ENVIRONMENTAL CONTAMINANTS ENCYCLOPEDIA

ACENAPHTHYLENE ENTRY

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Like a library or most large databases (such as EPA's national STORET water quality database), this document contains information of variable quality from very diverse sources. In compiling this document, mistakes were found in peer reviewed journal articles, as well as in databases with relatively elaborate quality control mechanisms [366,649,940]. A few of these were caught and marked with a "[sic]" notation, but undoubtedly others slipped through. The [sic] notation was inserted by the editors to indicate information or spelling that seemed wrong or misleading, but which was nevertheless cited verbatim rather than arbitrarily changing what the author said.

Most likely additional transcription errors and typos have been added in some of our efforts. Furthermore, with such complex subject matter, it is not always easy to determine what is correct and what is incorrect, especially with the "experts" often disagreeing. It is not uncommon in scientific research for two different researchers to come up with different results which lead them to different conclusions. In compiling the Encyclopedia, the editors did not try to resolve such conflicts, but rather simply reported it all.

It should be kept in mind that data comparability is a major problem in environmental toxicology since laboratory and field methods are constantly changing and since there are so many different "standard methods" published by EPA, other federal agencies, state agencies, and various private groups. What some laboratory and field investigators actually do for standard operating practice is often a unique combination of various standard protocols and impromptu "improvements." In fact, the interagency task force on water methods concluded that [1014]:

> It is the exception rather than the rule that water-quality monitoring data from different programs or time periods can be compared on a scientifically sound basis, and that...
>
> No nationally accepted standard definitions exist for water quality parameters. The different organizations may collect data using identical or standard methods, but identify them by different names, or use the same names for data collected by different methods [1014].

Differences in field and laboratory methods are also major issues related to (the lack of) data comparability from media other than water: soil, sediments, tissues, and air.

In spite of numerous problems and complexities, knowledge is often power in decisions related to chemical contamination. It is therefore often helpful to be aware of a broad universe of conflicting results or conflicting expert opinions rather than having a portion of this information arbitrarily censored by someone else. Frequently one wants to know of the existence of information, even if one later decides not to use it for a particular application. Many would like to see a high percentage of the information available and decide for themselves what to throw out, partly because they don't want to seem uniformed or be caught by surprise by potentially important information. They are in a better position if they can say: "I knew about that data, assessed it based on the following quality assurance criteria, and decided not to use it for this application." This is especially true for users near the end of long decision processes, such as hazardous site cleanups, lengthy ecological risk assessments, or complex natural resource damage assessments.

For some categories, the editors found no information and inserted the phrase "no information found." This does not necessarily mean that no information exists; it simply means that during our efforts, the editors found none. For many topics, there is probably information "out there" that is not in the Encyclopedia. The more time that passes without encyclopedia updates (none are planned at the moment), the more true this statement will become. Still, the Encyclopedia is unique in that it contains broad ecotoxicology information from more sources than many other reference documents. No updates of this document are currently planned. However, it is hoped that most of the information in the encyclopedia will be useful for some time to come even with out updates, just as one can still find information in the 1972 EPA Blue Book [12] that does not seem well summarized anywhere else.

Although the editors of this document have done their best in the limited time available to insure accuracy of quotes as being "what the original author said," the proposed interagency funding of a bigger project with more elaborate peer review and quality control steps never materialized.

The bottom line: The editors hope users find this document useful, but don't expect or depend on perfection herein. Neither the U.S. Government nor the National Park Service make any claims that this document is free of mistakes.

The following is one chemical topic entry (one file among 118). Before utilizing this entry, the reader is strongly encouraged to read the README file (in this subdirectory) for an introduction, an explanation of how to search for power key section headings and how to use this document in general, an explanation of the organization of each entry, an information quality discussion, a discussion of copyright issues, and a listing of other entries (other topics) covered.

See the separate file entitled REFERENC for the identity of numbered references in brackets.

HOW TO CITE THIS DOCUMENT: As mentioned above, for critical applications it is better to obtain and cite the original publication after first verifying various data quality assurance concerns. For more routine applications, this document may be cited as:

> **Irwin, R.J., M. VanMouwerik, L. Stevens, M.D. Seese**, and **W. Basham.** 1997. Environmental Contaminants Encyclopedia. National Park Service, Water Resources Division, Fort Collins, Colorado. Distributed within the Federal Government as an Electronic Document (Projected public availability

on the internet or NTIS: 1998).

Acenaphthylene (CAS number 208-96-8)

Brief Introduction:

Br.Class: General Introduction and Classification Information:

Acenaphthylene is a low molecular weight, 2-ring Polycyclic Aromatic Hydrocarbon (PAH) and an EPA Priority Pollutant [697,634]. See also: PAHs (as a group) entry. Although acenaphthylene was formerly flagged by EPA as a carcinogen for modeling purposes [446], recent sources have determined that acenaphthylene is not classifiable as to its carcinogenicity to humans [788,847,893].

Acenaphthylene is included on the expanded scan list used by the Geochemical and Environmental Research Group (GERG) Laboratory at Texas A&M [828]. This list includes most of the PAHs recommended by the NOAA's National Status and Trends program [680].

Br.Haz: General Hazard/Toxicity Summary:

Studies conclude that the (aquatic) toxicity of an oil appears to be a function of its di-aromatic and tri-aromatic hydrocarbons (which includes two-ring hydrocarbons such as acenaphthylene) [770].

The heavier (4-, 5-, and 6-ring) PAHs are more persistent than the lighter (2- and 3-ring) PAHs (such as this one) and tend to have greater carcinogenic and other chronic impact potential [796].

Acute toxicity is rarely reported in humans, fish, or wildlife, as a result of exposure to low levels of a single PAH compound such as this one. PAHs in general are more frequently associated with chronic risks. These risks include cancer and often are the result of exposures to complex mixtures of chronic-risk aromatics (such as PAHs, alkyl PAHs, benzenes, and alkyl benzenes), rather than exposures to low levels of a single compound (Roy Irwin, National Park Service, Personal Communication, 1996, based on an overview of literature on hand). See also "PAHs as a group" entry.

The drinking water criterion for human health for this compound is less than 1 ppb, indicating strong concern for human health (see W.Human section below). The sediment Effects Range Low (ERL), relating to estuarine ecological health, is 44 ppb, indicating strong potential for biological effects (see Sed.General section below).

The solubility of this compound is greater than for some heavier PAHs, increasing potential mobility and risk in certain habitats.

For additional details on immunological effects of PAHs in general, see ATSDR [881].

Potential effects of PAHs on humans were summarized by the Agency for Toxic Substances and Disease Registry in a 1995 toxicological profile for polycyclic aromatic hydrocarbons [881], so no lengthy summary will be attempted here.

Br.Car: Brief Summary of Carcinogenicity/Cancer Information:

IRIS Database 1996 EPA Information [893]:

Evidence for classification as to human carcinogenicity; weight-of-evidence classification:

Classification: D; not classifiable as to human carcinogenicity

BASIS Based on no human data and inadequate data from animal bioassays.

HUMAN CARCINOGENICITY DATA None.

ANIMAL CARCINOGENICITY DATA Inadequate.

Recent (1994) EPA weight-of-evidence evaluations have determined that acenaphthylene is not classifiable as to human carcinogenicity [881].

This compound is often found in the company of other PAHs, and complex mixtures of PAHs tend to be carcinogenic and possibly phototoxic (see "PAHs as a group" entry).

Br.Dev: Brief Summary of Developmental, Reproductive, Endocrine, and Genotoxicity Information:

A number of 1,2-ring fused acenaphthenes, together with the parent cmpd acenaphthene & acenaphthylene, were evaluated for mutagenicity using the pour-plate technique with salmonella typhimurium TA1537 and TA1538. Although acenaphthene & acenaphthylene were non mutagenic (at concn of 0, 10, 100 & 250 ug/ml), all the 1,2-ring fused acenaphthenes evaluated in this study were indirect frameshift mutagens /S9-department/ in TA1537. [Gatehouse D; Mutat Res 78 (2): 121-35 (1980) [366].

This compound is often found in the company of other PAHs, and complex mixtures of PAHs tend to have various potential developmental, rerpoductive, endocrine, and genotoxic hazards (See PAHs (as a group) entry.

Br.Fate: Brief Summary of Key Bioconcentration, Fate, Transport, Persistence, Pathway, and Chemical/Physical Information:

See also "PAHs as a group" entry.

The heavier (4-, 5-, and 6-ring) PAHs are more persistent than the lighter (2- and 3-ring) PAHs [796]. This compound is a 2- ring PAH. However, even the 2 ring componds can be persistent in certain situations:

> Acenaphthylene was found in groundwater at a coal and oil gasification plant some 30 years after the plant shut down [788].

Environmental Fate/Exposure Summary [366]:

> Acenaphthylene is a component of crude oil, coal tar and a product of combustion which may be produced and released to the environment during natural fires. Emissions from petroleum refining and coal tar distillation are major contributors of acenaphthylene to the environment. Acenaphthylene is contained in a variety of coal tar products and may be released to the environment via manufacturing effluents and the disposal of manufacturing waste byproducts. Because of the widespread use of materials containing acenaphthylene, releases to the environment also occurs through municipal waste water treatment facilities and municipal waste incinerators. Acenaphthylene should biodegrade in the environment. The reported biodegradation half-lives for acenaphthylene in aerobic soil range from 12 to 121 days. Acenaphthylene is not expected to hydrolyze or bioconcentrate in the environment; yet, may undergo direct photolysis in sunlit environmental media. A calculated Koc range of 950 to 3315 indicates acenaphthylene will have a low to slight mobility class in soil. In aquatic systems, acenaphthylene may partition from the water column to organic matter contained in sediments and suspended solids. A Henry's Law constant of 1.13X10-5 atm-cu m/mole at 25 deg C suggests volatilization of acenaphthylene from environmental waters may be important. The volatilization half-lives from a model river and a model pond, the later considers the effect of adsorption, have been estimated to be 4 and 184 days, respectively. Acenaphthylene is expected to exist entirely in the vapor-phase in ambient air. In the atmosphere,

reactions with photochemically produced hydroxyl radicals and ozone (respective estimated half-lives of 5 and 1 hr) are likely to be important fate processes. The most probable human exposure would be occupational exposure, which may occur through dermal contact or inhalation at places where acenaphthylene is produced or used. Atmospheric workplace exposures have been documented. Non-occupational exposures would most likely occur via urban atmospheres, contaminated drinking water supplies and recreational activities at contaminated waterways (SRC).

Synonyms/Substance Identification:

Cyclopenta(de)naphthalene [366]

Molecular Formula:
C12-H8 [366]

Associated Chemicals or Topics (Includes Transformation Products):

See also individual entry:

PAHs as a group

Metabolism/Metabolites [366]:

Metabolic scission of the 5-membered ring of acenaphthylene to yield 1,8-naphthalic acid proceeds via the cis- & trans-acenaphthene-1,2-diols & scission of the diols has been shown to be affected by microsomal prepn of rat liver. [Parke, D. V. The Biochemistry of Foreign Compounds. Oxford: Pergamon Press, 1968. 71.

A Beijerinckia species and a mutant strain, Beijerinckia species strain B8/36, were shown to oxidize the polycyclic aromatic hydrocarbons acenaphthene and acenaphthylene. Both organisms oxidized acenaphthene to the same spectrum of metabolites, which included 1-acenaphthenol, 1-acenaphtheneone, 1,2-acenaphthenediol, acenaphthenequinone, and a compound that was tentatively identified as 1,2-dihydroxyacenaphthylene. In contrast, acenaphthylene was oxidized to acenaphthenequinone and the compound tentatively identified as 1,2-dihydroxyacenaphthylene was also formed when the organism was incubated with synthetic cis-1,2-acenaphthenediol. A metabolite identified as cis-1,2-acenaphthenediol was formed from acenaphthylene by the mutant Beijerinckia species strain B8/36. Cell extracts prepared from the wild-type Beijerinckia strain contain a constitutive pyridine nucleotide-dependent dehydrogenase which can oxidize 1-acenaphthenol and 9-fluorenol. The results indicate that although acenaphthene and acenaphthylene are both oxidized to acenaphthenequinone, the pathways leading to the formation of this end product are different. [Schocken MJ, Gibson DT; Appl Environ Microbiol 48 (1): 10-16 (1984).

Water Data Interpretation, Concentrations and Toxicity (All Water Data Subsections Start with "W."):

W.Low (Water Concentrations Considered Low):

No information found.

W.High (Water Concentrations Considered High):

Groundwater from the site of a Seattle coal and oil gasification plant, which ceased operation in 1956, contained acenaphthylene in the range of 0.01-0.25 mg/L with an average concentration of 0.098 mg/L [788].

Information from ATSDR on PAHs in water (for information on embedded references, see ATSDR) [881]:

> PAHs have been detected in urban runoff generally at concentrations much higher than those reported for surface water. Data collected as part of the Nationwide Urban Runoff Program indicate concentrations of individual PAHs in the range of 300-10,000 ng/L, with the concentrations of most PAHs above 1,000 ng/L (Cole et al. 1984). Few data are available on the concentrations of PAHs in U.S. groundwater. Basu and Saxena (1978b) reported total PAH concentrations in groundwater from three sites in Illinois, Indiana, and Ohio to be in the range of 3-20 ng/L. Groundwater levels of PAHs near a coal and oil gasification plant and U.S. wood treatment facilities have been found to be elevated. Groundwater samples from the site of a Seattle coal and oil gasification plant which ceased operation in 1956 were found to contain acenaphthylene, acenaphthene, fluorene, phenanthrene, fluoranthene, pyrene, and chrysene at concentrations ranging from not detected (detection limit 0.005 mg/L) to 0.25, 0.18, 0.14, 0.13, 0.05, 0.08, and 0.01 mg/L, respectively (Turney and Goerlitz 1990). Individual PAHs in the groundwater from 5 U.S. wood treatment facilities were reported at average concentrations of 57 ppb (0.057 mg/L) for benzo[a]pyrene to 1,825 ppb (1.8 mg/L) for phenanthrene (Rosenfeld and Plumb 1991) [881].

W.Typical (Water Concentrations Considered Typical):

Information from ATSDR on PAHs in water (for information on embedded references, see ATSDR) [881]:

> PAHs have been detected in surface waters of the United States. In an assessment of STORET data covering the period 1980-82, Staples et al. (1985) reported median concentrations in ambient water of less than 10 ug/L for 15 PAHs (acenaphthene, acenaphthylene, anthracene, benz[a]anthracene, benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[g,h,i]perylene, benzo[a]pyrene, chrysene, fluoranthene, fluorene, indeno[1,2,3-c,d]pyrene, naphthalene, phenanthrene, and pyrene).

Information from HSDB [366]:

> RAIN/SNOW: Rain water in Portland, OR contained acenaphthylene at concn ranging from 23 to 59 ng/l between Feb 12 and April 12, 1984, with an average for 7 samples of 37 ng/l(1). Snow pack from the city of St Marie, Canada contained acenaphthylene at concn ranging from less than 0.050 to 0.153 ug/l(2). [(1) Ligocki MP et al; Atmos Environ 19: 1609-17 (1985) (2) Boom A, Marsalek J; Sci Total Environ 74: 133-48 (1988)].
>
> SURFACE WATER: Acenaphthylene is listed as a contaminant of Great Lakes Ontario, Erie, Michigan and Superior(1). Acenaphthylene had a median conc less than 10 ug/l and tested positive in 3.0% of 920 ambient waters in the USEPA STORET database(2). Acenaphthylene was detected at 2 of 4 sampling stations along the Mississippi River at an average concn of 3 ng/l(3). Acenaphthylene was also detected in Yellow River water, Peoples Republic of China(4). Ohio river water contained acenaphthylene at the cities of Wheeling. [(1) Great Lakes Water Quality Board; Report on Great Lakes Water Quality p. 19 (1983) (2) Staples CA et al; Environ Toxicol Chem 4: 131-42 (1985) (3) DeLeon I et al; Chemosphere 15(6): 795-805 (1986) (4) Ren-Ming W et al; Intern J Environ Anal Chem 22: 115-26 (1986) (5) Ohio River Valley water Sanitation Commission; Assessment of Water Quality Conditions Ohio River Mainstream 1978-9 Cincinnati OH (1980).
>
> GROUNDWATER: Acenaphthylene was detected in a coal tar contaminated aquifer in St Louis Park, MN(1) at concn ranging from 0.01 to 0.11 mg/kg sediment(2). Wood preserving chemicals at Pensacola, FL are responsible for an acenaphthylene concn of 0.05 and 0.03 mg/l at ground water depths of 18 and 24 m, respectively(3). Groundwater samples from nearby

the Hooker Chemical and Plastics Corp disposal site at Love Canal, NY contained acenaphthylene(4). [(1) Rostad CE et al; Chemosphere 14: 1023-36 (1985) (2) Ehrlich GG et al; Ground Water 20: 703-10 (1982) (3) Goerlitz DF et al; Environ Sci Technol 19: 995-61 (1985) (4) Hauser TR, Bromberg SM; Environ Monit Assess 2: 249-72 (1982)].

Effluent Concentrations:

Acenaphthylene was identified as a stack emission(1) and a component of grate(2) and fly ash(1-3) from municipal waste incinerators. Effluent from a sewage treatment facility at Bekkelaget, Norway contained acenaphthylene at concn of 37, 471 and 73 ng/l for dry Fall and Spring days, and after a summer rain, respectively(4). [(1) Tong HY et al; J Chrom 285: 423-41 (1984) (2) Junk GA, Ford CS; Chemosphere 9: 187-230 (1980) (3) Eiceman GA et al; Anal Chem 51: 2343-50 (1979) (4) Kveseth K et al; Chemosphere 11: 623-39 (1982).

The biotreatment and final effluents of Class A, B and E oil refineries contained acenaphthylene at concn of 4, less than 1; less than 1, less than 1; and 87, less than 1 ug/l, respectively(1). Wastewater from the gaseous diffusion plant operated by Union Carbide at Oak Ridge, TN contained acenaphthylene in the volatile fraction(2). Leachate from Hooker Chemical and Plastics Corp disposal site at Love Canal, NY contained acenaphthylene(3). Emissions from the pouring, cooling and shakeout of iron castings contained acenaphthylene at an average concn of 350 and 80 ug/kg for the evaporative casting and green sand processes, respectively(4). Effluent from a textile finishing operation also contained acenaphthylene(5). Acenaphthylene had a median concn less than 10 ug/l and tested positive in 2.8% of 1,271 industrial discharges in the USEPA STORET database(6). [(1) Snider EH, Manning FS; Environ Int 7: 237-58 (1982) (2) McMahon LW; Organic Priority Pollutants in Wastewater. NTIS DE83010817 Gatlinburg, TN p. 220-49 (1983) (3) Hauser TR, Bromberg SM; Environ Monit Assess 2: 249-72 (1982) (4) Gressel MG et al; Appl Ind Hyg 3: 11-17 (1988) (5) Gordon AW, Gordon M; Trans KY Acad Sci 42: 149-57 (1981) (6) Staples CA et al; Environ Toxicol Chem 4: 131-42 (1985)].

Drinking water: Eastern Ontario drinking water June to October 1978, 0.1-2.0 ng/l (n= 12); Raw water June to October 1978, 0.1-0.5 ng/l (n= 2).

[Verschueren, K. Handbook of Environmental Data of Organic Chemicals. 2nd ed. New York, NY: Van Nostrand Reinhold Co., 1983. 139].

DRINKING WATER: Two of five samples of Nordic tap water contained acenaphthylene at concn of 1.6 to 0.40 ng/l(1). Acenaphthylene was listed as a contaminant found in drinking water(2,3) for a survey of US cities including Pomona, Escondido, Lake Tahoe and Orange Co, CA and Dallas, Washington, DC, Cincinnati, Philadelphia, Miami New Orleans, Ottumwa, IA, and Seattle(4). [(1) Kveseth K et al; Chemosphere 11: 623-39 (1982) (2) Kool HJ et al; Crit Rev Env Control 12: 307-57 (1982) (3) Fawell JK, Fielding M; Sci Total Environ 47: 317-41 (1985) (4) Lucas SV; GC/MS Anal of Org in Drinking Water Concentrates and Advanced Treatment Concentrates Vol 1 EPA-600/1-84-020A (NTIS PB85-128239) p. 397 (1984)].

W.Concern Levels, Water Quality Criteria, LC50 Values, Water Quality Standards, Screening Levels, Dose/Response Data, and Other Water Benchmarks:

W.General (General Water Quality Standards, Criteria, and Benchmarks Related to Protection of Aquatic Biota in General; Includes Water Concentrations Versus Mixed or General Aquatic Biota):

Water Quality Criteria in ug/L:

Freshwater Acute Criteria: None Published [446].

Freshwater Chronic Criteria: None Published [446].

Marine Acute Criteria: None Published [446].

Marine Chronic Criteria: None Published [446].

W.Plants (Water Concentrations vs. Plants):

No information found.

W.Invertebrates (Water Concentrations vs. Invertebrates):

No information found.

W.Fish (Water Concentrations vs. Fish):

No information found.

W.Wildlife (Water Concentrations vs. Wildlife or Domestic Animals):

No information found.

W.Human (Drinking Water and Other Human Concern Levels):

EPA 1996 IRIS Database [893]:

Ambient Water Quality Criteria EPA 1996 for Human Health Water & Fish: 2.8E-3 ug/liter [893]. Older references:

Human Health (E-06 Risk Level for Carcinogens):

IRIS Recalculated (7/93) Criteria for Water and Organisms: 0.0028 ug/L [689,928];

IRIS Recalculated (7/93) Criteria for Organisms Only: 0.0311 [689,893,928] 45 FR 79318 (11/28/80) [893].

IRIS note: For the maximum protection from the potential carcinogenic properties of this chemical, the ambient water concentration should be zero. However, zero may not be obtainable at this time, so the recommended criteria represents a E-6 estimated incremental increase of cancer over a lifetime [893].

IRIS Drinking Water Health Advisories: empty [893].

Reference: Criteria Federal Register Notice Number: 45 FR 79318 (11/28/80) [893].

Drinking Water MCL: None Published [446,928,893].

Numeric Water Quality Criteria in Arizona [881]:

Domestic water supply: 0.003 ug/L
Fish consumption: 0.002 ug/L
Full body contact: 0.12 ug/L

Criteria for human health protection in Missouri [881]:

Fish consumption: 0.03 ug/L
Drinking water supply: 0.003 ug/L
Groundwater: 0.003 ug/L

W.Misc. (Other Non-concentration Water Information):

No information found.

Sediment Data Interpretation, Concentrations and Toxicity (All Sediment Data Subsections Start with "Sed."):

Sed.Low (Sediment Concentrations Considered Low):

No information found.

Sed.High (Sediment Concentrations Considered High):

No information found.

Sed.Typical (Sediment Concentrations Considered Typical):

In an assessment of STORET data covering the period 1980-1982, Staples et al. (1985) reported median concentrations in sediment of less than or equal to 500 ug/kg dry weight for 15 PAHs (acenaphthene, acenaphthylene, anthracene, benz[a]anthracene, benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[g,h,i]perylene, benzo[a]pyrene, chrysene, fluoranthene, fluorene, indenopyrene, naphthalene, phenanthrene, and pyrene). The number of sample ranged from 236 (anthracene) to 360 (benzo[a]pyrene, fluoranthene); the percentage of samples in which these PAHs were detected ranged from 6.0 (acenaphthene, benzo[b]fluoranthene, benzo[k]fluoranthene, indeno[1,2,3-c,d]pyrene) to 22.0 (fluoranthene, pyrene) [881].

Acenaphthylene was detected in 61.2 percent of urban-bay samples from the Puget Sound area. The mean concentration was 281.52 dry weight ug/kg (ppb), while the median concentration was 40 ug/kg (ppb) [852].

Acenaphthylene was detected in 35.6 percent of non-urban-bay samples from the Puget Sound area. The mean concentration was 79.82 ug/kg dry weight (ppb), while the median concentration was 40.5 ug/kg (ppb) [852].

> NOTE: The above values are not normalized for total organic carbon (TOC) content. Urban bay concentrations may be lower than or near non-urban bay concentrations due to more frequent dredging practices in urban bays, and also to the fact that most of the urban bays are at the mouths of rivers which are continually depositing "clean" sediment

into these bays.

Information from HSDB [366]:

Acenaphthylene was also detected in sediments from Dohkai Bay, WA(1), the Elizabeth River, VA(2,3), the Black River, OH(4) and the Great Lakes of Michigan(5) and Ontario(6). One of 3 sediment samples from the NY, NY harbor contained acenaphthylene at a concn of 30 ng/g(7). Between March 1984 and April 1985, acenaphthylene was detected at trace concn in sediments located 0.5 and 1 km from a sewage outfall at the Fraser River Estuary, British Columbia, Canada (8). Acenaphthylene was detected in 2 of 30 samples from Casco Bay, ME at concn of 1870 and 165 ppb(9). Acenaphthylene was detected in 1 of 10 sediment samples from streams feeding Lake Erie within the city of Erie, PA at concn of 3261 ug/kg(10). Acenaphthylene had a median concn less than 500.0 ug/kg and tested positive in 6.0% of 359 sediments in the USEPA STORET database(11). [(1) Shinohara R et al; Environ Internat 4: 163-74 (1980) (2) Bieri R et al; Intern J Environ Anal Chem 26: 97-113 (1986) (3) Merrill EG, Wade TL; Environ Sci Technol 19: 597-603 (1985) (4) West WR et al; Environ Sci Technol 22: 224-8 (1988) (5) Helfrich J, Armstrong DE; J Great Lakes Res 12: 192-9 (1986) (6) Onuska FI et al; J Great Lakes Res 9: 169-82 (1983) (7) Farrington JW, Westall J; NATO ASI Ser C 172: 361-425 (1986) (8) Rodgers IH, Hall KJ; Water Poll Res J Canada 22(2): 197-210 (1987) (9) Larsen PF et al; Bull Environ Contam Toxicol 30: 530-5 (1983) (10) Plowchalk DR, Zagorski SJ; Proc PA Acad Sci 60: 174-8 (1986) (11) Staples CA et al; Environ Toxicol Chem 4: 131-42 (1985)].

Sediment samples from nearby the Hooker Chemical and Plastics Corp disposal site at Love Canal, NY contained acenaphthylene(1). [(1) Hauser TR, Bromberg SM; Environ Monit Assess 2: 249-72 (1982)].

Sed.Concern Levels, Sediment Quality Criteria, LC50 Values, Sediment Quality Standards, Screening Levels, Dose/Response Data and Other Sediment Benchmarks:

Sed.General (General Sediment Quality Standards, Criteria, and Benchmarks Related to Protection of Aquatic Biota in General; Includes Sediment Concentrations Versus Mixed or General Aquatic Biota):

NOAA 1995 Concern Levels for Coastal and Estuarine

Environments: After studying its own data from the National Status and Trends Program as well as many literature references concerning different approaches to determining sediment criteria, NOAA suggested that the potential for biological effects of this contaminant sorbed to sediments was highest in sediments where its concentration exceeded the 640 ppb dry weight Effects Range-Median (ERM) concentration and was lowest in sediments where its concentration was less than the 44 ppb dry weight Effects Range-Low (ERL) concentration [664]. To improve the original 1990 guidelines [233], the 1995 report included percent (ratios) incidence of effects for ranges below, above, and between the ERL and ERM values. These numbers represent the number of data entries within each concentration range in which biological effects were observed divided by the total number of entries within each range [664]:

<ERL	14.3
ERL-ERM	17.9
>ERM	100

AET, EPA 1988: The apparent effects threshold (AET) concentrations for acenaphthylene in sediments proposed for Puget Sound ranged from >.560 mg/kg dry weight (microtox) to 1.3 mg/kg dry weight (amphipod) [416]. Although the authors of the Puget Sound AETs have cautioned that Puget Sound AETs may not be appropriate for comparison with data from other geographic areas, so few concern levels for this chemical have been published that the proposed Puget Sound concern level is included in this text as a reference item.

> NOTE: Even lower concentrations of this PAH may be of concern related to its contribution to "total PAH" sums (see "PAHs as a group" entry).

St. Lawrence Interim Freshwater Sediment Criteria, 1992. No effect level: 10 ug/kg dry weight [761].

Sed.Plants (Sediment Concentrations vs. Plants):

No information found.

Sed.Invertebrates (Sediment Concentrations vs. Invertebrates):

No information found.

Sed.Fish (Sediment Concentrations vs. Fish):

No information found.

Sed.Wildlife (Sediment Concentrations vs. Wildlife or Domestic Animals):

No information found.

Sed.Human (Sediment Concentrations vs. Human):

No information found.

Sed.Misc. (Other Non-concentration Sediment Information):

No information found.

Soil Data Interpretation, Concentrations and Toxicity (All Soil Data Subsections Start with "Soil."):

Soil.Low (Soil Concentrations Considered Low):

No information found.

Soil.High (Soil Concentrations Considered High):

Soil Concentrations (mg/kg dry weight) Polycyclic Aromatic Hydrocarbons (PAHs) at Contaminated Sites. Highest values found at wood preserving, gas works, and coking site plants (mg/kg dry weight) [881]:

Acenaphthylene	187

Soil.Typical (Soil Concentrations Considered Typical):

Background Soil Concentrations of Acenaphthylene (PAH concentration in ug/kg) [881]:

Agricultural Soil: 5

Soil.Concern Levels, Soil Quality Criteria, LC50 Values, Soil Quality Standards, Screening Levels, Dose/Response Data and Other Soil Benchmarks:

Soil.General (General Soil Quality Standards, Criteria, and Benchmarks Related to Protection of Soil-dwelling Biota in General; Includes Soil Concentrations Versus Mixed or General Soil-dwelling Biota):

No information found.

Soil.Plants (Soil Concentrations vs. Plants):

No information found.

Soil.Invertebrates (Soil Concentrations vs. Invertebrates):

No information found.

Soil.Wildlife (Soil Concentrations vs. Wildlife or Domestic Animals):

No information found.

Soil.Human (Soil Concentrations vs. Human):

No information found.

Soil.Misc. (Other Non-concentration Soil Information):

No information found.

Tissue and Food Concentrations (All Tissue Data Interpretation Subsections Start with "Tis."):

Tis.Plants:

A) As Food: Concentrations or Doses of Concern to Living Things Which Eat Plants:

No information found.

B) Body Burden Residues in Plants: Typical, Elevated, or of Concern Related to the Well-being of the Organism Itself:

No information found.

Tis.Invertebrates:

A) As Food: Concentrations or Doses of Concern to Living Things Which Eat Invertebrates:

No information found.

B) Concentrations or Doses of Concern in Food Items Eaten by Invertebrates:

No information found.

C) Body Burden Residues in Invertebrates: Typical, Elevated, or of Concern Related to the Well-being of the Organism Itself:

See also Tis.Fish, C), below.

No detections of this compound were made in certain samples of Exxon Valdez mussels [971].

Tis.Fish:

A) As Food: Concentrations or Doses of Concern to Living Things Which Eat Fish (Includes FDA Action Levels for Fish and Similar Benchmark Levels From Other Countries):

No information found.

B) Concentrations or Doses of Concern in Food Items Eaten by Fish:

No information found.

C) Body Burden Residues in Fish: Typical, Elevated, or of Concern Related to the Well-being of the Organism Itself:

No detections of this compound were made in certain samples of Exxon Valdez fish [971].

Fish/Seafood Concentrations [366]:

Bullhead catfish from the Black River, OH and Striped Bass from the Potomac River, MD contained acenaphthylene at concn of 270 and 43 ppb, respectively(1). Oysters and clams from Lake Pontchartrain, LA contained acenaphthylene at an average concn of 36 and 130 ppb, respectively(2). Fish samples from the Great Lakes harbors and tributary mouths contained acenaphthylene(3,4). Coral rock oysters (Saccostrea cucculata) collected in Sept 1982 from six locations at Mermaid Sound in NW Australia contained acenaphthylene at concn ranging from less than 0.4 to 3 ppb with a 45% frequency of occurrence(5). Acenaphthylene had a median concn less than 2,000 mg/kg and tested positive in less than 0.5% of 140 biota surveyed in the USEPA STORET database(6). [(1) Vassilaros, DL et al; Anal Chem 54: 106-12 (1982) (2) McFall JA et al; Chemosphere 14: 1561-9 (1985) (3) DeVault DS; Arch Environ Contam Toxicol 14: 587-94 (1985) (4) Camanzo J et al; J Great Lakes Res 13: 296-309 (1987) (5) Kagi R et al; Intern J Environ Anal Chem 22: 135-53 (1985) (6) Staples CA et al; Environ Toxicol Chem 4: 131-42 (1985)].

Tis.Wildlife: Terrestrial and Aquatic Wildlife, Domestic Animals and all Birds Whether Aquatic or not:

A) As Food: Concentrations or Doses of Concern to Living Things Which Eat Wildlife, Domestic Animals, or Birds:

No information found.

B) Concentrations or Doses of Concern in Food Items Eaten by Wildlife, Birds, or Domestic Animals (Includes LD50 Values Which do not Fit Well into Other Categories, Includes Oral Doses Administered in Laboratory Experiments):

No information found.

C) Body Burden Residues in Wildlife, Birds, or Domestic Animals: Typical, Elevated, or of Concern Related to the Well-being of the Organism Itself:

No information found.

Tis.Human:

A) Typical Concentrations in Human Food Survey Items:

See also Tis.Fish, C), above.

Food Survey Results [366]:

One of 22 samples of margarines, butter and vegetable oils contained acenaphthylene at a concn of 0.07 ug/kg(1). Composite fish samples from the Great Lakes harbors and tributary mouths contained acenaphthylene(2). Three analyses of trout from Iceland showed acenaphthylene at an average concn of 4 ppb(3). Japanese horse mackerel contained acenaphthylene for 3 different methods of preparation at concn of 77-392, 160 and 45 ppb(3). [(1) Hopia A et al; JAOCS 63: 889-93 (1986) (2) DeVault DS; Arch Environ Contam Toxicol 14: 587-94 (1985) (3) Lo M, Sandi E; Res Rev 69: 35-86 (1978)].

Seafood & agricultural products contain polycyclic aromatic hydrocarbons (PAHs) because of their sedimentation from air & subsequent penetration into water systems. Crude coconut oil, heavily smoked ham, roasted coffee, tea, & charcoal-broiled meat contain PAHs in concn up to 20 to 40 ug/kg. /Polycyclic aromatic hydrocarbons/ [Ellenhorn, M.J. and D.G. Barceloux. Medical Toxicology - Diagnosis and Treatment of Human Poisoning. New York, NY: Elsevier Science

Publishing Co., Inc. 1988. 953].

B) Concentrations or Doses of Concern in Food Items Eaten by Humans (Includes Allowable Tolerances in Human Food, FDA, State and Standards of Other Countries):

RfD: under review [893].

C) Body Burden Residues in Humans: Typical, Elevated, or of Concern Related to the Well-being of Humans:

No information found.

Tis.Misc. (Other Tissue Information):

No information found.

Bio.Detail: Detailed Information on Bioconcentration, Biomagnification, or Bioavailability:

During the Exxon Valdez spill, bioconcentration explained the buildup of PAHs in tissues better than biomagnification; most accumulation was of an equilibrium partitioning nature across the gills rather than from the food chain [971]. Immature fish seem to have higher bioconcentration of PAHs than adults, perhaps because their PAH breakdown systems are not fully developed and at times perhaps because of a higher percentage of lipid tissues (yolk tissues, etc) [971] (confirmed by Jerry Neff, Battelle Ocean Sciences, Duxbury, MA, personal communication 1996).

Bioconcentration [366]:

Based on a water solubility of 16.1 mg/l at 25 deg C(1) and an estimated log Kow of 3.94(2), the log BCF of acenaphthylene has been calculated to range from 2.11 to 2.76 from various regression-derived equations(3,SRC). These log BCF values suggest acenaphthylene has the potential to bioconcentrate in aquatic systems(SRC). [(1) Walters RW, Luthy RG; Water Res 18: 795-809 (1984A) (2) Walters RW, Luthy RG; Environ Sci Technol 18: 395-403 (1984) (3) Lyman WJ et al; Handbook of Chemical Property Estimation Methods NY: McGraw-Hill p. 5-4, 5-10 (1982)].

Interactions:

This compound is often found in the company of other PAHs, and complex mixtures of PAHs tend to be carcinogenic and possibly phototoxic and generally hazardous in various other ways (see "PAHs as a group" entry).

Uses/Sources:

This compound is often found in various petroleum products in the company of other PAHs (see "PAHs as a group" entry).

Acenaphthylene was found in groundwater at a coal and oil gasification plant some 30 years after the plant shut down [788].

Natural Sources [366]:

> Acenaphthylene is a natural component of crude oil(1) and coal tar(2). Acenaphthylene is also a product of combustion and can be released to the environment via natural fires associated with lightening, volcanic activity, and spontaneous combustion(SRC). [(1) Elliott JJ, Melchior MT; Kirk-Othmer Encycl Chem Tech 3rd NY,NY: Wiley 17: 119-31 (1982) (2) Gaydos RM; Kirk-Othmer Encycl Chem Tech 3rd NY,NY: Wiley 15: 698-719 (1981)].
>
> The primary environmental sources of polycyclic aromatic hydrocarbons (PAHs) are forest fires. /Polycyclic aromatic hydrocarbons/ [Ellenhorn, M.J. and D.G. Barceloux. Medical Toxicology - Diagnosis and Treatment of Human Poisoning. New York, NY: Elsevier Science Publishing Co., Inc. 1988. 953].

Artificial Sources [366]:

> Acenaphthylene may be emitted to the environment by effluents from petroleum refining and coal tar distillation(1,2). Acenaphthylene is contained in a variety of coal tar products(1). Consequently, acenaphthylene may be released to the environment via manufacturing effluents(3-6) and the disposal of manufacturing waste byproducts(7-8). Because of the widespread use of acenaphthylene in a variety of products, acenaphthylene is also released to the environment through municipal waste water treatment facilities(9) and waste incinerators(10-13). [(1) Gaydos RM; Kirk-Othmer Encycl Chem Tech 3rd NY,NY: Wiley 15: 698-719 (1981) (2) Snider EH, Manning FS; Environ Int 7: 237-58 (1982) (3) McMahon LW; Organic Priority Pollutants in Wastewater. NTIS DE83010817 Gatinburg, TN p. 220-49 (1983) (4) Gressel MG et al; Appl Ind Hyg 3: 11-17 (1988) (5) Gordon AW, Gordon M; Trans Ky Acad Sci 42: 149-57 (1981) (6) Staples CA et al; Environ Toxicol Chem 4: 131-42 (1985) (7) Hauser TR, Bromberg SM; Environ Monit Assess 2: 249-72 (1982) (8) Goerlitz DF et al; Environ Sci Technol 19: 995-61 (1985) (9) Kveseth K et al; Chemosphere 11: 623-639 (1982) (10) Tong, HY et al; J Chrom 285: 423-41 (1984A) (11) Junk GA, Ford CS; Chemosphere 9: 187-230 (1980) (12) Eiceman GA et al; Anal Chem 51: 2343-50 (1979) (13) Eiceman GA et al; Anal Chem 53: 955-9 (1981)].
>
> The primary environmental sources of polycyclic aromatic hydrocarbons (PAHs) are forest fires & combustion of fossil fuel, where high temperatures convert organic

substances to PAHs. /Polycyclic aromatic hydrocarbons/ [Ellenhorn, M.J. and D.G. Barceloux. Medical Toxicology - Diagnosis and Treatment of Human Poisoning. New York, NY: Elsevier Science Publishing Co., Inc. 1988. 953].

Polycyclic aromatic hydrocarbons (PAH) found in exhaust gas of 2 automobiles & separated by gas chromatography were characterized by mass spectrometry subsequent to enrichment from exhaust gas condensate. Amt of polycyclic aromatic hydrocarbon boiling above 338 deg c found in exhaust gas were compared with amt found in gasoline used, & PAH profiles for exhaust gas & original fuel indicated that most of PAH emitted were produced in engine during combustion, even though most of polycyclic aromatic hydrocarbon in fuel undergo complete combustion. /Polycyclic aromatic hydrocarbons/ [Grimmer G et al; Erdoel, Kohle, Erdgas, Petrochem 30 (9): 411-7 (1977)].

Chemical composition of coal liquefaction products indicates they may exhibit considerable carcinogenicity. Concn of polynuclear aromatic hydrocarbons (PAH), in coal liquefaction products as a whole, greatly exceeded those found in smokes & known tumor-promoting compounds. /Polynuclear aromatic hydrocarbons/ [Guerin MR et al; Proc Environ Prot Conf 3RD 2: 661-85 (1975) [366].

The levels of selected polynuclear aromatic hydrocarbons (PACs) in several crude shale-oils & crude petroleum oils have been analyzed /& reported in this monograph on Shale-Oils/. /Polycyclic aromatic hydrocarbons/ [IARC. Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man. Geneva: World Health Organization, International Agency for Research on Cancer,1972-PRESENT. (Multivolume work).,p. V35 161 (1985) [366].

Soots are generally lustreless black substances which can be defined as the by-products of the incomplete combustion or pyrolysis of any kind of carbon-containing material ... . The exact composition of the mixture of a particular soot is dependent upon the type of material burned & the combustion conditions that existed when the soot was formed. ... The fraction of soots that can be extracted with organic solvents, the so-called soluble organic fraction (SOF), includes several classes of compounds, including polynuclear aromatic compounds (PACs), their derivatives, & heterocyclic analogs of such compounds. PACs are present in large amounts in high percentages of loosely-retained tarry matter in soots, & the bulk of the tarry matter is immediately soluble in organic solvents. /Specific polynuclear aromatic compounds found in the soluble organic fraction (SOF) of chimney soots & the total polynuclear aromatic compounds found in different soots from different fuels have been reported/. /Soots/ [IARC. Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man. Geneva: World Health Organization, International Agency for Research on Cancer,1972-PRESENT. (Multivolume work).,p. V35 219 (1985) [366].

Coal tar pitch volatiles (CTPV) are products of the destructive distillation of bituminous coal and contain polynuclear aromatic hydrocarbons. /Coal tar pitch volatiles/ [Mackison, F. W., R. S. Stricoff, and L. J. Partridge, Jr. (eds.). NIOSH/OSHA - Occupational Health Guidelines for Chemical Hazards. DHHS(NIOSH) PublicationNo. 81-123 (3 VOLS). Washington, DC: U.S. Government Printing Office, Jan. 1981. 2. [366].

Polycyclic aromatic hydrocarbons can be found in gases from premixed flame and fuel combustion. /Polycyclic aromatic hydrocarbons/ [Prado G et al; Chem Anal and Biol Fate: Polynucl Aromat Hydrocarbons, Int Symp 5th: 189-98 (1981). [366].

In coal gasification, polynuclear aromatic hydrocarbons are emitted to the air during gasifer operations, gas quenching and cooling, gas-liquor separation, and oil and tar storage. /Polynuclear aromatic hydrocarbons, from table/ [IARC. Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man. Geneva: World Health Organization, International Agency for Research on Cancer,1972-PRESENT. (Multivolume work).,p. V34 75 (1984). [366].

In coke production, polynuclear aromatic hydrocarbons are emitted to the air during coke-oven operations. /Polynuclear aromatic hydrocarbons, from table/ [IARC. Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man. Geneva: World Health Organization, International Agency for Research on Cancer,1972-PRESENT. (Multivolume work).,p. V34 106 (1984). [366].

Forms/Preparations/Formulations:

No information found.

Chem.Detail: Detailed Information on Chemical/Physical Properties:

Solubility:

3.88 - 3.93 mg/L at 25 degrees C [848].

3.93 mg/l distilled water at 25 deg C [Verschueren, K. Handbook of Environmental Data of Organic Chemicals. 2nd ed. New York, NY: Van Nostrand Reinhold Co., 1983. 139 [366].

Sol in alcohol, ether, benzene [Weast, R.C. (ed.) Handbook of Chemistry and Physics. 69th ed. Boca Raton, FL: CRC Press Inc., 1988-1989.,p. C-42.

Sol in water l6.l mg/l at 25 deg C [Boyd RH et al; J Am Chem Soc 87: 3554-9 (l965) [366].

Density:

0.899 g/cm3 at 95 degrees C [848].

0.8988 at 16 deg C/2 deg C [Weast, R.C. (ed.) Handbook of Chemistry and Physics. 69th ed. Boca Raton, FL: CRC Press Inc., 1988-1989.,p. C-42 [366].

Melting point:

92.0 - 96.2 degrees C [848].

92-93 deg C [Weast, R.C. (ed.) Handbook of Chemistry and Physics. 69th ed. Boca Raton, FL: CRC Press Inc., 1988-1989.,p. C-42 [366].

Boiling point:

280 degrees C [848].

265-275 DEG C [Weast, R.C. (ed.) Handbook of Chemistry and Physics. 69th ed. Boca Raton, FL: CRC Press Inc., 1988-1989.,p. C-42 [366].

Octanol/Water partition coefficient (low Kow):

4.06 - 4.08 [848].

log Kow= 4.07 [Callahan, M.A., M.W. Slimak, N.W. Gabel, et al. Water-Related Environmental Fate of 129 Priority Pollutants. Volume II. EPA-440/4-79-029b. Washington, D.C.: U.S.Environmental Protection Agency, December 1979.,p. 95-3 [366].

Comparative Log Kows:

Naphthalene:	3.37
C1-Naphthalene:	3.87
C2-Naphthalene:	4.37
C3-Naphthalene:	5.0
C4-Naphthalene:	5.55
Acenaphthylene:	4.07

Sorption partition coefficient (low Koc) [848]: 3.59 - 3.83

Molecular Weight [366]:

152.20 [Weast, R.C. (ed.) Handbook of Chemistry and Physics. 69th ed. Boca Raton, FL: CRC Press Inc., 1988-1989.,p. C-42.

PAH concentrations (ug/g oil sampled) were determined for three different crude oil sample types (weathered and unweathered oil) taken from the Exxon Valdez oil spill. Acenaphthylene was not detected in any of them [790; Reprinted with permission from Environmental Toxicology and Chemistry, Vol.14(11), W.A. Stubblefield, G.A. Hancock, W.H. Ford, and R.K. Ringer, "Acute and Subchronic Toxicity of Naturally Weathered Exxon Valdez Crude Oil in Mallards and Ferrets." Copyright 1995 SETAC].

Acenaphthylene content in one fresh sample of NSFO (Fuel Oil 5, Chuck Rafkind, National Park Service, Personal Communication, 1996): 4.1 ng/mg or ppm.

Acenaphthylene content in one sample of groundwater subjected to long term contamination of NSFO (Fuel Oil 5), possibly mixed with some JP-4, motorgas, and JP-8, Colonial National Historical Park Groundwater Site MW-10 (Chuck Rafkind, National Park Service, Personal Communication, 1996): 81.2 ng/L or ppt.

NOTE: the above two PAH concentrations were analyzed by a GC/MS/SIM NOAA protocol [828] modified with methylene chloride extraction for use with water samples (Guy Denoux, Geochemical and Environmental Research Group, Texas A&M University, personal communication 1996).

Acenaphthylene concentration in Used Engine Oil: 1.5 ppm [519; Reprinted with permission from Environmental Toxicology and Chemistry, Volume 12, Upshall, C., J.F. Payne and J. Hellou. "Induction of MFO enzymes and production of bile metabolites in rainbow trout (Oncorhynchus mykiss) exposed to waste crankcase oil." Copyright 1992 SETAC].

Fate.Detail: Detailed Information on Fate, Transport, Persistence, and/or Pathways:

Environmental Fate [366]:

TERRESTRIAL FATE: The reported biodegradation half-lives for acenaphthylene in aerobic soil range from 12 to 121 days(1). Acenaphthylene is not expected to undergo hydrolysis in soils; yet, should undergo direct photolysis in sunlit surface soils(2). A calculated Koc range of 2065 to 3230(3), indicates acenaphthylene will have a low to slight mobility class in soil(4). Monitoring data also demonstrates that acenaphthylene will flow with groundwater when spilled or deposited at heavy concn. A calculated Henry's Law constant of 1.13X10-5 atm-cu m/mole at 25 deg C(SRC) suggests volatilization of acenaphthylene from moist soils where absorption has not occurred may be important.(SRC) [(1) Coover MP, Sims RC; Haz Waste Haz Mat 4: 69-82 (1987) (2)

Behymer TD, Hites RA; Environ Sci Technol 19: 1004-6 (1985) (3) Lyman WJ et al; Handbook of Chemical Property Estimation Methods NY: McGraw-Hill p. 4-9 (1982) (4) Swann RL et al; Res Rev 85: 16-28 (1983)].

AQUATIC FATE: Based on evidence of biodegradation in soil, acenaphthylene should biodegrade in aquatic systems. Acenaphthylene is not expected to undergo hydrolysis or bioconcentrate in environmental waters. However, acenaphthylene may undergo direct photolysis in sunlit waters based upon aqueous photolysis data for acenaphthene(1) and photolysis data for acenaphthylene absorbed onto various particulate materials(2). Monitoring data and an estimated Koc ranging from the low to slightly mobile class for soil(3), suggests acenaphthylene will partition from the water column to organic matter contained in sediments and suspended solids. A Henry's Law constant of 1.13X10-4 atm-cu m/mole at 25 deg C(SRC) suggests volatilization of acenaphthylene from environmental waters may be important(4). Based on this Henry's Law Constant, the volatilization half-life from a model river has been estimated to be 4.1 days(4,SRC). The volatilization half-life from an model pond, which considers the effect of adsorption, has been estimated to be about 184 days(5,SRC). [(1) Fukuda K et al; Chemosphere 17: 651-9 (1988) (2) Behymer TD, Hites RA; Environ Sci Technol 19: 1004-6 (1985) (3) Swann RL et al; Res Rev 85: 16-28 (1983) (4) Lyman WJ et al; Handbook of Chemical Property Estimation Methods NY: McGraw-Hill p. 15-15 to 15-29 (1982) (5) USEPA; EXAMS II Computer Simulation (1987)].

ATMOSPHERIC FATE: Based upon a vapor pressure of 9.12X10-4 mm Hg at 25 deg C(1), acenaphthylene is expected to exist entirely in the vapor phase in ambient air(2). Acenaphthylene absorbs UV in the environmentally significant range (>290 nm), with Lambda max of 311, 323, 335 and 340 nm in cyclohexane(3). Based upon aqueous photolysis data for acenaphthene(4) and photolysis data for acenaphthylene absorbed onto various particulate materials(5), acenaphthylene will probably undergo direct photolysis in the atmosphere. The vapor phase reactions of acenaphthylene with photochemically produced hydroxyl radicals and ozone are likely to be important fate processes in the atmosphere. The rate constants for the vapor-phase reactions of acenaphthylene with photochemically produced hydroxyl radicals and ozone have been estimated to be 84.45X10-12 and 25.2X10-17 cu cm/molecule-sec, respectively, at 25 deg C; which correspond to an atmospheric half-lives of about 5 and 1 hours at an atmospheric concn of 5X10+5 hydroxyl radicals per cu cm and 7X10+11 ozone molecules per cu cm(6). [(1) Boyd RH et al; J Am Chem Soc 87: 3554-9 (1965) (2) Eisenreich SJ et al; Environ Sci Technol 15: 30-8 (1981)

(3) Weast RC et al; Hnbk Chem & Phys 67th ed (1986) (4) Fukuda K et al; Chemosphere 17: 651-9 (1988) (5) Behymer TD, Hites RA; Environ Sci Technol 19: 1004-6 (1985) (6) Atkinson R; Intern J Chem Kin 19: 799-828 (1987)].

Biodegredation [366]:

The degradation of acenaphthylene, in water solutions was studied. At the 25-150 ug/l level this compound was almost totally degraded at ambient temperature within 3 days. The microbial population responsible for the degradation occurs naturally in ground water taken from an aquifer which is contaminated with coal tar products. Filtration through a 0.45 Um filter was the most effective procedure for preserving hydrocarbons in these waters. [Ogawa I et al; Talanta 28 (10): 725 (1982)].

Acenaphthylene at a concn of 1 mg/g disappeared from a Nixon sandy loam soil within 4 months(1). However, only 51% was recovered at time zero(1). Also, acenaphthylene was completely lost from poisoned controls after 16 mo incubation in the dark at 20 deg C; suggesting volatilization was more important than biodegradation(1). [(1) Bossert ID, Bartha R; Bull Environ Contam Toxicol 37: 490-5 (1986)].

Acenaphthylene at a initial concn of 30.4 ug/g completely disappeared within 60 days in an unacclimated agricultural sandy loam soil incubated at both 10 and 20 deg C(1). In 97 days, 130 mg/kg of acenaphthylene in a mixture of sludge degraded to 42 mg/kg in a Derby soil column with nitrogen and phosphorous additions(2). In 76 days, 772 mg/kg of acenaphthylene in a mixture of oil sludge degraded to 244 mg/kg in a Derby soil column with nitrogen and phosphorous additions(2). In 76 days, 661 mg/kg of acenaphthylene in a mixture of oil sludge degraded to 9.2 mg/kg in a Masham soil column with nitrogen and phosphorous additions(2). In 203 days, 958 mg/kg of acenaphthylene in a wood preserving sludge degraded to 35 mg/kg in a Derby soil column with nitrogen and phosphorous additions(2). At 83 days the concn of acenaphthylene was 2003 mg/kg and at 287 days the concn was 50 mg/kg in a Masham soil column with nitrogen and phosphorous additions inoculated with wood preserving sludge(2). The succeeding first order rate constants are 0.0116, 0.0152, 0.0562 and 0.163 day-1, with a second order rate constant of 0.0181 day-1; which correspond to half-lives of 60, 45.6, 12.3, 42.5 and 121.3 days for acenaphthylene.(2). [(1) Coover MP, Sims RC; Haz Waste Haz Mat 4: 69-82 (1987) (2) Kincannon DF and Lin YS; Prod Ind Waste Conf 40: 607-19 (1985)].

Abiotic Degredation [366]:

Acenaphthylene was ozonated in hexane, methanol and water. The major products were 1,8-naphthalenedialdehyde (hexane, methanol and water); 1,8-naphthalene anhydride (hexane, methanol and water); methyl 8-formyl-1-naphthoate (methanol); dimethoxyacetal 1,8-naphthalenedialdehyde (methanol); 1,2-epoxyacenaphthylene (water); 1-naphthoic acid (water); and 1,8-naphthaldehyde acid (water). [Chen PN et al; Environ Sci Technol 13 (4): 451-4 (1979).

Polycyclic aromatic hydrocarbons and alkenes are generally resistant to hydrolysis(1). Therefore, acenaphthylene probably will not undergo hydrolysis in the environment. Acenaphthylene absorbs UV in the environmentally significant range (>290 nm), with Lambda max of 311, 323, 335 and 340 nm in cyclohexane(2). Based upon aqueous photolysis data for acenaphthene(3), acenaphthylene will probably undergo direct photolysis in the environment. Photolytic half-lives of acenaphthylene absorb onto silica gel, alumina, fly ash and carbon black were 0.7, 2.2, 44 and 170 hours, respectively; when placed in a pyrex photoreactor and exposed to a 450 W medium pressure mercury lamp, which had an irradiance of 17.6 + or - 1.4 W/sq m between the spectral region of 300 to 410 nm(4). The vapor phase reactions of acenaphthylene with photochemically produced hydroxyl radicals and ozone are likely to be important fate processes in the atmosphere. The rate constants for the vapor-phase reactions of acenaphthylene with photochemically produced hydroxyl radicals and ozone have been estimated to be 84.4491X10-12 and 25.2X10-17 cu cm/molecule-sec, respectively, at 25 deg C; which correspond to an atmospheric half-lives of about 5 and 1 hours at an atmospheric concn of 5X10+5 hydroxyl radicals per cu cm and 7X10+11 ozone molecules per cu cm(5). [(1) Lyman WJ et al; Handbook of Chemical Property Estimation Methods NY: McGraw-Hill p. 7-4 (1982) (2) Weast RC et al; Hnbk Chem & Phys 67th ed (1986) (3) Fukuda K et al; Chemosphere 17: 651-9 (1988) (4) Behymer TD, Hites RA; Environ Sci Technol 19: 1004-6 (1985) (5) Atkinson R; Intern J Chem Kin 19: 799-828 (1987)].

Soil Adsorption/Mobility [366]:

Based on a water solubility of 16.1 mg/l at 25 deg C(1) and a log Kow of 3.94(2), the Koc of acenaphthylene has been calculated to range from 950 to 3315 from various regression-derived equations(3,SRC). These Koc values indicate acenaphthylene will have a low to slight mobility class in soil(4). [(1) Walters RW, Luthy RG; Water Res 18: 795-809 (1984) (2) Walters RW, Luthy RG; Environ Sci Technol 18: 395-403 (1984) (3) Lyman WJ et al; Handbook of Chemical Property Estimation Methods NY: McGraw-Hill p. 4-9 (1982) (4) Swann RL et al; Res Rev 85:

16-28 (1983).

Volatilization from Water/Soil [366]:

Based upon a water solubility of 16.1 mg/l at 25 deg C(1) and a vapor pressure of 9.12X10-4 mm Hg at 25 deg C(2), a Henry's Law Constant of 1.13X10-5 atm-cu m/mole has been calculated(SRC). This value indicates volatilization of acenaphthylene from environmental waters may be important(3). The volatilization half-life from a model river (1 meter deep flowing 1 m/sec with a wind speed of 3 m/sec) has been estimated to be 4 days(3,SRC). The volatilization half-life from a model pond, which considers the effect of adsorption, has been estimated to be 184 days(4,SRC). [(1) Walters RW, Luthy RG; Water Res 18: 795-809 (1984) (2) Boyd RH et al; J Am Chem Soc 87: 3554-9 (1965) (3) Lyman WJ et al; Handbook of Chemical Property Estimation Methods NY: McGraw-Hill p. 15-15 to 15-29 (1982) (4) USEPA; EXAMS II Computer Simulation (1987)].

Absorption, Distribution and Excretion [366]:

Polynuclear aromatic hydrocarbons (PAH), some of which are potent carcinogens, are common environmental pollutants. The transport processes for these hydrophobic compounds into cells and between intracellular membranes are diverse and are not well understood. A common mechanism of transport is by spontaneous desorption and transfer through the aqueous phase. From the partitioning parameters, we have inferred that the rate limiting step involves solvation of the transfer species in the interfacial water at the phospholipid surface. Transfer of 10 polycyclic aromatic hydrocarbons ... out of phosphatidylcholine vesicles has been examined. Our results show that the molecular volume of the polycyclic aromatic hydrocarbons is a rate-determining factor. Morever, high performance liquid chromatography (HPLC) data confirms the hypothesis that the rate of transfer is correlated with the size of the molecule and with the partitioning of the molecule between a polar and hydrocarbon phase. The kinetics and characteristics of the spontaneous transfer of carcinogens are likely to have a major impact on the competitive processes of polycyclic aromatic hydrocarbons metabolism within cells. /Polynuclear aromatic hydrocarbons/ [Plant AL et al; Chem-biol Interact 44 (3): 237-46 (1983).

It has been observed that polynuclear aromatic hydrocarbons (PNAs) are highly soluble in adipose tissue and lipids. Most of the PNAs taken in by mammals are oxidized & the metabolites excreted. Effects of that portion remaining in the body at low levels have not been documented. /Polynuclear aromatic hydrocarbons/ [Sittig, M. Handbook of Toxic and Hazardous Chemicals and Carcinogens, 1985. 2nd ed. Park Ridge, NJ: Noyes Data Corporation, 1985. 741.

The waxy surface of some plant leaves and fruits can concentrate polyaromatic hydrocarbons through surface adsorption. /Polynuclear aromatic hydrocarbons/ [USEPA; Ambient Water Quality Criteria Doc: Polynuclear Aromatic Hydrocarbons p.C-11 (1980)].

PAH Biotransformation [366]:

For any polycyclic aromatic hydrocarbon ... the bulk of biotransformation leads to detoxified metabolites that are conjugated & rapidly excreted. Inhibition of the carcinogenicity of this class of compounds by xenobiotics depends on increasing the level of detoxication reactions. /Polycyclic aromatic hydrocarbons/ [Doull, J., C.D.Klassen, and M.D. Amdur (eds.). Casarett and Doull's Toxicology. 3rd ed., New York: Macmillan Co., Inc., 1986. 108].

Laboratory and/or Field Analyses:

Recommended detection limits:

Most of the PAH methods which have been commonly used historically for routine monitoring, including PAH parent compound standard methods:

EPA 8270 (8270 includes several PAH parent compounds along with a long list of other organics) for solid waste/RCRA applications [1013], and

EPA NPDES method 610 as specified in 40 CFR Part 136 (method 610 includes 16 PAH parent compounds) [1010],

EPA method 625 for Base/Neutral Extractables (method 625 includes several PAH parent compounds along with a long list of other organics) as specified in 40 CFR Part 136 [1010],

are all inadequate for generating scientifically defensible information for Natural Resource Damage Assessments [468]. These standard EPA scans do not cover important alkyl PAHs and do not utilize low-enough detection limits. When biological effects, ecological risk assessment, damage assessment, or bio-remediation are being considered, detection limit should be no higher than 1-10 ng/L (ppt) for water and 1 ug/kg (ppb) dry weight for solids such as tissues, sediments, and soil.

> Note: Utilizing up to date techniques, many of the better labs can use detection limits of 0.3 to 1 ppb for tissues, sediments, and soils. When no biological resources are at risk, detection limits for solids should nevertheless generally not be above 10 ppb. One reason that low detection limits are needed for PAHs is that so many of the criteria, standards, and screening benchmarks are in the lower ppb range (see various entries on individual PAHs).

In the past, many methods have been used to analyze for PAHs [861,1010,1013]. However, recent (1991) studies have indicated that EPA approved methods used for oil spill assessments (including total petroleum hydrocarbons method 418.1, semivolatile priority pollutant organics methods 625 and 8270, and volatile organic priority pollutant methods 602, 1624, and 8240) are all inadequate for generating scientifically defensible information for Natural Resource Damage Assessments [468]. These general organic chemical methods are deficient in chemical selectivity (types of constituents analyzed) and sensitivity (detection limits); the deficiencies in these two areas lead to an inability to interpret the environmental significance of the data in a scientifically defensible manner [468].

For risk, damage assessment, drinking water, or to determine if biodegradation has occurred, the NOAA expanded scan for PAHs and alkyl PAHs [828], or equivalent rigorous and comprehensive scans. (such as SW-846 method 8270 modified for Selective Ion Mode detection limits and an equivalent list of parent compound and alkyl PAH analytes), are recommended.

If a Park Service groundwater investigation at Colonial National Historical Park performed in response to contamination by Fuel Oil 5 had utilized EPA semi-volatile scan 8270 or any of the other typical EPA scans (625, etc.) all of which only include parent compounds and typically utilize detection limits in the 170-600 ppb range, the false conclusion reached would have been that no PAHs were present in significant (detection limit) amounts. This false negative conclusion would have been made because the parent compound PAHs present constituted only 7.6% of the PAHs detected in groundwater by the expanded scan [828], and the highest concentration found for any parent compound was 8.4 ppb, far below the detection limits used on the older standard EPA scans. Utilizing the NOAA protocol expanded scan [828], it was determined that 92.4% of the total concentration values of the PAHs detected in groundwater were alkyl PAHs, and that all 39 PAHs and alkyl PAHs were present. Of course, all 39 PAHs were also present in the fresh product, in much higher concentrations, and also having alkyl compounds with the highest percentage of higher values compared to parent compounds.

In a similar vein, if the Park Service sediment investigation at Petersburg National Historical Battlefield (this study was performed in response to contamination by Diesel) had utilized EPA semi-volatile scan 8270 or any of the other typical EPA scans (625, etc.), all of which only include parent compounds and often utilize detection limits no lower than the 170-600 ppb range, the false conclusion reached would have been that only one PAH was present in significant (detection limit) amounts. This false negative conclusion would have been made because the parent compound PAHs present constituted only 2.4% of the PAHs detected in sediments, and the highest concentration found for any parent compound except pyrene was 85.5 ppb, far below the detection limits used on the older standard EPA scans. Pyrene was 185 ppb, which would have been non-detected on many of the EPA scans, but not all. However, utilizing the NOAA protocol expanded scan [828], it was determined that 97.6% of total quantity of PAHs detected in sediments were alkyl PAHs, and that all 39 PAHs and alkyl PAHs were present in these sediments.

When taking sediment samples for toxic organics such as PCBs, PAHs, and organochlorines, one should also routinely ask for total organic carbon analyses so that sediment values may be normalized for carbon. This will allow comparison with the newer EPA interim criteria [86,127]. TOC in sediments influences the dose at which many compounds are toxic (Dr. Denny Buckler, FWS Columbia, personal communication).

In some cases (where the expanded scans are too expensive) an alternative recommendation is that one screen sediments with a size-exclusion high-performance liquid chromatography (HPLC)/fluorescence method. The utility and practicality of the HPLC bile and sediment screening analyses were demonstrated on board the NOAA R/V Mt. Mitchell during the Arabian Gulf Project. Estimates of petroleum contamination in sediment and fish were available rapidly, allowing modification of the sampling strategy based on these results [522].

Variation in concentrations of organic contaminants may sometimes be due to the typically great differences in how individual investigators treat samples in the field and in the lab rather than true differences in environmental concentrations. This is particularly true for volatiles and for the relatively lighter semi-volatiles such as the naphthalene PAHs, which are so easily lost at various steps along the way. Contaminants data from different labs, different states, and different agencies, collected by different people, are often not very comparable (see disclaimer section at the top of this entry).

As of 1997, the problem of lack of data comparability (not only for water methods but also for soil, sediment, and tissue methods) between different "standard methods" recommended by different agencies seemed to be getting worse, if anything, rather than better. The trend in quality assurance seemed to be for various agencies, including the EPA and others, to insist on quality assurance plans for each project. In addition to quality control steps (blanks, duplicates, spikes, etc.), these quality assurance plans call for a step of insuring data comparability [1015,1017]. However, the data comparability step is often not given sufficient consideration. The tendency of agency guidance (such as EPA SW-846 methods and some other new EPA methods for bio-concentratable substances) to allow more and more flexibility to select options at various points along the way, makes it harder in insure data comparability or method validity. Even volunteer monitoring programs are now strongly encouraged to develop and use quality assurance project plans [1015,1017].

At minimum, before using contaminants data from diverse sources, one should determine that field collection methods, detection limits, and lab quality control techniques were acceptable and comparable. The goal is that the analysis in the concentration range of the comparison benchmark concentration should be very precise and accurate.

It should be kept in mind that quality control field and lab blanks and duplicates will not help in the data quality assurance goal as well as intended if one is using a method prone to false negatives. Methods may be prone to false negatives due to the use of detection limits that are too high, the loss of contaminants through inappropriate handling, or the use of an inappropriate methods such as many of the EPA standard scans. This is one reason for using the NOAA expanded scan for PAHs [828]; or method 8270 [1013] modified for Selective Ion Mode (SIM) detection limits (10 ppt for water, 0.3 to 1 ppb for solids) and additional alkyl PAH analytes; or alternative rigorous scans. These types of rigorous scans are less prone to false negatives than many of the standard EPA scans for PAH parent compounds (Roy Irwin, National Park Service, Personal Communication, 1997).

For a much more detailed discussion of the great many different lab and field methods for PAHs in general, see the entry entitled PAHs as a group (file name starting with letter string: PAHS). There the reader will find much more detailed discussions of lab methods, holding times, containers, comparability of data from different methods, field sampling methods, quality assurance procedures, the relationship of various methods to each other, the various EPA standard methods for various EPA programs, the pros and cons of various methods, and additional documentation concerning why many standard EPA methods are inadequate for certain applications. A decision tree key for selecting the most appropriate methods for oil or oil products spills is also provided in the lab section of the PAHs entry. Due to the length of these discussions, they are not repeated here (see PAHs entry).