Stormwater Runoff Water Quality Newsletter
Devoted to Urban/Rural Stormwater Runoff
Water Quality Management Issues

* * * * *

Volume 9 Number 4
March 31, 2006

Editor: Anne Jones-Lee, PhD
Contributor to this Issue:
G. Fred Lee, PhD, PE, DEE

* * * * *

This issue of the Stormwater Runoff Water Quality Newsletter is devoted to **structure sealants as a source of PCBs, benzothiazoles as a stormwater pollutant, recently proposed OEHHA fish tissue contaminant screening values, BASS modeling of bioaccumulation of chemicals, US EPA water quality criteria for diazinon, sediment toxicity due to pyrethroid-based pesticides, USGS national pesticide studies,** as well as several announcements of publications and conference proceedings.

Structure Sealants as a Source of PCBs

At the recent meeting of the California Stormwater Quality Association (CASQA), T. Mumley of the San Francisco Regional Water Quality Control Board made a presentation on TMDL issues in San Francisco Bay. In this presentation he discussed the PCB situation in San Francisco Bay, pointing out that several types of fish have excessive tissue concentrations compared to human health guidelines for fish consumption. During his discussion of PCB issues, he mentioned that a recently recognized source of PCBs for the environment is joint sealants (caulking compounds, fillers) that are used in various types of structures, such as concrete, wood, etc. F. Hensel of the San Francisco Regional Water Quality Control Board provided a list of references on this issue. A review of these references shows that this issue has been recognized for several years in Europe, Australia and other countries. There are a number of papers and reports on this issue from other countries, which provide additional information on the presence of PCBs in various types of structures. Of particular concern are the publications by Åstebro et al. (2000), BUWAL (date unknown) and CFMEU (date unknown). A comprehensive review of what was known in 2004 about PCBs in structures as a diffuse source of PCBs for the environment has been developed by Kohler et al. (2005). The widespread former use of PCBs, such as for sealants, may help account, at least in part, for their ubiquitous occurrence in fish tissue in many areas.

Benzothiazoles as a Stormwater Pollutant

Several of the past Newsletters (NL 7-3, 8-5 and 9-3) have provided information on unrecognized, unregulated environmental pollutants. This is an area of concern that is beginning to receive increasing attention. Following the last Newsletter, a reader inquired about information on benzothiazoles as water pollutants. Benzothiazoles, used as fungicides, corrosion inhibitors and rubber vulcanization accelerators in industry and tire manufacturing, are present in urban and highway stormwater runoff as part of vehicular tire wear. They have been reported in aquatic sediments in San Francisco Bay in the late 1980s. The Internet contains considerable information on these chemicals. Evans, et al. (1999) have reported on studies on the toxicity of benzothiazole to estuarine fish. Benzothiazoles have also been found in municipal wastewater effluents (Kloepfer et al. 2005). Kloepfer et al. (2005) found that, *"Benzothiazoles, a class of polar and biologically active industrial chemicals, are regularly released with treated municipal*

wastewater and exhibit a considerable lifetime in surface waters." C. Delos of the US EPA (pers. comm.) has recently indicated that the US EPA Washington, D.C. headquarters is considering developing a water quality criterion for benzothiazole. Benzothiazoles are just one of the many thousands of types of organic chemicals that are present in urban area and highway stormwater runoff that have potential to adversely affect water quality and are currently unregulated.

Proceedings of the US EPA Workshop on Pharmaceuticals in the Environment

As reported in Newsletter NL 8-5, in August 2005 the US EPA held a Workshop on Pharmaceuticals in the Environment. Recently the US EPA has announced the availability of the proceedings from this workshop. The presentations, abstracts and a meeting summary are available online at http://es.epa.gov/ncer/publications/meetings/drinking_aug23-25_03.html.

Availability of Ports and Harbors Conference Proceedings

M. A. Champ, a Ports and Harbors conference organizer, has recently announced that a CD ROM has been developed which presents the proceedings from the New Orleans 2003 International Symposium on Prevention of Pollution from Ships, Shipyards, Drydocks, Ports and Harbors. This CD ROM also contains the proceedings of conferences and workshops that have been held since the 1999 Seattle conference, as well as two workshop proceedings on copper. These include:

- International Symposium on Pollution Prevention from Ships and Shipyards. 2003. Held at the University of New Orleans, November 5-7, 2003, New Orleans, LA. Office of Naval Research. Vol. No. (1). Champ, M.A. and P.S. Seligman (Proceedings Editors).
- International Symposium on Pollution Prevention from Ships and Shipyards. 2001. Oceanology International 2001 Conference. April 4-5, 2001. Miami, Florida. Office of Naval Research. Vol. No. (1). 351p. Champ, M.A. (Chairman and Proceedings Editor).
- Treatment of Regulated Discharges from Shipyards and Drydocks. 1999. Proceedings of the Special Sessions held at Oceans '99 in Seattle Washington, Sept 13-16, 1999. The Marine Technology Society, Washington, D.C. 20036. ISBN No. 0-933957-24-6. Office of Naval Research. Vol. No. (4). 223p. Champ, M.A., Fox, T.J., and A.J. Mearns (Co-Chairmen and Editors Special Volume).
- Chemistry, Toxicity, and Bioavailability of Copper and its Relationship to Regulation in the Marine Environment. Seligman P.F., and A. Zirino (Editors). 1998. Office of Naval Research Workshop. SPAWAR Systems Center, San Diego. Technical Document 3044. 99p.
- Copper Chemistry, Toxicity, and Bioavailability and its Relationship to Regulation in the Marine Environment. Zirino, A. and P.F. Seligman (Editors). 2002. Office of Naval Research 2nd Workshop. SPAWAR Systems Center. San Diego Technical Document 3044. 80p.

Those wishing to receive the CD ROM should send their request and $185 for processing, shipping and handling to ATRP Corporation, Attn: Symposium Proceedings, 7000 Vagabond Drive, Falls Church, Virginia 22042.

The Seattle conference proceedings included a paper by Lee and Jones-Lee:

Lee, G. F. and Jones-Lee, A., "Assessing the Degree of Appropriate Treatment of Shipyard and Drydock Wastewater Discharges and Stormwater Runoff," Proc. Oceans '99 MTS/IEEE Conference proceeding session, "Treatment of Regulated Discharges from Shipyards and Drydocks," Seattle, WA, paper 9B1 published on CD ROM, September (1999). http://www.gfredlee.com/shipyard_drydock.pdf.

Lee, G.F. and Jones-Lee, A., "Assessing the Degree of Appropriate Treatment of Urban Stormwater Stormwater Runoff," Adapted from Presentation at Marine Technology Society, Oceans 99 Conference Seattle, WA, September (1999).
http://www.gfredlee.com/impact.pdf

Lee and Jones-Lee also made a presentation at the New Orleans conference:

Lee, G. F. and Jones-Lee, A, "Regulating Water Quality Impacts of Port and Harbor Stormwater Runoff," Proc. International Symposium on Prevention of Pollution from Ships, Shipyards, Drydocks, Ports, and Harbors, New Orleans, LA, November (2003). Available on CD ROM from www.ATRP.com.
http://www.members.aol.com/duklee2307/PHStormwater-papfinal.pdf

Lee, G. F. and Jones-Lee, A., "Regulating Water Quality Impacts of Water Column and Sediment Contamination in Port and Harbor Stormwater Runoff," PowerPoint slides presented at Intern. Conference on Prevention of Pollution from Ships, Shipyards, Drydocks and Harbors, New Orleans, LA, November (2003).
http://www.gfredlee.com/NewOrleansStormwaterDerivedSed.pdf

EPA's National Center for Environmental Publications

The US EPA has announced "new enhancements" to the National Environmental Publications Information System (NEPIS) website (http://nepis.epa.gov/). According to the announcement, over 13,000 environmental publications are maintained in the Agency's online archive.

Nonpoint Source (NPS) News-Notes

Periodically, the US EPA issues its Nonpoint Source (NPS) News-Notes. The most recent (January 2006) edition #77 is available at http://www.epa.gov/newsnotes. Those interested in NPS pollution water quality issues may wish to subscribe to News-Notes by sending an email message to lyris@lists.epa.gov and including the following message in the subject line or the body of the message: "subscibe news-notes [your name]". A free paper subscription is available by writing to Carol Forshee, NPS News-Notes (4503T), US EPA, 1200 Pennsylvania Ave, NW, Washington, D.C. 20460, Fax: 202-566-1332, Email: forshee.carol@epa.gov.

Recently Proposed OEHHA Fish Tissue Contaminant Screening Values

The California Office of Environmental Health Hazard Assessment (OEHHA) has recently proposed revised fish tissue screening values (SVs) for protection of human health (Klasing and Brodberg 2006). According to Klasing and Brodberg (2006), screening values are defined by the US EPA as "*concentrations of target analytes in fish or shellfish tissue that are of potential public health concern and that are used as threshold values against which levels of*

contamination in similar tissue collected from the ambient environment can be compared. Exceedance of these SVs should be taken as an indication that more intensive site-specific monitoring and/or evaluation of human health risk should be conducted" (U.S. EPA, 2000). Table 1 presents the US EPA and current OEHHA screening values, as well as the proposed screening values. Examination of this table shows that for some chemicals there are significant differences. These differences are the result of several factors, including new information on the potential human health impacts of the chemicals (updated RfD-reference dose values), and changes in the assumed fish consumption rates and allowed cancer risk.

Examination of Table 1 shows that for several of the organochlorine legacy pesticides the OEHHA proposed fish screening value has been increased, in some cases, significantly. If these values are adopted, this could have significant impact on waterbodies' being listed as Clean Water Act 303(d) impaired due to excessive concentrations of a chemical of concern in edible fish/shellfish tissue.

Table 1: US EPA and OEHHA Screening Values (µg/kg wet weight)

CHEMICAL	US EPA Value[1]	OEHHA Value[2]	OEHHA 2006 Proposed Value[8]
Chlordane[3]	80	30	200
Total DDT[4]	300	100	560
Dieldrin	7	2	16
Total endosulfan[5]	60,000	20,000	
Endrin	3,000	1,000	
Heptachlor epoxide	10	4	
γ-hexachlorocyclohexane (lindane)	80	30	
Toxaphene	100	30	220
PCBs[6]	10	20	20
Dioxin TEQ[7]	0.7 ppt	0.3 ppt	
Methylmercury			80
Selenium			1,940

Source: SARWQCB (2000)

1: USEPA SVs (US EPA, 1995b) for carcinogens were calculated for a 70 kg adult using a cancer risk of 1x10-5. SVs for non-cancer effects were calculated for a 70 kg adult and exposure at the RfD (hazard quotient of 1). A fish consumption value of 6.5 g/day was used in both cases.

2: California OEHHA (1999) SVs (CLS-SVs) specifically for this study were calculated according to US EPA guidance (US EPA, 1995b). CLS-SVs for carcinogens were calculated for a 70 kg adult using a cancer risk of 1x10-5. CLS-SVs for non-cancer effects were calculated for a 70 kg adult and exposure at the RfD (hazard quotient of 1). A fish consumption value of 21 g/day was used in both cases

3: Sum of alpha and gamma chlordane, cis- and trans-nonachlor and oxychlordane.

4: Sum of othro and para DDTs, DDDs and DDEs.

5: Sum of endosulfan I and II.

6: Expressed as the sum of Aroclor 1248, 1254 and 1260.

7: Expressed as the sum of TEQs for dibenzodioxin and dibenzofuran compounds which have an adopted TEF.

8: OEHHA (Klasing and Brodberg 2006).

(For the above references, see Lee and Jones-Lee 2002.)

Lee and Jones-Lee (2002) conducted a comprehensive review of the database available on fish tissue residues for fish taken from Central Valley waterbodies. Examination of this database

shows that, for a number of the organochlorine legacy pesticides, the recent measured fish tissue concentrations were at or just above the current OEHHA screening value. Adoption of the proposed screening values could result in waterbodies that are currently listed as impaired for excessive organochlorine legacy pesticide bioaccumulation to be removed from this listing and no longer be required to have a TMDL to control the concentrations of the chemicals in current sources of them from agricultural and urban area stormwater runoff/discharges, as well as waterbody sediments.

Examination of the basis for OEHHA's 2006 proposed screening values shows that there are a number of important policy issues that need to be considered in adoption of these values as values upon which 303(d) listings would be based. The current screening value allowed cancer risk is one additional cancer case in 100,000 people (10^{-5}) who consume an average of 21g per day of fish at the screening value over a 70-year lifetime. The average person is assumed to weigh 70kg. OEHHA's proposed screening value is based on an allowed cancer risk of one additional cancer case in 10,000 people (10^{-4}) who consume an average of 12 meals per month (90g per day) of fish at the screening value over a 70-year lifetime. A meal is assumed to consist of eight ounces (227g) of fish (uncooked). In raising the allowed cancer risk from 10^{-5} to 10^{-4}, Brodberg (pers. comm. 2006) has indicated that the allowable range of cancer risk used by regulatory agencies across the country is 10^{-4} to 10^{-6}; therefore, the 10^{-4} value is within the allowable range. He indicated that increasing the allowed cancer risk to 10^{-4} reflects a position that there are significant health benefits from eating fish, even those fish that contain potentially hazardous chemicals at less than the proposed screening value.

One of the issues of controversy today in establishing fish screening values for potential carcinogens is the assumption about the amount of fish consumed. Increasing the fish consumption from the current 21g per day to the new 90 g/day (12 meals per month) is a step toward providing greater protection for those who consume more fish from a local waterbody than the average person in the US. However, there are still individuals (subsistence fishermen) in economically disadvantaged and minority populations who are projected to consume more than 12 meals per month of locally-caught contaminated fish. Adjusting the screening values to protect these individuals would require that the values be decreased in proportion to the increased amount of fish consumed. In some areas this can become an important environmental justice issue.

Brodberg (pers. comm. 2006) indicated that OEHHA's adoption of these proposed screening values would not in itself become a regulatory limit upon which 303(d) listings would be based. He indicated that it would be up to the State and Regional Water Quality Control Boards to decide the allowable cancer risk and the fish consumption rates that would be used to establish a revised screening value for a particular waterbody or region. This approach would mean that the State and Regional Water Quality Control Boards could become more involved in establishing screening values than they have been in the past.

The Klasing and Brodberg (2006) proposed screening values have been released for public comment. All comments must be received by 5:00 p.m. on April 3, 2006. Further information is available at http://www.oehha.ca.gov/fish/gtlsv/gtlsv1.html.

Availability of BASS Version 2.2 FTP Site

The US EPA has been developing a computer model for predictions of bioaccumulation of potentially toxic/hazardous chemicals through the aquatic food web. According to the Foreword of the Users Manual for version 2.1 of the Bioaccumulation and Aquatic System Simulator (BASS), it is designed to *"…predict the population and bioaccumulation dynamics of age-structured fish communities that are exposed to hydrophobic organic chemicals and class B and borderline metals that complex with sulfhydryl groups (e.g., cadmium, copper, lead, mercury, nickel, silver, and zinc)."* The model's "*… process-based algorithms for predicting chemical bioaccumulation, growth of individual fish, predator-prey interactions, and population dynamics either have been corroborated or have been formulated using widely accepted ecological and ecotoxicological principles."* Those interested in this topic may wish to contact Dr. M. Craig Barber, Ecologist, US EPA, Office of Research and Development, National Exposure Research Laboratory, Ecosystems Research Division, 960 College Station Road, Athens, GA 30605, Phone: 706-355-8110, Fax: 706-355-8104, Email: barber.craig@epa.gov.

US EPA Water Quality Criteria for Diazinon

One of the issues that has been addressed in a number of past Newsletters is the aquatic life toxicity of the organophosphorus pesticides diazinon and chlorpyrifos in stormwater runoff from urban areas. In California and some other parts of the US, residential use of diazinon and/or chlorpyrifos has until recently been a significant source of aquatic life toxicity in urban area stormwater runoff. The magnitude of the toxicity has decreased significantly since the US EPA has adopted a ban on the sale of these pesticides to the public for residential use. These pesticides are still being used in agricultural areas.

One of the issues that has been of concern in regulating these pesticides in urban and agricultural runoff/discharges is the need for water quality criteria for these pesticides. The US EPA adopted water quality criteria for chlorpyrifos as part of the Gold Book of water quality criteria (US EPA 1987). The Agency has just announced that it recently published final criteria for the protection of aquatic life for diazinon. The acute (1 hr) and chronic (4 day) freshwater criteria are both set at 0.17 micrograms per liter (μg/L), not to be exceeded more than once every three years. Both saltwater criteria are set at 0.82 μg/L, not to be exceeded more than once every three years. Further information on these criteria is available at
http://www.epa.gov/waterscience/criteria/diazinon/.

Urban Stream Sediment Toxicity due to Pyrethroid-Based Pesticides

Previous Newsletters have discussed the widespread occurrence in California and some other areas of aquatic life toxicity in urban streams due to residential use of pesticides. As discussed, such as in Newsletter NL 9-3, the emphasis has shifted from organophosphorus pesticides to pyrethroid-based pesticides as a cause of this toxicity. Much of the work on pyrethroid-based pesticide-caused aquatic life toxicity has been conducted by D. Weston of the University of California, Berkeley, and his associates. Recently, Amweg et al. (2006) has published another paper on this issue concerned with aquatic life toxicity in urban stream sediments in the Central Valley of California. They have reported, as would be expected because of the widespread residential use of pyrethroid-based pesticides in urban areas as replacements for the organophosphorus pesticides diazinon and chlorpyrifos, finding sediment toxicity which is attributed to pyrethroid-based pesticides that have accumulated in the urban stream sediments.

As discussed in Newsletter NL 9-3, these findings of toxicity are violations of the Central Valley Regional Water Quality Control Board's Basin Plan water quality objectives for pesticides, which do not allow for pesticide-caused aquatic life toxicity in a waterbody's water column or sediments. Ultimately this toxicity could lead to needing to restrict the use of pyrethroid-based pesticides in urban areas, as well as in some agricultural areas where runoff/discharges from the areas of use leads to an accumulation of pyrethroid-based pesticides in waterbody sediments that are toxic to benthic organisms.

USGS Pesticide Studies

The US Geological Survey (USGS) has recently released a report (Gilliom et al. 2006) presenting summaries of the pesticide monitoring data that the Survey collected on pesticide occurrence and concentrations in streams and groundwater from 51 studies across the US during the period 1992 to 2001. These results were based on the Survey's National Water-Quality Assessment (NAWQA) studies. A number of the studies were conducted for a couple of years during the overall study period. Gilliom et al. (2006) reported finding pesticides or pesticide degradation products in most surface waterbodies receiving drainage from agricultural and urban areas. They reported that the organochlorine pesticides, such as DDT and its degradates, are still commonly found in fish and bed-sediment samples from most streams in agricultural, urban, and mixed-land-use watersheds. As discussed in previous Newsletters, failing to detect organochlorine legacy pesticides in the water column does not mean that these pesticides are not still causing water quality problems due to bioaccumulation through the food web, typically involving transfer from sediments to aquatic life.

The USGS, in its 2006 report, attempts to provide information on the water quality significance of the pesticide concentrations that have been found in the water column and sediments. A critical review of their "benchmarks" of critical concentrations shows that a number of them are not necessarily technically valid. Of particular concern are those associated with the concentrations of pesticides found in sediments relative to co-occurrence (coincidence)-based sediment quality guidelines. As discussed in previous issues of the Newsletter, this approach is not a technically valid approach for determining whether pesticides found in sediments are causing adverse effects to aquatic life and other beneficial uses of a waterbody.

The USGS studies on pesticide occurrence are of value to show that during the 1990s there was widespread contamination of US surface waters with pesticides used in urban and agricultural areas; however, the aquatic life related water quality significance of the occurrence of these pesticides at the concentrations found is still largely unknown. The information available today on pesticide impacts, much of which has been available over the last 10 years, shows that for many of the pesticides it is necessary to conduct toxicity tests in order to determine whether the pesticides found, alone or in combination with other pesticides or other chemicals, are causing aquatic life toxicity. The USGS' attempts to characterize the nation's water quality through its NAWQA program has been significantly deficient with respect to providing data that can be reliably used to assess aquatic life related beneficial uses of waterbodies. This problem is inherent in how the NAWQA program was established, and, unfortunately, still persists today.

US EPA Water Quality Criteria for Nonylphenol

The US EPA has recently announced that it has published final water quality criteria for nonylphenol, which is a chemical found in some household detergents. Some of the commonly used detergents have appreciable aquatic life toxicity. While this toxicity is primarily associated with inadequately treated domestic wastewaters, there is concern about the water quality impacts of stormwater runoff from areas where detergents are used in the washing of cars in streets and driveways. The acute criterion (1 hr exposure) for nonylphenol is set at 28 µg/L for freshwater and 7.0 µg/L for saltwater, not to be exceeded more than once every three years. The chronic criterion (4 day exposure) is set at 6.6 µg/L for freshwater and 1.7 µg/L for saltwater, not to be exceeded more than once every three years. Further information on these criteria is available at http://www.epa.gov/waterscience/criteria/nonylphenol.

References

Amweg, E.; Weston, D.; You, J. and Lydy, M. J., "Pyrethroid Insecticides and Sediment Toxicity in Urban Creeks from California and Tennessee," *Environ. Sci. Technol.* 40(5):1700-1706 (2006). http://pubs.acs.org/cgi-bin/abstract.cgi/esthag/2006/40/i05/abs/es051407c.html

Åstebro, A.; Jansson, B. and Bergström, U., "Emissions During Replacement of PCB Containing Sealants – a Case Study," *Organohalogen Compounds* 46:248-251 (2000).

BUWAL, "PCB haltige joint sealings: New guideline to the protection of humans and environment." Execution Assistance for Cantons and Municipalities, Bundesamt für Umwelt, Wald und Landschaft (date unknown).

CFMEU, "PCBs in Concrete Structures: What are PCBs?" Hazard Alert, Environmental & Occupational Health & Safety Unit, Victoria, CFMEU, Construction, Forestry, Mining and Energy Union, Sydney, Australia (date unknown).
http://www.cfmeu.asn.au/construction/pdfs/ohsalert_mch03pcbs.pdf#search='pcbs%20concrete%20structures%20cfmeu'

Evans, J. J.; Shoemaker, C. A. and Klesius, P. H., "In Vivo and In Vitro Effects of Benzothiazole on Sheepshead Minnow," Tenth International Symposium on Pollutant Responses in Marine Organisms, USDA Agricultural Research Service, Washington, D.C. (1999).
http://www.ars.usda.gov/research/publications/publications.htm?SEQ_NO_115=100313

Gilliom, R. J.; Barbash, J. E.; Crawford, C. G.; Hamilton, P. A.; Martin, J. D.; Nakagaki, N.; Nowell, L. H.; Scott, J. C.; Stackelberg, P. E.; Thelin, G. P. and Wolock, D. M., "The Quality of Our Nation's Waters: Pesticides in the Nation's Streams and Ground Water, 1992–2001," Circular 1291, US Geological Survey, Washington, D. C. (2006).
http://ca.water.usgs.gov/pnsp/pubs/circ1291/

Klasing, S. and Brodberg, R., "Development of Guidance Tissue Levels and Screening Values for Common Contaminants in California Sport Fish: Chlordane, DDTs, Dieldrin, Methylmercury, PCBs, Selenium, and Toxaphene," Draft GTL Report, Pesticide and

Environmental Toxicology Branch, Office of Environmental Health Hazard Assessment, California Environmental Protection Agency, Sacramento, CA, February (2006). http://oehha.ca.gov/fish/gtlsv/pdf/draftGTLSVchddt.pdf

Kloepfer, A.; Jekel, M. and ReemtsmaT., "Occurrence, Sources, and Fate of Benzothiazoles in Municipal Wastewater Treatment Plants," *Environ. Sci. Technol.*, 39(10):3792-3798, April 2 (2005). http://pubs.acs.org/cgi-bin/abstract.cgi/esthag/2005/39/i10/abs/es048141e.html

Kohler, M.; Tremp, J.; Zennegg, M.; Seiler, C.; Minder-Kohler, S.; Beck, M.; Lienemann, P.; Wegmann, L. and Schmid, P., "Joint Sealants: An Overlooked Diffuse Source of Polychlorinated Biphenyls in Buildings," *Environ. Sci. Technol*. 39:1967-1973 (2005). http://pubs.acs.org/cgi-bin/abstract.cgi/esthag/2005/39/i07/abs/es048632z.html

Lee, G. F. and Jones-Lee, A., "Organochlorine Pesticide, PCB and Dioxin/Furan Excessive Bioaccumulation Management Guidance," California Water Institute Report TP 02-06 to the California Water Resources Control Board/Central Valley Regional Water Quality Control Board, 170 pp, California State University Fresno, Fresno, CA, December (2002). http://www.gfredlee.com/OClTMDLRpt12-11-02.pdf

US EPA, Quality Criteria for Water 1986, US Environmental Protection Agency, EPA 440/5-86-001, Washington, D.C., May (1987).

US EPA, "Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories. Vol. 2. Risk assessment and fish consumption limits," 3rd Edition, EPA 823-B-00-008, US Environmental Protection Agency, Washington, D.C. (2000).