ANNEX 1

Bibliography

Supporting documents


**Cited references**


---

1 In chapter 11, selected bibliographical references are included at the end of each microbial fact sheet. In chapter 12, principal references are provided at the end of each chemical fact sheet.
ANNEX 1. BIBLIOGRAPHY


Hertzberg RC (1989) Fitting a model to categorical response data with application to special extrapolation to toxicity. Health Physics, 57(Suppl. 1):404–409.


463
GUIDELINES FOR DRINKING-WATER QUALITY


Rooney RM et al. (in press) Water safety on ships. A review of outbreaks of waterborne disease associated with ships. Accepted for publication in *Public Health Reports*.


World Health Assembly (1991) *Elimination of dracunculiasis: resolution of the 44th World Health Assembly.* Geneva, World Health Organization (Resolution No. WHA 44.5).
ANNEX 2

Contributors to the development of the third edition of the *Guidelines on drinking-water quality*

Mr M. Abbaszadegan, (21: iv), American Water Works Services Inc., Belleville, IL, USA
Dr M. Abdulraheem, (9), United Nations Environment Programme, Manama, Bahrain
Dr H. Abouzaid, (1, 7, 9, 15, 23, 25, 27), WHO, Regional Office for the Eastern Mediterranean, Cairo, Egypt
Mr R. Abrams, (19), WHO, Regional Office for the Western Pacific, Manila, Philippines
Mr J. Adams, (5), (formerly of Oxfam, Oxford, UK)
Dr Z. Adee, (15), The United Nations University, Tokyo, Japan
Mr M. Adriaanse, (5), United Nations Environment Programme, The Hague, Netherlands
Mr R. Aertgeerts, (7, 15, 23, 25, 27), European Centre for Environment and Health, Rome, Italy
Dr R. Ainsworth, (12, 20, 23, 25), Water Science and Technology, Bucklebury, UK
Dr A. Aitio, (26), WHO, Geneva, Switzerland
Ms M. Al Alili, (9), Abu Dhabi Water and Electricity Authority, Abu Dhabi, United Arab Emirates
Dr F. Al Awadhi, (9), United Nations Environment Programme, Bahrain, and Regional Organization for the Protection of the Marine Environment, Kuwait
Dr M.M.Z. Al-Ghali, (21), Ministry of Health, Damascus, Syria
Dr B. Ali, (27), Kwame Nkrumah University of Science and Technology, Kumasi, Ghana
Dr M. Ali, (27), Water, Engineering and Development Centre, Loughborough University, Loughborough, UK
Dr A. Ali Alawadhi, (9), Ministry of Electricity and Water, Manama, Bahrain
Mr M. Al Jabri, (9), Ministry of Regional Municipalities, Environment and Water Resources, Muscat, Oman
Dr A. Allen, (27), University of York, Ireland
Dr M. Allen, (14), American Water Works Association, Denver, CO, USA
Mr H. Al Motairy, (9), Ministry of Defence and Aviation, Jeddah, Saudi Arabia
Ms E. Al Nakhi, (9), Abu Dhabi Water and Electricity Authority, Abu Dhabi, United Arab Emirates
Dr M. Al Rashed, (9), Kuwait Institute for Scientific Research, Safat, Kuwait
Mr M. Al Sofi, (9), House of Sofia, Al Khobar, Saudi Arabia
Dr M. Al Sulaiti, (9), Qatar Electricity and Water Corporation, Doha, Qatar
Dr S. Ambu, (11), Ministry of Health, Kuala Lumpur, Malaysia
American Chemistry Council, (19), Washington, DC, USA
Ms Y. Andersson, (6), Swedish Institute for Infectious Disease Control, Solna, Sweden
Dr M. Ando, (15), Ministry of Health, Labour and Welfare, Tokyo, Japan
Dr M. Asami, (11, 15), National Institute of Public Health, Tokyo, Japan
Dr N. Ashbolt, (6, 8, 13, 14, 23, 28), University of New South Wales, Sydney, Australia
Ms K. Asora, (10), Samoa Water Supply, Apia, Samoa
Dr K.-K. Au, (24), Greeley and Hansen, Limited Liability Company, Chicago, USA
Dr S. Azevedo, (29), Federal University of Rio de Janeiro, Rio de Janeiro, Brazil
Dr L. Backer, (19), National Center for Environmental Health, Atlanta, USA
Mr D. Bahadur Shrestha, (15), Department of Water Supply and Sewerage, Kathmandu, Nepal
Dr K. Bailey, (5), WRC-NSF Ltd, Marlow, UK (now retired)
Dr H. Bakir, (9), Centre for Environmental Health Activities, Amman, Jordan
Dr G. Ball, (3), NSF International, Ann Arbor, MI, USA
Dr M. Balonov, (20), International Atomic Energy Agency, Vienna, Austria
Mr R. Bannerman, (27), Water Resources Consultancy Service, Accra, Ghana
Dr J. Bartram, (1, 2, 3, 4, 5, 6, 7, 8, 9, 12, 13, 14, 15, 16, 18, 19: xiii–lii, liv–lxviii, 21: i–v, 22, 23, 24, 25, 29), WHO, Geneva, Switzerland
Dr A. Basaran, (10, 11, 12, 15, 25), WHO, Regional Office for the Western Pacific, Manila, Philippines
Dr A. Bathija, (19: xxvi), US Environmental Protection Agency, Washington, DC, USA
Mr U. Bayar, (11), State Inspectorate for Health, Ulaanbaatar, Mongolia
Mr G. Bellen, (2), NSF International, Ann Arbor, MI, USA
Dr R. Belmar, (15), Ministry of Health of Chile, Santiago, Chile
Dr R. Bentham, (16), Department of Environmental Health, Adelaide, Australia
Dr K. Bentley, (4), Centre for Environmental Health, Woden, Australia
Mrs U. Bera, (10), Ministry of Health, Suva, Fiji
Dr P. Berger, (21: iv, 27), US Environmental Protection Agency, Washington, DC, USA
Dr U. Blumenthal, (6, 28), London School of Hygiene and Tropical Medicine, London, UK
Dr A. Boehncke, (19: vii), Fraunhofer Institute of Toxicology and Experimental Medicine, Hanover, Germany
Ms E. Bolt, (27), International Research Centre on Water and Sanitation, Delft, Netherlands
Dr L. Bonadonna, (14, 21: i), Istituto Superiore di Sanità, Rome, Italy
Dr X. Bonnefoy, (19: xii, liii, lxix), WHO European Center for Environment and Health, Bonn, Germany (formerly of WHO Regional Office for Europe, Copenhagen, Denmark)
Mr L. Bontoux, (6), European Commission, Brussels, Belgium
Ms T. Boonyakarnkul, (8, 12, 15, 22, 25), Ministry of Public Health, Nonthaburi, Thailand
Professor K. Botzenhart, (5, 16, 21: iii), Tuebingen University, Tuebingen, Germany
Dr L. Bowling, (29), Department of Land and Water Conservation, Parramatta, Australia
Dr E. Briand, (16), Centre Scientifique et Technique du Bâtiment, Marne-la Vallée, France
Dr S. Bumaa, (11), Health Inspection Services, Ulaanbaatar, Mongolia
Mr M. Burch, (8, 29), Australian Water Quality Centre, Salisbury, Australia
Dr T. Burns, (19), The Vinyl Institute, Inc., Arlington, VA, USA
Professor D. Bursill, (8), Australian Water Quality Centre, Salisbury, Australia
Dr J. Butler, (21: iii), Centers for Disease Control and Prevention, Atlanta, GA, USA
Dr P. Byleveld, (10), New South Wales Department of Health, Gladesville, Australia
Mr P. Callan, (7, 8, 13, 15, 17, 19: xiii–lii, liv–lxviii, 22, 25), National Health and Medical Research Council, Canberra, Australia
Professor G. Cangelosi, (18), Seattle Biomedical Research Institute, Seattle, USA
Professor W. Carmichael, (29), Wright State University, Ohio, USA
Mr R. Carr, (23), WHO, Geneva, Switzerland
Dr R. Carter, (27), Cranfield University, Silsoe, UK
Dr C. Castell-Exner, (27), The German Technical and Scientific Association for Gas and Water, Bonn, Germany
Dr M. Cavalieri, (29), Local Agency for Electricity and Water Supply, Rome, Italy
Dr R. Chalmers, (26), Public Health Laboratory Service, Swansea, UK
Dr K. Chambers, (23), WRc-NSF Ltd, Swindon, UK
Professor P. Chambon, (1, 4, 19: i–xii), University of Lyon, Lyon, France
Mr C.K.R. Chan, (11), Shatin Treatment Works, Shatin, Hong Kong, Special Administrative Region of China
Mr S. Chantaphone, (11), Ministry of Health, Vientiane, Lao People's Democratic Republic
Dr D. Chapman, (29), Cork, Ireland
Mr G.P.R. Chaney, (7), International Association of Plumbing and Mechanical Officials, Ontario, CA, USA
Ms L. Channan, (10), South Pacific Applied Geoscience Commission, Suva, Fiji
Professor W. Chee Woon, (11), University of Malaya, Kuala Lumpur, Malaysia
Dr T. Chi Ho, (11), Health Department, Macao, Macao, People's Republic of China
Dr N. Chiu, (15, 19: xlvi), US Environmental Protection Agency, Washington, DC, USA
Dr Y.-G. Cho, (11), Waterworks Gwangju, Gwangju City, Republic of Korea
ANNEX 2. CONTRIBUTORS TO THE DEVELOPMENT OF THE THIRD EDITION

Dr J. Donohue, (7, 19: xxxvi), US Environmental Protection Agency, Washington, DC, USA
Dr J. Doss, (19, 20), International Bottled Water Association, Alexandria, USA
Dr V. Drasar, (16), OHS-National Legionella Reference Laboratory, Vyskov, Czech Republic
Dr M. Drikas, (19, 29), Australian Water Quality Center, Salisbury, Australia
Dr J. Du, (19: lii), US Environmental Protection Agency, Washington, DC, USA
Dr A. Dufour, (6, 8, 14, 16, 27), US Environmental Protection Agency, Cincinnati, OH, USA
Dr S. Edberg, (14), Yale University, New Haven, CT, USA
Dr N. Edmonds, (19: xxxi), Health Canada, Ottawa, Canada
Dr J. Eisenberg, (6, 28), University of California, Berkeley, CA, USA
Dr M. El Desouky, (9), Kuwait Institute for Scientific Research, Safat, Kuwait
Dr H. El Habr, (9), United Nations Environment Programme, Managa, Bahrain
Professor F. El Zaatari, (18), Baylor College of Medicine, Houston, TX, USA
Dr M. Ema, (19: xlii, xlix), National Institute of Health Sciences, Tokyo, Japan
Mr P. Emile, (10), Ministry of Health, Rarotonga, Cook Islands
Dr R. Enderlein, (29), United Nations Economic Commission for Europe, Geneva, Switzerland
Dr T. Endo, (5, 7, 14, 15, 19, 22), Ministry of Health, Labor and Welfare, Tokyo, Japan
Mr H. Enevoldsen, (9), Intergovernmental Oceanographic Commission of UNESCO, IOC Science and Communication Centre on Harmful Algae, Copenhagen, Denmark
Dr S. Enkhsetseg, (15), Ministry of Health, Ulaanbaatar, Mongolia
Dr O. Espinoza, (19: xii, liii, lxix), WHO Regional Office for Europe, Copenhagen, Denmark
Mr S. Esrey, (6), deceased (formerly of UNICEF, New York, USA)
Mr G. Ethier, (4), International Council of Metals and the Environment, Ottawa, Canada
Dr C. Evins, (23), Drinking Water Inspectorate, London, UK
Dr M. Exner, (14, 16, 22), Universität Bonn, Bonn, Germany
Professor I. Falconer, (29), University of Adelaide, Adelaide, Australia
Dr J. Falkinham, (18), Fralin Biotechnology Center, Blacksburg, VA, USA
Dr M. Farrimond, (23), UK Water Industry Research, London, UK
Dr J. Fastner, (15, 29), Federal Environmental Agency, Berlin, Germany
Professor B. Fattal, (6), Hebrew University of Jerusalem, Jerusalem, Israel
Mr J. Fawell, (4, 5, 7, 15, 17, 19: vi, xii–lxix, 20, 22, 29), independent consultant, High Wycombe, UK
Ms F. Feagai, (10), Princess Margaret Hospital, Funafuti, Tuvalu
Dr T. Fengthong, (15), Ministry of Health, Vientiane, Lao People's Democratic Republic
Dr I. Feuerpfeil, (21: iv), Umweltbundesamt, Bad Elster, Germany
GUIDELINES FOR DRINKING-WATER QUALITY

Dr L. Fewtrell, (6, 12), Center for Research into Environment & Health, University of Wales, Aberystwyth, UK
Mr B. Fields, (16), Centers for Disease Control and Prevention, Atlanta, GA, USA
Mr J. Filiomea, (10), Ministry of Health and Medical Service, Honiara, Solomon Islands
Dr J. Fitch, (20), South Australian Health Commission, Adelaide, Australia
Dr J. Fitzgerald, (29), South Australian Health Commission, Adelaide, Australia
Dr J. Fleisher, (6), State University of New York, Downstate Medical Center, New York, NY, USA
Dr L. Forbes, (23), Leith Forbes & Associates Pty Ltd, Victoria, Australia
Dr T. Ford, (18), Montana State University, Bozeman, MT, USA
Dr R. Franceys, (27), Cranfield University, Silsoe, UK
Ms P. Franz, (10), Paulau Environment Quality Protection Agency, Koror, Republic of Palau
Dr I. Fraser, (19, 20), Department of Health, London, UK
Dr C. Fricker, (14, 21: iv), CRF Consulting, Reading, UK
Dr A. Friday, (22), Ministry of Health, Kampala, Uganda
Dr E. Funari, (7), Istituto Superiore di Sanità, Rome, Italy
Dr H. Galal-Gorchev, (1, 2, 4, 5, 19: i–xii, liii, lxix), US Environmental Protection Agency, Washington, DC (formerly of WHO, Geneva, Switzerland)
Dr P. Gale, (8), WRc-NSF Ltd, Marlow, UK
Dr Y. Ganou, (22), Ministry of Health, Ougadougo, Burkino Faso
Dr M. Gardner, (19), WRc-NSF Ltd, Marlow, UK
Dr A.E.H. Gassim, (22), Ministry of Health, Makkah, Saudi Arabia
Dr R. Gaunt, (4), International Council of Metals and the Environment, Ottawa, Canada
Dr A.-M. Gebhart, (3), NSF International, Ann Arbor, MI, USA
Dr B. Genthe, (27), Division Environment, Pretoria, South Africa
Dr C. Gerba, (14, 28), Arizona University, Tucson, AZ, USA
Dr T. Gerschel, (19), European Copper Institute, Brussels, Belgium
Dr H. Gezairy, (9), WHO, Regional Office for the Eastern Mediterranean, Cairo, Egypt
Ms M. Giddings, (15, 19: xiii–lii, liv–lxviii, 20, 22, 29), Health Canada, Ottawa, Canada
Professor W. Giger, (27), Swiss Federal Institute for Environmental Science and Technology, Dübendorf, Switzerland
Dr N. Gjolme, (29), National Institute for Public Health, Oslo, Norway
Dr A. Glasmacher, (14), Universität Bonn, Bonn, Germany
Dr A. Godfrev, (23, 25, 27), United Utilities Water, Warrington, UK
Mr S. Godfrey, (10, 12), Water, Engineering and Development Centre, Loughborough University, Loughborough, UK
Dr M.I. Gonzalez, (19, 20, 22), National Institute of Hygiene, Epidemiology and Microbiology, Havana, Cuba
Ms F. Gore, (22), WHO, Geneva, Switzerland
ANNEX 2. CONTRIBUTORS TO THE DEVELOPMENT OF THE THIRD EDITION

Dr P. Gosling, (21: i), Department of Health, London, UK
Dr P. Gowin, (9), International Atomic Energy Agency, Vienna, Austria
Professor W. Grabow, (5, 6, 8, 13, 19, 20, 21: ii, 22, 25), retired (formerly of University of Pretoria, Pretoria, South Africa)
Mr W. Graham, (4), CropLife International, Brussels, Belgium
Dr P. Grandjean, (19, 20), Institute of Public Health, Odense, Denmark
Dr S. Grant-Trusdale, (19: xxxiv), Health Canada, Ottawa, Canada
Dr R. Gregory, (29), WRc-NSF Ltd, Swindon, UK
Professor A. Grohmann, (19, 27), independent, Berlin, Germany
Dr S. Gupta, (19: v), Health Canada, Ottawa, Canada
Professor C. Haas, (6, 28), Drexel University, Philadelphia, PA, USA
Dr W. Haas, (18), Robert Koch Institute, Berlin, Germany
Ms L. Haller, (12), WHO, Geneva, Switzerland
Mr F. Hannecart, (10), Noumea City Hygiene Service, Noumea, New Caledonia
Dr K.-I. Harada, (29), Meijo University, Nagoya, Japan
Dr M. Hardiman, (20), WHO, Geneva, Switzerland
Mr H. Hashizume, (5, 9, 15, 17, 19: xiii–lii, liv–lxviii, 22), Ministry of the Environment, Tokyo, Japan (formerly of WHO, Geneva, Switzerland)
Dr A. Havelaar, (1, 2, 5, 6, 7, 8, 20, 21: i–v, 22, 25, 26, 28), National Institute for Public Health and the Environment (RIVM), Bilthoven, Netherlands
Mr T. Hayakawa, (1, 5), Ministry of Health & Welfare, Tokyo, Japan
Mr J. Hayes, (16), Institute for Healthcare Management, High Wycombe, UK
Mr P. Hecq, (22), European Commission, Brussels, Belgium
Mr P. Heinsbroek, (10, 11, 15), WHO, Regional Office for the South Pacific, Manila, Philippines
Dr R. Heinze, (29), Umweltbundesamt, Bad Elster, Germany
Mr E. Hellan, (10), Pohnpei Environment Protection Agency, Kolonia, Federated States of Micronesia
Dr R. Helmer, (1, 4, 19: xii, liii, lxix, 22), retired (formerly of WHO, Geneva, Switzerland)
Dr P. Henriksen, (29), National Environmental Research Institute, Roskilde, Denmark
Dr N. Hepworth, (27), Lancaster, UK
Professor J. Hermon-Taylor, (18), St George’s Hospital Medical School, London, UK
Mr A. Hicking, (10), Marshall Islands Environment Protection Agency, Majuro, Marshall Islands
Dr G. Hoetzel, (29), La Trobe University, Victoria, Australia
Dr A. Hogue, (6), US Department of Agriculture, Washington, DC, USA (formerly of WHO, Geneva, Switzerland)
Dr D. Holt, (23), Thames Water Utilities Ltd, Reading, UK
Mr M. Hori, (7), Ministry of Health and Welfare, Tokyo, Japan
Professor H. Höring, (2), Umweltbundesamt, Bad Elster, Germany
Ms M. Hoshino, (15), UNICEF, Tokyo, Japan

473
Dr G. Howard, (2, 5, 7, 8, 12, 13, 15, 19, 20, 22, 23, 25), DFID Bangladesh, Dhaka, Bangladesh (formerly of Water Engineering and Development Centre, Loughborough University, Loughborough, UK)
Dr P. Howsam, (27), Cranfield University, Silsoe, UK
Professor S. Hrudey, (8, 29), University of Alberta, Edmonton, Canada
Mr J. Hueb, (20, 21: v, 23), WHO, Geneva, Switzerland
Dr J. Hulka, (19, 20), National Radiation Protection Institute, Prague, Czech Republic
Dr N. Hung Long, (15), Ministry of Health, Han Noi, Viet Nam
Dr P. Hunter, (14, 23), University of East Anglia, Norwich, UK
Dr K. Hussain, (9), Ministry of Health, Manama, Bahrain
Mr O.D. Hydes, (4, 5, 7), independent consultant, West Sussex, UK (formerly of Drinking Water Inspectorate, London, UK)
Dr A. Iannucci, (3), NSF International, Ann Arbor, MI, USA
Mr S. Iddings, (11, 15), WHO, Phnom Penh, Cambodia
Dr M. Ince, (12, 25), independent consultant, Loughborough, UK (formerly of Water, Engineering and Development Centre, Loughborough University, Loughborough, UK)
International Bottled Water Association, (19), Alexandria, VA, USA
Mr K. Ishii, (15), Japan Water Works Association, Tokyo, Japan
Mr J. Ishiwata, (11), Ministry of Health, Labour and Welfare, Tokyo, Japan
Mr P. Jackson, (2, 5, 7, 15, 19: xiii–lii, liv–lxviii, 22, 25), WRc-NSF Ltd, Marlow, UK
Dr J. Jacob, (21: v), (formerly of Umweltbundesamt, Bad Elster, Germany)
Dr M. Janda, (21: i), Health and Welfare Agency, Berkeley, CA, USA
Mr A. Jensen, (1, 2), DHI Water and Environment, Horsholm, Denmark
Dr R. Johnson, (19), Rohm and Haas Company, USA
Dr D. Jonas, (7), Industry Council for Development, Ramsgate, UK
Dr G. Jones, (29), Commonwealth Scientific and Industrial Research Organisation, Brisbane, Australia
Mr C. Jörgensen, (5), DHI Water and Environment, Horsholm, Denmark
Dr C. Joseph, (16), Communicable Disease Surveillance Control, London, UK
Mr H. Kai-Chye, (10), Canberra, Australia
Ms R. Kalmet, (10), Mines and Water Resources, Port Vila, Vanuatu
Mr I. Karnjanareka, (15), Ministry of Public Health, Nonthaburi, Thailand
Dr D. Kay, (6), University of Wales, Aberyystwyth, UK
Dr H. Kern dorff, (27), Umweltbundesamt, Berlin, Germany
Dr S. Khamdan, (9), Ministry of State for Municipalities and Environment Affairs, Manama, Bahrain
Mr P. Khanna, (21: ii), National Environmental Engineering Institute, Nagpur, India
Mr M. Kidanu, (22), WHO, Regional Office for Africa, Harare, Zimbabwe
Dr J. Kielhorn, (4, 19: vii, xv, lxvii), Fraunhofer Institute of Toxicology and Experimental Medicine, Hanover, Germany
ANNEX 2. CONTRIBUTORS TO THE DEVELOPMENT OF THE THIRD EDITION

Dr R. Kirby, (8, 25), Industry Council for Development, Ramsgate, UK
Dr G. Klein, (1), WHO, Bonn, Germany (formerly of Umweltbundesamt, Bad Elster, Germany)
Dr J. Komarkova, (29), Hydrobiological Institute of the Czech Academy of Sciences, České Budejovice, Czech Republic
Dr H. Komulainen, (22), National Public Health Institute, Kuopio, Finland
Dr F. Kondo, (29), Aichi Prefectural Institute of Public Health, Nagoya, Japan
Dr M. Koopmans, (26), National Institute for Public Health and the Environment (RIVM), Bilthoven, Netherlands
Dr F. Kozisek, (19), National Institute of Public Health, Prague, Czech Republic
Dr A. Kozma-Törökne, (29), National Institute for Public Health, Budapest, Hungary
Dr T. Kuiper-Goodman, (29), Health Canada, Ottawa, Canada
Dr S. Kunikane, (7, 15, 17, 22), Ministry of Health, Labour and Welfare, Tokyo, Japan
Dr T. Kwader, (27), URS Corporation, Tallahassee, FL, USA
Miss K. Kwee-Chu, (11), Ministry of Health, Kuala Lumpur, Malaysia
Mr P. Lafitaga, (10), Department of Health, Pago-pago, American Samoa
Dr B. Lang, (4), Novartis Crop Protection AG, Basel, Switzerland
Dr J. Langford, (8), Water Services Association, Melbourne, Australia
Dr J. Latorre, (25), Universidad del Valle, Cali, Colombia
Dr L. Lawton, (29), Robert Gordon University of Aberdeen, Aberdeen, UK
Dr M. LeChevallier, (7, 8, 14, 18, 23, 24), American Water Works Service Company, Inc., Voorhees, NJ, USA
Dr H. Leclerc, (14, 19, 20), University of Lille, Lille, France
Dr J. Lee, (5, 16, 21: iii), Queen’s Medical Centre, Nottingham, UK
Mr F. Leitz, (9), Water Treatment Engineering and Research Group, Denver, CO, USA
Professor Le The Thu, (11), Institute of Hygiene and Public Health, Ho Chi Minh City, Viet Nam
Dr Y. Levi, (23), Laboratoire Santé Publique – Environnement, Université Paris XI, Chatenay-Malabry, France
Dr D. Levy, (19, 20), Centers for Disease Control and Prevention, Atlanta, GA, USA
Dr N. Lightfoot, (14), UK Public Health Laboratory Service, Newcastle-upon-Tyne, UK
Dr P. Literathy, (2, 5, 29), Kuwait Institute for Scientific Research, Safat, Kuwait (formerly of Water Resource Research Centre VITUKI, Budapest, Hungary)
Mr S. Loau, (15), Preventive Health Services, Apia, Samoa
Dr J.F. Luna, (26), Secretariat of Health, Mexico City, Mexico
Dr U. Lund, (4, 7, 19: i–xii, liii, lxix), DHI Water and Environment, Horsholm, Denmark
Dr Y. Magara, (1, 4, 5, 7, 14, 15, 19: xiii–lii, liv–lxviii, 21: iv, 22), Hokkaido University, Sapporo, Japan
Mr T. Magno, (10), WHO Representative’s Office in Papua New Guinea, Port Moresby, Papua New Guinea
Dr B. Magtibay, (11, 22), Bureau of International Health Cooperation, Manila, Philippines
Dr I. Mäkeläinen, (20), Radiation and Nuclear Safety Authority, Helsinki, Finland
Dr D. Mangino, (3), NSF International, Ann Arbor, MI, USA
Dr A. Marandi, (19), University of Tartu, Tartu, Estonia
Dr T. Mariee, (21: iii), Queen Elizabeth II Health Science Centre, Halifax, Canada
Mr A. Marquez, (10), Guam Environmental Protection Agency, Barrigada, Guam
Dr B. Marsalek, (29), Institute of Botany, Brno, Czech Republic
Professor M. Martin, (27), Bangladesh University of Engineering and Technology, Dhaka, Bangladesh
Dr R. Mascarenhas, (19: xxiii, xxiv, xxx, lvi, lxii, lxiii), Metcalf and Eddy, Devizes, UK
Dr D. McFadden, (3), NSF International, Ann Arbor, MI, USA
Dr M. McLaughlin, (27), Commonwealth Scientific and Industrial Research Organization, Land and Water, Glen Osmond, Australia
Dr B. McCrae, (8), Australian Water Association, Artarmon, Australia
Dr D. Medeiros, (26), Health Canada, Ottawa, Canada
Dr G. Medema, (5, 7, 8, 21: iv), KIWA N.V, Nieuwegein, Netherlands
Ms M.E. Meek, (4), Health Canada, Ottawa, Canada
Dr J. Meheus, (4), International Water Supply Association, Antwerpen, Belgium
Ms G. Melix, (10), Papeete, French Polynesia
Dr J.M. Melse, (26), National Institute for Public Health and the Environment (RIVM), Utrecht, Netherlands
Dr T. Meredith, (22), WHO, Geneva, Switzerland
Mr T. Metutera, (10), Public Utilities Board, Tarawa, Kiribati
Dr E. Meyer, (3), Umweltbundesamt, Berlin, Germany
Dr S. Miller, (27), US Department of Agriculture – Agricultural Research Service (USDA-ARS), Tucson, AZ, USA
Dr B. Mintz, (19: xii, lii, lxix), Centers for Disease Control and Prevention (CDC), Atlanta, GA, USA
Mr M.Z. bin Mohd Talha, (11), Ministry of Health, Kuala Lumpur, Malaysia
Ms M.N. Mons, (7), KIWA Research and Consultancy, Nieuwegein, Netherlands
Professor M.R. Moore, (19), National Research Centre for Environmental Toxicology, Queensland, University of Queensland, Queensland, Australia
Dr G. Morace, (21: ii), Istituto Superiore di Sanità, Rome, Italy
Dr A. Moreau, (14, 19, 20), Danone Water Technology Centre, Evian, France
Dr R. Morris, (5, 7, 23), IWA, London, UK
Dr D. Mossel, (14), Eijkman Foundation, Utrecht, Netherlands
Ms G. Motturi, (2, 5), WHO, Regional Office for Europe, Copenhagen, Denmark
Dr G. Moy, (4, 29), WHO, Geneva, Switzerland
Dr L. Mur, (29), University of Amsterdam, Amsterdam, Netherlands
Ms S. Murcott, (19, 20), Massachusetts Institute of Technology, Massachusetts, USA
Dr P. Murphy, (26), US Environmental Protection Agency, Edison, NJ, USA
ANNEX 2. CONTRIBUTORS TO THE DEVELOPMENT OF THE THIRD EDITION

Dr S. Murphy, (3), NSF International, Ann Arbor, MI, USA
Dr F.J. Murray, (4), International Life Sciences Institute, San José, CA, USA
Mr M.W. Muru, (10), Health Protection, Waigani, Papua New Guinea
Mr C. Mwesigye, (7), WHO, Kampala, Uganda
Dr D. Nabarro, (22), WHO, Geneva, Switzerland
Dr G.B. Nair, (21: v), National Institute of Cholera and Enteric Diseases, Calcutta, India
Pr. K. Nath, (19), Institution of Public Health Engineering, Calcutta, India
Mr P. Navuth, (11), Ministry of Industry, Mines and Energy, Phnom Penh, Cambodia
Mr M. Neal, (19), Invista, Teesside, UK
Dr A. Neller, (8), University of Sunshine Coast, Maroochydore, Australia
Mr J. Newbold, (16), Health and Safety Executive, Bootle, UK
Dr E. Ngoni Mudege, (27), Institute of Water and Sanitation Development, Harare, Zimbabwe
Dr C. Nhachi, (15), WHO, Regional Office for Africa, Harare, Zimbabwe
Dr G. Nichols, (18), Health Protection Agency, London, UK
Dr T. Nishimura, (15, 19: xix, xlii, xlix, lvii), Ministry of Health, Labour and Welfare, Tokyo, Japan
Ms S. Nofal, (9), WHO, Cairo, Egypt
Dr C. Nokes, (25), Environmental Science and Research Ltd, Christchurch, New Zealand
Dr L. Ofanoa, (10), Ministry of Health, Nuku’olofa, Tonga
Dr H. Ogawa, (23), WHO, Regional Office for the Western Pacific, Manila, Philippines
Dr E. Ohanian, (4, 7, 19: i–lii; liv–lxviii, 22), US Environmental Protection Agency, Washington, DC, USA
Dr Y. Okumura, (20), Nagasaki University, Japan
Ms J. Orme-Zavaleta, (1), US Environmental Protection Agency, Washington, DC, USA
Dr Y. Ortega, (21: iv), University of Arizona, Tucson, AZ, USA
Dr J. Padišák, (29), University of Veszprém, Veszprém, Hungary
Dr F. Pamminger, (23), Yarra Valley Water, Melbourne, Australia
Mr I. Papadopoulos, (5, 7), European Commission, Athens, Greece (formerly of European Commission, Brussels, Belgium)
Dr C.N. Paramasivan, (18), Indian Council of Medical Research, Chennai, India
Mr R. Paramasivan, (21: ii), National Environmental Engineering Research Institute, Nagpur, India
Mr D. Parish, (10), Pacific Water Association, Suva, Fiji
Dr C. Pastoris, (21: iii), Istituto Superiore di Sanità, Rome, Italy
Dr E. Pawlitzky, (29), Umweltbundesamt, Berlin, Germany
Dr P. Payment, (6, 14, 23), National Institute of Scientific Research, University of Quebec, Montreal, Canada
ANNEX 2. CONTRIBUTORS TO THE DEVELOPMENT OF THE THIRD EDITION

Ms R. Rooney, (12, 16), WHO, Geneva, Switzerland
Dr J. Rose, (14, 21: iv, 28), University of South Florida, St. Petersburg, FL, USA
Dr K. Rotert, (19, 20), US Environmental Protection Agency, Washington, DC, USA
Dr J. Rothel, (18), Cellestis Limited, Victoria, Australia
Mr H. Salas, (2), WHO, Regional Office for the Americas, Washington, DC, USA
Mr A. Salem, (9), Abu Dhabi Water and Electricity Authority, Abu Dhabi, United Arab Emirates
Dr P. Samnang, (15), Ministry of Health, Phnom Penh, Cambodia
Dr M. Santamaria, (16), WHO, Geneva, Switzerland
Mr M. Saray, (11), Ministry of Rural Development, Phnom Penh, Cambodia
Mr D. Sartory, (5, 21: i), Severn Trent Water Ltd, Shelton, UK
Dr M. Savkin, (20), Institut Biophysics, Moscow, Russian Federation
Dr S. Schaub, (6, 16, 21: iv, 28), US Environmental Protection Agency, Washington, DC, USA
Professor R. Schertenleib, (27), Swiss Federal Institute for Environmental Science and Technology, Dübendorf, Switzerland
Dr J. Schijven, (27), National Institute for Public Health and the Environment (RIVM), Bilthoven, Netherlands
Mrs G. Schlag, (5), Umweltbundesamt, Berlin, Germany
Mr O. Schmoll, (8, 15, 27), Umweltbundesamt, Berlin, Germany
Professor L. Schwartzbrod, (19, 20), WHO Collaborating Center for Microorganisms in Wastewater, Nancy, France
Mr P. Scott, (8), Melbourne Water, Melbourne, Australia
Professor K.-P. Seiler, (27), National Research Center for Environment and Health, Institut für Hydrologie, Neuherberg, Germany
Dr Y.-C. Seo, (11), Sangji University, Wonju, Republic of Korea
Dr I. Shalaru, (19, 20, 22), Ministry of Health, Chisinau, Republic of Moldova
Dr D. Sharp, (10, 15), WHO Representative Office in South Pacific, Suva, Fiji
Ms S. Shaw, (7, 21: iv), US Environmental Protection Agency, Washington, DC, USA
Ms E. Shoaei, (9), Department of the Environment, Tehran, Islamic Republic of Iran
Dr Y. Shun-Zhang, (29), Institute of Public Health, Shanghai, People's Republic of China
Dr E. Sievers, (19, 20), Kiel, Germany
Dr D. Simazaki, (15), National Institute of Public Health, Tokyo, Japan
Professor I. Simmers, (27), Vrije University, Amsterdam, Netherlands
Mr T. Simons, (1, 4), European Commission, Brussels, Belgium
Dr M. Sinclair, (8), Monash University Medical School, Prahran, Australia
Dr K. Sivonen, (29), University of Helsinki, Helsinki, Finland
Dr B. Skinner, (12), Water, Engineering and Development Centre, Loughborough University, Loughborough, UK
Dr O. Skulberg, (29), Norwegian Institute for Public Health, Oslo, Norway
Professor H.V. Smith, (5, 21: iv), Scottish Parasite Diagnostic Laboratory, Stobhill Hospital, Glasgow, UK
Dr M. Smith, (23), Water, Engineering and Development Centre, Loughborough University, Loughborough, UK
Dr M. Snozzi, (7), Swiss Federal Institute for Environmental Science and Technology, Dübendorf, Switzerland
Professor M. Sobsey, (7, 8, 12, 13, 19, 20, 22, 25, 28), University of North Carolina, Chapel Hill, USA
Professor J.A. Sokal, (19, 20, 22), Institute of Occupational Medicine and Environmental Health, Sosnowiec, Poland
Dr F. Solsona, (15, 23, 25, 27), retired (formerly of WHO, Regional Office for the Americas/Centro Panamericano de Ingenieria Sanitaria Ciencias del Ambiente [CEPIS], Lima, Peru)
Dr G.J.A. Speijers, (4, 19: iv), National Institute for Public Health and the Environment (RIVM), Bilthoven, Netherlands
Dr D. Srinivasan, (10), University of the South Pacific, Suva, Fiji
Dr G. Stanfield, (5, 7, 21: ii, 25), WRc-NSF Ltd, Marlow, UK
Dr T.A. Stenstrom, (6, 16, 22), Swedish Institute for Infectious Disease Control, Solna, Sweden
Dr M. Stevens, (8, 12, 13, 14, 15, 19, 20, 23, 25), Melbourne Water Corporation, Melbourne, Australia
Dr T. Stinear, (18), Institut Pasteur, Paris, France
Dr M. Storey, (23), University of New South Wales, Sydney, Australia
Mr M. Strauss, (6), Swiss Federal Institute for Environmental Science and Technology, Dübendorf, Switzerland
Dr K. Subramanian, (7), Health Canada, Ottawa, Canada
Dr S. Surman, (16), Health Protection Agency, London, UK
Mr T. Tauea, (10), Ministry of Health, Tarawa, Kiribati
Mr P. Talota, (10), Ministry of Health and Medical Service, Honiara, Solomon Islands
Mr C. Tan, (11), Ministry of Environment, Singapore
Mr B. Tanner, (2), NSF International, Brussels, Belgium
Mr H. Tano, (4), Ministry of Health and Welfare, Tokyo, Japan
Professor I. Tartakovsky, (16), Gamaleya Research Institute for Epidemiology and Microbiology, Moscow, Russian Federation
Dr A. Tayeh, (20), WHO, Geneva, Switzerland
Dr M. Taylor, (8, 19, 20, 22, 27), Ministry of Health, Wellington, New Zealand
Dr R. Taylor, (8, 10, 15), Health Surveillance and Disease Control, Rockhampton, Australia
Mr J. Teio, (10), Department of Health, Waigani, Papua New Guinea
Dr P.F.M. Teunis, (7, 8, 28), National Institute for Public Health and the Environment (RIVM), Bilthoven, Netherlands

480
ANNEX 2. CONTRIBUTORS TO THE DEVELOPMENT OF THE THIRD EDITION

Dr B.H. Thomas, (4), independent consultant (formerly Health Canada, Ottawa, Canada)
Mr T. Thompson, (7, 12, 15, 17, 22, 23, 25, 27), WHO, Regional Office for South-East Asia, New Delhi, India
Dr F. Tiefenbrunner, (21: iii), Institute of Hygiene and Social Medicine, Innsbruck, Austria
Mr Tiew King Nyau, (11), Public Utilities Board, Singapore
Dr D. Till, (8, 28), Consultant Public Health Microbiologist, Wellington, New Zealand
Mr T. Tipi, (10), Health Department, Apia, Samoa
Mr T.Q. Toan, (11), National Institute of Occupational and Environmental Health, Hanoi, Viet Nam
Dr P. Toft, (1, 4, 7, 15, 19: xiii–lii, liv–lxviii, 22), independent consultant, Qualicum Beach, Canada
Mr V. Tovu, (10), Ministry of Health, Port Vila, Vanuatu
Mr L. Tu’itupou, (10), Ministry of Health, Nuku’olafo, Tonga
Professor J. Tuomisto, (4, 19: x), National Public Health Institute, Kuopio, Finland
Dr I. Turai, (20, 22), WHO, Geneva, Switzerland
Dr R. Uauy, (4, 15, 19, 20), Instituto de Nutrición y Tecnologia de los Alimentos, Santiago, Chile
Mr S. Unisuga, (2), Ministry of Health and Welfare, Tokyo, Japan
Dr H. Utkilen, (29), National Institute for Public Health, Oslo, Norway
Dr J. van Den Berg, (3), KIWA N.V., Nieuwegein, Netherlands
Dr D. van der Kooij, (14, 21: i, 23), KIWA N.V., Nieuwegein, Netherlands
Ms K. VandeVelde, (19), International Antimony Oxide Industry Association, Campine, Beerse, Belgium
Dr A.M. van Dijk-Looijaard, (4), KIWA N.V, Nieuwegein, Netherlands
Dr F.X.R. van Leeuwen, (4), National Institute of Public Health and the Environment (RIVM), Bilthoven, Netherlands (formerly of WHO European Centre for Environment and Health, Netherlands)
Dr J. Vapnek, (29), Food and Agriculture Organization of the United Nations, Rome, Italy
Mr A. Versteegh, (16), National Institute for Public Health and the Environment (RIVM), Bilthoven, Netherlands
Dr V. Vincent, (18), Institut Pasteur, Paris, France
The Vinyl Institute, (19), Arlington, VA, USA
Dr D. Vitanage, (23), Sydney Water, Sydney, Australia
Dr U. von Gunten, (19), Swiss Federal Institute for Environmental Science and Technology Dübendorf, Switzerland
Professor F. Von Reyn, (18), Dartmouth Hitchcock Medical Centre, Hanover, NH, USA

481
Professor M. Von Sperling, (6), Federal University of Minas Gerais, Belo Horizonte, Brazil
Dr T. Vourtsanis, (23), Sydney Water, Sydney, Australia
Dr P. Waggit, (27), Environment Australia, Darwin, Australia
Dr I. Wagner, (3), Technologie Zentrum Wasser, Karlsruhe, Germany
Mr M. Waite, (6), Drinking Water Inspectorate, London, UK
Mr M. Waring, (19, 20), Department of Health, London, UK
Ms M. Whittaker, (3), NSF International, Ann Arbor, MI, USA
Dr B. Wilkins, (20), National Radiological Protection Board, UK
Dr J. Wilson, (3), NSF International, Ann Arbor, MI, USA
Dr R. Wolter, (27), Umweltbundesamt, Berlin, Germany
Dr D. Wong, (19: xxvii, xxxiii, lxviii), US Environmental Protection Agency, Washington, DC, USA
Dr A. Wrixon, (20), International Atomic Energy Agency, Vienna, Austria
Professor Y. Xu, (27), University of the Western Cape, Bellville, South Africa
Mr T. Yamamura, (7), (formerly of WHO, Geneva, Switzerland)
Dr S. Yamashita, (20), Nagasaki University, Japan
Dr C. Yayan, (15), Institute of Environmental Health Monitoring, Beijing, People’s Republic of China
Dr B. Yessekin, (27), The Regional Environmental Centre for Central Asia, Almaty, Kazakhstan
Dr Z. Yinfa, (11), Ministry of Health, Beijing, People’s Republic of China
Mr N. Yoshiguti, (1), Ministry of Health and Welfare, Tokyo, Japan
Dr M. Younes, (1, 7, 20), WHO, Geneva, Switzerland
Mr J. Youngson, (10), Crown Public Health, Christchurch, New Zealand
Dr V. Yu, (21: iii), Pittsburgh University, Pittsburgh, PA, USA
Professor Q. Yuhui, (11), Institute of Environmental Health Monitoring, Beijing, People’s Republic of China
Mrs N. Zainuddin, (11), Ministry of Health, Kuala Lumpur, Malaysia

2. Expert Consultation on Protection and Control of Water Quality for the Updating of the WHO Guidelines for Drinking-water Quality, Bad Elster, Germany, 17–19 June 1996
ANNEX 2. CONTRIBUTORS TO THE DEVELOPMENT OF THE THIRD EDITION

7. Drinking-water Quality Committee Meeting, Berlin, Germany, 5–9 June 2000
8. Expert Consultation on Effective Approaches to Regulating Microbial Drinking-water Quality, Adelaide, Australia, 14–18 May 2001
10. Workshop on Drinking-water Quality Surveillance and Safety, Nadi, Fiji, 29 October–1 November 2001
13. WHO Meeting: Guidelines on Drinking-water Quality, Micro Working Group, Melbourne, Australia, 13–14 April 2002
19. Contributors to the chemical substantiation document on:
   i. Aluminium
   ii. Boron
   iii. Nickel
   iv. Nitrate and Nitrite
   v. Cyanobacterial Toxins: Microcystin-LR
   vi. Edetic Acid (EDTA)
   vii. Polynuclear aromatic hydrocarbons
   viii. Cyanazine
   ix. 1,2-Dichloropropane (1,2-DCP)
   x. Pentachlorophenol
   xi. Terbutylazine (TBA)
   xii. Trihalomethanes
xiii. 1,1,1-Trichloroethane
xiv. 1,2-Dibromoethane
xv. 1,2-Dichloroethane
xvi. Di(2-ethylhexyl)adipate
xvii. 2-Phenylphenol
xviii. 2,4-Dichlorophenoxyacetic acid
xix. Acrylamide
xx. Aldicarb
xxi. Aldrin and Dieldrin
xxii. Antimony
xxiii. Arsenic
xxiv. Barium
xxv. Bentazone
xxvi. Bromate
xxvii. Brominated Acetic Acids
xxviii. Cadmium
xxix. Carbofuran
xxx. Carbon Tetrachloride
xxxi. Monochloramine
xxxii. Chlordane
xxxiii. Monochloroacetic acid
xxxiv. Chlorite and Chlorate
xxxv. Chlorpyrifos
xxxvi. Copper
xxxvii. DDT and its Derivatives
xxxviii. Dimethoate
xxxix. Diquat
xl. Endosulfan
xli. Endrin
xlii. Epichlorohydrin
xliii. Fenitrothion
xliv. Fluoride
xlv. Glyphosate and AMPA
xlvi. Halogenated Acetonitriles
xlvii. Heptachlor and Heptachlor Epoxide
xlviii. Hexachlorobenzene
xlix. Hexachlorobutadiene
l. Lindane
li. Malathion
lii. Manganese
liii. Methoxychlor
liv. Methyl Parathion
ANNEX 2. CONTRIBUTORS TO THE DEVELOPMENT OF THE THIRD EDITION

lv. Monochlorobenzene
lvi. MX
lvii. Dialkytins
lviii. Parathion
lix. Permethrin
lx. Propanil
lxi. Pyriproxyfen
lxii. Sulfate
lxiii. Inorganic Tin
lxiv. Toluene
lxv. Trichlorobenzenes
lxvi. Uranium
lxvii. Vinyl Chloride
lxviii. Trichloroacetic Acid
lxix. Dichloroacetic Acid

20. Provision of comments on drafts of the Guidelines for Drinking-water Quality (3rd edition)

21. Contributor to Guidelines for Drinking-water Quality (2nd edition), Addendum, Microbiological Agents in Drinking-water
   i. Aeromonas
   ii. Enteric Hepatitis Viruses
   iii. Legionella
   iv. Protozoan Parasites (Cryptosporidium, Giardia, Cyclospora)
   v. Vibrio cholerae


27. Contributor to the background document “Protecting Groundwaters for Health – Managing the Quality of Drinking-water Sources.”

28. Contributor to the background document “Hazard Characterization for Pathogens in Food and Water: Guidelines.”

29. Contributor to the background document “Toxic Cyanobacteria in Water.”
A3.1 Drinking-water consumption and body weight

Global data on the consumption of drinking-water are limited. In studies carried out in Canada, the Netherlands, the United Kingdom and the USA, the average daily per capita consumption was usually found to be less than 2 litres, but there was considerable variation between individuals. As water intake will vary with climate, physical activity and culture, the above studies, which were conducted in temperate zones, can give only a limited view of consumption patterns throughout the world. At temperatures above 25 °C, for example, there is a sharp rise in fluid intake, largely to meet the demands of an increased sweat rate (ICRP, 1992; see also Howard & Bartram, 2003).

In developing guidelines for microbial hazard, per capita daily consumption of 1 litre of unboiled water was assumed.

In developing the guideline values for potentially hazardous chemicals, a daily per capita consumption of 2 litres by a person weighing 60 kg was generally assumed. The guideline values set for drinking-water using this assumption do, on average, err on the side of caution. However, such an assumption may underestimate the consumption of water per unit weight, and thus exposure, for those living in hot climates, as well as for infants and children, who consume more fluid per unit weight than adults. The higher intakes, and hence exposure, for infants and children apply for only a limited time, but this period may coincide with greater sensitivity to some toxic agents and less for others. Irreversible effects that occur at a young age will have more social and public health significance than those that are delayed. Where it was judged that this segment of the population was at a particularly high risk from exposure to certain chemicals, the guideline value was derived on the basis of a 10-kg child consuming 1 litre per day or a 5-kg bottle-fed infant consuming 0.75 litre per day. The corresponding daily fluid intakes are higher than for adults on a body weight basis.

A3.2 Inhalation and dermal absorption

The contribution of drinking-water to daily exposure includes some indirect routes – such as inhalation of particles and droplets containing microbes and volatile
substances, and dermal contact during bathing or showering – as well as direct ingestion.

In most cases, available data are insufficient to permit reliable estimates of exposure by inhalation and dermal absorption of contaminants present in drinking-water. It was not always possible, therefore, to address intake from these routes specifically in the derivation of the guideline values. However, that portion of the total tolerable daily intake (TDI) allocated to drinking-water is generally sufficient to allow for these additional routes of intake (see section 8.2.2). Should there be reason to believe that potential inhalation of volatile compounds and dermal exposure from various indoor water uses (such as showering) are not adequately addressed, authorities could consider taking this into account in setting national standards or guidelines.
## ANNEX 4

### Chemical summary tables

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Reason for exclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amitraz</td>
<td>Degrades rapidly in the environment and is not expected to occur at measurable concentrations in drinking-water</td>
</tr>
<tr>
<td>Beryllium</td>
<td>Unlikely to occur in drinking-water</td>
</tr>
<tr>
<td>Chlorobenzilate</td>
<td>Unlikely to occur in drinking-water</td>
</tr>
<tr>
<td>Chlorothalonil</td>
<td>Unlikely to occur in drinking-water</td>
</tr>
<tr>
<td>Cypermethrin</td>
<td>Unlikely to occur in drinking-water</td>
</tr>
<tr>
<td>Diazinon</td>
<td>Unlikely to occur in drinking-water</td>
</tr>
<tr>
<td>Dinoseb</td>
<td>Unlikely to occur in drinking-water</td>
</tr>
<tr>
<td>Ethylene thiourea</td>
<td>Unlikely to occur in drinking-water</td>
</tr>
<tr>
<td>Fenamiphos</td>
<td>Unlikely to occur in drinking-water</td>
</tr>
<tr>
<td>Formothion</td>
<td>Unlikely to occur in drinking-water</td>
</tr>
<tr>
<td>Hexachlorocyclohexanes</td>
<td>Unlikely to occur in drinking-water</td>
</tr>
<tr>
<td>(mixed isomers)</td>
<td></td>
</tr>
<tr>
<td>MCPB</td>
<td>Unlikely to occur in drinking-water</td>
</tr>
<tr>
<td>Methamidophos</td>
<td>Unlikely to occur in drinking-water</td>
</tr>
<tr>
<td>Methomyl</td>
<td>Unlikely to occur in drinking-water</td>
</tr>
<tr>
<td>Mirex</td>
<td>Unlikely to occur in drinking-water</td>
</tr>
<tr>
<td>Monocrotophos</td>
<td>Has been withdrawn from use in many countries and is unlikely to occur in drinking-water</td>
</tr>
<tr>
<td>Oxamyl</td>
<td>Unlikely to occur in drinking-water</td>
</tr>
<tr>
<td>Phorate</td>
<td>Unlikely to occur in drinking-water</td>
</tr>
<tr>
<td>Propoxur</td>
<td>Unlikely to occur in drinking-water</td>
</tr>
<tr>
<td>Pyridate</td>
<td>Not persistent and only rarely found in drinking-water</td>
</tr>
<tr>
<td>Quinozene</td>
<td>Unlikely to occur in drinking-water</td>
</tr>
<tr>
<td>Toxaphene</td>
<td>Unlikely to occur in drinking-water</td>
</tr>
<tr>
<td>Triazophos</td>
<td>Unlikely to occur in drinking-water</td>
</tr>
<tr>
<td>Tributyltin oxide</td>
<td>Unlikely to occur in drinking-water</td>
</tr>
<tr>
<td>Trichlorfon</td>
<td>Unlikely to occur in drinking-water</td>
</tr>
</tbody>
</table>
Table A4.2 Chemicals for which guideline values have not been established

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Reason for not establishing a guideline value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminium</td>
<td>Owing to limitations in the animal data as a model for humans and the uncertainty surrounding the human data,</td>
</tr>
<tr>
<td></td>
<td>a health-based guideline value cannot be derived; however, practicable levels based on optimization of the</td>
</tr>
<tr>
<td></td>
<td>coagulation process in drinking-water plants using aluminium-based coagulants are derived: 0.1 mg/litre or</td>
</tr>
<tr>
<td></td>
<td>less in large water treatment facilities, and 0.2 mg/litre or less in small facilities</td>
</tr>
<tr>
<td>Ammonia</td>
<td>Occurs in drinking-water at concentrations well below those at which toxic effects may occur</td>
</tr>
<tr>
<td>Asbestos</td>
<td>No consistent evidence that ingested asbestos is hazardous to health</td>
</tr>
<tr>
<td>Bentazone</td>
<td>Occurs in drinking-water at concentrations well below those at which toxic effects may occur</td>
</tr>
<tr>
<td>Bromochloroacetate</td>
<td>Available data inadequate to permit derivation of health-based guideline value</td>
</tr>
<tr>
<td>Bromochloroacetonitrile</td>
<td>Available data inadequate to permit derivation of health-based guideline value</td>
</tr>
<tr>
<td>Chloride</td>
<td>Not of health concern at levels found in drinking-water</td>
</tr>
<tr>
<td>Chlorine dioxide</td>
<td>Guideline value not established because of the rapid breakdown of chlorine dioxide and because the chlorite</td>
</tr>
<tr>
<td></td>
<td>provisional guideline value is adequately protective for potential toxicity from chlorine dioxide</td>
</tr>
<tr>
<td>Chloroacetones</td>
<td>Available data inadequate to permit derivation of health-based guideline values for any of the chloroacetones</td>
</tr>
<tr>
<td>Chlorophenol, 2-</td>
<td>Available data inadequate to permit derivation of health-based guideline value</td>
</tr>
<tr>
<td>Chloropicrin</td>
<td>Available data inadequate to permit derivation of health-based guideline value</td>
</tr>
<tr>
<td>Dialkyltins</td>
<td>Available data inadequate to permit derivation of health-based guideline values for any of the dialkyltins</td>
</tr>
<tr>
<td>Dichloroacetate</td>
<td>Available data inadequate to permit derivation of health-based guideline value</td>
</tr>
<tr>
<td>Dichloroformine, 1,3-</td>
<td>Toxicological data are insufficient to permit derivation of health-based guideline value</td>
</tr>
<tr>
<td>Dichloroethane, 1-</td>
<td>Very limited database on toxicity and carcinogenicity</td>
</tr>
<tr>
<td>Dichlorophenol, 2,4-</td>
<td>Available data inadequate to permit derivation of health-based guideline value</td>
</tr>
<tr>
<td>Dichloropropane, 1,3-</td>
<td>Data insufficient to permit derivation of health-based guideline value</td>
</tr>
<tr>
<td>Di(2-ethylhexyl)adipate</td>
<td>Occurs in drinking-water at concentrations well below those at which toxic effects may occur</td>
</tr>
<tr>
<td>Diquat</td>
<td>Rarely found in drinking-water, but may be used as an aquatic herbicide for the control of free-floating and</td>
</tr>
<tr>
<td></td>
<td>submerged aquatic weeds in ponds, lakes and irrigation ditches</td>
</tr>
<tr>
<td>Endosulfan</td>
<td>Occurs in drinking-water at concentrations well below those at which toxic effects may occur</td>
</tr>
<tr>
<td>Fenitrothion</td>
<td>Occurs in drinking-water at concentrations well below those at which toxic effects may occur</td>
</tr>
<tr>
<td>Fluoranthene</td>
<td>Occurs in drinking-water at concentrations well below those at which toxic effects may occur</td>
</tr>
<tr>
<td>Glyphosate and AMPA</td>
<td>Occurs in drinking-water at concentrations well below those at which toxic effects may occur</td>
</tr>
<tr>
<td>Hardness</td>
<td>Not of health concern at levels found in drinking-water</td>
</tr>
<tr>
<td>Heptachlor and</td>
<td>Occurs in drinking-water at concentrations well below those at which toxic effects may occur</td>
</tr>
<tr>
<td>heptachlor epoxide</td>
<td></td>
</tr>
</tbody>
</table>

*continued*
<table>
<thead>
<tr>
<th>Chemical</th>
<th>Reason for not establishing a guideline value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hexachlorobenzene</td>
<td>Occurs in drinking-water at concentrations well below those at which toxic effects may occur</td>
</tr>
<tr>
<td>Hydrogen sulfide</td>
<td>Not of health concern at levels found in drinking-water</td>
</tr>
<tr>
<td>Inorganic tin</td>
<td>Occurs in drinking-water at concentrations well below those at which toxic effects may occur</td>
</tr>
<tr>
<td>Iodine</td>
<td>Available data inadequate to permit derivation of health-based guideline value, and lifetime exposure to iodine through water disinfection is unlikely</td>
</tr>
<tr>
<td>Iron</td>
<td>Not of health concern at concentrations normally observed in drinking-water, and taste and appearance of water are affected below the health-based value</td>
</tr>
<tr>
<td>Malathion</td>
<td>Occurs in drinking-water at concentrations well below those at which toxic effects may occur</td>
</tr>
<tr>
<td>Methyl parathion</td>
<td>Occurs in drinking-water at concentrations well below those at which toxic effects may occur</td>
</tr>
<tr>
<td>Monobromoacetate</td>
<td>Available data inadequate to permit derivation of health-based guideline value</td>
</tr>
<tr>
<td>Monochlorobenzene</td>
<td>Occurs in drinking-water at concentrations well below those at which toxic effects may occur, and health-based value would far exceed lowest reported taste and odour threshold</td>
</tr>
<tr>
<td>MX</td>
<td>Occurs in drinking-water at concentrations well below those at which toxic effects may occur</td>
</tr>
<tr>
<td>Parathion</td>
<td>Occurs in drinking-water at concentrations well below those at which toxic effects may occur</td>
</tr>
<tr>
<td>Permethrin</td>
<td>Occurs in drinking-water at concentrations well below those at which toxic effects may occur</td>
</tr>
<tr>
<td>pH</td>
<td>Not of health concern at levels found in drinking-water</td>
</tr>
<tr>
<td>Phenylphenol, 2- and its sodium salt</td>
<td>Occurs in drinking-water at concentrations well below those at which toxic effects may occur</td>
</tr>
<tr>
<td>Propanil</td>
<td>Readily transformed into metabolites that are more toxic; a guideline value for the parent compound is considered inappropriate, and there are inadequate data to enable the derivation of guideline values for the metabolites</td>
</tr>
<tr>
<td>Silver</td>
<td>Available data inadequate to permit derivation of health-based guideline value</td>
</tr>
<tr>
<td>Sodium</td>
<td>Not of health concern at levels found in drinking-water</td>
</tr>
<tr>
<td>Sulfate</td>
<td>Not of health concern at levels found in drinking-water</td>
</tr>
<tr>
<td>Total dissolved solids (TDS)</td>
<td>Not of health concern at levels found in drinking-water</td>
</tr>
<tr>
<td>Trichloramine</td>
<td>Available data inadequate to permit derivation of health-based guideline value</td>
</tr>
<tr>
<td>Trichloroacetonitrile</td>
<td>Available data inadequate to permit derivation of health-based guideline value</td>
</tr>
<tr>
<td>Trichlorobenzenes (total)</td>
<td>Occurs in drinking-water at concentrations well below those at which toxic effects may occur, and health-based value would exceed lowest reported odour threshold</td>
</tr>
<tr>
<td>Trichloroethane, 1,1,1-</td>
<td>Occurs in drinking-water at concentrations well below those at which toxic effects may occur</td>
</tr>
<tr>
<td>Zinc</td>
<td>Not of health concern at concentrations normally observed in drinking-water</td>
</tr>
</tbody>
</table>

* May affect acceptability of drinking-water (see chapter 10).

b An important operational water quality parameter.
## Table A4.3 Guideline values for chemicals that are of health significance in drinking-water

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Guideline value $^a$ (mg/litre)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acrylamide</td>
<td>0.0005$^b$</td>
<td></td>
</tr>
<tr>
<td>Alachlor</td>
<td>0.02$^b$</td>
<td></td>
</tr>
<tr>
<td>Aldicarb</td>
<td>0.01</td>
<td>Applies to aldicarb sulfoxide and aldicarb sulfone</td>
</tr>
<tr>
<td>Aldrin and dieldrin</td>
<td>0.00003</td>
<td>For combined aldrin plus dieldrin</td>
</tr>
<tr>
<td>Antimony</td>
<td>0.02</td>
<td></td>
</tr>
<tr>
<td>Arsenic</td>
<td>0.01 (P)</td>
<td></td>
</tr>
<tr>
<td>Atrazine</td>
<td>0.002</td>
<td></td>
</tr>
<tr>
<td>Barium</td>
<td>0.7</td>
<td></td>
</tr>
<tr>
<td>Benzene</td>
<td>0.01$^b$</td>
<td></td>
</tr>
<tr>
<td>Benzo(a)pyrene</td>
<td>0.0007$^b$</td>
<td></td>
</tr>
<tr>
<td>Boron</td>
<td>0.5 (T)</td>
<td></td>
</tr>
<tr>
<td>Bromate</td>
<td>0.01$^b$ (A, T)</td>
<td></td>
</tr>
<tr>
<td>Bromodichloromethane</td>
<td>0.06$^b$</td>
<td></td>
</tr>
<tr>
<td>Bromoform</td>
<td>0.1</td>
<td></td>
</tr>
<tr>
<td>Cadmium</td>
<td>0.003</td>
<td></td>
</tr>
<tr>
<td>Carbofuran</td>
<td>0.007</td>
<td></td>
</tr>
<tr>
<td>Carbon tetrachloride</td>
<td>0.004</td>
<td></td>
</tr>
<tr>
<td>Chloral hydrate (trichloroacetaldehyde)</td>
<td>0.01 (P)</td>
<td></td>
</tr>
<tr>
<td>Chlorate</td>
<td>0.7 (D)</td>
<td>For effective disinfection, there should be a residual concentration of free chlorine of ( \geq 0.5 \text{ mg/litre} ) after at least 30 min contact time at pH &lt;8.0</td>
</tr>
<tr>
<td>Chloride</td>
<td>0.0002</td>
<td></td>
</tr>
<tr>
<td>Chloride</td>
<td>5 (C)</td>
<td></td>
</tr>
<tr>
<td>Chlorine</td>
<td>0.7 (D)</td>
<td></td>
</tr>
<tr>
<td>Chloroform</td>
<td>0.2</td>
<td></td>
</tr>
<tr>
<td>Chlorotoluron</td>
<td>0.03</td>
<td></td>
</tr>
<tr>
<td>Chlorpyrifos</td>
<td>0.03</td>
<td></td>
</tr>
<tr>
<td>Chromium</td>
<td>0.05 (P)</td>
<td>For total chromium</td>
</tr>
<tr>
<td>Copper</td>
<td>2</td>
<td>Staining of laundry and sanitary ware may occur below guideline value</td>
</tr>
<tr>
<td>Cyanazine</td>
<td>0.0006</td>
<td></td>
</tr>
<tr>
<td>Cyanide</td>
<td>0.07</td>
<td></td>
</tr>
<tr>
<td>Cyanogen chloride</td>
<td>0.07</td>
<td>For cyanide as total cyanogenic compounds</td>
</tr>
<tr>
<td>2,4-D (2,4-dichlorophenoxyacetic acid)</td>
<td>0.03</td>
<td>Applies to free acid</td>
</tr>
<tr>
<td>2,4-D</td>
<td>0.09</td>
<td></td>
</tr>
<tr>
<td>DDT and metabolites</td>
<td>0.001</td>
<td></td>
</tr>
<tr>
<td>Di(2-ethylhexyl)phthalate</td>
<td>0.008</td>
<td></td>
</tr>
<tr>
<td>Dibromoacetonitrile</td>
<td>0.07</td>
<td></td>
</tr>
<tr>
<td>Dibromochloromethane</td>
<td>0.1</td>
<td></td>
</tr>
<tr>
<td>1,2-Dibromo-3-chloropropene</td>
<td>0.001$^b$</td>
<td></td>
</tr>
<tr>
<td>1,2-Dibromoethane</td>
<td>0.0004$^b$ (P)</td>
<td></td>
</tr>
<tr>
<td>Dichloroacetate</td>
<td>0.05 (T, D)</td>
<td></td>
</tr>
<tr>
<td>Dichloroacetonitrile</td>
<td>0.02 (P)</td>
<td></td>
</tr>
<tr>
<td>Dichlorobenzene, 1,2-</td>
<td>1 (C)</td>
<td></td>
</tr>
</tbody>
</table>
### Table A4.3 Continued

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Guideline value (mg/litre)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dichlorobenzene, 1,4-</td>
<td>0.3 (C)</td>
<td></td>
</tr>
<tr>
<td>Dichloroethane, 1,2-</td>
<td>0.03&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Dichloroethene, 1,1-</td>
<td>0.03</td>
<td></td>
</tr>
<tr>
<td>Dichloroethene, 1,2-</td>
<td>0.05</td>
<td></td>
</tr>
<tr>
<td>Dichloromethane</td>
<td>0.02</td>
<td></td>
</tr>
<tr>
<td>1,2-Dichloropropane (1,2-DCP)</td>
<td>0.04 (P)</td>
<td></td>
</tr>
<tr>
<td>1,3-Dichloropropene</td>
<td>0.02&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Dichloroprop</td>
<td>0.1</td>
<td></td>
</tr>
<tr>
<td>Dimethoate</td>
<td>0.006</td>
<td></td>
</tr>
<tr>
<td>Edetic acid (EDTA)</td>
<td>0.6</td>
<td>Applies to the free acid</td>
</tr>
<tr>
<td>Endrin</td>
<td>0.0006</td>
<td></td>
</tr>
<tr>
<td>Epichlorohydrin</td>
<td>0.0004 (P)</td>
<td></td>
</tr>
<tr>
<td>Ethylbenzene</td>
<td>0.3 (C)</td>
<td></td>
</tr>
<tr>
<td>Fenoprop</td>
<td>0.009</td>
<td></td>
</tr>
<tr>
<td>Fluoride</td>
<td>1.5</td>
<td>Volume of water consumed and intake from other sources should be considered when setting national standards</td>
</tr>
<tr>
<td>Formaldehyde</td>
<td>0.9</td>
<td></td>
</tr>
<tr>
<td>Hexachlorobutadiene</td>
<td>0.0006</td>
<td></td>
</tr>
<tr>
<td>Isoproturon</td>
<td>0.009</td>
<td></td>
</tr>
<tr>
<td>Lead</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td>Lindane</td>
<td>0.002</td>
<td></td>
</tr>
<tr>
<td>Manganese</td>
<td>0.4 (C)</td>
<td></td>
</tr>
<tr>
<td>MCPA</td>
<td>0.002</td>
<td></td>
</tr>
<tr>
<td>Mecoprop</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td>Mercury</td>
<td>0.001</td>
<td>For total mercury (inorganic plus organic)</td>
</tr>
<tr>
<td>Methoxychlor</td>
<td>0.02</td>
<td></td>
</tr>
<tr>
<td>Metolachlor</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td>Microcystin-LR</td>
<td>0.001 (P)</td>
<td>For total microcystin-LR (free plus cell-bound)</td>
</tr>
<tr>
<td>Molinate</td>
<td>0.006</td>
<td></td>
</tr>
<tr>
<td>Molybdenum</td>
<td>0.07</td>
<td></td>
</tr>
<tr>
<td>Monochloramine</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Monochloroacetate</td>
<td>0.02</td>
<td></td>
</tr>
<tr>
<td>Nickel</td>
<td>0.02 (P)</td>
<td></td>
</tr>
<tr>
<td>Nitrate (as NO&lt;sub&gt;3&lt;/sub&gt;⁻)</td>
<td>50</td>
<td>Short-term exposure</td>
</tr>
<tr>
<td>Nitritoltriacetic acid (NTA)</td>
<td>0.2</td>
<td></td>
</tr>
<tr>
<td>Nitrite (as NO&lt;sub&gt;2&lt;/sub&gt;⁻)</td>
<td>3</td>
<td>Short-term exposure</td>
</tr>
<tr>
<td></td>
<td>0.2 (P)</td>
<td>Long-term exposure</td>
</tr>
<tr>
<td>Pendimethalin</td>
<td>0.02</td>
<td></td>
</tr>
<tr>
<td>Pentachlorophenol</td>
<td>0.009&lt;sup&gt;h&lt;/sup&gt; (P)</td>
<td></td>
</tr>
<tr>
<td>Pyriproxyfen</td>
<td>0.3</td>
<td></td>
</tr>
<tr>
<td>Selenium</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td>Simazine</td>
<td>0.002</td>
<td></td>
</tr>
<tr>
<td>Styrene</td>
<td>0.02 (C)</td>
<td></td>
</tr>
<tr>
<td>2,4,5-T</td>
<td>0.009</td>
<td></td>
</tr>
<tr>
<td>Terbuthylazine</td>
<td>0.007</td>
<td></td>
</tr>
<tr>
<td>Tetrachloroethene</td>
<td>0.04</td>
<td></td>
</tr>
<tr>
<td>Toluene</td>
<td>0.7 (C)</td>
<td></td>
</tr>
</tbody>
</table>
## Annex 4. Chemical Summary Tables

### Table A4.3 Continued

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Guideline value (mg/litre)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trichloroacetate</td>
<td>0.2</td>
<td></td>
</tr>
<tr>
<td>Trichloroethene</td>
<td>0.07 (P)</td>
<td></td>
</tr>
<tr>
<td>Trichlorophenol, 2,4,6-</td>
<td>0.2^b (C)</td>
<td>The sum of the ratio of the concentration of each to its respective guideline value should not exceed 1</td>
</tr>
<tr>
<td>Trifluralin</td>
<td>0.02</td>
<td></td>
</tr>
<tr>
<td>Trihalomethanes</td>
<td></td>
<td>Only chemical aspects of uranium addressed</td>
</tr>
<tr>
<td>Uranium</td>
<td>0.015 (P, T)</td>
<td></td>
</tr>
<tr>
<td>Vinyl chloride</td>
<td>0.0003^b</td>
<td></td>
</tr>
<tr>
<td>Xylenes</td>
<td>0.5 (C)</td>
<td></td>
</tr>
</tbody>
</table>

^a P = provisional guideline value, as there is evidence of a hazard, but the available information on health effects is limited; T = provisional guideline value because calculated guideline value is below the level that can be achieved through practical treatment methods, source protection, etc.; A = provisional guideline value because calculated guideline value is below the achievable quantification level; D = provisional guideline value because disinfection is likely to result in the guideline value being exceeded; C = concentrations of the substance at or below the health-based guideline value may affect the appearance, taste or odour of the water, leading to consumer complaints.

^b For substances that are considered to be carcinogenic, the guideline value is the concentration in drinking-water associated with an upper-bound excess lifetime cancer risk of $10^{-5}$ (one additional cancer per 100,000 of the population ingesting drinking-water containing the substance at the guideline value for 70 years). Concentrations associated with upper-bound estimated excess lifetime cancer risks of $10^{-4}$ and $10^{-6}$ can be calculated by multiplying and dividing, respectively, the guideline value by 10.
### Index

Page numbers in **bold** indicate main discussions.

*Acanthamoeba* 122, 123, 125, **259–261**  
Acceptability 7, 23, **210–220**  
- biologically derived contaminants 211–213  
- chemical contaminants 146, 156, 213–219  
- desalinated water 112–113  
in emergency and disaster situations 106  
**Acceptable daily intake (ADI)** 150  
- derivation of guideline values 152  
- uncertainty factors 150–151  
**Access to water (accessibility)** 90, **91–92**  
- definition of reasonable 91  
equitability 105  
*Acinetobacter* 102, 124, **222–224,** 286  
Acrylamide **296–297**  
- analysis 162  
- guideline value 194, 296, 491  
Actinomycetes 212  
Activated alumina 179  
Activated carbon  
- adsorption **176–177**  
- granular (GAC) 176, 177  
- powdered (PAC) 176  
Additives 30  
Adenoviruses 122, **248–250,** 295  
**Adequacy of supply, surveillance** **90–93**  
**ADI** see Acceptable daily intake  
Advanced oxidation processes 173  
Aeration processes **175**  
*Aeromonas* 102, 124, **224–225,** 286  
Aerosols 123  
Affordability 90, **92**  
Aggressivity, desalinated water 112  
Aggressivity index 183  
**Agricultural activities, chemicals from** 147  
- analysis 159, 161  
- guideline values **187–188,** 189, 190, 191  
- treatment achievabilities 169–170  
**AIDS** 124, 270  
**Air**  
- chemical intake 152  
- radon intake 206–207  
Air stripping 175  
**Aircraft** **116–117**  
**Airports** **116–117**  
**Alachlor** **297–298**  
- analysis 161  
- guideline value 191, 298, 491  
- treatment achievability 169, 298  
**Aldicarb** **298–300**  
- analysis 161  
- guideline value 191, 299, 491  
- treatment achievability 169, 299  
**Aldrin** **300–301**  
- analysis 161  
- guideline value 191, 300, 491  
- treatment achievability 169, 300  
**Algae** 213  
- blue-green see Cyanobacteria  
- harmful events 111, 213  
- toxins 111  
**Alkalinity** 217  
- corrosion and 181, 184  
- see also **pH**  
**Alkylbenzenes** 217  
**Alpha radiation activity**  
- measurement 207–208  
- screening levels 204, 205, 206  
**Alumina, activated** 179  
**Aluminium** 193, 213, **301–303,** 489
Alzheimer disease (AD) 302
Ameriicum-241 202
Aminomethylphosphonic acid (AMPA) 190, 379–380, 489
Amitraz 189, 488
Ammonia 190, 303–304, 489
taste and odour 213
treatment to remove 220
Amoebae 63
Legionella ingestion 234
see also Acanthamoeba; Entamoeba histolytica; Naegleria fowleri
Amoebiasis 266
Amoebic meningoencephalitis, primary (PAM) 123, 272, 273
AMPA 190, 379–380, 489
Analytical methods
chemicals 157–166
radionuclides 207–208
Ancylostoma 124
Animals
in drinking-water 212–213
toxicity studies 148
uncertainty factors 151
Anion exchange 177
Anthrax 225
Antimony 304–306
analysis 159
guideline value 194, 305, 491
Appearance 7, 210, 211–220
biologically derived contaminants 211–213
chemical contaminants 213–219
treatments for improving 219–220
Argyria 434
Arsenic 6, 306–308
analysis 159
in drinking-water sources 146, 306
guideline value 186, 306, 491
priority 35–36
treatment achievability 167, 307
Asbestos 190, 308, 489
Asbestos–cement pipes 183
Ascaris (Ascarisis) 124, 276
Asellus aquaticus 212
Aspergillus 102
Assessing Microbial Safety of Drinking Water: Improving Approaches and Methods 18, 59
Astroviruses 250–251
Atomic absorption spectrometry (AAS) 159–164
Atomic emission spectrometry (AES) 164
Atrazine 308–309
analysis 161
guideline value 191, 309, 491
treatment achievability 169, 309
Audit 86–87, 94
Avoidance, water 79
Bacillus 221, 225–226
Bacillus cereus 221, 225, 226
Bacillus thuringiensis israelensis 190
Backflow 62, 63
large buildings 101
Bacteria 221
indicator and index 282–289
pathogenic 122, 222–247
persistence in water 125
treatment effects 138–141
Bacteriophages 142, 289–294
Bacteroides fragilis 292–294
coliphages 289–292
Bacteroides fragilis phages 292–294
Balantidium coli (balantidiasis) 124, 261–262
Barium 310–311
analysis 159
guideline value 186, 310, 491
BDCM see Bromodichloromethane
Becquerel (Bq) 201
Benchmark dose (BMD) 152, 153
Bentazone 190, 311–312, 489
Benzene 312–313
analysis 160
guideline value 188, 312, 491
treatment achievability 168, 312
3,4-Benzfluoranthene 429
11,12-Benzfluoranthen 429
Benzo[a]pyrene 428–429, 430
analysis 162
guideline value 194, 428, 491
1,12-Benzpyrene 429
3,4-Benzpyrene 429
Beryllium 187, 488
Beta-Poisson dose–response relation 129
Beta radiation activity 205
measurement 207–208
screening levels 204, 205, 206
Bilharziasis 123
Biofilms 4–5, 63
atypical mycobacteria 235, 236
coliform bacteria 283
desalinated water 113
Klebsiella 233
Legionella 234, 235
Biological denitrification 179
GUIDELINES FOR DRINKING-WATER QUALITY

Biological nitrification 179
Biologically derived contaminants 211–213
Bleach, household 107
Blooms, cyanobacterial 195, 213, 281
“Blue-baby syndrome” (methaemoglobinemia) 6, 418–420
Blue-green algae see Cyanobacteria
Body weight 150
assumptions 486
Boil water orders 79
Boiling of water
bottle-fed infants 114
emergencies and disasters 79, 107
travellers 110
Borehole water supplies 65–66
Boron 313–314
analysis 159
guideline value 186, 313, 491
Bottle-fed infants 114, 418, 419
Bottled water 113–115
international standards 114–115
potential health benefits 114
travellers 110, 111
Brackish water 111
Brass corrosion 182–183
Bromate 179, 315–316
analysis 162
guideline value 194, 315, 491
strategies for reducing 180
Brominated acetic acids 316–317
Bromochloroacetate 193, 316–317, 489
Bromochloroacetonitrile 193, 380–382, 489
Bromodichloromethane (BDCM) 451–454
analysis 162, 452
guideline value 194, 451, 491
Bromoform 451–454
analysis 162
guideline value 194, 451, 491
Buildings
large 99–104, 235
plumbing systems 17–18
Burkholderia pseudomallei 122, 221, 226–227
Burns injuries 103
Cadmium 317–319
analysis 159
guideline value 188, 317, 491
treatment achievability 168, 317
Caesium-134 (134Cs), 202
Caesium-137 (137Cs), 202
Calcium, taste threshold 215
Calcium carbonate
corrosion control 181, 182, 183, 184
scale 183–184, 215–216
see also Hardness
Calcium hypochlorite 107, 171
Calcium sulfate 218
Caliciviruses 251–253
Campylobacter 228–229
performance target setting 132
risk characterization 129, 130
in source waters 137
Campylobacter coli 122, 228
Campylobacter jejuni 122, 228
Campylobacter pylori see Helicobacter pylori
Cancer
radiation-induced 200
radon-related risk 207
tolerable risk 46–47
see also Carcinogens
Carbofuran 161, 319–320
guideline value 191, 319, 491
treatment achievability 169, 319
Carbon, activated see Activated carbon
Carbon-14 (14C), 202
Carbon tetrachloride 320–321
analysis 160
guideline value 188, 320, 491
treatment achievability 168, 320
Carcinogens
derivation of guideline values 149
genotoxic 148–149, 154
guideline values 154
IARC classification 149
non-genotoxic 149
tolerable risk 46–47
uncertainty factors 151
Cascade aeration 175
Catchments 53, 54, 56–59
control measures 58–59
hazard identification 56–58
mapping, emergency and disaster situations 108
new systems 52–53
roles and responsibilities 11, 12–13, 14
see also Source waters
Categorical regression 152, 153–154
Cation exchange 177
Cement, corrosion 183
Cercariae 123
Certification 16–17, 42
agencies 16–17
chemicals in water 43
desalination systems 112
Chemical Safety of Drinking-water: Assessing Priorities for Risk Management 18, 36
INDEX

Chemical-specific adjustment factors (CSAF) 152, 154
Chemicals 6–7, 145–196
acceptability aspects 146, 156, 213–219
agricultural activities see Agricultural activities, chemicals from allocation of intake 151–152
alternative routes of exposure 43–44, 146
analytical methods 157–166
achievabilities 157–158, 159, 160–163
ranking of complexity 158
categorization by source 147
desalination systems 111–112
emergencies involving 79, 108–109
guideline values see Guideline values
health-based targets 41, 42–43
health hazards 6–7, 145–147
IARC classification 149
industrial sources and human dwellings see Industrial sources and human dwellings, chemicals from information sources 36, 148, 156
inorganic
analytical methods 158, 159
guideline values 185, 186
mixtures 156
naturally occurring see Naturally occurring chemicals
non-guideline 156
non-threshold 148–149
derivation of guideline values 154
provisional guideline values 155–156
organic, analytical methods 158, 160–161
priority setting 35–36
on ships 118
"short-listing" 36
summary tables 488–493
threshold 148, 149–154
alternative approaches 152–154
derivation of guideline values 149–152
treatment 166–184
achievabilities 166–171
for corrosion control 180–184
process control measures 179–180
processes 171–179
used in treatment/materials in contact with water 147
analysis 159, 162
guideline values 188–190, 193–194
see also Disinfection by-products
water quality
emergency and disaster situations 108–109
targets 42–43
verification 30–31, 72, 73
Children
consumption assumptions 486
hygiene education 103–104
radionuclide guidance levels 204
see also Infants
Chironomus larvae 212
Chloral hydrate (trichloroacetaldehyde) 321–322
analysis 162
guideline value 194, 322, 491
Chloramination 63–64, 172
by-products 179, 180, 192
nitrite formation 417, 418
Chloramines 172
dialysis water 103
see also Monochloramine
Chlorate 179, 326–329
analysis 162
guideline value 194, 326, 491
Chlordane 323–324
analysis 161
guideline value 191, 323, 491
treatment achievability 169, 323
Chloride 185, 324–325, 489
acceptability 213–214, 324
corrosion and 181, 182, 184
Chlorinated acetic acids 145, 179, 349–350, 412–413, 445–446
Chlorinated anisoles 214
Chlorinated ketones 179
Chlorination 61, 171–172
breakpoint 171
by-products 145, 179–180, 192, 451
in emergencies 79
marginal 171
microbial reduction 140
for travellers 110
Chlorine 5, 171, 325–326
acceptable levels 214
analysis 162
gas, liquefied 171
guideline value 194, 325, 491
residual
emergency and disaster situations 107, 108
monitoring 69, 82
treatment see Chlorination
Chlorine dioxide 326
by-products 179, 180, 192, 326
see also Chlorate; Chlorite
guideline value 193, 328, 489
microbial reduction 140
toxicity 327
water treatment 173
Chlorite 179, 326–329
analysis 162
guideline value 194, 326, 491
3-Chloro-4-dichloromethyl-5-hydroxy-2(5H)-furanone (MX) 193, 414–415, 490
Chloroacetones 193, 329, 489
Chlorobenzilate 189, 488
Chloroform 145, 451–454
analysis 162, 452
guideline value 194, 451, 491
2-Chlorophenol 193, 214, 329–331, 489
Chlorophenols 214, 329–331
Chloropicrin 193, 331–332, 489
Chlorothalonil 189, 488
Chlorotoluron 332–333
analysis 161
guideline value 191, 332, 491
treatment achievability 169, 332
Chlorpyrifos 190, 333–334
analysis 163
guideline value 195, 333, 491
Cholera 244–245
Chromatography 164–165
Chromium 334–335
analysis 159
guideline value 186, 334, 491
Chydorus sphaericus 212
Citrobacter 282, 284
Clarification 138–139
drinking-water for travellers 110
emergency and disaster situations 105
Clostridium perfringens 142, 288–289
Closure, drinking-water supply 79
Cloudiness 211
Co-precipitation method, radionuclide analysis 208
Coagulation (chemical) 60, 175–176
before disinfection 179–180
microbial reduction 138–139
Coal-tar linings, pipes 428, 430
Coastal water 111
Code of good practice 33–34
Code of Practice for Collecting, Processing and Marketing of Natural Mineral Waters 115
Codex Alimentarius Commission (CAC) 114–115
Coliform bacteria
detection methods 144
thermotolerant 142, 143, 282, 284–285
total 282–284
Coliphages 289–292
F-RNA 290–291
somatic 290, 291
Colitis, amoebic 266
Collection, water
emergency and disaster situations 106
household use 71
Colorimetric methods 158
Colour 211, 214
Communication 27–28
emergency and disaster situations 106
surveillance information 95–97
water safety plans 82–83
Community
communication 28, 96
involvement in setting standards 34
organizations 12, 96
Community drinking-water systems 64–67
control measures 65–67
development of water safety plans (WSPs) 85
ensuring operation and maintenance 94
grading schemes 97, 98
hazard identification 64–65
management 81–82
operational monitoring 71, 82
roles and responsibilities 11–12, 14–15
surveillance 87, 88–89
verification testing 74–75
Concise International Chemical Assessment Documents (CICADs) 36
Concrete, dissolution 183
Confidence intervals 153
Conjunctivitis, adenovirus 248, 249
Consumers
acceptability to see Acceptability interaction with 96
right of access to information 83, 96
roles and responsibilities 15–16
Consumption, drinking-water, daily per capita 90
assumptions 486
performance target setting and 128, 133–134
Contact, transmission via 221
Contact lenses 238, 260–261
INDEX

Continuity of supply 90, 92–93
Control measures 26, 49, 68
assessment and planning 55–56
defined 55
monitoring performance see Operational monitoring
operational and critical limits 70
prioritizing hazards 53–55
validation see Validation
Cooling towers 100, 234
Copper 335–337
acceptability 214–215
analysis 159
corrosion 182
guideline value 194, 336, 491
impingement attack 182
pitting 182
Corrosion 180–184, 217
control strategies 184
galvanic 182
indices 183–184
inhibitors 181, 184
pitting 182
Costs
treatment 166–167
water supply 92
Coxsackieviruses 253–254
Crangonyx pseudogracilis 212
Critical limits 70
Crustaceans 212
Cryptosporidiosis 259, 262–263
Cryptosporidium (parvum) 122,
262–264
disinfection 140–141
oocysts 110, 262, 263
performance target setting 131–132,
133–134
risk characterization 130
in source waters 137
Ct concept 61
Culex larvae 212
Cyanazine 337–338
analysis 161
guideline value 191, 337, 491
treatment achievability 169
Cyanide 339–340
analysis 159
guideline value 188, 339, 491
Cyanobacteria 147, 192, 221, 279–281
acceptability 213
blooms 195, 213, 281
health concerns 4
toxins see Cyanotoxins
treatment 171, 195
Cyanogen chloride 162, 194, 340, 491
Cyanotoxins 4, 280, 281
classification 192
guideline values 192–196
treatment 171, 195
see also Microcystin-LR
Cyclops 212, 276, 277
Cyclospora cayetanensis 122, 259,
264–265
Cyclosporiasis 264
Cylindrospermopsin 192, 280
Cypermethrin 189, 488
Cystic fibrosis 238
2,4-D (2,4-dichlorophenoxyacetic acid) 340–342
analysis 161
guideline value 191, 341, 491
treatment achievability 169, 341
DALYs see Disability-adjusted life years
Data
fitness for purpose 75
regional use 96–97, 98
system assessment and design 53–56
Day care centres 103–104
2,4-DB 161, 191, 342–343, 491
DBCP see 1,2-Dibromo-3-chloropropane
DBPs see Disinfection by-products
DCBs see Dichlorobenzenes
DDT and metabolites 190, 343–345
analysis 163
guideline value 195, 344, 491
treatment achievability 170, 344
“Dealkalization” 177
Dechlorination 171
DEHA see Di(2-ethylhexyl)adipate
DEHP see Di(2-ethylhexyl)phthalate
Demineralized water 114
Denitrification, biological 179
Dermal absorption
assumptions 486–487
chemicals 152
Desalination systems 111–113, 178
Detergents, synthetic 218
Developing countries, urban areas 88
“Deviations” 77
Devices
certification see Certification
medical, washing 103
Dezincification of brass 182
Di(2-ethylhexyl)adipate (DEHA) 187,
362–363, 489
Dialkyltins 193, 345–346, 489
Dialysis, renal 103

499
GUIDELINES FOR DRINKING-WATER QUALITY

Diarrhoea
- cryptosporidiosis 262–263
- Escherichia coli 230
- Giardia 267
- rotavirus 258
- travellers’ 109

Diatomaceous earth 139

Diazinon 189, 488

1,2-Dibromo-3-chloropropane (DBCP) 346–347
- analysis 161
- guideline value 191, 346, 491
- treatment achievability 169, 346

Dibromoacetate 193, 316, 489

Dibromochloromethane (DCBM) 451–454
- analysis 162
- guideline value 194, 451, 491

1,2-Dibromoethane (ethylene dibromide) 347–349
- analysis 161
- guideline value 191, 347, 491
- treatment achievability 169, 348

Dichloramine 193, 411, 489

Dichloracetate 162, 491

1,1-Dichloroacetone 329

1,2-Dichloromethane 160, 357–358

2,4-Dichlorophenol 193, 214, 329–331

2,4-Dichlorophenoxyacetic acid see 2,4-D

1,2-Dichloropropane (1,2-DCP) 358–359
- analysis 161
- guideline value 191, 358, 492
- treatment achievability 169, 358

1,3-Dichlorobenzene 187, 350–352

1,2-Dichloropropene 191, 360–361, 492

Dichlorprop (2,4-DP) 161, 361–362, 492

Dieldrin 300–301
- analysis 161
- guideline value 191, 300, 491
- treatment achievability 169, 300

Dimethoate 364–366
- analysis 161
- guideline value 191, 365, 492
- treatment achievability 169, 365

Dinoseb 189, 488

1,4-Dioxane 168

Di(2-ethylhexyl)phthalate (DEHP) 160, 188, 363–364, 491

Diquat 190, 366–367, 489

Disability-adjusted life years (DALYs) 45–47
- microbial hazards 129–130
- reference level of risk and 45

Disasters 63, 104–109
- chemical and radiological guidelines 108–109
- microbial guidelines 107–108
- monitoring 106–107
- practical considerations 105–106
- sanitary inspections and catchment mapping 108
- testing kits and laboratories 109
- see also Emergencies

Disease burden
- health outcome targets and 134–135
- waterborne infections 129–130

Disinfectants 188–189
- analysis 162
- DBP formation and 180
- guideline values 193, 194
- residual, piped distribution systems 63
- see also specific disinfectants

Disinfection 5–6, 61
- in emergency and disaster situations 105–106, 107
- indicator organisms 283, 284, 286
- limitations 5
- methods 171–173
- microbial reduction 140–141
- non-chemical 180
- resistant organisms 142
INDEX

on ships 120
for travellers 110
vendor supplies 15
Disinfection by-products (DBPs) 5, 145, 179–180, 189, 192
analysis 162
desalinated water 111–112
guideline values 193, 194
strategies for reducing 179–180
see also specific chemicals
Displaced populations 104
Distilled water 114
Documentation 27–28
incidents and emergencies 28, 77
supporting 18–21
water safety plans 82–83
Domestic supplies see Household drinking-water supplies
Domestic Water Quantity, Service Level and Health 18
Dose, infectious 129
Dose–response assessment, microbial pathogens 127, 128–129
Dracunculus Eradication Programme 276
Dracunculus medinensis (guinea worm) 123, 124, 221, 276–277
intermediate host 212
significance in drinking-water 122, 277
Dreissena polymorpha 212
Droughts 104
Dysentery
amoebic 266
bacillary 240–241
Earthquakes 104
Echinococcus 124
Echoviruses 253
Edetic acid (EDTA) 367–368
analysis 160
guideline value 188, 367, 492
treatment achievability 168, 367
EDTA see Edetic acid
Education programmes 12, 71, 89
establishing 94
schools and day care centres 103–104
Electrode, ion-selective 158
Electron capture detection (ECD) 165
Electrothermal atomic absorption spectrometry (EAAS) 164
ELISA (enzyme-linked immunosorbent assay) 165–166
Emergencies 76, 104–109
chemical and radiological guidelines 108–109
documentation and reporting 28, 77
follow-up investigation 77
microbial guidelines 107–108
monitoring 106–107
practical considerations 105–106
radionuclide releases 198
response plans 76–77, 78–79
sanitary inspections and catchment mapping 108
testing kits and laboratories 109
see also Disasters; Incidents
Emerging diseases 259
Empty bed contact time (EBCT) 177
Encephalitis, granulomatous amoebic (GAE) 260, 261
Encephalitozoon 270, 271
Endosulfan 190, 368–369, 489
Endrin 369–370
analysis 161
guideline value 191, 369, 492	
treatment achievability 169, 369
Entamoeba histolytica 122, 265–267
Enteric fever 239
Enteric pathogens, in source waters 136–137

Enteric viruses 247–248, 294–295
coliphages as indicator 290–291
indicator value 294
in source waters 137
Enterobacter 282, 284
Enterococci, intestinal 287–288
Enterococcus spp. 287
Enterocolitis, Staphylococcus aureus 242
Enterocytozoon 270
Enteroviruses 122, 142, 253–254, 295
Environmental Health Criteria monographs (EHCs) 36
Environmental Protection Agency, US (US EPA) 36
Enzyme-linked immunosorbent assay (ELISA) 165–166
Epichlorohydrin (ECH) 162, 194, 370–372, 492
Equitability, access to water 105
Escherichia coli 282
detection methods 144
emergency and disaster situations 108
enterohaemorrhagic (EHEC) 122, 229–230
enteroinvasive (EIEC) 229, 230
enteropathogenic (EPEC) 229, 230
enterotoxigenic (ETEC) 229, 230
guideline values 143
as indicator of faecal pollution 29, 142, 284–285
pathogenic 122, 229–231
phages (coliphages) 289–292
piped distribution systems 63
in source waters 137
see also Coliform bacteria
Ethylbenzene 372–373
analysis 160
guideline value 188, 372, 492
odour and taste thresholds 215
treatment achievability 168, 372
Ethylene dibromide see 1,2-Dibromoethane
Ethylene thiourea 189, 488
Evaluation of the H2S Method for Detection of Fecal Contamination of Drinking Water 19
Evaporation method, radionuclide analysis 207–208
Exposure assessment, microbial pathogens 127, 128
Eye infections
Acanthamoeba 260
adenovirus 248, 249
Faecal–oral route of transmission 122, 221
Faecal contamination 3–4
control measures 5, 59
in emergencies 79, 107
indicator organisms see Faecal indicator organisms
large buildings 100
on ships 117
Faecal indicator organisms 29, 281–295
community supplies 82
criteria 281–282
desalinated water 112
emergency and disaster situations 107, 108
guideline values 143
methods of detection 143–144
operational monitoring 69
presence/absence (P/A) testing 72
in source waters 136–137
verification testing 72, 74, 142
Fasciola 124, 276, 278–279
Fascioliasis 278–279
Fasciolopsiasis 124
Fenamiphos 189, 488
Fenitrothion 190, 373–374, 489
Fenoprop 161, 191, 374–375, 492
Field test kits 109, 158
Filtration 60–61, 173–175
after coagulation 176
direct 173
drinking-water for travellers 110
dual-media or multimedia 174
granular high-rate 139
horizontal 173, 174
membrane 139
microbial reduction 139–140
precoat 139
pressure 173, 174
rapid gravity 173–174
roughing 138, 174
slow sand 139, 173, 174–175
First-flush diverters 66
Fit for purpose 75
Flame atomic absorption spectrometry (FAAS) 159
Flame ionization detection (FID) 165
Flavobacterium 124, 286
Flocculation 60, 138–139, 175–176
Floods 104
Flotation, dissolved air 138, 176
Flow diagrams 52
Fluoranthene 193, 428, 489
health-based values 429, 430
Fluoride 375–377
analysis 159
desalinated water 113
guideline value 186, 376, 492
health concerns 6, 376–377
priority 35–36
treatment achievability 167, 376
Fluorosis 376–377
Food
acceptable daily intakes (ADIs) 150
intake of chemicals 152
production and processing 115–116
safety, travellers 109–110
Food and Agriculture Organization (FAO) 114
Food poisoning
Bacillus cereus 225, 226
Campylobacter 228
Salmonella 239, 240
Staphylococcus aureus 242
Formaldehyde 162, 194, 377–378, 492
Formothion 189, 488
Framework for safe drinking water 2–3, 22–36
health-based targets 24–25
key components 22
management plans, documentation and communication 27–28
operational monitoring 26–27
requirements 22–29
INDEX

risk assessment 44
supporting information 22–23
surveillance of drinking-water quality 28–29
system assessment and design 25–26
Fulvic acids 214
Fungi 212
β-Galactosidase 282, 283
Galvanized iron 183
Gammarus pulex 212
Gas chromatography (GC) 165
Gas chromatography/mass spectrometry (GC/MS) 165
Gastroenteritis
adenovirus 248–249
astrovirus 250
calicivirus 252
Campylobacter 228
rotavirus 258
Salmonella 239
Yersinia 246
Genotoxic carcinogens 148–149
Geosmin 212, 213
Geothermal waters 272, 273
Giardia (intestinalis) 122, 267–268
disinfection 140–141
in source waters 137
Giardiasis 267
β-Glucuronidase 284
Glyphosate 190, 379–380, 489
Gnat larvae 212
Grading schemes, safety of drinking-water 29, 53–55, 97, 98
Granular activated carbon (GAC) 176, 177
Granulomatous amoebic encephalitis (GAE) 260, 261
Gray (Gy) 201
Groundwaters
Acinetobacter 222–223
arsenic contamination 146
control measures 58, 59, 65–66
hazard identification 56, 57
pathogen occurrence 136–137
radon 206
system assessment and design 53, 54
Guide to Ship Sanitation 118
Guideline values (GVs) 1–2, 6–7, 25, 30
acceptability and 156
applying 30–31
chemicals by source category 184–196
chemicals excluded 488
chemicals of health significance 491–493
chemicals without established 489–490
derivation 47, 147–156
approaches 148–149
data quality 154–155
non-threshold chemicals (non-TDI-based) 154–155
significant figures 152
threshold chemicals (TDI-based) 149–154
see also Tolerable daily intake in emergencies 108–109
health-based targets based on 41
mixtures of chemicals and 156
provisional 31, 148, 155–156
high uncertainty and 151
use and designation 155
radionuclides 202–204
radon 207
summary tables 488–493
treatment achievability 166–171
verification of microbial quality 143
Guillain–Barré syndrome 228
Guinea worm see Dracunculus medinensis
Haemolytic uraemic syndrome (HUS) 229–230
Hafnia 282
Halogenated acetonitriles 380–382
Hardness 185, 382–383, 489
acceptability 215–216
corrosion and 182, 184
treatment to reduce 220
Hazard 52
identification 127
prioritization, for control 53–55
Hazard Characterization for Pathogens in Food and Water: Guidelines 19
Hazardous events 52, 127
Health-based targets 24–25, 37–47
benefits 38
establishing 43–47
microbial hazards 126–135
role and purpose 37–39
types 39–43
Health care facilities
drinking-water quality 102–103
health risk assessment 100
Health education 89, 103–104
see also Education programmes
Health outcome targets 24–25, 40, 43
waterborne infections 134–135
Health promotion 89
Health risks 3–7
aircraft and airports 116
chemicals 6–7, 145–147
<table>
<thead>
<tr>
<th>Term</th>
<th>Page(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>large buildings</td>
<td>100</td>
</tr>
<tr>
<td>microbial see Microbial hazards</td>
<td></td>
</tr>
<tr>
<td>radiological</td>
<td>7, 198, 200–201</td>
</tr>
<tr>
<td>ships</td>
<td>117–118</td>
</tr>
<tr>
<td>travellers</td>
<td>109</td>
</tr>
<tr>
<td>Helicobacter pylori</td>
<td>221, 231–232</td>
</tr>
<tr>
<td>Helminths</td>
<td>4, 221, 275–279</td>
</tr>
<tr>
<td>significance in drinking-water</td>
<td>122, 124</td>
</tr>
<tr>
<td>Hepatitis A virus (HAV)</td>
<td>122, 125, 254–256</td>
</tr>
<tr>
<td>Hepatitis E virus (HEV)</td>
<td>122, 256–257</td>
</tr>
<tr>
<td>Heptachlor</td>
<td>190, 383–384, 489</td>
</tr>
<tr>
<td>Heptachlor epoxide</td>
<td>190, 383–384, 489</td>
</tr>
<tr>
<td>Heterotrophic micro-organisms</td>
<td>69, 286</td>
</tr>
<tr>
<td>Heterotrophic plate counts (HPC)</td>
<td>5, 285–286</td>
</tr>
<tr>
<td>Heterotrophic Plate Counts and Drinking-water Safety</td>
<td>19</td>
</tr>
<tr>
<td>Hexachlorobenzene (HCB)</td>
<td>187, 385–386, 490</td>
</tr>
<tr>
<td>Hexachlorobutadiene (HCBD)</td>
<td>386–387</td>
</tr>
<tr>
<td>analysis</td>
<td>160</td>
</tr>
<tr>
<td>guideline value</td>
<td>188, 386, 492</td>
</tr>
<tr>
<td>treatment achievability</td>
<td>168, 386</td>
</tr>
<tr>
<td>Hexachlorocyclohexanes</td>
<td>189, 488</td>
</tr>
<tr>
<td>High-income countries, rotavirus</td>
<td></td>
</tr>
<tr>
<td>performance targets</td>
<td>131–132</td>
</tr>
<tr>
<td>High-performance liquid chromatography (HPLC)</td>
<td>165</td>
</tr>
<tr>
<td>Holistic approach</td>
<td>3</td>
</tr>
<tr>
<td>Hookworm infections</td>
<td>276</td>
</tr>
<tr>
<td>Hospital-acquired (nosocomial) infections</td>
<td></td>
</tr>
<tr>
<td>Acinetobacter</td>
<td>222, 223</td>
</tr>
<tr>
<td>Klebsiella</td>
<td>252, 253</td>
</tr>
<tr>
<td>Pseudomonas aeruginosa</td>
<td>238</td>
</tr>
<tr>
<td>Hospitals</td>
<td></td>
</tr>
<tr>
<td>drinking-water quality</td>
<td>102–103</td>
</tr>
<tr>
<td>health risk assessment</td>
<td>100</td>
</tr>
<tr>
<td>Hot water systems</td>
<td>100</td>
</tr>
<tr>
<td>Hotels</td>
<td>100</td>
</tr>
<tr>
<td>Household drinking-water supplies</td>
<td></td>
</tr>
<tr>
<td>collection, transportation and storage of water</td>
<td>71</td>
</tr>
<tr>
<td>control measures</td>
<td>65–67</td>
</tr>
<tr>
<td>hazard identification</td>
<td>64–65</td>
</tr>
<tr>
<td>management</td>
<td>81–82</td>
</tr>
<tr>
<td>operational monitoring</td>
<td>71</td>
</tr>
<tr>
<td>quantity of water collected and used</td>
<td>90–91</td>
</tr>
<tr>
<td>roles and responsibilities</td>
<td>11–12, 15–16</td>
</tr>
<tr>
<td>surveillance</td>
<td>89</td>
</tr>
<tr>
<td>system assessment</td>
<td>64–67</td>
</tr>
<tr>
<td>treatment</td>
<td>141</td>
</tr>
<tr>
<td>water safety plans (WSPs)</td>
<td>48–49, 85</td>
</tr>
<tr>
<td>Human dwellings, chemicals originating</td>
<td></td>
</tr>
<tr>
<td>from see Industrial sources and</td>
<td></td>
</tr>
<tr>
<td>human dwellings, chemicals from</td>
<td></td>
</tr>
<tr>
<td>Humic acids</td>
<td>214</td>
</tr>
<tr>
<td>Hydrocarbons, low molecular weight</td>
<td>217</td>
</tr>
<tr>
<td>Hydrogen peroxide</td>
<td>173, 180</td>
</tr>
<tr>
<td>Hydrogen sulfide</td>
<td>185, 387–388, 490</td>
</tr>
<tr>
<td>acceptable levels</td>
<td>216</td>
</tr>
<tr>
<td>treatment to remove</td>
<td>220</td>
</tr>
<tr>
<td>Hydroquinone</td>
<td>118</td>
</tr>
<tr>
<td>Hydroxyl radicals</td>
<td>173</td>
</tr>
<tr>
<td>Hygiene</td>
<td></td>
</tr>
<tr>
<td>education programmes see Education</td>
<td></td>
</tr>
<tr>
<td>programmes</td>
<td></td>
</tr>
<tr>
<td>service level and</td>
<td>90, 91</td>
</tr>
<tr>
<td>Hypertension</td>
<td>436</td>
</tr>
<tr>
<td>Hypochlorite</td>
<td>107, 171</td>
</tr>
<tr>
<td>Hypochlorous acid</td>
<td>171</td>
</tr>
<tr>
<td>Ice</td>
<td>110, 113</td>
</tr>
<tr>
<td>Immunity</td>
<td></td>
</tr>
<tr>
<td>acquired</td>
<td>125, 130–131</td>
</tr>
<tr>
<td>variations in</td>
<td>121, 125</td>
</tr>
<tr>
<td>Immunocompromised persons</td>
<td>102, 124</td>
</tr>
<tr>
<td>Aeromonas infections</td>
<td>224</td>
</tr>
<tr>
<td>atypical mycobacteria infections</td>
<td>236</td>
</tr>
<tr>
<td>disease burden estimates</td>
<td>130</td>
</tr>
<tr>
<td>isosporiasis</td>
<td>269</td>
</tr>
<tr>
<td>Klebsiella infections</td>
<td>232</td>
</tr>
<tr>
<td>Pseudomonas aeruginosa</td>
<td>238</td>
</tr>
<tr>
<td>toxoplasmosis</td>
<td>274</td>
</tr>
<tr>
<td>travellers</td>
<td>111</td>
</tr>
<tr>
<td>Tsukamurella infections</td>
<td>243</td>
</tr>
<tr>
<td>Impingement attack</td>
<td>182, 183</td>
</tr>
<tr>
<td>Improvement, drinking-water systems</td>
<td>67–68</td>
</tr>
<tr>
<td>Incidents</td>
<td>76</td>
</tr>
<tr>
<td>audit</td>
<td>86–87</td>
</tr>
<tr>
<td>documentation and reporting</td>
<td>28, 77</td>
</tr>
<tr>
<td>follow-up investigation</td>
<td>77</td>
</tr>
<tr>
<td>predictable</td>
<td>77</td>
</tr>
<tr>
<td>response plans</td>
<td>76–77, 78</td>
</tr>
<tr>
<td>unplanned events</td>
<td>77–78</td>
</tr>
<tr>
<td>see also Emergencies</td>
<td></td>
</tr>
<tr>
<td>Indeno [1,2,3-cd] pyrene</td>
<td>429</td>
</tr>
<tr>
<td>Index organisms</td>
<td>281–295</td>
</tr>
<tr>
<td>Indicator organisms</td>
<td>29, 281–295</td>
</tr>
<tr>
<td>Inductively coupled plasma/atomic emission spectrometry (ICP/AES)</td>
<td>164</td>
</tr>
<tr>
<td>Inductively coupled plasma/mass spectrometry (ICP/MS)</td>
<td>164</td>
</tr>
<tr>
<td>Industrial effluents</td>
<td>214</td>
</tr>
</tbody>
</table>
INDEX

Industrial sources and human dwellings, chemicals from analysis 159, 160
guideline values 185–187, 188
treatment achievability 168

Infants
bottle-fed 114, 418, 419
consumption assumptions 486
see also Children

Infections, waterborne 4, 121–124, 221
asymptomatic 125–126
emergency and disaster situations 79, 104, 106
health-based targets 39, 43
health outcome targets 134–135
public health aspects 10–11, 125–126
risk characterization 127, 129–131
routes of transmission 221
ships 117
see also Pathogens

Infiltration
bankside 138
contamination via 62, 63

Information channels, establishing 94

Ingress
non-piped distribution systems 65
piped distribution systems 62, 63

Inhalation
assumptions 486–487
chemicals 152
micro-organisms 123, 221
radionuclides 197
radon 206–207

Inorganic tin 193, 388–389

Invertebrate animals 212–213

Intakes
control measures 59
hazard identification 57–58

Intestinal enterococci 287–288

Invertebrate animals 212–213

Iodine 389–390
guideline value 193, 389, 490
treatment, for travellers 110, 111

Iron 193, 390–391, 490
acceptable levels 216, 390
corrosion 181
galvanized 183
priority 35–36

Iron bacteria 213, 216

Isoproturon 391–392
analysis 161
guideline value 191, 391, 492
treatment achievability 169, 391

Isospora belli 221, 268–270

Isosporiasis 269

Jar tests 176

Joint FAO/WHO Expert Committee on Food Additives (JECFA) 36, 150

Joint FAO/WHO Meetings on Pesticide Residues (JMPR) 36, 150

Keratitis, Acanthamoeba 260–261

Keratoconjunctivitis, epidemic ("shipyard eye") 248, 249

Kits, testing 109, 158

Klebsiella 232–233

as indicator organism 282, 284, 286
pathogenicity 124, 232

Lakes 137

Land use 12–13

Langelier index (LI) 184

Large buildings 99–104, 235
drinking-water quality 102–104
health risk assessment 100
independent surveillance and supporting programmes 102
management 101
monitoring 101–102
system assessment 100–101

Larson ratio 184

Larvae 212

Larvicides, aquatic 190

Lactose fermentation 282, 283, 284

Laboratories, in emergencies and disasters 109

Lakes 137

Land use 12–13

Larval ratio 184

Large buildings 99–104, 235
drinking-water quality 102–104
health risk assessment 100
independent surveillance and supporting programmes 102
management 101
monitoring 101–102
system assessment 100–101

Larval ratio 184

Larvae 212

Larvicides, aquatic 190
Latrines, contamination from 186
Laws, national drinking-water 31–32
Lead 6, 392–394
   analysis 159
   corrosion 181–182
   guideline value 194, 392, 492
   priority 35–36
   sampling locations 73
Lead-210 202
Legionella spp. 4, 123, 221, 233–235
   control measures 64, 234–235
   health care facilities 103
   large building systems 100, 235
   persistence 125
   significance in drinking-water 122, 234–235
Legionellosis 100, 123, 233–234
Legionnaires' disease 123, 233–234
Likelihood categories 54–55
Lime softening 139, 179
Lindane 394–396
   analysis 161, 395
   guideline value 191, 395, 492
   treatment achievability 169, 395
Liver flukes see Fasciola
LOAEL see Lowest-observed-adverse-effect level
Local authorities 11–12
Low-income countries, rotavirus performance targets 131–132
Lowest-observed-adverse-effect level (LOAEL) 149, 150
   uncertainty factors 151
Lung cancer, radon-related risk 207
Magnesium 215
Malathion 190, 396–397, 490
Management
   aircraft and airports 117
   community and household supplies 81–82
   large buildings 101
   piped distribution systems 76–81
   plans 27–28, 49
   roles and responsibilities 8–18
   ships 119–120
Managing Water in the Home 19, 66–67
Manganese 397–399
   acceptability 216, 398
   analysis 159
   guideline value 186, 398, 492
   priority 36
   treatment to remove 167, 220
Mass spectrometry (MS) 164, 165
MCPP see Mecoprop
MCPP 400–401
   analysis 161
   guideline value 191, 401, 492
   treatment achievability 169, 401
Medical devices, cleaning 103
Melioidosis 226–227
Membrane processes, water treatment 178, 180
Meningoencephalitis, primary amoebic (PAM) 123, 272, 273
Mercury 402–403
   analysis 159
   guideline value 188, 402, 492
   treatment achievability 168, 402
Meringue dezincification 182–183
Methaemoglobinaemia 6, 418–420
Methamidophos 189, 488
Methanol 189, 488
Methoprene 190
Methoxychlor 403–404
   analysis 161
   guideline value 191, 403, 492
   treatment achievability 169, 403
4-(2-Methyl-4-chlorophenoxy)acetic acid see MCPA
2-(2-Methyl-chlorophenoxy) propionic acid see Mecoprop
2-Methyl isoborneol 212, 213
Methyl parathion 190, 404–405, 490
Methylene chloride see Dichloromethane
Methylmercury 402
Metolachlor 405–407
   analysis 161
   guideline value 191, 406, 492
   treatment achievability 169, 406
Micro-organisms, indicator and index 281–295
Microbial aspects 3–5, 121–144
Microbial growth
   bottled water 114
   desalinated water 113
Microbial hazards 3–4, 121–126
   health-based target setting 126–135
   identification 127
   water quality targets 43, 126
Microbial pathogens see Pathogens
Microbial quality
assessing priorities 35
emergency and disaster situations 79,
107–108
grading schemes based on 97, 98
health care facilities 102–103
verification 29–30, 72, 142–143
Microcystin-LR 195–196, 407–408, 492
Microcystins 103, 192, 196, 280
Microfiltration 139, 178
Microsporidia 221, 259, 270–272
Microstraining 138
Millennium Development Goals 33
Mineral waters, natural 114–115
see also Bottled water
Mining activities 186
Minister of health 33
Ministries, government 33, 34
Mirex 189, 488
Molinate 161, 191, 408–409, 492
Molluscs 212
Molybdenum 159, 186, 410–411, 492
Monitoring
dissolved radionuclides 204–205
emergency and disaster situations
106–107
operational see Operational monitoring
plans, preparing 80
see also Sanitary inspection; Surveillance
Monobromoacetate 193, 316–317, 490
Monochloramine 411–412
acceptability 216–217
analysis 162
by-products 179, 180
disinfection activity 140, 172
guideline value 194, 411, 492
Monochloroacetate 162, 194, 412–413,
492
Monochlorobenzene (MCB) 187, 217,
413–414, 490
Monocrotophos 189, 488
Moraxella 286
Mudslides 104
Multiagency approach, collaborative 8
Multiple-barrier concept 3, 5, 56
MX (3-chloro-4-dichloromethyl-5-
hydroxy-2(5H)-furanone) 193,
414–415, 490
Mycobacterium (mycobacteria) 235–237
atypical (non-tuberculous) 122, 124,
221
health care facilities 102
Mycobacterium avium complex 235, 236
Mycobacterium kansasii 235, 236
Naegleria fowleri 123, 125, 221, 272–273
control measures 64, 273
significance in drinking-water 122, 273
Nais worms 212
Nanofiltration 140, 178
National Academy of Sciences (NAS) (USA)
207
National drinking-water policy 31–34
National performance targets 133–134
National priorities, supply improvement
93
National standards and regulations 31–32
chemical contaminants 146
developing 2, 32–34
Natural disasters 63, 104
Naturally occurring chemicals 147
analysis 159
guideline values 184–185, 186
treatment achievability 167
see also Chemicals
Necator 124
Nematodes 212, 276
New drinking-water supply systems
assessment and design 52–53
source verification 74
Nickel 415–417
analysis 159, 416
guideline value 194, 416, 492
leaching 183
Nitrate 6, 417–420
agricultural sources 187
analysis 159, 418
guideline value 191, 417, 492
treatment achievability 169, 418
Nitrification, biological 179
Nitrilotriacetic acid (NTA) 420–421
analysis 160, 420
guideline value 188, 420, 492
treatment achievability 168
Nitrite 6, 417–420
analysis 159, 418
desalinated water 113
guideline value 191, 417, 492
treatment achievability 169, 418
Nitrosamines 419
No-observed-adverse-effect level (NOAEL)
149, 150
uncertainty factors 151
vs benchmark dose 153
NOAEL see No-observed-adverse-effect
level
Non-piped water systems 64–67
control measures 65–67
hazard identification 64–65
Octanol/water partition coefficient 177
Odour 7, 210, 211–220
- biologically derived contaminants 211–213
- chemical contaminants 213–219
- treatments for removing 219–220
Oils, petroleum 186, 217
Operational limits 70
Operational monitoring 26–27, 49, 68–71
- aircraft and airports 116–117
- community supplies 71, 82
defined 68
- large buildings 101–102
- parameters 68–70
- ships 119
Organic matter 214
Organisms, visible 211, 212–213
Organotins 345–346
Orthophosphate 181, 182
Orthoreoviruses 257–259, 295
Osmosis 178
- reverse 140, 178
Oxamyl 189, 488
Oxidation processes, advanced 173
Oxygen
- dissolved 215
- transfer 175
Ozonation 172
- by-products 179, 180, 192
- microbial reduction 141
Ozone 172, 173
Packaged drinking-water 113–115
- international standards 114–115
- safety 113–114
see also Bottled water
Parasites 420
- persistence in water 125
- secondary hosts 212
- waterborne 122, 124
see also Helminths; Protozoa
Parathion 190, 421–422, 490
Particulate matter 211, 219
Pathogenic Mycobacteria in Water 19
Pathogens 121–124
- alternative routes of transmission 5, 43–44, 122
- bacterial 222–247
- dose–response assessment 127, 128–129
- exposure assessment 127, 128
- fact sheets 221–279
- health-based targets 39
- helminth 275–279
- occurrence 135, 136–137
- performance targets 41–42, 131–134
- persistence and growth in water 124–125
- protozoan 259–275
- special properties 142
- transmission pathways 123
- treatment 137–141
- viral 247–259
see also Infections, waterborne
Pendimethalin 422–423
- analysis 161
- guideline value 191, 423, 492
Pentachlorophenol (PCP) 424–425
- analysis 160, 424
- guideline value 188, 424, 492
- treatment achievability 168, 424
Performance targets 25, 40, 41–42, 126
- national/local adaptation 133–134
- pathogens in raw water 131–132, 133
- risk-based development 131–134
Perlite 139
Permethrin 190, 425–426, 490
Pesticides 187
- used in water for public health 147
- analysis 161, 163
- guideline values 190–192, 195
- treatment achievability 170
see also Agricultural activities, chemicals from; specific compounds
Petroleum oils 186, 217
pH 185, 426–427, 490
- chemical coagulation 175–176
- community supplies 82
- corrosion and 181, 182, 184
- DBP formation and 179–180
- emergency and disaster situations 108
- optimum range 217, 426
- saturation 184
Phages see Bacteriophages
Pharyngconjunctival fever 248
2-Phenylphenol (and its sodium salt) 190, 427–428, 490
Phorate 189, 488
INDEX

Piped distribution systems 61–64
assessment and design 54
control measures 63–64
hazard identification 62–63
intermittent supply 63
large buildings 100, 101
management procedures 76–81
microbial hazards 123
operational monitoring parameters 69
on ships 118, 119
verification testing 74

Pipes 17–18
bursts 62
cement lining 183
carbon-tar linings 428, 430
contaminants 193, 194
corrosion 181, 182, 183
lead 181
Pitting corrosion 182
Platyhelminthes 276
Pleistophora 270
Plumatella 212
Plumbing 17–18
household 16
on ships 118
Plumbosolvency 181–182
Plutonium-239 (239Pu) 202
Pneumonia, *Burkholderia pseudomallei* 226
Poisson distribution 129
Policy
development, wider 10
national drinking-water 31–34
Poliovirus 253, 295
Polonium-210 (210Po) 202
Polyacrylamides 296
Polyaromatic hydrocarbons (PAHs) 428–430
Polyphosphates 181
Polyvinylchloride (PVC) 456
Pontiac fever 233, 234
Pools, stagnant 101
Port authority 118, 119
Potassium-40 (40K) 205
measurement 208
Potassium bromate 315
Powdered activated carbon (PAC) 176
Presence/absence (P/A) testing 72
Pressure, water 62, 63
large buildings 101
measurement, operational monitoring 69
Pretreatment 60, 138
Prevention, disease 6
Preventive integrated management approach 8
Priorities
assessing chemical 35–36
assessing microbial 35
identifying 34–36
setting 34
Problem formulation, microbial hazards 127
Propanil 190, 430–431, 490
Propoxur 189, 488
Protozoa 221
cysts and oocysts, removal 61
pathogenic 122, 259–275
resistance to treatment 142
treatment effects 138–141
*Pseudomonas* 286
*Pseudomonas aeruginosa* 102, 122, 124, 237–239
Public awareness, establishing 94
Public health
authorities, roles and responsibilities 10–11
policy context 44
surveillance 10–11
waterborne infections and 125–126
Purge-and-trap packed-column GC method 165
Purge-and-trap packed-column GC/MS method 165
Pylon technique 208
Pyridate 189, 488
Pyriproxyfen 190, 431–432
analysis 163
guideline value 195, 432, 492
treatment achievability 170, 432
QMRA see Quantitative microbial risk assessment
Quality assurance 75–76
Quality control 8–9, 75–76
Quantifying Public Health Risk in the WHO Guidelines for Drinking-water Quality 19, 47
Quantitative microbial risk assessment (QMRA) 43, 126–131
dose–response assessment 128–129
exposure assessment 128
problem formulation and hazard identification 127
risk characterization 129–131
Quantitative risk assessment 43
Quantitative service indicators 74–75
Quantity of supply
assessment of adequacy 90–91
emergency and disaster situations 105
Quintozene 189, 488
Radiation
- absorbed dose 201
- background exposures 198
- committed effective dose 201, 205
dose 201–202
- effective dose 201
- equivalent dose 201
- exposure through drinking-water 200
- health risks 7, 198, 200–201
- reference dose level (RDL) 198, 202
- sources 198–201

Radioactivity
- measurement 207–208
- screening 204
- units 201–202

Radiological aspects 7, 197–209

Radionuclides 7, 197–209
- activity concentration 201, 202
- analytical methods 207–208
dose coefficients 201–202
- emergency and disaster situations 108–109
- guidance levels 202–204
- monitoring and assessment for dissolved 204–205
- remedial measures 205
- reporting of results 209
- sampling 209
- screening for 204, 206
- sources 200
- strategy for assessing drinking-water 205, 206

Radium-226 (226Ra) 202
Radium-228 (228Ra) 202
Radon (222Rn) 197, 206–207
- in air and water 206
- guidance levels 207
- measurement 208
- risk 207
- sampling 209

Rainfall 29–30
Rainwater
- collection systems 65, 66, 141
- consumption 114

Records see Documentation

“Red water” 181, 216
Reference dose level (RDL) 198, 202
Reference level of risk 44–45, 47, 132–133
Regional level
- performance target setting 133–134
- supply improvement 93
- use of data for priority setting 96–97, 98
- “Regrowth” 5

Regulations, national see National standards and regulations

Reoviridae 257

Reporting
- incidents and emergencies 28, 77
- radioactivity analysis 209
- surveillance information 95–97

Reservoirs 54
- control measures 58–59, 64
- hazard identification 57–58
- occurrence of pathogens 137

Resource protection 56–59, 81
- control measures 58–59
- hazard identification 56–58

Respiratory infections, adenoviral 248
Reverse osmosis 140, 178

Risk
- defined 52
- judgement of tolerable 2, 37
- reference level 44–45, 47, 132–133
- scoring 53–55

Risk–benefit approach 2, 45

Risk assessment 53–55
- in framework for safe drinking water 44
- quantitative 43
- quantitative microbial see Quantitative microbial risk assessment

Risk characterization, waterborne infection 127, 129–131
Rivers, occurrence of pathogens 136, 137
Roles and responsibilities, management 8–18

Rotaviruses (HRVs) 122, 257–259
- performance target setting 131–132, 133, 134, 135
- risk characterization 129, 130–131
- Roughing filters 138, 174
- Routes of transmission 123

Safe, Piped Water: Managing Microbial Water Quality in Piped Distribution Systems 19–20

Salmonella (salmonellae) 122, 137, 239–240
Salmonella Enteritidis 239
Salmonella Paratyphi 239
Salmonella typhi 122, 239
Salmonella Typhimurium 239, 240
Sample numbers, minimum 74
Sampling
- community-managed supplies 89
- frequencies 72, 73, 75
- ISO standards 75
- locations 73
- radioactive contaminants 209
INDEX

Sanitary code 33–34
Sanitary inspection 86
community-managed supplies 71, 74, 75, 89
emergency and disaster situations 108
use of data 97, 98
Sapovirus (Sapporo-like viruses) 122, 251
Scale, calcium carbonate 183–184, 215–216
Schistosoma spp. 122, 221
Schistosomiasis 123, 276
“Schmutzdecke” 174
Schools 100, 103–104
Screening, radionuclides in drinking-water 204, 206
Scum 215
Seasonal discontinuity of supply 93
Seawater 111, 112
Sedimentation 60, 138–139, 176
Selenium 6, 432–434
analysis 159, 433
guideline value 186, 433, 492
priority setting and 35–36
treatment achievability 167, 433
Septata 270
Septic tanks 186
Serratia 124, 282, 286
Service indicators, quantitative 74–75
Service levels 90–91
Severity categories 54–55
Shigella 122, 240–241
Shigellosis 240–241
Ships 117–120
health risks 117–118
management 119–120
operational monitoring 119
surveillance 120
system risk assessment 118
“Shipyard eye” 248, 249
Sievert (Sv) 201
Significant figures 152
Silicates 181
Silver 434–435
guideline value 193, 490
treatment, for travellers 110
Simazine 435–436
analysis 161
guideline value 191, 435, 492
treatment achievability 170, 435
Single-hit principle 128–129
Skin absorption see Dermal absorption
Snails 123, 212
Sodium 185, 436–437, 490
taste threshold 217–218, 436
Sodium bromate 315
Sodium hypochlorite 107, 171
Sodium sulfate 218
Softening 177
lime 139, 179
precipitation 179
Solids, total dissolved (TDS) 185, 218, 444–445, 490
Solubility, water 177
Source protection 56–59, 66
Source waters
chemical contaminants 147
community and household systems 71, 82
control measures 58–59
desalination systems 111
emergency and disaster situations 105
hazard identification 56–58
microbial hazards 123
naturally occurring chemicals 185
new systems 52–53
operational monitoring 69, 71
pathogen occurrence 135, 136–137
seasonal fluctuation 93
verification 73–74
see also Catchments
Spas 234, 273
Specified technology targets 25, 40, 41
Spirometra 124
Springs 65, 141
Stagnant pools 101
Standard for Bottled/Packaged Waters 115
Standard for Natural Mineral Waters 114–115
Standard operating procedures (SOPs) 81
incident responses 77, 78
Standards
bottled drinking-water 114–115
certification 17
drinking-water 10
national see National standards and regulations
Staphylococcus aureus 242–243
Stomach cancer, radon-related risk 207
Storage
after disinfection 61
emergency and disaster situations 106
home 71
large buildings 101
off-stream/bankside 138
on ships 119
systems
control measures 58–59, 64, 66
surveillance 89
Streams, occurrence of pathogens 136, 137
Streptococci, faecal 142, 287
Strongyloidiasis (Strongyloides) 124, 276
Strontium-90 ($^{90}$Sr) 202
Styrene 437–438
analysis 160, 437
guideline value 188, 437, 492
odour threshold 218
treatment achievability 168, 437
Styrene-7,8-oxide 437, 438
Sulfate 185, 438–439, 490
acceptable level 218
corrosion control 181, 184
notifiable level 438–439
Superchlorination/dechlorination 171
Suppliers, drinking-water
audit-based surveillance 87
independence of surveillance 8–9
legal functions and responsibilities 31–32
management plans see Water safety plans
roles and responsibilities 9, 13–14
Supply, drinking-water
adequacy 90–93
efficiency and disaster situations 105–106
improved technologies 92
intermittent 63, 92–93, 101
planning and implementing
improvement 93–94
unimproved technologies 92
Supporting programmes 80–81
aircraft and airports 117
large buildings 102
ships 120
Surface waters
control measures 58, 66
efficiency and disaster situations 105
hazard identification 56–57
Helicobacter pylori 231
pathogen occurrence 136–137
system assessment and design 53, 54
verification 73
Surveillance 8–9, 28–29, 84–98
adapted to specific circumstances 88–89
adequacy of supply 90–93
agencies 9, 32, 85
aircraft and airports 117
approaches 85–87
audit-based 86–87
direct assessment 87
community drinking-water supplies 87, 88–89
definition 9, 84
large buildings 102
planning and implementation 93–95
public health 10–11
reporting and communicating 95–97
ships 120
stages of development 94–95
urban areas in developing countries 88
see also Monitoring
Swimming pools 249, 272, 273
System assessment and design 25–26, 49, 51–68
aircraft and airports 116
collecting and evaluating available data 53–56
large buildings 100–101
ships 118
treatment 59–61
Systems, drinking-water
large buildings 99, 100
maintaining control 68–71
new 52–53, 74
non-piped see Non-piped water systems
operational monitoring see Operational monitoring
piped see Piped distribution systems
resource and source protection 56–59
on ships 118
upgrade and improvement 67–68, 94
validation see Validation
verification see Verification
2,4,5-T (2,4,5-trichlorophenoxy acetic acid) 439–440
analysis 161
guideline value 191, 439, 492
treatment achievability 170, 440
Taenia solium 124
Tankers, water 15
Tanks, storage 64
Taps 101
Targets
health-based see Health-based targets
health outcome 24–25, 40, 43
incremental improvements towards 2
performance see Performance targets
specified technology 25, 40, 41
water quality see Water quality targets
Taste 7, 210, 211–220
biologically derived contaminants 211–213
chemical contaminants 213–219
treatments for removing 219–220
TBA see Terbutylazine
TDI see Tolerable daily intake
Team, water safety planning 51
Temephos 190
INDEX

Temperature, water
acceptable levels 220
Legionella growth/survival 100, 234–235
Naegleria survival 272, 273
Terbuthylazine (TBA) 440–442
analysis 161
guideline value 191, 441, 492
treatment achievability 170, 441
Testing kits 109, 158
3,3',4,4'-Tetrachloroazobenzene 430
Tetrachloroethene 442–443
analysis 160, 442
guideline value 188, 442, 492
treatment achievability 168, 442
Thermotolerant coliform bacteria 142, 143, 282, 284–285
THMs see Trihalomethanes
Thorium-228 202
Thorium-230 202
Thorium-232 202
Tin, inorganic 193, 388–389, 490
Titration, volumetric 158
Tolerable daily intake (TDI) 149, 150
allocation to drinking-water 151–152
alternative approaches 152–154
calculation of guideline values 149–150, 152
uncertainty factors 150–151
Toluene 443–444
acceptability 218
analysis 160, 443
guideline value 188, 443, 492
treatment achievability 168, 443
Total coliform bacteria 282–284
Total dissolved solids (TDS) 185, 218, 444–445, 490
Toxaphene 189, 488
Toxic Cyanobacteria in Water 20
Toxic shock syndrome 242
Toxicity studies, animal 148
Toxocara 124
Toxoplasma gondii 122, 274–275
Toxoplasmosis 274, 275
2,4,5-TP see Fenoprop
Trachipleistophora 270
Transportation, household water 71
Travellers 109–111
Treatment 59–61, 166–184
achievability 166–171
chemicals used in see under Chemicals
community sources 71
corrosion control 180–184
desalinated water 112
emergency and disaster situations 105, 107
hazard identification 59–60
household 71, 89, 141
indicator organisms 282, 286
membrane processes 178, 180
operational monitoring parameters 69
pathogen removal 137–141
performance target setting and 131–132, 133–134
processes 138–141, 171–179
control measures 179–180
ranking of complexity/costs 166–167
validation 67
see also specific treatments
for ships 119
system assessment and design 53, 54
taste, odour and appearance problems 219–220
for travellers 110
water quality targets 42
see also Disinfection
Triazophos 189, 488
Tributyltin oxide (TBTO) 189, 488
Trichloramine 193, 411, 490
Trichlorfon 189, 488
Trichloroacetaldehyde see Chloral hydrate
Trichloroacetic acid 145, 445–446
analysis 162, 445
guideline value 194, 445, 493
Trichloroacetonitrile 193, 380–382, 490
Trichlorobenzenes (TCBs) 187, 218–219, 446–447, 490
1,1,1-Trichloroethane 187, 447–448, 490
Trichloroethene 448–449
analysis 160, 449
guideline value 188, 448, 493
treatment achievability 168, 449
Trichloronitromethane see Chloropicrin
2,4,6-Trichlorophenol 329–331
acceptable levels 214
analysis 162
guideline value 194, 330, 493
2,4,5-Trichlorophenoxy acetic acid see 2,4,5-T
2,4,5-Trichlorophenoxy propionic acid see Fenoprop
Trichuriasis (Trichuris) 124, 276
Trifluralin 450–451
analysis 161
guideline value 191, 450, 493
treatment achievability 170, 450

513
Trihalomethanes (THMs) 145, 179, 451–454
analysis 162
guideline values 194, 451, 493
strategies for reducing 179–180
Trimethylbenzene 217
Tritium (T³H) 202
True colour units (TCU) 214
Tsukamurella 221, 243–244
Tubewells 65
Turbidity 5, 219
community supplies 82
emergency and disaster situations 108
operational monitoring 69
Turner diagram 184
Typhoid fever 239, 240

Ultrafiltration 139, 178
Ultraviolet (UV) absorption 159
Ultraviolet (UV) irradiation 141, 173, 180
Uncertainty factors (UF) 149, 150–151
data-derived 154
United Nations Scientific Committee on the
Effects of Atomic Radiation (UNSCEAR) 198–199, 207
Unplanned events 77–78
Upgrading, drinking-water systems 67–68, 94
Upgrading Water Treatment Plants 20
Uranium 6, 454–456
analysis 159, 455
guideline value 186, 454, 493
priority setting and 35–36
treatment achievability 167, 455
Uranium-234 (²³⁴U) 202
Uranium-238 (²³⁸U) 202
Urban areas
in developing countries 88
zoning 88
Uveitis, Acanthamoeba 260

Validation 26, 50–51, 67, 136
Vendors, water 15
Verification 29–31, 51, 71–76
chemical quality 30–31, 72, 73
community-managed supplies 74–75
microbial safety and quality 29–30, 72, 142–143, 284
piped distribution systems 74
quality assurance and quality control 75–76
water sources 73–74
Vessels
emergency and disaster situations 106
packaged drinking-water 113

Vibrio 244–246
Vibrio cholerae 122, 125, 244–246
Vinyl chloride 456–458
analysis 162
guideline value 194, 457, 493
Vinylidene chloride see 1,1-Dichloroethene
Viruses 221
enteric see Enteric viruses
indicator and index 289–295
pathogenic 122, 247–259
persistence in water 125
treatment effects 138–141
Visible organisms 211, 212–213
Vittaforma 270
Volumetric titration 158

Warm water systems 100
Wastewater, domestic, chemicals in 186
Water avoidance orders 79
Water extraction systems, control measures 58–59
Water quality 90
health care facilities 102–103
monitoring see Monitoring
sources, in disaster situations 105
see also Guideline values
Water Quality Monitoring (Bartram & Ballance) 75–76
Water quality targets (WQTs) 25, 40, 42–43, 126
Water resource management 12–13
see also Resource protection
Water Safety Plans 20, 48, 66
Water safety plans (WSPs) 4, 24, 26, 48–83
aircraft and airports 116
approval and review 85
audit 86, 94
community and household supplies 85
documentation and communication 82–83
health care facilities 103
key components 49
large buildings 99, 102
management 76–82
model 66
operational monitoring and maintaining control 68–71
ships 120
stages in development 50
supporting programmes 80–81
surveillance see Surveillance
system assessment and design 51–68
verification see Verification
Water sources see Source waters
INDEX

Water suppliers see Suppliers, drinking-water
Water treatment see Treatment
Water Treatment and Pathogen Control 20, 61
Water vendors 15
Waterborne infections see Infections, waterborne
Weight, body see Body weight
Wells 59, 65, 141
WHO Pesticide Evaluation Scheme (WHOPES) programme 148, 190
Winter vomiting disease 252
Wound infections, Aeromonas 224
WQTs see Water quality targets
WSPs see Water safety plans

Xanthomonas 286
Xylenes 458–459
  acceptable level 219
  analysis 160, 458
  guideline value 188, 458, 493
  treatment achievability 168, 458

Yersinia 246–247
Yersinia enterocolitica 122, 246, 247
Yersinia pseudotuberculosis 246, 247

Zinc 193, 459–460, 490
  acceptable level 219, 459
  corrosion 183
  dissolution from brass 182–183
Zoning, urban areas 88