



**Draft Data Quality Evaluation Information for
General Population, Consumer, and Environmental Exposure for
Ethylene Dibromide**

Systematic Review Support Document for the Draft Risk Evaluation

CASRN: 106-93-4



June 2026

This supplemental file contains information regarding the data quality evaluation results for data sources that met the PECO (Population, Exposure, Comparator or Scenario, and Outcomes) screening criteria for the *Draft Chemistry, Fate, Release, and Exposure Assessment for Ethylene Dibromide*. EPA conducted data quality evaluation and extraction based on author-reported descriptions and results; additional analyses (e.g., statistical analyses) potentially conducted by EPA are not contained in this supplemental file. EPA performs data quality evaluation as a part of the TSCA systematic review process described in the *Draft Systematic Review Protocol Supporting TSCA Risk Evaluations for Chemical Substances*. (referred hereafter as the “2021 Draft Systematic Review Protocol”). The systematic review steps are further described in the *Draft Systematic Review Protocol for Ethylene Dibromide*.

Additionally, the overall quality determination (OQD) for each reference represents the data as a whole for each evidence stream, not for individual scenarios described within a study. For example, a reference that has both monitoring and experimental data would have OQDs using the data quality evaluation metrics for monitoring and experimental data, respectively. An OQD utilizing the data quality evaluation metrics for monitoring data, or any other single evidence stream, would consider all data pertinent to that evidence stream in the reference. Acronyms and abbreviations used within this supplemental file are defined in the table at the end of this file. This supplemental file may also be referred to as *Draft Data Quality Evaluation Information for General Population, Consumer, and Environmental Exposure for Ethylene Dibromide*.

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HERO ID	Reference	Page
Monitoring		
27314	Cohen, M. A., Ryan, P. B., Yanagisawa, Y., Spengler, J. D., Ozkaynak, H., Epstein, P. S. (1989). Indoor/outdoor measurements of volatile organic compounds in the Kanawha Valley of West Virginia. <i>Journal of Air Pollution Control Association</i> 39(8):1086-1093.	6
644898	Kawata, K., Tanabe, A., Saito, S., Sakai, M., Yasuhara, A. (1997). Screening of volatile organic compounds in river sediment. <i>Bulletin of Environmental Contamination and Toxicology</i> 58(6):893-900.	7
658661	Bell, J., Melcer, H., Monteith, H., Osinga, I., Steel, P. (1993). Stripping of volatile organic compounds at full-scale municipal wastewater treatment plants. <i>Water Environment Research</i> 65(6):708-716.	8
658751	Laternus, F. (1996). Volatile halocarbons released from Arctic macroalgae. <i>Marine Chemistry</i> 55(3-4):359-366.	9
659889	Cohen, M. A., Ryan, P. B., Spengler, J. D., Ozkaynak, H., Hayes, C. (1991). Source-receptor study of volatile organic compounds and particulate matter in the Kanawha Valley, WV—I. Methods and descriptive statistics. <i>Atmospheric Environment, Part B: Urban Atmosphere</i> 25(1):79-94.	10
666747	Loscutoff, W. V., Poore, M. V. (1993). Ambient air toxics data from California's toxic air contaminant monitoring program. :191-203.	11
737432	Blount, B. C., McElprang, D. O., Chambers, D. M., Waterhouse, M. G., Squibb, K. S., Lakind, J. S. (2010). Methodology for collecting, storing, and analyzing human milk for volatile organic compounds. <i>Journal of Environmental Monitoring</i> 12(6):1265-1273.	12
1356178	Great Lakes Chemical Corp, (1987). Exposure assessment for hazardous waste landfill with cover letter dated 072187.	13
1488836	Bi, E., Liu, Y., He, J., Wang, Z., Liu, F. (2012). Screening of emerging volatile organic contaminants in shallow groundwater in East China. <i>Ground Water Monitoring and Remediation</i> 32(1):53-58.	14
1740826	Westinghouse Savannah River Company, (1997). Sanitary landfill groundwater monitoring report. Fourth quarter 1996 and 1996 summary. 14(GRA and I):506.	15
1742362	Harkov, R., Kebbekus, B., Bozzelli, J. W. (1987). Volatile organic compounds at urban sites in New Jersey. :69-90.	16
1745619	Geraghty & Miller Inc, (1988). Results of the second phase of a hydrogeologic investigation at the Allied-Signal Inc facility, Morristown, New Jersey with cover letter dated 012089.	17
1941262	Boillot, C., Bazin, C., Tissot-Guerraz, F., Droguet, J., Perraud, M., Cetre, J. C., Trepo, D., Perrodin, Y. (2008). Daily physicochemical, microbiological and ecotoxicological fluctuations of a hospital effluent according to technical and care activities. <i>Science of the Total Environment</i> 403(1-3):113-129.	18
2799717	Connecticut Dept Of Health, (1987). Laboratory reports on methyl tert-butyl ether from various locations with cover letter dated 090887. 8713368:#40-8713368.	19
2859218	Nikolaou, A. D., Golfinopoulos, G., Kostopoulou, M. N., Kolokythas, G. A., Lekkas, T. D. (2002). Determination of volatile organic compounds in surface waters and treated wastewater in Greece. <i>Water Research</i> 36(11):2883-2890.	20
3227643	Wallace, L., Zweidinger, R., Erickson, M., Cooper, S., Whitaker, D., Pellizzari, E. (1982). Monitoring individual exposure. Measurements of volatile organic compounds in breathing-zone air, drinking water, and exhaled breath. <i>Environment International</i> 8(1/6):269-282.	21
3364193	Kingsbury, J. A., Delzer, G. C., Hopple, J. A. (2008). Anthropogenic organic compounds in source water of nine community water systems that withdraw from streams, 2002–05. <i>Scientific Investigations Report</i> 2008-5208 :68.	22
4214419	ICI Americas Inc, (1991). Letter from ICI Americas Inc to USEPA submitting follow-up information concerning phenol and other chemicals in groundwater at the facility in Hopewell, Virginia with attachments.	23
4214481	Radian Corp, (1989). Monitoring near refineries for airborne chemicals on the Sara Title III Section 313 List - Volume I, validated ambient air concentration around 3 refineries - cover ltr dtd 041789. :0489-0687.	24

4973765	Klick, S. (1993). The release of volatile halocarbons to seawater by untreated and heavy metal exposed samples of the brown seaweed <i>Fucus vesiculosus</i> . <i>Marine Chemistry</i> 42(3-4):211-221.	25
5424474	Schall, C., Heumann, K. G., Demora, S., Lee, P. A. (1996). Biogenic brominated and iodinated organic compounds in ponds on the McMurdo Ice Shelf, Antarctica. <i>Antarctic Science</i> 8(1):45-48.	26
5431563	Huang, Y., Su, T., Wang, L., Wang, N., Xue, Y., Dai, W., Lee, S. C., Cao, J., Ho, S. S. H. (2019). Evaluation and characterization of volatile air toxics indoors in a heavy polluted city of northwestern China in wintertime. <i>Science of the Total Environment</i> 662:470-480.	27
5438106	Glass, R. L. (1996). Hydrologic and water-quality data for U.S. Coast Guard Support Center Kodiak, Alaska, 1987-89. :1-73.	28
5438210	Guimaraes, W. B. (1995). Water quality in the Withers Swash Basin, with emphasis on enteric bacteria, Myrtle Beach, South Carolina, 1991-93. :1-102.	29
5438509	Heck, B. A., Myers, N. C., Hargadine, D. A. (1992). Hydrogeology and ground-water quality conditions at the Reno County Landfill, South-Central Kansas, 1990-91.	30
5492344	Sawhney, B. L. (1986). Why does a volatile pesticide, like EDB, persist in soils for years?. <i>Frontiers in Plant Science</i> 39(1):3-5.	31
5492929	Libbey, A. J., Jr (1986). Determination of ethylene dibromide in aquatic environments. <i>Analyst</i> 111(10):1221-1222.	32
5493125	Heikes, D. L. (1985). Purge and trap method for determination of ethylene dibromide in table-ready foods. <i>Journal of the Association of Official Analytical Chemists</i> 68(3):431-436.	33
5553456	Rowe, B. L., Toccalino, P. L., Moran, M. J., Zogorski, J. S., Price, C. V. (2007). Occurrence and potential human-health relevance of volatile organic compounds in drinking water from domestic wells in the United States. <i>Environmental Health Perspectives</i> 115(11):1539-1546.	34
5639273	Landmeyer, J. E., Campbell, B. G. (2014). Assessment of ethylene dibromide, dibromochloropropane, other volatile organic compounds, radium isotopes, radon, and inorganic compounds in groundwater and spring water from the Crouch Branch and McQueen Branch aquifers near McBee, South Carolina, 2010-2012.	35
5679227	Juhler, R. K., Felding, G. (2003). Monitoring methyl tertiary butyl ether (MTBE) and other organic micropollutants in groundwater: Results from the Danish national monitoring program. <i>Water, Air, and Soil Pollution</i> 149(1):145.	36
5695461	Midwest Research Institute, (1975). Sampling and analysis of selected toxic substances. Task II-ethylene dibromide.	37
6353594	Shell Oil, (1994). Initial submission: letter from Shell Oil Co to USEPA reporting slow dissipation of ethylene dibromide following spill from its Belpre, Ohio plant into Ohio River dated 062494.	38
7697510	Kolhatkar, R. V., Luo, H., Berns, E. C., Gaule, C., Watterson, J. (2021). Evaluation of vapor intrusion risk from ethylene dibromide using the vertical screening distance approach. <i>Ground Water Monitoring and Remediation</i> 41(2):48-60.	39
10065927	Hers, I., Wilson, J. T., Kolhatkar, R. V., Lahvis, M. A., Luo, E., Jourabchi, P. (2021). Field study of vertical screening distance criteria for vapor intrusion of ethylene dibromide. <i>Ground Water Monitoring and Remediation</i> 42(1):65-80.	40
11273432	CTEH, (2021). Shell Puget Sound Refinery 9-29-2020 flaring event: Supplemental report.	41
12795200	Bugher, N. A., Xiong, B., Gentles, R. I., Glist, L. D., Siegel, H. G., Johnson, N. P., Clark, C. J., Deziel, N. C., Saiers, J. E., Plata, D. L. (2024). Domestic groundwater wells in Appalachia show evidence of low-dose, complex mixtures of legacy pollutants. <i>Environmental Science: Processes & Impacts</i> 26(12):2250-2263.	42
Experimental		
5492344	Sawhney, B. L. (1986). Why does a volatile pesticide, like EDB, persist in soils for years?. <i>Frontiers in Plant Science</i> 39(1):3-5.	43
Database		
10709399	U.S. EPA, U.S.G.S. and National Water Quality Monitoring Council (2022). Ethylene dibromide (EDB) (CAS RN: 106-93-4): WQP Output (NWIS, STEWARDS & STORET), Site data & sample results (physical/chemical metadata).	44

11195094	U.S. EPA, (2022). Ambient Monitoring Technology Information Center (AMTIC) - Ambient Monitoring Archive for HAPs.	45
Completed Assessment		
1270201	ENSR, (1991). Letter from Texaco Refining and Marketing Inc to U.S. EPA submitting enclosed information and studies concerning several 8(d) chemicals with attachments.	46
1356137	Radian Corp, (1991). Air toxic hot spots - AB 2588 health risk assessment (volume I & II) (final reports) with attachments and cover letter dated 032991. 910000774:#86-910000774.	47
1356138	Radian Corp, (1991). Air toxic hot spots - AB 2588 health risk assessment - Shell Oil Company Martinez Refinery (volume I and II) with attachments, cover sheets and letter 040291. 910000771:#86-910000771.	48
1481756	ENSR, (1991). Ab 2588 Health Risk Assessment for Kern River and Racetrack Oil Fields, Bakersfield, California with attachments and cover letter dated 090591.	49
1481763	ENSR, (1991). Acute ISC input data-full grid & AB 2588 health risk assessments: Corrected & alternative emissions cases for the Cymric area oil fields McKittrick, California with letter 090591.	50
1874145	Radian Corp, (1991). Letter from Exxon Chemical Inc to USEPA submitting information concerning the California Assembly Bill 25588, the toxic hot spots information and assessment act of 1987 w-attachments.	51
5451606	ATSDR, (1994). Public health assessment for Otis Air National Guard Base/Camp Edwards, Falmouth, Barnstable County, Massachusetts, Region I. MA2570024487. Final rept.	52
6338980	ENSR, (1991). AB 2588 health risk assessment for the Texaco Refinery Areas 1 and 2 Bakersfield, California.	53
Modeling		
25108	Mckone, T. E. (1987). Human exposure to volatile organic compounds in household tap water: The indoor inhalation pathway. Environmental Science & Technology 21(12):1194-1201.	54
3360329	Ma, J., Li, H., Spiese, R., Wilson, J., Yan, G., Guo, S. (2016). Vapor intrusion risk of lead scavengers 1,2-dibromoethane (EDB) and 1,2-dichloroethane (DCA). Environmental Pollution 213:825-832.	55
Glossary of Select Terms for Data Evaluation Tables		56

Study Citation:		Cohen, M. A., Ryan, P. B., Yanagisawa, Y., Spengler, J. D., Ozkaynak, H., Epstein, P. S. (1989). Indoor/outdoor measurements of volatile organic compounds in the Kanawha Valley of West Virginia. Journal of Air Pollution Control Association 39(8):1086-1093.		
HERO ID:		27314		
Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	Low	Passive OVM air samplers at breathing zone height, but little details provided. No storage info.
	Metric 2:	Analytical Methodology	Medium	GC/FID using NIOSH method. Calibration conducted. Only LOD range provided.
	Metric 3:	Biomarker Selection	N/A	air sampling
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	USA
	Metric 5:	Currency	Low	1987
	Metric 6:	Spatial and Temporal Variability	High	3 week integrated samples from 35 homes
	Metric 7:	Exposure Scenario	High	Location relative to industry provided (50 m to 1 km from fence line). Correlations made to presence of garage, house age, AC use, and open windows.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	No raw data. mean, stdev, max, median. Correlations
	Metric 9:	Quality Assurance	Medium	Limited QC provided. Calibration standards used. No recoveries provided, but desorption efficiencies were provided. No field blanks greater than LOD for chemicals of interest.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Medium	Compared to TEAMS study. Conducted regression analysis for some factors.
Overall Quality Determination			Medium	

Study Citation:		Kawata, K., Tanabe, A., Saito, S., Sakai, M., Yasuhara, A. (1997). Screening of volatile organic compounds in river sediment. Bulletin of Environmental Contamination and Toxicology 58(6):893-900.		
HERO ID:		644898		
Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	Low	Sampling details lacking. Sample storage described but no description of how sediment samples were collected.
	Metric 2:	Analytical Methodology	High	GC/MS method described and LODs reported with results.
	Metric 3:	Biomarker Selection	N/A	River sediment
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	Niigata, Japan
	Metric 5:	Currency	Low	Samples collected in September 1995.
	Metric 6:	Spatial and Temporal Variability	Medium	7 samples were prepared per sediment.
	Metric 7:	Exposure Scenario	Medium	VOCs from sediment were measured in headspace.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Low	Raw data not provided but summary data is adequate.
	Metric 9:	Quality Assurance	High	Recoveries listed in detail.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Medium	Limitations were discussed briefly.
Overall Quality Determination			Medium	

Study Citation:		Bell, J., Melcer, H., Monteith, H., Osinga, I., Steel, P. (1993). Stripping of volatile organic compounds at full-scale municipal wastewater treatment plants. Water Environment Research 65(6):708-716.		
HERO ID:		658661		
Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	High	Appropriate methodology and clearly described
	Metric 2:	Analytical Methodology	High	Appropriate methodology and clearly described
	Metric 3:	Biomarker Selection	N/A	Testing for parent chemical in environmental media
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	Geographic area clearly reported
	Metric 5:	Currency	Low	Sampling date not reported, but likely between 1988 and 1993.
	Metric 6:	Spatial and Temporal Variability	Medium	8 (4 in duplicate) samples, each 24-hour composites, at each of 4 sampling locations to account for variability.
	Metric 7:	Exposure Scenario	Medium	Primarily addresses air pathway, additional monitoring of wastewater effluent, both routes of potential exposure.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Low	Raw data not reported
	Metric 9:	Quality Assurance	Medium	More thorough QA documentation previously published (Bell et al. 1988)
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Medium	More thorough QA documentation previously published (Bell et al. 1988)
Overall Quality Determination			Medium	

Study Citation:		Laternus, F. (1996). Volatile halocarbons released from Arctic macroalgae. <i>Marine Chemistry</i> 55(3-4):359-366.		
HERO ID:		658751		
Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	Medium	Biota sampling was described.
	Metric 2:	Analytical Methodology	Medium	Range of LOD provided. Methods described.
	Metric 3:	Biomarker Selection	N/A	NA - Arctic macroalgae, no biomarkers needed
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	Spitsbergen, Norway
	Metric 5:	Currency	Low	August to September - year not specified. Submitted 1995.
	Metric 6:	Spatial and Temporal Variability	Medium	Sample size not reported. 22 different macroalgae types sampled, different plant parts, see Table 1 for type of sample
	Metric 7:	Exposure Scenario	Low	Arctic microalgae. Sampling numbers and year not provided but data could be useful to estimate exposure to marine animals.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Low	error bars are shown. Text does not mention mean or median or what type of error is shown.
	Metric 9:	Quality Assurance	Low	Quality not discussed
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Low	variability and uncertainty are not discussed
Overall Quality Determination			Low	

Study Citation:		Cohen, M. A., Ryan, P. B., Spengler, J. D., Ozkaynak, H., Hayes, C. (1991). Source-receptor study of volatile organic compounds and particulate matter in the Kanawha Valley, WV{\textemdash}I. Methods and descriptive statistics. Atmospheric Environment, Part B: Urban Atmosphere 25(1):79-94.		
HERO ID:		659889		
Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	High	Sampling methodology description provided. Sites description, EPA’s mobile air-sampling van was used
	Metric 2:	Analytical Methodology	Medium	Some analytical methods not reported, such as recovery samples
	Metric 3:	Biomarker Selection	N/A	NA - Air samples
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	Kanawha Valley, West Virginia
	Metric 5:	Currency	Low	Data collected in 1987 and 1988
	Metric 6:	Spatial and Temporal Variability	High	Various set ups for different sampling sites, see Table 2 a and b for details: continuous parameters were reported as hourly averages for at least 15 days per month at each site. Twenty 12-h averaged measurements of particles and VOCs were made each month at the in-valley site.
	Metric 7:	Exposure Scenario	High	Outdoor air
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	No raw data reported
	Metric 9:	Quality Assurance	High	Analytical QA/QC methods provided, described and reported/summarized.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Medium	Few gaps and limitations reported
Overall Quality Determination			Medium	

Study Citation:		Loscutoff, W. V., Poore, M. V. (1993). Ambient air toxics data from California's toxic air contaminant monitoring program. :191-203.		
HERO ID:		666747		
Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	Medium	Methodology is briefly described as adaptation of NIOSH or other environmental methods. It's noted at CARB contracted with Batelle to QA/QC/evaluate sampling, analysis and quality control procedures of this study.
	Metric 2:	Analytical Methodology	Medium	LOD provided but methodology is briefly described as adaptation of NIOSH or other environmental methods. It's noted at CARB contracted with Batelle to QA/QC/evaluate sampling, analysis and quality control procedures of this study.
	Metric 3:	Biomarker Selection	N/A	Parent chemical only.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	California.
	Metric 5:	Currency	Low	1989-1990
	Metric 6:	Spatial and Temporal Variability	High	20 sites
	Metric 7:	Exposure Scenario	High	Ambient air exposure pathway
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	Raw data not provided, stats include min, max, mean and figures of trends
	Metric 9:	Quality Assurance	Medium	QA processes are discussed.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Medium	Discussed seasonality of sampling
Overall Quality Determination			Medium	

Study Citation:		Blount, B. C., Mcelprang, D. O., Chambers, D. M., Waterhouse, M. G., Squibb, K. S., Lakind, J. S. (2010). Methodology for collecting, storing, and analyzing human milk for volatile organic compounds. Journal of Environmental Monitoring 12(6):1265-1273.		
HERO ID:		737432		
Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	Medium	Breast milk sampling procedures and equipment described in detail as manual expression directly into pre-cleaned Vacutainer with immediate replacement of stopper following collection or manual expression into pre-cleaned wide-mouth glass jars with subsequent transfer to low headspace Vacutainer for storage and shipment. Samples stored at 4°C for less than two weeks prior to analysis for most samples. Insufficient information on number of samples expressed into Vacutainer versus those expressed into wide-mouth glass jars. Insufficient information on number of samples stored for longer than two weeks prior to analyses.
	Metric 2:	Analytical Methodology	Low	Method detection limit calculations described, however chemical-specific limits of detection not reported or referenced. Analytical and extraction methodology noted as modified from existing SPME-GC-MS methodology and referenced (Blount et al., 2006) and described in detail. Authors noted a full set of eight calibrators, including one blank, was analyzed with each set of samples to generate calibration curves for each analytical run. Authors report concentrations for the 10 of the 36 original chemicals with median concentrations higher than the lowest reportable level (LRL), but chemical-specific LRL’s and recoveries not reported.
	Metric 3:	Biomarker Selection	N/A	Sampling for parent chemical of interest.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	Samples collected from participants in Baltimore, MD.
	Metric 5:	Currency	Low	Insufficient information on dates of sample collection, 2010 publication date.
	Metric 6:	Spatial and Temporal Variability	Low	Single samples from 12 participating women for reported total of twelve samples from a convenience, non-statistical sampling approach at single time.
	Metric 7:	Exposure Scenario	Medium	Data likely represent relevant, non-occupational exposure scenario—authors note participants completed questionnaire, however insufficient information on whether data on occupation was collected.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Low	Median reported as below the lowest reportable level (LRL). Insufficient information regarding chemical-specific frequency of detection, dates of sampling, raw data and lipid-adjustment for breast milk samples.
	Metric 9:	Quality Assurance	Medium	Chemical-specific recoveries not detailed, however extensive details on quality control measures for sampling, extraction and analyses—characterized control human milk sample described as left exposed to room air while breast milk sample expressed with final sample concentrations corrected for the background air VOC levels derived from the control open-air sample. Each analysis batch described as evaluated at two blind QC-concentration levels and evaluated by an independent, blinded QC officer. Lab blanks utilized with blanks described as prepared from VOC-free blank water.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Medium	Study characterized sample variability in terms of concentration range, with detailed discussion regarding potential uncertainties derived from sampling, extraction and analysis procedures. Authors discussed differences in reported concentrations between this pilot study and previous reports, however additional potential limitations, such as sample size, not discussed (although this was noted as a pilot study).
Overall Quality Determination			Low	

Study Citation:		Great Lakes Chemical Corp, (1987). Exposure assessment for hazardous waste landfill with cover letter dated 072187.		
HERO ID:		1356178		
Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	Low	Sampling methodology not described, only briefly mentioned
	Metric 2:	Analytical Methodology	High	Analytical reports included in the appendix
	Metric 3:	Biomarker Selection	N/A	Biomarkers of interest were not addressed in this reference.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	El Dorado, AR
	Metric 5:	Currency	Low	1986
	Metric 6:	Spatial and Temporal Variability	Medium	7 waste samples analyzed along with air samples collected in the months of Jan-March (33 samples) and May 1985 (14 days). No replicates.
	Metric 7:	Exposure Scenario	High	Report characterizes facility and sources as well as nearby residential communities and explores various exposure pathways through different medias.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	Individual data points available for waste samples but only monthly averages and summaries available for air samples. No other statistics were used
	Metric 9:	Quality Assurance	Low	QA/QC was not mentioned but lab reports for analyses and air data from the Arkansas Dept of Pollution Control Ecology imply SOP and methods.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Low	Key limitations and data gaps not addressed.
Overall Quality Determination			Medium	

Study Citation:		Bi, E., Liu, Y., He, J., Wang, Z., Liu, F. (2012). Screening of emerging volatile organic contaminants in shallow groundwater in East China. Ground Water Monitoring and Remediation 32(1):53-58.		
HERO ID:		1488836		
Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	High	Sampling methodology and sites described.
	Metric 2:	Analytical Methodology	High	Analytical methods mentioned, described and briefly summarized.
	Metric 3:	Biomarker Selection	N/A	Ground water samples no biomarker needed.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	The study was conducted in China
	Metric 5:	Currency	Medium	The study took place in 2008 and 2009
	Metric 6:	Spatial and Temporal Variability	Medium	n=130 samples (from Table 2). No replicate samples.
	Metric 7:	Exposure Scenario	High	The data closely represent relevant exposure scenarios related to polluted ground water in China.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	Maximum concentrations reported, no raw data.
	Metric 9:	Quality Assurance	High	QA/QC was described, including MDLs and recoveries.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Low	Variability and uncertainty sources were not discussed or attributed to anything.
Overall Quality Determination			High	

Study Citation:		Westinghouse Savannah River Company, (1997). Sanitary landfill groundwater monitoring report. Fourth quarter 1996 and 1996 summary. 14(GRA and I):506.		
HERO ID:		1740826		
Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	Medium	Some sampling methods not reported such as sample storage conditions and sampler calibration
	Metric 2:	Analytical Methodology	High	Key analytical methods reported
	Metric 3:	Biomarker Selection	N/A	the study is testing for the parent chemical in an environmental media.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	USA
	Metric 5:	Currency	Low	Samples collected in 1996
	Metric 6:	Spatial and Temporal Variability	Medium	>10 samples; no replicates
	Metric 7:	Exposure Scenario	High	Exposure source characterized
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	High	Raw data reported
	Metric 9:	Quality Assurance	High	Key QA reported
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Low	Few gaps and limitations reported
Overall Quality Determination			Medium	

Study Citation:		Harkov, R., Kebbekus, B., Bozzelli, J. W. (1987). Volatile organic compounds at urban sites in New Jersey. :69-90.		
HERO ID:		1742362		
Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	Medium	Followed a sampling protocol and described the sample medium, flow rate, etc. Did not discuss sample storage
	Metric 2:	Analytical Methodology	Medium	Used GC with FID. Limits not provided.
	Metric 3:	Biomarker Selection	N/A	NA - air samples biomarker not needed.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	US
	Metric 5:	Currency	Low	1982
	Metric 6:	Spatial and Temporal Variability	Medium	>24 samples, multiple seasons.
	Metric 7:	Exposure Scenario	High	Described possible sources nearby.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Low	Only mean value provided.
	Metric 9:	Quality Assurance	Medium	QA QC discussed, although no specific recoveries provided.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Medium	No standard deviation but did assess variability.
Overall Quality Determination			Medium	

Study Citation:		Geraghty & Miller Inc, (1988). Results of the second phase of a hydrogeologic investigation at the Allied-Signal Inc facility, Morristown, New Jersey with cover letter dated 012089.		
HERO ID:		1745619		
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling Methodology	Critically Deficient	The study did not report storage conditions, sampling equipment or procedures.
	Metric 2:	Analytical Methodology	Low	The study did not describe analytical methods or reported LODs however it cited EPA Method 601.
	Metric 3:	Biomarker Selection	N/A	The study is testing for the parent chemical in an environmental media (water).
Domain 2: Representativeness	Metric 4:	Geographic Area	High	Geographic location is reported; New Jersey, USA.
	Metric 5:	Currency	Low	Timing of sample collection for monitoring data is not consistent with when current exposures (sampling occurred in 1987; >15 years old) may be expected and likely to have a substantial impact on results.
	Metric 6:	Spatial and Temporal Variability	Low	Sampling approach does not captures variability of environmental contamination in population/scenario/media of interest. The study used 20 samples and no replicates.
	Metric 7:	Exposure Scenario	Medium	The study did not provide details about the population of interest or exposure assessment.
Domain 3: Accessibility/Clarity	Metric 8:	Reporting of Results	Medium	Individual sample concentrations (raw data) reported but there is no summary statistics.
	Metric 9:	Quality Assurance	Medium	Limited description of QA/QC techniques.
Domain 4: Variability and Uncertainty	Metric 10:	Variability and Uncertainty	Low	Did not characterize variability, or discussed uncertainties and limitations.
Overall Quality Determination		Uninformative		

Study Citation:	Boillot, C., Bazin, C., Tissot-Guerraz, F., Droguet, J., Perraud, M., Cetre, J. C., Trepo, D., Perrodin, Y. (2008). Daily physicochemical, microbiological and ecotoxicological fluctuations of a hospital effluent according to technical and care activities. Science of the Total Environment 403(1-3):113-129.			
HERO ID:	1941262			
Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	High	Sampling described. Sampling was performed with several EPIC 1011 automatic samplers which were installed in parallel
	Metric 2:	Analytical Methodology	Low	The analytical instrument was provided in Table 1 for each chemical, but references to the standards were not in the reference section. Little description of QA/QC.
	Metric 3:	Biomarker Selection	N/A	Biomarkers of interest were not addressed in this reference.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	France
	Metric 5:	Currency	Low	Unclear because date is not in standard form. "The samples were taken from 06/04/12 at 1 p.m. to 06/04/13 at 1 pm." This seems to be Apr-12-2006 to Apr-13-2006
	Metric 6:	Spatial and Temporal Variability	Low	One 24 hour air sample and five samples of various time extents (5–9 a.m.; 9 a.m.–1 p.m.; 1–5 p.m.; 5–11 p.m. and 11 p.m.–5 a.m)
	Metric 7:	Exposure Scenario	Medium	This measured effluent from a hospital.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Low	Only one result from the average sample.
	Metric 9:	Quality Assurance	Low	Used a standard method so QC implied, but no info on QA procedures or results.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Low	The sample is a 24 average, so a little implied variability.
Overall Quality Determination			Low	

Study Citation:		Connecticut Dept Of Health, (1987). Laboratory reports on methyl tert-butyl ether from various locations with cover letter dated 090887. 8713368:#40-8713368.		
HERO ID:		2799717		
Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	Critically Deficient	Sample type reported, but no additional details.
	Metric 2:	Analytical Methodology	Critically Deficient	No methods described. Detection limit included.
	Metric 3:	Biomarker Selection	N/A	environmental samples
Domain 2: Representativeness				
	Metric 4:	Geographic Area	Critically Deficient	Probably U.S. but not stated.
	Metric 5:	Currency	Low	samples collected 1987
	Metric 6:	Spatial and Temporal Variability	Critically Deficient	Sample size not reported.
	Metric 7:	Exposure Scenario	Low	tap water
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	Individual sample reported.
	Metric 9:	Quality Assurance	Critically Deficient	No supporting text.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Critically Deficient	No supporting text.
Overall Quality Determination			Uninformative	

Study Citation:		Nikolaou, A. D., Golfinopoulos, G., Kostopoulou, M. N., Kolokythas, G. A., Lekkas, T. D. (2002). Determination of volatile organic compounds in surface waters and treated wastewater in Greece. Water Research 36(11):2883-2890.		
HERO ID:		2859218		
Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	High	Sampling was performed seasonally at 10 rivers, 2 sampling points in each river. Three sampling points were established in seawater areas. Samples were also collected from three municipal wastewater treatment plants and in wastewater from two industries.
	Metric 2:	Analytical Methodology	High	Samples were analyzed using a Hewlett Packard Purge and Trap Concentrator 7695 and a Hewlett Packard Gas Chromatograph 5890 Series II FMass Spectrometer HP 5971. QA/QC described, reported, including detection limits.
	Metric 3:	Biomarker Selection	N/A	NA - water samples no biomarker needed.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	Greece
	Metric 5:	Currency	Low	Data collected from October 1998 to September 1999
	Metric 6:	Spatial and Temporal Variability	High	Sampling was performed seasonally, from October 1998 to September 1999, at 10 rivers. Duplicate samples for VOCs measurement were collected (sample size is unclear).
	Metric 7:	Exposure Scenario	High	The data closely represent exposure scenarios from various water bodies in Greece.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	no raw data reported. Limited summary statistics were reported.
	Metric 9:	Quality Assurance	Medium	Some analytical QA reported in Table 2, missing information about blanks
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Low	Variability among locations was not addressed, only providing range of concentrations. Uncertainty sources were not identified.
Overall Quality Determination			Medium	

Study Citation:		Wallace, L., Zweidinger, R., Erickson, M., Cooper, S., Whitaker, D., Pellizzari, E. (1982). Monitoring individual exposure. Measurements of volatile organic compounds in breathing-zone air, drinking water, and exhaled breath. Environment International 8(1/6):269-282.		
HERO ID:		3227643		
Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	Medium	Sample storage and instrument calibration not detailed, but study site characteristics described as campus near-industrial site and non-industrial campus area with sampling conducted for 5-9 hour/day as participants had normal daily activities with spirometry conducted at end of day when returning personal air and drinking water samples; sampling equipment/procedures for personal exposure monitoring (MSA Model C-200 pump w/Tenax cartridge), drinking water and spirometry breath samples described.
	Metric 2:	Analytical Methodology	Medium	Instrument calibration not described, but analytical instrumentation (GC/MS) described and methodology referenced (unknown if standard, accepted methods); LOD's (Table 7) and recoveries (Table 3) detailed.
	Metric 3:	Biomarker Selection	High	The authors measured EDB as parent chemical in human breath.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	Lamar University campus near industrial site and UNC campus areas.
	Metric 5:	Currency	Low	March 4-5, 1980 (Lamar Univ) and June 10-11, 1980 (UNC)
	Metric 6:	Spatial and Temporal Variability	Low	Acceptable moderate sample size with 11 Lamar Univ samples and 6 UNC samples for personal air (5-9 hours for one day) and spirometry breath (single sample, for each of 11 Lamar Univ and 6 UNC participants), similar number with drinking water as samples provided for each time participant drank water during sampling day. Non-statistical sampling approach and no duplicate samples. Sampling conducted for one day for each participant.
	Metric 7:	Exposure Scenario	Medium	Exposure source/scenario described as industrial and non-industrial, field and laboratory blanks and controls described, however unable to distinguish between indoor/outdoor (ambient) sampling for breathing-zone personal air monitoring, indoor/ outdoor sampling scenario not described (building characteristics, climate, etc.), although questionnaire noting residence on/off campus, etc. administered to subjects.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	High	Raw data from each participant noted within Tables 7-8, summary data Tables 13-14 with range, percent detected, SD, mean and sample size.
	Metric 9:	Quality Assurance	Medium	No baseline pre-exposure samples, but field and lab controls and percent recoveries detailed.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Low	Key uncertainties and data gaps not discussed but variability characterized in summary statistics and limited discussion. Discussion of contribution to variance within regression modeling, and discrepancies between personal air monitoring and spirometry breath samples taken after personal air monitoring. Measurement of non-specific chemical isomers. Authors discuss need for additional studies to validate concentrations reported in various media.
Overall Quality Determination			Medium	

Study Citation:		Kingsbury, J. A., Delzer, G. C., Hopple, J. A. (2008). Anthropogenic organic compounds in source water of nine community water systems that withdraw from streams, 2002-2005. Scientific Investigations Report 2008-5208 :68.		
HERO ID:		3364193		
Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	High	The sampling methods followed standard USGS sampling protocols.
	Metric 2:	Analytical Methodology	Medium	Analyzed using USGS approved analytical methods, but recoveries and LOD were not reported.
	Metric 3:	Biomarker Selection	N/A	The authors analyzed water samples.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	Samples were collected in United States.
	Metric 5:	Currency	Medium	Samples were collected between 2002-2005.
	Metric 6:	Spatial and Temporal Variability	High	n=12-17 source-water samples collected at each site over 12-month period; variety of flow conditions; field blanks and replicates
	Metric 7:	Exposure Scenario	High	The data likely represent relevant exposure scenarios related to stream water collected prior to water treatment and then finished water tested at nine community water systems.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Low	Limited summary statistics were reported DF, n, max concentration reported in appendices.
	Metric 9:	Quality Assurance	High	QA/QC techniques were described in detail, including the use of field blanks and replicates.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Medium	Variability was not characterized. Section "Changes in Concentration" address uncertainties and need for additional information.
Overall Quality Determination			High	

Study Citation:		ICI Americas Inc, (1991). Letter from ICI Americas Inc to USEPA submitting follow-up information concerning phenol and other chemicals in groundwater at the facility in Hopewell, Virgina with attachments.		
HERO ID:		4214419		
Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	Critically Deficient	Sampling methods were not described
	Metric 2:	Analytical Methodology	Critically Deficient	Analytical methods were not described
	Metric 3:	Biomarker Selection	N/A	The authors analyzed environmental samples.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	Virginia, USA
	Metric 5:	Currency	Low	Sampling in 1990
	Metric 6:	Spatial and Temporal Variability	Critically Deficient	Sample size is not reported
	Metric 7:	Exposure Scenario	Low	Data lacks key pieces of information and this impacts the exposure scenario characterization
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	No summary statistics
	Metric 9:	Quality Assurance	Low	Analyzed control samples, did not describe QA/QC techniques
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Low	Did not characterize variability, did not discuss uncertainties or study limitations
Overall Quality Determination			Uninformative	

Study Citation:		Radian Corp, (1989). Monitoring near refineries for airborne chemicals on the Sara Title III Section 313 List - Volume I, validated ambient air concentration around 3 refineries - cover ltr dtd 041789. :0489-0687.		
HERO ID:		4214481		
Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	Medium	The sampling methodology is reported. Tables 2-5 report field QC.
	Metric 2:	Analytical Methodology	High	The analytical approach is reported in tables 3-5, including the limit of detection (LOD).
	Metric 3:	Biomarker Selection	N/A	This metric is not applicable to this study which sampled for the parent chemical in ambient air.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	Sampling was conducted in Louisiana, Kentucky and California, USA.
	Metric 5:	Currency	Low	The study was conducted in 1989.
	Metric 6:	Spatial and Temporal Variability	Critically Deficient	One 24-hour sample was taken per refinery.
	Metric 7:	Exposure Scenario	High	The exposure scenario for this study was adequately described as air contamination near 3 refineries.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Critically Deficient	The quality of the document prevents the reading of the results in tables 2-3.
	Metric 9:	Quality Assurance	High	QA/QC was described in section 4.0. Tables 4-3 to 4-7 report QA /QC results.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Low	Variability was depicted across different refineries.
Overall Quality Determination			Uninformative	

Study Citation:		Klick, S. (1993). The release of volatile halocarbons to seawater by untreated and heavy metal exposed samples of the brown seaweed <i>Fucus vesiculosus</i> . <i>Marine Chemistry</i> 42(3-4):211-221.		
HERO ID:		4973765		
Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	Medium	The study described the sampling of the seaweed in details. Study site information was not known. It's assumed that the seawater which was used as a culture medium was collected in the same condition.
	Metric 2:	Analytical Methodology	Low	Analytical method was mentioned (GC); however, no LOD or LOQ was provided.
	Metric 3:	Biomarker Selection	N/A	Environmental sampling
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	West coast of Sweden
	Metric 5:	Currency	Low	Sampling took place in 1991
	Metric 6:	Spatial and Temporal Variability	Low	The sample size of seawater was not certainly reported, but can be inferred from the sampling of seaweed.
	Metric 7:	Exposure Scenario	Low	The data likely represent the relevant exposure scenario but lacked sources of chemicals, potential exposure matrix.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	Individual data was not reported, but instead reported as average of the sum.
	Metric 9:	Quality Assurance	Low	Quality assurance/quality control techniques and results were not directly discussed, but can be implied through the study's use of standard field and laboratory protocols.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Medium	The study has some discussion of uncertainty and explored reasons for variability in data.
Overall Quality Determination			Low	

Study Citation:		Schall, C., Heumann, K. G., Demora, S., Lee, P. A. (1996). Biogenic brominated and iodinated organic compounds in ponds on the McMurdo Ice Shelf, Antarctica. Antarctic Science 8(1):45-48.		
HERO ID:		5424474		
Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	Medium	The water sampling methods were discussed with procedural details.
	Metric 2:	Analytical Methodology	Medium	Individual LOD not provided.
	Metric 3:	Biomarker Selection	N/A	Biomarkers of interest were not discussed in this reference.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	McMurdo Ice Shelf, Antarctica
	Metric 5:	Currency	Low	1994
	Metric 6:	Spatial and Temporal Variability	Medium	Six samples for about 8 days daily from each site.
	Metric 7:	Exposure Scenario	Medium	Meltwater in remote area.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	Range, avg, st. dev. of each site provided.
	Metric 9:	Quality Assurance	Low	No discussion.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Low	limited discussion.
Overall Quality Determination			Medium	

Study Citation:		Huang, Y., Su, T., Wang, L., Wang, N., Xue, Y., Dai, W., Lee, S. C., Cao, J., Ho, S. S. H. (2019). Evaluation and characterization of volatile air toxics indoors in a heavy polluted city of northwestern China in wintertime. Science of the Total Environment 662:470-480.		
HERO ID:		5431563		
Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	High	Field blanks were used. Storage temp provided. Equipment calibration and flow rates provided. Detailed sampling procedures in other publications (Spaulding et al., 1999; Ho et al., 2011).
	Metric 2:	Analytical Methodology	Medium	Details on method shown in Dai et al., 2012, but relatively robust description provided. Limits only provided as a range.
	Metric 3:	Biomarker Selection	N/A	Paper reports chemical concentrations in environmental media.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	China
	Metric 5:	Currency	High	2016-2017
	Metric 6:	Spatial and Temporal Variability	High	44 samples from 11 homes.
	Metric 7:	Exposure Scenario	High	Questionnaire provided details to characterize the building and activity patterns of occupants. No known pollution sources near buildings.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	High	Mean and sd in main report. Individual samples appear o have been provided in SI. Conducted source apportionment for indoor sources.
	Metric 9:	Quality Assurance	Medium	Calibration curve was established. Precision was <25%. Recoveries not discussed.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Medium	Variability assessed via factor analysis. No discussion of uncertainties.
Overall Quality Determination			High	

Study Citation:		Glass, R. L. (1996). Hydrologic and water-quality data for U.S. Coast Guard Support Center Kodiak, Alaska, 1987-89. :1-73.		
HERO ID:		5438106		
Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	High	Key sampling methods reported. Samples were collected according to publicly available SOPs that are scientifically sound and widely accepted (i.e., USEPA methods).
	Metric 2:	Analytical Methodology	High	Key sampling methods reported. Samples were collected according to publicly available SOPs that are scientifically sound and widely accepted (i.e., USEPA methods).
	Metric 3:	Biomarker Selection	N/A	The study is testing for the parent chemical in an environmental media (water).
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	Kodiak, Alaska
	Metric 5:	Currency	Low	Samples collected in 1987 to 1989
	Metric 6:	Spatial and Temporal Variability	High	Sampling approach accurately captures variability of environmental contamination in media of interest. Used large sample size (Large sample size (i.e., > 10 samples for a single scenario). Used replicates.
	Metric 7:	Exposure Scenario	Medium	Exposure source not well characterized
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	Supplementary or raw data (i.e., individual data points) are not reported , and therefore summary statistics cannot be reproduced.
	Metric 9:	Quality Assurance	High	Acceptable QA
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Low	Few gaps and limitations reported
Overall Quality Determination			Medium	

Study Citation:		Guimaraes, W. B. (1995). Water quality in the Withers Swash Basin, with emphasis on enteric bacteria, Myrtle Beach, South Carolina, 1991-93.		
HERO ID:		:1-102. 5438210		
Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	Medium	The water sampling methods were discussed but didn’t include procedure details. The authors cited previously published articles.
	Metric 2:	Analytical Methodology	Medium	The analytical methods were reported, including instrumentation, LOD but did not include recoveries.
	Metric 3:	Biomarker Selection	N/A	The authors analyzed water samples.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	The study was conducted in South Carolina, USA.
	Metric 5:	Currency	Low	The samples were taken in 1991 and 1992.
	Metric 6:	Spatial and Temporal Variability	High	n≥ 10 samples for a single scenario. The sample size was not explicitly reported but the results throughout the report suggest a large sample collection from 51 sites in total.
	Metric 7:	Exposure Scenario	Medium	The data likely represent relevant exposure scenarios related to water contamination in Withers Swash and its two tributaries in Myrtle Beach, S.C, USA.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	Only summary statistics were reported (median, min, max).
	Metric 9:	Quality Assurance	Low	QA/QC techniques were not discussed.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Medium	The authors provided a limited characterization of variability (range). Uncertainties and limitations were not discussed.
Overall Quality Determination			Medium	

Study Citation:		Heck, B. A., Myers, N. C., Hargadine, D. A. (1992). Hydrogeology and ground-water quality conditions at the Reno County Landfill, South-Central Kansas, 1990-91.		
HERO ID:		5438509		
Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	Medium	Some sampling methods not reported such as sampler calibration
	Metric 2:	Analytical Methodology	Low	LOD nor LOQ reported
	Metric 3:	Biomarker Selection	N/A	Biomarkers of interest were not addressed in this reference.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	Reno County, Kansas
	Metric 5:	Currency	Low	Data collected in 1991
	Metric 6:	Spatial and Temporal Variability	Medium	>10 samples; no replicates
	Metric 7:	Exposure Scenario	Medium	Exposure source not well characterized. Further investigation needed to determine usefulness of information.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	High	Raw data reported. Most summary statistics provided.
	Metric 9:	Quality Assurance	Low	Limited QA reported
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Medium	Few gaps and limitations reported
Overall Quality Determination			Medium	

Study Citation:		Sawhney, B. L. (1986). Why does a volatile pesticide, like EDB, persist in soils for years?. Frontiers in Plant Science 39(1):3-5.		
HERO ID:		5492344		
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling Methodology	Low	very limited sample methodology, just says soils were air dried and passed through a 2mm sieve. no mention of what container was used to collect, etc.
	Metric 2:	Analytical Methodology	Critically Deficient	no analytical methodology, no instrumentation mentioned
	Metric 3:	Biomarker Selection	N/A	no biomonitoring data
Domain 2: Representativeness	Metric 4:	Geographic Area	High	Connecticut, USA
	Metric 5:	Currency	Low	no sampling data, but publication year available
	Metric 6:	Spatial and Temporal Variability	Low	3 sites (one composite sample from 2 sites taken; 5 samples from 1 site taken)
	Metric 7:	Exposure Scenario	Medium	Soils and agricultural settings, previously fumigated soils.
Domain 3: Accessibility/Clarity	Metric 8:	Reporting of Results	Low	individual points not reported (there were 5 samples at one site but only range reported); no summary statistics for that one site
	Metric 9:	Quality Assurance	Critically Deficient	QA not discussed, no mention of study protocols
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Low	Sources or variability and uncertainty were not discussed.
Overall Quality Determination		Uninformative		

Study Citation:		Libbey, A. J., Jr (1986). Determination of ethylene dibromide in aquatic environments. Analyst 111(10):1221-1222.		
HERO ID:		5492929		
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling Methodology	Critically Deficient	sampling methodology from the well not discussed
	Metric 2:	Analytical Methodology	Low	this is a methods paper; detection limit provided but validation was based on samples from only one well
	Metric 3:	Biomarker Selection	N/A	no biomonitoring data
Domain 2: Representativeness	Metric 4:	Geographic Area	Critically Deficient	does not explicitly say where the well water was collected; reader can assume it's from Connecticut based on the intro
	Metric 5:	Currency	Low	no sampling date but publication date is available
	Metric 6:	Spatial and Temporal Variability	Critically Deficient	single sample - only one well (4 replicates) sampled - really no variability measured
	Metric 7:	Exposure Scenario	Low	Dissolved organics in sea water with very few additional details
Domain 3: Accessibility/Clarity	Metric 8:	Reporting of Results	Medium	mean, stdev, 95% CI reported; no individual data
	Metric 9:	Quality Assurance	Low	not much mentioned; does mention results from unspiked blanks
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Critically Deficient	one real world sample = no variability
Overall Quality Determination		Uninformative		

Study Citation:		Heikes, D. L. (1985). Purge and trap method for determination of ethylene dibromide in table-ready foods. Journal of the Association of Official Analytical Chemists 68(3):431-436.		
HERO ID:		5493125		
Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	Medium	Samples were table ready food items from a market basket study, not much information given on where the foods were purchased.
	Metric 2:	Analytical Methodology	Low	Did not see mention of detection or reporting limit for this new method.
	Metric 3:	Biomarker Selection	N/A	Metric is not applicable to the data source.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	Geographic area was not explicitly stated but since samples are from the Food and Drug Administration’s Total Diet Study, must be the U.S.
	Metric 5:	Currency	Low	No sampling date provided but publication date is available.
	Metric 6:	Spatial and Temporal Variability	Medium	Food types and purge and trap method in Table 1 had duplicates; n = 25.
	Metric 7:	Exposure Scenario	High	Exposure scenario applicable for background calculation.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	Table 1 reports the individual data points for the 25 table foods but no summary statistics are presented.
	Metric 9:	Quality Assurance	High	Reference had procedural blanks, recoveries between 91-104%.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Low	Reference compares to another method but no real discussion on variability between the different table foods (some discussion on difficulty of extraction from certain foods).
Overall Quality Determination			Medium	

Study Citation:		Rowe, B. L., Toccalino, P. L., Moran, M. J., Zogorski, J. S., Price, C. V. (2007). Occurrence and potential human-health relevance of volatile organic compounds in drinking water from domestic wells in the United States. Environmental Health Perspectives 115(11):1539-1546.		
HERO ID:		5553456		
Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	High	methods cited elsewhere for a USGS book on protocols and procedures
	Metric 2:	Analytical Methodology	High	MRLs reported in supporting info; method cites a USGS reference
	Metric 3:	Biomarker Selection	N/A	no biomonitoring data
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	Figure 2 shows the wells in the US
	Metric 5:	Currency	Low	1985-2002
	Metric 6:	Spatial and Temporal Variability	Medium	single sample collected at each well (no replicates)
	Metric 7:	Exposure Scenario	High	Domestic well throughout the USA.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	info likely in the supporting information
	Metric 9:	Quality Assurance	Medium	quality-control samples used in this study have been reported elsewhere (USGS references); unclear what was done exactly
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Low	study characterizes variability around the US based on samples collected in many states but no standard deviation/measure of variation mentioned (unclear if in SI)
Overall Quality Determination			Medium	

Study Citation:		Landmeyer, J. E., Campbell, B. G. (2014). Assessment of ethylene dibromide, dibromochloropropane, other volatile organic compounds, radium isotopes, radon, and inorganic compounds in groundwater and spring water from the Crouch Branch and McQueen Branch aquifers near McBee, South Carolina, 2010-2012.		
HERO ID:		5639273		
Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	High	USGS method
	Metric 2:	Analytical Methodology	High	USGS method
	Metric 3:	Biomarker Selection	N/A	NA- water samples no biomarker needed.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	SC, USA
	Metric 5:	Currency	Medium	2010-2011
	Metric 6:	Spatial and Temporal Variability	Medium	single samples over multiple years
	Metric 7:	Exposure Scenario	High	Ground water and spring water, for environmental and general population scenarios.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	only average
	Metric 9:	Quality Assurance	High	Analytical QA/QC was reported and is reliable.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Low	Sources or variability and uncertainly are not discussed.
Overall Quality Determination			High	

Study Citation:		Juhler, R. K., Felding, G. (2003). Monitoring methyl tertiary butyl ether (MTBE) and other organic micropollutants in groundwater: Results from the Danish national monitoring program. Water, Air, and Soil Pollution 149(1):145.		
HERO ID:		5679227		
Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	Low	Sampled under the Danish National Groundwater Monitoring program. Few sampling details provided.
	Metric 2:	Analytical Methodology	Low	Little info provided beside GC, although more info may be in the companion source (Apfalter 1999).
	Metric 3:	Biomarker Selection	N/A	NA - water samples no biomarker needed.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	Denmark
	Metric 5:	Currency	Low	Data from 1993 to 2001.
	Metric 6:	Spatial and Temporal Variability	Medium	1115 locations, but not sure if replicates. Samples collected over multiple years.
	Metric 7:	Exposure Scenario	Medium	Specifies that samples are from water supply wells, detailed description of locations and well info not provided.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Low	Only median and max provided.
	Metric 9:	Quality Assurance	Low	Not mentioned, but assumed since used govt protocols.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Low	No standard deviation.
Overall Quality Determination			Low	

Study Citation:		Midwest Research Institute, (1975). Sampling and analysis of selected toxic substances. Task II-ethylene dibromide.		
HERO ID:		5695461		
Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	Low	Sample site descriptions provided (temp and wind directions noted). Air sampling described in detail. Water sampling protocols were not well described
	Metric 2:	Analytical Methodology	Medium	Analytical procedures were proposed and tested before use in samples
	Metric 3:	Biomarker Selection	N/A	Sampling was conducted in environmental media
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	Various sampling sites across U.S.
	Metric 5:	Currency	Low	Sampling was conducted in 1975
	Metric 6:	Spatial and Temporal Variability	Low	Replicate sampling was not described
	Metric 7:	Exposure Scenario	High	Well described characterization of sample locations (industrial facility). Weather described.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Medium	No raw data reported.
	Metric 9:	Quality Assurance	Medium	Minimal info, although overall recovery provided.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Low	No discussion of variability or uncertainty of results
Overall Quality Determination			Medium	

Study Citation:		Shell Oil, (1994). Initial submission: letter from Shell Oil Co to USEPA reporting slow dissipation of ethylene dibromide following spill from its Belpre, Ohio plant into Ohio River dated 062494.		
HERO ID:		6353594		
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling Methodology	Critically Deficient	No sampling methodology reported.
	Metric 2:	Analytical Methodology	Critically Deficient	No analytical methodology reported.
	Metric 3:	Biomarker Selection	N/A	NA - water samples no biomarker needed.
Domain 2: Representativeness	Metric 4:	Geographic Area	High	Belpre, Ohio
	Metric 5:	Currency	Low	1994
	Metric 6:	Spatial and Temporal Variability	Critically Deficient	Sample size not reported.
	Metric 7:	Exposure Scenario	Low	The memo reports that sampling was conducted because of run-off from fire fighting water after a fire at the plant. No further details provided
Domain 3: Accessibility/Clarity	Metric 8:	Reporting of Results	Low	Range provided. Not other details provided.
	Metric 9:	Quality Assurance	Critically Deficient	QC not discussed.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Critically Deficient	Variability or uncertainty not discussed.
Overall Quality Determination		Uninformative		

Study Citation:		Kolhatkar, R. V., Luo, H., Berns, E. C., Gaule, C., Watterson, J. (2021). Evaluation of vapor intrusion risk from ethylene dibromide using the vertical screening distance approach. Ground Water Monitoring and Remediation 41(2):48-60.		
HERO ID:		7697510		
Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	Medium	Groundwater samples were collected according to establishedstate-specific sampling and analysis protocols, however, protocol names were not specifically stated. Soil-gas sampleswere collected using laboratory certified Summa® canistersat recommended sampling flow rates (<200 mL/min) incombination with appropriate leak detection protocol withhelium as a tracer compound (California EPA DTSC 2015;NJDEP 2018). Depth to groundwater was reported.
	Metric 2:	Analytical Methodology	Medium	Groundwater samples were shipped to the certified analytical labsfor analysis of EDB by U.S. EPA method 8011. The limit of detection was not explicitly stated for groundwater, but the minimum sample concentration was reported as <0.01 ug/L. Soil-gas samples were analyzed using a modified U.S. EPA method TO-15 high sensitivity/selectivity (TO-15 HSS) that could achieve a detection limit <0.16 µg/m3. It uses GC and a Time-of-Flight mass spectrometer (TOF-MS) to detect EDB. Additionalmethod details for HO-15 HSS are provided in Hayes andBenton (2018) and Eurofins (2019), but are not provided in this study.
	Metric 3:	Biomarker Selection	N/A	Analysis of TSCA chemical in environmental sample.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	Samples were collected from US sites in CA, NC, AK, SC, MI, PA, and Washington DC.
	Metric 5:	Currency	High	Field sampling events took place in 2017 and 2019.
	Metric 6:	Spatial and Temporal Variability	Medium	Number of samples was not clearly specified, but the number of groundwater and soil-gas data pairs was 57 for sites with groundwater concentrations above 0.18 ug/L and 46 for sites with groundwater concentrations below 0.18 ug/L. The total number of well locations was 13. Samples were collected in the second half of two different years from 6 different states and the District of Columbia.
	Metric 7:	Exposure Scenario	Medium	Eight petroleum UST sites with leaded gasoline releases were sampled. The sites had two types of vapor sources (LNAPL and dissolved phase) and three types of soils in the vadose zone. Information on the date of release, amount of release, or remediation efforts was not provided. No background samples were collected. The purpose of the study was not to assess exposure to a population but to use measured soil-gas data to assess vertical screening distances to EDB.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Low	Groundwater concentrations were provided as a range above and below a threshold. No raw data was provided.Soil-gas concentrations were not provided, only frequency of detection.
	Metric 9:	Quality Assurance	Low	Quality assurance was not discussed.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Low	The study characterized groundwater concentration by vapor source. No standard deviation was provided. Uncertainties were not discussed with respect to the monitoring data.
Overall Quality Determination			Medium	

Study Citation:		Hers, I., Wilson, J. T., Kolhatkar, R. V., Lahvis, M. A., Luo, E., Jourabchi, P. (2021). Field study of vertical screening distance criteria for vapor intrusion of ethylene dibromide. Ground Water Monitoring and Remediation 42(1):65-80.		
HERO ID:		10065927		
Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	Low	Minimal information was provided on sampling methodology for groundwater. Soil-gas sampling methodology was described in more depth. Figure 2 shows the location of the monitoring wells and soil vapor probes. The supplemental contains information on conditions at the site when samples were collected (depth to groundwater, groundwater flow direction, soil properties, etc.) and difficulties during sampling. No information was provided on sample storage conditions.
	Metric 2:	Analytical Methodology	Medium	Groundwater was analyzed using U.S. EPA Method 8260 (reporting limits of 0.5 to 1 μg/L). EDB was measured in soil gas samples using modified U.S. EPA Method TO-14, which is a GC method with electron capture detection (reporting limit of 0.16 ug/m3). Calibration and recoveries were discussed for soil-gas, but not for groundwater.
	Metric 3:	Biomarker Selection	N/A	Parent chemical in environmental media.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	The sampling site is located in Sobieski, Minnesota, USA (45.9244°N, 94.4592°W).
	Metric 5:	Currency	High	Samples were collected in July 2017 and March 2018.
	Metric 6:	Spatial and Temporal Variability	Low	Soil gas (depth-discrete) and groundwater were collected from areas with LNAPL in the capillary zone and areas with a plume of soluble components in groundwater. Single samples were collected at each of two time intervals, resulting in 10-14 soil gas samples and 4 groundwater samples per time interval for EDB.
	Metric 7:	Exposure Scenario	Low	The primary purpose of this study was to determine if vertical screening distances recommended by regulatory agencies at vapor instruction sites are applicable for EDB over the range of anticipated source concentrations and soil types at most sites. The field testing to support the study represents a single site with spillage of leaded gasoline from underground storage tanks. The specifics of the spill (amount, age, etc.) were not provided. As compared to 102 sites in an EPA survey in cooperation with Association of State and Territorial Solid Waste Management Officials, only 4 other sites had higher concentrations of EDB in groundwater than this site. As compared to 28 sites in the CA Geotracker Database, only 2 other sites had higher concentrations of EDB in groundwater than this site. Remediation at the site was not discussed in the paper, however, the UST was removed. It is not known if the site is under remediation at the time of sampling or not. Location of drinking water sources relative to the site was not discussed.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	Low	Data points were provided. No summary stats were provided except the maximum groundwater concentration.
	Metric 9:	Quality Assurance	Medium	QA/QC was discussed, but primarily for soil-gas and not groundwater. A matrix study with spiked soil-gas showed an EDB recovery of 93%. Field duplicates were with 20% of each other and trip blanks were non-detect. Co-elution and consequent mis-quantitation while possible was considered unlikely according to the study authors.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Low	The study only assessed a single UST site, but did collect samples at multiple time points and from multiple wells / soil bores at the site. No quantitative method of variability was used. Limitations were not discussed with respect to occurrence of EDB in the environmental media.
Overall Quality Determination			Low	

Study Citation:		CTEH, (2021). Shell Puget Sound Refinery 9-29-2020 flaring event: Supplemental report.		
HERO ID:		11273432		
Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	High	Sampling was completed using 1.4 L MiniCans(TM). Sample sites are also reported.
	Metric 2:	Analytical Methodology	High	Samples were analyzed via the USEPA Method TO-15 by a third-party analytical laboratory. Reported detection limit range is referenced in each sample results.
	Metric 3:	Biomarker Selection	N/A	The parent chemical was tested in ambient air.
Domain 2: Representativeness				
	Metric 4:	Geographic Area	High	Samples were collected in Anacortes, Washington, USA.
	Metric 5:	Currency	High	Samples were collected in October 2020.
	Metric 6:	Spatial and Temporal Variability	Medium	Six samples were collected for a 24h period
	Metric 7:	Exposure Scenario	High	This study measures air concentrations after a flare event at a refinery.
Domain 3: Accessibility/Clarity				
	Metric 8:	Reporting of Results	High	Individual data is reported in attachment B.
	Metric 9:	Quality Assurance	High	Attachment B reports a range of laboratory quality controls.
Domain 4: Variability and Uncertainty				
	Metric 10:	Variability and Uncertainty	Medium	Variability is not reported but the chemical data is all reported as ND, the study also reports qualifier of the results for uncertainty.
Overall Quality Determination			High	

Study Citation:		Bugher, N. A., Xiong, B., Gentles, R. I., Glist, L. D., Siegel, H. G., Johnson, N. P., Clark, C. J., Deziel, N. C., Saiers, J. E., Plata, D. L. (2024). Domestic groundwater wells in Appalachia show evidence of low-dose, complex mixtures of legacy pollutants. Environmental Science: Processes & Impacts 26(12):2250-2263.		
HERO ID:		12795200		
Domain		Metric	Rating	Comments
Domain 1: Reliability				
Metric 1:		Sampling Methodology	High	Wellheads were purged until pH, temperature, dissolved oxygen, and specific conductance readings stabilized and were collected in method-specific containers, as described in other sources including 1) Siegel et al 2022, 2) EPA Method 8015C: Nonhalogenated Organics by Gas Chromatography, 3) EPA Method 3510C: Separatory Funnel Liquid-Liquid Extraction, 1996, and 4) USGS, National Field Manual for the Collection of Water-Quality Data, 2018. While specifics were not provided, widely accepted USGS and EPA protocols were used. Samples were analyzed within two months following collection.
Metric 2:		Analytical Methodology	High	Water sample analysis followed EPA Method 8015C, EPA Method 3510C, and the USGS Field Manual. Quantification of VOC utilized purge and trap extraction (Teledyne Tekmar) paired with GC-FID. Authentic standards were used to confirm compound identities and calibrate the instrument following EPA-method specific requirements. Laboratory and field blanks were used for quality control. The method LOD was provided.
Metric 3:		Biomarker Selection	N/A	Analysis of TSCA chemical in environmental media.
Domain 2: Representativeness				
Metric 4:		Geographic Area	High	Samples collected in Appalachian region of Pennsylvania, Ohio, and West Virginia.
Metric 5:		Currency	High	Samples were collected between 2018 and 2020.
Metric 6:		Spatial and Temporal Variability	High	Samples were collected from 94 sites in Pennsylvania (primarily Bradford, PA), 162 sites in Ohio (primarily Belmont and Monroe Counties), and 56 sites in West Virginia (northeastern region); all areas which contain unconventional oil and gas (UOG) activities. It does not appear that multiple samples were collected from the same well, but multiple wells in the same region were sampled.
Metric 7:		Exposure Scenario	Medium	Domestic groundwater samples were collected in regions of extensive hydraulic fracturing activity, as well as other extractive and industrial technologies, in close proximity to communities reliant on private drinking water sources. The geology, environmental regulation, and legacy pollution of the three states in the study varied. No wells in areas outside of the hydraulic fracturing region were collected.
Domain 3: Accessibility/Clarity				
Metric 8:		Reporting of Results	Medium	Min, Max, Median, Mean, Standard Deviation, and % detection was provided for each state. Raw data points were not provided.
Metric 9:		Quality Assurance	Medium	Field and laboratory blanks were analyzed. VOC detection frequencies were less than 10%. However, field, laboratory, and/or storage recovery results were not reported.
Domain 4: Variability and Uncertainty				
Metric 10:		Variability and Uncertainty	High	Results were characterized with respect to locations of conventional and unconventional wells and superfund sites, and the number of compounds detected. Results were compared to those of national assessments. Measure of variance was provided.
Overall Quality Determination			High	

Study Citation:		Sawhney, B. L. (1986). Why does a volatile pesticide, like EDB, persist in soils for years?. Frontiers in Plant Science 39(1):3-5.		
HERO ID:		5492344		
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Sampling Methodology and Conditions	Low	limited description of sampling
	Metric 2:	Analytical Methodology	Critically Deficient	analysis method not provided or described
	Metric 3:	Biomarker Selection	N/A	Study is measuring chemical in environmental media.
Domain 2: Representative	Metric 4:	Testing Scenario	Low	The study sampled soil samples from a farm fields to try to remove EDB using physical methods and biological degradation. However, there is limited information about how the experiment was conducted, including amount of soil used and experimental conditions.
	Metric 5:	Sample Size and Variability	Critically Deficient	sample size for experiments not reported; could be single sample
	Metric 6:	Temporality	Critically Deficient	mentions "fresh" EDB added at time of testing but published in 1986
Domain 3: Accessibility/Clarity	Metric 7:	Reporting of Results	Critically Deficient	very limited quantitative data reported
	Metric 8:	Quality Assurance	Low	No mention of QA/QC
Domain 4: Variability and Uncertainty	Metric 9:	Variability and Uncertainty	Low	characterization of variability is absent
Overall Quality Determination		Uninformative		

Study Citation:		U.S. EPA, U.,S.G.S. and National Water Quality Monitoring Council (2022). Ethylene dibromide (EDB) (CAS RN: 106-93-4): WQP Output (NWIS, STEWARDS {\&} STORET), Site data {\&} sample results (physical/chemical metadata).		
HERO ID:		10709399		
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Sampling Methodology	Medium	Sampling methodology information is provided in columns AF to AJ, including the sampling method code and the equipment used. No information was provided on transportation or storage conditions for any sample. Note that for a large portion of the samples the sampling methodology was reported as "UNKNOWN".
	Metric 2:	Analytical Methodology	High	Description of the methods reported in column BQ and detection limit in column BY. A detection limit was not provided for all samples. While there is heterogeneity in the information provided, the confidence rating of high is based on the samples with the most complete data.
Domain 2: Representative	Metric 3:	Geographic Area	High	Column X reports the location identifier code. All samples are from the U.S. The station.xlsx file included as part of the HERO reference provides detailed information on the sites sampled. The information of each code can be found at https://waterdata.usgs.gov/nwis/si
	Metric 4:	Temporal	High	Data was collected from 1986 to 2023. The date is reported in column G.
	Metric 5:	Exposure Scenario	Medium	Media are reported in column E and F; location and time are also reported. The station.xlsx file included as part of the HERO reference provides, for some samples, more detailed information on the sites sampled, such as sample depth. There is no information provided on sources of chemicals.
Domain 3: Accessibility/Clarity	Metric 6:	Availability of Database and Supporting Documents	High	The database is widely accepted, and a user guide is available which describes all of the data fields.
	Metric 7:	Reporting Results	Medium	The database does not report summary of statistics, only point values. While the data are well organized, since the data originates from numerous different entities (states) and monitoring programs, some data may be difficult to interpret due to the lack of populated data fields or discrepancies between columns.
Domain 4: Variability and Uncertainty	Metric 8:	Variability and Uncertainty	Medium	Uncertainty is characterized by the inclusion of data qualifier column AR; however, it was not expected for all rows to have a data qualifier code. Column AS reports the results status identifier that indicates the acceptability of the result with respect to QA/QC criteria.
Overall Quality Determination			High	

Study Citation:		U.S. EPA, (2022). Ambient Monitoring Technology Information Center (AMTIC) - Ambient Monitoring Archive for HAPs.		
HERO ID:		11195094		
Domain		Metric	Rating	Comments
Domain 1: Reliability				
	Metric 1:	Sampling Methodology	High	Widely accepted sampling methodologies, the sampling frequency, duration, and description of sampling collection are reported in columns SAMPLING_FREQUENCY_CODE, DURATION_DESC, and SAMPLE_COLLECTION_DESC.
	Metric 2:	Analytical Methodology	High	Analytical methodology described at the SAMPLE_ANALYSIS_DESC column. A description of all the methods is reported in the compendium: https://www.epa.gov/amtic/compendium-methods-determination-toxic-organic-compounds-ambient-air .
Domain 2: Representative				
	Metric 3:	Geographic Area	High	Data was collected in the United States. Columns MONITOR_LATITUDE and MONITOR_LONGITUDE report the exact monitoring location.
	Metric 4:	Temporal	High	The database reports data from 1990-2020.
	Metric 5:	Exposure Scenario	High	The exposure scenario is the measurement of key hazardous air pollutants across cities, regions and specific areas of interest.
Domain 3: Accessibility/Clarity				
	Metric 6:	Availability of Database and Supporting Documents	High	The database is widely accepted, and guidance materials are available which describes all of the data fields.
	Metric 7:	Reporting Results	High	The database is organized, and key information is readily accessible. Raw data is provided in the output file, and a summary of statistics is presented here: https://www.epa.gov/system/files/documents/2022-10/AMA2020_annual.xlsx
Domain 4: Variability and Uncertainty				
	Metric 8:	Variability and Uncertainty	High	Variability reported in the annual statistics as variance of daily averages and percentiles. Uncertainty reported as data qualifiers.
Overall Quality Determination			High	

Study Citation:		ENSR, (1991). Letter from Texaco Refining and Marketing Inc to U.S. EPA submitting enclosed information and studies concerning several 8(d) chemicals with attachments.		
HERO ID:		1270201		
Domain	Metric		Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	The sources for modeling inputs cited in the footnotes of the data tables and modeling methods were outlined with equations, and the assumptions for predicted exposures were presented.
Domain 2: Representative	Metric 2:	Exposure Scenario	Medium	The exposure activity assessed likely represents the scenario of interest. Study limitations within exposure estimations were not directly discussed, however assumptions within the calculations were presented.
Domain 3: Accessibility/Clarity	Metric 3:	Documentation of References	Medium	References are available and provided, however some references may not be publicly available or may not be from peer reviewed sources.
Domain 4: Variability and Uncertainty	Metric 4:	Variability and Uncertainty	Low	Study characterization of variability within the population/media concentration data was lacking, however key assumptions in calculations were presented.
Overall Quality Determination			Medium	

Study Citation:		Radian Corp. (1991). Air toxic hot spots - AB 2588 health risk assessment (volume I {\&} II) (final reports) with attachments and cover letter dated 032991. 910000774:#86-910000774.		
HERO ID:		1356137		
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Modeling methodologies of ambient air concentrations from emissions data were presented with equations and model inputs, with assumptions and uncertainties reported and described.
Domain 2: Representative	Metric 2:	Exposure Scenario	Medium	Characterization of the population at risk through census tract, city data was presented, and temporality in risk data was calculated for 70-year lifetime. The range of dates for data used in emissions calculations was unclear.
Domain 3: Accessibility/Clarity	Metric 3:	Documentation of References	Medium	References are available and provided, however some references may not be publicly available or are not from peer reviewed sources.
Domain 4: Variability and Uncertainty	Metric 4:	Variability and Uncertainty	Low	The complete assessment provides a discussion of key uncertainties within the risk assessment, however it does not provide a measure of variance for modeled ambient air data results.
Overall Quality Determination		Medium		

Study Citation:		Radian Corp, (1991). Air toxic hot spots - AB 2588 health risk assessment - Shell Oil Company Martinez Refinery (volume I and II) with attachments, cover sheets and letter 040291. 910000771:#86-910000771.		
HERO ID:		1356138		
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	High	Modeling methodologies of ambient air concentrations from emissions data were presented with equations and model inputs, assumptions and uncertainties reported and described (page 8).
Domain 2: Representative	Metric 2:	Exposure Scenario	Medium	The population at risk was characterized through census tract and city data, and temporality within the risk data was calculated for a 70-year lifetime. The range of dates for data used in emissions calculations was unclear.
Domain 3: Accessibility/Clarity	Metric 3:	Documentation of References	Medium	References are available and provided, however some references may not be publicly available or are not from peer reviewed sources.
Domain 4: Variability and Uncertainty	Metric 4:	Variability and Uncertainty	High	The complete assessment provides a discussion and evaluation of key uncertainties and gaps in the risk assessment. It appears that a Monte Carlo simulation was conducted and SD and percentiles for risk estimates were calculated.
Overall Quality Determination			High	

Study Citation:		ENSR, (1991). Ab 2588 Health Risk Assessment for Kern River and Racetrack Oil Fields, Bakersfield, California with attachments and cover letter dated 090591.		
HERO ID:		1481756		
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Low	There is only a brief discussion of assumptions, extrapolations, measurements, and models, or some components may be missing. Model inputs for predicted concentration data described as reported in Appendix C-1, but Appendix C-1 data output column headings not clearly defined and modeling methodology unclear in text.
Domain 2: Representative	Metric 2:	Exposure Scenario	Low	Geographical area described in area maps and text, however text on characterization of potential exposure pathways and other sections missing.
Domain 3: Accessibility/Clarity	Metric 3:	Documentation of References	Low	Appendices are either not identified or missing, references lacking although risk assessment guideline sources identified in text.
Domain 4: Variability and Uncertainty	Metric 4:	Variability and Uncertainty	Low	Statistical characterization of variability is lacking. Limitations not discussed.
Overall Quality Determination			Low	

Study Citation:	ENSR, (1991). Acute ISC input data-full grid {\&} AB 2588 health risk assessments: Corrected {\&} alternative emissions cases for the Cymric area oil fields McKittrick, California with letter 090591.
HERO ID:	1481763

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Critically Deficient	The exposure assessment is described in section 3-2. Industrial Source Complex Short-Term (ISCST) dispersion model was used to predict concentrations. Receptor locations described in appendix F and modeling inputs in appendix D-1. However, not much information is presented about the methods, resulting in high uncertainty of the methods used.
Domain 2: Representative	Metric 2: Exposure Scenario	Low	The data may represent relevant exposure scenarios to chemicals of interest, but the lack of specific methodological details limits the potential generalization of the report findings.
Domain 3: Accessibility/Clarity	Metric 3: Documentation of References	Low	References are sparsely documented throughout the report and numerous references may not be publicly available or are not from peer reviewed sources.
Domain 4: Variability and Uncertainty	Metric 4: Variability and Uncertainty	Low	Variability was not characterized. Uncertainties and limitations were discussed (PDF p. 221)

Overall Quality Determination

Uninformative

Study Citation:		Radian Corp, (1991). Letter from Exxon Chemical Inc to USEPA submitting information concerning the California Assembly Bill 25588, the toxic hot spots information and assessment act of 1987 w-attachments.		
HERO ID:		1874145		
Domain		Metric	Rating	Comments
Domain 1: Reliability	Metric 1:	Methodology	Low	Some components of the modeling of ambient air concentrations were missing due to missing Appendices. Sample calculations for emissions by source data, used in calculating ambient air concentrations in Table 7, were presented in Appendix B-1 but the PDF is missing Appendix B. The ISCST and SHORTZ programs were used to predict air concentrations. It seems like details about the exposure assessment are cut off on page 6 of the PDF. Page 26 of the PDF gives details on the exposure assessment variables.
Domain 2: Representative	Metric 2:	Exposure Scenario	Medium	The exposure likely represents the population and scenario of interest. Risks were described as calculated for both the occupational site and the neighborhood around the facility. Characterization of the surrounding neighborhood population was not presented.
Domain 3: Accessibility/Clarity	Metric 3:	Documentation of References	Medium	References are available and provided, however some references may not be publicly available or are not from peer reviewed sources.
Domain 4: Variability and Uncertainty	Metric 4:	Variability and Uncertainty	Medium	The complete assessment provides a discussion of key uncertainties in the risk assessment. The study conducts probabilistic analysis to account for variability. No discussion of limitations was presented.
Overall Quality Determination			Medium	

Study Citation: ATSDR, (1994). Public health assessment for Otis Air National Guard Base/Camp Edwards, Falmouth, Barnstable County, Massachusetts, Region 1.**HERO ID:** MA2570024487. Final rept.
5451606

Domain	Metric	Rating	Comments
Domain 1: Reliability	Metric 1: Methodology	Critically Deficient	The study reports field data quality, laboratory data quality and sample design. However, no information reported on sample methodology and analytical methods.
Domain 2: Representative	Metric 2: Exposure Scenario	High	Health risk assessment for a surrounding community from a superfund site.
Domain 3: Accessibility/Clarity	Metric 3: Documentation of References	Medium	References are available for all reported data, inputs, and defaults; however, some references may not be publicly available or are not from peer reviewed sources. References for background concentrations, and comparison values for both cancerous and non-cancerous effects reported.
Domain 4: Variability and Uncertainty	Metric 4: Variability and Uncertainty	High	Variability reported in terms of different sites. Page 81 includes recommendations for future studies

Overall Quality Determination**Uninformative**

Study Citation:		ENSR, (1991). AB 2588 health risk assessment for the Texaco Refinery Areas 1 and 2 Bakersfield, California.		
HERO ID:		6338980		
Domain		Metric	Rating	Comments
Domain 1: Reliability		Metric 1: Methodology	Medium	The modeling (ISCST program) and methodology are described with calculations. However, some of the exposure assumptions and justifications are not fully explained.
Domain 2: Representative		Metric 2: Exposure Scenario	Low	The data may represent relevant exposure scenarios related to Texaco Inc. Bakersfield Refinery Areas 1 and 2 in Bakersfield, California. However, the lack of methodological details limits the validity of the assessment, and the assessment was conducted in 1962, 1963 and 1964.
Domain 3: Accessibility/Clarity		Metric 3: Documentation of References	Critically Deficient	The reported inputs are only sparsely documented and explained.
Domain 4: Variability and Uncertainty		Metric 4: Variability and Uncertainty	Medium	Variability was characterized by modeling 3 different years. Uncertainties were discussed.
Overall Quality Determination			Uninformative	

Study Citation:		Mckone, T. E. (1987). Human exposure to volatile organic compounds in household tap water: The indoor inhalation pathway. Environmental Science & Technology 21(12):1194-1201.		
HERO ID:		25108		
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Mathematical Equations	High	Modeled described in detail and equations provided for mass transfer/mass transfer coefficient equation, time-dependent concentrations for each compartment, air exchange parameters
	Metric 2:	Model Evaluation	Medium	Model outputs compared with measured results from other studies under similar scenarios/conditions and sensitivity analysis conducted
Domain 2: Representative	Metric 3:	Exposure Scenario	Medium	Exposure to chemicals in water while showering is a realistic current exposure scenario, but the study is from 1987
	Metric 4:	Model and Model Documentation Availability	Low	Most equations provided but PREMOD/MODAID software cited for concentrations is not free/publicly available
Domain 3: Accessibility/Clarity	Metric 5:	Model Inputs and Defaults	Medium	Inputs provided with citations or equations (eg Tables II and III) but data quality criteria not discussed
	Metric 6:	Variability and Uncertainty	High	Model applied to seven VOCs, discussion of differences between modeled/measured data, sensitivity analysis results, and uncertainties/variabilities of the model for future research
Overall Quality Determination		Medium		

Study Citation:		Ma, J., Li, H., Spiese, R., Wilson, J., Yan, G., Guo, S. (2016). Vapor intrusion risk of lead scavengers 1,2-dibromoethane (EDB) and 1,2-dichloroethane (DCA). Environmental Pollution 213:825-832.		
HERO ID:		3360329		
Domain	Metric	Rating	Comments	
Domain 1: Reliability	Metric 1:	Mathematical Equations	Low	No equations are provided, but the theory is described in general with citations.
	Metric 2:	Model Evaluation	High	References were provided for other peer-reviewed studies that use the model. Degradation rate results were compared to previous studies.
Domain 2: Representative	Metric 3:	Exposure Scenario	Medium	Model is intended to capture vapor intrusion at leaking underground storage tank sites, so may be relevant depending on geography and proximity to industrial sites.
Domain 3: Accessibility/Clarity	Metric 4:	Model and Model Documentation Availability	Low	Most model documentation is in the supplemental file or other cited studies.
	Metric 5:	Model Inputs and Defaults	High	All model inputs are detailed with references in the supplemental file, including a graphic of the modeled domain/house foundation size.
Domain 4: Variability and Uncertainty	Metric 6:	Variability and Uncertainty	Medium	Model applied to variety of soil types, degradation scenarios, and source depths.
Overall Quality Determination		Medium		

Glossary of Select Terms for Data Evaluation Tables

Table 51: Glossary of Select Terms for Data Evaluation

Term	Definition
AK	Alaska
ATSDR	Agency for Toxic Substances and Disease Registry
CA, USA	California
DF	Detection Frequency
ECD	Electron Capture Detector
EDB	Ethylene Dibromide
EPA	Environmental Protection Agency
FAQ	Frequently Asked Question
FDA	Food and Drug Administration
GC	Gas Chromatography
GSD	Geometric Standard Deviation
HPLC	High Performance Liquid Chromatography
ISCST	Industrial Source COMplex Short Term
KY	Kentucky
LA	Louisiana
LLE	Liquid LIquid Extraction
LOD	Limit of Detection
LOQ	Limit of Quantification
LRL	Lowest Reportable Level
MDL	Method Detection Limit
MS	Mass Spectrometry
n	Sample Size
N/A	Not Applicable
NC	North Carolina
NJ	New Jersey
OQD	Overall Quality Determination
P & T	Purge and Trap
PA	Pennsylvania
PM	Particulate Matter
QA/QC	Quality Assurance/Quality Control
SC	South Carolina
SD	Standard Deviation
TSCA	Toxic Substance Control Act
US or USA	United States of America
USGS	United States Geological Survey
VOC	Volatile Organic Compound
WTP	Water Treatment Plant
WWTP	Wastewater Treatment Plant