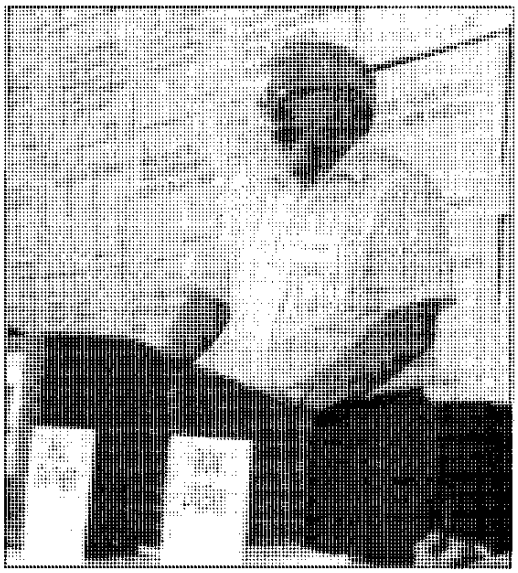








APPENDICES

APPENDIX A

Glossary of Abbreveviations and Acronyms

BMP	Best Management Practices
DBP	Disinfection By-Product
CDC	Center for Disease Control
GWDR	Groundwater Disinfection Rule
HACCP	Hazard Analysis, Critical Control Point
MTBF	Meantime Between Failures
NGT	Nominal Group Technique
NWRI	National Water Research Institute
POE	Point of Entry
POU	Point of Use
RFF	Resources for the Future
USEPA	U.S. Environmental Protection Agency

APPENDIX B

Workshop Graphic Presentation Materials

NATURAL AND ENGINEERED ELEMENTS OF WATER SUPPLY PROTECTION

Major CONCEPTS to consider:

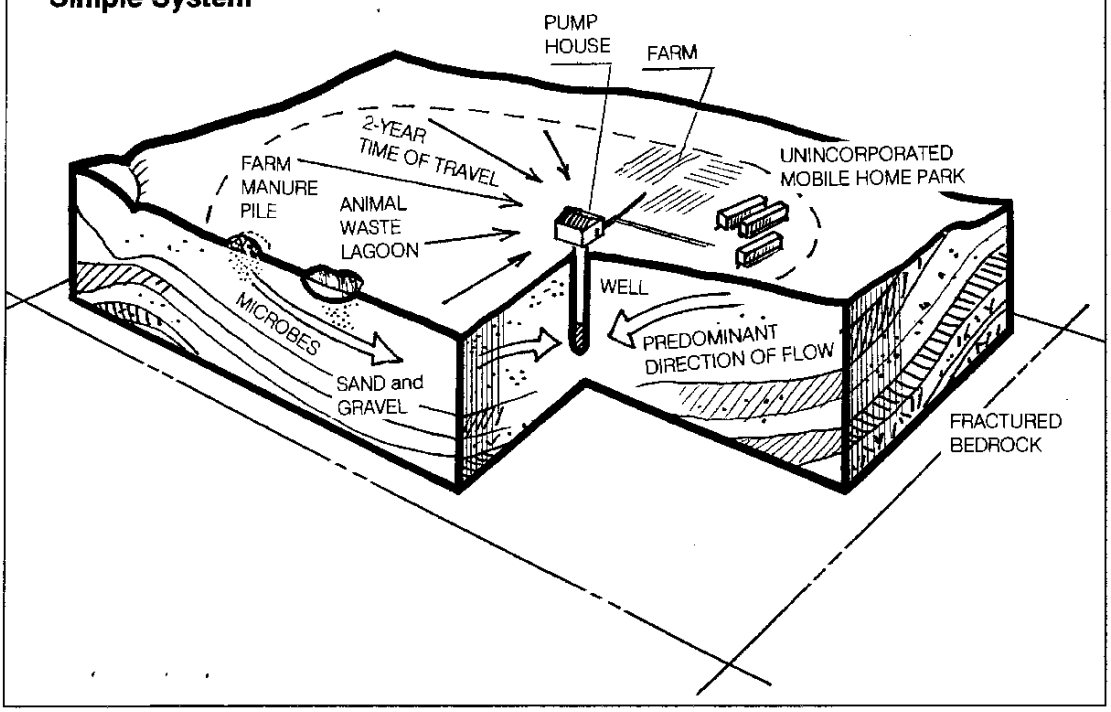
- ✻ Natural System
- ✻ Engineered System
- ✻ Sources of Contamination
- ✻ Range of Community Sizes
- ✻ Contaminant Movement
- ✻ Monitoring at Start and All Stages

Major COMPONENTS of a System:

- **Aquifer Evaluation**
  - Assess Aquifer Indicators
- **Monitor Natural Systems**
  - Evaluate vulnerability from potential sources of contamination and excessive withdrawal
- **Sanitary Survey at Wellhead(s)**
  - Evaluate Well construction and operation
- **Treatment System Management**
  - Operator Training and Experience
  - Management Discipline
  - Quality of Treatment Chemicals
  - Maintenance Programs
- **Distribution System**
  - Flushing, Cleaning and Biofilm control
  - Cross connection control
  - Residual Chlorination protection
  - System Security
  - Emergency Systems and Procedures

NATURAL AND ENGINEERED ELEMENTS OF WATER SUPPLY PROTECTION

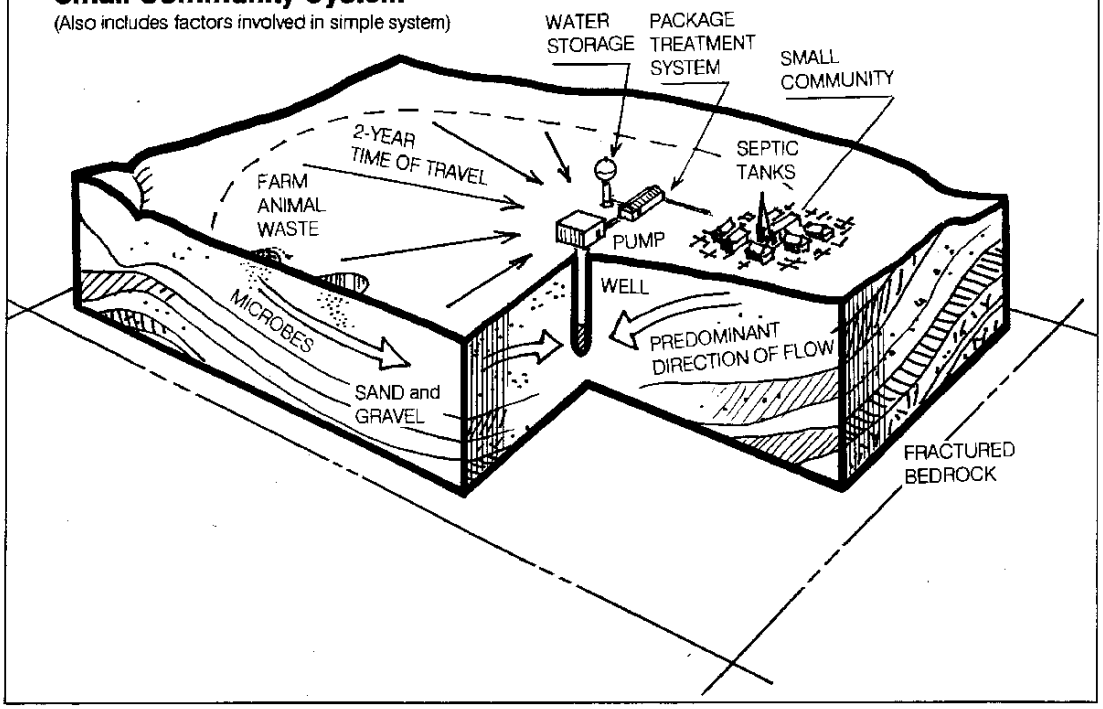
Simple System



NATURAL AND ENGINEERED ELEMENTS OF WATER SUPPLY PROTECTION

Small Community System

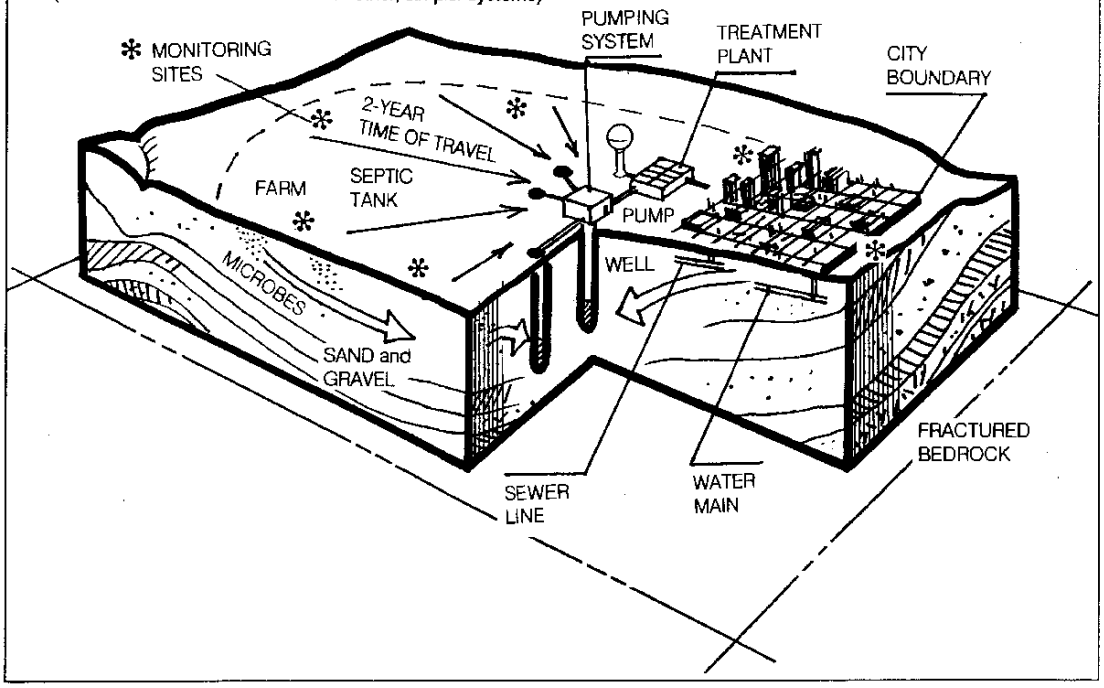
(Also includes factors involved in simple system)



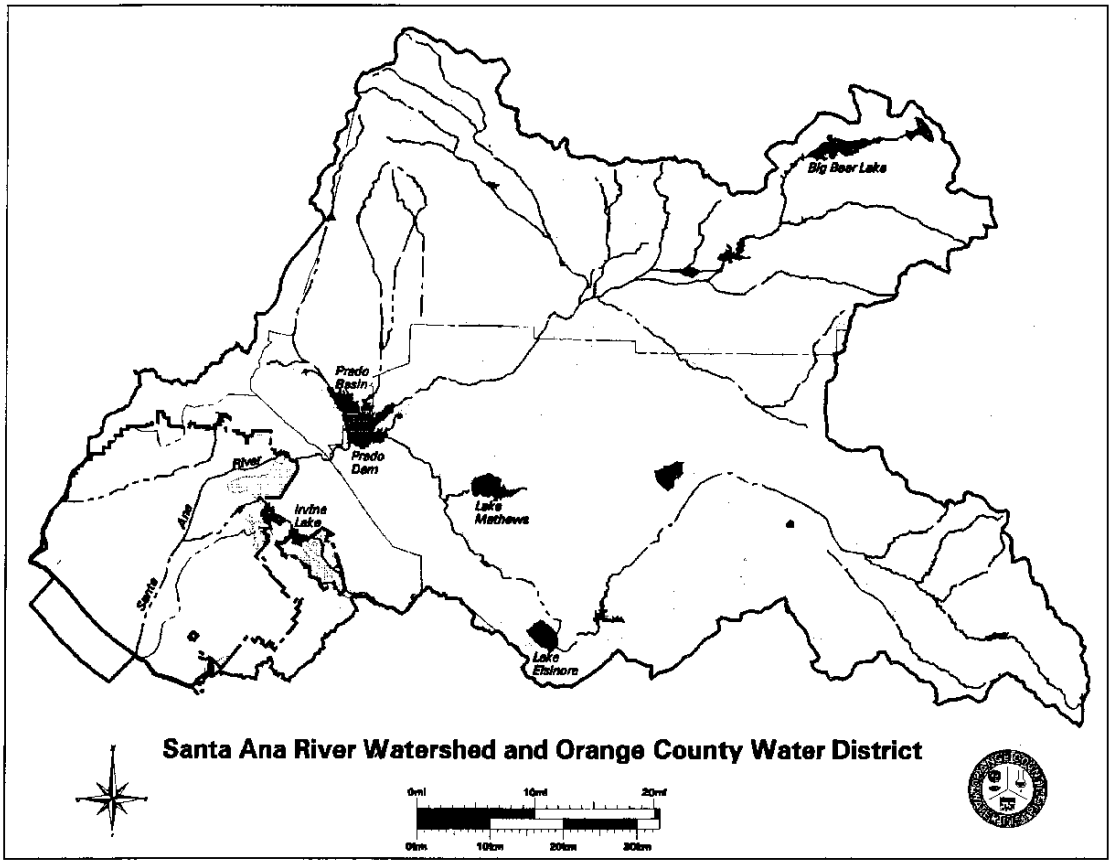
NATURAL AND ENGINEERED ELEMENTS OF WATER SUPPLY PROTECTION

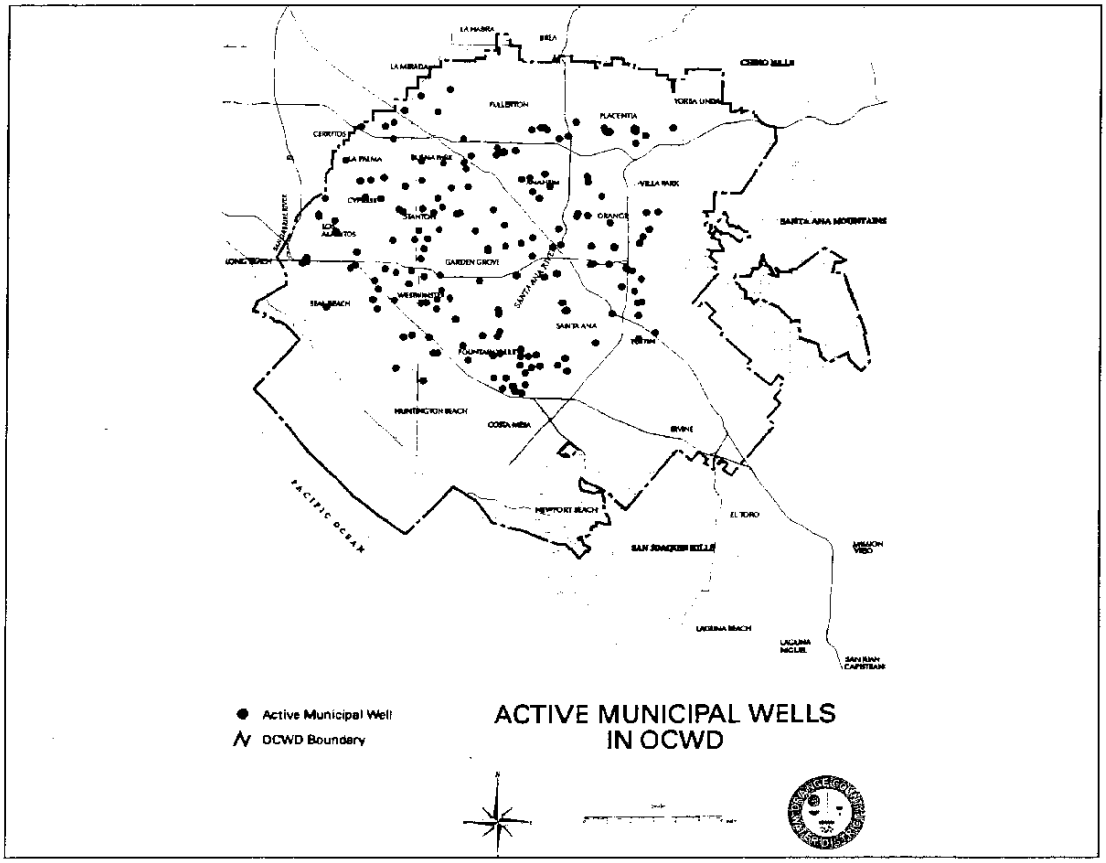
Large Scale Multiple Well System

(Also includes all factors involved in other, simpler systems)

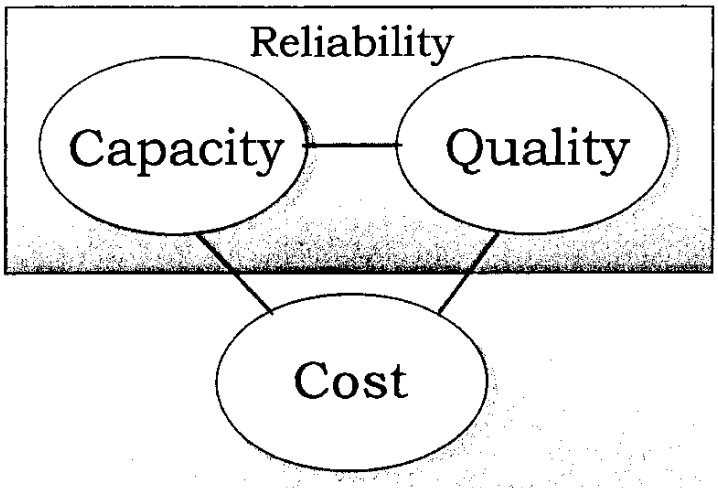


How does Orange County Water District protect the quality of its groundwater resource?



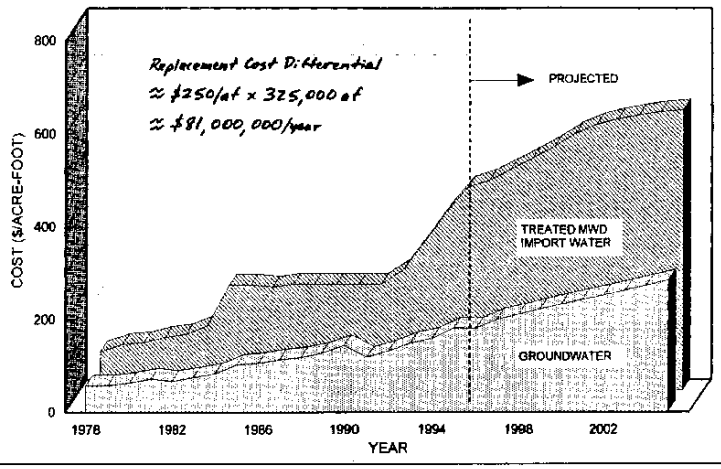


1. Define the resource's value relative to alternate supplies.



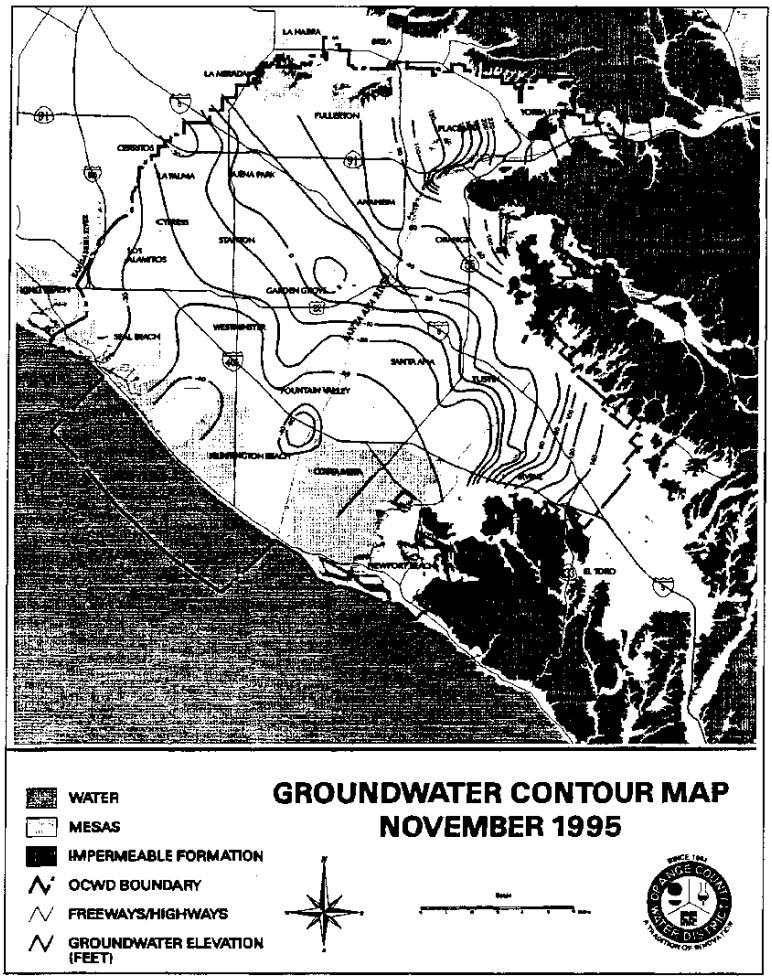
- Groundwater provides 2 million OCWD residents a reliable, high-quality, economical water supply.
  - 70% of total demand (470,000 af/yr)
  - 1 million af producible yield provides drought protection
  - Few poor-quality areas
  - < 1/2 cost of imported water, subject to growing demand and environ. pressures

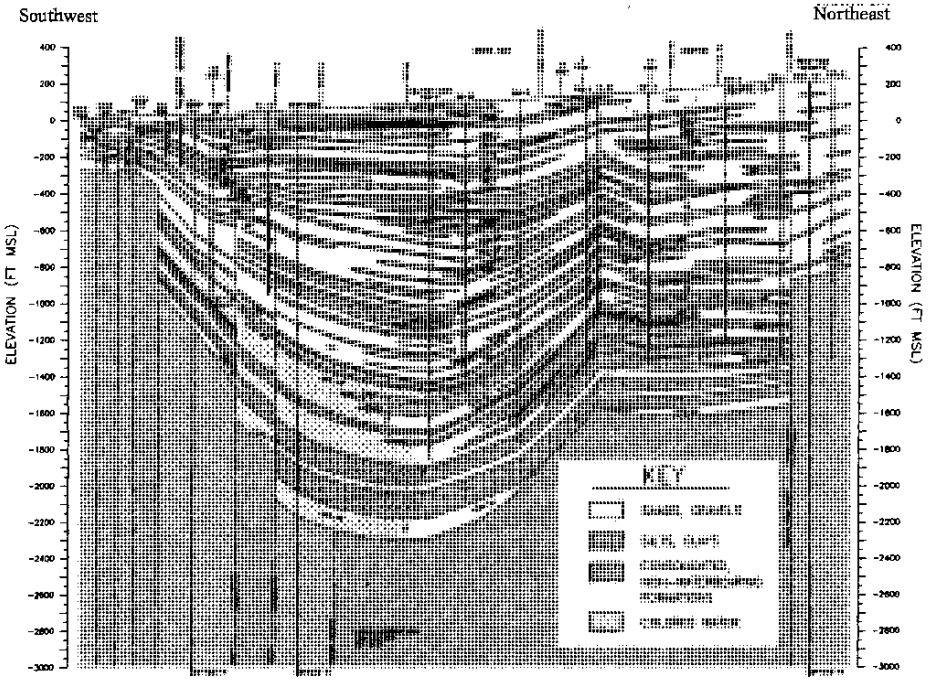
PROJECTED WATER RATES
GROUNDWATER VS. IMPORTED WATER

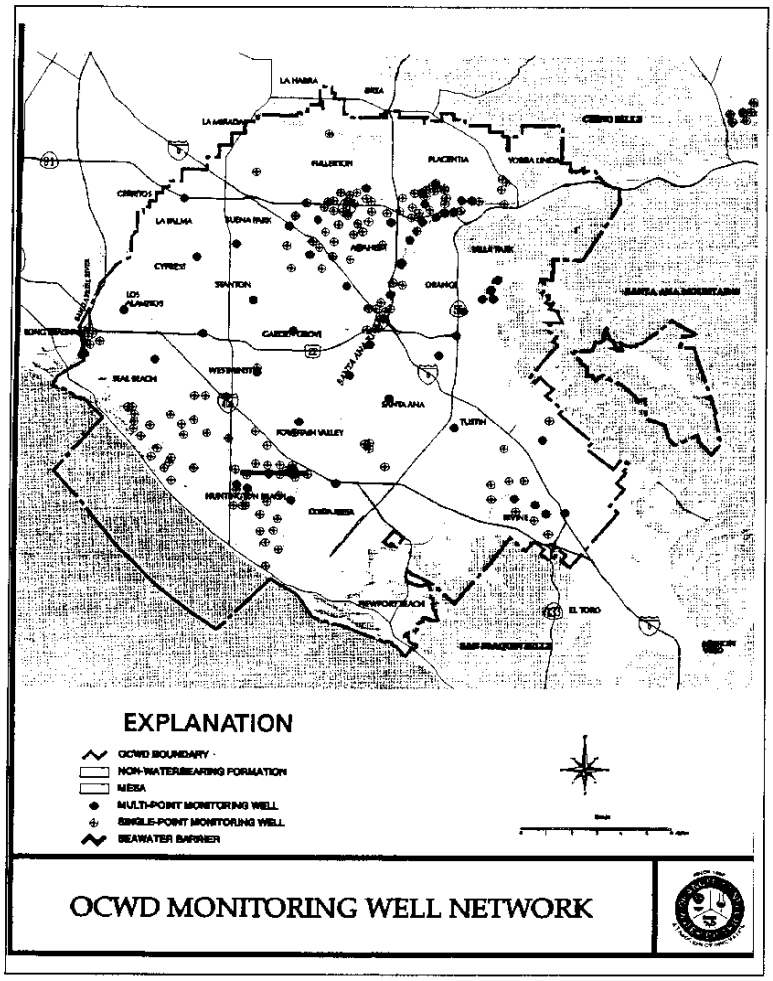


2. Understand the physical flow system.

- Boundaries -- area, depth, topography
- Properties -- structure, permeability, storage capacity
- Inflow -- rivers, precip., irrigation, seawater, injection
- Outflow -- wells, underflow


WATER
MESAS
IMPERMEABLE FORMATION
OCWD BOUNDARY
FREEWAYS/HIGHWAYS
GROUNDWATER ELEVATION (FEET)
GROUNDWATER CONTOUR MAP
NOVEMBER 1995

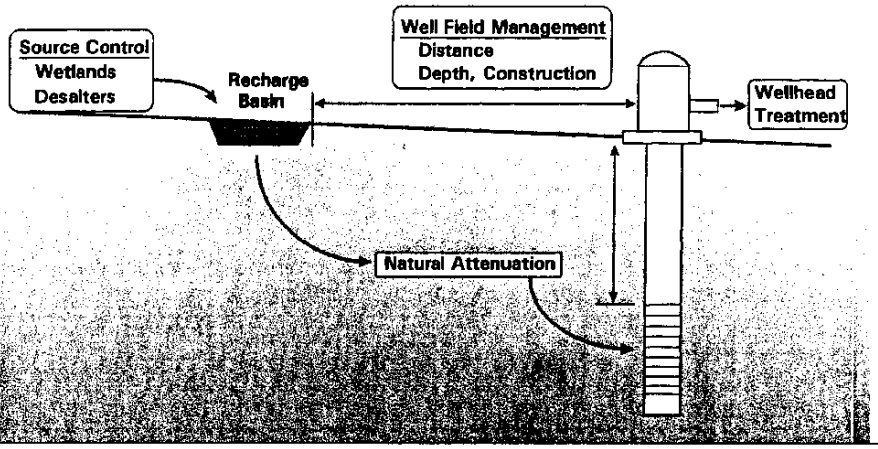

Southwest
Northeast
ELEVATION (FT MSL)
KEY



3. Evaluate water quality conditions/ potential impacts.

- Ambient conditions/trends
- Potential contaminant sources
  - wastewater treatment plants (TDS, NO_3)
  - dairies (NO_3)
  - industry (VOCs)
- Contaminant identification
- Migration potential to wells
  - dilution, adsorption, degradation
  - well construction/depth

4. Assess/implement options to mitigate quality impacts.



SOME VALUATION TECHNIQUES

- Market-Price/Demand Function
- Supply or Cost Function
- Consumer/Producer Cost Savings
- Contingent Valuation
- Hedonic Price/Property Value
- Averting Behavior
- Benefits Transfer

SERVICE/BENEFIT

- Drinking Water

EFFECTS

- Change in public welfare from increase or decrease in availability of drinking water
- Change in human health or health risks

SERVICE/BENEFIT

- Water for Crop Irrigation

EFFECTS

- Change in value of crops or production costs
- Change in human health or health risks

SERVICE/BENEFIT

- Water for Livestock

EFFECTS

- Change in value of livestock products or production costs
- Change in human health or health risks

SERVICE/BENEFIT

- Water for Food Product Processing

EFFECTS

- Change in value of food products or production costs
- Change in human health or health risks

SERVICE/BENEFIT

- Water for Other Manufacturing Processes

EFFECTS

- Change in value of manufactured goods or production costs

SERVICE/BENEFIT

- Water for Cooling Water for Power Plants

EFFECTS

- Change in cost of electricity generation

SERVICE/BENEFIT

- Erosion, Flood, and Storm Protection

EFFECTS

- Change in cost of maintaining public or private property
- Change in human health or health risks through personal injury protection
- Change in economic output attributable to use of surface water supplies for disposing of wastes

SERVICE/BENEFIT

- Transport and Treatment of Wastes and Other By-Products of Human Economic Activity

EFFECTS

- Change in human health or health risks attributable to change in surface water quality
- Change in animal health or health risks attributable to change in surface water quality *(Continued)*

(Continued) Transport and Treatment of Wastes and Other By-Products of Human Economic Activity

- Change in economic output attributable to use of surface water supplies for disposing of wastes

SERVICE/BENEFIT

- Support of Recreational Swimming, Boating, Fishing, Hunting, Trapping, and Plant Gathering

EFFECTS

- Change in quantity or quality of recreational activities
- Change in human health or health risks

SERVICE/BENEFIT

- Support of Commercial Fishing, Hunting, Trapping, and Plant Gathering

EFFECTS

- Change in value of commercial harvest or costs

SERVICE/BENEFIT

- Support of On-Site Observation or Study of Fish, Wildlife, and Plants for Leisure, Educational, or Scientific Purposes

EFFECTS

- Change in quantity or quality of on-site observation or study activity

SERVICE/BENEFIT

- Support of Indirect, Off-Site Fish, Wildlife, and Plant Uses (e.g. viewing wildlife photos)

EFFECTS

- Change in quantity or quality of indirect, off-site activities

SERVICE/BENEFIT

- Clean Air Through Support of Living Organisms

EFFECTS

- Change in human health or health risks attributable to change in air quality
- Change in animal health or health risks attributable to air quality

SERVICE/BENEFIT

- Clean Water Through Support of Living Organisms

EFFECTS

- Change in human health or health risks attributable to change in water quality
- Change in animal health or health risks attributable to water quality
- Change in value of economic output or production cost attributable to change in water quality

SERVICE/BENEFIT

- **Regulation of Climate Through Support of Plants**

EFFECTS

- **Change in human health or health risks attributable to change in climate**
- **Change in animal health or health risks attributable to change in climate**
- **Change in value of economic output or production cost attributable to change in climate**

APPENDIX C

Explanation of Priority Ranking System and Data Analysis

Appendices D, E, F, G, H, I, J, and K present detailed analyses of priority ranking data derived from the ranking sheets (Appendix R) that were completed by each participant as the final phase of the workshop. These appendices contain three types of information, in addition to the title of the problem.

First, the numerator of the fraction in the first column (i.e., *Times Picked/Pts.*) is the number of times which that benefit was selected by the participants from the group, or subgroup, identified at the top of the page.

The second piece of information, the denominator of the fraction, is the total number of points the benefit received based on a number one (highest) rank being given ten points, a number two rank nine points, and so on down to the tenth ranked benefit being given one point. All other benefits not selected received zero points.

The third item of information in the three following appendices is given in the column titled *Strength of Feeling.* This is simply the percentage obtained by dividing the total number of points received by the total number of points which the benefit could have been given if everyone had selected that benefit as their first priority.

Since there were 24 participants, the denominator in Appendices D (*All Participants*) is 240. If every participant awarded a particular issue their highest rank, (i.e., a one), then the Strength of Feeling would be 100% (i.e., 24 x 10 = 240, then 240/240 x 100 = 100%). If all rankers selected another benefit as their second highest priority, its Strength of Feeling would be 90%. If no one selected a particular benefit, its Strength of Feeling would be 0%.

As an example, the highest ranking issue selected by all participants (shown in Appendix D) received 224 points. Thus, the Strength of Feeling is computed as 224/240 x 100 = 93.3%.

APPENDIX D

All Benefits (28) Ranked by All Participants (24)

RANK	TITLE	TIMES PICKED/PTS.	STRENGTH OF FEELING
1.	Reduced Risk of Waterborne Illness	23/224	93.3%
2.	Increased Reliability and Availability of Groundwater Systems	17/119	49.6%
3.	Prevent Microbial Contamination of the Source Water	17/104	43.3%
4.	Comprehensive Quality Assurance Plan for Assessing the Quality of Drinking Water	16/100	41.7%
5.	Close the Information Gap on the Microbial Quality of Drinking Water to Enhance State, Local and Utility Surveillance and Regulatory Programs and to Identify the Impact and Extent of Contamination	13/76	31.7%
6.	Reduce Uncertainty about Health-Effects Incidence and Severity through Better Integration of Public Health Disease Surveillance and Regulatory Monitoring	15/64	26.7%
7.	Identification of Wells that Pose the Maximum Threat to Public Health	11/63	26.3%
8.	Benefits to Future Generations	11/62	25.8%
9.	Improved Approaches to Developing Drinking Water Regulations	15/62	25.8%
10.	Value of Avoiding Disinfection by Identification of Wells with Adequate Natural Protection	11/61	25.4%
11.	Improved Implementation of State Programs that Provide Flexible Approaches to Protect Groundwater from Microbial Contamination	12/54	22.5%
12.	Changes in Risk Premia	9/51	21.3%
13.	Avoid Switching to Bottled or Other More Expensive Sources of Drinking Water	11/49	20.4%
14.	Increased Public Understanding of and Confidence in Drinking Water Safety	9/33	13.8%
15.	Provide Incentives to Develop and Adopt New Technologies and Improved Management Practices Designed to Meet Regulations	7/33	13.8%
16.	Concomitant Water Quality Benefits	6/23	9.6%
17.	Nonuse Values	5/21	8.8%
18.	Environmental Justice	5/21	8.8%
19.	Lower Cost of Disease Prevention Strategies	6/20	8.3%
20.	Value of Improved Management of Small Systems	3/17	7.1%

RANK	TITLE	TIMES PICKED/PTS.	STRENGTH OF FEELING
21.	Promote More Sustainable Levels of Water Consumption by Raising the Price of Water	4/13	5.4%
22.	Downstream Recreation in Uncontaminated Water	3/12	5.0%
23.	Increased and Improved Public Involvement	2/9	3.8%
24.	Ecosystem Values	3/9	3.8%
25.	Local Economic Development	3/8	3.3%
26.	Use Best Available Sources of Drinking Water	2/7	2.9%
27.	Groundwater Disinfection Trust Fund	1/5	2.1%
28.	Enhanced International Leadership in Drinking Water Protection	0/0	0.0%

APPENDIX E

All Benefits (28) Ranked by Utility Manager Participants (2)

RANK	TITLE	TIMES PICKED/PTS.	STRENGTH OF FEELING
1.	Identification of Wells that Pose the Maximum Threat to Public Health	2/17	85.0%
2.	Close the Information Gap on the Microbial Quality of Drinking Water to Enhance State, Local and Utility Surveillance and Regulatory Programs and to Identify the Impact and Extent of Contamination	2/14	70.0%
3.	Increased Reliability and Availability of Groundwater Systems	2/13	65.0%
4.	Value of Improved Management of Small Systems	2/13	65.0%
5.	Reduced Risk of Waterborne Illness	1/10	50.0%
6.	Value of Avoiding Disinfection by Identification of Wells with Adequate Natural Protection	1/10	50.0%
7.	Comprehensive Quality Assurance Plan for Assessing the Quality of Drinking Water	1/7	35.0%
8.	Changes in Risk Premia	1/6	30.0%
9.	Reduce Uncertainty about Health-Effects Incidence and Severity through Better Integration of Public Health Disease Surveillance and Regulatory Monitoring	2/5	25.0%
10.	Improved Implementation of State Programs that Provide Flexible Approaches to Protect Groundwater from Microbial Contamination	1/4	20.0%
11.	Benefits to Future Generations	1/3	15.0%
12.	Improved Approaches to Developing Drinking Water Regulations	1/3	15.0%
13.	Increased Public Understanding of and Confidence in Drinking Water Safety	1/2	10.0%
14.	Using Best Available Sources of Drinking Water	1/2	10.0%
15.	Prevent Microbial Contamination of the Source Water	1/1	5.0%

APPENDIX F

All Benefits (28) Ranked Federal Regulator Participants (3)

RANK	TITLE	TIMES PICKED/PTS.	STRENGTH OF FEELING
1.	Reduced Risk of Waterborne Illness	3/30	100.0%
2.	Prevent Microbial Contamination of the Source Water	3/22	73.3%
3.	Increased Reliability and Availability of Groundwater Systems	2/16	53.3%
4.	Comprehensive Quality Assurance Plan for Assessing the Quality of Drinking Water	2/14	46.7%
5.	Improved Implementation of State Programs that Provide Flexible Approaches to Protect Groundwater from Microbial Contamination	2/13	43.3%
6.	Benefits to Future Generations	2/9	30.0%
7.	Changes in Risk Premia	1/9	30.0%
8.	Increased and Improved Public Involvement	1/8	26.7%
9.	Close the Information Gap on the Microbial Quality of Drinking Water to Enhance State, Local and Utility Surveillance and Regulatory Programs and to Identify the Impact and Extent of Contamination	1/7	23.3%
10.	Increased Public Understanding of and Confidence in Drinking Water Safety	2/6	20.0%
11.	Provide Incentives to Develop and Adopt New Technologies and Improved Management Practices Designed to Meet Regulations	2/5	16.7%
12.	Avoid Switching to Bottled or Other More Expensive Sources of Drinking Water	1/5	16.7%
13.	Value of Avoiding Disinfection by Identification of Wells with Adequate Natural Protection	1/4	13.3%
14.	Nonuse Values	1/4	13.3%
15.	Value of Improved Management of Small Systems	1/4	13.3%
16.	Local Economic Development	1/3	10.0%
17.	Improved Approaches to Developing Drinking Water Regualtions	2/3	10.0%
18.	Lower Cost of Disease Prevention Strategies	1/2	6.7%
19.	Ecosystem Values	1/1	3.3%

APPENDIX G

All Benefits (28) Ranked by State Regulators (3)

RANK	TITLE	TIMES PICKED/PTS.	STRENGTH OF FEELING
1.	Reduced Risk of Waterborne Illness	2/20	100.0%
2.	Increased Reliability and Availability of Groundwater Systems	2/17	85.0%
3.	Prevent Microbial Contamination of the Source Water	2/13	65.0%
4.	Value of Avoiding Disinfection by Identification of Wells with Adequate Natural Protection	2/11	55.0%
5.	Comprehensive Quality Assurance Plan for Assessing the Quality of Drinking Water	2/9	45.0%
6.	Identification of Wells that Pose the Maximum Threat to Public Health	2/8	40.0%
7.	Improved Approaches to Developing Drinking Water Regualtions	1/7	35.0%
8.	Environmental Justice	1/7	35.0%
9.	Reduce Uncertainty about Health-Effects Incidence and Severity through Better Integration of Public Health Disease Surveillance and Regulatory Monitoring	2/6	30.0%
10.	Improved Implementation of State Programs that Provide Flexible Approaches to Protect Groundwater from Microbial Contamination	2/6	30.0%
11.	Increased Public Understanding of and Confidence in Drinking Water Safety	1/5	25.0%
12.	Close the Information Gap on the Microbial Quality of Drinking Water to Enhance State, Local and Utility Surveillance and Regulatory Programs and to Identify the Impact and Extent of Contamination	1/1	5.0%

APPENDIX H

All Benefits (28) Ranked by Public Health Participants (2)

RANK	TITLE	TIMES PICKED/PTS.	STRENGTH OF FEELING
1.	Reduced Risk of Waterborne Illness	2/15	75.0%
2.	Comprehensive Quality Assurance Plan for Assessing the Quality of Drinking Water	2/15	75.0%
3.	Reduce Uncertainty about Health-Effects Incidence and Severity through Better Integration of Public Health Disease Surveillance and Regulatory Monitoring	2/15	75.0%
4.	Identification of Wells that Pose the Maximum Threat to Public Health	2/11	55.0%
5.	Increased Public Understanding of and Confidence in Drinking Water Safety	1/9	45.0%
6.	Value of Avoiding Disinfection by Identification of Wells with Adequate Natural Protection	1/8	40.0%
7.	Benefits to Future Generations	1/7	35.0%
8.	Provide Incentives to Develop and Adopt New Technologies and Improved Management Practices Designed to Meet Regulations	1/6	30.0%
9.	Avoid Switching to Bottled or Other More Expensive Sources of Drinking Water	2/6	30.0%
10.	Close the Information Gap on the Microbial Quality of Drinking Water to Enhance State, Local and Utility Surveillance and Regulatory Programs and to Identify the Impact and Extent of Contamination	1/5	25.0%
11.	Prevent Microbial Contamination of the Source Water	2/5	25.0%
12.	Nonuse Values	1/4	20.0%
13.	Improved Implementation of State Programs that Provide Flexible Approaches to Protect Groundwater from Microbial Contamination	1/3	15.0%
14.	Concominant Water Quality Benefits	1/1	5.0%

APPENDIX I

All Benefits (28) Ranked by Economist Participants (6)

RANK	TITLE	TIMES PICKED/PTS.	STRENGTH OF FEELING
1.	Reduced Risk of Waterborne Illness	6/60	100.0%
2.	Benefits to Future Generations	4/25	41.7%
3.	Changes in Risk Premia	4/24	40.0%
4.	Avoid Switching to Bottled or Other More Expensive Sources of Drinking Water	4/24	40.0%
5.	Improved Approaches to Developing Drinking Water Regulations	4/22	36.7%
6.	Concomitant Water Quality Benefits	3/18	30.0%
7.	Provide Incentives to Develop and Adopt New Technologies and Improved Management Practices Designed to Meet Regulations	3/17	28.3%
8.	Reduce Uncertainty about Health-Effects Incidence and Severity through Better Integration of Public Health Disease Surveillance and Regulatory Monitoring	3/16	26.7%
9.	Increased Reliability and Availability of Groundwater Systems	2/15	25.0%
10.	Identification of Wells that Pose the Maximum Threat to Public Health	2/15	25.0%
11.	Nonuse Values	3/13	21.7%
12.	Promote More Sustainable Levels of Water Consumption by Raising the Price of Water	4/13	21.7%
13.	Environmental Justice	3/13	21.7%
14.	Prevent Microbial Contamination of the Source Water	2/12	20.0%
15.	Downstream Recreation in Uncontaminated Water	3/12	20.0%
16.	Close the Information Gap on the Microbial Quality of Drinking Water to Enhance State, Local and Utility Surveillance and Regulatory Programs and to Identify the Impact and Extent of Contamination	2/10	16.7%
17.	Increased Public Understanding of and Confidence in Drinking Water Safety	2/5	8.3%
18.	Use Best Available Sources of Drinking Water	1/5	8.3%
19.	Local Economic Development	2/5	8.3%
20.	Ecosystem Values	1/3	5.0%
21.	Comprehensive Quality Assurance Plan for Assessing the Quality of Drinking Water	1/2	3.3%
22.	Lower Cost of Disease Prevention Strategies	1/1	1.7%

APPENDIX J

All Benefits (28) Ranked by Microbiologist Participants (4)

RANK	TITLE	TIMES PICKED/PTS.	STRENGTH OF FEELING
1.	Reduced Risk of Waterborne Illness	4/40	100.0%
2.	Prevent Microbial Contamination of the Source Water	4/29	72.5%
3.	Comprehensive Quality Assurance Plan for Assessing the Quality of Drinking Water	3/27	67.5%
4.	Increased Reliability and Availability of Groundwater Systems	4/24	60.0%
5.	Reduce Uncertainty about Health-Effects Incidence and Severity through Better Integration of Public Health Disease Surveillance and Regulatory Monitoring	4/17	42.5%
6.	Value of Avoiding Disinfection by Identification of Wells with Adequate Natural Protection	4/16	40.0%
7.	Lower Cost of Disease Prevention Strategies	3/15	37.5%
8.	Close the Information Gap on the Microbial Quality of Drinking Water to Enhance State, Local and Utility Surveillance and Regulatory Programs and to Identify the Impact and Extent of Contamination	2/10	25.0%
9.	Improved Implementation of State Programs that Provide Flexible Approaches to Protect Groundwater from Microbial Contamination	2/9	22.5%
10.	Changes in Risk Premia	2/8	20.0%
11.	Improved Approaches to Developing Drinking Water Regulations	2/6	15.0%
12.	Benefits to Future Generations	1/5	12.5%
13.	Provide Incentives to Develop and Adopt New Technologies and Improved Management Practices Designed to Meet Regulations	1/5	12.5%
14.	Increased Public Understanding of and Confidence in Drinking Water Safety	1/3	7.5%
15.	Identification of Wells that Pose the Maximum Threat to Public Health	1/3	7.5%
16.	Avoid Switching to Bottled or Other More Expensive Sources of Drinking Water	1/2	5.0%
17.	Increased and Improved Public Involvement	1/1	2.5%

APPENDIX K

All Benefits (28) Ranked by Engineer Participants (4)

RANK	TITLE	TIMES PICKED/PTS.	STRENGTH OF FEELING
1.	Reduced Risk of Waterborne Illness	4/40	100.0%
2.	Increased Reliability and Availability of Groundwater Systems	4/33	82.5%
3.	Prevent Microbial Contamination of the Source Water	3/22	55.0%
4.	Comprehensive Quality Assurance Plan for Assessing the Quality of Drinking Water	4/20	50.0%
5.	Close the Information Gap on the Microbial Quality of Drinking Water to Enhance State, Local and Utility Surveillance and Regulatory Programs and to Identify the Impact and Extent of Contamination	3/19	47.5%
6.	Improved Approaches to Developing Drinking Water Regulations	4/14	35.0%
7.	Benefits to Future Generations	2/13	32.5%
8.	Value of Avoiding Disinfection by Identification of Wells with Adequate	2/12	30.0%
9.	Improved Implementation of State Programs that Provide Flexible Approaches to Protect Groundwater from Microbial Contamination	3/11	27.5%
10.	Avoid Switching to Bottled or Other More Expensive Sources of Drinking Water	2/7	17.5%
11.	Identification of Wells that Pose the Maximum Threat to Public Health	1/6	15.0%
12.	Reduce Uncertainty about Health-Effects Incidence and Severity through Better Integration of Public Health Disease Surveillance and Regulatory Monitoring	2/5	12.5%
13.	Groundwater Disinfection Trust Fund	1/5	12.5%
14.	Ecosystem Values	1/5	12.5%
15.	Concomitant Water Quality Benefits	2/4	10.0%
16.	Increased Public Understanding of and Confidence in Drinking Water Safety	1/3	7.5%
17.	Environmental Justice	1/1	2.5%

APPENDIX L

Letter of Invitation to Prospective Workshop Participants

NWRI *National Water Research Institute*

10500 Ellis Avenue, P.O. Box 20865, Fountain Valley, CA 92728-0865 *(714) 378-3278 Fax (714) 378-3375*

November 15, 1996

Henry A. Anderson, M.D.
Chief Medical Officer
Wisconsin Bureau of Public Health
1414 E. Washington Ave, Rm 96
Madison, WI 53703

Dear Dr. Anderson:

It is my pleasure to invite you to participate in a Nominal Group Technique (NGT) workshop sponsored by the National Water Research Institute (NWRI) to be held January 6-8, 1997. This technique, developed by Andre L. Delbecq and Andrew H. Van de Ven at the University of Wisconsin and modified by NWRI, aims at building consensus among a group of experts.

The purpose of this workshop will be to address the question, "What are the most significant benefits that should be considered in developing approaches to controlling microbial contaminants in public ground water supplies." In search of answers to this question, we are inviting a small representative group to attend a two- and a half-day workshop. A preliminary list of invitees is enclosed.

Participants will convene for registration at 3:30 p.m. on Monday, January 6, at the Arnold and Mabel Beckman Center of the National Academies of Sciences and Engineering which is adjacent to the University of California, Irvine campus. The Tuesday session will begin at 8:00 a.m. and run until 8:00 p.m. with breaks for lunch and dinner. The Wednesday session will again commence at 8:00 a.m. and will adjourn at noon.

All expenses associated with your participation in the workshop will be covered by NWRI. Hotel accommodations will be provided at The Sutton Place Hotel. Arrangements will be made for daily transportation between the hotel and the Beckman Center.

Would you please complete the enclosed form and mail or fax it upon receipt of this letter, but **no later than December 6, 1996**. Also, please return a one-page summary of your interest in/or experience with controlling microbial contaminants in public ground water supplies. We plan to distribute these summaries to participants, along with other materials,

prior to your arrival at the workshop. The results of the NGT workshop will be published as a report within 72 hours following the close of the workshop and will be mailed to each participant.

I look forward to your participation.

Sincerely,

NATIONAL WATER RESEARCH INSTITUTE

Ronald B. Linsky
Executive Director

Enclosures

APPENDIX M

Letter to Confirmed Workshop Participants

NWRI *National Water Research Institute*

10500 Ellis Avenue, P.O. Box 20865, Fountain Valley, CA 92728-0865 *(714) 378-3278 Fax (714) 378-3375*

Ronald B. Linsky
Executive Director

Board of Directors

Orange County Water District
Langdon W. Owen

Irvine Ranch Water District
Peer A. Swan

County Sanitation Districts of Orange County
Victor Leipzig

Municipal Water District of Orange County
William F. Davenport

San Juan Basin Authority
John V. Foley

December 4, 1996

Henry A. Anderson, M.D.
Chief Medical Officer
Wisconsin Bureau of Public Health
1414 E. Washington Ave, Rm 96
Madison, WI 53703

Dear Dr. Anderson:

Thank you for accepting our invitation to participate in the Nominal Group Technique (NGT) workshop sponsored by the National Water Research Institute on "*What are the most significant benefits that should be considered in the developing approaches to controlling microbial contaminants in public ground water supplies?*"

The participants will convene at 3:30 p.m. on Monday, January 6, 1997, at the Arnold and Mabel Beckman Center of the National Academies of Sciences and Engineering adjacent to the University of California, Irvine Campus. Hotel accommodations have been arranged at The Sutton Place Hotel, 4500 MacArthur Boulevard, Newport Beach, California. The attached agenda describes the workshop activities.

Costs associated with your attendance will be underwritten by the sponsors and include transportation, hotel and meals. Travel reimbursement forms will be provided upon your arrival. Please fax your **Travel Arrangement Form** no later than December 13, 1996.

Enclosed is information which will help you be a more effective workshop participant. Please allow yourself at least two hours to review this material and to prepare for the workshop before arriving. The **background papers** may be especially interesting. It is imperative you attend the entire workshop (Monday night, Tuesday and Wednesday) and do not depart before it is finished.

Please read the workshop **Guidelines and Procedures** we plan to follow during the workshop. We need to adhere to these so that we can complete our work before adjournment time. Of particular importance is the **Issue Identification Form**. Please prepare a full write-up on each topic which you plan to propose. You may propose as many topics as you wish.

If you have not forwarded your resume or personal experience summary, please do so as soon as possible.

We are looking forward to your participation at the workshop and to producing a useful report on the results of your efforts. Thank you again for accepting the invitation to participate in this workshop.

Should you have any questions prior to the workshop, please do not hesitate to contact me at (714) 378-3278.

Sincerely,

NATIONAL WATER RESEARCH INSTITUTE

Ronald B. Linsky
Executive Director

RBL:lb

Enclosures

APPENDIX N

Workshop Guidelines and Procedures

GROUNDWATER DISINFECTION RULE WORKSHOP
Guidelines and Procedures

Workshop to Identify the Most Significant Benefits That Should be Considered in the Development of Groundwater Disinfection Regulations

January 7-8-9, 1997

Arnold and Mabel Beckman Center of the National Academies of Science and Engineering

Irvine, California

The workshop will be conducted employing the Nominal Group Technique (NGT) process to ensure that (1) each participant's time and talents are used effectively, and (2) a useful report will result. Please observe the following guidelines:

- The workshop will begin at 3:30 p.m. on Monday, January 6, 1997 at the Arnold and Mabel Beckman Center and will conclude at 1:00 p.m. on Wednesday, January 8, 1997.
- If you **cannot** stay for the entire workshop, please **do not** come. Cellular telephones are not permitted inside the workshop room.
- Come prepared with each of your responses to the workshop question written up on an Benefit Identification Form. You will be free to modify, improve, or add to your write-ups as the workshop progresses.
- The workshop will consist of four distinct parts which will require your full attention and participation:

1. **Benefit Identification.** Each participant will be asked in turn to identify for the group his or her highest priority benefit. Three minutes of uninterrupted time will be allotted to give its title, describe the service or benefit, how to measure the effect of the benefit, and how to monetize it. Discussion will be limited to questions of clarification. The benefit title will be written in large letters on paper, numbered, the originator noted, and posted on the wall. This process will continue until all benefits are identified.

2. **Consolidation.** Each benefit description will be reviewed and discussed. When agreed by consensus, those benefits which fit into a similar theme, or major thrust, will be consolidated. An ad hoc working group will be formed to generate an overarching benefit title and description which incorporates the ideas expressed in the benefits being subsumed.

3. **Priority Ranking and Text Approval.** Each participant will be expected to rank in priority order his or her top 10 benefits. Each ranking sheet must be signed. Also, each participant will be expected to edit, proofread, and sign off on his or her final texts. The text of every benefit presented by a participant will appear in the workshop report.

4. **Benefit Synthesis and Task Group Membership.** The final part, following dinner on Day 2, will be for ad hoc working groups to consolidate and synthesize each of the top ten benefits and to recommend individuals to serve on each of the ten task groups. The morning of Day 3 will be devoted to presentation of the working group reports.

APPENDIX O

Workshop Agenda

NATIONAL WATER RESEARCH INSTITUTE

Groundwater Benefits Workshop

January 6-8, 1997

Arnold & Mabel Beckman Center
Irvine, California

FINAL AGENDA

Monday, January 6, 1997

3:15	PM	Bus to Beckman Center	Hotel Lobby
3:30	PM	Registration	Beckman Center
4:00	PM	Introduction	Lecture Room
6:00	PM	Reception and Dinner	
7:30	PM	Workshop Orientation	
9:00	PM	Bus to Hotel	

Tuesday, January 7, 1997

7:00	AM	Bus to Beckman Center	Hotel Lobby
7:15	AM	Breakfast	Beckman Center

Tuesday, January 7, 1997 (continued)

8:00 AM	Session I - Benefit Identification	Lecture room
12:00 PM	Lunch	
12:45 PM	Session II - Consolidation	
4:00 PM	Session III - Priority Ranking and Text Approval	
5:00 PM	Session IV - Benefit Synthesis and Task Group Membership	
6:00 PM	Dinner	
7:00 PM	Working Groups	Breakout Rooms
9:00 PM	Bus to Hotel	

Wednesday, January 8, 1997

7:00 AM	Bus to Beckman Center	Hotel Lobby
7:15 AM	Breakfast	Beckman Center
8:00 AM	Session V - Developing Action Plan	Lecture Room
9:00 AM	Presentations	
10:15 AM	Break	
10:30 AM	Presentations	
12:00 PM	Lunch	
1:00 PM	Bus to Hotel	

APPENDIX P

Benefit Identification Form

Please duplicate this form as required *Please print or type*

Benefit Identification Form
for
Groundwater Disinfection Rule Benefits Workshop
Tuesday 7 January 1997

Name: _____

Organization: _____

Workshop Question: *What are the most significant benefits that should be considered in the development of the final Groundwater Disinfection Rule?*

Title: (20 words maximum)

Limit to space provided below and to a three-minute oral presentation at the workshop

Benefit Description: (What is the benefit, or service, provided? Also, identify longer-term benefits 10-20-30 years)

How to Measure the Effect(s) of the Benefit (What are the physical, chemical, geological, hydrological, biological, or socialogical effects of changing the availability of the benefit (or service).

How to Value the Benefit (What methods can be used to monetize the value of the benefit or service?)

NWRI 9 December 1996

APPENDIX Q

Consolidation Worksheet

Consolidation Worksheet

for

Groundwater Benefits Workshop

Your Benefit #:_____

Other benefits which could be consolidated with this one:

#_____ Originator:_____

#_____ Originator:_____

#_____ Originator:_____

#_____ Originator:_____

APPENDIX R

Issue Ranking Sheet

Priority Ranking Form

for

Groundwater Benefits Workshop

(1 = Highest to 10 = Lowest)

Your Benefit Rank	Benefit Number
1.	_____
2.	_____
3.	_____
4.	_____
5.	_____
6.	_____
7.	_____
8.	_____
9.	_____
10.	_____

Name (Please Print):_____

Signature:_____

PART 2

Action Planning

ACTION PLANNING

Goal of Action Planning

The action planning phase followed immediately Part 1 of the workshop to capture the participants' ideas and products of their discussions that had just taken place. Stated differently, the action planning step was designed to "jell" the participants' thinking and to elicit additional thoughts from all participants after "sleeping on it."

The action planning process produced useful results that are presented in this section. Each of the top ten priority benefits was addressed by a small Working Group comprising two or three individuals, usually those who proposed the benefits. The following sections, augmented by appendices, describe the process.

Appointment of Working Group

Immediately after completion of the priority rankings, the workshop secretary and chair compiled and analyzed the results. This process involved entering into a computer program the ranking data by each of the 24 participants who were classified into seven subgroups described in Part 1 of this report. Those reports, including strenght of feeling data, are included in Appendices D, E, F, G, H, I, J, and K.

Working Groups were formed for each of the top ten priority issues and membership typically comprised individuals who had proposed one of the benefits subsumed under that priority benefit. Once a participant was assigned to the highest priority Working Group to which he or she contributed, they were not assigned to a lower priority benefit Working Group. This meant that several of the lower priority benefit Working Groups comprised participants who had not contributed to that particular benefit. In the following Working Group reports, the names of the Working Group members are listed alphabetically.

Working Group Deliberations

On Wednesday morning, the top ten priority benefit titles were posted on the wall with the names of Working Group members listed below each. The workshop chair then reviewed the Working Group Action Plan Guidelines (Appendix T) with the participants. A chair was designated for each Working Group. Working Groups were assigned a separate meeting room and asked to convene immediately. Working Groups were provided format guidelines for the scope and length of their written reports (Appendix U).

Agenda

Due to the longer-than-anticipated consolidation phase that took place the previous evening, the Wednesday schedule was revised (Appendix S).

Working Group Presentations and Discussions

At 9:30 a.m. on Wednesday, Working Group presentations began with Priority 1. Each group was allowed five minutes for their presentation followed by five minutes for discussion.

Following the discussion period after each presentation, participants were asked to make recommendations that would enhance the Working Group report, and recommend additional members for the Task Groups that were to be appointed the following week. Participants were provided *Working Group Presentation Comment Forms* shown in Appendix V.

The Next Step

The NGT Workshop with benefit identification and prioritization elements, as well as the action planning component, has laid the groundwork for the further development and valuing of the benefits identified in this workshop. **The next step will be to appoint Task Groups comprising six to ten individuals.** It is important to the success of the Task Groups that they be legitimate in the eyes of all potential critics. Task Groups will be appointed by NWRI and will be led, wherever practical, by an individual who participated in this workshop.

The Task Groups will be given approximately six weeks to confer as needed to prepare individual reports on their assigned benefit. These reports should be brief and focused, but must contain greater detail than the Working Group reports. The most important aspect of Task Group reports that distinguishes them from the Working Group reports given in this document is the level of detail that describes methods to value benefits and a demonstration of the method through one or more numerical examples. Guidelines for Task Groups are given in Appendix W.

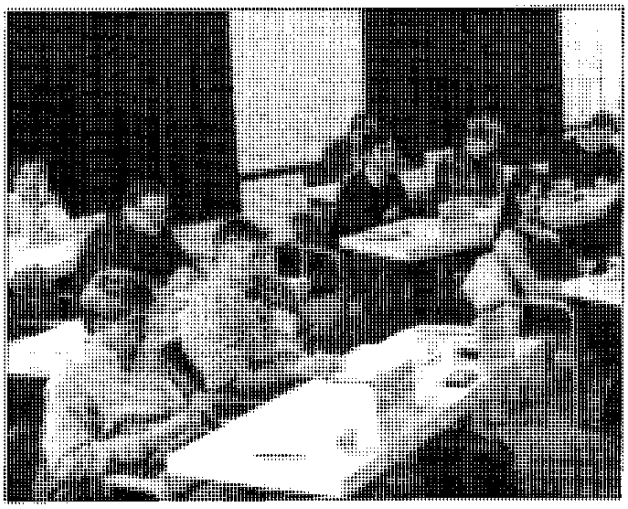
The presentation of Task Group reports will be made at the Benefits Conference scheduled to be held at the Arnold and Mabel Beckman Center of the National Academies of Science and Engineeering in Irvine, California on Monday, March 17th. This will be an all-day meeting following the agenda given in Appendix X. Representatives from all fifty states will be invited by the NWRI, as will recognized experts from the disciplines associated with groundwater issues.

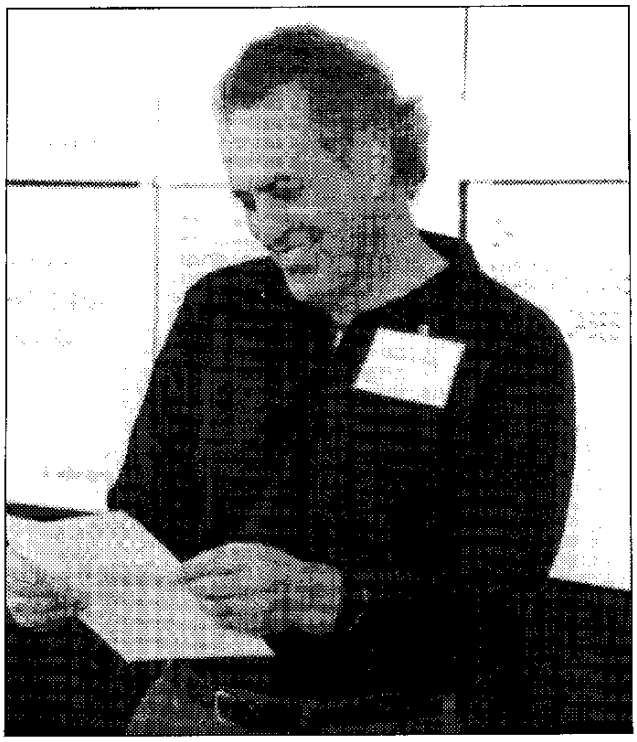
Working Group Reports, Comments and Visuals on the Ten Highest Priority of Benefits

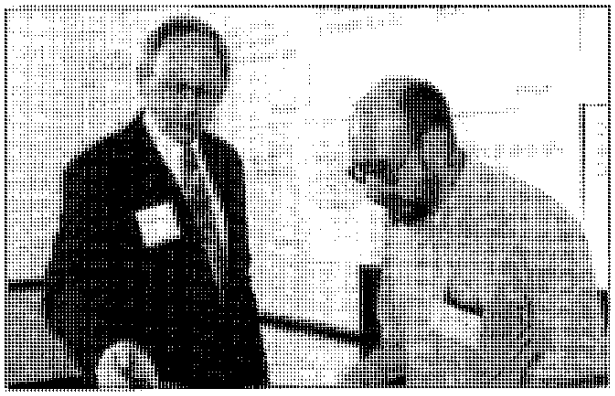
Notes:

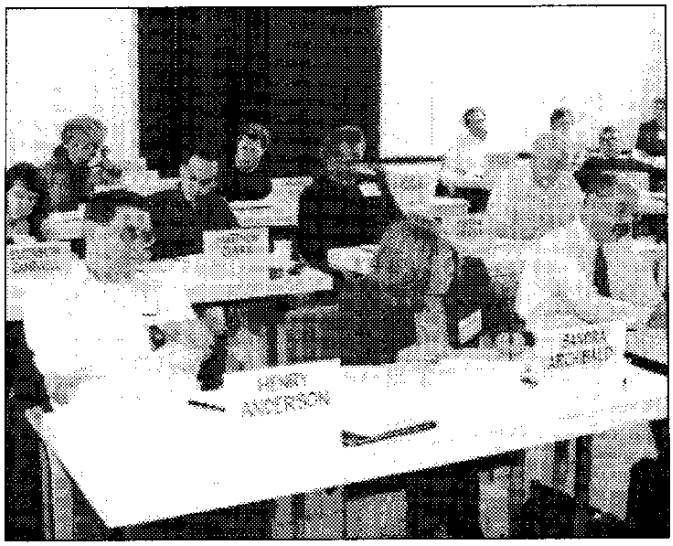
1. The following ten reports were prepared by ten separate Working Groups. Membership of each Working Group is given at the beginning of each report.

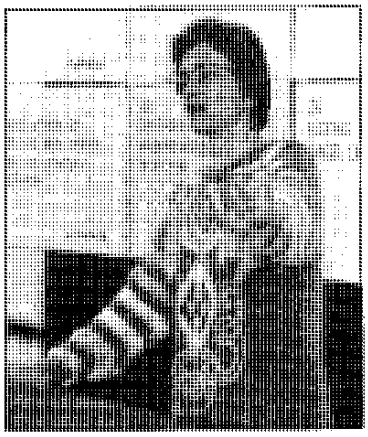
2. Signed recommendations for the enhancement of each report are presented after those reports that elicited written comments.








HENRY
ANDERSON



WORKING GROUP REPORT: 1

Reduced Risk of Waterborne Illness

WORKING GROUP MEMBERS:
Drago, Gerba, and Raucher

Benefit Description:

Risk reduction through control of exposure and re-exposure to pathogenic organisms in groundwater would include reductions in acute and chronic morbidity, disability and mortality in the general population and sensitive subpopulations (e.g., infants, elderly, diabetics and immuno-compromised). Resulting benefits would include lower health costs, increased worker productivity and leisure time, and reduced reliance on bottled and boiled water.

These benefits would be expected to continue over the long term. In addition, risk reduction may also be protective for emerging pathogens.

How to Measure the Effect(s) of the Benefit:

The major measurement challenge is to develop a baseline correlation between microbial contamination of groundwater and waterborne health effects using the endpoints of morbidity, mortality, and disability for both the general population and sensitive subpopulations. Baseline risk assessment and epidemiological studies (with retrospective follow-up studies after rule implementation) and probabilistic models are suggested as methods to develop these estimates. These estimates need to indicate the distribution of health impacts according to the duration and severity of illness and age of the affected. Once the occurrence estimates are made, measurements of expected reductions in societal costs (lost time and wages/productivity), medical treatment expenses, and loss of life would be developed.

How to Value the Benefit:

Willingness to pay (or accept compensation) is the appropriate valuation concept. Contingent valuation and hedonic (e.g., wage-based) studies could be used to estimate the willingness to pay (WTP) for actions that reduce the risk of waterborne illness. Specific values for benefits will vary depending on the type of risk reduction and the affected population. Morbidity and disability can be addressed by these methods to estimate the WTP to avoid various symptomatic effects. Cost-based measures such as lost wages/productivity and medical treatment expenses can be used as proxy benefit values for the general public (to the extent that reliable WTP estimates are not available), while lost wages/productivity may not be appropriate for sensitive subpopulations. Mortality would be addressed by existing or newly derived value(s) of a statistical life saved based on WTP concepts and using calibrated quality adjusted life years. Multiple valuation approaches should be employed to provide a weight of evidence for values and to enable comparisons across values derived by the different methods.

Recommended Task Group Membership:

- Microbiology
  - — Joan Rose — Department of Marine Science, University of South Florida
  - — Charles Haas — Drexel University
  - — Hubert Dupont — University of Texas Medical School
  - — Mark LeChaviller — American Water Works Services Company

- Economists
  - — Kip Viscusi — Harvard University
  - — Bill Schulze — Cornell University
  - — Laurie Chestnut — Hagler Bailly
  - — V. Kerry Smith — North Carolina State University

- Epidemiologist
  - — Pierre Payment — University of Quebec
  - — Floyd Frost — Lovelace Institute
  - — Gunther Craun — Virginia Poly Tech

Comments:

"This is an opportunity to try out and compare different valuation techniques. This is a good opportunity to actually measure averting behavior (bottled water) and avoided costs and to compare with contingent valuation outcomes."
– Sandra Archibald

"Make a clear distinction between illness, disease and mortality, to make it clear to whom the benefits accrue (particularly susceptible sub-populations)."
– Michael Barcelona

"More detailed consideration of how value would be useful. This is an area that merits a look at innovative methods." – Elizabeth Cantwell

"Develop a contingent valuation survey and gather data on the distribution of severity and duration of each symptomatic endpoint, and for mortality — age of infected population." – Matthew Clark

"Modeling should be only 20 percent or less of total effort." – Anita Highsmith

"Significant work needs to be done on method for valuing morbidity." – Jeff Lazo

"Valuation of WTP using hedonics as well as contingent valuation methods. Compare results of multiple valuation methods (e.g., compare hedonic < - > CVM < - > averted costs, etc.)." – Robert Raucher

"Use EPA data compiled from State Compliance Reports for estimates of population exposed and an estimate of the potential number of people impacted."
– Roger Selburg

"Clarify 'disability.' It may not be obvious to many readers .... Morbidity and mortality are generally better understood." – Mic Stewart

"Do people switch to bottled water because of safety or because of taste issues?"
– Marylynn Yates

View Graphs Used In Working Group Presentation

Reduced Risk of Waterborne Illness

Benefits

- Reduction in illnesses
  - morbidity
  - disability
  - mortality
- Reduction in use of bottled and boiled water

Measures of Effects

- Occurrence of microbial contamination (baseline risk)
  - risk assessment
  - epidemiological data
  - surveillance
  - probabilistic modeling
- Expected risk reduction

Valuation

- Willingness to pay with contingent valuation
  - endpoint specific
- Cost-based measures as proxy
  - cost of medical treatment
  - lost work and leisure time
  - averting costs (e.g., bottled water)

Reduced Risk of Waterborne Illness

Recommended Task Group Membership

- Microbiologists
  - Joan Rose, Department of Marine Sciences, University of South Florida
  - Charles Haas, Drexel University
  - Hubert Dupont, University of Texas Medical School

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View Graphs Used In Working Group Presentation

- Mark LeChaviller, American Water Works Services Company

- **Epidemiologists**
  - Pierre Payment, University of Quebec
  - Floyd Frost, Lovelace Institute
  - Gunther Craun, Virginia Poly Tech

- **Economists**
  - Kerry Smith, NC State University
  - Bill Shulze, Cornell University
  - Laurie Chestnut, Hagler Bally
  - Kip Viscusi, Harvard Univ.

WORKING GROUP REPORT: 2

Increased Reliability and Availability of Groundwater Systems

WORKING GROUP MEMBERS:

Bennett and Cantwell

Benefit Description:

- Reduced probability of incurring costs associated with system failures.

- Long-term:
  - — Reduced transaction costs.
  - — Reduced probability of intermittent system failure.
  - — Reduced probability of catastrophic failure.
  - — Improved consumer confidence and willingness to pay.

How to Measure the Effect(s) of the Benefit:

- Estimated reduction in failure probabilities from without regulation baselines.
- Reductions in number of microbiological violations.

How to Value the Benefit:

$$\sum_{i=1}^{N} \cdot (P) \; F_i * C_i$$

Where:

F_i = Failure events

C_i = Cost associated with F_i

i = Types of events

- minor

- major

Recommended Task Group Membership:

- Reliability expert (energy, water).
- Major water system engineer (with groundwater in system) with experience in failure event costs.
- Small water systems expert.
- Costing engineer.
- Distribution maintenance expert.
- Cross-connection expert.
- Reduced failures in the water system.

Comments:

"What is source water protection from microbial contamination? What are the costs? We need to be looking at net benefits." – Sandra Archibald

"Include some discussion of the relationship between reliability and availability as a function of time and how the design, especially Action II, will increase reliability. Include the concept of up-states and down-states and how one can take steps to minimize occurrence of down states?" – Jonathan Bulkley

It is important that input from a range of water utility sizes be solicited so that the ability of utilities to provide reliability be understood. When this effort was tried under the clean water grants program in the 1970's it was determined that reliability features were too expensive for USEPA to fund." – Joseph Drago

Terms should be carefully defined to avoid different meaning within different disciplines. – Erin Flanagan

"Issue needs to be more clearly defined. Reliability of microbial removal by disinfection processes versus no disinfection should be considered." – Charles Gerba

"Shouldn't there be some reference as to who is responsible for system reliability - such as who does cross connection backflow surveillance. Often there are gaps in monitoring and surveillance because responsibility for these tasks has not been clearly defined or agreed to." – Gerald Hansler

"Contingent valuation to value individuals' perceptions of and willingness to pay for preventing, avoiding, or reducing water systems failure (avoid incidences of crisis of obtaining alternative water supply)." – Jeff Lazo

View Graphs Used In Working Group Presentation

Increased Reliability & Availability of Groundwater Systems

- **Avoided costs**
  - **Capital, O & M, Failure Event Response**
  - **Association with response to violations (transaction costs)**

- **Reduced probability of failures**

$$\sum_{i=1}^{N} (P)_{\text{Failure event}_i} * C_{i\ \text{Cost of Failure event}}$$

- **Issues associated with system failures:**
  - **Design & construction**
  - **O & M**
  - **BMP**
  - **Regulatory data gathering**
  - **Sanitary surveys**

WORKING GROUP REPORT: 3

Prevent Microbial Contamination of the Source Water

WORKING GROUP MEMBERS:

Flanagan and Blomquist

Benefit Description:

- Implement a microbial source water protection approach that would include:
  - — Identification and measurement of the presence and volume of microbial contaminants.
  - — Identification and control or reduction of sources likely to contribute microbial and co-occurring contaminants.
- This approach would yield the following benefits:
  - — Maintain and preserve source water quality.
  - — Reduce the risk to human health from microbial contamination, co-occurring contaminants, and disinfection by-products.
  - — Increase the coordination of wastewater and drinking water programs.
  - — These activities, in conjunction with an ongoing monitoring program, will optimize the utilization of water and land resources and reduce the risk to human health from microbial pathogens.

How to Measure the Effect(s) of the Benefit:

- Routine monitoring with enforceable standards.
- Reduced contamination of groundwater by pathogenic organisms.
- Identify and measure changes in the health effects of microbial and co-occurring contaminants.
- Reduced costs and greater efficiency of wastewater and drinking water programs.
- Reduced need for treatment or replacement of source water.

How to Value the Benefit:

- Reduction in the cost of treating for microbial and co-occurring contaminants in source water protection areas.
- Reduction in the health costs associated with microbial and co-occurring contaminants in populations served by public water supply systems with source water protection programs.
- Reduction in downstream treatment costs.
- Avoided costs of replacing uncontaminated aquifer storage or stream flow contributed by an aquifer.
- Increased property values.

Recommended Task Group Membership:

- Bill Blomquist
  Indiana University
- Erin Flanagan
  USEPA
- Edna Loehman
  University of Arizona
  Agriculture/Economics department or school
- Susan Seacrest, President
  Groundwater Foundation
  (402) 434-2740
  PO Box 22558
  Lincoln, NE 68542-2558
- Jon Witten, AICP
  Horsley and Witten
  (508) 362-5570
- Michael Bradley
  Hydrogeologist
  School of Geology
  University of Arizona

Comments:

"Hope that you can emphasize the necessary linkage between wastewater and drinking water treatment regulatory programs." – Michael Barcelona

"... the increase in property value where the groundwater is protected may be particularly relevant to new developments - the property value may not be as directly tied to protection groundwater if the contaminated groundwater can be replaced by a treated supply from a central source." – Jonathan Bulkley

"May want to consider the value to water utilities of not installing treatment where it is currently not practiced, as this adds a new element to water utility operations." – Joseph Drago

"Counting increased property values could result in double counting of benefits." – Kenneth Frederick

"Define safe distances between production wells and contaminate sources." – Charles Gerba

"Suggest a definition of 'source water' up front. Is source water surface water prior to recharging groundwater or is it the groundwater prior to being withdrawn (or both)?" – Roy Herndon

"Separate monitoring from surveillance since in cases these efforts are carried out by different groups. Value of reduced illness may be difficult to measure since a) some persons do not see a physician, and b) State Health departments may not document." – Anita Highsmith

"Source water protection can generate existence values as it will (may) lead to uncontaminated water which no one will ever use." – Jeff Lazo

"Due consideration will be required to prevent double counting to the extent that increased property values embody reflects for other categories, e.g., reduced health risks." – Robert Raucher

"Prevention of contamination of groundwater sources may require concerted effort with other entities ... and integration with other regulations .... It may be necessary to empower regional and/or state level regional water-agencies to oversee the effort ..." – Mic Stewart

"The connection between wastewater disposal and drinking water needs to be strengthened this is a real opportunity to enhance coordination that is badly needed in most areas." – Marylynn Yates

View Graphs Used In Working Group Presentation

Prevent Microbial Contamination Of The Source Water

Benefit description:

- Maintain/preserve source water quality
- Reduce human health risks from microbial contamination and disinfection by-products
- Improve coordination of wastewater and drinking water programs
- Optimize use of land and water resources
- All of these are long-term benefits

Measuring the benefits:

- Routine monitoring of source water quality against enforceable standards
- Reduced contamination of source groundwater by microbial pathogens
- Reduced adverse health effects from microbial contamination of source water
- Reduced need to treat or replace source groundwater
- Reduced costs and improved efficiency of wastewater and drinking water programs

How to value the benefits:

- Reduced water treatment costs in systems supplying protected source water
- Reduced costs of medical treatment resulting from microbial or co-occurring contamination
- Reduced downstream treatment costs where protected groundwater discharges to surface
- Avoided replacement costs
- Increased property values

WORKING GROUP REPORT: 4

Comprehensive Quality Assurance Plan for Assessing the Quality of Drinking Water

WORKING GROUP MEMBERS:

Dufour and Highsmith

Benefit Description:

Quality assurance for drinking water systems can include monitoring water to ensure the quality of the product or monitoring the treatment process to ensure that it is operating properly. The benefits of quality assurance should apply to all systems. A quality assurance plan includes methods to specifically detect and quantify indicators and pathogens that would present clear evidence of a waterborne hazard. This may require the development of new methods, especially for emerging pathogens. This benefit will also
establish valuable databases of monitoring information.

How to Measure the Effect(s) of the Benefit:

The benefit of a clear, reliable, scientifically-defendable means of measuring the efficiency of the drinking water treatment process or the quality of the product would be an increase in public confidence, greater use by regulatory authorities, and minimal false alarms with respect to the degradation of drinking water quality.

Standardized quality assurance guideline for maintaining the quality of the water.

How to Value the Benefit:

Cost savings due to more effective monitoring tools. Increased lead time in public notification. These two benefits can be valued by requiring routine recording of monitoring data.

Public confidence and regulatory authority acceptance are a definite benefit but are difficult to measure.

Recommended Task Group Membership:

- Betty Olson, UCI
- Anita Highsmith, CDC
- Pat Seyfried, UT, CAN
- Gene Rice, EPA
- Gary Toronzos, UPR
- Pierre Payment, CAN
- Al Dufour, EPA
- Gordon McFeters, UM
- George Alford, Alford, Inc.
- Jerry Stelma, EPA
- Sue Binder, CDC
- Shay Fout, EPA

Comments:

"I would suggest that some effort be given to identify minimum data quality objectives for current methods and what could be expected from newer developing methods." – Michael Barcelona

Insure that any findings of the task group are crafted to encourage the development of new monitoring technologies and not stifle those possibilities."
– Elizabeth Cantwell

"Are the net costs of monitoring to assure quality in all small systems always positive? Implementation costs are not mentioned." – Kenneth Frederick

"Cost/benefits of monitoring - how often you sample vs. illness saved - those types of studies have been done for microbial sampling food supply ... consider the HACCP used in the food industry." – Charles Gerba

"... there should be more emphasis on elements of a required monitoring program: types of microbes to be tested; infective concentration triggers; frequency and location of sampling based upon profile of system." – Gerald Hansler

"Remove the lab method approval process from the regulations to a separate process that uses a demonstration/approval process." – Roger Selburg

"... include a component which addresses methods development." – Mic Stewart

View Graphs Used In Working Group Presentation

A Comprehensive Quality Assurance Plan for Assessing the Quality of Drinking Water

Benefit Description:

- Ensure quality of product or process
- Applies to all systems
- Highly specific methods for monitoring water quality
- Methods developed for indicators, pathogens and emerging pathogen

Measure Benefits:

- Reliable, scientifically defendable means of measuring the efficiency of the drinking water treatment process or the quality of the product
- Standardized quality assurance guideline for maintaining the quality of the water

Value of Benefits:

- Cost saving due to highly efficient monitoring tools
- Increased lead time to public notification
- Increased public confidence

Recommended Task Group Membership:

Betty Olson, UCI
Anita Highsmith, CDC
Pat Seyfried, UT, CAN
Gene Rice, EPA
Gary Toronzos, UPR
Pierre Payment, CAN
Al Dufour, EPA
Gordon McFeters, UM
George Alford, Alford, Inc.
Jerry Stelma, EPA
Sue Binder, CDC
Shay Fout, EPA


BOB
RAUCHER
GERALD
HANSLER

WORKING GROUP REPORT: 5

Upgrade State, Local and Utility Surveillance Programs to Obtain Critical Microbial Information to Make Cost-Effective Decisions

WORKING GROUP MEMBERS:

Bulkley and Hansler

Benefit Description:

Enhanced surveillance and monitoring programs will provide an improved basis for decision making on where to place available public resources and which remedial options will provide the most benefit to the public. The benefit will accrue particularly for small non-community systems which may have little technical basis for decision making at the current time. The regular and periodic surveillance activity will produce the data which documents a time-history picture of contamination or the absence of contamination in these groundwater systems.

How to Measure the Effect(s) of the Benefit:

- Cost savings in applying disinfection where needed versus treating across the board.
- The percentage decrease of pathogenic microbes in groundwater-supplied public water systems over time.
- The percentage increase of groundwater-supplied public water systems which meet national standards over time.
- The reduction in waterborne disease incidence by state and county considering the various types of groundwater systems such as large/small community, factory, transient, and individual over time.

How to Value the Benefit:

- Avoided costs of providing disinfection systems where they are not needed.
- Avoidance of illness (lost school/work days, health/hospital costs, lost leisure days) and mortality due to provision of disinfection where it is needed.
- Avoided litigation and settlement costs due to contaminated water and consequences thereof.

Recommended Task Group Membership:

- Bill Marrazzo, President, Weston Co., Westchester, Pennsylvania
- Tim Weston, Attorney, Harnsburg, Pennsylvania
- Pete Johnson, Ret. Ex.Mgr. of Investor owned Utility, Artesian Water Co., Newark, Delaware.
- Russell Harding (or his representative), Director, Michigan Department of Environmental Quality, Lansing, Michigan.
- Michael Schock, USEPA, Cincinnati, Ohio

Comments:

"There should be a mechanism to identify effective disinfection (useful for small systems) which do not interfere with corrosivity/lead control or water stability in the distribution system." – Michael Barcelona

"Would the enhanced data on groundwater contamination also benefit researchers who would not have to collect or estimate these data themselves? If so, then either the lower cost or greater/faster production of water quality research may be a benefit." – William Blomquist

"Cost effectiveness would also depend on the implementation costs of improve surveillance ..." – Kenneth Frederick

"Important to evaluate untreated water as well as treated water. Need data on pathogens, not just indicators - important for risk analysis." – Charles Gerba

View Graphs Used In Working Group Presentation

Upgrade State, Local, and Utility Surveillance Programs to Obtain Critical Microbial Information to Make Cost-Effective Decisions

Benefit Description:

- Improved basis for decision making
- Small non-community systems
- Regular surveillance-time history contamination

Measure Benefits:

- Cost savings
- Decrease pathogenic microbes
- Increase of groundwater systems meeting WQ Standard
- Reduction in waterborne disease

Value of Benefits:

- Avoided costs of disinfection systems
- Avoidance of illness
- Avoidance of litigation

Task Group Membership:

Bill Marrazzo, President
Weston Company

Tim Weston, Attorney

Pete Johnson, Ret.
Artesian Water Company

Russell Harding, Director
Michigan Dept. of Env. Qual.

Michael Schock
USEPA

WORKING GROUP REPORT: 6

Benefits of Integrating Public Health Information on Waterborne Disease with Water Management and the Regulatory Process

WORKING GROUP MEMBERS:

Anderson, Archibald, and Stewart

Benefit Description:

There are benefits to developing relationships between the public health community, the water industry and regulators. Shared information on the incidence of waterborne disease can ensure that uncertainty about health risks is reduced and that the appropriate resources are allocated to meet priority needs.

Information is needed on how much of the observed disease is attributable to drinking water. Studies to provide this information are being conducted in part by the EPA. It is recommended that regulations concerning groundwater currently under development include mechanisms for ongoing surveillance to refine standards and monitoring requirements, as appropriate. This would ensure that resources are allocated to priority problems. As the endemic rate of waterborne disease is reduced, the costs for further reductions increase. At that time, resources might be better spent on other non-water-related problems. This information would help regulators focus regulatory pressure on the areas of greatest threat to human health. For example, if a significant amount of waterborne illness results from day-care centers rather than the groundwater supplies, the incidence could continue to increase despite investments in further treatment of groundwater.

Information on the incidence and severity of waterborne disease should be gathered from health data and mechanisms developed to provide this information to water managers who could increase monitoring and/or take corrective actions, as necessary. This could result in a change of treatment. The information could also be used to modify regulations to refine the protection of public health. It could also be used to adjust or modify resource allocations to a higher priority problem; the goal would be to match resources with problems. For example, if observed incidences are non-water-related, there should be the flexibility to reallocate resources.

This information could also assist the EPA to validate predictive models. Another benefit would be to change baseline occurrences.

Public health agencies need to examine their systems of data collection to ensure that the data collected is useful to water managers and regulators. The systems need to be able to facilitate feedback of health effects to the regulatory process. For example, if water managers received information from the health community that there appeared to be an increased incidence of health effects, additional treatment or monitoring could then be undertaken.

How to Measure the Effect(s) of the Benefit:

- Avoided costs from unnecessary or inappropriate treatment.

How to Value the Benefit:

- Maximized reduction of overall morbidity and mortality in the community.
- Greater confidence in the regulatory process.
- Reduced costs of alternative water supplies or treatments (e.g., averting behavior - switching to higher cost supplies and/or treatment).

Recommended Task Group Membership:

- Water managers
- Infectious disease epidemiologists
- Health care industry (managed care)
- Economists
- Regulators: state and federal
- State laboratory representatives

Comments:

"Valuing (monetizing) the benefits could be addressed more specifically or directly. For example, greater public confidence in regulatory process is a benefit; how would we assign a non-zero value to that benefit?" – William Blomquist

"Reduction of risk and uncertainty has specific benefits which should be included here. This priority also falls under the idea of the value of information which is an important area in economics." – Jeff Lazo

"What happened to the part about reducing uncertainty of incidences and severity? The idea is a good one, but how can it be implemented?" – Marylynn Yates

View Graphs Used In Working Group Presentation

Benefits of Integrating Public Health Information on Waterborne Disease with Water Management and the Regulatory Process

Benefits:

- Appropriate allocation of resources to meet priority health needs
- Efficient use of regulatory resources
- Reduced waterborne disease and other health risks

- Streamlines regulatory process through continuous feedback

Measurement of benefits:

- Avoided cost of unnecessary or inappropriate treatment

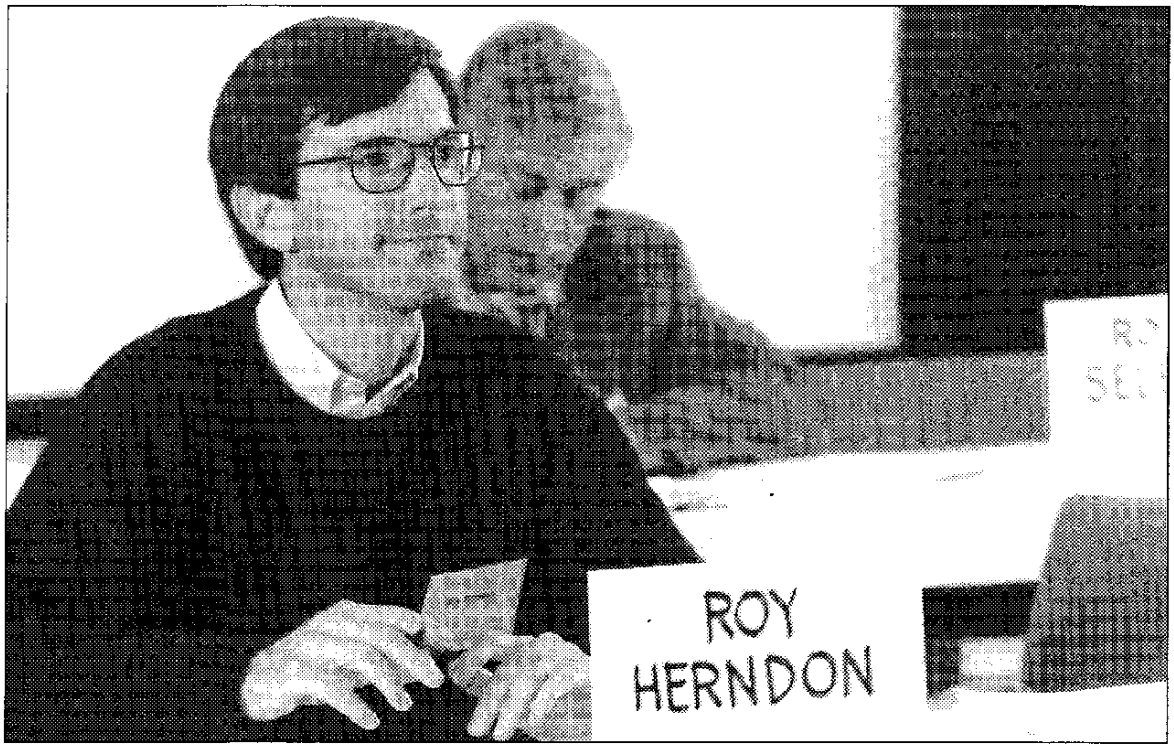
Value:

- Maximized reduction of overall morbidity and mortality in community
- Greater confidence in regulatory process
- Reduced costs of alternative water supplies or treatments

- Reduced litigation

Task Force:

1. Water managers
2. Infectious disease epidemiologists
3. Health care industry (managed care)
4. Economists
5. Regulators - state and federal
6. State laboratory representative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WORKING GROUP REPORT: 7

Reduced Waterborne Disease Due to Identification of and Response to Wells that Pose the Maximum Threat to Public Health

WORKING GROUP MEMBERS:

Herndon and Job

Benefit Description:

- Immediate positive impacts on public health can be attained by focusing on:

  Category 1 wells with positive indicators of microbial contamination.
  Category 2 wells with a high probability of future microbial contamination from:

  a) poor well construction or maintenance
  b) close proximity to contaminant sources
  c) location within sensitive hydrogeologic environment

- Once these wells have been identified, the following actions can be taken:

  Category 1: close or treat
  Category 2:

  a) close, improve, maintain, relocate, treat
  b) manage or relocate contaminant sources, treat
  c) manage or relocate contaminant sources, treat

- These actions, particularly for Category 1 wells, should produce an immediate reduction in risk of illness for the exposed population.
- For Category 2 wells, the long-term health risk for the potentially-exposed population would be greatly reduced.

How to Measure the Effect(s) of the Benefit:

- For Category 1 wells, the number of systems with microbial contamination may be estimated based in part on current violations. Public health experts will be consulted on probability of illness.
- For Category 2 wells, a project should be initiated to determine the number of wells with construction and/or maintenance problems; that are close to microbial contaminant sources, in sensitive hydrogeologic settings and the potentially-exposed population; and, then assign a risk contamination to each factor. Finally, after consulting health experts, potential health effects will be projected.

How to Value the Benefit:

- Contingent valuation could be used to value these imminent or potentially close-in-time health effects for Category 2 wells.
- For wells in sensitive hydrogeologic settings, estimating costs avoided for treatment or well relocation.
- For health effects, estimating loss of income, loss production, medical costs and other costs.

Recommended Task Group Membership:

- Roy Herndon, OCWD
- Chuck Job, USEPA
- John Bergstrom, University of Georgia
- Kevin Boyle, University of Maine
- Maureen Cropper, Resources for the Future
- Fletcher Driscoll, Geraghty and Miller
- George Hallberg, Iowa State Laboratory
- Anita Highsmith, CDC
- Richard Overmyer, Michigan Noncommunity program

Comments:

Category 1 Wells: measuring the effects of a benefit does not mean measuring the extent of the problem, but measuring the reduction of illness is the benefit you are trying to measure. The next step would be to monetize the benefit. Category 2 Wells: be sure to include the avoided replacement costs or avoided water treatment costs. – William Blomquist

"Use Category 2 wells to develop the information to identify what is causing the contamination. Category 2 wells suggests conditional probabilities, i.e., P (contamination/poor construction), P (contamination/close proximity source), P (contamination/other factors)." – Jonathan Bulkley

"Saying that wells should be identified and ranked raises two issues. The first is what are the primary means of identifying at-risk wells? How can the regulation ensure that these means are undertaken? Secondly, ranking assumes that the regulation somehow addresses the issue of prioritizing risks and resource allocation. The benefit identified relies on prioritization processes occurring up-front. How should the regulation address this?" – Elizabeth Cantwell

"It is important to consider past experiences of water utilities in dealing with microbially-contaminated wells." – Joseph Drago

"Try to identify wells by region." – Charles Gerba

"Why not report system monitoring reports on a daily or weekly basis to local newspapers, like daily air quality reports." – Gerald Hansler

"Need to clarify 'microbial contamination' especially with respect to monitoring schemes. Indicators or direct pathogen monitoring, i.e., what would trigger action?" – Robert Raucher

The challenge is determining those wells with higher probability of being contaminated. What criteria will be used for that determination? – Marylynn Yates

View Graphs Used In Working Group Presentation

Reduced Waterborne Disease Due to Identification of and Response to Wells that Pose the Maximum Threat to Public Health

- **Benefit Description**

  Immediate positive impacts on public health can be attained by focusing on:

  Category 1 -Wells with positive indicators of microbial contamination

Category 2 - Wells with high probability of future microbial contamination from:

a. Poor well construction or maintenance

b. Close proximity to sources

c. Location within susceptible hydrogeologic environment

Once these wells have been identified, the following actions could be taken:

Category 1 - Close or treat

Category 2 - a. Close, treat, relocate, or improve maintenance

b. c. Manage or relocate source(s) or treat

These actions, particularly for Category 1 wells, should produce an immediate reduction in risk of illness for the exposed population.

For Category 2 wells, the long-term health risk for the potentially exposed population would be greatly reduced.

View Graphs Used In Working Group Presentation

How To Measure The Effect

For Category 1 wells:

- Determine population currently exposed
- Consult experts on probability of illness

For Category 2 wells:

- Determine # of vulnerable wells
- Develop contam. risk factor
- Estimate potentially exposed pop.
- Project health effects based on probability of illness by microbe

How To Value Benefit

- Project health effects potentially avoided
- Value incidence and duration of health effects by:
  - Income loss
  - Lost production
  - Medical costs
  - Other, e.g., contingent valuation

WORKING GROUP REPORT: 8

Benefits to Future Generations

WORKING GROUP MEMBERS:

Barcelona and Lazo

Benefit Description:

Groundwater benefits extend over time encompassing all of the benefits identified for the current generation. For instance, current improvements to drinking water systems provide an infrastructure that will generate services to future generations. Intergenerational equity demands that we preserve for future generations equal opportunity for safe drinking water, including preserving uncontaminated aquifers and maintaining resources for water withdrawals at sustainable levels.

How to Measure the Effect(s) of the Benefit:

- The future is inherently unknown. To value benefits to future generations we may need to:
  - — Assume future preferences for safe drinking water are similar to the current generation.
  - — Make forecasts with respect to likely changes in benefits and costs over time.
  - — Identify areas of unknown or uncertain benefits and costs. Many of these are dependent on the successful implementation of groundwater disinfection regulations.
  - — Traditional benefit-cost criteria address the problem of use rates over time by comparing net benefits received in one period with the net benefits received in another period, relying on present value analysis. The present value of a one-time benefit received a year from now is the estimated net benefit in that year divided by $(1 + r)$ where "r" is the discount rate. The higher the discount rate, the greater the amount of the resource that will be allocated to earlier time periods.

How to Value the Benefit:

- Traditional approaches to valuing future services are being questioned. It may not be just a question of "choosing" the right discount rate. There are new approaches being considered to attain intergenerational equity in access to non-renewable and renewable resources.
- Two Approaches:

  — Traditional benefit-cost analysis using a range of discount rates including very low rates to avoid disregarding benefits and costs to future generations.
  — Setting a constraint of sustainable safe drinking water considering projections of future generations' needs and providing flexibility for uncertainty with respect to future conditions (e.g., impacts of climate change).

Recommended Task Group Membership:

- Jeff Lazo, Ph.D. - Pennsylvania State University
- Sandra Archibald, Ph.D. - University of Minnesota
- Bryan Norgard
- Richard Howorth
- Chuck Howe - University of Colorado, Dept. of Economics

Comments:

"Can contingent valuation or some other method be used to estimate the value folks place on having choices, options, and flexibility? If so, and if we also are assuming that future generations have the same preference structures as the current generation, then instead of leaving the flexibility value in the future while discounting all other values, why not incorporate the CVM-estimated value into the current generation's preference structure (which would raise the total value) and then extend the value into the future with discounting?" – William Blomquist

"Could the group discuss the implications of a zero discount rate or even a negative discount rate? Under what conditions, if any, do these concepts become relevant in terms of water, i.e., a life-sustaining resource for which there is no substitute." – Jonathan Bulkley

"The following should be considered by the working group: stock vs. flow relationships; 'green' accounting; optimal depletion rate." – Matthew Clark

"Discount rates are critical and use of a 'low' rate needs careful justification. Changes in productivity and technical progress are relevant to intergenerational equity." – Kenneth Frederick

View Graphs Used In Working Group Presentation

Benefits to Future Generations:

- **Benefits & costs extend over time**
- **Future is unknown**
- **Similar preferences for safe drinking water**
- **Intergenerational equity**
- **Same benefits as now**

How to measure:

- **Extend current methods into future**
- **Forecasts with respect to likely changes in benefits and costs**
- **Identify areas of uncertainty**

How to value:

- **Same methods as defined by other groups**
- **Traditional benefit-cost analysis**
- **Low discouut rates**
- **Set constraint at sustainable safe drinking water**
- **Provide flexibility for future generations (e.g., climate change)**

Task force membership:

Jeff Lazo, Pennsylvania State Univ.

Sandra Archibald, University of Minnesota

Chuck Howe, University of Colorado

Bryan Norgard

Richard Howorth

WORKING GROUP REPORT: 9

Improved Approaches to Developing Drinking Water Regulations

WORKING GROUP MEMBERS:

Frederick, Macler and Selburg

Benefit Description:

The approaches used to craft a groundwater disinfection regulation could be used to yield substantial improvements to all subsequent drinking water regulations. The ultimate benefits include enhanced public health protection, state and utility acceptance and implementation, and public perception of drinking water safety.

- Specific benefits to regulatory development include:

  — The use of best science in decision-making.
  — Implementation of regulations.
  — Minimized transactional costs.
  — Efficient use of available resources.
  — Early issues understanding via stakeholder participation.
  — Overt and full consideration of costs and benefits.
  — Identification of data gaps and potential problems to promulgation.

How to Measure the Effect(s) of the Benefit:

- Cost effectiveness could be measured by comparing illnesses and deaths prevented per dollar spent in response to regulations among all groundwater supply systems.
- Cost savings could be estimated for different regulatory schemes from the cost of defending lawsuits filed in response to those regulations.
- Time costs or opportunity costs for regulators, water managers, and citizens or advocates can be used to measure net benefits or costs of different regulatory schemes.
- Regulatory infractions could be monitored or estimated for different regulatory schemes. EPA data bases could be used.
- Leisure time and worker productivity can be differentially estimated for regulatory alternatives.

How to Value the Benefit:

- Quantification and valuation of time and resources spent in lawsuits.
- Contingent valuation of willingness to pay for improved health.
- Estimation of costs for implementation of different regulatory schemes.
- Valuation of fewer sick days by marginal productivity, cost of care, cost of bottled water, etc.
- Valuation of leisure time and worker productivity.

Recommended Task Group Membership:

- Ephraim King, USEPA, OGWDW
- Sandra Archibald, University of Minnesota
- Peter Shanaghan, USEPA, OGWDW
- Dave Leland, OR DOH
- Dave Terry, MA DOH
- Bruce Macler, USEPA, OGWDW
- Roger Selburg, USEPA, DPWS
- Ken Frederick, RFF

Comments:

"One of the measures of improved regulatory development could be a reduction in the frequency with which published rules are challenged or even enjoined from enforcement." – William Blomquist

"Including representatives of interest groups and the regulated community could shed light on avoidance of (or triggers for) lawsuits." – Joseph Drago

"Another benefit will be the avoidance of lawsuits contesting the promulgated regulation if a good spectrum of stakeholders had an integral hand in developing that regulation." – Gerald Hansler

"Suggest following individuals for one year to predict health effects, etc."
– Anita Highsmith

View Graphs Used In Working Group Presentation

Improved Approaches to Developing Drinking Water Regulations

Benefits:

- **Public health protection will be improved**
- **"Good science" will be used**
- **Regulations will be implementable**
- **Transactional costs will be minimized**
- **Available resources will be efficiently used**

- **Early stakeholder participation**
- **Benefits and costs will be overtly and completely considered**
- **Data gaps and potential problems will be identified and addressed**

Measuring Benefits

- **Monitor state implementation programs for infractions**
- **Estimate differential sick days, leisure time, health costs, worker productivity for regulatory alternatives**

Valuing Benefits

- **Quantification of time spent in lawsuits**
- **Contingent valuation of willingness to pay for improved health**
- **Estimation of costs for implementation of different regulatory schemes**
- **Valuation of fewer sick days by marginal productivity, cost of care, cost of bottled water, etc.**

View Graphs Used In Working Group Presentation

Task Group Membership

Bruce Macler, USEPA

Roger Selburg, USEPA

Ken Frederick, RFF

Ephraim King, USEPA

Peter Shanaghan, USEPA

Sandra Archibald, University of Minnesota

Dave Leland, OR DOH

Dave Terry, MA DOH

WORKING GROUP REPORT: 10

Avoiding Disinfection by Identifying Wells with Adequate Natural Protection

WORKING GROUP MEMBERS:

Mills and Yates

Benefit Description:

The purpose of the Groundwater Disinfection Rule is to reduce the level of endemic and epidemic microbial disease without exposing the public to unnecessary risks and costs associated with disinfection. By identifying those wells with adequate natural protection, the risks and costs associated with unnecessary disinfection can be avoided. The risks include acute risks associated with handling chemical disinfectants as well as long-term risks associated with exposure to disinfectants and disinfection by-products in water. Other benefits would be realized as a result of avoiding having individuals utilize alternative sources of water (e.g., bottled water) or additional on-site treatment. The avoided costs of unnecessary disinfection would be an additional benefit.

How to Measure the Effect(s) of the Benefit:

- Reduced cancer incidence.
- Reduced illness, injury, etc. related to disinfectant handling and treatment facilities.
- Avoided disinfection treatment costs.
- Avoided illnesses from bottled water.
- Avoided increases in water costs as a result of switching to bottled water.
- Less use of costly and potentially-unreliable (from a chemical and/or microbiological standpoint) POU/POE devices.

How to Value the Benefit:

- Ask an economist.

Recommended Task Group Membership:

- Henry Vaux, Associate Vice President, Division of Agriculture and Natural Resources, University of California
- Sandra Archibald, Assoc. Dean/ Assoc. Professor, Humphrey Institute of Public Affairs, University of Minnesota
- Bob Raucher, Director, Hagler Bailly Consulting
- Marty Rigby, OCWD
- AWWA - Alan Roberson (contact)
- National Rural Water Association - John Trax (contact)
- Groundwater Districts Management Association - NWRA - Tom Donnelly (contact)
- Southwest FL Water Management Agency - Peter Hubbell (contact)

Comments:

"Is there a continuing periodic monitoring program? To assume that a well, which has been identified as having 'adequate natural protection,' continues to NOT be a problem, or not contaminated, (is weak)." – Jonathan Bulkley

"Introduce implementation costs into the evaluation." – Kenneth Frederick

"Another benefit would be the savings to the consumer if you don't chlorinate. That customer would switch to bottled water because of taste or odor problems - palatability." – Gerald Hansler

Avoiding disinfection, or treatment, is a benefit that must be considered. - – Mic Stewart

Avoiding Disinfection by Identifying Wells with Adequate Natural Protection

Benefit description:

- Less cancer cases due to disinfectants and DBP formation
- Less illness, injury, and death to disinfection handlers and surrounding public
- Less disinfection treatment costs

- Less cost to individuals switching to bottled water as a result of objectionable tastes/odors from disinfection

How to measure the effects of the benefit:

- Reduced cancer incidence
- Reduced illness, etc., related to disinfection facilities
- Avoided disinfection treatment costs
- Avoided illnesses from bottled water

- Avoided increases in water costs as a result of switching to bottled water
- Less use of costly and potentially unreliable (microbiologically) POU/POE devices

How to value the benefit:

- Hire an economist- a good one!

View Graphs Used In Working Group Presentation

Recommended task force membership:

1. **Henry Vaux, University of California**
2. **Sandra Archibald, University of Minnesota**
3. **Bob Raucher, Hagler Bailly Consulting**
4. **Marty Rigby, OCWD**
5. **AWWA- Alan Roberson (contact)**
6. **National Rural Water Association- John Trax (contact)**
7. **Groundwater Districts Management Association- NWRA- Tom Donnelly (contact)**
8. **Southwest FL Water Management Agency- Peter Hubbell (contact)**

APPENDIX S

Revised Working Group Schedule

Revised Schedule
Wednesday, January 8, 1997

8:00 a.m.	Working Groups Orientation
8:05 a.m.	Working Groups Meet in Breakout Rooms to Prepare Reports
9:15 a.m.	Working Groups 1,2,3,4,5 Send Viewgraph Copy to Word Processors
9:30 a.m.	Convene in Workshop Room for Working Groups' Presentations (Working Groups 6,7,8,9,10 Send Viewgraph Copy to Word Processors)
9:30 - 9:45	Working Group #1
9:45 -10:00	Working Group #2
10:00 - 10:15	Working Group #3
10:15 - 10:30	Working Group #4
10:30 - 10:45	Working Group #5
10:45 - 11:00	Working Group #6
11:00 - 11:15	Working Group #7
11:15 - 11:30	Working Group #8
11:30 - 11:45	Working Group #9
11:45 - 12:00	Working Group #10
12:00 noon	Lunch
1:00 p.m.	Bus to Hotel

APPENDIX T

Working Group Action Plan Guidelines

Working Group Action-Plan Guidelines

Workshop Question: *"What are the most significant benefits that should be considered in the development of groundwater disinfection regulations?*

Purpose of Guidelines

These guidelines are to encourage uniformity of working group report presentations. Each working group is requested to distill, clarify, and focus information developed in the NGT workshop, and to recommend task-groups' memberships and strategies to attack one of the ten highest priority benefits/services at subsequent task group meetings. A Task Group will comprise stakeholders and/or experts who will prepare a detailed action plan to value a benefit or service and present its report at a subsequent Benefits Conference scheduled for 10 March 1997 at the Beckman Center.

Each working group is asked to complete its preliminary write-up on the three-page worksheet provided. This will be entered by word-processors and returned to the working group for editing. These working group reports will be included as Part 2 of the NGT workshop report.

Benefits Write-ups

Each working group will prepare their benefits write-up by providing text for the following sections. Please limit your write-up to the space provided on the three-page worksheet.

- Priority Benefit or Service Title
- Benefit Description: Recast and amalgamate the description of this benefit or service, including long-term benefits over 10-20 years.
- Propose how to measure the effects of changing the availability the benefit or service.
- Recommend a method, or methods, to value the benefit or service.

Presentation Viewgraphs

Working groups will be allowed five minutes to present their preliminary reports. No more than four viewgraphs should be prepared to enhance each oral presentation. Viewgraphs should include:

- Revised Benefit Title and Benefit Description (Use bullets)
- How to Measure the Effect(s) of the Benefit/Service (Use bullets)
- How to Value the Benefit (Propose methodology)
- Recommended Task Group membership (List names and affiliations)

Written Comments

Working Group presentations will be limited to five minutes. Ten minutes will be allowed for discussion of each presentation. Written recommendations to enhance the report will be solicited at the conclusion of each working group presentation discussion. Signed recommendations will be printed in the *Benefit Workshop Report* immediately following each working group's report.

APPENDIX U

Working Group Report Guidelines

Working Group Report Guidelines

Workshop Question: *"What are the most significant benefits that should be considered in the development of groundwater disinfection regulations?*

Names of Working Group Members

Priority Benefit Title (Working group may improve title but keep 20 word max.)

Benefit Description (Recast and amalgamate the description of the benefit or service provided. Also, identify long-term benefits 10-20 years.)

How to Measure the Effect(s) of the Benefit (Do not exceed space provided below.)

How to Value the Benefit: (What methods can be used to monetize the value of the benefit or service?)

Recommended Task Group Membership (Suggest six to ten individuals who will augment the working group members from the 6-7-8 January 1997 workshop. Also, please provide names, titles, affiliations, addresses, and telephone contacts where possible.)

APPENDIX V

Working Group Presentation Comment Forms

Working Group Presentation Comment Form

Priority Benefit Number:_____

Recommendations to enhance Working Group report:

Recommended Additional Members of Task Group (Please provide name, address, affiliation telephone)

Name (Please Print): _____

Signature: _____

APPENDIX W

Task Group Guidelines

Task Group Guidelines

Preparations for Benefits Conference

Task Groups will meet as required to prepare working reports describing the Most Significant Benefits that Should be Considered in the Development of Groundwater Disinfection Regulations

17 March 1997

Auditorium - Arnold and Mabel Beckman Center of the National Academies of Science and Engineering
Irvine, California

Purpose of Guidelines

These guidelines are intended to encourage uniformity of analysis for the high priority benefit reports to be submitted no later than one week before the Benefits Conference. Each specified section should be addressed as directly and succinctly as the allowable space will permit.

Source Document

The primary source document for task group deliberations will be the National Water Research Institute report titled *Groundwater Disinfection Regulations Workshop*. This report was prepared on 6-7-8 January 1997 and defines the priority benefits that task groups are to expand and refine in preparation for the Benefits Conference to be held on 17 March 1997.

Typeface and Margins

A formated disk is provided. Please submit draft report on this disk using 12 point *Times* typeface double spaced. Page limits given below must include all figures, tables, and graphs as well as text. Appendices will be counted as additions to the page limits specified. All appendix materials must be submitted in reproducible form.

Benefits Write-ups

Each task group will prepare their benefits write-up by providing text for the following sections:

- Executive Summary (0.5 page max.)
- Why Benefit is Important to Groundwater Disinfection Regulations (Use data to support argument, cite references where appropriate) (2.0 page max.)
- Recommend How to Measure the Effect of the Benefit (2.0 pages max.)
- Recommend How to Value (Monetize) the Benefit (2.0 page max.)
- References (2.0 page max.)

Example of How to Measure the Effect of the Benefit

Show one or more numerical examples (real or hypothetical) of exactly how to apply the measurement method you propose.

- Theory or principal of measurement method
- Quantities to be measured
- Instrumentation required

- Accuracy of measurements required
- Sensitivity to change of measurement program
- Recommend format for measurement data

Example of How to Monetize the Value of the Benefit

Show a sample calculation of how to apply the monetizing method that you propose. If practical, relate it to the measurement example used above.

Submission Deadline

Task Group write-ups will be due in the National Water Research Institute office on or before Monday, 3 March 1997 so that they can be reproduced and distributed to participants before the Conference.

Illustrations and Visual Materials

Illustrations used in the text of Task Group reports should be reproducible in black and white using xerographic processes. Visual materials used by Task Groups at the Benefits Conference should be placed on transparencies for use with an overhead projector. No more than 10 viewgraphs should be used during the 10 - 15 minute period allowed for presentation by the each task group.

If you have questions, please contact Dr. William S. Gaither, Chair, Benefits Conference, at (215) 386-6800 or Ron Linsky, Executive Director, NWRI, at (714) 378-3278.

APPENDIX X

Benefits Conference Agenda

BENEFITS CONFERENCE AGENDA
Auditorium - Arnold and Mabel Beckman Center
100 Academy Drive
Irvine, California 92715
17 March 1997

6:45 a.m.	Buses Depart Sutton Place Hotel
7:00 a.m.	Breakfast at Beckman Center Conference Registration
8:00 a.m.	Welcome and Conference Purpose
8:15 a.m.	Task Group #1 Presentation and Discussion[1]
9:00 a.m.	Task Group #2 Presentation and Discussion
9:45 a.m.	Task Group #3 Presentation and Discussion
10:30 a.m.	Break
10:45 a.m.	Task Group #4 Presentation and Discussion
11:30 a.m.	Task Group #5 Presentation and Discussion
12:15 p.m.	Lunch
1:15 p.m.	Task Group #6 Presentation and Discussion
2:00 p.m.	Task Group #7 Presentation and Discussion
2:45 p.m.	Task Group #8 Presentation and Discussion
3:30 p.m.	Break
4:15 p.m.	Task Group #9 Presentation and Discussion
5:00 p.m.	Task Group #10 Presentation and Discussion
5:45 p.m.	Adjourn

[1]Task Group appears as a panel on stage with the Chair making a 10-15 minute presentation with viewgraphs, allowing 30 minutes for floor discussion. Written comments will be solicited at the end of each discussion period.